TECHNICAL BULLETIN

OCCUPATIONAL AND ENVIRONMENTAL HEALTH SWIMMING POOLS AND BATHING FACILITIES

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*This bulletin supersedes TB MED 575, 1 June 1982.

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CHAPTER 1

GENERAL

1–1. Purpose

This bulletin applies to all swimming pools, spas and hot tubs, and natural bathing facilities established and operated at Active Army, U.S. Army National Guard, U.S. Army Reserve, and Corps of Engineers (including civil works) facilities. It serves as a guide to Army preventive medicine (PVNTMED) personnel by—

a. Identifying diseases associated with swimming and bathing facilities that present a potential health concern.

b. Describing health and safety hazards encountered and the measures necessary for the protection of personnel using swimming and bathing facilities.

c. Providing basic information about fundamental swimming pool and spa and hot tub equipment and operations. Additional operation and maintenance information is available in technical manual (TM) 5–662.

d. Outlining a surveillance program for proper operations and sanitary conditions at swimming and bathing facilities.

1–2. References

Appendix A provides a list of references and a selected bibliography.

1–3. Abbreviations and terms

The glossary provides a list of abbreviations and terms used in this bulletin. Refer to TM 5–662 for additional definitions.

1–4. Procedures

AR 40–5, paragraph 12–6, provides the responsibilities of installation PVNTMED personnel related to safe and sanitary operation of Army swimming facilities. To fulfill these responsibilities, use the following specific procedures:

a. The installation medical authority (IMA) ensures safe and healthful swimming and bathing facilities by—

(1) Maintaining information regarding engineering and operational features.

(2) Determining that operators and lifeguards are properly trained in the sanitary operation of the facility.

(3) Performing pre-opening inspections.

(4) Conducting pool water bacteriological and chemical surveillance.

(5) Providing technical reviews prior to renovations or new construction.

(6) Performing routine inspections or surveys.

b. Additional installation personnel typically involved in the management and operation of swimming and bathing facilities may refer to appendix B for a listing of their major procedures. This may vary according to local policy. Each activity at the local level maintains liaison with others to ensure swimming and bathing facilities operate properly.

CHAPTER 2

HEALTH AND DISEASE CONSIDERATIONS OF SWIMMING POOLS, SPAS AND HOT TUBS, AND NATURAL BATHING AREAS

2–1. General

a. Army swimming and bathing facilities provide recreational, physical therapy, and training opportunities for soldiers and their families. Proper operation and maintenance of these facilities, in accordance with the requirements of this bulletin and TM 5–662, will allow users to realize these benefits.

b. Individuals using these facilities must be protected from the transmission of disease.

(1) Current epidemiological evidence indicates that well-constructed, operated, and maintained swimming and bathing facilities are not major public health problems. However, facilities operated without adequate regard for proper sanitary control and safety can and have resulted in the spread of disease, injury, and death.

(2) Vigilance by all personnel involved in the operation, maintenance, and sanitary control of swimming and bathing facilities is necessary to prevent disease outbreaks and injuries, and to maintain these facilities for their intended purpose.

c. Diseases associated with swimming and bathing facilities are classified into the following broad categories:

(1) Gastrointestinal disease.
(2) Respiratory diseases.
(3) Diseases of the eye, ear, nose, and throat.
(4) Infections of the skin.

d. Disease transmission hazards are greatest among swimmers in the fresh water found in swimming pools because they tend to ingest more water than swimmers in the brackish estuarine water and saline water of the open seas.

2–2. Diseases of concern associated with swimming pools and spas and hot tubs

a. If a swimming pool is inadequately disinfected, all of the common waterborne diseases spread by ingestion, plus several other diseases, may be spread. The importance of the sanitary quality of the pool water cannot be overemphasized. Pathogenic microorganisms that pose a threat to swimmers or bathers in pools and spas and hot tubs are shown in table 2–1.

b. No scientific evidence is available that indicates acquired immune deficiency syndrome (AIDS) can be transmitted in a pool or spa or hot tub.

2–3. Diseases of concern associated with natural bathing areas

a. Background. Natural bathing areas are unique because of the many influences on the quality of the water, including wild animals, plants, sewage outfalls, and storm runoff.

(1) Early epidemiological studies associated gastrointestinal illness with swimming in sewage-contaminated water. For instance, typhoid fever and nonspecific enteritis were shown in some of these studies to be statistically related to swimming in water where raw sewage was discharged. In more recent epidemiological studies, swimming in natural bodies of water was found to be associated with outbreaks of shigellosis, salmonellosis, and viral infections caused by Coxsackie A16 and B viruses, hepatitis A virus, and Norwalk agent virus.

(2) From 1948 through 1950, epidemiological studies were conducted by the U.S. Public Health Service to determine specifically what, if any, relationship exists between the water quality of natural bathing areas and the illnesses of bathers. These inconclusive studies tended to show that a higher incidence of disease (including gastroenteritis, respiratory disease, and infections of the eyes, ears, nose, and throat) was associated with swimming in water of poor bacterial quality.

(3) More recently, the U.S. Environmental Protection Agency (EPA) undertook some epidemiological studies to gain a better insight into the public health problems associated with swimming in natural bathing areas. These studies showed that, in general, high gastrointestinal illness rates of swimmers were associated with high densities of fecal bacteria, that is, Escherichia coli (E. coli) and enterococci. Density values for total coliform bacteria showed little or no correlation with illness. These studies resulted in the proposal of new bacteriological standards for recreational waters (See para 10–2).

b. Natural bathing area diseases. Table 2–2 shows diseases associated with swimming in natural bathing areas.

Table 2–1. Diseases of concern associated with swimming pools and spas and hot tubs

Diseases	Sources	Characteristics	Symptoms
1. Giardiasis	*Giardia lamblia*; infected swimmers, usually young children, who contaminate the water through a bowel movement	Gastrointestinal illness	Diarrhea, cramps
2. Otitis externa	*Pseudomonas aeruginosa* and various species of staphlococci; swimming pools with little or no disinfection	Very common infection; also called "swimmer's ear"	Itching, pain, and discharge of the ear
3. Swimming pool granuloma or daphne sore	*Mycobacterium marinum (balnei)*; a skin abrasion creates a portal of entry for the organism	Associated with concrete, gunite (spray concrete), or masonry pools; sites of infection tend to be knees and elbows from contact with rough surface of the pool shell	Nodules on the skin that may ulcerate
4. Genital herpes	Herpes simplex virus (HSV); is not transmitted in water *but* can survive on plastic surfaces of a spa or hot tub	Contact with warm, moist environmental surfaces may lead to transmission; as a preventive measure, nude persons should sit on clean, dry towels when lounging around spas or hot tubs	Genital lesions
5. Follicular dermatitis	*Pseudomonas aeruginosa*; rash is related to spa and hot tub use	Common sites of lesions are buttocks, hips, and trunk	Rash, itching
6. Pontiac fever	*Legionella pneumophila* serotype 6; can be transmitted by aerosols generated by the agitation of spa and hot tub water	Respiratory disease; self-limiting	Fever, chills, malaise, and headache

Table 2–2. Diseases of concern associated with natural bathing areas

Diseases	Sources	Characteristics	Symptoms
1. Leptospirosis	*Leptospira interrogan*; water contaminated with urine from infected animals such as rats, swine, and cattle	Generally found in fresh water	Fever, chills, and headache
2. Giardiasis	*Giardia lamblia*; in the intestinal tracts of mammals such as beavers and foxes living near bathing area	Gastrointestinal illness; generally found in fresh water	Diarrhea, cramps
3. Schistosome dermatitis, known as "swimmer's itch" or "water rash"	Larvae of certain trematode worms of birds and mammals penetrate the skin	Common to fresh water lakes in northcentral U.S.; can be prevented by limiting exposure to infected water to less than 30 mins, followed by vigorous towel drying particularly between fingers and toes	Dermatitis characterized by skin eruptions
4. Primary amoebic meningoencephalitis (PAM)	*Naegleria fowleri*; a free-swimming amoeba associated with warm natural bodies of water	Common to southern U.S., a parasitic disease untreatable with antiparasitic agents, antibiotics, and antimetabolites	Severe headache, fever, death
5. Schistosomiasis, also known as bilharziasis	*Schistosoma mansoni* (blood flukes); snails act as intermediate hosts for the cercariae, a larval form of the fluke; also found in parasite-infected drinking water	Serious public health disease found in fresh or mildly brackish water of tropical and semitropical areas such as Puerto Rico, the Philippines, the Middle East, Asia, and Africa (not found in marine environment)	Diarrhea, abdominal pain; liver and urinary disorders

CHAPTER 3

SAFETY CONSIDERATIONS OF SWIMMING POOLS

3–1. General

Considering the number of people using swimming pools each year, the swimming pool accident rate is low. In general, swimming pools are the safest place for people to swim; however, investigations of swimming pool injuries and drownings indicate that most could have been prevented by taking simple precautions.

3–2. Drowning

a. Lack of adequate supervision contributes to many drownings in swimming pools. Most of the accidental drownings that occur in swimming pools involve children under 5 years of age, often because there was no fence or barrier to prevent intrusion. Some drownings have been traced to improper design, faulty equipment, swimming alone, and, in some instances, the misconduct of swimmers themselves.

b. Some soldiers may not be accomplished swimmers. Therefore, it is important for a person to either receive survival swimming training in accordance with Training Circular (TC) No. 21–21 or swim only when accompanied by an able swimmer, in approved locations where qualified lifeguards are on duty. If not mandated, survival swimming training is highly encouraged for those units whose mission requires exposure to water hazards. Swimming should occur only in approved locations during daylight hours or at adequately lit facilities. Paragraph 6–29c contains additional information on survival swimming training.

3–3. Swimming pool injuries

a. Recent studies have shown that the leading causes of pool injuries are—

(1) Striking the bottom or side of the swimming pool when diving into water that is too shallow.

(2) Using a swimming pool slide.

(3) Hitting objects in the pool such as protruding waterpipes and ladders.

b. Other common factors identified as leading to swimming pool injuries are—

(1) No qualified person was supervising the swimming pool area.

(2) No signs were posted warning of potential dangers.

(3) Depth markers were absent or improperly placed or marked.

c. An analysis of persons who received spinal cord injuries from diving or sliding into a swimming pool head first noted that the victim is usually an 18 to 20 year old male, 6 feet (ft) (1.8 meters (m)) tall, over 175 pounds (79 kilograms (kg)), without formal diving training. This profile should be publicized to make young soldiers particularly wary of the dangers that exist.

d. Alcohol is incompatible with safe swimming. Use of alcohol increases risk of injury. Limit the use of alcohol at swimming pools.

CHAPTER 4

SAFETY CONSIDERATIONS OF SPAS AND HOT TUBS

4–1. General

An increasing number of injuries, some very serious, and a significant number of deaths involve spas and hot tubs. Studies conducted or sponsored by the U.S. Consumer Product Safety Commission identify some of the causes of these injuries and deaths as—

a. Improper drain covers (for example, broken or missing) causing people to be trapped by the suction force of the water.

b. A person slipping or falling while entering or leaving a spa or hot tub.

4–2. Water temperature of spas and hot tubs

a. The temperature of the water in spas and hot tubs can cause injury or even death. Maintain spas and hot tubs at or below 98 degrees Fahrenheit (°F) (36.7 degrees Centigrade (°C)), as there are no physiological benefits to operating at temperatures above this value.

b. When a person is submerged shoulder-deep in the water within a spa or hot tub, only the head, neck, and upper portions of the shoulders are available to dissipate the heat generated by body metabolism. If the deep body temperature reaches or exceeds 104°F (40°C), serious health consequences may result.

c. Evidence now exists that exposure to the elevated temperatures of a spa or hot tub can have a damaging effect to the developing fetus. Therefore, pregnant women should not use spas or hot tubs. Post a sign at the spa or hot tub to warn pregnant women of the potential hazard.

d. Persons using spas or hot tubs with high water temperatures may experience drowsiness, followed by unconsciousness and possible drowning. Because alcohol also relaxes the bather, the risk of drowning in a spa or hot tub is heightened significantly if alcoholic beverages are consumed before or during spa or hot tub use.

CHAPTER 5

SAFETY CONSIDERATIONS OF NATURAL BATHING AREAS

5–1. General

Safety at natural bathing facilities depends upon bathers being able to swim and to take care of themselves under ordinary conditions, and to recognize and avoid hazardous water conditions and practices.

5–2. Guidelines for safe natural bathing areas

a. To provide a reasonably safe natural bathing area—

(1) Promote the prevention of accidents and injuries.

(2) Supervise the swimmers.

(3) Have suitable rescue equipment readily available.

(4) Maintain the quality of the water to nonhazardous levels of chemical and biological contaminants.

b. The bottom of the natural bathing area should—

(1) Slope gently and uniformly toward deep water.

(2) Have no holes or sudden step-offs.

(3) Be free of hidden or submerged obstructions such as rocks, stumps, snags, and sunken logs.

(4) Be composed of firm sand, small-sized gravel, or shale.

(5) Have no silt, quicksand, shell patches, sharp and broken rock, or debris in depths of 5 ft (1.5 m) or less.

c. Clearly define and mark swimming areas for various classes of swimmers.

d. Permit no watercraft in the swimming areas other than those used for lifesaving.

e. Mark the outermost limits of swimming areas at regular intervals with buoys, or similar devices, bearing signs warning all watercraft to keep out.

f. Post signs on offshore floats or rafts indicating whether or not diving is permitted.

g. Post signs at marine bathing beaches to warn swimmers or bathers of the possible presence of harmful aquatic life such as jellyfish. Of particular concern is the Portuguese man-of-war, a jellyfish that floats on the surface of tropical seas and the Gulf Stream. The Portuguese man-of-war is not a single animal, but a group of animals attached to a hollow float that looks like a bladder. Hanging from the float are poisonous tentacles used for grasping food. Swimmers or bathers touching the tentacles may experience painful welts or go into shock and prostration that may be fatal.

h. Keep beach areas clean and well raked at all times.

i. Prohibit picnicking on the beach proper.

j. Prohibit bottles and cans for food and drink on the beach proper.

k. Designate picnic areas near the beach and provide proper waste receptacles.

5–3. Supervision of swimmers at natural bathing areas

To effectively supervise all persons using organized bathing beaches—

a. Provide lifeguards who are trained to control swimming activities and respond to emergencies. At a minimum, assign one lifeguard to every 200 ft (61 m) of beach.

b. Isolate lifeguards from the swimmers by using towers, stands, or elevated chairs to minimize distractions and provide a better view of the water areas.

c. Position a lifeguard in a boat near the outer portion of large bathing areas.

CHAPTER 6

DESIGN STANDARDS FOR SWIMMING POOLS AND SPAS AND HOT TUBS

Section I. TYPE AND LOCATION OF POOLS AND SPAS AND HOT TUBS

6–1. Recirculation swimming pool with filters

The only type of swimming pool approved for new construction is a recirculation swimming pool with filters. In this type of swimming pool—

a. Water is continuously withdrawn, filtered, disinfected, and returned to the swimming pool.

b. Adjustment of chemical characteristics (for example, hydrogen-ion concentration (pH) adjustment) may be performed.

c. Inlets and outlets are installed in the swimming pool shell to prevent "dead spots," areas of poor circulation.

6–2. Wading pools

a. A wading pool is intended to be used by children and supervising adults. The probability of infection from wading pools is greater than that from swimming or spray pools because young children are more likely than adults to contaminate and ingest the bathing water.

b. In some instances, the wading pools are independently operated, but in most cases, they are located within the swimming facility.

c. Wading pools should be—

(1) No deeper than 24 inches (in.) (61 centimeters (cm)).

(2) Constructed of the same material as all-purpose pools.

(3) Provided with a continuous flow of treated water for a complete change of water every 2 hours.

(4) Separated from the shallow area of adjacent swimming pools by a minimum deck width of 6 ft (1.8 m).

(5) Controlled so that no water is discharged into adjacent swimming pools.

d. Extend an open overflow completely around the wading pool, and either return the water to the filter system or drain it through an air gap to a sanitary sewer. Treatment may be in conjunction with an all-purpose swimming pool. In either case, supply an adequate quantity of water to the wading pool to provide the necessary turnover.

6–3. Spray pools

a. A spray pool is primarily used by children. In some instances, the spray pool may be independently operated, but in most cases, it is located within the swimming facility.

b. In spray pools, treated water is sprayed into a pool and then drained or recycled into a filtration system. Unlike a wading pool, potentially contaminated water is not allowed to accumulate and, therefore, a spray pool is easier to control from a sanitary perspective. Improperly designed wading pools can be converted to spray pools so they can be operated in a sanitary manner.

c. As is the case with wading pools, separate spray pools from adjacent swimming pools and do not discharge water from a spray pool into a swimming pool.

6–4. Flow-through swimming pools

a. In flow-through swimming pools, a continuous supply of fresh or chlorinated water enters at one end of the pool and an equal amount of used water flows out the other end. Sanitary control is exercised by—

(1) Chlorinating the inflowing water.

(2) Regulating the quantity of water flowing through.

(3) Limiting the number of swimmers.

b. Flow-through pools are not approved for new construction since there is very limited control over the quality of water in the swimming pool.

6–5. Fill and draw swimming pools

It is difficult to maintain fill and draw pools in good sanitary condition, so they are NO LONGER AUTHORIZED FOR USE. These swimming pools are filled, used until the water is dirty, then emptied and refilled with clean water. Although some fill and draw pools are equipped to recirculate a small portion of the water for chlorination, do not confuse them with recirculating filter pools (para 6–1).

6–6. Spas and hot tubs

Spas and hot tubs are basins, chambers, or tanks of heated water designed for recreational use and physiological and psychological relaxation.

a. Spas, also called whirlpools or Jacuzzis®,[1] are—

(1) Made of cement, tile, plastic, or fiberglass.

(2) Shallow in depth.

(3) Of varying sizes and capacities to accommodate one or several persons at one time.

(4) Equipped with a recirculation system including filters, water heating devices, disinfectant feeders, and chemical feeders for pH adjustment.

(5) Sometimes equipped with water jets or bubblers for underwater massage.

b. Hot tubs are similar to spas, but they are usually made of wood and may not have underwater jets or bubblers.

c. A spa or hot tub may be located in the same room or area with a swimming pool, but not in the same area with a wading or spray pool. If the spa or hot tub is located in the same room or area with the swimming pool—

(1) Do not directly connect or physically attach the spa or hot tub to the swimming pool.

(2) Do not discharge any water from the spa or hot tub into the swimming pool.

[1] ®Jacuzzi is a registered trademark of Jacuzzi Whirlpool Bath (of Kidde Inc.), Drawer J., Walnut Creek, CA 94596.

Section II. DESIGN AND CONSTRUCTION DETAILS

6–7. Review of design and construction plans

a. The IMA and the installation safety officer will review all concept design and final plans for construction of swimming pools and spas and hot tubs with regard to sanitary control and safety prior to final acceptance of the plans and authorization for construction.

b. Alternatively, obtain design review support from the supporting agency or laboratory listed in appendix C.

c. The design and construction details presented in the remainder of this chapter are intended to—

(1) Provide guidance for design review of proposed new facilities.

(2) Point out possible deficiencies that should be addressed either on an immediate basis or deferred until the next scheduled upgrade, as the seriousness of the deficiency dictates.

6–8. Designated areas

a. Instructional areas. Visually set apart the areas of a swimming pool used primarily for instruction from the rest of the pool by installing both a life line and a 4 in. (10 cm) minimum width row of floor tile, painted line, or equivalent, in a color contrasting with the pool bottom and sides.

b. Shallow areas. Shallow areas are those areas of a swimming pool that are from 3 ft (0.9 m) to 5 ft (1.5 m) in depth. The shallow area should be visually set apart from the rest of the pool in the same manner as the instructional areas.

c. Diving areas. Diving areas should be visually set apart from the rest of the pool in the same manner as shallow areas.

6–9. Bather load

Determine the maximum bather load based on the requirements listed below. Use the number to determine how many patrons may be admitted into the facility.

a. Base the maximum bather load on the sum of the following three requirements:

(1) One bather for each 15 square feet (sq ft) (1.4 square meter (sq m)) of shallow, instructional, or wading area (less than 5-ft deep).

(2) One bather for each 25 sq ft (2.3 sq m) of deep swimming area, not counting the diving area.

(3) One bather for each diving area. Each diving area is defined as 300 sq ft (27.9 m) of deep area.

b. Determine the bather load by calculating the pool area per swimmer requirement for each of the three specified areas that are shown in figure 6–1. The shallow area should comprise approximately 70 percent of the total pool area. An example of a calculation to determine the bather load follows:

Total pool area = 50 X 100 = 5,000 sq ft

Diving area = 300 sq ft = 1 person

Nonswimming area
.7 X 5,000 = 3,500 sq ft
3,500/15 sq ft/person = 233 people

Swimming area
5,000 − (300 + 3,500) = 1,200 sq ft
1,200/25 sq ft/person = 48 people

Maximum bather load = 1 + 233 + 48 = 282

*If the shallow area is <70 percent, use that value to determine the nonswimming area.

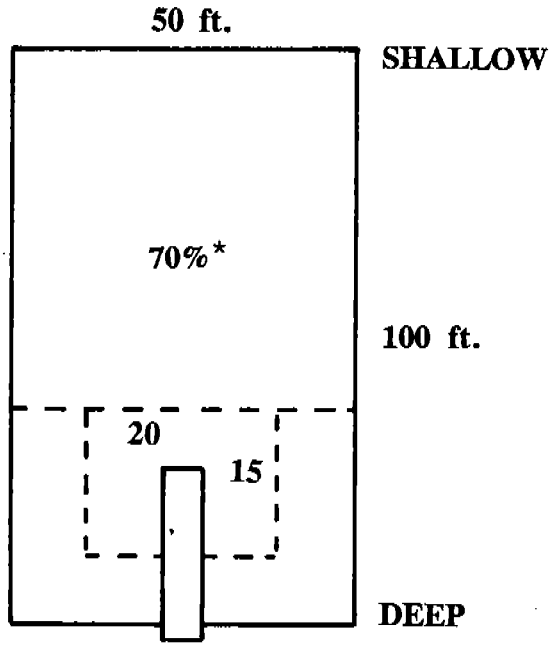

Figure 6–1. Specified swimming pool areas

6–10. Materials

a. Construct swimming pools and accessories using materials that—

(1) Are inert, nontoxic to humans, impervious, and permanent.

(2) Can withstand design stresses.

b. The swimming pool should have a watertight tank with a smooth and easily cleaned surface, or the tank should consist of a material to which a cleanable surface finish is applied.

c. Finish the swimming pool in white or light colors. This finish will be smooth, without cracks or joints, with the exception of structural expansion joints. Tile sides and bottom if smooth, are permissible. Earth or sand bottoms are not permitted.

6–11. Design

a. The shape of all swimming pools will not impair the circulation of pool water or the control of the swimmers' safety. Generally speaking, the minimum allowable depth of water is 3 ft (0.9 m). Do not exceed 3 ft 6 in. (1.1 m) at the shallow end of the swimming pool, except for competitive or special purpose pools.

b. The design and construction considerations presented in this bulletin are not intended to interfere with the design responsibilities of the Chief of Engineers, but merely to identify those considerations that have significant impact upon safety, sanitary control, and public health aspects of swimming facilities.

6–12. Markings

a. Ensure markings and numerals are—

(1) A minimum of 4 in. (10 cm) in height.

(2) Colored to contrast with pool sides and deck.

(3) At no more than 25-ft (7.6-m) intervals.

(4) Plainly visible to persons in the swimming pool and to people on the deck.

b. Consider the effects of sunlight and glare in determining the proper position and color selection.

c. Plainly mark water depth at or above the water surface in two places:

(1) On the vertical pool wall, and

(2) At the edge of the deck next to the pool. If depth markers cannot be placed on the vertical walls of the pool above the water level, use other means of display (such as signs on the walls, and so forth). Also mark points of maximum and minimum depth; points of break between deep and shallow portions; and appropriate intermediate increments of depth.

d. In areas where the water is less than 5 ft (1.5 m) deep, place the following sign on the adjacent horizontal surface or pool deck (coping) and in other appropriate places:

DANGER
NO DIVING—SHALLOW WATER

e. All signs, except those on the adjacent horizontal surface or pool deck (coping), should have letters that are at least 4 in. (10 cm) in height, and colored to contrast with the background. For addi-

tional clarity, augment the signs with graphic labels such as the one shown in figure 6–2, which is available through the local pool equipment supplier.

f. Mark the drain outlet of the pool in an appropriate contrasting color.

6–13. Water supply

a. The water supply serving all swimming pools, spas and hot tubs, and plumbing fixtures, including drinking fountains, lavatories, toilets, and showers, will meet all applicable requirements for potable water. Submit requests to use alternate water sources, including the use of saline or brackish water, for swimming pools or spas and hot tubs through the major Army command (MACOM) to The Surgeon General (TSG), HQDA (SGPS–PSP), Falls Church, VA 22041–3258.

b. Protect all portions of the water distribution system serving a swimming pool, spa or hot tub, and their auxiliary facilities against backflow.

c. To introduce water in a swimming pool or spa or hot tub either directly or by the circulation system, supply the water through one of the following or its equivalent, to protect the public water supply:

(1) An air-gap which is two times the diameter of the water supply outlet or pipe (American National Standards Institute (ANSI) 112.1.2–1979).

(2) A pipe-applied atmospheric vacuum breaker installed at least 6 in. above the highest downstream outlet and downstream of all valves and pumps (ANSI/American Society of Sanitary Engineers (ASSE) #1001–1971).

(3) A pressure type anti-siphon vacuum breaker installed at least 12 in. above the highest downstream outlet (ANSI/ASSE #1020–1976).

(4) A reduced-pressure principle backflow preventer (ASSE #1013–1979; American Water Works Association #C 506–1978).

d. Whenever an over-the-rim spout is used to introduce water into a swimming pool or spa or hot tub, shield it so that it does not create a hazard.

(1) If the swimming pool is equipped with a diving board, locate the over-the-rim spout under the diving board.

(2) The open end of the spout will—

(*a*) Have no sharp edges.

(*b*) Not protrude more than 2.0 in. (5.0 cm), preferably not more than 1.0 in. (2.5 cm), beyond the edge of the swimming pool or of the spa or hot tub.

(*c*) Be at least 6 in. (15 cm) above the deck level.

6–14. Inlets

a. Locate inlets for makeup, fresh, or treated water to produce a uniform circulation of water and to facilitate the maintenance of a uniform disinfectant residual throughout the entire pool.

b. Place inlets at approximately 20-ft (6.0-m) intervals around the entire perimeter of the pool. Water may be supplied through bottom inlets at the same intervals.

c. Base the number of inlets on whichever of these calculations results in the greater number of inlets—

(1) One inlet per 600 sq ft (55.8 sq m).

(2) One inlet per 15,000 gallons (gals) (57 kiloliters (kl)) of swimming pool capacity.

d. Design or provide each inlet with an individual valve to permit adjustment of water flow for greatest circulation.

6–15. Outlets

a. Provide all swimming pools with an outlet at the deepest point to permit the pool to be completely and easily emptied.

(1) Cover openings with a proper grating that is not readily removable by swimmers.

(2) Provide a total opening area in the outlet grates that is equal to or exceeds four times the area of the discharge pipe, allowing sufficient area so that the maximum velocity of the water passing through the grating does not exceed 1.5 ft (0.5 m) per second.

(3) Provide grate openings with a maximum width of ½ in. (1 cm), designed to prevent a swimmer's hands and feet from being caught.

(4) Provide multiple outlets at or near one end of pools with deep water, preferably at 20–ft (6.0-m) intervals, but in no case at greater than 30 ft (9.1 m) intervals, nor more than 15 ft (4.5 m) from sidewalls.

b. Install appropriate backflow prevention devices or airgaps to swimming pool drains connected to a sanitary sewer system to prevent sewage contamination of the pool. Do not connect drains to the storm sewer system. Pool operators will notify the wastewater treatment plant (WWTP) prior to draining the pool. This will ensure that the WWTP can accommodate the discharge of large volumes of water. The sanitary sewer system connection may require a National Pollutant Discharge Elimination System (NPDES) permit.

c. In order to maintain a swimming pool in satisfactory condition, provide some form of skimming device such as properly designed overflow

Figure 6–2. A typical sign which should be posted in areas having a water depth less than 5 ft (1.5 m). The word DANGER should have a bright red contrasting background. This sign may be reduced to a 4 in. by 6 in. sign and mounted on the coping of the swimming pool.

gutters or skimmers (paras 6–17 and 6–18). Do not permit direct connection of skimming devices to sewers.

6–16. Bottom slope, side walls, and safety ledges

a. Construct the bottom slope so that it is uniform and does not exceed—

(1) 1 ft (0.3 m) over a distance of 12 ft (3.6 m), for the area of the pool with a depth less than 5 ft (1.5 m).

(2) 1 ft (0.3 m) over a distance of 3 ft (0.9 m), for the area of the pool with a depth greater than 5 ft (1.5 m).

b. Construct the swimming pool walls so that they are vertical to the depth of at least 5 ft (1.5 m) below the water level and then curved to the bottom with a radius not greater than 2.0 ft (0.6 m). The arc of the radius will be tangent to the wall. Walls may be sloped to the bottom instead of curved, provided the sloped area does not intersect the area formed by a curve with a 2.0 ft (0.6 m) radius.

c. Safety ledges, when provided on vertical walls in deep portions of the pool, will—

(1) Be of a contrasting color.

(2) Not be wider than 4 in. (10 cm).

(3) Be at least 4 ft (1.2 m) below the water surface.

(4) Slope ½ in. (1 cm) across the width of the ledge toward the center of the swimming pool.

6–17. Overflow gutters

a. When using overflow gutters instead of skimmers (para 6–18), install overflow gutters that—

(1) Extend completely around the pool, except at steps or recessed ladders in the shallow portion.

(2) Serve as a handhold.

(3) Are hydraulically capable of continuously removing 100 percent of the recirculating water and returning it to the filter through a surge tank located near the filter.

(4) Are designed to prevent entrapment of the swimmers' arms or legs.

b. Ensure the opening into the gutter beneath the coping (horizontal surface) is a minimum of 4 in. (10 cm) wide.

c. Ensure the interior of the gutter is a minimum of 3 in. (8 cm) wide, with a depth of at least 3 in. (8 cm).

d. Provide the overflow outlets with outlet pipe at least 2 in. (5 cm) in diameter. The area of grate opening will total at least one and one-half times the cross-sectional area of the outlet pipe.

6–18. Skimmers

a. When using skimmers instead of overflow gutters (para 6–17), install—

(1) At least one skimming device for each 500 sq ft (46 sq m) of water surface area or fraction thereof.

(2) The skimming devices in the swimming pool water at locations that will—

(*a*) Minimize interference with each other.

(*b*) Allow proper skimming of the entire pool surface.

(*c*) Develop sufficient velocity on the water surface to induce floating oils and wastes into the skimmer from the entire pool area.

b. Ensure the skimming devices—

(1) Are designed to handle 100 percent of the required filter flow; no skimmer will have a flow-through rate of less than 30 gallons per minute (gpm) (113 liters (L) per minute).

(2) Have an easy-to-remove and easy-to-clean basket or screen through which all overflow water must pass to allow for removal of hair and other debris.

(3) Have a mechanism to prevent air locks in the suction line. Provide adequate amounts of water in a surge tank or other device to assure proper suction.

(4) Are cleaned daily to avoid air locks in the suction line.

c. When using an equalizer pipe—

(1) Size the pipe to meet the capacity requirements of the filter and pump. Never size it less than 2 in. (5 cm) in diameter.

(2) Locate the pipe no less than 1 ft (0.3 m) below the lowest overflow level of the skimmer.

(3) Provide the pipe with a valve or other device that is tightly closed under normal operating conditions. The valve should automatically open when the water level drops 2 in. (5 cm) below the lowest weir level.

d. Recessed automatic surface skimmers shall comply in all respects with the NSF International (formerly National Sanitation Foundation) (See app D.) standards for pool equipment. The NSF International Mark affixed to the skimmer indicates conformance to this requirement.

e. In the construction of new swimming pools or modification of existing pools, consider the prevailing summer wind direction in the placement of skimming devices. The wind may push floating oils and wastes to an area that does not contain a skimming device, therefore requiring manual cleaning.

6–19. Steps and ladders

a. Provide steps or ladders at the shallow end of a swimming pool. As a minimum, provide a means of exit for every 75 linear ft of pool wall. Provide ladders or recessed steps, one on each side, at the deep end of the swimming pool.

(1) Ensure steps leading into pools are of a nonslip design, and have a minimum tread width of 12 in. (30 cm) and a maximum rise of 10 in. (25 cm).

(2) Equip corrosion-resistant ladders with nonslip treads. Provide handholds and securely install them with a clearance of not more than 5 in. (13 cm) nor less than 3 in. (8 cm) between the ladder and the pool wall.

b. If steps are inserted in the walls or if step holes are provided, ensure that they are easily cleanable and arranged to drain into the pool to prevent the accumulation of dirt. Step holes will have a minimum width of 14 in. (36 cm).

c. Where steps, step holes, or ladders are located within the pool, provide a handrail at the top of both sides extending over the edge of the deck. Locate steps and ladders where they will not interfere with racing lanes, if applicable.

d. Ensure that the platform or diving board steps are corrosion-resistant, easily cleanable, and of a nonslip design. Provide handrails at all steps and ladders leading to diving boards. Equip all platforms and diving boards with guardrails. Additional protective measures may be necessary to prevent falls around diving boards and should be evaluated on a case-by-case basis.

6–20. Connections for safety lines

Recess all connections for safety lines, lane markers, and similar fittings in the walls at appropriate locations, and in a manner that presents no hazards to persons using the swimming pool.

6–21. Decks and adjacent areas

a. Construct the pool deck—

(1) With a minimum width of 5 ft (1.5 m), preferably 8 ft (2.4 m) or more.

(2) With a nonslip, unpainted surface.

(3) Completely around the swimming pool.

(4) To slope ¼ to ⅜ in. per ft (1.9 to 3.0 cm per m) to drains or surface water disposal areas.

b. Extend the paved area of the swimming pool at least 5 ft (1.5 m) from the sides and rear of the diving board or its appurtenances.

c. Ensure the surface of the paved walk or deck does not drain into the swimming pool or the overflow gutter. Direct drainage away from the pool area to prevent muddy, hazardous, or objectionable conditions. If deck drains are provided, they will—

(1) Have an inlet opening of at least 4 in. (10 cm) in diameter.

(2) Be spaced and arranged so that not more than 100 sq ft (9.3 sq m) of area is tributary to each drain.

(3) Not be spaced over 25 ft (7.6 m) apart.

d. Completely fence the swimming pool area so that the only entrance and exit to the pool is made via the bathhouse (para 6–30).

e. Fence off the unpaved areas accessible to swimmers, and install a shower for use by the swimmer before reentry to the paved area of the pool.

6–22. Diving areas

a. For stability under the greatest possible load, install diving platforms, jump stands, and supports for springboards that are rigidly constructed and properly anchored. These areas should also have a nonslip surface.

b. Provide at least 15 ft (4.5 m) of unobstructed head room above all diving boards, jump stands, and platforms.

c. Provide a horizontal separation of at least 10 ft (3.0 m) between diving boards and jump stands and side walls of the swimming pool.

(1) Increase this separation to 12 ft (3.7 m) for 3-meter diving boards.

(2) Reduce this separation to 9 ft (2.7 m) for deck-level diving boards.

d. The maximum safe elevation of diving boards and platforms above the surface of the water in relation to the depth of the water is given in table 6–1. Figure 6–3 provides a profile of a swimming pool equipped with a diving board and shows the locations of the dimensions specified in table 6–1.

6–23. Swimming pool slides

a. If not properly constructed, located, and used, swimming pool slides may be very dangerous appurtenances at any swimming pool.

(1) Ensure the maximum height of the swimming pool slide is not more than 10 ft (3.3 m) above the water surface.

(2) Ensure the maximum angle of discharge measured over the last 3 ft (0.9 m) before the discharge is not greater than minus 11 degrees (−11°), measured from the horizontal.

(3) If the swimming pool slide is used by adults, locate the slide so that the discharge end of the slide is 1 ft (0.3 m) or less above the water's surface and the water depth is at least 5 ft (1.5 m).

Table 6–1. Minimum, preferred, and maximum dimensions of swimming pools equipped with diving boards of various heights above water

Dimension	Diving Board Height (H) Above Water							
	Deck Level Board (20″ or less)			One Meter Diving Board (More than 20″ but not more than 39″			Three Meter Diving Board (More than 3′–3″, but not more than 10′–0″)	
	Minimum	Preferred	Maximum	Minimum	Preferred	Maximum	Minimum	Preferred
D_0	6′–0″	—	—	6′–0″	—	—	6′–0″	—
D_1	9′–0″	10′–0″	—	10′–0″	12′–0″	—	12′–6″	13′–0″
D_2	3′–0″	3′–0″	3′–0″	3′–0″	3′–0″	—	3′–0″	3′–0″
O_h	2′–6″	3′–0″	3′–0″	4′–10½″	6′–0″	—	4′–10½″	6′–0″
L_1	15′–0″	16′–0″	—	18′–0″	20′–0″	—	20′–0″	20′–0″
L_2	12′–0″	15′–0″	—	15′–0″	21′–0″	—	22′–6″	24′–0″
L_3	15′–0″	24′–0″	—	15′–0″	24′–0″	—	24′–0″	24′–0″
S_1	—	1:12	1:10	—	1:12	1:12	1:12	1:12
S_2	—	—	1:3	—	—	1:3	1:3	1:3
B_1	6′–0″	9′–0″	12′–0″	9′–0″	16′–0″	—	—	16′–0″

NOTE: See figure 6–3 for locations of dimensions.

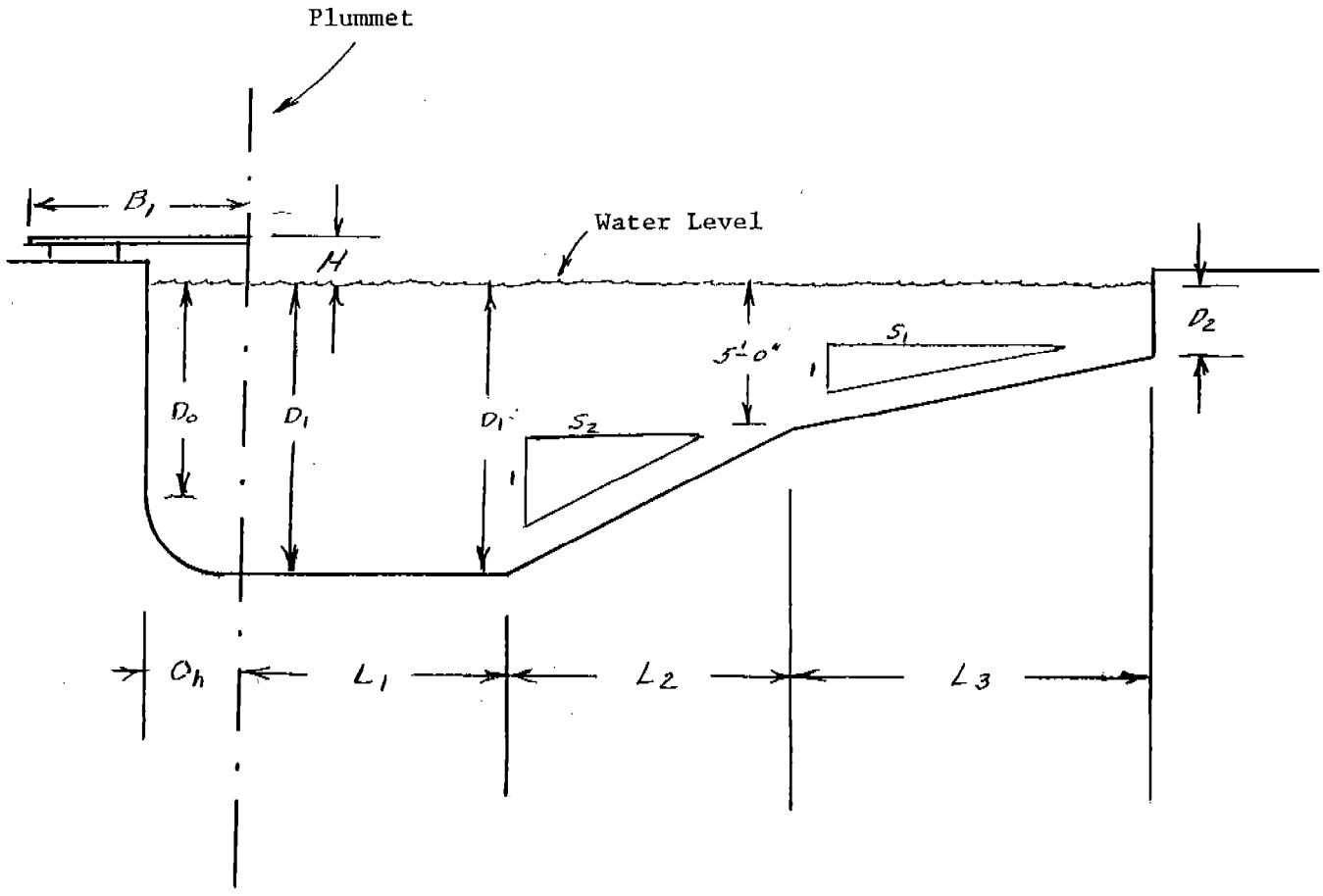

Figure 6–3. Profile of swimming pool equipped with a diving board and showing locations of critical dimensions specified in table 6–1.

(4) If the swimming pool slide is used only by children, locate the slide in water that is 3–5 ft (0.9–1.5 m) deep.

b. Monitor the use of swimming pool slides for safe operation and proper maintenance.

(1) Appendix E, paragraph E–2 provides suggested rules specific to the use of swimming pool slides.

(2) Part 1207, title 16, Code of Federal Regulations (16 CFR 1207) contains safety standards pertaining to the safe design, construction, and installation of swimming pool slides.

(3) Direct questions concerning the proper maintenance of swimming pool slides to the appropriate equipment manufacturer.

6–24. Recirculation system appurtenances

Provide a recirculation system consisting of pumps, pipes, filters, and water conditioning and disinfection equipment for all new construction. Ensure this equipment clarifies and disinfects the pool water providing a complete turnover of at least three times in 24 hours. For an explanation of recirculation and turnover rates, see appendix F.

a. Pumps.

(1) Design the recirculation system with two pumps, whenever possible, to provide a backup should one pump fail. Pump(s) will—

(*a*) Have an adequate capacity to provide the required number of turnovers of pool water (three times in 24 hours).

(*b*) When possible, be located in a position that eliminates the need for priming.

(*c*) Be capable of providing flow adequate for the backwashing of filters (para 6–27).

(2) Provide the pump suction header with a gauge, installed as close to the pump inlet as possible, that indicates both pressure and vacuum.

(3) Ensure centrifugal pumps used for recirculation and filtration comply in all respects with NSF International standards. The NSF International Mark affixed to the pump indicates conformance to this requirement.

b. Piping.

(1) Proportion and construct the piping system to permit cleaning or repair of any part of the system.

(2) Ensure piping is nontoxic, resistant to corrosion, and capable of withstanding operating pressures.

(3) Provide a blowoff fixture at the lowest point of the system to permit removal of any accumulation of sediment or rust.

(4) Provide outlets for obtaining water samples before and after treatment.

c. Hair catchers. Include a hair catcher in the recirculation system to reduce the amount of hair, lint, and other filamentous material that may reach the filters.

(1) The hair catcher consists of a metal chamber containing a cylindrical strainer with the water flow from the inside to the outside of the strainer. Ensure strainers are—

(*a*) Corrosion resistant with openings not more than ⅛ in. (0.3 cm) in size, providing a free flow area at least four times the area of the pump suction line.

(*b*) Readily accessible for frequent cleaning.

(2) Ensure hair catchers are located on the suction side of the pumps and are cleaned at least once a day.

d. Vacuum cleaners.

(1) Clean pool bottoms and walls with built-in suction cleaners connected to a separate vacuum pump that discharges to the sanitary sewer. When fixed hose connections are used, ensure they are–

(*a*) No less than 3 in. (8 cm) in diameter.

(*b*) Located at least 8 in. (20 cm) below the water surface and flush-mounted in the pool walls.

(*c*) Placed so all parts of the pool can be reached with a 50-ft (15.2 m) hose.

(*d*) Covered when not in use.

(2) Instead of a fixed suction system, clean the pool with a portable suction cleaner consisting of a low capacity pump with an engine or motor mounted on a small truck or dolly for wheeling around the pool. Do not operate this system during swimming hours. The pump discharge may empty into the overflow gutter or deck drainage system and will not under any circumstances re-enter the pool prior to filtration.

e. Heating.

(1) Maintain heated indoor pools between 74 °F (23 °C) and 82 °F (28 °C). For pools used for recreational purposes only, maintaining pool temperatures above 82 °F (28 °C) is energy wasteful and provides no additional comfort to the swimmer.

(2) Blowing steam directly into the pool or placing heating coils in the pool is prohibited.

(3) Use a thermostatically controlled heater designed to warm all or part of the recirculating water, with a fixed thermometer in the recirculation line at the heater outlet and another near the outlet of the pool.

(4) In pools designated for physical therapy use only, the water temperature may be maintained up to 90 °F (32 °C) for the comfort of the patient.

(5) For pools that do not have temperature regulation (that is, outdoor pools), limit swimming in 70 °F (21 °C) or colder water to a maximum of 25 minutes per hour. Do not permit swimming in water colder than 60 °F (15 °C).

f. Rate-of-flow indicator. Install a rate-of-flow indicator (reading in gpm or L per minute), preferably on the pool return line, so that the rate of recirculation is indicated. Ensure the indicator is—

(1) Capable of measuring flows at least one and one-half times the design flow rate.

(2) Accurate within 10 percent of true flow.

(3) Easy to read.

Section III. TREATMENT OF SWIMMING POOL WATER

6–25. General

Design all new swimming pools with a provision for adequate treatment and recirculation of swimming water. Modify existing swimming pools to meet these requirements.

6–26. Disinfection

a. Types of disinfectants. While there are a number of disinfectants in use for treatment of swimming pool waters, including chlorine compounds, bromine, ozone, and others; chlorine and chlorine compounds are used most frequently due to their high degree of effectiveness, availability, ease of measuring residuals, relative ease in handling, and economy. The sections that follow deal exclusively with the use of chlorine and chlorine compounds for the disinfection of pool water.

(1) In the event that the use of a disinfectant other than chlorine or chlorine compound is desired, route requests for approval to TSG as described in paragraph 6–13. If ozone is used only as an oxidant and chlorine is used as the disinfectant, the approval of TSG is not required.

(2) Requests for approval of alternate disinfectants are necessary due to the possibility of toxic effects, and the variation in application and testing procedures. Consider these factors in light of equipment and manpower capabilities.

(3) The use of alternative disinfectants will be evaluated on a case-by-case basis.

b. Disinfection of pool water.

(1) Disinfect swimming pool water by maintaining a bactericidal concentration of a residual disinfectant, such as chlorine, throughout the pool.

(*a*) In recirculation-type pools (including recirculation-type wading and spray pools), add the required concentration of disinfectant solution to the recirculated water.

(*b*) In flow-through pools, add the chemical to the inlet water.

(2) The essential equipment required for disinfection includes—

(*a*) Pump(s).

(*b*) A disinfection unit (chlorinator).

(*c*) An outlet system to bring water from the pool for disinfection.

(*d*) An inlet system to distribute the disinfected water uniformly throughout the pool.

(3) Optimum disinfectant concentrations—

(*a*) Provide rapid destruction of all potential pathogenic microorganisms (for example, bacteria, cysts, fungi, viruses, protozoa).

(*b*) Control algae.

(*c*) Provide continual oxidation of organic impurities and ammonia nitrogen fractions.

(*d*) Do not cause eye irritation.

(*e*) Are maintained at an adequate measurable residual to ensure continuing disinfection and algae control in the swimming pool.

c. Disinfection using chlorine.

(1) There are a number of factors that affect the bactericidal action of chlorine in swimming pool water. Among these are the pH of the water and the amount of free available chlorine (FAC) residual. Further explanation of chlorine chemistry is provided in TM 5–662.

(2) The pH of the water affects the disinfecting action of chlorine. In general, the higher the pH, the less efficient the disinfection of the FAC. At a pH of 7.4, the mucous membrane of the eyes, nose, and throat are affected the least by residual chlorine. For ideal conditions, maintain the pH of the pool water between values of 7.2 and 8.0.

(*a*) If the pH falls below 7.2, add alkaline substances, such as sodium carbonate (soda ash), to the water in amounts to raise the pH to a value between 7.2 and 8.0.

(*b*) If the pH is greater than 8.0, add sodium bisulfate or hydrochloric acid (muriatic acid) to reduce the pH to a value between 7.2 and 8.0.

(3) The required minimum FAC levels for various pH values of the swimming pool water are shown in table 6–2.

Table 6–2. Required minimum FAC levels

pH	Minimum free available chlorine residual (not stabilized with cyanuric acid) mg/L
7.2	0.40
7.3	0.40
7.4	0.40
7.5	0.40
7.6	0.50
7.7	0.60
7.8	0.70
7.9	0.80
8.0	1.00

(4) Figure 6–4 shows the relationship between the maintenance of pH and the disinfection capability of chlorine, as well as eye comfort considerations.

(5) For those facilities using elemental chlorine in the compressed gaseous form, follow guidance provided in appendix G on safety precautions for chlorination facilities. TM 5–662 provides detailed instruction about gas chlorination equipment.

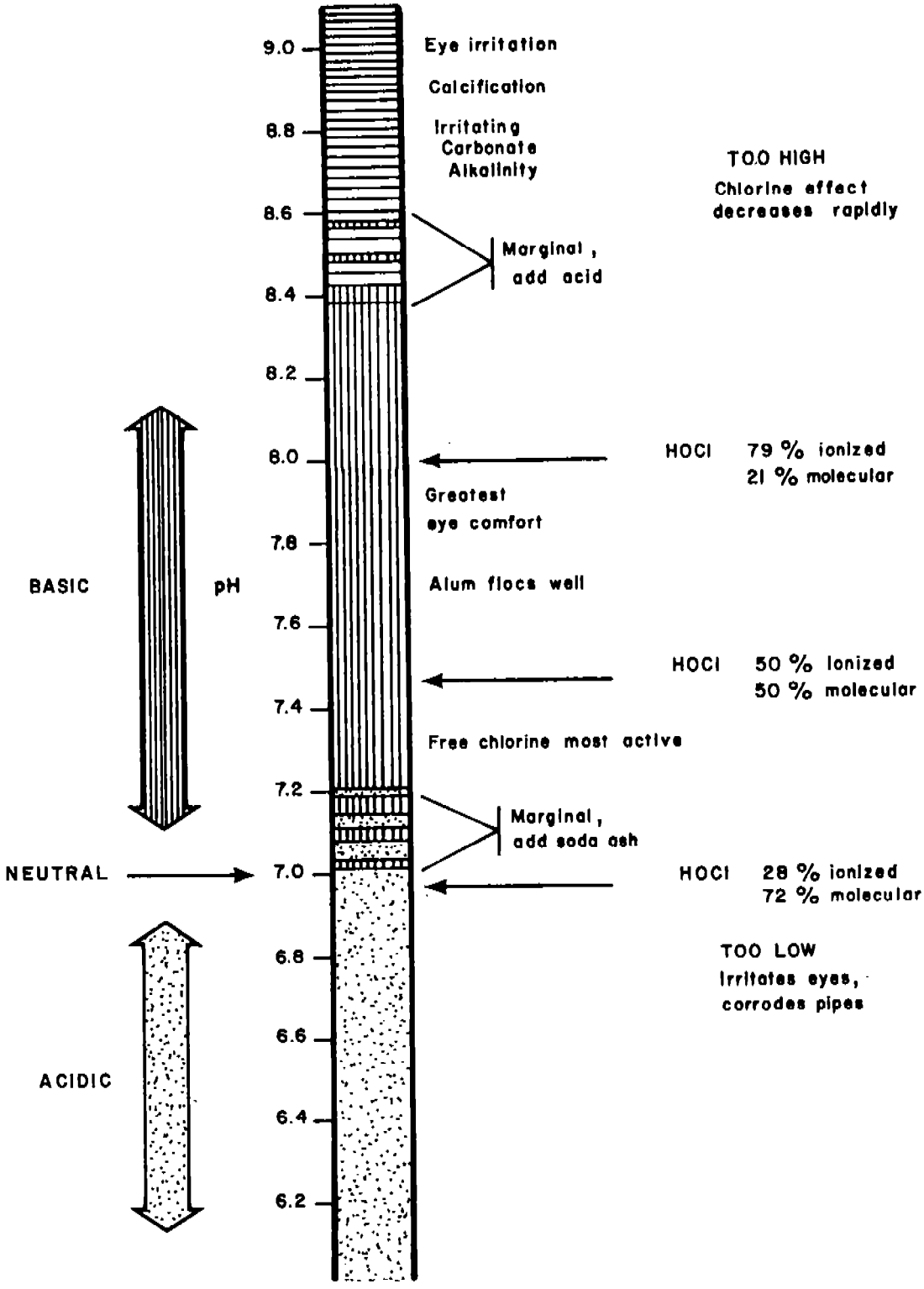

Figure 6–4. Relationship of pH, chlorine residual, and eye comfort for swimming pools. Source: Centers for Disease Control: Swimming Pools: Safety and Disease Control Through Proper Design and Operation

(6) When chlorine is added to water that has nitrogenous substances (for example, ammonia, urine, perspiration, and so on), chlorine may combine with these substances to form chloramines or combined available chlorine (CAC), which is only $^{1}/_{50}$ to $^{1}/_{100}$ as effective as FAC. Do not use chlorine-ammonia treatment because chlorine odors are likely and chloramines are more irritating to the eyes of swimmers.

(7) Some Army facilities have potable water supplies disinfected with chloramines. A portion of the chloramines (CAC) will be consumed by the routine addition of free chlorine. However, a certain level of the chloramines may remain in the pool water. Avoid a CAC level above 0.2 mg/L which can result in odors and eye irritation. The level of the CAC may be measured using procedures provided in appendix H. Eliminate the CAC by raising the FAC to 10 times the measured CAC level. This procedure may be used at all pools where the CAC exceeds 0.2 mg/L.

d. Pertinent measurements.

(1) Determine chlorine residuals according to the procedures outlined in appendix H.

(2) Record chlorine residuals and pH determinations on DA Form 3164–R (Swimming Pool Operating Log) (TM 5–662).

(*a*) At swimming pools, determine the chlorine residual and pH at a minimum of every 2 hours during the time the pool is in use.

(*b*) At wading pools, spray pools, and spas and hot tubs, greater usage of these facilities may require testing the water more frequently.

(*c*) Test the water 30 to 60 minutes before the facility opens.

(3) If the tests reveal the water quality does not meet the minimum requirements, do not open the facility until the water quality is brought into compliance.

(4) Measure the swimming pool water temperature at least twice each day and record the temperature on DA Form 3164–R. Record the spa or hot tub water temperature each time the residual chlorine and the pH are measured.

(5) Retain all records for at least two swimming seasons.

e. Chlorine stabilized with cyanuric acid.

(1) For outdoor swimming pools, one of the chlorinated isocyanurates may be used as the water disinfectant. Cyanuric acid may be added to the swimming pool to stabilize the FAC when either sodium hypochlorite or calcium hypochlorite is used as the disinfecting agent.

(*a*) The presence of a concentration of cyanuric acid that is at least 30 mg/L, but not greater than 100 mg/L, tends to stabilize the FAC against the destructive action of sunlight.

(*b*) When cyanuric acid is present in swimming pool water, the disinfecting action of the chlorine is reduced. Therefore, the minimum stabilized FAC levels require adjusting as shown in table 6–3.

Table 6–3. Minimum stabilized FAC levels

pH	Minimum free available chlorine residual stabilized with cyanuric acid between 30 mg/L and 100 mg/L
7.2	1.00
7.3	1.00
7.4	1.00
7.5	1.00
7.6	1.25
7.7	1.50
7.8	1.75
7.9	2.00
8.0	2.50

(2) Compare these values with the values listed in paragraph 6–26*c* for chlorine used without cyanuric acid. If a chlorine cyanurate disinfectant is used, both the water operators and the IMA should measure the cyanuric acid levels at the time other operational parameters are checked. A test kit, other than that used for the pH/FAC, is necessary to measure the cyanuric acid level.

f. Disinfection using ion-generating devices. Some studies advocate the use of ionized silver and copper, either alone or in combination, because superior disinfection is achieved.

(1) The electrical ion-generating devices are available from several manufacturers. However, these products may not be used without supplemental chlorination or bromination, despite the claims of some manufacturers. The requirement for supplemental disinfection is contained in NSF Standard Number 50–1992.

(2) The NSF International is only now beginning (late 1992) evaluation of such systems for conformance with NSF Standard Number 50–1992. Until NSF International lists specific systems as approved appurtenances, they cannot be considered for Army use.

6–27. Filtration

In order to provide swimming pool water of adequate clarity, filters are a necessary part of the recirculating system. Commonly used types are sand filters, diatomaceous earth or diatomite filters, and cartridge filters.

a. Standard filter requirements.

(1) Ensure all pressure filters are—

(*a*) Capable of providing a turnover of at least three times in 24 hours. For an explanation

of the recirculation and turnover rates see appendix F.

(*b*) Designed, manufactured, and installed to provide easy accessibility for cleaning, operating, maintaining, and servicing.

• Include valves and pipes to completely drain the filter. For multi-filter units, the capability to isolate, backwash, or drain an individual filter for maintenance or repair is required.

• Position all filter tanks to provide adequate circulation of air beneath and around all sides to reduce corrosion and facilitate cleaning. If filter tanks are installed in the ground (that is, buried), ensure compliance with manufacturer recommendations, to protect the tanks from corrosion.

(*c*) Equipped with an approved pressure gauge or gauges with appropriate capacity. Install the gauges so that pressure or vacuum readings, as appropriate, may be obtained on both the influent and effluent lines of the filter or filters. The difference between the gauge readings for the influent and effluent is the headloss of the filter.

(*d*) Installed with an air-relief valve or valves located at or near the highest point of the filters.

(*e*) Designed and constructed in accordance with the applicable provisions of the NSF Standard Number 50–1992. The NSF International Mark affixed to the filter indicates compliance with the standards of that organization.

(2) It may be necessary to obtain an NPDES discharge permit from the EPA or the state to discharge backwash water from these filters. A more thorough discussion of filtration is presented in TM 5–660/AFR 91–26/NAVFAC M0–210 and TM 5–662.

b. Sand filters.

(1) A sand filter may be either a gravity or pressure sand filter, a standard rate or high-rate sand filter.

(*a*) Design standard rate filters for filtration rates not to exceed 3 gpm per sq ft of filter surface area (122 L per minute per sq m).

(*b*) Design high-rate filters for filtration rates not to exceed 15 gpm per sq ft of filter surface area (612 L per minute per sq m). Use higher rates of filtration when such units have been successfully tested against applicable NSF International standards.

(2) When a sand filter is installed on a swimming pool, design, construct, and install the filter to backwash at a rate not less than 15 gpm per sq ft of filter surface area (612 L per minute per sq m), or at a rate recommended by the manufacturer. Discharge filter backwash water to the sanitary sewer system. Provide a sight glass or other means for viewing the clarity of the backwash water.

c. Diatomaceous earth filters.

(1) Diatomaceous earth filters may be designed to operate either with or without continuous body feed.

(*a*) Design diatomaceous earth filters that operate with continuous body feed for filtration rates not to exceed 2.5 gpm per sq ft (102 L per minute per sq m) of filter area.

(*b*) Design diatomaceous earth filters that operate without continuous body feed for filtration rates not to exceed 2.0 gpm per sq ft (82 L per minute per sq m) of filter area.

(2) When a diatomaceous earth filter is installed on a swimming pool, design, manufacture, and install the filter with provisions for cleaning by one or more of the following methods:

(*a*) Backwashing.

(*b*) Air pump-assisted backwashing.

(*c*) Spray wash (either mechanical or manual).

(*d*) Agitation.

(3) Discharge the water used in cleaning a diatomaceous earth filter to the sanitary sewer system or in a manner approved by the appropriate authority.

d. Cartridge filters.

(1) There are two kinds of cartridge filters: depth cartridge and surface cartridge.

(*a*) Depth cartridge filters are designed for filtration rates not to exceed 3 gpm per sq ft (122 L per minute per sq m) of effective filtration area.

(*b*) Surface cartridge filters are designed for filtration rates not to exceed 0.375 gpm per sq ft (15 L per minute per sq m) of effective filter area.

(2) Ensure swimming pool cartridge filters are designed, manufactured, and installed according to the provisions and requirements necessary for cleaning or replacement as recommended by the manufacturer.

6–28. Control of algae

a. The growth of algae in swimming pools is promoted by—

(1) Exposure to the sun.

(2) Increased temperatures.

(3) Insufficient chlorine.

(4) Excessive amounts of ammonia and other nutrients.

b. The best and simplest method of algae control is to prevent the growths from forming. To effectively accomplish this, maintain an acceptable disinfectant residual (para 6–26) in the swimming pool at *all* times. Intermittent recirculation and chlorination is ineffective.

c. Algae development in a swimming pool can cause two types of slimy growths: free-floating or clinging. Several techniques can be used to control algal growths once formed. These include heavy chlorination and copper sulfate treatment.

(1) Heavy chlorination or superchlorination is the preferred treatment.

(*a*) Increase the FAC residual to 5 through 10 mg/L to remove the growths. Operations personnel may find it advantageous to raise the FAC to 10 mg/L for an overnight period. The capacity of the chlorinator may limit the chlorine level which can be attained.

(*b*) If higher levels are required, hand application is an option. Hand application of household liquid bleach (sodium hypochlorite 2.5 to 5 percent) or the clear supernatant of a 1 to 5 percent solution of calcium hypochlorite, well mixed, can expedite the superchlorination buildup.

(*c*) Suspend swimming until the free chlorine residual is returned to the levels described in paragraph 6–26.

(2) Swimming pools that experience continuous algae difficulties due to some uncontrollable factor may require a "shock" treatment with copper sulfate. Due to its tendency under some conditions to form an inky precipitate that discolors swimmers' suits and hair, seek technical advice from the supporting agencies and laboratories listed in appendix C or the manufacturer prior to using copper sulfate.

(3) As a last resort, drain the pool and scrub the bottom and sides with a 5 percent hypochlorite slurry or copper sulfate solution (non-chelated 0.2–0.3 mg/L) to remove tenacious algal growths. Personnel performing cleaning operations should wear appropriate protective clothing that limits skin exposure. Further discussion of algae control is found in TM 5–662.

CAUTION

Do not use mercury compounds or arsenites to remove algal growths due to the toxicity of these substances.

6–29. Cleaning swimming pools

a. To a large degree, users determine the acceptability of a facility based on the appearance of the swimming pool. Therefore, lifeguards and pool managers should keep the swimming pool and its area clean by—

(1) Inspecting the water daily and removing all visible foreign material in the pool. Wearing a face mask will assist in underwater visibility.

(2) Removing dirt on the swimming pool bottom and floating material at least once every 24 hours.

(3) Cleaning sidewalls daily, or as necessary, to reduce the buildup of foreign material.

b. Equip the flushing and cleaning hose used in cleaning pool walls or walkways with a backflow prevention device. Swimming pool cleaning is discussed further in TM 5–662.

c. Survival swimming training, whereby soldiers in battle dress uniforms (BDUs), to include boots, practice swimming and maneuvering techniques in the pools, can have a detrimental effect on the pool.

(1) The BDUs to include boots may be soiled, resulting in debris entering in the pool. To avoid this, the units conducting such training will—

(*a*) Ensure that BDUs and boots are cleaned of all visible debris prior to pool entry.

(*b*) Provide necessary equipment (that is, basins and brushes) to clean boots in the shower room prior to pool entry.

(2) The dye in new BDUs may also bleed into the water. This places an excessive burden on the pool filter(s). Therefore, units performing survival swimming should use only clean BDUs intended for this purpose. In many cases, the BDUs can be maintained at the recreation facility by the unit performing the training or by the sponsoring training office.

Section IV. BATHHOUSE

6–30. General

a. A bathhouse, located immediately adjacent to each swimming pool, is a service facility for the activities related to a swimming pool complex. A bathhouse provides swimming pool patrons with dressing rooms, lockers, toilets, and a first-aid room. Also, it may include a snack bar and the pool's administrative facilities. In some situations, a bathhouse contains the control center, offices, staff facilities, and storage room for equipment and supplies. Often the filter room is located in one unit of the bathhouse.

b. Locate the bathhouse at the shallow end of the swimming pool with—

(1) Separate facilities for males and females if used simultaneously by both sexes.

(2) Partitions separating the areas used by males and females consisting of tight walls or screens placed at entrances and exits to break the line of sight.

(3) Floors made of nonslip, impervious material with coved corners and intersections between floors and walls. Floors should not have any protrusions, such as hose bibs.

c. Keep all facilities clean to preclude infection (for example, athlete's foot fungus). To control the growth of fungi, scrub floors daily and disinfect with a 50 mg/L chlorine solution as needed. A 50 mg/L solution can be prepared by adding 0.64 fluid ounces (19.2 milli-L) of 5 percent sodium hypochlorite to 5 gals of water.

6–31. Dressing rooms

Dressing rooms should have—

a. Floors that slope about ¼ in. per ft (0.6 cm per 0.3 m) toward the drains.

b. Walls and partitions of smooth, impervious materials, with no open cracks or joints. If the walls and partitions are of wood or similar surfaces, they should be painted.

c. Partitions between dressing compartments raised above the floor or placed on continuous raised masonry or concrete bases.

d. Well-ventilated lockers, if provided, located above the floor.

e. Furniture that is water resistant and easily cleaned.

6–32. Showers

a. For design or renovation purposes, provide one shower head for every 50 persons of each sex based on the maximum bather load (para 6–9). Provide a minimum of two shower heads for each sex. Supply all showers with adequate amounts of soap, preferably in hand-operated dispensers, and hot water. Shower valves and fixtures should prevent scalding. Do not exceed 110 °F (43 °C) maximum water temperature.

b. For new construction, locate the showers to require passage through them enroute from the bathhouse and toilets to the swimming pool.

c. For existing swimming pools where bathhouses are not provided, install outdoor showers at the entrance to and from the swimming pool.

d. Construct the floors of impervious nonslip material which is sloped ⅜ in. per ft (0.9 cm per 0.3 m) towards the drain.

6–33. Toilet facilities

a. Provide adequate toilet facilities at all swimming pools for swimmers of each sex. Place these facilities so that swimmers using them pass through the shower before entering or returning to the swimming pool. For design or renovation purposes, use the maximum bather design load (para 6–9) to determine the number of facilities required on the basis of—

(1) One water closet for every 40 female swimmers or fraction thereof (minimum of 2).

(2) One water closet plus one urinal for every 60 male swimmers or fraction thereof.

b. In addition to the above fixtures, provide "wet toilets," adjacent to the shower rooms, for wet swimmers.

(1) One "wet toilet unit" for men consisting of one water closet and one urinal.

(2) One "wet toilet unit" for women consisting of two water closets. If the bather load is greater than 200 swimmers, add an additional water closet in both the male and female facilities.

c. In addition to facilities for swimmers, provide toilet facilities for spectators and other nonbathers (TM 5–810–5). Separate facilities are desirable.

6–34. Lavatories

Provide one lavatory for every 60 persons of each sex.

6–35. Footbaths

Do not use footbaths at Army swimming pools and swimming areas.

6–36. Ventilation

a. Ventilate dressing rooms, toilet rooms, and shower rooms by either natural or artificial means to prevent odors and to dry floors, walkways, benches, and other areas that become wet. A minimum ventilation rate of 0.5 cfm/ft^2 (cubic feet per minute per sq ft) or 2.5 L/sm^2 (L per second per sq m) is suggested to achieve proper ventilation.

b. Ventilate indoor pools to prevent the accumulation of moisture and condensation on cold surfaces. Provide sufficient ventilation to dry floors and decks, and so forth, in less than 90 minutes.

Section V. LIGHTING/ELECTRICAL

6–37. Lighting

Illumination standards for bathhouses and other interior swimming pool facilities are provided in TM 5–811–2/AFM 88–9. Provide illumination for exterior swimming pool facilities based on standards of the Illuminating Engineering Society's current recommended practice for sports lighting. Locate outdoor swimming pool area floodlights outside the deck of the swimming pool to prevent light-attracted insects from dropping into the pool.

6–38. Electrical

a. Construct and install all electrical wiring and equipment to meet or exceed the most current requirements of the National Fire Protection Association Code 70, National Electrical Code, Article 680.

b. The installation of ground-fault circuit interrupters (GFCIs), where required, is critical to the safety of personnel at all pool facilities. Equip all electrical circuits located within 15 ft (4.57 m) of a swimming pool, wading pool, spray pool, or spa or hot tub with ground-fault interrupters that conform to Article 680. Additionally, equip bathhouses with the GFCIs.

Section VI. SPECTATOR AND CONCESSION AREAS

6–39. Spectator areas

Install a separate entrance for the spectator area, if provided. Ensure the spectator area does not overhang or is not closer than 10 ft (3.0 m) from the edge of the pool. This minimizes the possibility of spectators dropping food or other items in the swimming pool.

6–40. Concession areas

a. Concession areas may be designated at both swimming pools and natural bathing areas. It is important to recognize that concession areas may constitute a problem area in terms of sanitary control.

(1) At swimming pools, separate the concession areas from decks and walkways of the pool.

(2) Maintain concession areas in a sanitary manner by—

(*a*) Prohibiting glass (soft drink containers, and so on) in the area.

(*b*) Disposing of refuse, such as cans or wrappers, in the area prior to returning to the deck or pool area.

(*c*) Providing covered trash receptacles, and ensuring they are emptied frequently.

b. All food service sanitary requirements pertaining to these facilities will apply (AR 40–5 and TB MED 530).

Section VII. LANDSCAPING, FENCING, AND ENCLOSURES

6–41. Landscaping

a. Swimming pool areas.

(1) Design the area around the swimming pool to prevent surface drainage from entering the swimming pool.

(2) Minimize dirt, dust, and debris from being carried or blown into the swimming pool by placing the top of the swimming pool well above the surrounding ground level.

(3) Do not plant trees and shrubbery where the leaves and blossoms can fall into the swimming pool.

b. Wading pools and spray pools. The guidance in (1) through (3) above also applies to wading and spray pools.

c. Spas and hot tubs. The guidance in (1) through (3) above also applies to outdoor spas and hot tubs.

6–42. Fencing and enclosures

a. Swimming pools and spas and hot tubs.

(1) Provide barriers to prevent drownings, near-drowning injuries, and the unauthorized use of swimming pools and spas and hot tubs. Fences and similar enclosures are effective in preventing these deaths and injuries, particularly among children.

(2) Design the fence or barrier to a height of at least 60 in. (152 cm) and with a maximum vertical clearance to grade of 2 in. (5 cm) when measured on the side opposite the swimming pool or spa or hot tub. If the fence or barrier is greater than 60 in. (152 cm) in height, make provisions that permit an adult to view all of the water surface areas of the pool or spa or hot tub when standing outside of the fence or barrier.

(3) For picket-type fences, ensure no horizontal openings between the pickets exist at heights less than 60 in. (152 cm) except for manufacturing tolerances in assembly. Locate horizontal fence support beams on the swimming pool or spa or hot tub side of the fence.

(4) Where a chain-link fence is provided, ensure the opening between links do not exceed 1 in. (2.5 cm), or provide slats on the fence so that the openings do not exceed 1 in. (2.5 cm).

(5) Design or construct access gates to be—

(*a*) At least 60 in. (152 cm) in height.

(*b*) In compliance with (2), (3), and (4) above.

(*c*) Self-closing.

(*d*) Equipped with a self-latching device, placed on the pool or spa or hot tub side of the gate, at least 54 in. (137 cm) from the bottom of the gate.

(*e*) Installed to open outwards, away from the pool or spa or hot tub.

(*f*) Equipped to accomodate a lock.

(6) Construct all barriers around swimming pools and spas or hot tubs so that there are no footholds or other physical characteristics which would enable a child to climb over the barrier.

(*a*) Masonry and stone barriers will not contain indentions or protrusions except for normal construction tolerances.

(*b*) No opening in a barrier will allow the passage of a ball measuring 4 in. (10 cm) in diameter.

b. Wading pool. When a wading pool is located adjacent to a swimming pool—

(1) Provide a toddler-proof barrier, such as a fence with a gate, to separate the two.

(2) Design the fence to conform with the same requirements as swimming pools in paragraph a above.

(3) Equip fence gates or doors with self-closing and positive self-latching closure mechanisms and permanent locking devices at a height of at least 36 in. (91 cm) from the ground, deck, or walkway.

CHAPTER 7

DESIGN STANDARDS FOR NATURAL BATHING AREAS

7–1. General

One of the primary requirements of natural bathing areas is the protection of the health and safety of the users of these facilities, considering—

a. Water quality.

b. Physical characteristics.

c. Support facilities.

d. Lifesaving and safety equipment.

7–2. Beach design

a. Site selection for the natural bathing area is critical to maintaining good sanitary quality. In evaluating beaches for recreational use or training, select only those areas that are remote from sources of pollution (for example, wastewater discharge). Adequate water circulation is required to minimize high bacterial counts that may occur when a large number of swimmers are in the water. Good water circulation will generally remove surface debris such as weeds or other floating objects.

b. Avoid areas with native populations of waterfowl. Post signs to restrict feeding of migratory waterfowl which may encourage the birds to remain in the area. The presence of the birds increases the chances of contaminating the beach with pathogenic bacteria such as salmonella.

c. The ideal beach is one that provides the swimmer with protection not only from sources of pollution, but also from boats, boat wakes, fuel spillage, and so on. Situate the beach to ensure maximum solar exposure; however, avoid western exposure to reduce afternoon glare to lifeguards. Consider prevailing winds to reduce debris accumulation on the beach.

d. The slope of the land both above and below the water line is important. Ensure slopes in the underwater portion of the beach are gradual, uniform, and preferably not greater than 1 in 15 in the nonswimming areas or 1 in 10 in the swimming areas. Ensure there are no sudden drop-offs, submerged rocks, and so on.

e. To determine the beach capacity, allow 50 sq ft (4.6 sq m) of swimming area and 50 sq ft (4.6 sq m) of beach area per person. At any one time, expect 60 percent of the swimmers on the beach, with 30 percent in the water and 10 percent elsewhere.

7–3. Depth and type of sand

a. The minimum depth of sand on the beach area and within the nonswimming area is 20 to 24 in. (51 to 61 cm). If the sand layer is less than 20 in. (51 cm), it may easily erode by wave action.

b. It may be necessary to import sand to create desirable beach conditions. A coarse grain sand is the most practical for resisting wave action. Fine grain sand is easily eroded and may cause some turbidity of the water when agitated. White sand tends to be more aesthetically pleasing than brown sand, but creates more glare. When an option is possible, coarse, natural brown sand is recommended.

7–4. Diving areas

Designated diving areas tend to enhance the use of natural bathing facilities. However, exercise care to prevent the creation of safety hazards.

a. Locate diving areas far enough from the shore to discourage swimmers from swimming to the diving raft or float.

b. Locate rafts or floats where the minimum depth of water is 10 ft (3 m).

c. Provide diving boards that are no higher than 3 ft 3 in. (1 m) above the water.

d. If a raft or float is located where the water depth is less than 10 ft (3 m), post conspicuous and easy-to-read signs that prohibit diving.

7–5. Support facilities

a. Provide at least one bath change shelter for each natural bathing area. Whenever possible, combine dressing rooms with toilet facilities and showers.

(1) Locate the facility between 200 and 500 ft (60 and 150 m) from the water's edge.

(2) Design the floors of the bathhouse with easy-to-clean material with a nonslip surface, impervious to moisture, and sloped to allow drainage of water.

(3) To determine the number of required toilet fixtures, see paragraph 6–33.

b. Refreshment stands provided at natural bathing areas may range from a small vending machine to large snack bars.

(1) Since glass bottles and cans are prohibited from the beach area, serve food and beverages on and in paper containers. The use of plastic materi-

als is prohibited since many of these items are environmental contaminants.

(2) Provide properly covered trash receptacles in the vicinity of the refreshment stands and on the beach.

(3) Exercise particular care that paper wastes are not buried in the sand.

7–6. Lifeguard and first-aid stations

a. Ensure elevated lifeguard stands are–

(1) Constructed and strategically located to provide complete surveillance of all swimmers, bathers, and divers.

(2) At least 6 ft (1.8 m) high.

(3) Provided for every 200 ft (60 m) of beach or fraction thereof.

b. At large natural bathing areas, provide facilities for a lifesaving boat for use by the lifeguards.

c. At all natural bathing areas, have a properly equipped first-aid station (See paras 12–5 and 12–6.) and a telephone readily available. While the first-aid station may be located in a building that is used for another purpose, do not use the first-aid room for any other purpose.

7–7. Beach operations

a. At natural bathing areas the year-round maintenance program includes–

(1) The beach area.

(2) Support facilities.

(3) Concession buildings.

(4) Parking area.

(5) Walkways.

(6) Access roads.

b. Competent beach management personnel are essential to proper beach operation, which is necessary for health and safety reasons.

c. Enact and enforce regulations pertaining to the safe and healthful use of natural bathing areas. Make these regulations available to all who use the facility. Suggested regulations for natural bathing areas are provided in appendix E, paragraph E-4.

CHAPTER 8

INSPECTIONS

8–1. New construction pre-opening

a. Approximately 30 days before opening, knowledgeable representatives of the IMA, the Directorate of Engineering and Housing (DEH), the installation safety office, and the installation Directorate of Personnel and Community Activities (DPCA) will perform a pre-opening inspection of a newly constructed swimming pool, spa or hot tub, or natural bathing area.

b. The purpose of this inspection is to determine compliance with this bulletin and to ensure that procedures are established to provide for the effective sanitary control and safety of the facility. This inspection is not a substitute for the proper sanitary design and construction of a facility, nor is it intended to take the place of competent design review. The purpose is only to identify areas that were overlooked during construction. The facility will not open until the deficiencies noted are corrected.

8–2. Annual inspection

Approximately 30 days prior to opening, knowledgeable representatives of the IMA, DEH, safety office, and DPCA will perform a thorough annual inspection of all swimming facilities and spas and hot tubs to ensure safe and healthful swimming and bathing. At indoor facilities operated year round, conduct the annual inspection at a specified time, preferably 30 days prior to the start of heavy seasonal use. Do not open the facility until the deficiencies noted are corrected.

8–3. Routine inspection

The IMA will conduct routine periodic inspections of all swimming pools, spas and hot tubs, and natural bathing areas in use. DA Form 7267–R (Checklist for Routine Inspection of Swimming Pools) is provided for this purpose. (DA Form 7267–R will be locally reproduced on 8½ by 11–inch paper. A copy for reproduction purposes is located at the back of this bulletin.) These inspections determine if the sanitary control and safety of these facilities meets or exceeds the minimum requirements of this bulletin.

a. During periods of heavy use, inspect all swimming and bathing facilities on a weekly basis. Conduct more frequent inspection and concurrent bacteriological analysis if local conditions so dictate. Frequent inspection is the best means available to the IMA to ensure that proper sanitary and safety controls are implemented and adhered to at the swimming facilities and spas and hot tubs in its area of responsibility.

b. Appendix I contains an example of a completed DA Form 7267–R (Checklist for Routine Inspection of Swimming Pools).

c. Give special attention to the following details in—

(1) Swimming pools and spas and hot tubs:
  (*a*) Chlorine residual (and cyanuric acid, if used).
  (*b*) pH.
  (*c*) Turbidity.
  (*d*) Water temperature.
(2) Natural waters:
  (*a*) Turbidity.
  (*b*) Flow and tidal action.
  (*c*) Evidence of pollution.
  (*d*) Natural area bed or bottom conditions.

d. Determination of the enforcement of regulations for swimming and bathing facilities (app E), maintenance of operating records and safety and lifesaving equipment, and measurement of bacterial counts applies to swimming pools, spas and hot tubs, and natural bathing areas.

8–4. Sanitary survey

The IMA will conduct a sanitary survey at least yearly for all natural bathing areas. The survey examines potential sources of pollution (for example, wastewater discharge or agricultural drainage) that could impact on the swimming area, as well as safety hazards. Appendix J contains a detailed list of factors that influence the suitability of a natural bathing area.

CHAPTER 9

WATER QUALITY STANDARDS FOR SWIMMING POOLS AND SPAS AND HOT TUBS

9–1. Bacteriological water quality

a. General. Use the heterotrophic plate count (HPC), formerly known as the standard plate count, as the bacteriological quality indicator of the water in swimming pools and spas and hot tubs. In addition, use other indicators (for example, coliforms, *E. coli*, and staphylococci), as necessary. The basic purpose of a bacterial quality indicator of water in a swimming pool or spa or hot tub is to confirm the accuracy of the disinfectant and pH tests. If accurate tests for FAC and pH are made, and the values are greater than the minimum values expressed in table 6–2 or table 6–3, then the swimming pool or spa or hot tub water should be of acceptable bacterial quality. However, problems, such as those with the distribution system, may result in invalid tests. Perform laboratory examinations of water samples in accordance with the procedures described in the current edition of Standard Methods.

b. Heterotrophic plate count.

(1) The HPC is the most efficient and simplest method to determine the bacterial quality of water in a swimming pool or spa or hot tub. It is a measure of the effectiveness of disinfection. Most organisms responsible for eye, ear, nose, throat, and skin infections can grow rapidly on HPC agar. (Use appropriate formulation of agar based on the standard methods' HPC technique selected.) This is also true for bacteria capable of causing gastroenteritis. As an absolute minimum, test HPC levels weekly as an indicator of water quality.

(2) If the water in the swimming pool or spa or hot tub is of satisfactory quality, the bacterial colony count on HPC agar after 48 hours incubation at 35 ± 0.5 °C is less than or equal to 200 bacterial colonies per 1.0 milliliter (ml). Since an individual count may show some insignificant variance, a water of satisfactory quality will have no more than 15 percent of the samples examined during a 30-day period with a bacterial count exceeding 200 colony forming units (CFU) per 1.0 ml of sample. If the HPC exceeds 200 CFU per 1.0 ml of sample, collect and analyze additional samples immediately. Review the operating records in order to discover irregularities in operations. Further, evaluate the testing of the water for pH, residual disinfectant, and so forth.

c. Other bacterial indicators.

(1) The total coliform test may provide additional useful information about the sanitary quality of indoor pool water. When using the membrane filter (MF) procedure, the total coliform level should not exceed 2 CFU per 100 ml of the sample tested. Analysis using the 5 tube multiple tube fermentation (MTF) technique should yield no positives. Use the fecal coliform test to provide supplementary information for disinfected outdoor pools.

(2) If the water in a swimming pool or spa or hot tub is suspected in the transmission of disease, tests for other bacterial agents such as staphylococci and *P.* (Psuedmonas) *aeruginosa* may be desirable. In particular, *P. aeruginosa* is associated with spa waters. Methods for the enumeration of these species are in the current edition of Standard Methods. The level of staphylococci should not exceed 50 CFU per 100 ml. No maximum acceptable value has been established for *P. aeruginosa*. Until a maximum value is established, use a guideline value of not more than 1 CFU of *P. aeruginosa* per 100 ml.

9–2. Chemical water quality

a. The lifeguard or pool operator will determine the chemical quality of water in swimming pools at least once every 2 hours. Maintain the pH and residual chlorine as per table 6–2 or table 6–3. The minimum FAC in water in a spa or hot tub will not be less than the values shown in table 9–1 according to the pH of the water. The use of chlorinated isocyanurates or cyanuric acid is not permitted in the treatment of water in a spa or hot tub.

Table 9–1. Required minimum FAC levels for spas and hot tubs

pH	Minimum free available chlorine mg/L
7.2	2.00
7.3	2.00
7.4	2.00
7.5	2.00
7.6	2.50
7.7	3.00
7.8	3.50
7.9	4.00
8.0	5.00

b. Ensure the total alkalinity of the water in a swimming pool or spa or hot tub is at least 50 mg/L, but not greater than 150 mg/L as measured by the methyl-orange test. Alkalinity within this range of values helps to maintain the pH at proper levels. The pool operators will perform and document a test for alkalinity at least once weekly.

c. To reduce the corrosive action of water with low alkalinity or the scaling of water with high alkalinity, water in swimming pools and spas should be chemically balanced as determined by the Langelier Index. (See app K.) For some swimming pool or spa waters, the calcium bicarbonate content is very soluble. When calcium bicarbonate breaks down, it forms calcium carbonate, an insoluble compound, which then forms scale on the inside of the pipes, conduits, and other surfaces. Scale may—

(1) Appear on the walls of a swimming pool or spa as white or lightly colored rough blotches.

(2) Form on the grains of sand type filters and reduce the efficiency of filtration.

(3) Shorten filter runs.

d. If the water in a swimming pool or spa is low in calcium and magnesium, these minerals may be leached out of the walls and bottoms of swimming pools and spas constructed of masonry materials.

9–3. Physical water quality

Always maintain the water quality, so that the bottom of the swimming pool or spa or hot tub is clearly visible when the water is undisturbed. If at any time the turbidity is such that the bottom of the swimming pool or spa or hot tub is not clearly visible, close the facility until the water is clear enough to see the bottom.

CHAPTER 10

WATER QUALITY STANDARDS FOR NATURAL BATHING AREAS

10–1. General

a. Bathing in natural waters (that is, streams, rivers, lakes, and tidal or salt waters) presents special problems. The sanitary quality of these waters cannot be controlled nearly as easily as in well-designed swimming pools. Site selection for these facilities is the most critical factor in maintaining good sanitary quality. Ensure bathing areas are free of the effects of point and nonpoint source discharges. Sources of potentially dangerous contamination of bathing or recreational waters are wastewater discharges from communities, industries, military installations, individual homes, marine craft, local animal populations, and water fowl.

b. Bacteriological examination, as part of a rigorous sanitary survey, is essential for all areas and tributary watersheds considered for use as bathing or recreational areas. Determine acceptability of the site using the water quality criteria discussed below. The use of all natural bathing areas under installation control will be subject to approval by the IMA. Additional guidance for evaluating natural bathing or recreational areas may be available in specific State regulations or policies on this subject.

c. Conduct sanitary surveys of natural bathing areas on a yearly basis. See paragraph 8–4 for a discussion of sanitary surveys.

10–2. Bacteriological indicators

a. The use of bacteriological indicators for evaluating the sanitary quality and the healthfulness of natural bathing areas is undergoing some revision. Until recently, fecal coliform bacteria were used as the indicator organisms. However, studies conducted by the EPA's Health Effects Research Laboratory have indicated that total coliform bacteria and fecal coliform bacteria showed little or no correlation with illnesses acquired by swimmers (para 2–3). These research studies suggested that *E. coli* and enterococci (a subgroup of fecal streptococci) were better indicators of the risk of gastroenteritis for swimmers in fresh water, and that enterococci alone were the preferred health indicators for marine waters. The acceptable limits of the maximum allowable densities of these indicator organisms is found in appendix L.

b. Some State authorities do not use these new indicator organisms and have retained fecal coliform as the indicator organism. In appendix L, there are interpretive guidelines for determining water quality with both fecal coliform bacteria, which may be preferred by the State regulatory authority, and enterococcal organisms, as recommended by the EPA. Contact the State authority for their requirements.

c. Monitoring the natural bathing area after rainfall can provide a baseline of data to—

(1) Determine the extent that runoff affects the quality of the bathing water.

(2) Establish the period of time required for bacterial levels to return to normal.

This information can support decisions to close beaches.

10–3. Physical water quality

Clarity and visibility in the waters of natural bathing areas are very important. Water clarity will allow for—

a. Clear observation of swimmers by the lifeguards.

b. Visibility of the bottom at wadeable depths.

CHAPTER 11

BACTERIOLOGICAL EXAMINATIONS

11–1. Collection of samples for laboratory analysis

a. The IMA should collect, at least once a week, samples for bacteriological examinations and concurrent pH and chlorine residual measurements of swimming and bathing facilities.

(1) Collect swimming pool samples, from both the deep and shallow ends, during the period of heaviest swimming loads.

(2) Collect natural water samples at least 25 ft (7.6 m) from shore, in water at least 2 1/2 ft (0.8 m) deep, and in an area representative of the bathing water.

(3) Collect spa or hot tub water from any point within the tub.

b. When collecting samples for laboratory examinations, use only clean, widemouth, sterilized bottles made of borosilicate (or equivalent) glass or polypropylene (autoclavable) plastic, with suitable tops. Commercially packaged sterile sample bags containing sodium thiosulfate are also acceptable. If testing chlorinated water, add sodium thiosulfate to the bottle before sterilization to retard the action of the chlorine prior to the bacteriological examination. Add sodium thiosulfate as—

(1) Crystals (0.02 to 0.05 grams dry weight), or

(2) A sterile solution (approximately 0.1 ml of a 10 percent solution) for a 120 ml (4 ounce) sample.

(*a*) Ensure sodium thiosulfate solution is clear, free of microorganisms, and stored in the dark.

(*b*) Prepare fresh solutions at least quarterly, but more frequently if microbiological quality is not adequately maintained.

c. Perform the sampling procedure as follows:

(1) Carefully remove the cap or stopper from the bottle without touching either the inner surfaces of the stopper or the top of the bottle.

(2) Hold the sterile bottle near its base and at a 45 degree angle.

(3) Fill in one slow sweep, going down through the water with the mouth of the bottle always ahead of the hand.

(4) Avoid contamination of the sample by floating debris.

(5) Replace the stopper or cap.

d. Do not rinse the bottle in the pool because the sodium thiosulfate will be removed. Exercise care not to lose the sodium thiosulfate (if used) when plunging the bottle to collect the samples. For stream samples, move the bottle against the current.

e. At the time of collection, identify samples with date, time, location, and sampler's name (initials). Transport samples to the laboratory in a clean ice chest, protecting them from exposure to high temperatures and outside contamination.

f. Examine samples as soon as possible after collection—

(1) Examine unrefrigerated samples within 1 hour.

(2) Examine refrigerated samples, maintained at approximately 4 °C (40 °F), within 6 hours, but in no instance more than 30 hours after collection. If delay in laboratory analysis is unavoidable, special techniques for filtering the sample onsite, followed by delayed incubation, in a laboratory are necessary (see current edition of Standard Methods).

11–2. Laboratory analyses

a. Conduct all tests for bacteriological indicator organisms according to the current edition of Standard Methods.

(1) The IMA will maintain the capability to perform analyses for the HPC. More specific bacterial identification may require outside laboratory assistance.

(2) A laboratory performing the HPC may use the pour plate, spread plate, or MF technique. Record the medium used and the incubation temperature and length.

b. Use either the MF method or the MTF method for testing for total and fecal coliforms.

(1) The MTF method, which produces a most probable number (MPN) value, is a statistical number and technically may not be used to obtain a mean value of a series of samples. It is acknowledged that MPN values are averaged by some agencies.

(2) If the MTF method is used to determine the density of indicator organisms, and if a central value is desired, use the median of the values instead of an arithmetic or geometric mean.

(3) For laboratories testing for total coliforms, defined substrate technology is an alternative to the MF and MTF.

(*a*) The technology is based on the premise that only specific species of bacteria that are able

to metabolize the nutrients in the medium will grow and produce a positive test.

(*b*) The minimal medium ortho-nitrophenyl-β-D-galactopyranoside (ONPG) and 4-methylumbelliferyl-β-D-glucuronide (MUG) (MMO–MUG) is a test that indicates both the presence of total coliforms and *E. coli* in the same test vessel after a 24-hour incubation.

11–3. Bacteriological remedial action

a. In the event bacteriological standards as specified in chapters 9 and 10 are exceeded, take the following actions:

(1) Collect repeat samples promptly at the points of previous collection.

(2) Expedite shipment of samples so that a prompt report is obtained from the laboratory.

(3) Make an immediate investigation to determine if any unusual conditions, such as repairs to facilities, storms (if an outdoor facility), drown-proofing at the facility, and so on, might have caused a problem. Also, determine if the filtration and disinfection systems have been operating properly.

(4) Ensure that pH and chlorine residuals are within acceptable ranges (for swimming pools, see table 6–2 and table 6–3; for spas and hot tubs, see table 9–1).

(5) Attempt to identify the specific organisms causing excessive bacterial counts. Seek the advice of the U.S. Army Medical Department Activity/U.S. Army Medical Center (MEDDAC/MEDCEN) laboratory serving the installation for organism identification.

b. If the results of the resample again exceed standards, close the facility until the cause of the problem is determined. Superchlorination of the pool may be required (para 6–26) to reduce the bacterial presence to acceptable levels. Consult the supporting agency or laboratory listed in appendix C for further guidance.

CHAPTER 12

LIFESAVING AND SAFETY REQUIREMENTS

Section I. SWIMMING POOLS

12–1. Lifeguards

a. Qualified lifeguards certified in first aid and cardiopulmonary resuscitation (CPR), will be on duty at all times when a swimming pool is in use. Completion of either the American Red Cross Basic Lifeguarding course or Lifeguard Training course is required. Locate lifeguards in positions where they can observe the entire swimming area.

b. At least two lifeguards for the first 150 swimmers or less, plus one additional lifeguard for each additional 75 swimmers or less, are required. Under limited circumstances, when a small number of persons are using a swimming pool (for example, up to 15 or 20 persons) one lifeguard may be enough. Under such circumstances, if the lifeguard leaves the swimming pool area for any reason, close the swimming pool until a lifeguard comes on duty again. The IMA and DPCA will jointly determine the policy regarding use of only one lifeguard.

c. Structure lifeguarding shifts to avoid fatigue of lifeguards. Swimming pools having a large area or any unusual features may require additional lifesaving personnel. Site specific conditions help to determine the actual number of lifeguards required to adequately control a swimming pool.

12–2. Lifesaving equipment

As designated in TM 5–662, furnish each swimming pool with—

a. One or more poles—

(1) Each greater in length than one-half of the swimming pool width.

(2) Capable of extension to all sections of the floor of the swimming pool.

(3) Constructed of bamboo or other suitable light material.

(4) Having at the end a blunt hook (shepherd's crook) with an aperture of at least 18 in. (45 cm) between the tip of the hook and the tip of the pole.

b. One or more "flutter boards," each approximately 1 ft (0.3 m) by 3 ft (0.9 m) by 2 in. (5 cm), capable of supporting a minimum weight of 20 pounds (9 kg) in the water.

c. One or more throwing-ring buoys having a maximum diameter of 15 in. (38 cm), with $^3/_{16}$ in. (.5 cm) lines attached at least equal in length to the maximum width of the pool. Also furnish a separate throwing rope with a length not less than one-half the maximum width of the pool. Provide these items on the basis of one each for every 2,000 sq ft (196 sq m) of pool surface area or fraction thereof.

d. Elevated lifeguard platforms or chairs on the basis of one per 2,000 sq ft (196 sq m) of pool surface area or fraction thereof.

e. A complete first-aid kit, stretcher, blankets, and a standard plywood backboard made to the specifications of the American Red Cross.

12–3. Location of equipment

a. Mount lifesaving equipment in conspicuous places and distribute it around the pool deck at lifeguard chairs or elsewhere. They will be readily accessible; kept in good repair and operating condition; and instructions for equipment function should be visible. Do not permit swimmers or other unauthorized personnel to tamper with or use equipment for any purpose other than its intended use.

b. Provide a telephone at each bathing facility for emergency use. Restrict public access to the phone in order to ensure its availability in case of an emergency. Emergency information posted at the telephone location will include the telephone numbers of the nearest ambulance service, hospital, military police, fire rescue unit, and DEH emergency assistance.

Section II. NATURAL BATHING AREAS

12–4. Lifeguards

a. Whenever a natural bathing area is open for use, at least two qualified lifeguards (completion of American Red Cross Lifeguard Training) certified in first aid and CPR will be on duty, one of whom will be stationed in a lifeguard tower or elevated chair. Heavily patronized natural bathing areas will have one lifeguard tower or elevated chair for every 200 ft (60 m) of beach or fraction thereof. Also, provide one lifeguard in a boat for every 1,000 ft (300 m) of beach.

b. Identify lifeguards, when on duty, by distinguishing apparel, emblems, or signs. When on duty, lifeguards will not perform any other duties and will not be in the water except in the line of duty. Equip each lifeguard with a whistle or megaphone, umbrella, sunglasses, and a wide-brimmed helmet.

12–5. Lifesaving equipment

a. At all natural bathing areas, provide the lifeguards with the following lifesaving equipment:

(1) A light surfboard, kept in the immediate vicinity of each lifeguard tower.

(2) One or more throwing lines with a ring-buoy attached, having a maximum diameter of 15 in. (38 cm) with a 75-ft (23-m) length of $^{3}/_{16}$-in. (0.5 cm) line. Keep at least one throwing line at each lifeguard tower.

(3) A swimming rescue buoy, kept at each lifeguard post. This device is towed out to a victim by a lifeguard to provide buoyance to the victim and assist the lifeguard in bringing the victim to safety.

b. In addition to the equipment listed above—

(1) Provide at least one American Red Cross 24-unit first-aid kit, or equivalent. Maintain the kit in the first-aid room.

(2) Maintain a standard plywood backboard made to the specifications of the American Red Cross.

12–6. Location of equipment

a. Position some of the lifesaving equipment at each lifeguard tower or elevated chair. In addition, keep extra equipment at a central point where it is readily available.

b. In the first-aid room, maintain a cot or bed equipped with blankets, mouth-to-mouth tubes, and additional first-aid equipment. Provide a telephone with a listing of emergency telephone numbers (para 12–3).

12–7. Signs

a. Place marking signs and buoys at all natural bathing areas to define the safe swimming areas. If there are submerged hazards, mark these with distinctive signs or markers.

b. Conspicuously post bathing areas that do not comply with these regulations with warning signs such as—

UNPROTECTED WATERS
SWIMMING AND BATHING
MAY BE HAZARDOUS

12–8. Emergency procedures for lifeguards

a. At every approved natural bathing area, prominently post an emergency plan for viewing by both beach staff and patrons. The plan will, at a minimum, identify the names and telephone numbers of police, fire, ambulance, and other emergency service personnel, and will show the basic steps in administering mouth-to-mouth resuscitation. A portion of an emergency plan follows—

(1) *One short blast* on a whistle is used when a lifeguard wants the attention of a swimmer.

(2) *One long blast* is a signal used to clear the water of swimmers.

(3) *Two short blasts* on a whistle are used when a lifeguard wants the attention of another lifeguard.

(4) *Three long blasts* on a whistle are the signal for an emergency. All lifeguards on break or off-duty are to report immediately to the beach area.

b. If an emergency occurs (for example, a person needing rescue)—

(1) The lifeguard who is first aware of the situation sounds the emergency signal.

(2) When the other lifeguards hear the emergency signal, they order all other swimmers out of the water.

(3) The lifeguard who is nearest to the telephone or emergency center summons an ambulance or rescue unit.

(4) The lifeguard who detected the emergency begins rescue of the victim; other lifeguards will assist as needed.

(5) First aid will be given as needed. If the victim requires CPR or mouth-to-mouth, it will begin as soon as possible. Efforts will not be stopped until emergency medical technicians have taken over.

c. Conduct emergency drill procedures periodically to ensure that—

(1) All lifeguards are familiar with their responsibilities.

(2) Communication procedures are operative.

(3) Rescue equipment is operational.

APPENDIX A

REFERENCES

A–1. Army Regulations

AR 11–34	The Army Respiratory Protection Program
AR 40–5	Preventive Medicine
AR 200–1	Environmental Protection and Enhancement
AR 310–25	Dictionary of United States Army Terms
AR 385–15	Water Safety
AR 420–10	Management of Installation Directorates of Engineering and Housing
AR 420–46	Water Supply and Wastewater

A–2. Technical Bulletins (Medical)

TB MED 502	Respiratory Protection Program
TB MED 530	Food Service Sanitation
TB MED 576	Sanitary Control and Surveillance of Water Supplies at Fixed Installations

A–3. Other publications

TC No. 21–21	Water Survival Training
TM 5–660/AFR 91–26/ NAVFAC MO–210	Maintenance and Operation of Water Supply, Treatment, and Distribution Systems
TM 5–662	Swimming Pool Operations and Maintenance
TM 5–810–1	Mechanical Design: Heating, Ventilating, and Air Conditioning
TM 5–810–5/AFM 88–8	Plumbing
TM 5–811–2/AFM 88–9	Electrical Design, Interior Electrical System
16 CFR 1207	Safety Standard for Swimming Pool Slides
29 CFR 1910.134	Respiratory Protection
20 CFR 1910.1200	Hazard Communication

A–4. Prescribed Form

DA Form 7267–R	Checklist for Routine Inspection of Swimming Pools

A–5. Referenced Form

DA Form 3164–R	Swimming Pool Operating Log (TM 5–662)

A–6. Selected bibliography

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Kroeber, Frederick V. *Public Swimming Pools: A Manual of Operations,* A.S. Barnes and Co., NY, 1976.

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Microbiological Methods for Monitoring the Environment, Water and Waste, U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Office of Research and Development, EPA 600/8–78–017, 1978.

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NSF International Listings: Swimming Pools, Spas and Hot Tubs, Circulation System Component, Current Edition, NSF International, 3475 Plymouth Rd., P.O. Box 130140, Ann Arbor, MI 48113.

Planning, Design, Operation and Maintenance of Inland Water Swimming Beaches: Safety Standards, The National Water Safety Congress, 1982.

Public Swimming Pools: Recommended Regulations for Design and Construction, Operation and Maintenance, American Public Health Association, 1015 15th St., N.W., Washington, DC 20005, 1981.

Salvato, Joseph A. *Environmental Engineering and Sanitation*, 3rd ed., Wiley Interscience, NY, 1982.

Standard for Public Swimming Pools, National Spa and Pool Institute, ANSI/NSPI–1–1991, February 1991.

Standard Methods for the Examination of Water and Waste Waters, Current Edition, American Public Health Association, 1015 Eighteenth Street, N.W., Washington, DC 20036.

Stevenson, A.H. *Studies of Bathing Water Quality and Health*, Journal, American Public Health Association, 1953.

Suggested Health and Safety Guidelines for Public Spas and Hot Tubs, Centers for Disease Control, U.S. Public Health Service, Atlanta, GA 30333, DHEW Publication No. 99–960, 1985.

Summary of Injury Date on Pools and Spas, U.S. Consumer Product Safety Commission, Washington, DC, May 1985.

Swimming Pools: Safety and Disease Control through Proper Design and Operation, U.S. Dept. of Health, Education, and Welfare, Public Health Service, Centers for Disease Control, Atlanta, GA 30330.

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Ventilation for Acceptable Indoor Air Quality, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., ASHRAE Std 62–1989.

Water Quality Criteria, Report of the National Technical Advisory Committee to the Secretary of the Interior, Federal Water Pollution Control Administration, Washington, DC, 1968.

APPENDIX B

PROCEDURES FOR ADDITIONAL INSTALLATION PERSONNEL

B–1. Installation medical authority

The IMA interacts and coordinates with several installation components in order to oversee the safe and sanitary operation and use of swimming and bathing facilities. AR 40–5 delineates responsibility for swimming facilities. However, the information provided here is intended as a general guideline for the IMA.

B–2. Installation commander

The installation commander—

a. Provides overall swimming and bathing facilities supervision.

b. Enforces safety, health, and sanitation regulations.

c. Forwards requests for exception from any of the provisions contained in this bulletin through the MACOM, to TSG (HQDA (SGPS–PSP) Falls Church, VA 22041-3258).

d. Ensures the correction of deficiencies found during pre-season or pre-opening inspections before the swimming and bathing facilities are opened.

B–3. Directorate of engineering and housing

The installation DEH—

a. Operates and maintains swimming pool(s), and spas and hot tubs in accordance with TM 5–662 and this TB MED.

b. Ensures proper operation of the recirculation system and adjustment of chemical feed rates (for example, pH adjustment and chlorine addition).

c. Provides emergency engineering assistance to correct health related deficiencies as they develop. For example, quick responsive action to adjust chlorine or other chemicals once lifeguards identify inadequate chemical levels.

d. Provides water test kits for each swimming or bathing facility.

e. Ensures that material safety data sheets are available for all hazardous materials used in the pool.

B–4. The installation safety office

a. Conducts a yearly Standard Safety and Occupational Health Inspection to include evaluations of the chlorine equipment and attachments, personal protective equipment, respiratory protection program, and electrical and grounding hookups.

b. Ensures proper maintenance and placement of personal protective equipment.

B–5. Directorate of personnel and community activities

The DPCA—

a. Adequately trains lifeguard staff.

b. Provides proper lifesaving equipment for all facilities.

c. In coordination with the IMA, trains lifeguards in use of chlorine residual and pH tests kits.

d. Keeps facilities clean.

B–6. Lifeguards

The swimming and bathing facility lifeguards—

a. Ensure appropriate chlorine and pH measurements.

b. Enforce safety, including bather load.

c. Record maintenance.

APPENDIX C

ARMY LABORATORIES AND AGENCIES AND AREAS SERVED

Laboratory or agency	*Area served*
US Army Environmental Hygiene Activity—North Fort George G. Meade, MD 20755 DSN 923-6205	Connecticut, Delaware, District of Columbia, Eastern Kentucky, Indiana, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia
US Army Environmental Hygiene Activity—South Fort McPherson, GA 30330 DSN 588-3234	Alabama, Arkansas, Florida, Georgia, Western Kentucky, Louisiana, Mississippi, Oklahoma, Panama, Puerto Rico, South Carolina, Tennessee, Central & Eastern Texas
US Army Environmental Hygiene Activity—West Fitzsimons Army Medical Center Aurora, CO 80045 DSN 943-8881	Arizona, California, Colorado, Idaho, Illinois, Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, Nevada, North Dakota, Oregon, South Dakota, West Texas, Utah, Washington, Wisconsin, Wyoming
Commander US Army Pacific Environmental Health Engineering Agency Sagami APO AP 96343-0079 Ask overseas operator for Camp Zama 288-4114	Alaska, Hawaii, Japan, Korea, Okinawa, Philippines, Thailand, and all other Far East
Commander Tenth Medical Laboratory ATTN: Preventive Medicine Division APO AE 09180 DSN 486-8203/8237	Europe, Africa, Middle East
Commander US Army Environmental Hygiene Agency ATTN: HSHB-ME-WR Aberdeen Proving Ground, MD 21010-5422 DSN 584-3816/3554	Support to laboratories listed and areas not specified

APPENDIX D

NSF INTERNATIONAL APPROVED SWIMMING POOL AND SPA AND HOT TUB EQUIPMENT

D–1. The NSF International (formerly National Sanitation Foundation (NSF)), an independent testing agency, maintains a listing of swimming pool, spa, and hot tub equipment that they have approved and is updated three times per year. This listing refers to NSF Standard 50–1992 which is titled *Circulation System Components and Related Materials for Swimming Pools, Spas and Hot Tubs.* This standard defines the requirements that swimming pool and spa and hot tub equipment, such as filters, pumps, skimmers, and chemical feeders, must meet in order to bear the NSF International Mark.

D–2. Equipment selected for the replacement of existing components or for the construction of new facilities will be NSF International listed indicating compliance with NSF Standard 50–1992.

D–3. The address and telephone number for NSF International headquarters is: NSF International, P.O. Box 130140, Ann Arbor, MI 48113-0140, Commercial: 313-769-8010.

APPENDIX E

SUGGESTED REGULATIONS FOR SWIMMING AND BATHING FACILITIES

E–1. The following regulations are suggested for all swimming pools:

a. All swimmers and bathers will comply with the orders and instructions of pool attendants.

b. Not more than ____ swimmers are allowed within the pool enclosure at one time.

c. All swimmers will take a shower with warm water and soap before entering the pool enclosure.

d. No running, scuffling, dunking, or other forms of horseplay are permitted.

e. Spitting, blowing the nose, urinating, or defecating in the pool is forbidden.

f. No bottles or drinking glasses are allowed in the bathhouse or pool enclosure.

g. If food is consumed, it will be—

(1) Served in appropriate disposable containers.

(2) Eaten in designated concession or spectator areas.

h. No person who has a respiratory disease, other communicable disease, disease discharge, a bandage of any kind, or is otherwise ill is permitted to enter the pool enclosure.

i. No person reported by the surgeon as having or as being a carrier of an infectious disease is permitted to enter the pool.

j. Only swimmers who have complied with these regulations and those concerned with the operation of the pool are allowed within the pool enclosure.

k. General swimming is prohibited in the diving area while diving equipment is in use.

l. Pets of any kind are not allowed within the pool enclosure.

E–2. The following additional rules are recommended for swimming pools with slides.

a. Allow only one person on the slide at any time.

b. Roughhousing or horseplay on the slide is strictly forbidden.

c. Do not use the slide as a diving platform. The slide is made for sliding—not for diving.

d. Before sliding, always be sure that the slide is properly lubricated in accordance with the manufacturer's instructions.

e. Only two kinds of slide activities are allowed. All persons may use sitting (feet-first) entries. Under certain circumstances, children may use belly slides.

(1) In sitting slides, face forward on the slide holding the legs and arms forward with the palms of your hands forward and tilted up.

(2) In belly slides, slide headfirst on your stomach with your head up and arms straight ahead with your fingers pointing up. Do not drop your head or arms on entering the water.

f. Take your time in preparing to slide. Move forward slowly and get yourself positioned properly before starting your slide.

g. Look out for people or objects in the pool along the path of the slide.

h. Supervise young children and nonswimmers at all times.

i. Do not use the slide if any part of it becomes damaged, weakened, or broken. Don't take chances.

j. Teenagers and adults are prohibited from using slides placed in less than 5 ft (1.5 m) of water. Serious injury can occur by striking the bottom. If the slide is located where the water depth is 5–8 ft (1.5–2.4 m), teenagers and adults must use a sitting (feet-first) entry.

k. Allow only individuals less than 4 ft (1.2 m) in height to use slides where the water depth is 3–5 ft (0.9–1.5 m). Place a 4 ft (1.2 m) height indicator near the slide to allow monitoring by a lifeguard. Use sitting (feet-first) slides only. Individuals may use belly slides only if the slide is located where the water depth is 5 ft (1.5 m) or more.

E–3. To maintain sanitary conditions in spas and hot tubs, adopt suggested regulations from paragraph E–1 as appropriate.

E–4. In addition to the following suggested regulations for natural bathing areas, adopt suggested regulations from paragraph E–1 as appropriate.

a. Provide one or more warning signs indicating when a beach is closed for swimming or indicating that no lifeguard is on duty and persons will swim at their own risk.

b. Conspicuously post beach regulations on easy-to-read signs at the bathhouse and on the beach.

c. Swimmers are required to stay within designated swimming areas.

d. No boats other than a lifeboat or a surf board

used by a lifeguard are permitted within 100 ft (30 m) of the designated swimming area. The swimming area will be designated by buoys which are—

(1) Marked "No Boating."

(2) Spaced not more than 200 ft (60 m) apart.

e. No pets are permitted on the beach or in the swimming area.

f. Unless the beach area is adequately lighted by artificial lighting, no swimming is permitted from sunset to sunrise.

g. No swimming is permitted during electrical storms.

h. Glass containers, cans, or alcoholic beverages are not permitted on the beach.

i. No fishing is permitted within the designated swimming area.

APPENDIX F

SIGNIFICANCE OF THE RECIRCULATION RATE

F–1. General

In a recirculation or a flow-through pool, turbid (dirty) water is continuously being withdrawn and replaced by filtered or fresh water. Clarification of the pool water is accomplished by consecutive dilution. Due to the constant admixture of entering clean water with the remaining dirty water, each succeeding portion of water withdrawn should consist of a decreasing proportion of dirty water mixed with an increasing proportion of clean water.

F–2. Turbidity reduction

A turnover is completed when a quantity of water is added to a pool in an amount equal to the volume of water in the pool. It may be calculated, and has been supported by experimentation, that at the end of one complete turnover (assuming turbidity-free water) the turbidity removal is 63 percent. With a like percentage of the remaining turbidity removed by succeeding turnovers, removal after two turnovers is 86 percent, after three turnovers is 95 percent, and up to 99 percent after 10 turnovers. These examples are for purification by consecutive dilution in a pool not in active use. (See fig F–1.)

F–3. Eight-hour turnover

The logic of the 8-hour turnover goal is readily explained by critical review of the percentages of treatment and the equilibrium loads obtained by an 8-hour turnover as compared with the longer turnover. Experience supports this requirement since pools are not maintained in a clean, sanitary manner unless adequate dilution of turbid water with clean water is provided. Continuous operation is essential because an 8-hour turnover is essentially equivalent to a 24-hour turnover system operated continuously. Table F–1 gives the minimum filter flow rates required, based upon the volume of the pool in order to achieve the required 8-hour turnover rate.

F–4. Bacterial reduction

Removal of bacteria cannot be calculated in the same manner as the mechanical removal of turbidity because bacterial life is influenced by time, temperature, and food supply. Properly controlled chlorination is the means of maintaining acceptable bacterial counts (para 9–1). Bacterial reduction is influenced by the form of the chlorine residual, the concentration of bacteria, the amount of organic matter present, pH, the efficiency of clean water distribution, and other factors.

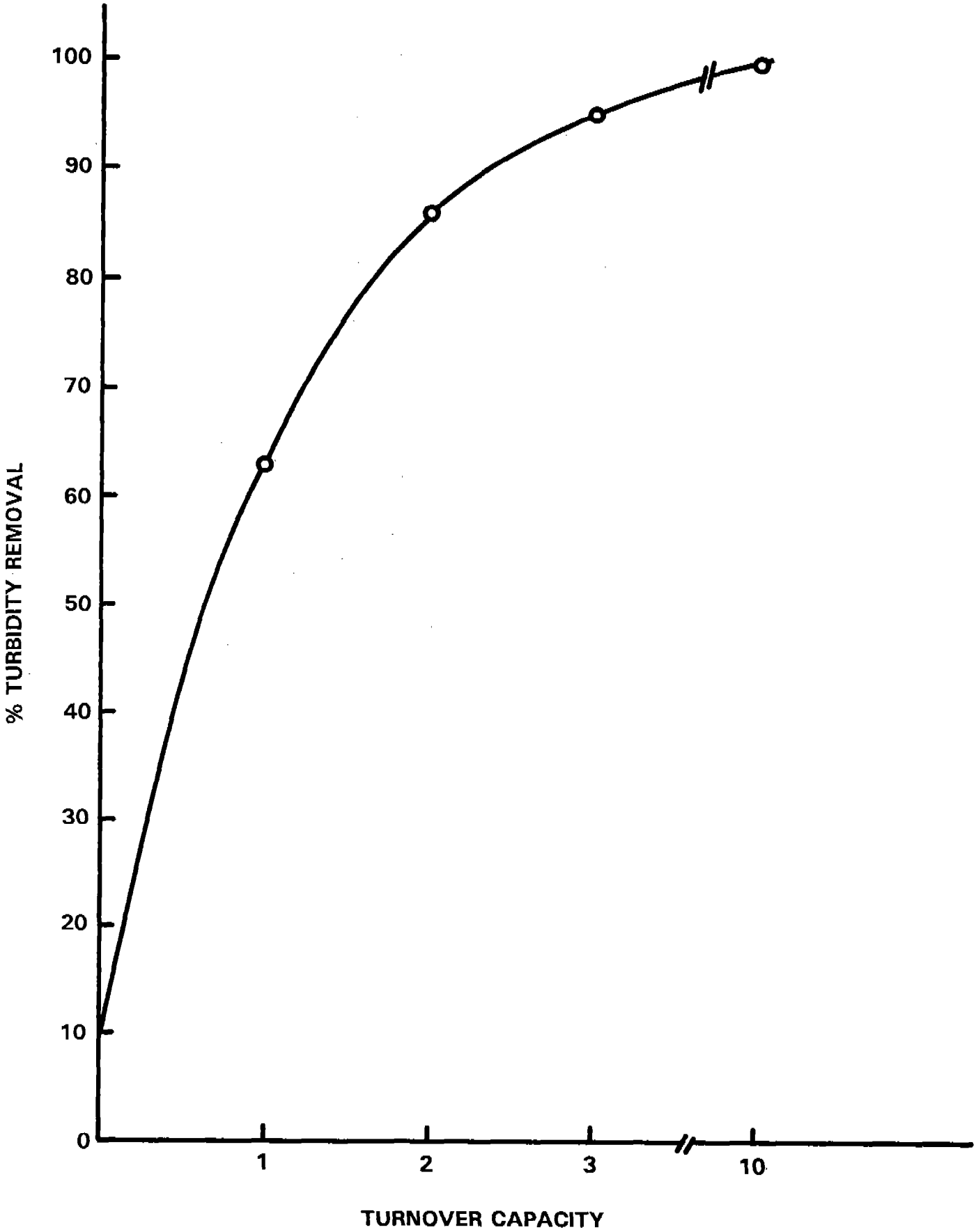

Figure F–1. Theoretical turbidity removal in a swimming pool based on turnover capacity

Table F–1. Pool turnover rate chart

Pool Capacity		Filter flow rates required for 8-hr turnover (minimum)	
Gallons	Liters	gpm	Liters/Minute
50,000	189,000	104	394
75,000	284,000	156	590
100,000	378,500	208	787
125,000	473,000	260	984
150,000	568,000	312	1,181
175,000	662,000	365	1,382
200,000	757,000	417	1,578
225,000	852,000	469	1,775
250,000	946,000	521	1,972
275,000	1,041,000	573	2,168
300,000	1,136,000	625	2,366
325,000	1,230,000	677	2,562
350,000	1,325,000	729	2,759
375,000	1,419,000	781	2,956
400,000	1,514,000	833	3,153
425,000	1,608,000	885	3,350
450,000	1,703,000	938	3,550

F–5. Turnover calculation

The period of time, in hours, required for a complete turnover of a pool of known volume (gals) with a known recirculation rate (gals per hour) can be found as follows:

$$\frac{\text{Pool Volume (gals)}}{\text{Recirculation Rate (gals/hour)}} = \text{Turnover Period (hours)}$$

F–6. Remedial action

If a facility does not have equipment capable of maintaining an 8-hour turnover, then recommend remedial action. This may include—

a. A reduction in maximum permitted bather load.

b. Scheduling upgrade of facilities as dictated by seriousness of the deficiency.

c. No action if bacteriological analyses and other indicators of safe and healthful operation are acceptable and the deficiency is marginal (for example, 2.8 versus 3 turnovers per day).

APPENDIX G

SAFE OPERATION OF CHLORINATION FACILITIES

G–1. Isolate bulk chlorine storage and (powder, granular, and liquid forms) and compressed chlorine gas cylinders and any other water treatment operations and chemicals from other swimming pool areas and maintain the area(s) in a dry condition. Secure all chlorine cylinders to prevent rolling or falling. Segregate empty cylinders from full cylinders and appropriately tag the cylinders. Do not store cylinders near ventilation system motors, heat sources, or areas of elevated temperature. Store the bulk chlorine cylinders above ground in a well-ventilated area separated from the pool and other occupied areas by a gas tight partition. In existing pools where the chlorinator or cylinder storage is below grade, provide mechanical exhaust ventilation. Mechanical exhaust must be sized to provide at least one air change every 2 minutes. The controls must be located outside the room. The mechanical ventilation should be wired so that it will turn on either manually or when the lights are turned on.

G–2. Locate exhaust grilles no more than 6 in. (15 cm) above the floor level. Exhaust the ventilated air to the outdoors and not into interior areas. Mechanical ventilation in above-ground chlorination facilities should be provided to reduce any unnecessary exposure in case of leakage or spill of chlorine. Locate the vapor tight fan switch outside the room and equip the switch with an indicator light. Fresh air intake grille(s) are required to provide makeup air. These grille(s) should be of equal total face area to the exhaust grille(s), but do not need to be connected to a powered air system. Air intake grille(s) should be at least 6 ft (1.8 m) above the exhaust grille(s) and on opposite walls, if possible.

G–3. Hinge all doors to open outward and ensure that at least one door has a viewport to permit operators to look into the room before entering. Post written operating instructions near the chlorination facility for the handling and use of chlorine.

G–4. Affix the following warning sign in a readily visible location at or near entrances to the chlorination room:

CAUTION
CHLORINE HAZARD AREA
UNAUTHORIZED PERSONS KEEP OUT
CAUSES BURNS, SEVERE EYE HAZARD
MAY BE FATAL IF INHALED
IN CASE OF EMERGENCY OR
SUSPECTED LEAKS CALL
(insert emergency phone no.)

TURN ON EXHAUST FAN
PRIOR TO ENTRY.

G–5. For those facilities using chlorine cylinders, place a small squeeze bottle of dilute ammonium hydroxide outside the area. Squirt a small amount into the chlorine room prior to entry. If a "snow" forms, a chlorine leak exists. An emergency notification of the leak will be made. Label the squeeze bottle as follows:

FOR CHLORINE LEAK DETECTION
AMMONIUM HYDROXIDE
CAUSES BURNS TO SKIN, EYES

G–6. For those facilities having automatic chlorine alarms, squeeze bottles of ammonium hydroxide are not required. However, there must be a documented inspection maintenance and calibration program for chlorine detectors and alarms. The installation of automatic chlorine alarms is highly recommended for new construction.

G–7. Personnel entering the area for routine inspection will wear chemical goggles. When cylinders are changed or adjustments made to the system, wear impervious (neoprene or teflon) gloves, chemical goggles, and a full faceshield.

G–8. Swimming pool operators or lifeguards should not enter chlorinated rooms or chlorine storage areas if a release of chlorine or system malfunction is suspected. If a spill or chlorine leak occurs, the installation emergency response team must be contacted immediately. Only trained personnel wearing appropriate chemical protective clothing, including head, hand, and foot covers and self-contained breathing apparatus (SCBA), should enter the area. Personnel who enter the chlorinator room to perform visual adjustment and inspec-

tion of the cylinder and system and cylinder changing will carry a NIOSH-approved 5- or 10-minute escape only respirator. All personnel who are required to wear respiratory protection, including escape only respirators, must be medically cleared, trained, and if appropriate, fit tested, and enrolled in the installation respiratory protection program, as defined in AR 11–34, TB MED 502, and 29 CFR 1910.134. The requirement to carry an escape only respirator may be waived by the IMA, based on either individual sampling results or use of a chlorine alarm.

G–9. Only personnel properly trained in the use of and equipped with SCBA will make leak repairs.

a. Maintain SCBA equipment (two sets)—

(1) At a central location so that they can be used throughout the installation where the need arises.

(2) In accordance with the respirator program (TB MED 502).

b. The SCBA may be stored on the DEH maintenance truck used to support maintenance at the pool or other chlorination rooms.

c. Wear protective clothing, neoprene gloves, chemical apron, and boots, along with the full-face piece SCBA.

G–10. Provide an eye lavage and a deluge shower at the chlorination facility for use in case of emergency. Keep passageways to the eye lavage and deluge shower clear and unobstructed.

APPENDIX H

MEASUREMENT OF RESIDUAL CHLORINE (N,N-diethyl-p-phenylenediamine (DPD) Method)

H–1. General

The instructions for the LaMotte-Palin® [1] DPD Chlorine-pH test set are provided below. Instructions are keyed to this kit because of its applicability to swimming pool monitoring for pH and chlorine residuals. Other kits can be used in lieu of this recommended kit; consult manufacturer's specific instructions as required. The IMA will approve the use of other kits. Order the kit using the nomenclature in paragraph H–7. Testing for other operational parameters (for example, alkalinity) can also be performed using field test kits. Consult manufacturers for information on these items. Generally FAC and, in some instances, combined chlorine are the only necessary chlorine tests. If a reading of 0.2 mg/L of combined chlorine is obtained, then consideration should be given to superchlorinating. Other methods are presented to be used only if necessary (for example, when FAC drops off or is nondetectable).

H–2. Procedure I: Free available chlorine, monochloramine, dichloramine, and total residual chlorine

a. Free available chlorine.

(1) Rinse the test tube with the test sample, then fill to the mark.

(2) Add one DPD No. 1 rapid-dissolving tablet.

(3) Cap the test tube and shake to dissolve the tablet.

NOTE

Make comparator readings in direct light with a sunlight background.

(4) Immediately insert the test tube in the comparator and match the color of the sample with the color standards. Color matching should be completed within 1 minute from the addition of the DPD No. 1 tablet. This is the FAC concentration of the test sample. Identify this as Reading A.

(5) Retain this test sample if the monochloramine determination is to be made.

b. Monochloramine.

(1) To the test sample from step H–2a(5) above, add one DPD No. 2 tablet. Cap the test tube and shake to dissolve.

(2) Compare the resulting color with the color standards and identify this as Reading B. Any increase in color over Reading A is due to monochloramine. Reading B minus Reading A equals monochloramine content.

(3) Retain this test sample if the dichloramine determination is to be made.

c. Dichloramine and total residual chlorine.

(1) To the test sample from step H–2b(3) above, add one DPD No. 3 tablet. Cap the test tube and shake to dissolve.

(2) Compare the resulting color with the color standards and identify this as Reading C. The increase in color over Reading B is due to dichloramine. Reading C minus Reading B equals dichloramine content.

(3) Reading C also represents the total residual chlorine content.

H–3. Procedure II: Free available chlorine, combined chlorine, and total residual chlorine

a. Free available chlorine. Follow steps H–2a(1) through (5) above. This is Reading A. Retain the test sample for the combined chlorine determination.

b. Combined chlorine and total residual chlorine.

(1) To the test sample from H–3a above, add one DPD No. 3 tablet, cap, and shake to dissolve.

(2) Compare the resulting color to the color standards and identify this as Reading C. Any increase in color over Reading A is due to combined chlorine (monochloramine plus dichloramine). Reading C minus Reading A equals combined chlorine content.

(3) Reading C also represents the total residual chlorine content.

H–4. Procedure III: Total residual chlorine

The DPD No. 4 tablet provides a one-step determination for total residual chlorine and is used where it is not necessary to distinguish the separate chlorine fractions.

a. Rinse the test tube with the test sample, then fill to the mark.

b. Add one DPD No. 4 tablet, cap, and shake to dissolve.

[1] ®LaMotte-Palin is a registered trademark of LaMotte Chemical Products Company, Chestertown, MD 21620.

c. Compare the resulting color with the color standards. This reading represents the total residual chlorine content.

NOTE

In situations where chlorine values in excess of 6.0 parts per million (ppm) are encountered, dilute the test sample with chlorine-free water to bring the chlorine concentration within the test range of the Octet®[2] comparator. The test result is then multiplied by the appropriate factor. For example, if one part test sample is diluted by one part chlorine-free water, the test result is multiplied by a factor of two.

H–5. Procedure IV: pH test

The Lamotte-Palin Phenol Red Indicator Tablet contains Halidex that eliminates the bleaching effect of chlorine or bromine on the pH indicator dye. No additional treatment is required when the halogen level is below 8.0 ppm.

a. Rinse the test tube with the sample, then fill it to the mark.

b. Add one LaMotte-Palin Phenol Red Indicator Tablet, cap, and gently shake to dissolve.

c. Immediately insert the tube in the comparator to obtain a color match. If the test sample color is between two standard colors, the midpoint between the two standard values is taken as the value of the sample.

H–6. Precautions for use of testing equipment

The following suggestions are made so that you may obtain the maximum performance from this equipment:

a. Follow all instructions with great care.

b. Carefully wash and rinse all apparatus used in the test procedure.

c. Tighten the reagent container caps immediately after use. Do not interchange caps.

d. Avoid prolonged exposure of all test reagents to direct sunlight.

e. Avoid extreme high temperatures and protect all test components from freezing.

f. Anticipate your requirements for replacement reagents.

g. Keep the reagent containers out of reach of young children.

H–7. Equipment

If new equipment kits are needed, or available equipment is not adequate, order DPD chlorine residual kits using the following information:

a. NSN 6630–01–027–3914, COMPARATOR, COLOR, Chlorine and pH Determination, DPD Method. The kit contains tablets for determining the presence of free chlorine, monochloramine, dichloramine, total chlorine residual and pH. Cost: $59.95.

(1) This kit may be deleted from the Federal Supply System, however, it will be available by local purchase from the LaMotte Chemical Products Co., Box 329, Chestertown, MD 21620, telephone: 410-778-3100, as Model No. LP–8, Code 6980.

(2) Installation personnel wishing to order this kit will go through supply procedures for ordering local purchase items. Installation procurement personnel will handle all the local purchase administrative requirements.

b. DPD No. 1 tablets are available through the Federal Supply System (NSN 6810–01–044–0315).

c. Other reagents to refill those supplied with the kit (DPD #2, #3, #4, and pH tablets) are not available through the Federal Supply System. Contact installation procurement personnel for these requests.

[2] ®Octet is a registered trademark of LaMotte Chemical Products Company, Chestertown, MD 21620.

APPENDIX I

SAMPLE CHECKLIST FOR ROUTINE INSPECTION OF SWIMMING POOLS

CHECKLIST FOR ROUTINE INSPECTION OF SWIMMING POOLS

For use of this form, see TB MED 575; the proponent agency is the OTSG

1. Installation (APO)	2. Building No.	3. Facility Designation
Aberdeen Proving Ground	E-9999	Edgewood Area Pool
4. Person in charge of facility	**5. Telephone No.**	**6. Copy checklist furnished to**
Maj. Doe	671-9999	Pool Manager
7. Mailing address	**8. Purpose of inspection**	
Attn: STEAP-XX APG, MD. (ZIP CODE)	☒ Regular ☐ Pre-opening ☐ Courtesy ☐ Other (*specify*): _____	

(Check appropriate box.)

Satisfactory	Unsatisfactory	SECTION I - WATER
X		a. Free available chlorine residual (mg/L): .4 shallow end .4 deep end
X		b. Combined chlorine (mg/L) (*if measured*): 1 shallow end 1 deep end
X		c. pH: 7.4 shallow end 7.4 deep end
X		d. Temperature: 78 °F
X		e. Visual clarity.
X		f. Water sample collected for bacteriological analysis at shallow and deep ends; after analysis, attach copy of results.
		SECTION II - GENERAL
X		a. Bather load posted / # in pool area 100
X		b. Pool clean
X		c. Surface drainage
X		d. Pool properly enclosed
X		e. Area clean
X		f. Lifeguards (*qualified / min. 2*)
X		g. Lifesaving equipment / First Aid Kit / Tel or Emer Veh present
X		h. Regulations posted and enforced
X		i. Operating records (*FAC & pH minimum 4 daily*)
X		j. Test kit available
X		k. Spectators / tables / chairs - 10 feet from edge of pool

SAMPLE

(Continue on reverse.)

DA FORM 7267-R, Mar 93

(*Check appropriate box.*)		SECTION III - POOL CONSTRUCTION
Satisfactory	Unsatisfactory	
X		a. Smooth, easily cleaned surfaces
X		b. Depth markings
X		c. Steps and ladders / diving area
X		d. Overflow gutters or skimmers / water inlets and drains
		SECTION IV - RESTROOMS AND DRESSING ROOMS
X		a. Rooms clean
X		b. Soap, toilet paper, and paper towels available
X		c. Floors and showers disinfected daily
		SECTION V - REMARKS (*Explanation of any unsatisfactory findings*)

Reverse of DA Form 7267-R, Mar 93

APPENDIX J

SANITARY SURVEY FOR NATURAL WATERS

J–1. As discussed in paragraph 8–4, the IMA will conduct a sanitary survey at least yearly for all natural bathing areas. The survey examines potential sources of pollution (for example, wastewater discharge or agricultural drainage) that could impact on the bathing area, as well as safety hazards.

J–2. The following is a list of factors that influence the suitability of a natural bathing area.

a. Location and volume of point and non-point source discharges and their chemical, bacterial, and physical characteristics.

(1) No specific distance can be given from point and non-point surface discharges to a bathing area that would apply in all cases.

(2) Make an evaluation of the bacteriological and chemical effects of these discharges on the bathing area as part of this survey. Interpretation of these results will determine if discharges are of significance.

b. Volume and quality of the receiving water.

c. Water depth and slope within the proposed bathing area.

d. Water surface area.

e. Tides (if applicable).

f. Time of day and year and weather conditions at the time of the survey.

g. Thermal and salinity stratification.

h. The effects of tributaries on the area.

i. Water current.

j. Prevailing winds.

k. Other site-specific criteria that may apply.

l. Submerged objects, sharp drop-offs, condition and stability of beach bottom, and water depth in diving area.

APPENDIX K

USE OF THE LANGELIER INDEX TO BALANCE POOL WATER

K–1. General

a. In swimming pool waters, calcium bicarbonate is very soluble. When it breaks down it forms the insoluble calcium carbonate, the chief scale former. Scale generally appears as white or lightly colored rough blotches on pool walls. It also adheres to other objects in the pool. Calcium carbonate scale in the piping and filter system can restrict water flow and cause calcification of the filter bed, thus reducing filtration efficiency and shortening filter runs.

b. Scale deposits are usually caused by the presence of excess calcium and magnesium in pool water. These minerals become insoluble and can form scale. The factors which influence the formation of scale are:

(1) Calcium hardness.
(2) Total alkalinity.
(3) pH level.
(4) Water temperature.
(5) Total dissolved solids.

K–2. Preventing scale-forming tendencies

a. The five factors above can be given numerical values and applied to a formula known as the Langelier Index or Saturation Index. The formula indicates whether a particular water has scale-forming or corrosive tendencies and what is done to correct this condition. In the Langelier table (table K–1), numerical values are given for three of the five factors. An average factor for total solids is included in the formula. Using figures from the table and the following simplified version of the Langelier formula, the proper alkalinity balance of a pool's water—and hence its ability to resist scale-forming or corrosive tendencies—is obtained.

Saturation Index = pH + TF + CF + AF − 12.1

pH, actual reading
TF, temperature factor
CF, calcium hardness factor
AF, total alkalinity factor

b. For example:

(1) If the Saturation Index is 0, the water is chemically in balance.

(2) If the Saturation Index is a minus quantity, corrosive tendencies are indicated.

(3) If the Saturation Index is a plus quantity, scale-forming tendencies are indicated.

c. The Saturation Index is considered satisfactory in a swimming pool if the value is between plus one-half (+0.5) and minus one-half (−0.5).

K–3. Examples

The following examples show how to use the Saturation Index to determine appropriate adjustment of pool water.

a. This example illustrates a pool with soft water having low temperature, low alkalinity, and low hardness:

pH, 7.2
Calcium hardness, 5 ppm
Total alkalinity, 5 ppm
TF = 0.3
CF = 0.3
AF = 0.7

Table K–1. Numerical Values for Langelier Formula

Temp °C	Temp (°F)	TF	Calcium Hardness Expressed as: ppm $CaCO_3$	CF	Total Alkalinity Expressed as: ppm $CaCO_3$	AF
0	(32)	0.0	5	0.3	5	0.7
3	(37)	0.1	25	1.0	25	1.4
8	(46)	0.2	50	1.3	50	1.7
12	(53)	0.3	75	1.5	75	1.9
16	(60)	0.4	100	1.6	100	2.0
19	(66)	0.5	150	1.8	150	2.2
24	(76)	0.6	200	1.9	200	2.3
29	(84)	0.7	300	2.1	300	2.5
34	(94)	0.8	400	2.2	400	2.6
40	(105)	0.9	800	2.5	800	2.9
53	(128)	1.0	1,000	2.6	1,000	3.0

Saturation Index = 7.2 + 0.3 + 0.3 + 0.7 − 12.1 = −3.6

Corrective action: This high negative Saturation Index of -3.6 shows an extreme corrosive condition.

(1) To correct it, add sodium bicarbonate (baking soda), $NaHCO_3$, which has a mild effect on pH, to increase the alkalinity to about 100 ppm. (1.5 lb sodium bicarbonate per 10,000 gal (87 g/kl) of water will raise the alkalinity by 10 ppm.)

(2) To correct the problem of low water hardness, add a chemical such as calcium chloride, $CaCl_2$, to increase the hardness level to a minimum of about 100 ppm. (1 lb $CaCl_2$ per 10,000 gals (58 g/kl) of water will raise the calcium hardness about 11 ppm.)

(3) The water temperature can also be increased to a more comfortable level of about 70 °F (21 °C).

(4) Finally, if required, adjust the pH to the desired 7.2 to 7.6 range. With the adjusted condition, the pool water should now be in balance, as shown below in the Saturation Index.

pH, 7.6
Temperature, 70 °F (21 °C)
Calcium hardness, 100 ppm
Total alkalinity, 100 ppm
TF = 0.5
CF = 1.6
AF = 2.0

Saturation Index = 7.6 + 0.5 + 1.6 + 2.0 − 12.1 = −0.4

b. This example illustrates a pool with both hard and highly alkaline water.

pH, 8.5
Temperature, 84 °F (29 °C)
Calcium hardness, 800 ppm
Total alkalinity, 400 ppm
TF = 0.7
CF = 2.5
AF = 2.6

Saturation Index = 8.5 + 0.7 + 2.5 + 2.6 − 12.1 = +2.2

Corrective action: This positive Saturation Index of +2.2 shows extreme tendency to form scale.

(1) The first factors to consider in correcting this condition are pH and total alkalinity, since they can be adjusted most readily.

(2) To correct this, muriatic acid, HCl, or sodium bisulfate, $NaHSO_4$, is added daily to lower the pH and total alkalinity to about 75 ppm.

(3) Add 1.5 pints muriatic acid per 10,000 gals (19 ml/kl) of water to lower alkalinity 10 mg/l. The pool water is now in balance, as shown by the near zero Saturation Index:

pH, 7.4
Temperature, 84 °F (29 °C)
Calcium hardness, 800 ppm
Total alkalinity, 75 ppm
TF = 0.7
CF = 2.5
AF = 1.9

Saturation Index = 7.4 + 0.7 + 2.5 + 1.9 − 12.1 = +0.4

c. The next example illustrates a pool with balanced water.

pH, 7.6
Temperature, 76 °F (24 °C)
Calcium hardness, 400 ppm
Total alkalinity, 50 ppm
TF = 0.6
CF = 2.2
AF = 1.7

This shows a balanced condition. This example also demonstrates that with a pH of 7.6, a total alkalinity of 50 ppm and a temperature of 76 °F (24 °C), the Saturation Index is at a satisfactory value despite a calcium hardness range of 150 ppm (CF = 1.8) to 1,000 ppm (CF = 2.6):

Saturation Index = 7.6 + 0.6 + 1.8 + 1.7 − 12.1 = −0.4

Saturation Index = 7.6 + 0.6 + 2.6 + 1.7 − 12.1 = +0.4

Maintaining total alkalinity at 50 to 100 ppm and pH range from 7.2 to 7.6 has four benefits.

(1) Residual available chlorine does a more efficient job of controlling bacteria and algae.

(2) Scale formation is minimized.

(3) Scaling of heater coils is reduced to a minimum.

(4) Any pool problem due to chemical unbalance is eliminated.

K–4. In summary: Keeping pool water in balance

With the Saturation Index formula, a change in pH of a given value will change the index by a like amount. The most direct method of lowering pH is to add a common acid material such as muriatic acid, HCl. This not only lowers pH, but also reduces total alkalinity. Do not permit the pH of the water to drop below 7.2. Actually, during normal treatment of pool water most chemicals used have some effect on scale formation. Chlorine gas, muriatic acid, and other acid materials tend to reduce formation of scale while hypochlorites, soda ash, and caustic soda tend to favor its formation. By keeping track of the chemicals added to a pool and by controlling pH (by far the simplest of the factors to measure and control) the pool operator can learn to keep the water in proper balance.

APPENDIX L

BACTERIOLOGICAL INDICATORS FOR FRESH AND MARINE WATERS

L–1. Fecal Coliforms—Fresh and marine waters

Fecal coliforms may be used as the indicator organism for evaluating the bacteriological suitability of recreation waters. As determined by the multiple-tube fermentation or membrane filter procedures and based on a minimum of five samples taken over not more than a 30-day period, the fecal coliform content of swimming waters shall not exceed a log mean of 200 CFU per 100 ml of water. Further, not more than 10 percent of the total samples collected during any 30-day period shall exceed 400 CFU per 100 ml of water.

L–2. Enterococci—Marine waters

The EPA recommends that enterococci be used as the indicator organisms for evaluating the bacteriological suitability of marine swimming waters. It is further recommended that the membrane filter procedure be used in making these tests. (See EPA Research and Development Report, EPA 600/4–85/076 *Test Methods for Escherichia coli and Enterococci in Water by the Membrane Filter Procedure.*) Marine waters which demonstrate a geometric mean of not more than 35 CFU per 100 ml of water based on a minimum of five samples collected over a 30-day period are considered as acceptable for swimming. If a single sample is collected, the maximum allowable density for enterococci in marine waters at a designated beach area shall not exceed 104 CFU per 100 ml of water. These values are based upon a swimming associated gastroenteritis illness rate of 19 cases per 1,000 swimmers.

L–3. Enterococci—Fresh waters

The EPA has determined that enterococci is a reliable indicator of the suitability of fresh waters for swimming. Using the membrane filter procedure, a fresh water swimming area is deemed to be acceptable if the geometric mean is not more than 33 CFU per 100 ml of water. If a single sample is collected, the maximum allowable density for enterococci in fresh water shall not exceed 61 CFU per 100 ml of water.

L–4. E. coli—Fresh water

The EPA studies have shown the *E. coli* is an indicator organism which may be used with equal accuracy as enterococci in denoting the acceptability of fresh waters for swimming. If *E. coli* is used as the indicator organism and the membrane filter procedure is employed, the geometric mean of at least five samples collected over a 30-day period shall not be greater than 126 CFU per 100 ml of water. This value would denote that the water is acceptable for swimming and that expected swimming associated gastroenteritis rate would not be greater than 8 cases per 1,000 swimmers. If a single sample is collected, the maximum allowable density of *E coli* CFU shall not exceed 235 CFU per 100 ml of water.

L–5. Suggested interpretation if enterococci and fecal coliforms are used simultaneously

It is quite possible that at a particular military establishment, it may be desirable to use both the fecal coliform test and the enterococci test since the local or state regulatory agency may prefer to continue using the fecal coliform test. If such is the case, the following guidelines are suggested to aid in the interpretation of results.

a. Condition #1. Using a single sample collected from fresh water, the concentration of fecal coliform bacteria is more than 200 but is less than or equal to 400 CFU per 100 ml of water and the enterococci count is less than or equal to 61 CFU per 100 ml of water, it may be concluded that the quality of water is acceptable for swimming.

b. Condition #2. Based upon a single sample collected from fresh water which has a fecal coliform count of greater than 400 CFU per 100 ml of water and an enterococci density of less than or equal to 61 CFU per 100 ml of water, it may be concluded that the water is of questionable quality. Make an immediate sanitary survey of the area and collect another sample. The swimming area may be kept open until the results of the second sample are evaluated.

c. Condition #3. Using a single sample collected from fresh water and the concentration of fecal coliform bacteria is found to be less than or equal to 200 CFU per 100 ml of water, but the enterococci density is greater than 61 CFU per 100 ml of water, it may be concluded that water is of questionable quality. Make an immediate sanitary survey of the area and collect another sample. The swimming area may be kept open until the results of the second sample are evaluated.

GLOSSARY

Section I. ABBREVIATIONS

AF..... total alkalinity factor
AIDS ..... acquired immune deficiency syndrome
ANSI ..... American National Standards Institute
ASSE ..... American Society of Sanitary Engineers
BDU..... battle dress uniform
CAC..... combined available chlorine
CF..... calcium hardness factor
CFU..... colony forming units
cfm/ft^2 ..... cubic foot per minute per square foot
cm..... centimeter(s)
CPR ..... cardiopulmonary resuscitation
°C..... degree Centigrade
°F..... degree Fahrenheit
DEH..... Directorate of Engineering and Housing
DPCA..... Director for Personnel and Community Activities
DPD..... N, N-diethyl-p-phenylenediamine
E..... Escherichia
EPA..... U.S. Environmental Protection Agency
FAC..... free available chlorine
ft..... foot/feet
g ..... gram(s)
gals..... gallons
GFCI ..... ground-fault circuit interrupters
gpm..... gallons per minute
H..... height
HPC..... heterotrophic plate count
HSV..... herpes simplex virus
in..... inch/inches
IMA ..... installation medical authority
Kg..... kilogram(s)
kl..... kiloliter(s)
L..... liter(s)
L/sm^2 ..... liter per second per square meter
m..... meters
MACOM ..... Major Army Command
MEDCEN ..... U.S. Army Medical Center
MEDDAC ..... U.S. Army Medical Department Activity
MF ..... membrane filter
mg/L..... milligrams per liter
ml..... milliliter(s)
MMO–MUG... minimal medium ONPG–MUG
MPN..... most probable number
MTF..... multiple tube fermentation
MUG 4-methylumbelliferyl-β-D-glucuronide
NIOSH..... National Institute for Occupational Safety and Health
NPDES ..... National Pollutant Discharge Elimination System
NSF ..... NSF International (formerly National Sanitation Foundation)
ONPG ..... ortho-nitrophenyl-β-D-galactopyranoside
P. ..... psuedmonous
PAM..... primary amoebic meningoencephalitis
pH..... hydrogen-ion concentration
ppm..... parts per million
PVNTMED.... preventive medicine
SCBA..... self-contained breathing apparatus
sq..... square
sq ft ..... square feet
TF..... temperature factor
TM ..... technical manual
TSG ..... The Surgeon General
USAEHA ..... U.S. Army Environmental Hygiene Agency
WWTP..... wastewater treatment plant

Section II. TERMS

Algae
Primitive plants, single or multi-celled, usually aquatic and nonvascular, and capable of elaborating their foodstuffs by photosynthesis.

Alkalinity
A measure of the buffering capacity of a solution or its ability to resist a change in pH. It represents the sum of the concentrations of bicarbonates, carbonates, and hydroxides expressed as calcium carbonate.

Appurtenances
Machinery, appliances, or auxiliary structures attached to a main structure, but not considered an integral part thereof, for the purpose of enabling it to function.

Backflow
A reversal in water direction resulting in mixing of nonpotable with potable water.

Backwash
Process of reversing waterflow through a filter in order to remove entrapped particles and thereby clean the media.

Bacteria
Single-celled microorganisms which have no chlorophyll and multiply by simple division; do not contain a true cell nucleus.

Chloramine
Any of various compounds containing chlorine and nitrogen.

Chlorination
The application of chlorine to water, generally for the purpose of disinfection, but frequently for accomplishing other biological or chemical results.

Clarification
The process of removing suspended or colloidal matter from a turbid liquid.

Clarity
A term describing the clearness of water. The absence of suspended matter which affects transmission of light.

Coagulant
A material that, when added to water, will combine with certain substances ordinarily present and form precipitate comprising floc particles more or less gelatinous in character, having the capacity to remove colloids from water.

Coagulation
a. The agglomeration of colloidal or finely divided suspended matter by the addition to the liquid of an appropriate chemical coagulant, by biological processes, or by other means.
b. The process of adding a coagulant and other necessary reactants.

Colloids
Very fine solid particles that will not settle out by themselves. Colloids may be removed by coagulation or biochemical action.

Contamination
A general term signifying the introduction into water of micro-organisms, chemicals, wastes, or sewage, which render the water unfit for its intended use.

Corrosion
The gradual deterioration or destruction of a substance or material by chemical action, frequently induced by electrochemical processes, the action proceeding inward from the surface.

Diatomaceous earth (diatomite)
Minute, variously shaped, silica skeletons of diatoms that were small, single-cell marine plants that lived years ago. Diatomaceous earth is often used as a filter medium in swimming pool filters.

Diffuser
A porous plate or tube through which air is forced and divided into minute bubbles for diffusion in liquids. Commonly made of carborundum, alundum, or silica sand.

Disinfection
The killing of pathogenic microorganisms by chemical or physical means.

Epidemiology
The study of causes and control of illness or disease in a population.

Filter
A device or structure for removing solid or colloidal material, usually of a type that cannot be removed by sedimentation, from water or other liquid.

Hard Water
Water containing high concentrations of calcium and magnesium. It is difficult to obtain a lather with soap in hard water. Hard water can result in scale in boilers and pipes.

Heterotrophic bacteria
Bacteria which require organic carbon as a source of energy for life processes.

Hypochlorite
Chemical compounds including calcium hypochlorite (solid) and sodium hypochlorite (liquid) used as a chlorine carrier in pools and spas.

Installation medical authority
IMA refers to the unit surgeon, command chief surgeon. MEDDAC or MEDCEN commanders, and the director of health services or his or her representative responsible for provision of medical support at the unit, command, or installation concerned in consultation with sanitary engineers and environmental science officers when appropriate.

Isocyanurate
Compounds of stabilized chlorine containing a form of cyanuric acid.

Pathogenic
Disease producing.

pH
Measure of hydrogen-ion concentration, indicating degree of acidity or basicity of a solution. Values below 7.0 indicate acidic substances and above 7.0, basic substances.

Pollution
The addition of sewage, industrial waste, or other harmful or objectionable material to water.

Potable
Water that does not contain objectionable pollution, contamination, minerals, or infection, and is considered satisfactory for domestic consumption.

Protozoa
Small one-celled animals including amoebae, ciliates, flagellates.

Residual (chlorine)
The quantity of chlorine, in excess of the chlorine demand, remaining in water, sewage, or effluents after a selected contact period of time, expressed in milligrams per liter or parts per million. The difference between the chlorine dose and the chlorine demand.

Sanitary survey
An inspection conducted to evaluate site-specific geographic and environmental conditions in a watershed, stating finding and recommendations concerning use of the watershed for a particular purpose (for example, natural bathing facility).

Schistosome cercariae
Aquatic larvae of parasitic trematode worms that penetrate the skin. Some species migrate via the lungs and liver to the veins of the intestines and urinary bladder of the host. Other species become lodged in human skin, causing severe irritation (swimmer's itch).

Should
Indicates an advisory recommendation that is to be applied when practicable.

Slurry
A watery mixture of an insoluble or partially soluble material (such as, lime slurry).

Swimming pool
Any man-made, contained, or partially-contained structure used for swimming.

Turbidity
The cloudy appearance of water due to the presence of fine suspended particles in water that interfere with the passage of light.

Will
Indicates a requirement that is necessary or essential to meet the current Federal rules and regulations or other accepted standards of protection.

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By Order of the Secretary of the Army:

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Distribution:
To be distributed in accordance with DA Form 12–34–E, block 1781, requirements for TB MED 575.

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CHECKLIST FOR ROUTINE INSPECTION OF SWIMMING POOLS

For use of this form, see TB MED 575; the proponent agency is the OTSG

1. Installation (APO)	2. Building No.	3. Facility Designation
4. Person in charge of facility	5. Telephone No.	6. Copy checklist furnished to
7. Mailing address	8. Purpose of inspection ☐ Regular ☐ Pre-opening ☐ Courtesy ☐ Other (*specify*): _____	

(Check appropriate box.)

SECTION I - WATER

Satisfactory	Unsatisfactory	
		a. Free available chlorine residual (mg/L): _____ shallow end _____ deep end
		b. Combined chlorine (mg/L) (*if measured*): _____ shallow end _____ deep end
		c. pH: _____ shallow end _____ deep end
		d. Temperature:
		e. Visual clarity.
		f. Water sample collected for bacteriological analysis at shallow and deep ends; after analysis, attach copy of results.

SECTION II - GENERAL

		a. Bather load posted / # in pool area _____
		b. Pool clean
		c. Surface drainage
		d. Pool properly enclosed
		e. Area clean
		f. Lifeguards (*qualified / min. 2*)
		g. Lifesaving equipment / First Aid Kit / Tel or Emer Veh present
		h. Regulations posted and enforced
		i. Operating records (*FAC & pH minimum 4 daily*)
		j. Test kit available
		k. Spectators / tables / chairs - 10 feet from edge of pool

(Continue on reverse.)

(*Check appropriate box.*)		SECTION III POOL CONSTRUCTION
Satisfactory	Unsatisfactory	
		a. Smooth, easily cleaned surfaces
		b. Depth markings
		c. Steps and ladders / diving area
		d. Overflow gutters or skimmers / water inlets and drains
SECTION IV - RESTROOMS AND DRESSING ROOMS		
		a. Rooms clean
		b. Soap, toilet paper, and paper towels available
		c. Floors and showers disinfected daily
SECTION V - REMARKS (*Explanation of any unsatisfactory findings*)		