THE COMPLETE SWIMMING POOL REFERENCE
SECOND EDITION

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To William R. "Wild Bill" Campbell,
my mentor, who has already forgotten more about
swimming pools than I’ll ever know.

To Steve Shinholser, Founder of American Pool Service, and Premier Ponds,
my stellar student/athlete who taught me much
about diving, pools, ponds and life.

To my girls, Roni, Kendra, and Rachel,
And finally, to my father who passed away before seeing this second edition, and who I can still hear saying, “You can do it, Tommy!”
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This book combines technical aspects of pool operations manuals with practical information often found in water safety texts. The book is written for all those who own, operate, or otherwise work at swimming pools, including lifeguards, pool operators, pool managers, swimming coaches, diving coaches, swimming instructors, and even residential pool owners.

The Complete Swimming Pool Reference, Second Edition, is written clearly and concisely; even complicated topics are easy to understand. With 30 comprehensive chapters included, there is something for every aquatic professional. New chapters in the second edition include Chapter 6, Leisure Pool Filtration; Chapter 7, Improving Indoor Air Quality; Chapter 15, Recreational Water Illnesses; Chapter 19, Ponds; Chapter 20 Rethinking Pool Signage; Chapter 24, Psychological Aspects of Lifeguarding; Chapter 27, Emergency Action Plans; Chapter 29, Safe Handling of Swimming Pool Chemicals; and finally Chapter 30, Americans with Disabilities. Reviewing the latest information found in these newly added chapters should certainly place readers on the cutting edge of aquatic facility management and is of vital importance to today’s aquatic professionals. This work also includes a variety of references and resources to assist readers who wish to study a topic in more depth.
Introduction

Swimming attracts more than 125 million participants annually; this figure represents nearly half of the U.S. population. For years, swimming has been the most popular participant sport in the United States. Only walking has surpassed its popularity in recent years.

According to National Spa and Pool Institute estimates, there are nearly 10 million pools in this country. Six million are privately owned, residential pools. Homeowners maintain an additional three million hot tubs and spas. The number of public and semi-public pools in this country is approaching one million.

People frequent pools for a variety of reasons: fitness, relaxation, instruction, competition, and therapy. Today’s swimming facilities do not just accommodate lessons and lap swimmers but are multidimensional fitness centers encompassing all age groups.

During the writing of the first edition of this book in the early 1990s the drowning rate remained fairly constant, between 7,000 to 8,000 individuals a year. Fortunately, death by drowning was actually reduced to around 5,000 annually during the writing of the second edition of this book. Even though more and more Americans are being exposed to a growing number of aquatic facilities and activities, the fact that the drowning rate is actually decreasing bodes well for our water safety programs. Fortunately, only 10% of these drownings occur in swimming pools, but tragically almost half of these drownings involve small children. Some claim that nearly 500 drownings occur each year in guarded facilities.

Ironically, we build pools in this country to promote health, fitness, and safety, but several risks and hazards are produced with the construction of swimming facilities. This book can help maximize the health and safety benefits of aquatics while reducing hazards and risks. The second edition contains new and improved information on safe aquatic facilities and activities. Entrapments, Air Quality, Emergency Action Plans and RWI’s are some of the exciting new chapters. Safe, enjoyable, and clean swimming pools should result if the guidelines in this book are followed.

There are many good texts available that can assist the swimming pool owner, operator, or other employees. Some texts are technical and written primarily for swimming pool technicians who need precise information on pool chemistry and filtration. Concerning safety, the American Red Cross along with the YMCA, Ellis and Associates, and the Star Guard program, are the leaders on lifeguarding and water safety and produce excellent works on these subjects. Residential pool owners are often referred to pamphlets published by swimming pool chemical companies that are easy to follow and understand.

The Complete Swimming Pool Reference, second edition attempts to accomplish the formidable task of combining the most valuable elements of technical, practical, and water safety publications to produce a book that can be used by anyone in aquatics.

It is hoped that anyone associated with a pool, whether it be public or private, will find this book informative and helpful. The needs of homeowners, hotel/motel managers, park directors, pool operators, lifeguards, coaches, and parents are addressed. The Complete Swimming Pool Reference, second edition, includes many other references and resources that will allow the reader to gain additional information concerning pools and spas. All readers will benefit from this book, from professional pool technicians who service swimming facilities to homeowners who relax in their hot tubs.

How to Use this Book

The information presented in this book progresses from very simple ideas to more complex swimming pool issues. The novice pool owner or operator may wish to concentrate on the earlier sections before moving on to the filtration and chemistry chapters. Conversely, the experienced pool person may wish to skim the initial chapters and spend more time on the later sections in the book. Additionally, some readers will prefer to concentrate on the maintenance and operations sections of the book, while others may want to focus on the safety and human relations portions.

Before addressing each chapter, the reader should carefully read the key terms defined at the outset of each section. Reviewing the key terms will aid the reader in attending to the most critical aspects of each chapter. Appendix B contains a “Personal Pool Profile” that can be completed so the information read can be applied directly to the reader’s particular pool.
In addition to this book, there are several other valuable sources of swimming pool and water safety information. The American Red Cross, The Centers for Disease Control, Ellis and Associates, The U.S. Consumer Product Safety Commission, The National Pool and Spa Institute, National Swimming Pool Foundation, YMCA, and the National Recreation and Park Association are just a few organizations that can provide the reader with additional information on swimming pools and spas. Addresses and phone numbers can be found in Appendix.

Every pool owner and operator must understand fully the local health codes and ordinances that regulate swimming facilities in their region. This book is not intended to replace or supersede local swimming pool regulations; The Complete Swimming Pool Reference, second edition only serves as a general guide and helpful reference for those who own or operate swimming pools and spas. The reader must also understand that many state health codes regulating swimming pools are out of date. Much of what is found in these pages is more up to date.

(Photo courtesy of Water Technology, Inc.)
Section I

Pools

This initial section covers the basic physical components of swimming pools in very simple terms. Chapter 1 contains a brief, general description of swimming pools, including a classification of different types of pools to provide a basic overview that should be particularly helpful for novices. Topics introduced are circulation, pool configurations, construction materials, finishes, decking, and equipment. Safety, signage, and supervision are also introduced in this section, and chemical balancing is mentioned briefly. These topics are discussed in greater detail later in the book.

Chapter 2 specifically addresses the residential pool. This chapter is a comprehensive treatment of private pools, and the emphasis in this chapter is on safety. Layers of protection and pool barriers are important aspects of this chapter. This chapter is primarily written for homeowners who either have pools or are considering the construction of a pool on their premises. Additionally, residential pool service technicians might find this chapter helpful. Topics like filtration, circulation, and water chemistry will be presented in Sections II and III.

Chapter 3 discusses public pools in detail. Different types of pools are discussed, as well as construction materials and pool equipment. Ladders, lights, finishes, markers, barriers, programming, and security are covered in this section. Special considerations for outdoor pools are also discussed. Pool areas such as the entrance, locker rooms, first aid room, staff room, and concession areas are also included in this chapter. Chapters 1, 2, and 3 cover swimming pools in general terms, and Sections II through V contain specific, in-depth information regarding pools.

This book contains detailed information on all aspects of swimming pool safety and operations. The basics of swimming pools will be presented simply and clearly first, before they are discussed in depth. Regardless of what recommendations are made in this text, it is important to remember that they are general guidelines. Local swimming pool ordinances and health codes establish the standard of care in specific regions of this country but are often out of date and provide minimum standards only. Local ordinances and health codes should not be violated or ignored, but in some instances this text will recommend higher standards. Good common sense should not be overlooked and is also required for running a clean, safe pool.
On first glance a swimming pool appears to be a quiet, calm, and still body of water. A pool expert often refers to the perfectly calm pool as a “quiescent pool.” But in reality, whether busy or slow in terms of swimmers, a swimming pool is a dynamic system of moving water that continually flows from the pool for treatment and returns cleaned, heated, and sanitized. In fact, a pool is a recycling system whereby the entire volume of water passes through a filtration plant several times each day. As the water travels through the filter, it is cleaned of dirt and other organic debris. Before it returns to the pool, however, it is often heated and must be sanitized using a powerful chemical, most often chlorine. A clean, clear, germ-free pool requires tremendous attention. Large or small, every pool is required to filter and chemically treat its water through this process. When a pool is not filtering or there is an absence of chemical disinfectant in the water, the pool must be closed immediately. Without filtration and disinfection, the water will turn cloudy and bacteria will grow, thus becoming unsafe for all who enter.

Classifications of Swimming Pools

Public, semi-public, and private are three different ways of categorizing pools. For the purposes of this text, these classifications are defined as follows.

Public Pools

A public pool is usually a larger pool (more than 1800 square feet) that is owned or operated by some legal entity and is made available to anyone who pays a small entry fee. However, some public pools do not charge admission (Fig. 1-1).

Semi-public Pool

This pool is similar to the public pool but has specific entry restrictions like that of a fitness center, country club, or hotel/motel pool. Members must qualify and often pay to join before entry into the swimming complex.

Residential Pools

For the purposes of this text, residential pools are private pools that are not regulated by the health department or some other regulatory agency. Residential pools are not intended for commercial use and are not owned by more than three families. Specific dimensions are covered in Chapter 2. Public and semi-public pools are usually inspected by a health official, whereas residential pools are not.

There are further subclassifications of swimming pools, each of which fall under the public, semi-public, or...
residential categories. These include community and neighborhood pools, agency pools (YM/YW CAs, JCCs, Boy Scouts, Girl Scouts, etc.), school pools, hotel/motel/apartment/condo pools, water parks, and spa/hot tubs. Because of their popularity, residential, community, and hotel/motel/resort pools will be discussed in detail later in this text.

Circulation

Although all swimmers see the pool, few have the opportunity to become familiar with the pool’s plumbing. While this aspect of swimming may not be exciting to all pool owners and operators, an adequate understanding of filtration and chemical disinfection is a must if good, clean water is to be maintained. For the sake of discussion, a swimming pool plant functions like a closed loop system. Although swimming pools are not technically “closed loops” (most of the water stays in the system much of the time), they will be considered closed loops in this text for ease of understanding (Fig. 1-2).

To help understand how a swimming pool functions, one should consider how the human body works. The heart circulates blood in the body much the same way that a centrifugal pump recirculates swimming pool water. The kidneys remove toxic wastes from the blood just as filters remove debris from the pool water. Just as the veins and arteries carry blood to and from the heart, so do a series of influent and effluent pool pipes (Fig. 1-3). When we discuss water chemistry later in this book, you will learn that pool water can be either basic and scale-forming or aggressive and corrosive. Using the human body as an analogy once again, scale-forming water serves to block the pool’s plumbing like bad cholesterol blocks arteries. On the other hand, corrosive water eats away at the swimming pool plant in the same fashion that cancer deteriorates the human body.

More specifically, the basic components of a swimming pool and its circulation system include the following:
1. Vessel or swimming pool basin
2. Surge or balancing tank (in larger pools)
3. Pump
4. Hair and lint strainer (except on vacuum filters)
5. Filter or filters
6. Heater (if necessary)
7. Chemical disinfectant system

The water circulates by leaving the pool from outlets around the perimeter found in either surface gutters or skimmers. To a lesser extent, some water also leaves through the main drain or bottom outlet. The pool pump then either pushes or pulls the water through the filters. If necessary, the water is heated and then must be chemically treated before returning to the pool by way of inlets located on the pool bottom or pool walls. Typically, hundreds of gallons a minute flow through the filtration plant to be filtered, heated, and chemically treated during this process. Refer to Fig. 1-4 for a flow chart illustration of water circulation.

In addition to the pool and the filtration system, knowledgeable pool owners and operators should be familiar with different types of swimming pool construction, pool finishes, decking, accessories, and pool equipment.
Chapter 1

Fig. 1-2. Swimming pool circulation simplified: a closed loop.

Fig. 1-3. Swimming pool circulation is similar to the human body's circulation.

Fig. 1-4. Circulation components. (Illustrator, Nancy Bauer.)
Pool Configurations

When the first edition of The Complete Swimming Pool was published in 1994, most pools were either rectangular or square in shape. Today more and more pools are designed with free-form configurations and include amenities like waterfalls and walk-in, beach-like entries. Pools of tomorrow will be even more creatively constructed and will move even further away from the “boring rectangular” pool design of the past. This is a positive trend but it does make the discussion of pool configurations more challenging. When the word “traditional” is used in this text, it normally refers to older rectangular pools.

A variety of shapes and sizes of pools is available. After years of large pools being built to accommodate many different types of activities, pools are now being downsized for lap swimming, safety, and construction costs. Most pools have a shallow and a deep end, but a growing trend is to construct pools that are all shallow and have no deep water. Shallow water pools are less expensive to build and to operate. Typically, the shallow end of a swimming pool is approximately 3.5 feet deep.

However, many pools are being constructed today with zero-depth or beach-like entries. These types of pools are extremely popular, particularly with younger children and those with disabilities. Whenever possible, competition pools with starting blocks located in shallow water should be moved to the deep end. Headfirst entries must be prohibited from the pool deck in less than five feet of water, because 95% of all serious diving injuries occur in this depth. Many aquatic professionals are now recommending nine feet of water for headfirst entries from the pool deck. The deep end of the swimming pool ranges from 8 to 13 feet, although “diving” from a board should not be permitted into less than 11 feet. In public pools the preferred depth is 12.5 feet or adults may be seriously injured by striking the bottom. Springboard diving in this text does not refer to untrained, unsupervised recreational divers entering the water headfirst. Head first entries should be used instead of the term diving so as not to confuse this with the sport of competitive springboard diving.

Regardless of the type of pool, diving from a board should be permitted into a safe diving envelope only. According to the American Red Cross, a safe diving envelope is an underwater area that has adequate depth and distance to allow any diver to maneuver safely underwater without striking the bottom or slope of the pool. This important concept is discussed in greater detail in Chapter 16.

In traditional, older swimming pools, the straight, rectangular design is the most common, and when other shapes like T, Z, or L are observed, it is usually an attempt to entertain other activities in the pool without interfering with lap swimming or swim team practice. Creative pool designs are usually built with increased programming in mind (Fig 1-5). As mentioned earlier, free-form pools are becoming more popular today particularly in the case of leisure pools, waterparks and large, resort-type pools but more and more municipal pools are following the creative lead of waterparks to design family aquatic centers that have many similarities.

Diving Hopper or Spoon-Shaped Pools

Diving hoppers or spoon-shaped pools refer to the deepest section of the pool, which was constructed to accommodate diving. These are typically found in older, traditional swimming pools. To do this, a steep slope must be created between the shallow and deep areas of the pool (Fig 1-6). Although the American Red Cross addresses the dangers of diving in diving hoppers or spoon-shaped pools, the National Spa and Pool Institute (NSPI) makes little mention of these hazards. While this is one way of accommodating more than one activity in a rectangular-shaped pool, it does create some problems. The slope itself is problematic. Non-swimmers can slide down the slope into Fig. 1-5. Some standard swimming pool configurations. (From Gabrielson, M.: Swimming pools: A guide to their planning, design, and operation, Fourth Ed., Champaign, IL 1987, Human Kinetics.)
deeper water, and springboard divers can hit the slope with their heads following a dive. Black or red lines should be painted across the bottom of the pool to alert swimmers and divers of this slope. A surface line or life line should cross the pool on the surface to prevent novice swimmers from entering the diving area, but the presence of a life line does not guarantee safety of non-swimmers nor can it replace close supervision. While this is a common design for YMCA, high school, and even college pools, a separate diving well often provides more safety and greater programming options.

**Pool Construction**

There are two basic types of pool construction, above-ground and in-ground swimming pools. Above-ground pools are usually constructed with aluminum or galvanized panels, although a recent trend is toward inflatable rubber pools. Above-ground pools are much less expensive than in-ground pools and can be somewhat portable and temporary. Headfirst entries must be totally banned in above-ground pools.

Fig. 1-6. A, Top view of hopper-bottom pool. B, Cross-section of hopper-bottom pool. C, Top view of spoon-shaped pool. D, Cross-section of spoon-shaped pool. (From American Red Cross: Swimming and diving, St. Louis, 1992, Mosby.)
The Complete Swimming Pool Reference

In-ground pools are constructed of a variety of materials including different types of concrete, fiberglass, metal, vinyl, and even wood. In-ground pools are more expensive and permanent and in most cases, diving should be banned in these types of pools as well, unless they are built with competitive diving standards.

Pool Finishes

Regardless of what type of pool finish is selected, the color of the pool basin or finish should be white or at least lightly colored in almost all cases. A white underwater finish provides excellent visibility for safety and aesthetics. White pool basins full of water appear blue, although many naturalistic pools today are using dark bottoms. Outdoor pools using concrete will often have a plaster finish. Many indoor pools are finished with tile. Ceramic tile is the most versatile finish, but not surprisingly, it is also the most expensive. Residential pools are now using vinyl liners, which are both popular and reasonably priced. Vinyl liners can look like tile or plaster but are much less expensive. On the down side, vinyl liners can be torn or punctured. Stainless steel and fiberglass pools are also available. Of course, there are advantages and disadvantages of each pool finish selected.

Decking

Many different materials can be used for deck areas surrounding the pool. Whatever surface is used, however, it must be non-slip. Also, the deck must be a flat surface free of depressions or dimples that can collect water and must be sloped away from the pool for proper drainage. Puddles on the pool deck can attract algae, fungus and worse yet, mosquitoes that can spread the West Nile virus. Decks cluttered with furniture and other pool equipment can often obstruct views of the pool and create hazards. Some decking materials that work well include brick, tile, wood, flagstone, terrazzo, concrete, indoor/ outdoor carpeting, cocoa mat, flow-through tiles, and exposed aggregate concrete.

Please note that matting or carpeting often remains wet, thus promoting algae and fungi growth. Rubber, interlocking, self-draining deck tiles are becoming very popular, but they must also be cleaned regularly, and power washing these comes highly recommended.

Whatever the deck surface, it must be hosed down regularly to be debris-free, and care must also be taken to prevent algae from growing. Calcium hypochlorite (granular chlorine) works well in this application, as well as sodium hypochlorite (liquid chlorine).

Pool Equipment

Ladders, Steps, and Handrails

Ladders should be either recessed into the pool wall or should be the removable type. Ladders, handrails, and steps should not protrude into lap lanes to prevent accidents. Loose-fitting ladders should be repaired immediately. Ladders and handrails should be made of stainless steel or some other corrosion-resistant material. To prevent trips, slips, and falls, ladders and steps must have nonslip surfaces and the edges should be clearly marked with a contrasting color or colored tile. Ladders should be constructed and also be affixed to or found inside pool walls so that children cannot become entrapped between rungs when attempting to swim through them.

Diving Boards and Slides

Before either apparatus is installed, adequate depth must be determined for each piece of equipment. Smaller slides at public and residential pools should probably be reserved for children under 12 years of age, because older, larger individuals might discharge from the slide with too much force. Larger, water-park slides are designed for all ages. Regardless of the age of the slider or size of the slide, feet-first sliding is the only way to go. Headfirst sliding must be prohibited for all. Sliders must be certain that no other swimmers or sliders are in the discharge area.

Diving boards should be reserved for flat-bottom, deeper pools. Wherever possible, pools should be constructed to allow diving or sliding into a portion of the pool segregated from the general swim area or lap lanes. Rules and regulations concerning their use must be prominently posted. Many colorful playground-type slides are now being adapted for swimming pool use with great success. When it comes to drop slides, extra care must be taken to be certain that only swimmers use this type of slide because it discharges into water at least five feet deep. Non-swimmers must be kept away from these deeper water slides.
Chapter 1

**Signage, Safety, and Supervision**

Vigilant supervision is the key to swimming pool safety, regardless of the size of the pool or audience it attracts. Clear, concise signage prominently displayed is also a must. Water depths must be clearly marked both on the decks and on the pool walls. No diving and shallow water warnings must also be clearly displayed. Contrasting, colored letters and numbers must be at least four inches high but the bigger the better in most cases. Rules and regulations must also be displayed (see Appendix D2). Some signage experts strongly suggest using highway-type signs around the pool with contrasting colors like red and white, or yellow and black, which connote danger. Likewise, diamond- or octagonal-shaped signs may also convey danger. Pool signs similar to shapes and colors observed on our highways might be more recognized by swimmers and divers. International graphics should be used whenever possible, particularly in multicultural areas. Pool professionals continue to use the same signage that has been used for more than half a century. More creative signage is needed today, and the signage chapter has good suggestions for creative, clear, concise and conspicuous signage.

Whenever a hazard is created at the pool it should be repaired or removed immediately. Accidents at the pool are usually the result of a combination of irresponsible actions on the part of the pool patron, inadequate supervision, and a failure to warn. “Walk-abouts” during the early morning hours and the last thing in the evening can greatly reduce hazards and safety violations, but more and more risk managers suggest management checks as frequent as every 30 minutes at busy aquatic facilities.

**Water Chemistry**

The purpose of the disinfectant (usually chlorine, sometimes bromine) placed into the water is to keep the water germ-free and also clear for aesthetics and safety. Chlorine accomplishes this through sanitation (germ killing) and oxidation (burning up organic material). The immediate concern of any pool owner or operator is to keep appropriate disinfectant and pH levels in the pool. Although many pool patrons complain about excessive chlorine levels, most pools in this country are inadequately chlorinated. Malodorous, burning water comes from the spent form of chlorine called combined chlorine, not high levels of the active disinfectant called free chlorine. pH buffers the disinfectant and also relates to bather comfort.

In addition, the water must be balanced, which requires readings in temperature, total alkalinity, and calcium hardness (see Chapter 9) that many facility owners and operators unfortunately overlook. Balanced water not only keeps swimmers comfortable but also protects the pool shell, plumbing and all other related equipment from damage by aggressive or scale forming water.

pH and chlorine levels are the primary concern of the aquatic facility operator, who keeps the water healthy and comfortable for pool patrons, that is, user-friendly. Temperature, total alkalinity, and calcium hardness levels change more gradually, but must be monitored just the same.

As one’s understanding of basic water chemistry increases, water quality and clarity problems tend to decrease.

**Summary**

This chapter briefly describes and summarizes basic characteristics of swimming pools. Other more detailed information regarding pool basics may be found in the references listed. Pool shapes, sizes, construction materials, equipment, circulation, chemistry, and safety are introduced. Regardless of what type of pool is owned or operated (public, semi-public, or residential), local ordinances and regulations regarding swimming pools must be understood, followed, and wherever possible, surpassed. In addition, The National Spa and Pool Institute is a good resource for swimming pool publications and dealers; call (800)-359-SWIM.
Figure 1.7 Layers of Protection (Reprinted with permission from Pool and Spa News)
References

Bibliography

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