SWIMMING POOL MANAGEMENT MANUAL

One in a Series of Technical Assistance Publications from the Bureau of Recreation & Conservation

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Commonwealth of Pennsylvania

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Department of Community Affairs

SWIMMING POOL MANAGEMENT MANUAL

BUREAU OF RECREATION AND CONSERVATION
PENNSYLVANIA DEPARTMENT OF COMMUNITY AFFAIRS

in cooperation with
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INDIANA UNIVERSITY OF PENNSYLVANIA

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The Department of Community Affairs is pleased to provide this *Swimming Pool Management Manual* to help owners and operators manage swimming pools in a safe and cost effective manner, as well as reduce the liability exposure of pools.

Since swimming pools are regulated by the state Department of Environmental Resources, we have worked cooperatively with that agency in developing this manual. While this publication includes DER regulations, it also explains how pools should be operated based on what the aquatic profession has learned from the study of accidents and injuries, numerous court cases, and the research and development of new professional standards.

The Department's Bureau of Recreation and Conservation believes this guide will encourage sound training and staffing procedures and funding decisions in the operation of swimming pools.

William C. Bostic

William C. Bostic
Secretary

ACKNOWLEDGMENTS

The initial development and ongoing improvement of the *Swimming Pool Operations Manual* has been the work of individuals from government, educational institutions, the nonprofit sector and private industry.

Dr. Ralph Johnson, Director of Aquatics at Indiana University of Pennsylvania, provided expert advice and knowledge to develop the first edition of the manual in 1984. He has also played a key role in ongoing improvements to the document by keeping us posted on the current issues and changes facing swimming pool owners, operators and the industry in general. The Bureau acknowledges the academic and practitioner skills of Dr. Johnson and thanks him for his contribution to this initiative.

Greg Gove, senior specialist in charge of the Bureau's technical assistance program, recognized the need for the *Swimming Pool Operations Manual*. His overall coordination of the manual's preparation has produced what we believe is a valuable resource document for a diversity of interest groups.

We also wish to thank the state Department of Environmental Resources for its cooperation and assistance in helping to produce this manual, and to the other groups and individuals who contributed to this project.

Larry G. Williamson, Director
Bureau of Recreation and Conservation

PREFACE

The present Pennsylvania Bathing Code, by which all public Pennsylvania pools, beaches and spas are regulated, states that its purpose is "...to protect the public health through the proper design, operation and maintenance of public bathing places." The Code requires that a capable manager be responsible for the proper maintenance and use of the bathing place by keeping it in good repair and in a clean, sanitary and healthful manner. Proposed changes to the Code provide additional clarification about what is expected: "Public bathing places shall be designed, constructed, equipped, operated and maintained in a manner to prevent illness or injury to persons from drowning, falls, collisions, fires, nuisances and health and safety hazards of any kind, and in accordance with the rules and regulations of the Department...."

In a liability-conscious era in which the health and safety of the public has taken on increased importance, following the Bathing Code's provisions clearly makes considerable common sense. To meet these requirements, capable pool managers must be hired who are trained, skilled and certified in basic water chemistry, filtration, management and maintenance, lifeguard supervision, liability hazard identification and accident management.

For years in Pennsylvania, the recognized qualification to become a pool manager was the possession of an American Red Cross Water Safety Instructor (WSI) certificate or its YMCA equivalent. These courses prepared participants to teach swimming. In recent years, both agencies have revised those courses to more accurately reflect the true primary duty of lifeguards, i.e., to prevent accidents and drownings. However, both agencies admit that none of these programs were designed to produce pool managers.

This manual, together with the pool management workshops sponsored by the Department of Community Affairs, provides introductory information on proper swimming pool operations and management. This course, in and of itself, is only a start; it cannot produce fully trained, competent pool managers. The Department strongly encourages those who manage swimming facilities to pursue ongoing additional training and resources offered by educational institutions and professional organizations.

For additional information on design and operation considerations, consult the Department of Environmental Resources' Public Bathing Place Manual, DER's Chapter 193 — Public Swimming and Bathing Place Regulations, as well as those sources listed in Appendix J, Reference List for Pool Managers.

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SECTION I

DESIGN CONSIDERATIONS

Specific dimensions and the actual shape of the pool are determined by the requirements of the programs to be conducted in the pool and by the activities that will take place in and around the surrounding deck area.

Pool designers, in the past, were almost completely influenced by the rules and specifications for competitive swimming. Meeting the standards for competitive swimming in conventional rectangular pools invariably resulted in compromising other program needs. Where other program needs were the dominant factor, the pool often ended up being "nonregulation" with respect to competitive swimming standards. This dilemma of trying to meet all program needs still confronts pool designers, but there is significantly less emphasis on competition and more emphasis on recreational interests.

Another frequent problem is that architects too often design pools from a purely esthetic point of view, ignoring the basic design principle that "form follows function." The best solution to the problem of meeting all program needs appears to be the "multiple pool" concept where it is feasible. This idea, initiated in the 1930's by the Boy's Club of America, introduced the "T" shaped or multi-use pool which set off the diving area from the general swimming area.

A. Factors to Consider in Designing or Rehabilitating a Pool

1. General

There are three major areas that need to be considered.

Competitive Swimming Requirements

Planners of new pools must decide on the level of competition for which the pool must be designed and prepare plans accordingly. Check the NCAA (National Collegiate Athletic Association) and U.S. Swimming rule books for requirements.

Recreation Requirements

When a pool must serve the total recreation needs of a community, its design is greatly affected.

a. A considerable portion (surface area) of the water should be shallow for general swimming (up to 80% of the water should be less than five feet deep).

b. There should be a ramp, along with stairs, leading from the deck into the shallow end of the pool to accommodate handicapped and older persons. However, stairs and ramps, as potential obstructions to swimmers, must be recessed out of the way of the swimming lanes and main pool body.

c. There should be provision of a deep water well for springboard diving, scuba diving, water polo, synchronized swimming and ballet, and other activities that require deep water. This might be a physically separated diving tank or by way of the pool configuration, such as an "L" or "T."

d. The ratio of deck space to water area should be 2 to 3 for indoor pools, and 3 to 1 for outdoor pools.

Other Program Requirements

Some of the requirements are:

a. Instruction: Shallow water (maximum depth of 5 feet) with a training pool for young children ranging in depth from 2 to 4 feet.

b. Spray, wading and familiarization pools: spray pools have a spray mechanism in the center and allow for no standing water; wading or familiarization pools are, at the shallow end 0 to 6 inches deep, and at their deepest 18 inches. These help acquaint youngsters with the water in a less threatening environment.

c. Water Safety Instruction: No specific needs except it is desirable to have some deep water (12 feet in depth.)

d. Synchronized Swimming: 2000 to 3000 square feet of water area, all over 6 feet in depth, underwater speakers and lights, overhead flood and spotlights.

e. Water Polo: Special deck and pool markings, minimum of 6 feet deep water throughout playing area, receptacles (anchor sockets) to take goal nets.

f. Safety Equipment
Lifeguard chairs
Racks for hanging ring buoys and reaching poles.
Intercom/telephone/cb's at each lifeguard chair for communication between lifeguards and a phone with an outside line in the pool area for emergencies

2. Shape of the Pool

Pool form must follow the functions just outlined to satisfy competitive, recreational and educational requirements, usually dictating a rectangular form. On close analysis, the more elaborate shapes are, in fact, combined pool forms. The L-shaped pools are really two rectangular pools with a common wall omitted where they come in contact; Z-shaped pools are three rectangular pools with two common walls omitted, etc. In general, the large water surfaces created are more of a traffic control problem than the apparent savings of the common wall. A multiple pool complex (with physically separated pools) is generally the better value. Pool programs are better served by separating areas.

3. Water Depths and Bottom Contours

For the competitive or general swimming pool, the minimum depth is 3 1/2 feet, and should be specified in all new construction.

For younger bathers, there are several options in the "swimming pool arena." One is a spray pool, a pool where there is no standing water but rather where the water is sprayed up in the air, falls on the bathers and is immediately carried away in a drain. There are also wading or familiarization pools that serve the age group 6 and under. Depths vary, with the shallowest end being between 0" and 6"; the deepest portion of a wading pool should no more than 18 inches. The bottom slope of these pools should not be steeper than 1 to 15. These wading pools must have independent recirculation, filtration and disinfection systems adequate in size to provide a turnover rate of not more than 2 hours. The wading or spray pools may not contain any obstructions, raised drains, steps or concrete "gadgets" that pose a threat of injury to the users.

Bathers should be able to enter the water readily from the deck, with the overflow or deck at the pool level, and the deck must be no more than 6 inches above the water's surface.

For all pools, the bottom should at all points have some pitch, however slight, uniformly inclined, to insure complete drainage to the main bottom drain. Hopper and spoon shaped bottom designs should be avoided for safety and automatic vacuum sweeper usage reasons. Diving into a hopper or spoon-shaped bottom designed pool can easily result in the diver breaking his neck.

4. Overflow Systems

On all pools, the overflow is used for skimming the water and removing the surface film. Pool perimeter overflows have evolved through the years to meet program, hydraulic, and economic optimums. Basic overflow techniques available to the designer include the fully recessed overflow, partially recessed, roll-out, rimflow construction, and surface skimmers. Gutters must extend completely around the pool. Whatever the system, the water level must be maintained at a level above the gutters or skimmers (skimmers may be used to pools with widths of 30 feet or less) so that surface debris will be removed in the skimming process.

5. Copings

The coping is a finishing section serving as a top or cap for the vertical pool wall. Almost all pools are finished with a decorative concrete, stone coping, or tile finish.

A good coping must be of substantial, permanent material, have continuous surfaces without crevices or corners, be non-slip when wet, be installed hydraulically true (parallel to the water's surface,) serve as a handhold from pool side, and be capable of being firmly secured to the pool shell. It should be frostproof when used on outdoor pools in freezing climates.

6. Underwater Lights

Where underwater lighting is used it must be installed according to the National Electrical Code, or the stricter requirements that may prevail in certain localities.

The standards for general illumination have doubled every ten years since 1930. It now appears that minimum values of 2.5 to 3.0 watts per square foot of surface area (incandescent) are required to develop the lighting intensity needed for the visual tasks of a comprehensive aquatic program.

The Illuminating Engineering Society (IES) recommendation has remained the same for the last decade and yields excellent results. This recommendation is based on the lighting output of the source rather than the energy input. It is based on the surface area of the pools, and calls for 100 lumens per square foot for indoor pools and 60 lumens per square foot for outdoor pools — this is the DER requirement.The placement of the lighting fixtures also has great influence on their effectiveness. Lighting fixtures should be at least 3 feet deep in the shallow areas, and preferable 6 feet to 8 feet deep in the diving well. A slight inclination downward from the horizontal, approximately 3 to 5 degrees, is recommended to minimize annoying surface reflections. Obviously, the use of a white interior finish will optimize the light reflection and dispersion characteristics.

7. Pool Basin Finishes

Interior finishes can be selected which meet budget requirements of architectural decor, keeping in mind that pools must be constructed of materials that are inert, stable, nontoxic, watertight and enduring. Pool finishes are classified as: coatings, tiles, plaster, and natural. Whatever the finish, pool bottoms and sides must be white or light colored (so that the lifeguards can see the pool bottom clearly,) and have smooth and easily cleanable surfaces; however, bottom surfaces must be nonslip.

a. Protective coating are the most diverse group of pool finishes. These materials are applied to the finished interior surface and will fully reproduce the texture of the basic shell construction. In the classification of "paints," rubber-base applications are one of the least costly and considered by many as the most practical covering. One season's service, however, is about all that may be expected.

b. Tile remains the classical permanent swimming pool finish, but the cost of setting tile has restricted its use on many pools to a waterline band where serviceability is essential. Its service-free permanence remains unchallenged. Square edge modules are recommended to permit a smooth strike of the tile grout. All floor-to-wall and interior corners should be carefully fitted with the proper tile pieces to form a uniform smooth curvature.

c. Plaster finishes are medium cost applications capable of four to eight years' service life. Plaster mixes are prepared from granular media, white cement, waterproofing, and hardening additives. White sand can be used, although "marbledust" or limestone powder may be employed with great effect. A brown truing coat, 1/4" to 3/4," is usually applied first to the clean, rough shell surfaces, establishing a bond and truing the interior shell geometry. One or two hard, thin, white finish coats of the plaster are then placed as soon as possible. The plaster should be cured under water for best results.

d. Natural or Integral finishes are important methods of obtaining low maintenance costs. Precast concrete sections having an integral mold finished surface have been successfully used. Concrete pool bottoms made with white sand, light colored coarse aggregate and white cement will provide a pool finish with lifetime dependability.

e. Vinyl liner pools should be avoided. Vinyl is a very slippery material under water and many individuals have been seriously injured when diving into pools lined with vinyl. DER considers vinyl liner pools generally unacceptable.

8. Deck Area

Adequate deck space around the pool will materially contribute to its successful operation. Outdoor pools require more space to accommodate their peak capacity. Deck ratios of 3:1 and 4:1 afford the most functional arrangements for handling peak summertime crowds.

Indoor pools cannot be designed with such generous deck areas. Walk widths should be a minimum of 6 feet, preferably 8 feet, and must be clear and unobstructed. Carpeting is not permitted within 4 feet of water's edge. It is to advantage for the program and traffic control to maintain a minimum "total width" of 18 feet for the decks. This will permit the designer to better control the traffic pattern while also maintaining the minimum deck-to-pool ratio.

Decks must be textured to prevent slipping when wet, and within a 10 foot perimeter area around the pool, all areas should be carefully pitched to provide positive drainage. A slope of 1/4 inch per foot is a minimum standard to guarantee the required drainage.

9. Underwater Observation Windows

Underwater observation windows are popular for their instructional value in observing the competitive finish and turning areas, and also in the diving well. In addition, where underwater programs include scuba instruction, synchronized swimming, and research activities, classroom type instruction has been found to be a valuable adjunct to the underwater observation. Finally, these windows can serve as a significant lifeguard observation area, particularly in wave pools where the surface of the water is disrupted by wave action, thus making it more difficult for guards to see below the surface from the deck or chairs.

B. Safety by Design

1. Size, Shape and Location of Pools

a. The size of any pool must be predicated on the expected "peak" use of the pool. In pools with depths of 5 feet or less, 15 square feet per person in the water should be used to establish the safe-use capacity of the pool. Deep water (over 5 feet) requires 25 square feet per person.

b. The shape of a pool should be determined by the pool's function and type of activities that will be conducted in the pool.

c. Multiple pools (two or more within a complex,) that are physically separated, are more efficient than a single pool from a program-scheduling point-of-view, but usually require more lifeguards than a single pool.

d. The larger the pool, the more difficult is the job of supervising swimmers. Pools having over 10,000 square feet of water surface area generally contain areas in the middle where the bottom is extremely difficult to see and consequently the job of supervision is more difficult.

e. The location of the pool must be such that no structure, i.e., bathhouse, garage, wall, house, shed, tree, etc., is within 15 feet of the edge of the pool. Any structure closer constitutes an invitation to dive from it into the pool. This also applies to trees with overhanging branches that come close enough to the pool to invite youngsters to attempt to dive or jump from them, or to hang rope swings from them. When slides are placed in pools, people, particularly teenagers, must be warned against diving from the top of the slide, a practice that has resulted in several broken necks. Overhead and nearby electrical lines, which could fall into the pool or onto a wet deck, must be avoided.

2. Entrance to Pool

Even before leaving the locker room, hazards are encountered. Foot baths, once thought of as a good idea, are now banned. They promote the spread of disease, are frequently slippery and are tripping hazards.

Every effort should be made to orient pools so that swimmers entering the pool from the locker room or bathhouse do so at the shallow end of the pool. (DER regulations require this.) It is crucial to have depth markings and warning signs specifically at the point of entry so that swimmers are made aware immediately of the depth of the water, and so that they see the rules of the pool immediately.

Steps, stairs or ladders, with slip-resistant surfaces, are to be provided at the shallow end of the pool and at least every 75 feet, and steps or ladders at the deep end. Concrete steps should be cast into the pool wall (recessed) to avoid injuries from individuals swimming into or getting caught behind metal steps that protrude into the pool on the wall. All ladders/steps shall have handholds. There shall be a clearance of not less than 3 inches nor more than 6 inches between the handhold and the pool wall. If stairs are provided, they must be recessed out of the way from swimming lanes.

Wading pools should be contained in a separate enclosure with a minimum 4 foot high fence that includes self-closing, self-latching gate, and must be located at least 15 feet, preferably 25 feet, from the shallow end (as opposed to the deep end) of the main pool.

3. Water Depth

a. The deeper the water, the more critical becomes the need for supervision of users.

b. Public pools that are designed primarily for recreational use should have the major portion of the pool less than 5 feet deep (4 1/2 feet is recommended.)

c. The slope of the bottom in the shallow end of large pools (5 feet or less) should not exceed 1:12 feet. A maximum slope of 1:15 is preferable for safety.

   In the portion of the pool between 5 and 7 feet deep, the slope of the bottom must not exceed 1 foot vertical for 3 feet horizontal. In portions of the pool with a depth greater than 7 feet, the slope should not 1 foot vertical in 3 feet horizontal, and shall not exceed 1 foot vertical in 2 feet horizontal. (For safe accommodations of springboard diving, it sometimes becomes necessary to increase the slope to 1:2 feet to provide sufficient deep water far enough forward from the end of the board.)

d. To safely accommodate young children (up to the age of 4,) a water depth from 0 inch to a maximum of 18 inches should be provided. This is best accomplished by constructing a separate pool rather than attempting to incorporate this depth of water within the area of a larger pool. (DER requires a minimum depth of 3 feet in a "swimming" pool.) Children's pools (often called "junior," "wading," or "familiarization" pools) should be placed a safe distance from any deep water pool (recommended minimum distance: 25 feet,) should be enclosed by a fence or other suitable barrier 4 feet high, and must be supervised by a lifeguard specifically assigned to that pool. The guard cannot split his duties, at the same time, between such a pool and another pool. Incorporating shallow water portions (2 feet or less) less into a pool, or as a wing to a large pool, is dangerous since adults may dive into such an area without realizing the depth and be seriously injured or killed.

e. For safe springboard diving, adequate water depth is imperative. Any pool having a springboard that is 14 or 16 feet long must conform to competitive diving standards since it has been repeatedly proved that the inexperienced diver often deviates more from the normal dive pattern than the experienced competitive diver. The most crucial consideration related to water depth for diving is the need to provide sufficient deep water far enough forward from the end of the board so the diver will not hit the upslope of the bottom at a 5 or 6 foot depth, which would be extremely dangerous.

f. The competitive diving standard relative to required water depth for a one meter springboard calls for a depth of 12 feet at the plumb line (the point immediately below the front end of the board.) The 12 foot depth must be carried forward from the end of the board for 20 feet.

   The lateral distance that this depth must be carried from the center of the board is a minimum of 12 feet. These measurements provide a diving area of constant depth of 24 feet wide by 20 feet long. (See Diving Area Design in Appendices.)

4. Safety Markings and Signs

Safety marking represent one of the most important means of communicating with the pool user. Markings are used to communicate critical safety information regarding the location of hazards such as break points, deep water, steps, underwater ledges, etc.

a. All safety markings in and around the perimeter of the pool should be installed during the construction of the pool.

b. Marking should be specified on the pool's construction plans and must meet Department of Environmental Resources regulations and recommended professional standards such as those promulgated by the National Spa and Pool Institute (NSPI,) American Public Health Association (APHA) and Council for National Cooperation in Aquatics (CNCA.)

c. Depth markings must be placed both on the deck near the pool's edge (or on the coping of the pool) and the interior wall of the pool except in rimflow or deck level pools where the wall is below the water level. The markings must be in a contrasting color (black or dark blue,) against a light background, and letters and numbers should be a least 4 inches high, with 6 inches preferred. All depth markings must accurately show the actual water depth. Depth markings should be located at each point where the water depth increases or decreases by one foot, or at least every 25 feet, which ever comes first. The interval of depth measurement must be shown by including 'FT' and 'IN,' and may include 'M' for meters. When possible it is recommended that depths be identified in both feet and meters.

d. Depth marking indicating separation of deep water from shallow water must be at the breakpoint and must coincide with the exact depth of the water at that point.

e. The boundary line between the shallow and deep areas shall be marked by a black or red line 4 inches in width, located on the pool bottom and walls. A safety rope and buoys with buoy keepers shall be attached to the pool wall 1 to 2 feet toward the shallow end of the pool from the breakpoint.

f. In pools that do not possess bottom racing lines for competitive swimming, it is desirable to place a line along the bottom of the pool, equidistant from the sides, to provide users with a visual image of the contour of the pool's bottom. For indoor pools, a practical depth indicator can be effected by painting a 1-inch wide line on the wall parallel to the pool length. Such a line would show the pool depth profile in reverse or mirrorimage fashion.

g. "Hopper bottom" type pools (pools where the walls slope at an angle of 45 degrees to the bottom in the deep end,) are such a marked deviation from conventional pool design that they are extremely dangerous to the unsuspecting patron. The bottom is not a true reflection of what a diver sees on the surface; consequently, when diving into pools of this configuration, the diver may find himself striking the bottom before he expects to or at an angle that could nullify the protection that the arms and hands usually afford. The sides of the existing hopper should be stripped with 6 inch wide stripes or other marks to provide a graphic and perceptive representation to all divers.

h. The edge of the steps that are recessed into the deck or pool wall must have a black or red band, 2 to 3 inches wide, to facilitate their identification for underwater swimmers and those descending into the pool.

i. The leading edge of underwater ledges and obstacles, even those 4 inches wide, must have a red or black stripe to make the edges visible to divers and underwater swimmers.

j. Diving safety can be enhanced by color coding the pool's coping as follows: red in areas where diving is prohibited and green in the areas of the pool where diving from the deck is permitted. In shallow water (5 feet or less,) the words "NO DIVING - SHALLOW WATER" must be clearly marked on the pool deck with red letters or acceptable contrasting color. The letters must be at least 4 inches high, and the warning must be repeated at least every 15 feet in shallow water. In areas where diving is permitted, it is recommended that signs be stenciled on the green coping stating "DIVE FROM HERE."

k. To help clarify the water's depth and the location of the pool bottom, racing lines and geometric figures can be painted on the pool bottom.

l. Pool rules should be written in large letters on large signs, not typed on an 8 1/2" x 11" paper. The rules should be posted in several conspicuous locations in both locker rooms and in several locations around the pool.

5. Safety Lines

A safety line separating deep water from shallow water is an essential safety device that has a series of typically plastic floats strung together by a rope. They should be placed 1 to 2 feet toward the shallow end away from the breakpoint. Safety lines must be strung tightly enough to permit a swimmer to hold on to the line for support without having it sink more than 6 inches below the water's surface.

6. Other Safety Devices

a. Ground Fault Circuit Interrupters (GFCI) must be included on all electrical equipment and wiring around the pool to prevent shock.

b. A water sensor is a safety device that can be an effective night sentry that indicates a disturbance in the water or on the surface — such as that caused by an unauthorized swimmer. It should be installed with its alarm located where it will signal someone in authority and turn on a set of floodlights.

c. A safety light permanently "on" in the pool area is essential for identification of the pool at night.

d. A pool cover should be placed over all outdoor pools in which the water is retained during the off-season. The cover will prevent an intruder from accidently falling into the pool water.

e. Depending on the need for surveillance of a pool, such devices as an electronic eye, a closed circuit TV, or an electronic mat could prove to be effective sentries in the prevention of unauthorized entry to the pool.

f. Automatic emergency lights, capable of energizing instantly on power failure of the main lighting system, should be installed during initial construction in all pools.

g. The minimum surface illumination level is 50 foot candles per square foot with all glare eliminated for recreational swimming. Illumination for competitive swimming is 100 ft. candles.

7. Drains

Drains should incorporate covers or grates with openings no smaller than 1/2 inch in diameter and no larger than 1 inch, to prevent fingers of hands from getting stuck in them. Drains must not be located directly under or in front of diving boards, but they may be in the diving well area. Drains should be of an anti-vortex design so that if plugged, the system will shut down immediately.

The best form of drain cover is rectangular, covering a trench in which the outlet pipe is located. This design reduces the force of the suction from the outlet pipe and avoids the possible entrapment of swimmers. The grate should have a net-free area of at least six times, and preferably ten times, the diameter to the suction pipe below.

Drain covers or grates should be securely fastened to prevent the possibility of removal by swimmers.

8. Lifeguard Stands

a. The number of lifeguard stands needed is regulated by DER design guidelines. Special considerations may be necessary depending the amount of deep water (over 5 feet,) the location of the deep water, and the number of diving facilities. (Generally, no less than one stand should be provided for every 2000 square feet of pool surface.) Chairs must be located at waterside, should be positioned to minimize sun glare, be 5 to 6 feet above the deck, should have swivel chairs and straight backs, and give complete coverage of the pool. (Glare not only obscures the guard's view of surface and underwater activity but can also greatly increase eye fatigue.) Chairs should be positioned so that guards in those chairs are not expected to cover more than a 180 degree angle of view. Lifeguards in chairs are considerably more effective than those at ground level, and therefore must be provided and used by guards whenever the pool is in use.

b. In large pools (over 50 meters long) and multiple pool complexes, lifeguard stands should be equipped with intercoms or telephones to enable the pool manager or supervisor of lifeguards to communicate with guards at all times, and to control the pool area via public address loudspeakers.

c. A desirable addition to the lifeguard stand in large pools is an alarm system that can be activated when an emergency occurs.

d. By Pennsylvania law, lifeguards are required, when on duty, to be "...at water side," and thus the lifeguard stands should be "at water side." Guards and/or chairs even one step back from the water's edge create a blind spot (where the pool bottom meets the pool wall) that the guard cannot see. Chairs should be oriented so that the guards will not be looking directly into the sun, nor be directly facing the wind. Additionally, chairs should be elevated 5 to 6 feet off the deck. When chairs are located over shallow water (less than 5 feet,) lifeguards must be instructed in techniques of diving shallow or jumping shallow to avoid the possibility of injury. These entries should be practiced regularly.

e. Where there is a separate wading pool, this must be supervised by a separate lifeguard who is also certified in infant CPR.

9. Springboard Diving Stands and Starting Blocks

a. All stands that accommodate springboards should provide a "bed" under the board to prevent a person who accidently steps off the side of the board from falling off the stand onto the pool deck below. This bed should extend at least 1 foot beyond each side of the diving board to provide additional protection for divers from falling.

b. Handrails must be placed on all diving stands and be 30 inches high. The safest design is where the sides are entirely closed. Where the design does not include closed sides, intermediate rails should be provided, so that no opening is more than 12 inches. Rails should be carried forward to a point at least 1 foot, and preferable 2 feet, over the water toward the tip of the board.

c. Steps leading up to diving boards are safer than vertical ladders. The angle of the steps should not be more than 50 degrees from the horizontal, with the tread 6 inches deep and finished with a non-slip material. (Vertical ladders are not acceptable for diving boards and platforms higher than 1 meter.) Steps should be of a corrosion-resistant material and easily cleanable. Handrails should be provided on both sides of all steps and ladders leading to diving boards and platforms.

d. For safety reasons (based on recent studies), starting blocks must be installed in water no less than 5 feet deep with deeper water preferable. Starting blocks must be used during supervised practices and swim meets only. Only trained competitive swimmers should be permitted to use them. These blocks must be designed and installed so that they can be easily and completely removed when not being used by competitive swimmers.

Where starting blocks have been installed in the shallow end, signs must be posted regulating their use for "official competition only." Some starting block manufactures offer free warning labels that can be attached directly to the blocks. Coaches must warn their swimmers of the dangers of diving into shallow water. Another method of preventing the unauthorized use of starting blocks is to place traffic cones on the blocks and then cover the blocks and cones with waterproof nylon covers.

e. High performance diving boards, such as 14 and 16 foot long maxiflex boards, should not be mounted in pools that do not meet the minimum specifications provided in Appendix 1. This means that many older pools should not use these boards. This does not preclude altogether in such pools. Rather, it restricts the equipment that can be used (in terms of height, length and flexability,) and the height and weight of those who use the equipment.

f. To avoid glare from the sun and having the diver looking in to sun, diving boards and platforms at outdoor pools should face north if possible with east being the second choice. Windows and overhead lights should be placed so that glare is avoided to the greatest extent possible. Glare and reflection on the water's surface will obscure underwater swimmers from the diver's view. Glare is an important consideration in the placement of starting blocks as well.

10. First Aid Room

a. Pools with surface areas greater than 4,000 square feet must have a readily accessible first aid room or area designated and equipped for emergency care. This room/area should be located so that it is readily accessible to the street for easy transport of accident victims to an ambulance.

b. The room must have a cot, sink and phone; it should have a toilet and a shower room with hot water.

c. Emergency equipment and supplies should include an inhalator, resuscitator, and first aid equipment of the type recommended by the Department of Environmental Resources, including two spine boards for removal of swimmers who sustain back and neck injuries.

d. There should be a telephone available in the first aid room or other easily accessible location with clearly posted numbers to hospital, police, fire department, and any doctor who might be on call. It is advisable to post these numbers prominently. Written emergency procedures should be affixed to a wall near the telephone for review by pool staff.

For additional information specific to design, operation, and safety regulations promulgated by the Commonwealth of Pennsylvania, consult the Pennsylvania Bathing Code and the Bathing Place Manual published by the Department of Environmental Resources.

11. ADA Considerations

The Americans with Disabilities Act (ADA) mandates that pool owners provide access to swimming facilities. This is an issue not only for new pools but also for all existing pools whether or not a pool renovation is planned.

This includes not only traditional "swimming pools" but also wading and spray pools, beaches, hot tubs, etc. — i.e., all swimming facilities. However, not all pool-related facilities must necessarily be accessible; several potential exceptions include diving boards and water slides, depending on their height. As with the balance of ADA, the reasonableness of providing or not providing access is based on economic, design, historic and other considerations.

The requirement applies not only to the actual swimming facility, but to the support facilities as well. These include, among other things, parking lots, walkways from the parking areas to the use areas, bathhouse and locker facilities, restrooms, concession stands, picnic facilities, shade and lounging areas, etc., as well as programming.

Access to the actual pool itself can be accomplished in several ways, including transfer steps, transfer levels, ramps, lifts, and zero depth entry. The means of access might be a permanent fixture or removable, manual or mechanical, and there are pros and cons to each.

SECTION II

SWIMMING POOL CHEMISTRY

Few things in life provide such a beautiful and serene picture as a clear, sparkling swimming pool on a hot summer afternoon. Yet beneath the surface of that picture of calmness lies a veritable seething cauldron of chemical, biological and electrical activity. A swimming pool may be likened to a test tube involved in an ongoing experiment. Few people realize the multitude of changes taking place, some in seconds and some requiring hours or days. Yet many pool managers fail to test the water accurately, comprehensively, or frequently enough, and fail to keep accurate records to tell them what has been added to and been going on in this test tube.

Swimming pool water is an extremely unstable compound due to the many factors that exert influence on it. Factors that affect water chemistry are:

Human:

Skin and fecal bacteria; body oils (natural and artificial such as suntan oil); ammonia from human sweat and urine (from tiny tots); dirt; chewing gum; food; splash out.

Environmental:

Acid rain; air/water temperature; air pollution; algae and fungi; chemical gases formed in the water; geographic location; humidity; sun; temperature; evaporation; dust; leaves from trees.

Construction/Maintenance/Sanitation:

Backwash frequency; chemical conditioning; construction materials (some surfaces/materials break down in acid water); disinfectants; draining; filter media effectiveness and type; splash out and the makeup water quality; test kit reagent quality.

With all this potential activity, it is ludicrous to neglect a pool hour after hour, especially when the pool environment is always changing, sometimes very rapidly. The information in this chapter will help the homeowner, aquatic facility director, lifeguard or pool operator to manage their pool in a healthy, safe and cost effective manner. For planners of new pools, the material provides information on the different systems and chemicals that are used in maintaining proper water conditions.

A. Health, Safety and Cost Effectiveness

Health

A swimming pool is a public water supply, used for bathing instead of drinking. In most states the operator employed at the public water works must demonstrate his competency by successfully completing a water treatment plant operator's course before being hired and given the responsibility for such an important public trust. Unfortunately, the aquatic profession has no such standard, and as a result may entrust a teenager recently certified in lifeguarding or water safety to assume some of the same responsibilities for public safety and health as the operator of the local water treatment plant. Water is an excellent environment for the transmission and growth of bacteria - including those that produce Typhoid and Paratyphoid Fever, Amoebic and Bacillary Dysentery, Hepatitis, Pink Eye and Impetigo just to name a few. Bacteria prefer a warm, moist conditions with an adequate food source thus making the swimming pool an ideal environment.

Safety

Clear, sparkling water is created only by proper filtration, disinfection and chemical balance. Care-less management of any of these three factors can produce a degree a turbidity that can obscure a person's vision of the pool bottom, even in shallow water. Many times each year accidental deaths by drowning occur as a direct result of cloudy water in poorly managed pools. Turbidity stems from many causes, including environmental factors, such as algae and dust, from the improper preparation and use of disinfection systems such as calcium and sodium hypochlorite, poor filtration, and from precipitation of minerals in the water due to fluctuations in pH and alkalinity.

Cost Effectiveness

Two major problems that plague the aquatic profession today are costs and water treatment that includes, but is not limited to, water chemistry, disinfection and filtration. Both problems are significant, requiring a concerned attitude and a need for facility management to gain the knowledge necessary to deal with them.

Abuse of energy and water treatment systems will escalate the cost of operations, causing early replacement of major circulation equipment and construction materials, and may subsequently cause staff and budget cuts or perhaps the closing of the facility. In terms of energy, capital expenditures and the cost of annual maintenance, a swimming pool now borders on being a luxury. Swimming pools are designed to last for 40 to 50 years. Pool managers and staff must be educated and trained to obtain maximum life from their facilities and operate them on a cost effective basis. Aquatic facility employees have an obligation to protect their facilities. Employees might even view this as one way to insure their jobs for the future.

If a vandal was caught intentionally destroying a swimming pool, he would be called a criminal. The damage occurring at some pools due to unbelievably poor maintenance and operations is at least as bad as that caused by vandals. It's the result of either a lack of knowledge or concern by the pool staffs and managers. Too many agencies, municipalities and schools that have pools are being forced to spend huge sums of money for rehabilitation, including new filters, plumbing, pumps, surface finishes and heaters, after only ten years or less of operations. Unless pool managers become more cost conscious, energy costs and improper maintenance will force some pools to close long before their normal life expectancy had been reached.

B. The Chemistry of Pool Water

1. The pH of Water

Few abbreviations are used so extensively and understood so little as the pH of water. Managers adjust to it, lifeguards test it, and patrons talk about it. pH is a symbol that represents the potential of hydrogen ions, or the strength of the hydrogen ion concentration in a solution. The solution the pool operators and owners are concerned with is water (H_2O). In its natural state, as rain, water is ideally a neutral substance with a pH value of 7.0. Acid properties of water are due to the presence of hydrogen ions, written H+. Basic properties of water are caused by hydroxide ions, written as (OH) -. Water, or H_2O, can also be expressed H+(OH) -, and is a substance that is constantly breaking up or ionizing (dissociate) into an equal number of hydrogen ions. Since the number of each is equal, pure water is neutral.

All substances have a pH that can be established through any number of electrical and colorimetric tests. The pH test result of any substance, i.e., swimming pool water, is then compared with the standard pH table as indicated below.

pH Table

0.0—6.9	**7.0**	**7.1—14.0**
Acidic	Neutral	Basic
Corrosive to metal		Causes precipitates

Since all values between 0.0 and 6.9 are acidic, any pH test result falling within that range would indicate an acid water condition. Conversely, any result between 7.1 and 14.0 would identify the water as basic.

If a base substance such as soda ash is added to distilled (neutral) water, some hydrogen ions would be neutralized, showing an increase in hydroxide ions and a higher pH. If an acid was added to distilled water, the hydroxide ion concentration would be reduced and show a decrease in pH. Essentially the same reaction occurs in swimming pool water.

It is also important to point out that a pH test does not indicate by volume how acidic or basic a substance may be. It provides only an indication of an acid or base condition.

pH Recommendations

Authorities agree that pool water must be maintained on the basic side of the pH scale, as man is more comfortable in water that is slightly basic. In Pennsylvania, the Bathing Code requires that the pH be kept in a range between 7.2 and 8.2. If the pH is allowed to drop below 7.2 metal surfaces will corrode (filter tank, pipes, heater coils, etc.) Skin irritations and excessive chlorine odors may also be noticed.

High pH reading (above 7.6) must also be avoided. As readings approach 8.0, iron and calcium can form a precipitate (solid particles suspended in the water) causing turbidity or unclear water. In addition, scale can form on the filters, pipes, and heater. Another important factor related to high pH is the negative effect it has on the formation of hypochlorus acid (bactericide formed when chlorine is added to the water). At a pH of 7.2, approximately 60% of the chlorine dissolved in water will convert to hypochlorus acid, while at 8.5 the conversion is limited to approximately 10%. Practically speaking, the higher the pH above the recommended figures, the more chlorine it will take to maintain the proper level of bactericide in the water, thus the higher the cost of operation. A pH range of 7.4 to 7.6 should be maintained to provide pool managers and operators with the best results in bather comfort and balanced water.

Results of low pH: *(Moving downward, below 7.2)*

- Metal corrosion, leading to leaks in all metal in contact with the corrosive water.
- Rapid loss of chlorine.
- Skin, eye, and mucous membrane irritation.
- Excessive chlorine odor.

Results of high pH: *(Moving upward, at 7.8 and above)*

- Urine-like odor.
- Calcium and other minerals precipitate out causing cloudy water.
- Clogged pipes, pump impeller blades, and heater coils scaled with calcium.
- Calcium precipitates calcifying sand filters.

pH Control

Many pools today use calcium or sodium hypochlorite as disinfectants, both of which can increase the pH significantly depending upon the chemistry of the original water source feeding the pool. Pools equipped with gas chlorine have a problem with low pH, as it is a very powerful acid. A high pH can be lowered by adding an acid directly to the pool, preferably when the facility is not in use. These acids include a powder (sodium bisulfate), or liquid (muriatic acid.) Sodium bisulfate is more expensive but less dangerous to use, while muriatic acid is less expensive but requires cautionary use.

Raising the pH involves the addition of soda ash (sodium carbonate), a fine white powder that can be added directly to the pool or mixed with water and added through a chemical feed pump. For pools with chlorine gas the proper pH range can be maintained by using 1 to 1-1/2 pounds of soda ash for every pound of chlorine gas used.

2. Lowering pH with Carbon Dioxide (CO_2)

The use of CO_2 as an alternative to liquid and dry acids has recently become popular, especially with so many pool operations using sodium hypochlorite (liquid chlorine). When CO_2 is dissolved in water three reversible reactions occur. The first reaction is:

$CO_2 + H_2O \rightleftharpoons H_2CO_3$ (Carbonic Acid)

Since carbonic acid is dibasic it forms two series of salts:

1. $H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$ (Bicarbonate)
2. $HCO_3 \rightleftharpoons H^+ + CO_3^{--}$ (Carbonate)

Free hydrogen ions (H^+) react with hydroxides and lower the pH.

$H^+ + OH^- \dashrightarrow H_2O$

Because CO_2 forms a bicarbonate salt it has the added quality of raising the total alkalinity, while lowering pH, a condition that does not occur with muriatic acid (liquid) or sodium bisulfate (dry acid).

The advantages of CO_2 are:

1. Eliminates storage and use of acids.
2. Eliminates possibility of sodium hypochlorite and muriatic acid being accidentally mixed together.
3. Eliminates corrosive acid fumes in the storage room.
4. Stabilizes or buffers the pH because CO_2 doesn't lower the total alkalinity.
5. Eliminates use of eye protection equipment and protective clothing.

The disadvantages include:

1. Adequate ventilation in the storage room
2. Chaining or securing CO_2 container to prevent leaks or damage to tanks.

Cost comparisons with muriatic acid at this time show that CO_2 is comparable with muriatic acid and is much less expensive than sodium bisulfate.

3. Total Alkalinity

Of more concern to a pool operator is the amount of alkalinity present in the water, commonly called total alkalinity, which is a measurable quantity expressed in ppm (parts per million).

Total alkalinity is important to the pool operator. A low total alkalinity, for example, can result in highly corrosive water that will eat away all metal surfaces in contact with the water (pipes, pumps, filters, etc.)

Total alkalinity is a measure of the extent to which a given amount of water is buffered or made to respond to pH adjustment. The pH value of water is an indication of the concentration of hydroxide or hydrogen ions. However, some alkalinity remains un-ionized and is not identifiable in a pH test.

Alkalinity in water represents the amount of bicarbonates, carbonates, hydroxide, and sometimes borates, silicates and phosphates. Total alkalinity is the sum of the concentrations of the first three in the proven absence of the latter three. As previously stated, there are three common types of alkalinity:

a. Bicarbonate — HCO_3
b. Carbonate — CO_3-
c. Hydroxide — OH-

Total Alkalinity equals (OH-) + (CO_3-) + (HCO_3-)

Water with only bicarbonates may have a pH value of 4.0 to 8.4 and cannot exceed the value of 8.4, even if the bicarbonate alkalinity reaches 20,000 parts per million. Water which contains bicarbonates and carbonates cannot exceed pH 12.0 regardless of amount. In water containing carbonates and hydroxide, the pH value can increase still higher with small amounts of alkalinity. This is even more true if the alkalinity id due to hydroxide alkalinity alone. Water containing only hydroxide alkalinity has a pH range of 9.6 to 14.0 and can be insufficient in alkalinity to prevent corrosion of plumbing or maintain an alum floc on a sand filter.

With this information in hand, pH lacks significance unless the total alkalinity is known, and that it is related to the number of hydrogen ions (H+) in the water.

Bicarbonate alkalinity, in the amounts found in swimming pools, is not irritating to the body. At pH 8.3 some carbonate alkalinity may exist that will sometimes be irritating to the eyes. If the pH rises above 9.4 hydroxide alkalinity may be present, but it cannot exist below this level. This type of alkalinity is extremely irritating, but seldom occurs in swimming pools.

It is generally recognized that swimming pool water should contain between 80 and 120 ppm of total alkalinity. The alkalinity of water is expressed in terms of mg./L or ppm of calcium carbonate determined by titration.

The preferred method of increasing the total alkalinity is to add enough sodium bicarbonate (bicarbonate of soda, better known as baking soda) to the water to raise the level to a range of 100 - 150 ppm. It's also important to remember that a low alkalinity (50 ppm) can produce rapid changes in pH due to bather load, chlorine, temperature, etc. An alkalinity level of 300 ppm or above will make pH extremely difficult to adjust. If the total alkalinity is less than 80 ppm, it can be raised approximately 10 ppm per 10,000 gallons of pool water by adding 1-1/2 pounds of sodium bicarbonate for each 10,000 gallons of water until the desired level is achieved. Alkalinity can be reduced by adding muriatic acid or sodium bisulfate. The addition of these acids will also reduce the pH level.

The addition of soda ash to pool water will generally increase the total alkalinity, as soda ash will combine with the carbon dioxide found in the water to produce sodium bicarbonate. This is a desirable type of alkalinity because it provides a comfortable water condition for the bather and creates the least amount of corrosiveness.

Testing three times per week for total alkalinity and the subsequent addition of bicarbonate soda is the best procedure for maintaining the proper alkalinity level. A separate total alkalinity test kit is required to run this test. The kits are generally inexpensive, under $25, and the four step test procedure is easy to follow. The results of the test provide information that is crucial to proper pool operation.

4. Total Hardness

Hardness and alkalinity are closely related, but not identical. Hardness is a measure of the amount of calcium and magnesium ions found in the water. Hardness is also caused by metallic ions such as aluminum, iron manganese, strontium and zinc.

Essentially, there are two types of hardness: carbonate and non-carbonate. Carbonate hardness (calcium) is usually equivalent to the total alkalinity, therefore rendering the alkalinity measurement generally sufficient for water control. A separate test kit is required to test for calcium hardness. The kits are generally inexpensive, costing less that $25, and the four step test procedure is easy to follow. The results of the test provide information crucial to proper pool operation. Some mineral compounds impart a permanent hardness (non-carbonate) and others are non-permanent (carbonate) or temporary hardness, while some fall into both categories.

Listed below are compounds common to these three groups (in a table adopted from Swimming Pool Operators Handbook, NSPI, 1972.)

Group 1 — Alkaline Minerals

Sodium hydroxide
Potassium hydroxide
Sodium carbonate
Potassium carbonate
Sodium bicarbonate
Potassium bicarbonate

Group 2 — Alkaline and Hardness Minerals (Carbonate or temporary hardness)

Calcium carbonate
Calcium bicarbonate
Magnesium carbonate
Magnesium bicarbonate

Group 3 — Hardness Minerals (Non-carbonate or permanent hardness)

Calcium carbonate
Magnesium chloride
Calcium sulfate
Magnesium sulfate

Regardless of hardness type, it is important for the pool operator to understand the conditions which hardness can produce.

Hardness can cause scaling and clogging of plumbing. Pools with heated water can experience trouble when calcium or magnesium, which are precipitated by heating, cause a scale to form on the plumbing. Such scale reduces heating capacity and can cause leaks and blocks in filters.

Another consequence of hardness sometimes occurs with calcium and magnesium compounds that are present in a soluble state as bicarbonates. The addition of soda ash transfers them into an insoluble state such as carbonates that will turn clear water cloudy by releasing these fine particles in suspension. Calcium can also cause discoloration deposits on paint and tile. These deposits are unattractive in appearance, but cause no harm to the surfaces on which the calcium is deposited.

The amount of hardness in a pool is also due to evaporation (minerals remain in the pool) and the subsequent addition of make-up water. Disinfection systems such as calcium hypochlorite also increase water hardness. If the hardness level reaches 500 - 600 ppm, the pool should be drained and refilled with fresh water. Calcium hardness can be reduced by adding sodium hexametaphosphate, also known as "Calgon."

Soft water with no hardness whatsoever is another undesirable condition as this type of water is very corrosive. A minimum of 80 ppm of hardness is recommended with 150 - 200 ppm being acceptable. If the hardness level is too low, it can be increased by the addition of calcium chloride dihydrate This material is a weak acid, and should be pre-dissolved in water before being added to the pool. A test for calcium hardness should be run at least once a week.

5. Total Dissolved Solids (T.D.S.)

Total dissolved solids would be the residue left should all the pool water evaporate. This would include all minerals and undissolved portions of chemicals such as residue from calcium hypochlorite. Total dissolved solids should be tested for weekly. Once the total dissolved solids reach a level of 800 ppm, or at least once a year (whichever comes first), the pool should be drained and refilled with fresh water. Failure to maintain a T.D.S. reading below this level can result in irradic and wide fluctuations in the pH, and will make it difficult if not impossible to balance the pool water.

6. The Relationship Between Sand Filtration and Water Chemistry Flocculent Chemistry

A granular filter medium such as sand will remove most solid matter from the water, but in many cases clarity can be increased noticeably by using an alum compound. Among the most common compounds used are aluminum sulfate, ammonium aluminum sulfate (ammoniumalum), and potassium aluminum sulfate (potassium alum). Commercial coagulant mixtures are also available under various trade names.

Aluminum sulfate is the most commonly used coagulant for sand filters. Unless there is a specific reason for resorting to potassium alum, most filter authorities do not recommend it since it can cause chemical problems in some waters. Commercial mixtures have some advantages over alum compounds, but they are also more costly.

How Does Alum Aid Filtration?

Aluminum sulfate dissolves in water, creating an acid solution. When this solution is allowed to mix with large quantities of pool water, the acid is neutralized and aluminum hydroxide is formed.

The aluminum hydroxide then mixes with water, and if the pH is in the proper range (7.2 - 7.6) it precipitates as a white gelatinous snowflake. The precipitate then fills in the space between the sand grains forming a gelatinous mat, capturing solid particles from the water, which might otherwise pass through because of their extremely small size.

Where, When, and How Much Alum?

The amount of alum to be added to the filter tank is usually two ounces for each square foot of filter surface area. In specific cases, this amount may vary slightly.

After the alum is added to the circulation water, a brief interval of time is necessary for it to dissolve, for the acid to be neutralized and for the aluminum hydroxide precipitate to form into a floc. For this reason, the alum must be introduced to the water at a point between the pool drain and the filters, and preferably at a point that requires it to pass through the pump before entering the filters. This allows for additional mixing by the pump. If alum is added too quickly, too close to the filter or in too great a quantity, it can pass through a sand filter, leaving alum in the pool, irritating the eyes, and causing the hair and skin to feel sticky.

Since the pool water, with which the alum reacts before it enters the filters, is only slightly basic, large quantities of water are required to neutralize the acid formed by the dissolving of the alum. The dissolved alum solution should be allowed to enter the circulation line very slowly to ensure that sufficient pool water is mixed with it. Alum should be fed slowly, with the total amount taking approximately four hours to be introduced to the filters. Introduction of alum at too fast a rate will result in an acid solution reaching the filters, without the precipitate having been formed, allowing the solution to pass through the filters and floc in the pool.

Alum is usually introduced into the line by means of chemical feeder, although an alum pot can be employed in the system. The alum is dissolved slowly in this container by a regulated flow of water. When the required amount of alum has been dissolved and added, the lines from the alum pot should be opened to full flow and allowed to remain open. This procedure will help prevent the clogging of the small pipes by the sticky alum floc. Though an alum pot is usually supplied in large pools, it is seldom a part of the home pool filter equipment. Some pool operators prefer to dissolve alum in a large crock and feed it through a plastic line regulated by a hand valve tapped into the suction side of the pump line. This method works very well, allowing the operator to see the process and determine whether the line is open or clogged, and when all the alum has been fed. When finished, the crock should be rinsed at full flow and allowed to remain full of water until the next application.

The entire process of alum flocculation is very sensitive to the acidity of pool water and if the pH is not maintained in the proper range (7.2 - 7.6), the flocculation process may not produce the desired results. Alum coagulants are used only with low rate granular media filters having an application rate of 3 gallons per minute per square foot of filter area, or less. Coagulants should not be used with "high rate" filters unless specified by the manufacturer.

Affect of pH on Alum Floc

Alum is peculiar in that it flocs best in pool water at a pH of 7.2 - 7.6. If the pH moves out of this range the alum floc will begin to dissolve. Only experimentation will determine the exact pH that is best for coagulation a particular pool. Consider a hypothetical situation where the pH of the water is 7.4 and the optimum floc point is 7.2. Most of the alum will have formed a floc at 7.4, but some dissolved alum will remain in the water that will floc out gradually as the addition of chlorine causes the pH to drop toward 7.2. Since the pool operator usually attempts to hold the pH above 7.2 soda ash will likely need to be added at this point. If the pH is raised to 7.6 some alum floc holding the dirt in the filter will dissolve, and the dirt will be allowed to pass into the pool. The solution to this problem of maintaining proper pH in a sand filtered pool is to add soda ash constantly in small amounts rather than occasionally in large amounts. If the pH drops below 7.2, backwash may be necessary before the gauge pressure differential is reached to adjust the pH without disturbing flocculation.

The addition of make-up water may also change the pH of the pool. If the make-up water has a pH higher or lower than the pool water, care must be taken not to disturb the floc by adding water to the pool. Alum produces an acid when it reacts with water and will lower the pH. For this reason the pH should be elevated slightly before adding alum.

7. The Relationship Between Chlorine and pH.

When chlorine, i.e., gas (elemental Cl_2), is added to swimming pool water a chemical reaction occurs as expressed in the following illustration.

$Cl_2 + H_20$ becomes $HCl + HOCl$

The two molecular substances formed in this reaction are hydrochloric acid and hypochlorous acid. Hydrochloric acid reduces the pH of pool water and serves no useful purpose. It must be neutralized through the addition of soda ash to prevent it from attaching cement and metal surfaces.

Hypochlorus acid is a strong bactericide and oxidizer, a very useful acid for the pool operator in maintaining clear, bacteria free water. Hypochlorous acid, however, ionizes (breaks up) into two distinct ions at a rate contingent upon pH levels as illustrated below.

HOCl = H+ + (OCL)-

Ionization produces a hydrogen ion and a hypochlorite ion that subsequently reduces the disinfection and oxidation affects of chlorine. Higher pH levels, which can occur naturally with the use of calcium and sodium hypochlorite, increases ionization. Increased ionization of hypochlorous acid is wasteful in terms of disinfection products (chlorine) and will require the use of more chlorine gas, thus raising operating costs. According to Mood, a free available chlorine of 2.5 ppm at pH 8.0 is required to generate the same amount of hypochlorous acid (.5 ppm) as can be produced by 1.0 ppm free available chlorine at pH 7.5. This relationship can be better understood by observing the following chart.

pH and Hypochlorous Acid Relationship

pH	Approximate % of Hypochlorous Acid	Approximate % of Hypochlorite Ion
7.0	73	27
7.1	71	29
7.2	66	34
7.3	60	40
7.4	56	44
7.5	50	50
7.6	45	55
7.7	40	60
7.8	36	64
7.9	30	70
8.0	24	76
8.1	22	78
8.2	19	81

The chart shows very clearly that pH levels higher than 7.5 do not yield cost effective production of hypochlorous acid. Lower pH levels mean more disinfectant per chlorine dollar spent. The best pH range for bather comfort, alum flocculation of sand filters, and hypochlorous acid production is 7.4 - 7.6, with 7.5 identified as an ideal pH. More chlorine must be used to achieve desired levels, if higher pH levels are maintained, significantly increasing operation costs.

Levels beyond 7.6 are not cost effective, and levels higher than 7.8 may cause minerals such as calcium to precipitate out, causing cloudy water and in a sense defeating a primary reason for adding chlorine to pool water (clarity.)

8. Algaecides

Warm water, high pH and sunlight provide ideal conditions for red, green, brown, black or blue-green algae to grow and attach itself to the sides and bottom of the pool. Algae has been a problem for most outdoor pool operators at some time or another, depleting chlorine, causing turbidity, slimy surfaces in and out of the pool, and occasionally producing a foul odor.

Without question, preventive maintenance is the best solution to handling algae problems. This includes maintaining a free chlorine residual above 1.0 ppm and a pH range of 7.4 - 7.6. However, some pool operators resort to commercially prepared algaecides or other chemicals known to be effective against algae. When used correctly these algaecides do have a killing effect, but also effect the chemistry of the pool water.

Quarternary ammonium compounds, or QAC's, are often used because they are considered much safer than the various mercury and copper compounds. However, ammonium ions can combine with chlorine, producing eye irritation through the development of chloramine compounds. QAC's will reduce chlorine effects, increase chlorine demand, collect on filters, and cause pool water to foam. Some types of algae have also developed a resistance to ammonium algaecides.

Pool operators have also used copper sulfate and phenylmercuric acetate in the past to control algae. Neither of these compounds are recommended for use. Copper sulfate can cause discoloration of bathing suits, skin rash, green hair, a carbonate hardness precipitate or an inky precipitate if sulphur is present in the water (hydrogen sulfide.)

Mercury products are not recommended for use under any circumstances since mercury is known to be a cumulative poison.

9. Controlling Carbonate Stability and Corrosiveness of Pool Water

In addition to knowledge of disinfectants and pH, the pool operator must be aware of several diverse parameters at work in pool water. Of primary concern is a disinfection level (free chlorine) within a narrow range of pH and proper total alkalinity content. Additives required for control of each of these factors in one way or another affect the other factors. In addition, the changing number of swimmers and introduction of new swimmers into the pool constantly introduces new organic and ammonia nitrogen along with microorganisms into the water. If the pool is outdoors, sunshine, wind, and windblown matter will further affect chemical balance.

All chemicals in pool water affect the tendency of water to be either corrosive or to deposit carbonate scale. An optimum equilibrium is possible when factors affecting these properties of water are nearly balanced. Professor W.F. Langelier of the University of California developed a very useful method of obtaining balance, expressing in a single formula the relationship of dissolved solids, calcium, total alkalinity, and pH value. This method has been subjected to experimental study in the field, has been found a check with operating results in the treatment of many municipal water supplies, and is recommended for use in swimming pools.

Use of the Langelier Saturation Index will help pool operators avoid unacceptable acidic and basic water conditions and thus prolong the life of their facilities, achieve bather comfort, obtain better and more stable chlorine readings, and maximum efficiency of operation and cost effectiveness. This procedure should be run at least once per week.

A "Saturation Index" for a given temperature is used as a reference point for comparing values of pH against actual determined pH values of the pool water. When these are in balance, the water is in equilibrium with calcium carbonate ($CaCO_3$) at that temperature. If the index is positive (+), the water is super-saturated with $CaCO_3$, and may deposit a coating or scale in the pipeline, particularly in metal filters, valves, pumps, etc. When it is negative (-), water will dissolve $CaCO_3$, and may be corrosive. In the event the Saturation Index is negative, the quantity of soda ash, bicarbonate of soda or calcium carbonate required for corrective treatment may be determined, and immediate steps taken to eliminate corrosive condition of water, i.e., metal attack.

For swimming pools, a practical simplification of the Langelier Saturation Index accounts for five pool water variables:

(1) water temperature,

(2) pH,

(3) calcium hardness,

(4) total alkalinity, and

(5) total dissolved solids.

Each of these variable qualities of the water must be converted to an appropriate factor for substitution in the formula.

Saturation Index = pH + temperature factor + calcium factor + alkalinity factor - 12.1 (for Total Dissolved Solids (TDS) levels under 3,000 ppm. A TDS above 3,000 ppm requires a TDS factor of - 12.2) For water temperature, there is a factor (TF) as shown on the chart. Total hardness must be converted to the calcium hardness factor (CF) on the same chart. Alkalinity is converted to the alkalinity factor (AF). For simplification, calcium hardness is assumed to be 70 percent of total hardness. This is not exact, but within the pH range 6.5 to 9.5, it is a sufficiently accurate approximation.

Sample Problem

Pool water tests on a given day yield the following results:

Water Temperature	78
pH	7.4
Calcium Hardness	100 ppm
Total Alkalinity	50 ppm

Using the Saturation Index Formula, SI = pH + TF + CF + AF - 12.1 (TDS) and the table below, substitute the factors in the formula for the results of that water test and calculate the SI value. DO NOT USE ACTUAL POOL WATER TEST READINGS (except for the pH) in the SI formula and DO NOT INTERPOLATE BETWEEN FACTORS.

Factors Necessary to Calculate Water Balance

Table 1 (TF)		*Table 2 (CF)*		*Table 3 (AF)*	
Temp. (F)	= Factor	Calcium Hard.	= Factor	Total Alkalinity	= Factor
32	0.1	5ppm	0.3	5ppm	0.7
37	0.1	25	1.0	25	1.4
46	0.2	50	1.3	50	1.7
53	0.3	75	1.5	75	1.9
60	0.4	100	1.6	100	2.0
66	0.5	150	1.8	150	2.2
76	0.6	200	1.9	200	2.3
84	0.7	300	2.1	300	2.5
94	0.8	400	2.2	400	2.6
105	0.9	800	2.5	800	2.9
128	1.0	1000	2.6	1000	3.0

See page 46 for recommended water chemical levels.

Substitute the pool test results.

S.I. = 7.4 (pH) + 0.6 (TF) + 1.6 (CF) + 1.7 (AF) - 12.1 The result is a S.I. = -0.8

Correcting the Imbalance

For swimming pools, + 0.5 to - 0.5 is considered acceptable, with + 0.3 to - 0.3 better and a SI of 0.0 being best. Higher than + 0.5 is scale forming; lower than -0.5 is corrosive. The recommended objective is to maintain a Saturation Index of 0.0 or just slightly on the positive (+) side.

Since the Saturation Index in this example proves to be corrosive (-), two or three adjustments can be made to bring the S.I. closer to 0.0. First, the pH can be raised to 7.5 or 7.6 by adding soda ash to the pool. Second, the calcium hardness can be increased by adding enough calcium chloride dyhydrate (rock salt) to raise the calcium hardness to 150 ppm. Third, the total alkalinity, which is extremely low, must be raised to at least 100 ppm. This can be done without affecting the pH by adding bicarbonate of soda. If all three factors are corrected by increasing: pH to 7.5; calcium hardness to 150 ppm, total alkalinity to 150 ppm, then recalculate with the S.I. formula

S.I. = 7.5 (pH) +0.6 (TF) + 1.8 (CF) + 2.2 (AF) - 12.1 provides a S.I. = 0

The pool is now balanced, providing protection for all material in contact with the water, and the water chemistry will provide relatively good bather comfort and as maximum efficiency from the disinfection system is used.

C. Handling Pool Chemicals Safely

1. Environmental Concerns

The U.S. Environmental Protection Agency (EPA) was established in 1970 to implement regulatory laws passed by congress to protect the environment as well as and the health of humans and animals. Motivation to develop environmental regulations was undoubtedly stimulated by early environmentalists such as Rachel Carson in her classic text *Silent Spring*, published in 1962. Carson expressed alarm over pesticides such as DDT and other chlorinated hydrocarbons such as aldrin, chlordane, dieldrin and heptachlor because of their stability and persistence in the environment.

These chemicals were originally hailed for their long term residual life in the environment, a major factor in their effectiveness. However, scientists also began to realize that these insecticides could accumulate in the fatty tissues of some animals higher up in the food chain. Animals at the top experienced biomagnification, which means they accumulated chemical residues in higher concentrations than the total found in the organisms below them in the food chain. In 1972 the EPA banned the use of DDT in the United States, demonstrating for the first time a restrictive attitude toward chemicals that presented significant environmental and health hazards.

All chemicals discharged into the environment, such as those which accumulate in waste water discharged from swimming pools following backwash or pool draining, are included in the EPA's list of regulatory concerns. These chemicals include the many types of disinfectants used in swimming pools and spas, and are considered to be pesticides by the EPA regulatory agencies in Pennsylvania such as the Department of Agriculture and the Department of Environmental Resources.

Understanding Pool Chemical Container Labels

2. Label Development

One of the two most important components of disinfectant chemical safety (storage, disposal and use) is the product label which manufacturers are required to use by law. The other component is the Material Safety Data Sheet (MSDS). Labels are legal documents that provide directions on mixing, application, storage and disposal of pool and spa disinfectant products. The label on pool chemical containers is the result of years of product research by chemists in both laboratory and field tests. Acquisition of label information requires a minimum of six years of research and sometimes millions of dollars of expense. This product research must prove that: 1) the chemical disinfectant is safe to use; and, 2) that it is really effective in quickly eliminating viruses and bacteria.

3. Label Components

It is the responsibility of the pool manager to read and understand a label before applying, storing or disposing of disinfectants. When reading labels, it soon becomes apparent that certain label components are fairly common in the chemical industry. These label characteristics include:

1. Trade Name or Brand Name

   Each manufacturer has developed trade names for its products and most register their trade names as trademarks. The brand or trade name is placed conspicuously on a label and is commonly used in product advertising.

2. Active Ingredients

   Every pool chemical label must list each active ingredient and its percentage in the total volume. Inert ingredients are not usually listed, but the label must show what total percentage they comprise of the mixture. The ingredient statement must also list the actual chemical name, as well as the common names. As chemical names are long and difficult to pronounce, they are often given a short common name (which must be approved by EPA.)

3. Use Classification Statement

All pool chemicals and pesticide products are classified by the EPA as "unclassified/general use" or "restricted use." (At this point, no pool chemicals are "restricted use.") Any restricted use chemical must carry the following information on the front panel of its label:

"Restricted Use Pesticide"

For retail sale to and use by certified applicators or persons under their direct supervision and only for those uses covered by the certified applicator's certification."

4. Type of Pesticide

The type of pesticide is usually listed on the front panel of the label indicating what the product will control, i.e. herbicide - for the control of algae.

5. Net Contents

The front panel of the chemical label identifies how much product is in the container, and is expressed as pounds (dry chemicals) or as gallons or liters (liquids). Liquid chemicals may also list the pounds of active ingredient per gallon of product.

6. Name and Address of Manufacturer

Manufacturers or formulators of chemical products are required by law to put their name and address on the label (you should also get their phone number.)

7. Registration Numbers

All pesticide type products, i.e. chlorine, must be registered and their label approved by EPA. Therefore, an EPA registration number must appear on the label (for example, EPA Reg. No. 3120-280). Some pesticide chemicals may also carry a specific state registration such as EPA SLN No. PA-860009. PA is the symbol for Pennsylvania, while SLN indicates "special local need."

8. Establishment Numbers

An establishment number (EPA Est: No. 5840-AZ-1) must also appear on the label. This number identifies the company that produced the chemical (necessary, for example, in case a problem arises or the product is found to have been adulterated.)

9. Signal Words and Symbols

Signal words must appear in large letters on the frontpanel of the label, along with the statement "Keep out of reach of children." The following signal words may be found on a label:

a) Danger - poison (symbol used - skull & crossbones).

   These words and symbol must appear on highly toxic chemicals that can enter the body by any route (oral, dermal, optical or respiratory.)

b) Danger - these products can cause severe eye damage or skin irritation.

c) Warning - this signal word indicates a moderate toxicity. The Spanish word "aviso" (warning) must also appear on the label.

d) Caution - This word signals a slight toxicity.

10. Precautionary Statements

Pool chemical labels should also contain additional informational statements for pool operators about what precautions to take for protection against exposure.

These statements include:

a) Routes of Entry Statements - these statements immediately follow the signal words, either on the front or side panels of the label. They indicate routes of entry into the human body (mouth, skin, nose, eyes) and that they are particularly hazardous, thus requiring the use of protective devices.

   1) Danger label statements include:

      Fatal if swallowed

      Poisonous if inhaled

      Corrosive - causes eye and skin damage

   2) Warning label statements include:

      Harmful if swallowed

      Harmful or fatal if absorbed through skin

      Harmful or fatal if inhaled

   3) Caution label statements include:

      Harmful if swallowed

      May be harmful if inhaled

      May irritate eyes, nose, throat and skin

b) Specific Action Statements - these statements usually immediately follow after "route of entry statements." They recommend specific actions to prevent poisoning such as correct protective clothing and equipment. They are directly related to the toxicity of the product (signal word) and the routes of entry.

1) Danger label action statements include:

Do not breathe vapors

Do not get on skin, clothing or in the eyes

2) Warning labels combine action statements from "Danger" and "Caution" labels.

3) Caution labels contain action statements less severe than those on the danger label:

Avoid contact with skin or clothing

Avoid breathing dust or vapors

Avoid getting in the eyes

c) Protective Clothing and Equipment Statements -chemical labels vary a great deal in the type of clothing and equipment statements they contain and some labels have no statements at all. The best method for determining the correct type of protective clothing and equipment when no recommendation is made is to consider the:

- Signal word
- Route of entry statements
- Specific action statements

Some labels fully describe appropriate protective clothing, equipment and type of respirator. Be advised, however, that the absence of a protective statement does not rule out the need for clothing and equipment.

11. Practical Treatment Statement

Practical statements are recommended first aid steps to be used in the event of chemical poisoning. Examples of these statements include:

In case of contact with skin, wash immediately with plenty of soap and water.

In case of contact with the eyes, flush with water for 15 minutes and get medical attention.

All "Danger" labels and some "Warning" and "Caution" labels contain information describing medical procedures for poisoning emergencies and may include an antidote. Be sure to retain labels from containers and have them available in any chemical emergency as well as Material Safety Data Sheets (MSDS.)

12. Environmental Hazards

Pool chemicals can be harmful to the environment as well as to humans. Some chemicals are classified "restricted use" because of being hazardous to the environment. Be sure to observe these statements and understand what they mean in terms of use, storage and disposal.

13. Special Toxicity Statements

If a particular pool chemical is especially hazardous to wildlife, it will be stated on the label. These statements are ones such as:

This product is toxic to fish.

14. General Environmental Statements

Some of these statements appear on most chemical labels in an attempt to help users avoid contaminating the environment. Sometimes they follow a specific toxicity statement. They include statements like:

Do not contaminate streams or ponds by improperly disposing of backwash water.

15. Physical or Chemical Hazards

Some labels carry special warnings for chemicals that can cause fire or explosions, such as hypochlorite compounds, chlorinated cyanurates and hydantoin bromine. These warnings include:

Flammable - do not use near heat or open flame.

Corrosive - store only in corrosion proof containers.

Hazard statements (dealing with both humans and environment) are not always located in the same place on all chemical labels. Some statements are located beneath the word flammable or corrosive, while others will follow the headings "Note" or "Important." Be sure to read every label completely and understand these statements to ensure the safest possible use, storage and disposal.

16. Reentry Statement

Some chemical labels contain information about when it is safe to reenter an area where a leak or chemical spill has occurred. This statement tells how much time must pass before a person can reenter an area without protective clothing and equipment. If no reentry statement can be found on the label, contact the manufacturer, the Haz-Mat team, CHEMTREC or the nearest regional office of the PA Dept. of Environmental Resources to determine whether or there are established reentry intervals for the specific chemicals involved. Reentry intervals established by individual states are not always listed on the label.

The reentry statement may be printed in a box under the heading "Reentry" or located in a section of the label entitled "Important" or "Note" or "General Information." If reentry information does not appear on the label or is not available from the regional office of the PA Depts. of Agriculture or Environmental Resources, contact the director of your local Hazardous Materials Team (Haz-Mat). Their name and telephone number can usually be obtained from the local fire department or emergency medical service (EMS). Pool operators and employees are advised that it is illegal to ignore reentry intervals. If reentry information is not available for a specific pool chemical leak or spill:

1. Wait until the liquid has dried.

   or

2. Wait until the powder has settled to the floor.

If fumes are present, in either a ventilated or unventilated area, do not enter unless using self - contained breathing apparatus (SCBA). Note that canister gas masks or respirators are NOT acceptable substitutes.

17. Storage and Disposal

Pool chemical labels usually contain general instructions for storage and disposal of the chemical and its container. Since state laws vary a great deal, specific instructions are sometimes not included. A label generally includes a section entitled "Storage and Disposal" or a heading such as "Important" or "Note."

Instructions may include:

- Store at temperatures above 32°F (0°C)
- Do not reuse container; render unusable, then burn or bury in a safe place.
- Triple rinse and offer this container for recycling
- Dispose of in an approved landfill.

18. Directions for Use

Directions can be found on most labels identifying the best way to apply a pool chemical. These directions will indicate:

- The use of the chemical or what it controls
- Proper equipment to use
- Mixing instructions
- When the chemical should be used
- How to apply the chemical

The label on a pool chemical container provides a wealth of information. Failure to follow storage, use and disposal recommendations can produce poor results, a chemical accident or serious injury. Misuse of a chemical could result in civil or criminal prosecution (as the pool manager is liable, having a duty to pool users, pool staff and the surrounding community.)

4. Toxicity and Health

Many pesticide accidents can be traced to applicator carelessness or misuse. These accidents can endanger the health of the applicator and other humans. All pesticides must be toxic, or poisonous, to be effective against the pests they are intended to control. Toxicity is a property of the chemical itself. Hazard or risk, on the other hand, is the potential for injury, or the degree of danger involved in using a pesticide under a given set of circumstances. Hazard depends on both the toxicity of the pesticide and the chance of exposure to harmful amounts of the chemical. The best way to avoid pesticide hazards is to know the properties of the chemical and how to use it. If applicators mistakenly think they know exactly how to use a pesticide, or do not care what precautions should be taken, accidents are more likely to occur. People must realize their legal and moral obligations when using pesticides.

How Pesticides Enter The Body

There are four routes of entry by which a pesticide can enter the body: (1) the skin (dermal), (2) the lungs (inhalation), (3) the mouth (oral), and (4) the eyes (optical).

Dermal Route

The skin is the most important route of pesticide entry in the body. Dermal absorption may occur as the result of a splash, spill, or drift when mixing, loading, applying, or disposing of pesticides, or when cleaning or repairing contaminated equipment. Different parts of the body vary in their abilities to absorb pesticides. The scrotal area and the head tend to be more absorptive, although cuts, abrasions, and skin rashes can enhance absorption in other parts of the body. In general, granular pesticides are not as readily absorbed as are oil-based liquid formulations.

Inhalation Route

Protection of the lungs is especially important when pesticide powders, dusts, gases, vapors, or very small spray droplets can be inhaled during mixing, loading, or application, or when pesticides are applied in confined areas. Once breathed into the lungs, pesticides can enter the bloodstream rapidly and completely. Damage can also occur to the nose, throat and lung tissue during entry.

Oral Route

Oral exposure also occurs when liquid concentrates splash into the mouth during mixing or when cleaning equipment. The mouth should never be used to clear blocked plastic tubing on a chemical feeder or to begin siphoning a pesticide. Chemicals can also be swallowed when eating, drinking, or smoking, or even licking one's lips. Since many chemicals can be rapidly absorbed in the digestive tract, it is important to wash the hands and face thoroughly before eating, drinking or smoking.

Eyes

Eyes are very sensitive to many pesticides, and, considering their size, are able to absorb surprisingly large amounts of chemicals. Serious eye exposure can result from a splash or spill, from drift, or rubbing the eyes with contaminated hands or clothing. Preventing eye exposure is the key to safe pesticide use.

Acute Toxicity and Acute Effects

The harmful effects that occur from a single exposure by any route of entry are termed acute effects. In addition the effect of the chemical as an irritant to the eyes and skin is examined under laboratory conditions. Acute toxicity is usually expressed as LD_{50} (lethal dose 50) and LC_{50} (lethal concentration 50). These symbols identify the amount or concentration of a toxicant required to kill 50 percent of a test population of animals under a standard set of conditions. LD_{50} values of pesticides are recorded in milligrams of pesticide per kilogram of body weight of the test animal (mg/kg), or in parts per million (ppm). LC_{50} values of pesticides are recorded in milligrams of pesticide per volume of air or water (ppm). To put these units into perspective, 1 ppm is analogous to 1 inch in 16 miles or 1 minute in 2 years. The lower the LD_{50} value of a pesticide, the less it takes to kill 50 percent of the population, and therefore the greater the acute toxicity of the chemical. Acute toxicities are the basis for selecting the appropriate signal word (toxicity categories) to be used on a product label.

Signal Words

Those pesticides classified as "highly toxic," on the basis of either acute oral, dermal, or inhalation toxicity, must have the signal words DANGER and POISON (in red letters) and a skull and crossbones prominently displayed on the package label. PELIGRO, the Spanish word for DANGER, must also appear on the labels of highly toxic chemicals. Some pesticide products carry the signal word DANGER without the skull and crossbones symbol; these are "moderately toxic" and must have the signal words WARNING and AVISO displayed on the product label. Pesticide products classified as either "slightly toxic or relatively nontoxic" are required to have the signal word CAUTION on the pesticide label.

Chronic Toxicity and Chronic Effects

The harmful effects that occur from repeated small doses over a period of time are termed chronic effects. Some of the suspected chronic effects from exposure to certain pesticides include birth defects (teratogenesis); toxicity to a fetus (fetotoxic effects); production of tumors (oncogenesis), either benign (noncancerous) or malignant (cancerous/carcinogenesis); genetic changes (mutagenesis); blood disorders (hemotoxic effects); nerve disorders (neurotoxic effects); and reproductive effects. Some pesticides are required to include chronic toxicity warning statements on the product label.

First Aid For Pesticide Poisoning

Immediate action may be necessary to prevent serious injury to a victim of pesticide poisoning. It could be a life-or-death matter. The product label should be a first source of information in a pesticide exposure emergency. First aid may be necessary followed by professional medical assistance.

General First Aid Instructions

If oral or dermal exposure has occurred, the objective is usually to dilute the pesticide and prevent absorption.

If inhalation exposure occurs, move the victim to fresh air immediately.

Always have a source of clean water available. In an emergency, swimming pool water can be used.

Never try to give anything by mouth to an unconscious person.

Become familiar with the proper techniques of rescue breathing and CPR. The use of a pocket mask is strongly recommended to prevent contamination of the rescurer.

If there is a likelihood of being directly exposed to a pesticide while administering first aid, or removing the victim from an enclosed area, be sure to wear appropriate protective equipment.

Specific First Aid Instructions

If the pesticide is spilled on the skin or clothing. Remove clothing immediately if it has been contaminated and thoroughly wash the skin with soap and water. Avoid harsh scrubbing as this enhances pesticide absorption. Rinse the affected area with water; wash again and rinse. Gently dry the affected area and wrap it in a loose sterile dressing. If chemical burns of the skin have occurred, cover the area with a clean sterile dressing. Avoid the use of ointments, greases, powders, and other medications unless instructed by a medical authority.

It may be best to dispose of contaminated clothing. However, if you decide to keep the clothing, store and wash all items separately from the family laundry.

If the pesticide gets into the eye. Hold the eyelid open and immediately begin gently washing the eye with clean running water. Do not use chemicals or drugs in the wash water unless instructed by a physician or the poison control center. Continue washing for 15 minutes. Avoid contamination of the other eye if only one eye is involved. Flush under the eyelids with water to remove debris. Cover the eye with a clean sterile dressing and seek medical attention immediately.

If the pesticide is inhaled. Move the victim to fresh air immediately; carry the victim (do not allow the victim to walk). Have the victim lie down and loosen clothing. Keep the victim warm and quiet. If the victim is convulsing, closely monitor his breathing and protect the victim's head. Keep the head up to keep air passages free for breathing. If breathing stops or is irregular, give rescue breathing and monitor pulse. Do not attempt to rescue someone who is in a closed contaminated area unless you are wearing appropriate protective equipment.

If the pesticide is swallowed. The most important decision one must make is whether or not to induce vomiting. The decision must be made quickly and accurately because the victim's life may depend on it. Where specific instructions are given, always follow the label directions. If the pesticide has gotten into the mouth but has not been swallowed, the mouth should be rinsed with large amounts of water. NEVER induce vomiting if the victim has swallowed petroleum products (kerosene, gasoline, oil, lighter fluid) unless so directed by the label, a physician, or a poison control center.

NEVER induce vomiting if the victim has swallowed a corrosive poison - a strong acid or alkali (base). A corrosive poison will burn the throat and mouth as severely coming up as it did going down. Determine what poison the person has ingested. The victim may experience severe pain and have extensive mouth and throat burns. Pool disinfectants fall into this category. The best first aid is to dilute the poison as quickly as possible. For acids or alkalis, give the patient water or preferably milk. It is very important to activate EMS and get the victim to a hospital without delay.

To neutralize acids - if you are sure the poison is an acid, give the victim milk of magnesia (1 tablespoon in 1 cup the water). In an extreme emergency, if milk of magnesia is not available, give the victim baking soda in water. Exercise caution, however, because baking soda reacts with acids to form carbon dioxide (CO_2) gas. Medical reports indicate that large amounts of CO_2 can induce perforation of the intestines or stomach wall.

To neutralize alkalis - if you are sure the poison is alkali, give the victim lemon juice or vinegar.

INDUCE VOMITING ONLY as a first aid measure until you can get the victim to a hospital. Do not waste a lot of time attempting to induce vomiting. Make sure the victim is kneeling forward or lying on their side to prevent vomitus from entering the lungs and causing additional damage. Follow these first aid steps:

First give the patient at least 2 glasses of water to dilute the poison. Do not use carbonated beverages.

If possible, use ipecac syrup to induce vomiting. This material is extremely effective in emptying the stomach contents and is available in small quantities on a nonprescription basis from most drugstores.

If ipecac syrup is not available, put your finger or the blunt end of a spoon at the back of the throat. Do not use anything sharp or pointed. Do not use salt water to induce vomiting.

Collect some of the vomitus for the doctor who may need it for chemical analysis.

AFTER VOMITING has occurred, give the patient 2 to 4 tablespoons of activated charcoal in water. Activated charcoal acts as a sponge to absorb many poisons. Pharmaceutical grade activated charcoal is available from most drug stores; activated charcoal prepared for cleaning up pesticide spills may be substituted in an emergency.

Never administer activated charcoal at the same time as ipecac syrup, because the charcoal adsorbs the ipecac before it can induce vomiting.

Activated charcoal must be removed from the body.

Safe Use of Pool Chemicals

Chemicals used for disinfection, water balance, water clarity and killing algae have very specific purposes and should be carefully stored, applied and disposed of as intended or required by law. Safe use generally includes the following items:

1. Use pool chemicals for intended purposes only.
2. Know and understand federal and state pool chemical (pesticide) laws.
3. Know and understand the information on Material Safety Data Sheets.
4. Read chemical labels carefully.
5. Keep children away from pool chemicals, including water test kits.
6. Store chemicals in their original containers.
7. Store chemical containers in a locked storage room.
8. Work in pairs when performing maintenance on chemical feeders, especially chlorine gas systems and wear self-contained breathing apparatus when working with gas units.
9. Wear appropriate protective clothing and equipment.
10. Never eat, drink or smoke around pool chemicals and be careful not to allow perspiration to come into contact with dry hypochlorite compounds, bromine or chlorinated.
11. Avoid dust drift when using dry chemicals.
12. Prevent chemicals from spilling on skin and clothing.
13. Have an appropriate first aid kit and a water source in the immediate area.
14. Post the telephone number of the nearest poison control center next to all telephones.
15. If necessary to see a physician or go to a hospi-

tal take the chemical label with you, if possible.

16. Dispose of empty containers according to label instructions.
17. Wash or shower after using pool chemicals and treat contaminated clothing as you would the chemical itself.
18. Wash chemical contaminated clothes separately from other clothing.

5. Protective Clothing and Equipment

Unfortunately, some protective clothing and equipment is very uncomfortable to wear, particularly for long periods of time in hot and humid conditions. However, wearing the appropriate clothing and equipment offers the best protection from chemical spills, fumes and burns. For example, working in a chlorine environment (regardless if from a gas, solid or liquid source) can result in burned skin, eyes, throat and lungs. Many other pool chemicals are corrosive and will burn as well. The type of protective clothing used depends on the job and type of chemicals being used. The following items can be essential in preventing serious or life-threatening injuries.

a. Clothing

A long sleeved shirt and long pants made of tightly woven fabric or water repellant material can provide protection from irritations caused by items such as soda ash, baking soda and diatomaceous earth. A swim suit or shorts and T-shirt are NOT adequate protection.

.1 Aprons and Rainsuits

These protective items are useful when handling liquids such as sodium hypochlorite or muriatic acid. Liquid proof aprons and rainsuits should be made of rubber or a synthetic material resistant to acids and bases. An apron should cover the body from chest to shoes.

.2 Gloves

Waterproof, unlined gloves should be worn when performing maintenance on liquid chemical feeders, when mixing dry chemicals with water or filling containers. Gloves should cover wrists and forearms and should not have an elastic armband. Be sure there are no holes in the gloves (fill with water and squeeze). If the rubber gloves become sticky from a chemical reaction, discard them and use new gloves. Do not tuck long sleeves into the gloves, unless working with chemicals overhead. Wash chemicals off the gloves with soap and water before removing them to avoid contaminating hands when removing the gloves.

.3 Hats

A non-absorbent head covering should be worn when using liquid and dry chemicals. The hat should be liquid-proof and have a wide brim to protect the face. Hats should be disposable or easy to clean with soap and water.

.4 Shoes and Boots

Only unlined, rubber boots or shoes should be worn (because canvas, cloth or leather will absorb chemicals.) Keep pant legs out of boots to prevent liquid chemicals from entering boots.

.5 Goggles and Face Shields

Tightly fitting, non-fogging goggles or full-face shields are necessary when working around pool chemicals that might get in the eyes. Spray and splash accidents occur most often during repair or maintenance on liquid chemical feeders or when transferring chemicals from one container to another. Persons wearing contact lenses may want to consult an eye doctor about working around pool chemicals. Goggles and face shields should be cleaned thoroughly with soap and water after each use, while seals and headbands may have to be replaced on a regular basis.

b. Respiratory Protective Devices

The direct route of entry into the circulatory system for most pool chemicals is through the respiratory system. Toxic substances are rapidly removed from the blood capillaries of the lungs and transported throughout the body. Selection of a respiratory protective device depends upon the type of chemical (liquid or dry), its concentration and the length of exposure. More than one type of device may be required as swimming pools utilize a variety of chemicals. Only respiratory equipment approved by the National Institute of Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA) should be used. NIOSH approval numbers begin with the letters TC.

Types of Respiratory Protective Devices

Three categories of protective devices are currently in use:

1. Air - purification
2. Supplied - air
3. Self - contained breathing apparatus

Air Purification devices include chemical cartridges, mechanical filters and gas masks. These devices can only be used in atmospheres containing oxygen levels high enough to sustain life. They include:

1.a Chemical Cartridge Respirators - these units are limited to protection against certain gases and vapors in concentrations no higher than 1.0% by volume. They are manufactured as half-masks, covering only the nose and mouth, or as masks with full-face shields for eye protection. They must not be used around chlorine gas or ammonia.

1.b Gas Masks - canister type masks will afford protection against particulates and certain vapors and gases provided these gases do not reach concentrations in the air exceeding 1.0% by volume. Gas masks cover the eyes, nose and mouth, providing only minimal protection when oxygen levels are low in the atmosphere. Canister or chemical cartridge masks are prohibited for use around gas chlorine by the PA Dept. of Environmental Resources.

2 Supplied Air Apparatus - these devices feature a mask which covers the entire face and includes a hose through which air is supplied to the user. This mask must seal and cannot be safely used by people with facial hair such as long sideburns or beards.

3 Self-Contained Breathing Apparatus - air is contained in a high pressure tank worn on the users back and is supplied directly to the mask. The mask covers the entire face and must seal tightly, therefore beards and sideburns will render the mask unsafe for use. About 20 minutes of breathing time can be expected from one of these units under conditions of little or no work. An increase in physical activity will increase air consumption.

Use and Care of Respiratory Protective Devices

Before using any breathing device read the directions for use very carefully. Be sure it will provide the needed protection. Check all valves, filters or canisters to determine if they are properly positioned and sealed. In addition, be sure that the device is applied correctly, making a good seal over the face. If odors, vapors, tastes or breathing difficulties occur, move to an area of fresh air immediately. Practice assembling, using and disassembling your equipment often enough that total familiarity is achieved and maintained.

After each use, wash and sanitize the unit according to the manufacturers directions. Store the unit in a clean, dry place, but NOT the a filter or chemical storage room, or a room with a gas chlorine feeder.

Laundering Pesticide Contaminated Clothing

All protective clothing and equipment should be washed at the end of each day of use. Pesticide contaminated clothing should be stored and washed separately from the family laundry. Remember to wear gloves during these handling and laundering steps and be sure to check the label for any specific washing instructions. Clothing that has become saturated with a concentrate should be discarded.

Some residues may be removed by hosing the contaminated clothing with water or presoaking it in an appropriate container. Washing in hot water removes more pesticide from the clothing than washing in other water temperatures. The hotter the better.

Laundry detergents, whether phosphate, carbonate, or heavy-duty liquids are similarly effective in removing most pesticides from fabric; heavy duty liquid detergents typically have better oil removing ability and therefore are more effective than other detergents in removing emulsifiable concentrates. Bleach or ammonia may help in removing or breaking down certain pesticides. However, bleach and ammonia should never be mixed together because they react to form chlorine gas which can be fatal.

Washing should be done at the full water level. After washing, it is important to rinse the washing machine with an "empty load," using hot water and the some detergent. Line drying of clothing is recommended for two reasons. First, it eliminates the possibility of residues collecting in the dryer. Second, residues of many pesticides will break down when exposed to sunlight.

Mixing Pesticides Safely

Measure accurately; follow label instructions and mix only the amount you plan to immediately use. Newer measuring devices such as tip and pour containers are a great help in handling small amounts of concentrate. All measuring devices (spoons, cups, scales) should be kept in the pesticide storage area and never used for other purposes. Measuring cups should be rinsed and the rinsewater put into the chemical tank. Pesticide containers should be triple rinsed as soon as they are emptied because residues can become dried and difficult to remove later.

6. The Pool Chemical Storage Area

All pool chemicals should be stored in a secure place such as a separate building or properly vented storage room. Doors to these areas must be kept locked. In addition pool managers should:

1. Post highly visible warning signs on doors and windows, and list the chemicals contained therein.
2. No smoking signs must be posted.
3. Store chemicals away from each other in specifically identified locations in the room.
4. Store chemicals in a well ventilated area, free from extremes of temperature, high humidity and away from water.
5. Keep chemicals out of direct sunlight.
6. Keep plenty of soap and water nearby.
7. Secure a fire extinguisher approved for chemical fires, a first aid kit and have available a telephone with emergency numbers posted next to it.
8. Store chemicals in their original containers.
9. Retain original container labels or carefully copy the label components for possible emergency use.
10. Review the Material Safety Data Sheets frequently.
11. Close containers tightly and use retainer bands on dry chemical drums when not in use.
12. Place all chemical containers, drums, boxes or bags on pallets to get them off the floor.
13. Check containers and bags occasionally for leaks or spills.

Safety

Wear the appropriate protective clothing when handling pesticide containers.

Label all items used when handling pesticides (measuring utensils, protective equipment, etc.) to prevent their use for other purposes.

Keep clay, kitty litter or a similar material available to soak up spills or leaks. Hydrated lime and bleach should be available for decontamination of spill surfaces.

Store volatile cyanurates, hydantoin bromine, lithium and calcium hypochlorite separately to avoid possible cross contamination with other chemicals.

Chemical Shelf Life

Most pool chemicals have a definite shelf life although this information and the date of manufacture are not included on the container. Important shelf life information includes:

1. Dry hypochlorite compounds, bromine and stabilized chlorine - 12 months
2. Sodium hypochlorite - 60-90 days
3. Test kit chemicals - 12 months, with the exception of phenol red (pH) - 6 months

Disposal of Pool Chemicals (Post Season)

Swimming pool managers of summer facility operations often have excess chemicals remaining at the end of the season. Chemicals with an unlimited shelf life, such as muriatic acid, soda ash and baking soda should be appropriately stored for use during the next operating season. Chemical disinfectants such as sodium or calcium hypochlorite can be added to the pool to reduce algae, if the water will be retained in the pool until the following spring. If this is not the case, excess chemicals may need to be disposed of, a process which must be accomplished with regard for the law and the environment. Improper disposal of chemicals may create a hazard by polluting ground water. Pool managers should plan carefully and use the following guidelines.

1. Use good judgment in re-stocking necessary chemicals toward the end of the summer season, purchasing only necessary amounts.
2. Read the label carefully for correct disposal instructions.
3. Consider protective clothing and equipment that will be discarded as chemical waste and therefore handle the clothing as carefully as excess chemicals.
4. Be aware that federal and state laws regulate the disposal of chemical waste and chemical containers. Questions regarding disposal of chemicals and containers should be asked of professionals in the regional office of either the PA Dept. of Agriculture or the Dept. of Environmental Resources, or the regional office of the Environmental Protection Agency in Philadelphia.

Containers

Triple rinsing allows glass, metal, plastic, and even some heavy paper containers, to be considered nonhazardous waste. It also saves money because each rinse captures pesticide residues from the sides and bottom of the container that are included in the spray mix and not wasted. To triple rinse:

1. Allow the concentrate to drain from the empty container for 30 seconds.
2. Fill approximately 10 percent of the container volume with water, replace the lid, and rotate the container so all the interior surfaces are rinsed.
3. Dump the rinsewater into the chemical tank, allowing it to drain for at least 30 seconds.
4. Repeat the procedure two more times.

Triple-rinsed containers that will be held for disposal at a later time should be marked to indicate triple rinsing has been done and the date. Pesticide containers that will not be recycled through a recycling facility or the dealer should be rendered unusable by breaking, puncturing, or crushing. Never reuse pesticide containers. All containers should be kept in a locked storage area until disposal, and kept away from all possible contact with children and animals.

Pesticide Containers

Inspect containers before loading to be sure all caps and plugs are tightly closed and legible labels are attached. Handle containers carefully when loading to avoid rips or punctures. Be sure the outsides of containers are not contaminated with pesticide.

Secure containers to safeguard against spills or leaks that may result if the containers roll or slide. Packing or shipping containers provide extra protection. Also protect pesticides from temperature extremes.

7. Pool Chemical Fire Safety

Many pool chemicals are flammable or explosive. Those chemicals requiring extra precautions bear the warning "Strong Oxidizer" or the label statement "Do not use or store near heat or open flame." Certain dry hypochlorite disinfectant compounds are particularly sensitive or hazardous. In order to reduce fire hazards:

1. Keep storage areas locked at all times.
2. Prohibit smoking in the storage area.
3. Post signs showing the storage of combustible materials or strong oxidizers.
4. Keep all chemicals in original containers with lids sealed tightly.
5. Keep organic materials (lubricating oils, gasoline, detergents, styrofoam, paper products and human sweat) away from dry hypochlorite compounds.
6. Store combustible chemicals away from the pool heater.
7. Install fire detection systems in storage areas.

8. Keep a fire extinguisher approved for chemical fires outside but nearby the storage areas.
9. Notify your local fire department and hazardous materials team of the contents and location of the pool storage area.

In the event of a pool chemical fire or toxic gas escape:

1. Have a written facility evacuation plan ready to use.
2. Move everyone in the pool area upwind from smoke or gas and use the information provided on Material Safety Data Sheets.
3. When requesting the fire company or haz-mat team be sure to identify all chemicals kept in the storage area.

4.Be aware that some chemicals may explode.

8. Pool Chemical Spills

It is important that pool managers be aware of state and federal laws and understand their responsibilities for a chemical spill. Failure to respond quickly and decisively could endanger human life and/or the environment. The manager's responsibility focuses on 3 C's.

1. Control the spill
2. Contain the spill
3. Clean up the spill

In the event of large spills, these steps require assistance from local agencies (fire dept., DER) and sometimes national agencies such as the Chemical Transportation Emergency Center (CHEMTREC) in Washington, D.C. (800-424-9300.)

Control the Spill

Take immediate steps to control the flow of the material being spilled, regardless of the source. If a 5-gallon can on a storage shelf has rusted through and is leaking, do everything possible to stop the leak or spill. Smaller containers, up to 55 gallons, can be put into larger containers to prevent further release of the chemical. Ripped or torn bags can be placed into larger plastic bags.

Do not expose yourself unnecessarily to a leaking chemical; use protective equipment when attempting to control the leak. Also, do not charge into a spill area blindly if someone is injured; make sure you are properly protected.

Isolate the area. Keep people at least 30 feet away from the spill; rope off the contaminated area if necessary. Avoid coming in contact with any drift or fumes that may be released. Do not use road flares if you suspect the leaking material is flammable. At times it may be necessary to evacuate people downwind of the spill.

Do not leave the spill site until someone relieves you. Someone should be present at the spill site continuously until the chemical is cleaned up.

Get help. Unfortunately, stopping large leaks or spills may not be simple. If you encounter a pesticide accident or spill that you cannot handle or if problems occur during the clean-up phase, you should get help. Depending on the type of chemical, the severity and size of the spill, the ability of local agencies to deal with the situation, etc., you may want to contact the Chemical Transportation Emergency Center (CHEMTREC) in Washington, D.C. by calling (800) 424-9300. The CHEMTREC office is staffed 24 hours a day by competent and trained personnel who are knowledgeable in handling chemical emergencies.

If you request emergency assistance, have the product label available! An additional and very important emergency telephone number is found on many labels. These emergency lines are staffed 24 hours a day by the manufacturers, and the people on the other end of the lines are prepared to handle pesticide emergencies involving their products.

Have someone alert the state and local police if the spill occurs near a public highway. Contact a regional office of the PA Department of Agriculture (PDA) if the chemical is a pesticide or other agricultural chemical. In certain cases, it may be necessary to alert the fire department, but be sure to caution them not to wash down the spill until advised to do so. At times it may also be necessary to contact the local Hazardous Materials Team (Haz-Mat), public health officials and the hospital emergency room.

Contain the Spill or Leak. At the same time the leak is being controlled, contain the spilled material in as small an area as possible. Do everything possible to keep it from spreading. Use a hand tool such as a shovel, rake or power equipment to construct a dam of soil or reduce further movement. The important thing to remember is do not allow the spilled material to enter any body of water, no matter how small the spill.

If the chemical does contaminate a stream, pond, or any other waterway, contact a regional office of the PA Dept. of Environmental Resources (DER). Authorities should notify downstream users as soon as possible; prompt precautionary actions could prevent accidental poisoning of livestock and avoid contamination of crops and soil water from the stream. A pesticide contaminated well should be brought to the attention of a local or state health officials.

Liquid pesticide spills can be further contained as well as absorbed by covering the entire spill area with absorbent materials such as fine sand, vermiculite, sawdust, clay, kitty litter, or absorbent pads. However, avoid using sawdust or sweeping compounds on a spilled material that is a strong oxidizer because these materials create a fire hazard. Hypochlorites, such as lithium and calcium hypochlorite, are examples of oxidizers.

If dust, wettable powder, or granules spill, you can reduce further spread by lightly misting the material with water, or covering the spill with some type of plastic cover. Care must be exercised when cleaning or disposing of all materials (clothes, equipment, soil) used in containing or cleaning up a pesticide spill.

Clean Up the Spill. If you have not already done so, spread absorbent material over the contaminated area, sweep it up, and place it in a heavy-duty plastic bag. Keep adding the absorbent until the spilled liquid is soaked up. Absorbent materials are not used for dry spills. Dry spills should be swept up for reuse if possible. If dry materials have become wet or contaminated with soil and other debris, sweep them up and place them in a heavy-duty plastic bag.

Once the spill has been cleaned up, it may be necessary to decontaminate or neutralize the area. Mix full strength ordinary household bleach and hydrated lime. Wearing protective equipment if needed, work this preparation into the spill area with a coarse broom. Then add fresh absorbent material to soak up the now contaminated cleaning solution. This material should then be swept up and placed in a plastic bag or drum for disposal. If necessary, repeat this procedure several times to ensure that the area has been thoroughly decontaminated. Do not hose down the area with water.

Soil contamination. The only effective way to decontaminate soil saturated with a pesticide is to remove the top two to three inches of soil. Then cover the area with at least two inches of lime. Cover the lime with fresh topsoil. Be sure to dispose of this contaminated soil properly.

Soils contaminated by errors or minor spills can sometimes be amended by applying activated charcoal to the contaminated surface immediately after the spill or misapplication. The charcoal can adsorb or tie up enough chemical to avoid significant plant injury and long-term contamination. However, application of activated charcoal to areas where large spills have occurred is unlikely to reduce soil contamination and prevent subsequent plant damage. Charcoal is recommended for use only on soil surfaces because of the difficulty of clean up.

Cleaning up equipment. Clean up any equipment that was contaminated either as a result of the original spill or during the clean-up procedure. Before you begin, however, be sure you are properly clothed and protected to avoid contact with the chemical. Use a chlorine bleach-alkaline detergent (dishwasher soap) solution to clean the equipment. Porous material and equipment such as brooms, leather shoes, and cloth hats cannot be effectively decontaminated and should be discarded or destroyed. Also, do not try to save disposable garments and gloves or any clothing that is badly contaminated. You should properly dispose of them immediately after cleaning up.

Follow Up

For legal protection, it is advisable to keep records of your clean up activities and conversations with regulatory authorities, emergency personnel, and the general public when dealing with a pesticide spill. Photographs or video tape of the clean up will help to document any damages, as well as the clean-up process. Be sure the spill has been reported to the appropriate agencies (i.e., PA Depts. of Agriculture and Environmental Resources).

Title III of SARA (Superfund Amendments and Reauthorization Act of 1986) "Store Pesticides Safely," also requires the reporting of certain pesticide spills (if the amount spilled is greater than the "reportable quantity" for that chemical.)

Discharge of chemical substances into waterways must also be reported to the U.S. Environmental Protection Agency under the authority of the Clean Water Act.

Spill Prevention and Preparation

A key to preventing pesticide spills is to properly maintain all application equipment. Leaks and drips from cracks or loose fittings in equipment are indications of potential trouble. An understanding of how chemical feeders and a swimming pool circulation system functions is essential to controlling the flow of a product and minimizing equipment damage should a problem occur.

Knowing how to safely handle pesticide spills and leaks is as important as knowing how to correctly apply the chemical. All facilities in which pesticides are handled should have the telephone numbers:

Pesticide Information Telephone Numbers

National

CHEMTREC — 800-424-9300

Regional Numbers

PA Department of Agriculture

PA Department of Environmental Resources

EPA (Philadelphia) - main number — (215) 597-9800 or

EPA (Philadelphia) - pesticide information (215) 597-8598

Regional Numbers

1. Haz-Mat Team
2. State Police
3. Local Police
4. EMS
5. Fire Department
6. Poison Control Center
7. Hospital
8. Facility Physician

Always have the label with you! A Material Safety Data Sheet (MSDS) for every pesticide on the premises is also strongly recommended. The proper equipment is essential (absorbent materials; neutralizers; a shovel; protective clothing and/or equipment; clean water, soap, disposable towels and first aid supplies).

All persons using or transporting pesticides and other hazardous swimming pool chemicals have a responsibility to protect the public and the environment. Doing everything possible to avoid spills, and adhering to a few basic guidelines when handling spills and leaks, can go a long way toward meeting this responsibility.

9. Keeping Records

Certified applicators who use pesticides are **required** to keep records. Commercial and public applicators must keep records of all pesticide applications for a minimum of three years. Pool operation reports **must** also be mailed monthly to your regional Department of Environmental Resources Office. Useful information includes:

Date and time of application.

What pesticide (pool chemical) was used.

The way the pesticide was mixed (e.g., pounds per 100 gallons of water).

The rate of application (e.g., gallons or pounds of disinfectant used).

Type of equipment used.

What problem was treated (e.g., algae) other than normal disinfection requirements.

Names of the certified applicators.

Forms used for the monthly reports required to be submitted to D.E.R. can be obtained free of cost from the regional office.

All pesticide users are strongly advised to keep thorough records for their protection should a problem arise from an application, spill or leak.

10. Federal and Pennsylvania Pesticide Laws

1. Both the United States Congress and the Pennsylvania Legislature have enacted legislation that regulate the production, transportation, sale, use, and disposal of all pesticides. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), first enacted in 1947, was amended significantly in 1972, then again in 1975 and 1978. This statute is administered by the United States Environmental Protection Agency (EPA). The Pennsylvania Pesticide Control Act of 1973 (Act 24) became law March 1, 1974, and became fully operational in October, 1977. This statute was amended significantly in December 1986 with the passage of Senate Bill 1445.

2. The certification process by all the states and territories must be accomplished through EPA-approved programs. Each state is responsible for implementing the certification program; in Pennsylvania, the Department of Agriculture (PDA) is responsible for administering this program.

Although specific restrictions and circumstances may vary, pesticide manufacturers, dealers, transporters, and applicators are all subject to penalties for violations of FIFRA.

3. PENNSYLVANIA PESTICIDE CONTROL ACT OF 1973, AS AMENDED. The amended Pennsylvania Pesticide Control Act is a companion bill to FIFRA. The state act defines how FIFRA and the state statute will be administered and regulated. Copies of the specific rules and regulations of the act can be obtained by contacting an office of the PDA. The major aspects of the act include the following:

Section 15.1)Pesticide Application License.

Each business, public utility, government agency, etc. applying or contracting for the application of pesticides, which meets the definition of a commercial applicator, must obtain a pesticide application license (business license) for those categories in which it is doing business. A certified applicator must be employed by the business, utility, or agency at all times. (Representatives of government enteties taking the test via the Dept. of Community Affairs will have the business license requirement waived for the swimming pool category.)

Section 16.1) Standards of Qualifications for Certification of Commercial Applicators.

Individuals shall become certified upon the successful completion of a written examination in basic knowledge and pool chemical usage. Attendance at PDA/DCA approved courses will result in the accumulation of credits which will be applied to recertification requirements.

Section 16.2)Procedures to Register Pesticide Application Technicians with PDA.

Noncertified employees of any business or public agency must be registered as pesticide application technicians when these employees apply pesticides without a certified applicator physically present at the application site.

Section 17.1)Public Applicators.

Persons applying pesticides as employees of any unit of a federal, state, or local government agency must comply with Section 16.1 and 16.2 of this act.

11. Material Safety Data Sheets

Chemical Characteristics

The occupational Health and Safety Act requires the manufacturer to provide a Material Safety Data Sheet (MSDS) on every chemical used by employees.

The Material Safety Data Sheet includes everything necessary to know about a substance:

1. WHAT elements comprise the chemical.
2. WHY it's hazardous.
3. HOW it can be used safety.

The WHAT includes the chemical's identity: its common and chemical name, and the name and percentage of each chemical in a mixture and permissible concentrations.

Overexposure can be avoided by checking the MSDS for maximum safe exposure to a particular chemical.

The Permissible Exposure Limit (PEL) is the maximum legal exposure to a chemical over an 8 hour day and a 40 hour week.

The Threshold Limit Value (TLV) is the highest recommended concentration level believed to be safe for a chemical on a daily basis.

Another part of the chemical's physical characteristics is the melting point, flash point, and evaporation rate.

The substance's chemical characteristics are also provided on data sheets. This section of the MSDS informs the pool operator if the chemical is corrosive and could burn the skin or eyes.

The MSDS identifies the normal appearance and smell of the chemical so that comparisons can be made with chemicals on hand.

Next, the MSDS explains why the chemical is hazardous. It identifies physical hazards like explosiveness and flammability. And it reveals whether the chemical is reactive if exposed to heat, air, water, or other chemicals, as well as what kind of reaction-fire, toxic emissions, etc. could occur.

The MSDS also explains what other chemicals it is incompatible with (for the purpose of storing them safely away from each other.) Sometimes two chemicals that wouldn't catch fire individually could ignite if stored close together.Health Hazards

A key part of the MSDS is why chemical elements are possible health hazards. Some chemicals are toxic to humans. The MSDS lists any possible negative health effects that have been identified through research including anything from vomiting to cancer.

If a health hazard is listed, pool managers should know that it doesn't mean everyone will be affected; however, every employee has a right to know what could happen if proper precautions are not followed.

The health hazards section of the MSDS identifies three ways a chemical can enter a persons body:

- Inhalation-breathing
- Absorption-skin contact
- Ingestion-by mouth

Exposure can by minimized or eliminated by using protective gear and by following sensible safety practices. Don't eat, smoke, or drink in the storage or use area. Have work clothes washed at work. After working with hazardous substances, don't touch food or tobacco products or go to the bathroom without cleaning up first.

Signs and symptoms of overexposure to a chemical are also included in the MSDS such as headache, dizziness, or a rash.

There are two kinds of overexposure:

1. Acute effects, which show up immediately after brief exposure to a hazardous chemical.
2. Chronic effects, which come from exposure, (even low doses) over a long period of time.

If the chemical could aggravate an already existing medical condition, like asthma or heart trouble, the MSDS will identify those conditions as well.

If exposed, the MSDS also provides first aid instructions to follow until emergency medical help arrives.

Precautionary Measures

The pool or spa operator need not be concerned with why a chemical is hazardous if the safety instructions are followed. Material Safety Data Sheets provide complete instructions on how to prevent problems associated with hazardous chemicals.

This includes an explanation of the proper methods for handling and storage, directions for what to do for a spill or leak and how to dispose of the chemical correctly.

Instructions are also included for handling emergencies such as fire or explosion.

Other precautions covered in the MSDS include:

1. Personal health practices, such as taking a shower after working with the substance.
2. Engineering controls, such as ventilation needed in the work area.
3. Protective clothing and equipment required, such as gloves, goggles, protective suits, and the correct kind of respirator to use.

Training

The Material Safety Data Sheet provides all the information necessary to work safely with hazardous chemicals. However, some information is so detailed and the information so important that the

Hazard Communication Standard also requires some facility managers and staff members to understand and use the information on container labels and Material Safety Data Sheets.

OSHA regulations may also require employee training in the procedures to follow when working with hazardous chemicals: handling, storage, disposal, selecting and checking the right protective clothing and equipment for the job.

Training is more than talk. It includes practicing what has been learned. The government and facility owners usually provide whatever information is necessary to stay safe and healthy at work. Staff members are responsible for making the most of their training, for practicing until they are confident of their ability, to handle problem situations, and to ask questions about any area they are unsure of.

12. Hazards Communication Standard Employee Right-To-Know

One of the most important trends in the regulation of chemical substances has been the development of "right-to-know" laws. These provisions are of two major types; responsibilities for communication of information to staff, and training staff members in methods of safe handling and personal protection. Another type of right-to-know legislation requires that aquatic facility operators provide information to the county and surrounding communities and relevant regulatory agencies concerning chemicals used in that facility.

Right-to-know requirements have been instituted on both state and federal levels. Employee Right-to-Know on the federal level, the Occupational Safety and Health Administration (OSHA), passed in November (and was amended in 1983 by a "Hazard Communication Standard" (HCS)), and amended it on 8/24/87, requiring provision of chemical identity, safety and related health effects information to cover all staff members. OSHA defines "employee" (staff member) as "a worker who may be exposed to hazardous chemicals under normal operating conditions or in foreseeable emergencies".

A State or local institution that is located in a state which does have an OSHA approved plan is regulated by the state, rather than by OSHA.

Universities (public or private) and other aquatic facilities that are covered by the expanded OSHA standard were required to comply by June 24, 1988. These institutions are subject to the following principal requirements:

1. Ensure that each container of hazardous chemicals in the workplace is labeled, tagged or marked with the identity of the chemical and appropriate hazard warnings.
2. Maintain copies of Material Safety Data Sheets (MSDS) for each hazardous chemical in the workplace, and ensure that the MSDSs are readily accessible to staff members when they are in their work areas.
3. Provide staff members with specific information regarding hazardous chemicals in their work area at the time of their initial assignment and whenever a new hazard is introduced into their work area. The employees must be informed of: a) the requirements of the HCS; b) any operations in their work area where hazardous chemicals are present; and, c) the locations and availability of the written hazard communication program and the MSDS.
4. Provide staff members with training regarding hazardous chemicals in their work area at the time of their initial assignment and whenever a new hazard is introduced into their work area. The training must include at least: a) methods and observations that may be used to detect the presence of a chemical in the work area; b) the physical and health hazards of the chemicals in the work area; c) the measures employees can take to protect themselves from those hazards; and, d) the details of the employee's hazard communication program, including an explanation of the MSDS, the labeling system, all methods for employees to obtain and use the appropriate hazard information.

D. Disinfection Systems

Water has long been recognized as a transportation medium for disease. Hippocrates recognized this fact in the 5th century treatise *Air, Waters, Places.* In Rome, 1300 miles of aqueducts were used to bring water to the city from the mountains. Sextus Julius Frontinus, a Roman engineer of the latter part of the 1st century, wrote in *Deaquis urbis Romae* of the function of aqueducts, which exposed the water to a form of aeration and to the ultraviolet rays of the sun thus implementing a crude system of water disinfection.

Water borne disease include Hepatitis, Polio, Cholera, Dysentery, Herpes, Legionnaire's Disease and Giardiasis to name a few. Selection and continuous monitoring of a disinfection system approved by the Department of Environmental Resources is essential to a healthy and safe pool environment. Throughout the years many different methods of purification have been attempted. They include:

- Physical treatment-heat application
- Use of metallic ions-silver and copper salts
- Irradiation-ultraviolet
- Light
- Alkalis and acids-sulfamic acid
- Surface chemicals-ammonium sulphate
- Oxidizers-Halogens and ozone
- Chlorine generation from salt

Some of these methods have met with considerable success, a few have proved too expensive and others have not provided quality results.

Today disinfection of swimming pool water is usually accomplished with one of three of the four members of the Halogen family of elements on the periodic table. The Halogens include Fluorine, Chlorine, Bromine, and Iodine. Fluorine is a very powerful acid and is not used for pool water disinfection. Of the Halogen disinfectants, chlorine has proven to be the most popular, with chlorine gas, calcium hypochlorite and sodium hypochlorite leading the many types of chlorine products available on today's market. These three are discussed below in order of their cost effectiveness, beginning with the least expensive method presently known. Regardless of which system is used, the pool should be drained and cleaned yearly to dispose of the total dissolved solids in the water, and to get rid of the bacteria that are resistent to disinfectants. Also, regardless of the type of disinfections system, an automatic feeder that is easily adjustable must be provided for the continuous application of disinfectant. pH test kits with a range of 6.8 to 8.4, accurate to the nearest 0.2 pH, must be used. Precautions when working with chemicals!

Although some of the chemicals used around pools may appear relatively harmless, caution in handling all chemicals is crucial in order to avoid injury to those handling the chemicals, the patrons and the facility itself. It is the legal responsibility of the employer to provide employees with information regarding the hazards associated with handling specific chemicals. A good source of this information is the Material Safety Data Sheets, commonly known as MSDS's, which are required from the manufactures. These sheets include handling precautions.

As an example, personal protective equipment and the required mechanical equipment is important when handling liquid chlorine. Sloshing the chemical around or splashing it out of its container and into the eyes can result in blindness, so goggles are necessary. Chemical burns can result if it is spilled on the skin, so rubber gloves and a rubber apron are important. And the common practice of siphoning the chemical through a tube by mouth can result in asphyxiation if the chemical were to enter the lungs.

Dumping concentrated chemicals in the pool gutters can cause greatly accelerated deterioration of all metal parts that these concentrated chemicals come into contact with. If these chemicals are granular, windblown chemical dust can injury bather's eyes and lungs. Concentrations of granular chemicals in the water can burn bather's eyes, discolor bathing suits and hair, and so on. Following the manufacturer's handling recommendations, and those given here, is important for a safe and liability free operation.

1. Chlorine Gas (Cl_2)

Chlorine gas is prepared commercially by the electrolysis of table salt. It is dried, cooled, and compressed into steel cylinders. In the pure form (99.9%) at room temperature, it exists as a green yellow gas that is 2-1/2 times heavier than air. Chlorine gas liquefies under pressure when compressed into metal cylinders and exists in this state as an amber colored fluid approximately 1-1/2 times heavier than water. It returns to the gas form when emitted from the cylinder.

All chlorine containers must conform to prescribed guidelines that have been established by the Chlorine Institute, Inc. The valves on the containers are composed of a brass body with a monel (nickel-stainless steel) stem. On the side opposite the valve opening is a fusible plug designed to melt at 160 degrees. The purpose of this plug is to prevent the container from exploding, which might result from high internal pressure caused by extremes of external temperature. All gas cylinders, including the one in use, should be securely chained to the wall. The valve itself is protected with a cap that has non-standard threads. Each valve is covered by a screw or cylinder "bonnet" that attaches to a collar on top of the cylinder.

Chlorine, in the gaseous form, is an excellent oxidizer and bactericide in concentrations of 0.4 ppm or more, and is cheaper by far than other forms of chlorine. However, expensive safety precautions are required as the system must be housed in a separate ventilated room. This room must be at or above grade, and located on the opposite side of the pool from the direction of the prevailing wind. At least one self-contained breathing unit (S.C.B.A.) is necessary for emergencies (two units are recommended.) The S.C.B.A. must be in a closed cabinet; it must be accessible without a key and must be located outside the chlorine room. There must be a vent fan, and it must run 24 hours per day; this fan must not be operated by the room's light switch being turned on or by the door being opened.

Since chlorine is an acid, attention must be given to the pH of the water. Continual addition of soda ash (sodium carbonate) is required, usually at a ratio of 1 to 1-1/2 pounds of soda ash for each pound of chlorine gas expended. The self-contained breathing apparatus should be worn whenever work is performed on the chlorinator, or whenever there is a chance of any chlorine gas escaping, no matter how unlikely the event or how small the likely amount. Besides the obvious safety concerns, frequent use of S.C.B.A. will train the staff in its proper use so that, should there ever be an emergency involving a gas chlorine leak, the staff is prepared and doesn't waste valuable time trying to figure out how to use the S.C.B.A. equipment. Also note that gaseous chlorine will burn the skin.

If the concerns with gas chlorine and the associated maintenance seem like an overwhelming task, one practical solution is to contract out with a chlorine gas supplier for regular maintenance of the chlorine equipment (twice yearly check and clean).

Regardless of the source of chlorine (gas, calcium (solid) or sodium (liquid)), any accident that generates a gas level of 1,000 ppm can be lethal; small concentrations can cause severe eye, skin and lung irritations. Regardless of the form of chlorine used, a plan to handle the accident and evacuate the area is critical.

2. Calcium Hypochlorite (Ca(OCl))

Commercial grade calcium hypochlorite is a dry and relatively stable mixture of chlorine (50%), calcium (28%) and oxygen (22%). It is a potent oxidizing compound (72% = 50% Cl2 and 22% O22, and is usually manufactured in granular and tablet form (about 100 tablets per pound.)) Although it is usually safer to use and store than chlorine gas, calcium hypochlorite is a very strong oxidizer, and care must be taken to keep it dry and prevent all organic materials from coming into contact with it. This includes paper products, oil and oil products (gasoline and kerosene), detergents, cleaning fluids, and human sweat (ammonia). Store containers with the lid on (and the retainer band in place), up off wet floors (on skids), away from pool and hot water heaters, away from dripping pipes and post no smoking signs in the storage area. If contaminated by water or organic materials, or if fumes from these materials contact fumes from the calcium hypochlorite, a fire or explosion may occur.

Calcium hypochlorite requires more time to prepare and demands more maintenance to the chlorinator than gas chlorine. The granular type should be mixed with water in a plastic container and then allowed to sit for a minimum of 30 to 60 minutes, preferably for several hours while the calcium hydroxide and insoluble materials settle out. The green colored liquid above the sediment is the usable material; it should then be siphoned off into a separate container and fed through a hypochlorinator into the circulation line. The calcium hydroxide and insoluble materials (that settled to the bottom of the first container) are waste and should be disposed of carefully as this material is both toxic and flammable.

Although most of the calcium hydroxide and insolubles are precipitated out before transfer to the container that supplies the hypochlorinator, a small amount remains in suspension and gradual buildup of scale will take place in hypochlorinator. Periodic cleansing (once a month or so) with muriatic acid is the best method of preventing scale from clogging the hypochlorinator. Calcium hypochlorite should not be applied directly to pools as a precipitate of calcium carbonate will form, turning the water cloudy. Normal filtration will remove most of the precipitate; however, bathers will agitate the remaining sediment during swimming hours keeping the pool cloudy for some time. Additionally, direct application of calcium hypochlorite by hand will not result in the uniform disinfection as required by law.

Calcium hypochlorite is also a very effective algaecide. A few granules sprinkled on low spots in the cement, beneath and on diving boards, on steps and on the other surfaces where algae may grow will eliminate slippery spots and odors stemming from algae. Caution must be exercised in using it on painted or plastic surfaces as bleaching may occur. Granular chlorine is sometimes used in locker rooms as a disinfectant. Mixed with water it provides a solution that will remove black fungus growth from starting blocks and aluminum diving boards.

This form of chlorine can produce a significant increase in pH (depending on local water condition), thus requiring the use of muriatic acid or sodium bisulfate to reduce it to the 7.4 - 7.6 range. Compared with chlorine gas, it is more expensive since the dry compound has a lower chlorine content. No matter what type of chlorine is used, it is wise to keep a 50 pound drum of calcium hypochlorite on hand because of its multiplicity of uses.

Shelf life of product is approximately one year from the date of manufacture if stored under "ideal conditions." "Ideal conditions" means store in a cool, dry (70% humidity or less), dark room. Keep the containers elevated off the floor, and keep their lids on except when the chemical is actually being extracted. Post "NO SMOKING" signs. This material is flammable and explosive. Clean chemical feeders monthly by pumping one gallon of muriatic acid through them and into the pool circulation line.

3. Sodium Hypochlorite (NaOCl)

Sodium hypochlorite (household bleach) is used in much stronger concentrations for pool disinfection. Common bleach, available in most supermarkets, is a 5 to 5.25% strength solution. Stronger concentrations of 10 - 16% are required for swimming pool use (12% is most common). Sodium hypochlorite is produced by two methods. It is manufactured commercially by passing chlorine gas through a solution of sodium hydroxide (a strong base with a pH 14.0). It can also be made on site by adding soda ash to a mixture of calcium hypochlorite and water, allowing the contents to settle, and siphoning off the dark green liquid. This method is time consuming, messy and serves no useful financial purpose.

Liquid chlorine is best added to pool water through a hypochlorinator, although it can be applied directly to the pool. Direct application is not a good procedure for large pools, as periodic fluctuation will occur in free residuals and the chlorine will take a considerable amount of time to be evenly distributed throughout the pool. While it is virtually sediment free, some precipitation may occur in the storage container if the supply is not fresh or not immediately used.

Sodium hypochlorite is an unstable compound regardless of how it is manufactured. The solution cannot be manufactured stronger than 16% because the sodium hydroxide becomes completely saturated at that point and no more chlorine gas will be accepted. It is extremely susceptible to deterioration, especially if stored in a warm, humid area, or if exposed to sunlight. Although it is manufactured at 16% solution, it rarely reaches the pool operator above 15% and could be as weak as 10%. Rapid deterioration results in a shelf life of about 60 - 90 days from the date of manufacture if stored under ideal storage conditions. Therefore, the purchase and use of a chlorine bleach test kit (to check the chlorine level in the solution) is a sound and inexpensive investment.

One advantage of using the liquid form is that the sodium hydroxide provides a built-in pH, thus eliminating the need for soda ash. This can also be a disadvantage as the pH will rise to a point where sodium bisulfate or muriatic acid must be used daily to maintain the pH within a range congruent with maximum chlorine efficiency.

When added to hard water, calcium hydroxide or calcium carbonate deposits may form at the point of injection in the water line. Dilution of sodium hypochlorite is sometimes desirous before chlorinating (if the hypochlorinator is oversized for the pool and care should be exercised not to use hard water as a precipitate may result, clogging the hypochlorinator). Monthly purging of the hypochlorinator with muriatic acid is desirable to remove calcium hydroxide or carbonate deposits.

A cost comparison will show sodium hypochlorite to be slightly more expensive than calcium hypochlorite and considerably more so than gas chlorine. The greatest advantages are its availability, convenience in use, and savings on the purchase of soda ash. If the pump is oversized, don't mix the chemical with water to dilute it and then feed it continuously. Instead, get a timer for the pump.

4. Lithium Hypochlorite (LiOCl)

Lithium hypochlorite is commercially processed and occasionally used as a disinfectant in swimming pools. It is a dry and fairly stable compound of chlorine, and is closely related to calcium hypochlorite in its basic properties. However, this chemical burns and explodes under the same conditions as calcium hypochlorite.

Pure lithium hypochlorite contains approximately 61% available chlorine by weight, however, some lithium hydrates contain only 35% availability. If purchased in the hydrate form (35%), it will prove more expensive than calcium hypochlorite (50% availability).

Stability of this product regarding shelf life is excellent (about 1 year) at temperatures below 80 F. degrees. It deteriorates at a much faster rate than the calcium type of chlorinated cyanurates.

If a cheaper means of production can be discovered, lithium hypochlorite may come into more wide spread use in the near future.

5. Dichloroisocyanurates - ($C_3N_3C1_2ONa$) Sodium salt, ($C_3N_3C1_2OK$) Potassium salt

The chlorinated cyanurates are a more recent additions to the group of pool disinfectant products. This method of disinfection is also as controversial as it is recent. Chlorinated cyanurate is marketed as a white powder or in tablet form and contains approximately 60% available chlorine by weight. The most frequently used types are the potassium and sodium salts, as they are the most stable and soluble.

Potassium and sodium dichloroisocyanurate have many of the same properties as calcium hypochlorite (appearance, feeding, and handling). Although their reaction with water is not completely understood, it is generally accepted that hydrolysis does take place resulting in the formation of hypochlorous acid. With this material, chlorine is "locked up" in the pool. Sun, wind, wave action heat and humidity will not cause rapid dissipation of chlorine in this chemical's presence, which is the major selling point of this system.

At first glance, this system appears to be relatively inexpensive. However, when all the additional steps and chemicals required to use this system are considered, this is an expensive disinfection approach. A controversy occurs at this point, however, over how much of the available chlorine exists in the free or combined state.

Before using this type of chlorine, pool water must be stabilized by conditioning it with 30 - 75 ppm of cyanuric acid (to be effective, 30 ppm is the minimum acceptable concentration). Separate test kits to measure the cyanuric acid concentration must be provided. Conditioning helps to lock in the chlorine when it is added and slows down dissipation due to sunlight, heat, humidity, and wave action. The pool should then be superchlorinated with one gallon of sodium hypochlorite per 20,000 gallons of water. This completes the conditioning requirements. Then, approximately two to three ounces of sodium or potassium dichloroisocyanurate per 10,000 gallons of water should be applied to the pool every other day. Weekly superchlorination is necessary with another type of chlorine, as chlorinated cyanurates are completely ineffective in retarding algae growth. The chlorinated cyanurates offer several advantages as well as several disadvantages.

Advantages of Dichloroisocyanurates

a. Safe handling.

b. Easy application (by hand or chlorinator).

c. Residual stability.

d. No insoluble material to form precipitates or scale on plumbing or on the chlorinator.

e. Little or no fluctuation in pH.

Disadvantages of Dichloroisocyanurates

a. Less free chlorine.

b. Slower bacteria kill rates (5-10 times slower than gas or hypochlorite).

c. More expensive than other types of chlorine (because of conditioning of water and weekly per chlorination).

d. Not an effective algaecide.

e. Deterioration of chlorinated cyanurates produces ammonia (ammonia nitrogen or chloramines, an excellent nutriment of algae).

f. They are combustible.

g. Levels of cyanuric acid above 100 ppm are prohibited in most states by public health departments.

h. Flammable and explosive.

Warning

Cyanuric acid levels of 100 ppm or more are forbidden by the EPA (Environmental Protection Agency) as it is toxic to humans. Since some pools are not tested frequently, as they should be, concentrations of cyanuric acid exceeding 200 ppm have been found. It should be noted that in a significant increase in the risk of cancer and other diseases in these organs. At levels above 100 ppm, this is a cumulative poison. Cyanuric acid is also absorbed through the skin and caution in its use is advised.

6. Organic Bromine ($C_4H_40_2N_2BrCI$)

Bromine in the elemental form is unlike chlorine (gas) in that it exists at room temperature as a red or red-brown liquid three times heavier than water. It is extremely dangerous to handle, as it will damage almost any surface, severely burn skin and the fumes from an uncapped bottle will injure eyes and mucous membranes. Liquid bromine is always shipped in glass bottles, especially designed to prevent breakage.

The obvious dangers of elemental bromine (Br_2) have led to the development of a safer type called hydantoin or stick bromine. Hydantoin bromine is comparable to the cyanurates and hypochlorites, and has a total halogen availability of 62% (Br_2 plus Cl) by weight. It is manufactured in a cylinder or stick form and is more expensive than elemental bromine. Application to pool water is accomplished by eroding the sticks with water in a metal container and pumping the mixture into the recirculation line to the pool. Free residual levels may fluctuate with bromine because erosion of stick is not always constant.

The Advantages of Bromine Are:

a. Less eye irritation.

b. Effective oxidizer and disinfectant.

c. Effective algaecide.

d. Adds no insolubles to the pool.

The Disadvantages Are:

a. Danger in handling elemental bromine.

b. Organic stick form is flammable and explosive.

c. Will lower pH slightly (requiring soda ash).

d. Emits a strong odor around pool (due to excessive amounts), often turns pool water green, stain pool walls, and cause a sudsing effect in the water.

e. Expensive disinfection system to operate.

f. Can stain pool walls brown (when used in excess).

g. The use of a dissolving tank prohibits a quick increase if the residual falls to an unsatisfactory level (stick form).

7. Iodine (KI)

Iodine (I_2) exists in the free state as a blush-black solid and is the only member of the halogen family that exists as a solid at room temperature. In the free state (I_2) iodine has a very low solubility in water. Therefore, potassium iodine, which is very soluble in water, is used instead. Potassium iodine has an iodine availability of 70% by weight and is approved by some public health agencies in concentrations of 1.0 ppm and higher

Preparation of a potassium iodine solution requires dissolving four pounds of crystals in 40 gallons of water in a plastic container. This solution is pumped through a chemical feed pump (chlorinator) into the water as is chlorine. An iodine system also requires a small amount of chlorine to be added almost continually. Chlorine is added to supply the hypochlorite ion that can oxidize the iodide ion to hypoiodite ions or hypoiodous (HOl). The use of chlorine therefore, requires a second chlorinator.

Upon liberation, the free iodine combines with water to form hypoidous acid (a weak acid), a good disinfectant, which has almost no effect on pH. As long as make-up water has a total alkalinity of 50 ppm, no soda ash should be required to maintain the ideal pH (7.2 - 7.6).

Iodine is also very responsive to changes in pH and a green colored water, with the characteristic iodine color, will occur if water is not tested and pH adjusted frequently.

The Advantages of Iodine Are:

a. No eye irritations, bleaching of hair or bathing suits.

b. Safe and easy handling.

c. Effects on pH are insignificant.

d. Effective as a bactericide.

e. Very stable, requires little iodine adjustment.

f. Most of the free iodine converts back to iodine ion after being used as a disinfectant and can be reconverted as many as ten to thirteen times to free iodine by continuous addition of chlorine to pool water.

The Disadvantages of Iodine Are:

a. If the skin is exposed to the dry salt or strong solution, a rash may develop.

b. Produces an odor (negligence in pH control).

c. Requires two chemical feed pumps.

d. Completely ineffective against algae.

e. More expensive than chlorine (chlorine and related equipment are necessary to use iodine).

f. Ammonia compounds must be burned out by breakpoint chlorination.

g. Hypoidous acid is very unstable and usually decompose within a few minutes to iodide and iodate ions.

h. Iodine will discolor jewelry (gold and silver rings, bracelets, watches etc., should be removed before swimming.)

i. Requires a different test kit.

Many improvements are necessary in methods and controls of iodine if it is to be universally accepted.

8. Ozone

Ozone is a form of oxygen comprised of three atoms, whereas the oxygen contained in our air has two atoms. It is a very powerful oxidizer and disinfectant, two qualities that have been recognized for a long time. As an oxidizer it can eliminate tastes, odors, and colors from pool water and studies at Harvard University have shown ozone to be extremely effective in destroying all types of bacteria and viruses.

The production of ozone is accomplished through an onsite system attached to the pool circulation line. It has a chamber into which air is compressed over a short wave length ultraviolet light. As air passes over the light, ozone is produced and then injected into the circulation line where it mixes with pool water.

Ozone offers the advantage of not having to order, handle and store chemicals along with reducing the staining and scaling properties of iron and other metals dissolved in pool water. Its major disadvantage lies in the expense of installation. Ozone equipment can double the price of a pool disinfection system.

Regulations exist in some states requiring the removal of ozone from the water and therefore a carbon absorption system must be included to remove it from the water before to entering the pool. Further, Pennsylvania requires a halogen residual, usually a minimum of 0.4 ppm of chlorine or its equivalent, to insure that some residual bactericide remains the water. This of course means two systems of disinfection (a double expenditure).

9. Chlorine Generation

One of the newest innovation in swimming pool disinfection system, developed in Holland and the United States, is the generation of a sodium hypochlorite solution in a pool's circulation system by the electrolysis of salt previously dissolved in the water.

The required salt content lies between 0.017 - 0.023 lb./gallon, which equals a salinity of 1,250 - 3,000 ppm or about 1/15 the concentration of sea water. A quantity of food grade salt is added directly to the pool to bring the salinity to the required level. From this point only small additions are necessary after the initial application to make up losses from splash out and backwashing.

Chlorine is generated from an electrolytic cell incorporated into the line, which is operated by a transformer-rectifier controlled by a hand operated switch. The circulation pump forces water through the electrolytic cell, past anode and cathode plates. A 220 volt electrical supply is used initially, but is reduced in the transformer to 24 volts. Production of chlorine is controlled by varying the electric load on the cells allowing free residuals of up to 20 ppm to be achieved with this system.

Several advantages are built into the generation of sodium hypochlorite of which regeneration is most important. Active chlorine is converted back to chlorine during its disinfecting action; hence, there is no salt consumption. This system also eliminates ordering, transporting mixing, and storing, common practices with other chemicals.

As is true with all disinfection systems, there are some disadvantages. Chlorine generation is contingent upon electricity, a form of energy that will increase in cost significantly as world oil supplies dwindle. Some chlorine odor is discernible and the pH increases slightly requiring the use of small amounts of acid. The corrosiveness of salt water is also a factor to consider. Using P.V.C. pipe, fiberglass and stainless steel components in the circulation system and pool equipment that is in daily contact with salt water will, without question, lengthen the life of the pool and its associated equipment. Perhaps the most significant drawback is the cost of installation that will range between $10 - $15,000 for a pool containing 150 to 300 thousand gallons of water. However, with a lower per day cost of operation, the saving will be much greater in the long term.

10. Silver Salts and Ionized Silver

The use of silver salts (argerol) and silver nitrate ($Ag NO_3$) were popular at one time in Europe and to some extent in the United States (New York City). An overall satisfactory bacteria kill was possible, but kill rates were slow and the use of silver salts eventually became cost-prohibitive.

Silver ionization systems have been available for many years, but only recently have they become cost effective because of new technology. Ion generators are becoming somewhat popular. They use a silver electrode (anode) and a copper electrode (cathode) to establish a circuit in the pool circulation line. Silver ions are electrically released and kill bacteria on contact. Most of the silver ions collect again on the silver electrode for continued disinfection. Some manufacturers claim that the copper ions released in pool water will eliminate algae. This may be true to some extent; however, the copper electrode is really needed to complete the circuit in the ion generator.

The effectiveness of silver in killing bacteria is also based on the organic load which is determined primarily by the number of people using the pool and environmental conditions. Mangers should be aware that silver ion systems cannot replace chlorine or bromine systems. The National Sanitary Foundation (NSF) has approved the use of silver ion systems but requires that a halogen residual be maintained. However, a halogen (chlorine or bromine) system must be used in conjunction with a silver ion generator in all 50 states. A minimum free chlorine residual of 0.4 PPM or higher must be maintained at all times. This is necessary to improve on the slow kill rate of silver and to provide a continual free residual to handle the introduction of new bacteria into the pool. Further, silver has little or no oxidation capabilities; therefore, swimming pool filters must remove unoxidized organics. As a result, filters need to be cleaned or backwashed more often subsequently increasing operational costs.

The advantages of silver ion generators are:

a. less eye irritation
b. reduction in chlorine odor
c. decrease in chlorine consumption
d. no affect on pH

The disadvantages of silver ion generators are:

a. management and maintenance of 2 disinfection systems
b. slower bacteria kill
c. some bacteria are resistant to silver
d. little or no oxidation of organic materials
e. more frequent backwashing
f. copper staining of pool walls and bottom
g. excess silver could cause a black stain on pool walls and bottom

E. Breakpoint Chlorination

Frequent articles have appeared in swimming pool literature about the values of breakpoint chlorination. Operators of large pools having a high organic content (ammonia compounds) in the water would do well to investigate this method for controlling algae, eliminating chlorine odors and water tastes, reducing water tastes, and reducing irritation to the eyes. Breakpoint chlorination, or superchlorination as it sometimes is incorrectly called, should be used when combined chlorine is detected in the pool water. There are test kits that will detect combined chlorine levels at 0.3 ppm chlorine, hence any time the difference between the total and free chlorine reading (combined chlorine) is greater than 0.3 ppm, one should superchlorinate the pool to breakpoint by adding an amount of chlorine equal to 10 times the amount of combined chlorine present. For example, if a pool contains 1.5 ppm total chlorine and 1.2 ppm free chlorine, the combined chlorine is 1.5 minus 1.2 or 0.3 ppm. This pool should be treated with 10 times the 0.3 or 3.0 ppm of chlorine from a hypochlorite or chlorine gas source to remove ammonia and organic matter as discussed below.

Breakpoint chlorination is a process of chlorinating that is based on the following: first, chlorine added to a pool is immediately absorbed by two classes of nitrogen that occur in swimming pool water (ammonia nitrogen and organic nitrogen.) Ammonia nitrogen reacts very rapidly with chlorine and can be destroyed without much difficulty, but organic nitrogen can be a problem. As dosages of chlorine are added to water containing only ammonia nitrogen, monochloramine is formed followed by the presence of dichloramine. A fall in the measurable chlorine residual occurs as chlorine is continually added during the formation of dichloramines. A dramatic dip will occur when the level of chlorine to ammonia nitrogen reached 10:1. This is the "breakpoint" beyond which continued addition of chlorine causes an increase in the free chlorine residual directly proportional to the dose added.

In summary, breakpoint chlorination stresses: (1) that most of the effective chlorine is free available chlorine - HOCl or hypochlorous acid; (2) that the proper concentration to be maintained in a pool is that in which the free chlorine is not less than 75% of the total chlorine residual; (For example, if a pool has 1.3 ppm total chlorine, 1.0 ppm should be free chlorine and 0.3 ppm combined); (3) that differentiation between "free" and "combined" residual is the key to success of the free residual technique; and (4) that proper control of the free residual chlorine level greatly reduces eye irritation complaints, disagreeable odors, and "black algae" growths.

As noted above, since a great part of the so-called "chlorine odors" and taste is due to combined residuals, these odors and tastes will also disappear after reaching breakpoint. As chlorine is added past the breakpoint, most of the chlorine in the water will be in a free state, with combined chlorine remaining fairly constant.

F. Dosage Calculations

Calculating the Amount of Disinfectant Necessary to Raise Levels by 1 ppm.

(See Appendix L, *Pool Chemical Adjustments*)

First, find the percent of available disinfectant in the compound to be used by reading the label. Change the percent to a decimal by moving the decimal two places to the left (for this example, 70% becomes 0.70). Since 1 ppm equals 8.3 pounds of chemical per million gallons of water, or 0.13 ounces per thousand gallons of water, divide 1.3 by the decimal previously obtained to get the number of ounces of compound per 10,000 gallons of water to produce 1 ppm of disinfectant.

Example: Assume calcium hypochlorite having 70% available chlorine.

How much must be added to a pool containing 215,000 gallons of water to equal ppm chlorine?

Step 1: 70% equals 0.70

Step 2: 1.3 divided by 0.70 oz. per 10,000 gallons of water = 1.85

Step 3: 1.85 times 21.5 (gallons of water) equals 39.78 oz. of calcium hypochlorite needed to produce 1 ppm of free chlorine

G. Additive Controls

When gas chlorine is used, approximately 1.5 pounds of soda ash must be added for each pound of chlorine to maintain the pH. The exact amount depends upon other factors including make up water and other chemicals added to the pool. Caustic soda is sometimes used in larger pools to obtain the required pH. Other pH control problems should be solved by trial addition of small amounts of sodium carbonate to raise pH, or sodium bisulfate or acid to lower pH. Start with 1 pound of solid, or 1 quart of liquid acid, and adjust as needed.

For coagulation on granular media filters use 2 ounces of aluminum sulfate for each square foot of filter surface area. For algaecides, follow manufacturer's recommendations for dosage. For diatomaceous earth filters, precoat using about 5 ounces of diatomaceous earth for each square foot of filter area. Pool operators will find that optimum conditions of water clarity and chemical balances prevail when the following recommended water chemistry is scrupulously maintained.

Chemical Calculations and Dosage

1 part per million equals 1 pound of chemical per 1 million pounds of water

1 part per million equals 1 milligram per liter in water

1 part per million equals about 8.3 pounds of chemical per million gallons of water, or 0.13 ounces per thousand gallons of water.

Calculations for Chlorine Dosage

When chlorine is added to water, it begins acting immediately on impurities. The amount of chlorine needed depends upon the amount if impurities pre-

Recommended Control Levels:

Factor	Minimum	Recommended	Maximum
pH	7.2	7.4 - 7.6	7.8
Free chlorine	1.0 - 2.0 ppm, never lower than 75% of the total chlorine.		
Total alkalinity	80 ppm	100 ppm	120 - 150 ppm
Total calcium hardness	80 ppm	80 - 200 ppm	400 - 500 ppm
Water Temperature	78	82	84
Langelier Index	(-) 0.3	0.0	(+) 0.3
Total Dissolved Solids	—	—	800 ppm

sent. For that reason it is impossible to predict the amount of chlorine any given pool will use in a day. There are general guides that can be used, however. Basing the calculations on absolutely pure water will give the minimum dosage necessary to maintain a desired residual in addition to that necessary for reaction with impurities.

A chlorine dosage of 1 part per million means 1 ounce of chlorine for 1 million ounces of water. Therefore, 1.3 ounces of pure gaseous chlorine per 10,000 gallons of water equals 1 ppm.

About 2 ounces of granular or tablet calcium hypochlorite (70% available chlorine) per 10,000 gallons of water equals 1 ppm.

About 1 cup (8 oz.) of liquid sodium hypochlorite solution (15% available chlorine) per 10,000 gallons of water equals 1 ppm.

About 1 cup (8 oz.) of liquid sodium hypochlorite solution (15% available chlorine) per 10,000 gallons of water equals 1 ppm.

About 2.2 ounces of granular sodium dichloroisocyanurate (63% available chlorine) per 10,000 gallons yields 1 ppm.

About 1.5 ounces of trichloroisocyanurate (90% available chlorine) per 10,000 gallons yields 1 ppm.

1 pound of calcium hypochlorite (70% strength) equals 0.7 pounds of available chlorine.

1 pound of sodium dichloroisocyanurate (63% available chlorine) equals 0.63 pounds available chlorine.

1 gallon of sodium hypochlorite (15%) equals about 1 1/2 pounds of available chlorine.

1 pound of trichloroisocyanurate (90% strength) equals 0.9 pounds available chlorine. For scrubbing and sanitizing decks, use about 1 ounce of granular product or 1/2 cup of liquid sodium hypochlorite in a gallon of water.

H. Water Testing — General Tips And Procedures

Water testing procedures are crucial; if outdated chemicals are used, water samples taken from improper location, or testing is infrequent, safe, cost effective pool operation will not be possible. The result of faulty water testing procedures will be inaccurate an unusable water test results.

Operators run the risk of: spreading communicable diseases; causing rapid and unnecessary deterioration of the pool piping, pumps, and filters; creating conditions under which algae will form, and filters will not operate efficiently. Methodical, careful, and accurate water testing, therefore is crucial.

General Tips

1. Purchase a good test kit that is manufactured by a reputable company. At a minimum, the kit (or group of separate kits) should provide the capability of testing for pH, total alkalinity and calcium hardness. These three tests are vital to knowing what is happening chemically in the pool.
2. New water test cells should be labeled and used separately for each type of test, i.e., pH, total alkalinity, and total hardness (this will result in more accurate readings). Buy new glass or lucite test cells every six months (the cells discolor from use, thus giving inaccurate readings and they're cheap).
3. Purchase chemicals directly from the manufacturer to insure freshness.
4. Label the chemicals with the purchase date.
5. Use only chemicals made for your test kit. Don't buy a test kit from one company and use chemicals from another manufacturer. Chemicals from one company are not compatible with test kits from another company; the color standards are different, and the chemicals vary in terms of strength and composition.
6. Store the test kit and chemicals properly (in a dark area, at between 60 and 70 degrees, and low humidity). Chemicals break down rapidly when exposed to sunlight, heat, or humidity; the sun bleaches colors in the test chemicals and color comparators and discolors lucite test cells; and, color comparators break when exposed to freezing temperatures. Test kits must not be left out during the day, such as on a lifeguard's stand.
7. Almost all water testing chemicals are unreliable after one year, and will not give accurate test re-

sults — they may not be good for more than several weeks if improperly stored.

8. Recognize that Phenol Red, the most commonly used pH indicator solution, can only read a pH between 6.8 and 8.4. If the actual pH is outside that range, Phenol Red will not provide even an approximately correct reading. Also note that this chemical has a maximum shelf life of six months.

1. Procedures

1. Test the water frequently! Indoor pools should be tested no less than once every two hours; once an hour is much better. Outdoor pools should be tested once every hour. Frequency of tests depends on temperature, number of users, and many other factors.
2. Follow the tests kit's instructions explicitly!
3. Wash your hands thoroughly before testing to eliminate chemicals and dirt on your hands that will result in faulty test results.
4. Wash the test vials regularly with detergent, and rinse well using deionized (distilled) water.
5. Take two disinfectant tests, one in the deep end and one in the shallow end. Use the readings obtained in the shallow end as the basis for increasing or decreasing disinfectant levels.
6. Avoid taking water samples directly in front of water inlets (where chemical concentrations are strongest and not indicative of the pool in general).
7. Cover the top of the cell with a cap or your finger, submerge the vial (filled with air) 12 inches below the surface of the water, and uncover the cell, filling it with water. (Taking the sample 12 inches below the surface avoids surface dirt, body oils, etc.)
8. Use only the amount of water required (as indicated on the test cell) to obtain accurate test results. (If a meniscus forms when a test cell is filled with water, place the bottom of the meniscus on the water level line to get the right amount of water. The formation of a meniscus indicates that the test cell is dirty and should be washed).
9. When putting chemicals in test cells, do not let the chemical dropper touch the cell or the water therein. Doing so will contaminate the test reagent resulting in inaccurate test results in the future.
10. Use a different finger or cap to cover each separate cell for each chemical test. This is done to prevent the chemicals from one test from mixing with chemicals from another test and thus giving faulty readings.
11. The preference of light sources when reading test cells are, from best to worst; sunlight, florescent, and then incandescent. Other light sources are not acceptable.
12. Use caution in handling chemical reagents as chemical burns, and eye and mucous membrane irritation may occur.

2. Testing for Chlorine Residuals

The most common method for testing chlorine residuals in the past has been the orthotolidine color test. This method provided spurious results due to improper testing procedures. Orthotolidine is a carcinogen and for these reasons is no longer recommended.

The best method of testing for free chlorine directly is the Palin or DPD method. This is based on the use of diethyl-p-phenylene diamine. The method is also be used to measure the individual chloramines in pool water.

Another method for reading free chlorine and pH makes use of a simple test strip. In contact with the pool water, the test strip changes color and the resulting color can be compared with standards. These test strips measure free chlorine only. Therefore, they do not indicate when the combined chlorine level has increased and breakpoint chlorination is needed.

Residual bromine can be tested very easily with the same DPD test kit used for chlorine. If a chlorine test kit is used for testing bromine, however, the reading must be doubled. Thus, the 0.4 ppm chlorine reading, the minimum required by law, becomes a 0.8 ppm standard for bromine.

Free chlorine and pH test kits are essential for pool operation, whether the pool contains 3,000 or 300,000 gallons of water. Test kits are available for cyanuric acid and iodine and some manufacturers provide sophisticated electronic water testing apparatus that yield excellent results.

3. Testing for pH

Determining the pH of pool water is a simple operation. There are chemical reagents that are sensitive to acids and bases. The three most commonly used indicators are bromthymol blue (pH, 6.0 - 7.6), phenol red (pH 6.9 - 8.4), and Cresol red (pH 7.2 - 8.8). Of the three, phenol red is most often used.

The test is conducted with a color comparator similar to that used for testing chlorine residual except that a separate set of color standards and the proper indicator are used.

In water that has a very high chlorine content (10 ppm or over), the chlorine may bleach the pH indicator and give false pH readings. Here, a drop of sodium thiosulfate (photographer's hypo) must be added to the vial before adding the indicator. The hypo reduces or "neutralizes" the chlorine.

Note - many indicator solutions already contain the neutralizer. Check with the manufacturer of the test kit.

Thoroughly clean vials are essential to accurate tests. If a vial is covered with a finger before inverting to mix the solution, a false reading may result unless the finger is clean.

I. Common Water Problems and Solutions

There is no mystery to water chemistry, pool management and maintenance. The pool operator who has been exposed to basic water chemistry will probably not experience turbid, cloudy, or colored water. Conversely, the operator who has not taken the time to inform himself can easily experience these conditions along with eye, skin and mucous membrane sensitivity as well as damage to plumbing, pool heater and other related equipment.

The purpose of this section is to provide solutions to common problems in water management. These solutions are intended to serve only as guidelines and will not solve all problems to the satisfaction of the pool operator. The Department of Community Affairs does not accept responsibility for any damages incurred as a result of the use of this material. It is impossible to foresee other conditions due to water supply, geographic area and other causes that may have significance in each particular case.

1. Turbid Water

Turbidity implies the presence of dirt or impurities causing discoloration of water. This condition can be caused by contaminated water supply, faulty filter operations, or improper chemical procedures. Exposure of water to air is another factor as pollen, dust and automobile exhaust fumes can cause some cloudiness. The easiest way to cope with turbidity is to prevent it. This is done by:

a. Maintaining an adequate chlorine residual (1.0 - 2.0)

b. Maintaining the proper pH and alkalinity level (7.2 and 100 ppm).

c. Keeping the water level up to the skimmers or to a point of overflow into the gutters.

d. Backwashing when necessary; don't overextend filter runs, especially on hot or crowded days.

e. Keeping decks and pool entrances clean.

f. Outdoor pools — keep the grass cut, the trimmings cleaned up and shrubs and trees planted around the area to afford some protection from air-borne contaminants.

If a turbid condition exists, the procedure is:

a. Check immediately for chlorine and pH levels.

(1) If the chlorine residual is very low (0.2 ppm) or non-existent, and if the pH is high (8.0 plus) and the water is green, suspect algae.

(2) If the chlorine is high, the pH is low (below 7.0) and the water colored (green, brown, or black,) suspect metals in solution or suspension.

(3) If the water is cloudy or milky and the pool uses diatomaceous earth filtration, suspect a cracked or torn filter element

that is leaking D.E. into the pool. In this event, the filter element or cover must be replaced.

(4) If the water is dirty in appearance and the pool uses sand filters, recheck your backwash procedure to determine if the valves were open and closed at the proper time.

b. If the water is clear early in the day and cloudy late in the afternoon or evening, suspect overloaded filters. They may need back-washed or on crowded days may not be able to keep up with the load. If the latter is to blame, increase the chlorine residual to help oxidize the organic material.

2. Algae and Its Control

Algae is a single-celled green plant, which thrives in water of high pH and in sunlight. Although there are some 46 species of algae that grow well in pool water, three types are particularly bothersome to pool operators. They are: planktonic algae (floating); bottom algae (creates sediment); and sessile algae (grows in cracks and cement pores).

Algae spores are introduced into pool water in raindrops or by wind-borne dust. Once in the pool, the spores grow rapidly and can take over a pool in as little as 24 - 48 hours. The spores are nourished by nitrates (ammonia compounds and dissolved carbon dioxide). Other conditions conducive to algae growth are: high pH, low chlorine (below 0.2 ppm), sunlight, warm water (over 80F), mineral and chemical content.

Algae is not directly responsible for disease or infection, but should be eliminated because it decreases visibility, creates odors and slippery surfaces, and imparts objectionable tastes.

The best method for treating algae is to prevent it. This can be done as follows:

a. Maintain a good chlorine residual (1.0 ppm).

b. Maintain a pH between 7.4 - 7.6. Keep the level close to 7.4 during July and August.

c. Periodically (once a week) superchlorinate or use breakpoint chlorination as this also burns out ammonia compounds. Superchlorination should take place at night (no sunlight or bathers). Readjust chlorine and pH before permitting to enter the pool the next day.

d. Maintain 24-hour filtration with maximum turnover.

e. Vacuum the pool every day if possible.

f. Paint the pool once a year (fills cracks and pores, maintaining a smooth surface).

g. Watch for unexplained, sudden rises in pH as this is usually a warning sign of algae growth before it can be seen.

Should algae gain a foothold in your pool, the following steps should be taken:

a. Superchlorinate to 3.0 ppm overnight, killing the algae.

b. The next morning brush the pool walls and bottom with a stiff bristled brush to loosen the dead algae from pores and cracks.

c. Vacuum the bottom of the pool.

d. Adjust the chlorine residual by adding fresh water and keeping the chlorinator shut off until the desired level is reached.

e. If super chlorination is used, the chlorine level will come down automatically. Maintain careful checks throughout the breakpoint cycle.

f. If this procedure does not give satisfactory results, the pool must be drained, scrubbed with muriatic acid, rinsed and refilled.

3. Hard Water (Chelating or Sequestering of Minerals)

Hard water is a typical problem of people living in the Southwest, Gulf States and the North Central United States. Water becomes hard as it passes over or through calcium (limestone) deposits and magnesium. Hard water causes scale to form on plumbing and filters, clogging them. The formation of scale and cloudy water is affected by the amounts of dissolved solids in the water, temperature, amount of calcium, total alkalinity and pH. Of the five factors mentioned, only alkalinity and pH can be controlled significantly enough to reduce hardness unless the water is softened before the pool is filled.

If the pH maintained between 7.4 and 7.6 scaling or cloudy conditions are unlikely. Hard water problems can be reduced by following these steps:

a. Add sodium hexametaphosphate (Calgon) to the pool at a rate of 1/2 pound per 10,000 gallons of water upon filling the pool at the beginning of the season.

b. DO NOT CHLORINATE BEFORE SOFTENING.

c. Add one ounce of sodium hexametaphosphate per 10,000 gallons of water every two weeks during the season. (This chemical is very inexpensive and available in most supermarkets).

4. Colored Water

This condition is caused by the presence of metallic ions in solution or fine metal particles held in suspension. These metals are either present in the water supply or can result from corrosion of plumbing due to low pH. Each metal imparts its own characteristic color. The most common dissolved metals and their resultant colors are:

Copper — imparts a blue or blue-green color.

Iron — imparts a red or red-brown color. May also be green if the iron is dissolved and not oxidized and the pH has dropped close to 7.0 or below.

Manganese — imparts a brown or black color.The following steps should be taken to alleviate this condition.

a. For pools with diatomaceous earth filters.

(1) Adjust the pH to 7.4 - 7.6 range.

(2) Superchlorinate to 4.0 ppm.

(3) Scatter aluminum sulfate (alum) over the pool at a rate of two ounces per 1000 gallons of water.

(4) Flocculation similar to snowflakes will form and both alum and color compounds will set.

(5) Vacuum the pool bottom and maintain filtration at the maximum rate of turnover.

(6) Adjust the pH range to 7.4 - 7.6.

(7) Adjust the chlorine residual to 0.4 - 1.0 ppm before permitting bathers to enter the pool.

b. For pools with sand filters.

(1) Adjust the pH to 7.4 - 7.6.

(2) Superchlorinate to 4.0 ppm.

(3) Add alum at the rate of two ounces per square foot of filter surface area ahead of the filter. This will form a gelatinous coating on the sand, which will trap the color particles.

(4) Maintain filter operation at the maximum rate of turnover. Allow 24 - 48 hours for filtration to clear the water.

(5) Backwash the filters to waste.

(6) Check and adjust the pH to 7.4 - 7.6.

(7) Adjust the chlorine to 0.4 - 1.0 ppm.

(8) Vacuum the pool bottom. With both filter types, it is important to check the pH before and after treatment as alum creates acid when added to water.

SECTION III

FILTRATION

Physical treatment of water (filtration) refers to the removal of dirt and organic or inorganic materials in suspension and temporary media. When considering which system to choose, a lifecycle costing approach should be used. This method considers not only the initial capital costs, but also the long term operating costs.

The removal of soil from water is not one of man's engineering feats. We have, in essence, copied a long established method used in nature since the dawn of time. Water is naturally filtered as rain water passed from the earth's surface through the various layers of soil and sand, gravel and rock to collection points underground. Man has adapted this method and termed it sand and gravel filtration. He has also improved on it with diatomaceous earth filtration and high flow sand.

The heart of any pool recirculation system is a centrifugal pump. This pump by definition draws water to its impeller and discharges it from its housing back into the recirculation line. It is the placement of the pump that determines whether the pool has a pressure or vacuum system. If the water is filtered after being discharged from the pump, the water, therefore, enters the filters under pressure and the pool has a pressure system. If the water is drawn through the filters and then pumped to the pool, the system is considered a vacuum or gravity type. Since the hydraulics of both systems are very similar, the efficiency of the system is contingent upon how clean the filters are kept and the corresponding chemical condition of the water.

A. Types of Filtration

There are six types of filtration used in America's swimming pools today. In all six, some type of filter media (sand and gravel or diatomaceous earth) is used. All six methods are acceptable and are somewhat equal in their ability to remove dirt and impurities. They are classified as perpetual media and temporary media.

Perpetual types — those that reuse the same media.

1. Pressure sand — This was the former standard filtration method, widely used until the 1950's. It employs one or more steel filter tanks filled with layers of sand and gravel and operated by a pump and motor that for forces water down through the layers of sand and gravel and back to the pool.
2. Vacuum sand (gravity sand) — The oldest and most common method of pool filtration used until replaced by the pressure sand type. Once called gravity sand, it has undergone engineering changes and is now called vacuum sand. A large open bed, composed on layers of gravel and topped with sand, is used in this method. Water flows through the bed on a gravity basis and is pumped back to the pool.
3. High flow sand — This is a more recent type of sand filtration. Due to engineering problems the rate of filtration usually does not exceed 15 gallons per minute. Water is forced through sand that is kept in suspension by the high flow rate of the water. The system requires half the filter surface area as pressure sand. Another advantage offered is that no coagulant (alum) is needed. There is some question about whether high rate sand filters can deliver the same quality water as the regular sand filters.

Temporary types — those methods that require new media after backwashing.

4. Vacuum diatomaceous earth — The vacuum diatomaceous earth method of filtration is also commonly referred to as the open pit or open

tank. It features the same media, creating a filter cake on elements that are visible in an open tank. Water flows into the tank via gravity and is drawn through the elements and pumped back to the pool. The advantage of the vacuum method is easier access during maintenance and cleaning.

5. Pressure diatomaceous earth — Pressure diatomaceous earth filtration was developed during World War II. Fossilized diatoms serve as a screen on the surface of filter elements and strain dirt particles from the water. These elements are housed in steel tanks and water is drawn through them and recirculated back to the pool.
6. Regenerative Cycle Diatomaceous Earth — A recent development in D.E. filtration, regenerative filters are an adaptation of pressure D.E. filters. The elements, several hundred per tank, are small tubes, usually made of spring stainless steel and are covered with an acid-base resistant synthetic material. The primary difference between pressure and regenerative types is that the regenerative system is self-cleaning, uses no water for cleaning, and requires 6 to 12 fifty (50) pound bags of D.E. per 12 month operating season.

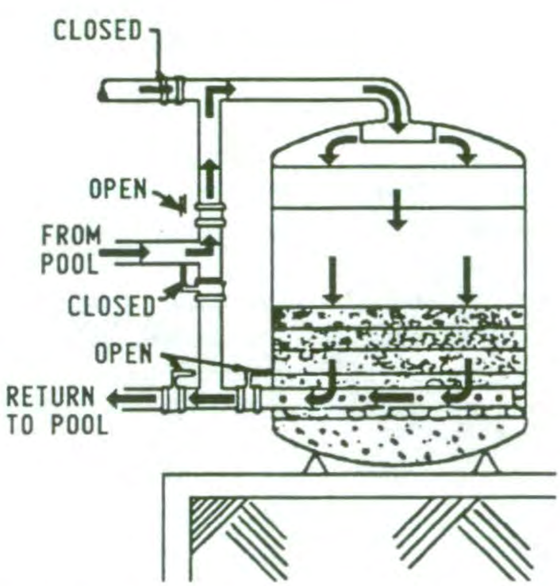
B. Sand Filtration

1. General - Pressure Sand

Pressure sand systems usually employ a bank of two to four steel tanks. These tanks vary in size from 30 to 120 inches in diameter (96 inches is standard) and from 5 to 24 feet in length. Longer types (as used in high flow and pressure sand) are generally set in a horizontal position.

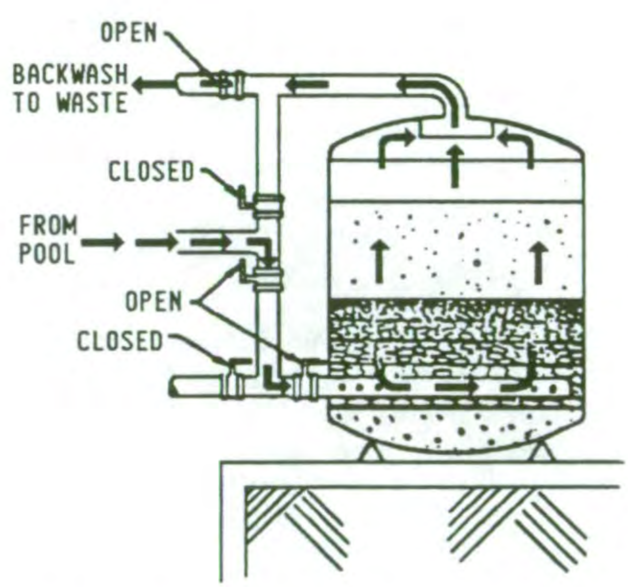
The filter bed in each tank is composed of three or four layers of gravel with a top layer of fine silica sand. The bottom of the tank includes a perforated manifold (that collects the filtered water) and that is surrounded by a layer of gravel

Conventional Pressure Sand Filter



FILTER CYCLE

Water from pool enters filter tank from top header line and is forced through filter sand and supporting rock bed out of tank through lateral underdrain system and returned to pool.



BACKWASH CYCLE

Water is forced into bottom of tank via the underdrain system up through the supporting rock bed where the filter sand expands causing scrubbing action to take place after which the dirt particles are flushed to waste through the top header piping.

about 3/4 inch in diameter. Above this is a layer of 1/4 - 1/2 inch gravel, while still another layer of 1/8 - 1/4 inch gravel is situated on this. All gravel layers vary from 10 - 18 inches in thickness. The layer of sand on top (12 - 18 inches) is composed of particles from 0.4 mm to 0.6 mm in size. Each layer is graded and settled as much as possible to prevent shifting or mixing during filtration and backwash. Above the sand is an area of freeboard approximately 18 - 24 inches in height. The freeboard serves as an expansion area for the sand layer during the backwash operation.

Connected to the pipe that carries the water to the filter is a baffle that serves as a splash plate. It disperses water equally over the surface of the sand. This helps to prevent channeling of the sand and gravel layers.

Dirt and solid impurities are retained, for the most part, on top of the sand layer, trapped between the sand particles. Provided the chemical residuals are adequate, semi-solids and materials in suspension, even body oil, can be filtered out.

An artificial floc can be applied to the filter in the form of aluminum sulfate. Alum is placed in an alum pot that is linked to the recirculation system, preferably ahead of the pump. A small amount of water flows through the pot, dissolving the alum slowly. If the alum is added too close to the filter bed, it may not dissolve completely. Consequently, it would pass through the sand, enter the pool and floc there, creating turbid water. Once the dissolved alum reaches the filter, a gelatin-like floc will form over the sand, trapping the solid particles and impurities. As the impurities collect on the alum, the pressure builds forcing the pump and motor to work harder. When the pressure reaches 12 PSI on the influent pressure gauge, backwash procedures should be undertaken. This floc will take place naturally within 8 to 12 hours after backwash, although filtration will be somewhat substandard up to this point.

2. Backwashing the Pressure Sand Filter

A flow rate of 3 gpm/sq. foot of filter surface has long been accepted as the most effective filtration rate for pressure sand filters by manufacturers. A faster flow rate will cause dirt to pass through the sand and gravel, which can create a turbid water condition.

To clean the filters (backwash) it is necessary to reverse the flow of water through the layers of gravel and sand at a rate exceeding 3 gpm/sq. foot. Most public health departments require a backwash rate of 12 gpm/sq. ft., or 4 times the normal filtration rate. Each filter tank in the pressure sand system is backwashed or flushed separately for 15 minutes, or until the effluent water (discharge) becomes clear as observed in a sight glass attached to the discharge level.

Backwashing causes the top two layers to expand somewhat thus releasing the trapped impurities and discharging them to waste. The need to backwash will be indicated by the difference in pressure between the influent gauge (measuring water going into the filter) and the effluent gauge (measuring the water leaving the filter and returning to the pool). Generally, when the difference in readings of the two gauges reaches about 5 pounds per square inch, it's time to backwash.

3. Operational Problems of Pressure Sand Filtration

During operation, "mudballs" may form in the sand layer due to insufficient backwash rate or insufficient chlorine residual. Mudballs are made of sand, lint and hair, held together by organic growths. If the backwash flow is insufficient to remove this organic material, they will cause channeling in the filter media. The pool operator must also be careful to insure that the proper backflow is achieved to effect expansion of the sand layer; otherwise, calcification, or hardening of the sand may develop, rendering the media useless. Channeling is generally caused by high concentrations of lime found in the water, use of too much alum or extremely high total alkalinity.

The development of channeling and mudballs takes place over a period of months and is usually noticed first through an observation of abnormal variations in the gauges of the filtration system. Either condition might be cleared by soaking the filters in a chlorine solution or commercial filter cleaner. However, in all probability the top layer of sand will have to be replaced with new sand.

C. High-Rate Pressure Sand Filtration

Conventional sand filters are designed to trap impurities in the top three inches of sand, thus rendering the rest of the filter media virtually useless. High rate sand, through precise hydraulic balance, forces water through the filter bed about seven times faster than conventional sand filters. The faster filter flow rate and smaller tank permits the entire sand bed to be used. Because of total depth penetration, the "dirt holding" capacity of each cubic foot of media is increased. This means that a smaller filter tank can be used and therefore less time and wasted water is required during backwash. The high rate of filter employes two grades of sand in separate layers on top of two layers of gravel. The top layer is composed of clean (dust free) No. 20 grade sand (0.45 mm). The No. 20 grade sand is placed on top of the layer of No. 12 grade sand (1.3 mm).

When the filter bed becomes clogged, turbidity is removed by backwashing. During the backwash cycle, water is forced into the bottom of the filter tank via the underdrain. It rinses through the supporting media, where the filter sand expands, causing a scrubbing action to take place. Dirt particles are then flushed to waste through the overdrain.

The motor and pump are placed so that water is drawn through the filter elements, is passed through the pump into the recirculation line and back to the pool. Water is pulled through the filters at a rate of up to 15 inches of mercury.

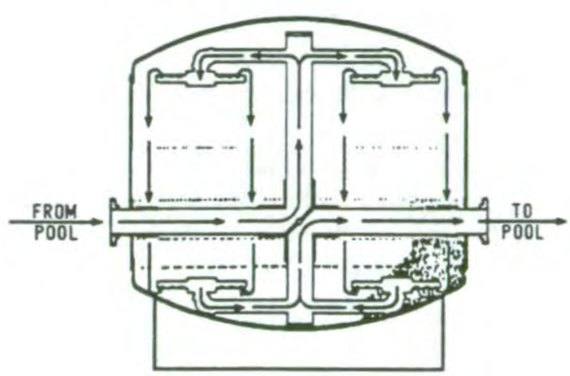
D. Diatomaceous Earth Filtration

1. General

Diatomaceous earth is the porous, fossilized, skeletal remains of microscopic marine plant life. Diatomite or D.E., as it is also called, is found in nine standard grades, ranging from course to very fine. The type used in each filter is determined by individual manufacturers. It depends on the type of water being filtered, the rating of the filter, and the clarity of the water desired.

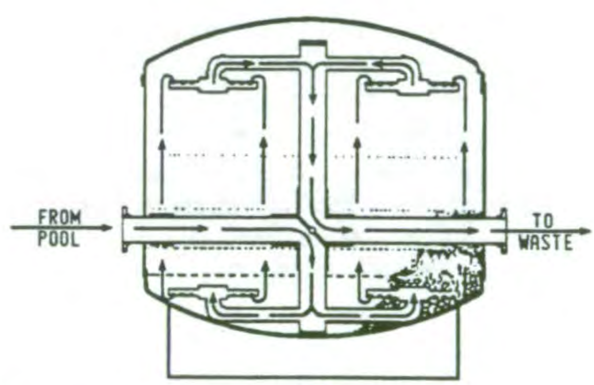
D.E. functions very efficiently as a filter media because of its skeletal, snowflake-like design. The entire space of each diatom is about 10% fossil and about 90% empty space. This permits it to filter out

Typical High-rate Sand Filter



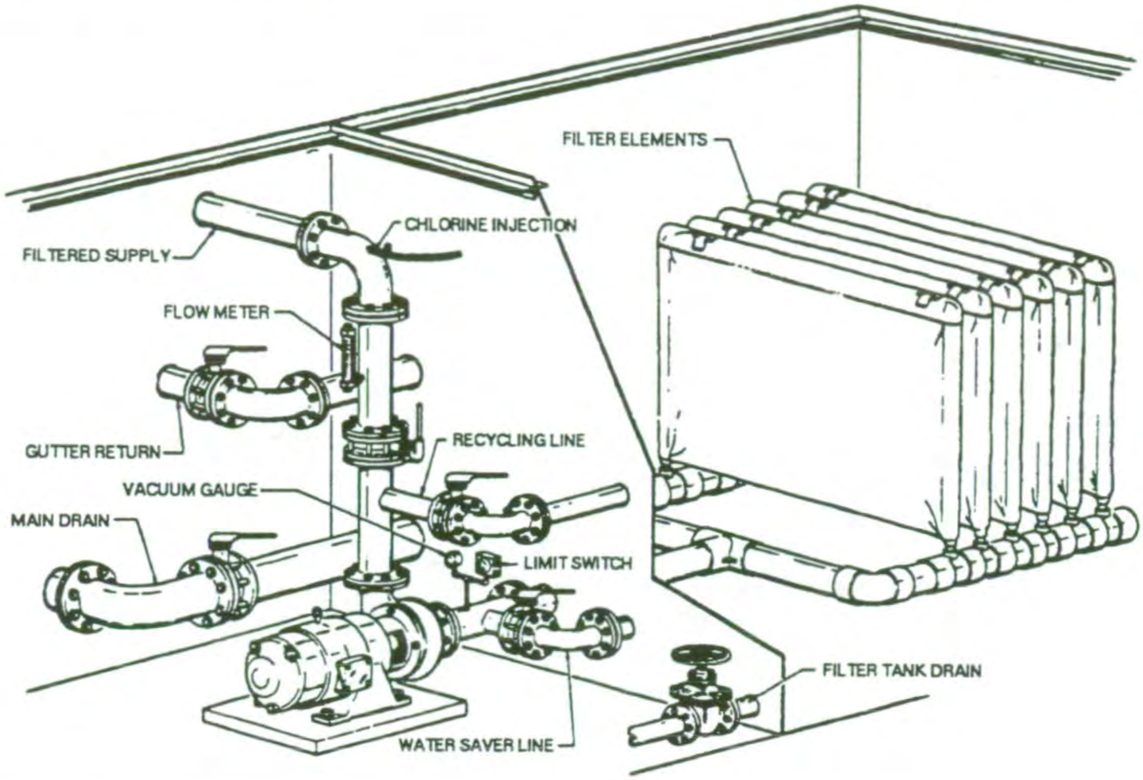
Filter Cycle

Water from pool enters tank form overdrain distributor, is forced through media bed out of the tank through the underdrain distributor system and returned to the pool.



Backwash Cycle

Water is forced into bottom of tank via the underdrain distributor system, through the supporting media where the filter expands causing a scrubbing action to take place during which the dirt particles are flushed out of the tank through the overdrain distributor to waste.



material as small as one micron (one millionth of an inch), which is the size of some types of bacteria.

The elements of the D.E. filter can be of various sizes and shapes. Among the most common are the tube or cylinder type, the rectangular or circular leaf, and the rectangular tube. These elements are generally made of plastic and covered with an acid-alkali resistent man-made material. The leaf system offers the most filter surface area per filter tank, much more than either the cylinder or rectangular tube types. The elements are attached to a pipe-manifold that collects the filtered water and sends it to the pump.

Before filtration can be started, the filter elements, or septum, must be precoated with a cake of D.E. This is done by circulating the water between the pump and the filter tank. At this point, all valves leading to and from the pool should be closed. The D.E. is added by pouring it slowly over the elements, or by mixing it with water to form a slurry and then adding it to the tank. About 1 to 1 1/2 pounds per 10 square feet of filter surface area should be applied. This will provide a precoat of about 1/16 of an inch.

Since the dirt is trapped on the surface of the D.E. coat, clogging of the cake will take place rapidly. The conventional pressure or vacuum D.E. filter, whether augmented by continuous slurry feeding or not, functions strictly as a surface filter. Under the traditional mode of operation, once the D.E. is applied to the filter elements it remains on the filter elements, undisturbed, until a specific point of pressure differential between the inflow and outflow valves is reached. At this time, the old D.E. cake is washed off the filter elements and flushed to waste, and new D.E. is applied to the filter. This is known as static cake operation. This conventional method of D.E. filter operation wastes a considerable amount of diatomaceous earth and treated water. Two methods of extending filter runs are available to the pool operator:

2. Continuous slurry feeding

Every other day, several pounds (the amount is based on the pool load) of D.E. are mixed with water and added through a slurry feeder. This will thicken the coat and enable it to hold more dirt. At some point, however, the critical pressure differential will be reached and all the D.E. will be flushed to waste. Slurry feeding is still costly as it also uses more D.E. and treated water than is actually needed to provide good pool water quality.

3. Interrupt or Regenerative Cycle Filtration

The latest technique in diatomaceous earth filtration completely reverses the concept of static cake filtration. By periodically removing the surface contaminated filter cake from the elements, mixing it within the filter, and then reapplying the mixture to the elements, it is possible to continue the filter cycle with the original D.E. precoat Studies have shown that static cake operation of a D.E. filter uses only 10% of the media's dirt holding capability since filtration essentially occurs at the surface of the media only. Studies also prove that when a surface-contaminated filter cake is removed and reapplied, unused filter surfaces are randomly presented to the filtration stream. Thus, the collective filter cake is again made porous and free flowing.

Each time this process is repeated, the dirt-to-filter ratio increases. The result is an in-depth usage of the diatomite precoat Since there is an apparent revitalization each time the precoat is removed and reapplied to the filter elements, the term regenerative filtration has been given to this operating technique.

This can be done by hand or automatically by specialized filtering equipment. If done by hand, the methodology is as follows. About 3 or 4 times per day, the pump motor is shut off for 5 minutes, and the water lines to and from the pool are closed. This will cause the D.E. precoat to fall off the fabric filter material. After this has occurred, the recirculation lines are opened up and the old D.E. and dirt are recycled back onto the filter elements. After the D.E. is reapplied, the lines to and from the pool are reopened. This interrupt filtration technique can save a considerable amount of money for treated water and diatomaceousearth.

4. Cleaning the Vacuum Diatomite Filter

In practice, the vacuum diatomite filter is not backwashed. Backwashing implies that water is forced through the filter in the opposite direction from the normal flow during filtration. In the vacuum system, when the pressure on the influent gauge reaches 12 psi., water coming into the tank through the main line is closed. The pump is permitted to run until most of the water in the filter tank is returned to the pool. The rest is discharged to waste. The operator then washes the dirt and old cake off the elements with a high pressure stream of water from a garden hose. When the old cake has been removed and the tank thoroughly cleaned, it is refilled with either fresh water from the supply line or with water from the pool. A new coat is applied and the filter restored to operation by opening the valves to the pool.

5. Pressure Diatomite Filtration

Pressure D.E. filters are housed in a closed steel tank. Inside are several cylindrical tubes composed of mesh screen or plastic covered with a synthetic fabric. These elements are coated with a layer of D.E. about 1/16 of an inch thick. Water is forced at a rate of 2 to 2 1/2 gpm/sq. ft. of surface area into the tank through the filter media and returned to the pool via a collection manifold-pipe at the bottom of the tank.

Cleaning the filter septum is done by backwashing or reversing the flow of water until the elements are free of the filter cake. Jet sprays and compressed air are also used in some systems to complement the removal of the filter cake. Although most pressure D.E. systems include a small window to observe the filter elements, the operator cannot be sure that all the cake has been removed.

SECTION IV

MAINTENANCE AND WINTERIZING

A. Maintenance

The pool operator's responsibility does not end with clean water. Good health procedures should be followed to assure cleanliness of equipment and areas that are next to the pool. Regular cleaning of equipment, locker rooms, and deck areas will help in keeping the pool water from becoming turbid or cloudy and will reduce the amount of pool disinfectant used. It also helps prevent the transmission of disease.

1. Daily Bathhouse Maintenance

a. Sweep all walkways. Scrub with a five percent solution of chlorine, rinse, and dry.

b. Sweep bathhouse floors. Scrub with hot water and detergent, rinse with clear hot water, and again with a five percent solution of chlorine.

c. Disinfect all benches, toilet seats, and fixtures with a five percent solution of chlorine.

d. Empty all trash receptacles and disinfect with a five percent solution twice a week.

e. Provide soap for showers.

2. Daily Deck and Deck Equipment Maintenance

a. Hose the deck daily to remove dust and dirt. Scrub the deck once or twice a week with a 5% chlorine solution to remove scum, algae, and odors that may occur (always hose away from pool).

b. Do not permit pools of water to collect and stand for long periods of time. Sweep collection points often and apply a little chlorine (diluted sodium hypochlorite or calcium hypochlorite) to kill bacteria and algae.

c. Check and repair equipment regularly. This should include lights, ladders, guard chairs, diving boards and lifesaving equipment.

d. Clean diving board surfaces, fiberglass, and aluminum, every two weeks with a 5% solution of chlorine. Apply the solution liberally. Do not scrub, especially with an abrasive material. Let stand for ten minutes and rinse with cold water.

3. Pool Cleaning

a. Removing stains — stains can be removed from tile surfaces, cement, and sometimes gunnite surfaces by scrubbing with a 5% - 10% solution of chlorine or an "inhibited" muriatic acid.

b. Vacuuming — cleaning of the pool bottom should be done daily for outdoor pools and every two days for indoor pools. Automatic cleaners are the most cost effective.

c. Hand skimming - should be done when necessary.

d. Maintain a water level over the gutters or skimmers, especially when the pool is not in use.

4. Maintenance of Pool Equipment

a. Make up tank

(1) Keep floats and valves in working order.

(2) Maintain a minimum air gap of at least twice the diameter of the inlet pipe.

b. Hair and lint catcher

(1) Check and clean daily, allow to dry before cleaning.

(2) Keep a spare on hand to permit drying.

(3) Clean with a wire brush.

c. Chemical feeders

(1) Check daily.

(2) Make sure all lines are open.

(3) Clean hypochlorinators once a month by

flushing with muriatic acid. Shut down the system, drain the lines, flush the pump and lines with water, then muriatic acid and finally with water, drain them and reconnect the system.

(4) Check venturies and valves to make sure they are functioning.

(5) Check gas chlorinator daily for leaks by holding an open bottle of ammonia near all lines, valves, and connections. If a white cloud appears, a leak is present. Do not apply ammonia directly to fittings or lines.

(6) Follow manufacturer's recommendations for maintenance of chemical feed apparatus.

d. Circulating pumps

(1) Keep the pump and motor in the correct alignment.

(2) Always keep the pump full of water.

(3) Lubricate according to manufacturer's specifications.

(4) Check the packing glands daily. A slight drip should be evident on some pumps when the pump is in operation.

e. Sand Filters — clean with calcium or sodium hypochlorite at least once per year and preferably twice to prevent channeling and calcification.

(1) Backwash and let the tank stand idle with a foot of water over the sand.

(2) Apply one pound of calcium hypochlorite (70% availability) per 25 sq. ft. of filter surface area.

(3) Allow the chlorine to dissolve and drain the solution into the bed leaving about one inch of water over the sand.

(4) Allow to stand about four hours.

(5) Backwash the unit and place the filter back in service.

f. Diatomaceous earth filters — remove the cloth covering and soak in the prescribed solution or brush the solution on while still on the elements.

(1) Mix a solution of one gallon of muriatic acid with one gallon of water and add one pound of sodium thiosulfate (photo fixer). Add the acid slowly to the water. Some commercial cleaners are as good or better than this mixture.

(2) Soak the filter cloths in this solution for six hours. Rinse with cold water. Allow to dry and replace back on the filter elements, or,

(3) Apply the solution with a stiff-bristled brush to the cloth while still on the elements. Rinse by hosing the cloth with cold water. Allow to dry and restore the elements to service.

(4) This procedure should be followed every four to six months for pools with D.E. filters that are in use 12 months a year. The same procedure should be used each spring for pools not used during the winter months.

5. Painting the Pool

Swimming pools which require painting should be painted annually. Concrete pools are especially vulnerable to chipping, cracking, and developing pores. Soft water is corrosive to cement as is chlorine. If the sides and bottom become rough, dirt, slime, and algae will stick to the pitted surface.

A painted pool will provide an attractive appearance and aid in giving the water a pleasant color. Many types of paint are available, however, some types will not be suitable. For example:

Oil base paints and enamels — unable to withstand soft water, blistering will occur. Lime in the concrete will chemically burn these types of paints.

Water based paint — inexpensive, but do not provide a glossy finish. Colors fade quickly, the paint breaks down and causes turbid water, stained swim suits and clogged filters. Once this paint is used, no other type can be painted over it.

Vinyl paint — will provide a smooth glossy surface if applied right. However, repainting over it often causes blistering.

Rubber base paint — a good quality chlorinated rubber base paint will provide a good surface that can easily be painted over.

Epoxy paint — while difficult to use, epoxy paint has given the best results to date. It is effective against fading and blistering. Contrary to advertisements by leading manufacturers, the pool should be repainted each year in freezing climates. Pools located in warmer part of the country may not have to be repainted as often.

Do not change types of paint. Once the pool is painted with epoxy, continue to use epoxy, unless the surface is sand blasted clean down to the original surface.

B. Winterizing

Winter and off-season care of a swimming pool are important to prevent repairs and ice damage.

It is safer, easier, and more economical, to keep the structure protected from rapid temperature changes that may cause spalling or cracking and straining of the walls and bottom by leaving the pool filled. An empty pool can be dangerous to pets and humans who may accidently fall into it.

1. General Procedure for Winter Care of Pools in Freezing Climates

In most sections where freezing occurs, it is recommended that pool covers be used and that all filtration and chemical treatment be stopped. It is advisable that an algaecide be used since algae will grow and develop during the coldest winter weather. The following procedures are considered basic for the winter care of a pool in freezing climates:

a. Rake leaves and remove them from the pool. This is desirable because leaves stain the sides and bottom of the pool and supply food for growth of algae and other microorganisms.

b. Though all pool piping may be buried below the frost line, it is recommended that all pipes, as well as the filter, chlorinator, pumps, heater, etc. be completely drained.

c. Remove and store diving boards, pool ladders, pumps, motors, and other accessory equipment in a dry, sheltered place.

d. Store chemicals regularly used to treat the pool water in a cool, dry place, preferably where they will not freeze. Water test kits and reagent chemicals should be stored in a heated place. Since liquid chlorine may deteriorate during long winter months, it is advisable to empty all remaining liquid chlorine into the pool. The same may be done for opened drums of calcium hypochlorite following the mixing procedures described earlier.

e. Before installing the pool cover, add the algaecide to the water. Repeat the use of algaecide at monthly intervals or until the pool freezes over. It is important that the algaecide be added to all pool whether covered or not.

f. The practice of putting one or more logs or floating objects in a pool before it freezes over as a precaution against the pressure of expanding ice is not recommended. Although there is some truth to the theory behind this practice, it is often observed that because logs have not been properly anchored, they may break loose and cause damage to the side of the pool. Many observations during the past several years in the more severe climates have indicated that logs are not necessary as a protection to the pool. (Automobile tires with inflated innertubes will serve the same purpose.)

g. Pump or drain water level down below the inlet fittings of the pool and allow all pool liners to drain into the pool.

2. Pumps

a. Turn off the pump switch and open the circuit breaker to the pump circuit. Waterproof or protect the terminal box.

b. Open all valves around the pump. Remove the lid and strainer from the strainer pot. Remove the drain plug from the pump.

c. Cover an outdoor pump with a waterproof covering to protect it from the weather or remove it to a warm, dry room.

d. Use the strainer basket to store miscellaneous fittings and drain plugs.

3. Gas Chlorinators

a. Drain the water from all chlorinator parts and hook-up lines.

b. Make certain the ejector is drained dry.

c. If the chlorinator is installed outdoors, remove and store indoors. Store all gas masks or self-contained breathing apparatus indoors.

d. All chlorine gas cylinders, empty or full, should be returned to the supplier since it is possible for cylinders to leak during storage.

4. Hypochlorinators

a. Remove all liquid from the hoses and diaphragm.

b. Clean out all calcium carbonate or calcium hydroxide deposits on the backcheck valves, hose, and diaphragm by using muriatic acid that will dissolve these formations.

c. Check the oil level and grease requirements of the hypochlorinator (oil types only).

d. Investigate electric connections and make any necessary repairs.

e. Damp air is an enemy to any electric motor that is exposed and is not operating. Remove to a warm, dry location.

5. Lights

a. Remove all lights from niches and examine for signs of leakage. When leakage has occurred, disassemble, dry, replace defective gaskets and reassemble.

b. Store lights on the pool deck, well-covered or in any other well protected place. Wood box them or use polyethylene bags.

6. Heaters

a. Turn off gas supply and, where necessary, cut off the circuit breaker to the pool heater circuit.

b. Drain water from heater according to manufacturer's instruction.

c. Clean heater tubes, following manufacturer's recommendations.

7. Skimmers

If possible, all skimmers should be drained, plugged with rubber plugs and covered to prevent entry of snow or rain water. Add one gallon of non-toxic antifreeze to each skimmer.

8. Recirculation System

a. Open all valves in the pool piping.

b. Shut off water to fill spout and drain the fill spout line.

c. Open any special drain plugs in the pool piping. These may be found at low points in the piping. If necessary, loosen unions to effect drainage. Be sure there are no low points in your pool piping system to collect water and freeze.

d. Remove the wall vacuum plug and allow the line to drain.

e. Blow the lines out with air to remove water from any low spots in the piping.

f. If some pipe cannot be drained or is a "wet pipe," it is necessary supply heat. Either a thermostatic controlled electric heater or a heat supplying wire wrap will be necessary.

9. Diatomaceous Earth Filters

a. Drain the filter tank and remove the filter elements from the tank if possible.

b. Remove the covers and store in a container where they will be free from dust and dirt. (Clean before storing.)

10. Miscellaneous Equipment

a. Remove diving boards and store inside on their sides. Remove and store ladders also.

b. Remove bolts and wedges from deck anchors. Thoroughly grease the bolts.

c. Store life rings, vacuum cleaners, hose and other miscellaneous equipment indoors.

When winterizing the pool, be sure to check all pool equipment and list all needed replacement parts. Any equipment that requires repair should be removed from the pool and sent for repair. Taking care of equipment, parts, and repairs in the fall and winter eliminates any delays and inconveniences when opening the pool in the spring. These winterizing suggestions are intended only as a guide and should not be

SECTION V

POOL SAFETY

A. Recruiting and Retaining Lifeguards

In recent years, newspapers have reported the lament of pool and beach managers over a perceived shortage of both applicants for lifeguard jobs and lifeguards. To date, the shortages have been geographical and specific to certain types of aquatic facilities. Without question the teenage workforce has shrunk and more young people are seeking employment in other seasonal jobs such as the service industry and fast food operations. However, it must be noted that west coast beaches and the water park industry have an overabundance of job applicants. Many water parks, for example, have trained lifeguards working daily maintenance and concession jobs while waiting their chance to move to a lifeguard chair. Administrators and facility managers in these high demand areas have adopted some recruiting and retention strategies worth implementing.

Wages

The primary reason for lifeguard shortages in some facilities is simply low wages. Two basic systems are used in most operations to pay lifeguards:

1. Weekly/Monthly Salary
2. Hourly rate

Most managers balk at putting lifeguards on salary; however, there are two advantages to paying a salary. First, accurate budgets can be developed that are not affected be weather (hot, wet summers); secondly, lifeguards know in advance how much they will earn over the summer. When lifeguards are on a salary, cold or rainy days become maintenance days guards are on salary.

In aquatic facilities where the hourly rate must be used, rates can be based on:

1. Years of experience ($1.00/hr per year above the base rate)
2. Certifications ($0.10 hr per certification - WSI, Lifeguard Instruction, Pool Manager License)
3. Swimming and mock accident performance ($0.05 - $0.10/hr increase during the season for maintaining or improving speed in timed swims or speed and quality in handling mock accident drills)

Bonuses

Bonuses are an excellent form of lifeguard motivation and include:

1. Time bonus ($250-$500) for working memorial Day - Labor Day
2. Time bonus ($250) for working as scheduled all summer
3. Fitness bonus ($50-$100) monthly for maintaining or improving timed swims each month

Incentives

Incentives, such as uniforms, meals, complimentary use of ancillary facilities, free guest passes and transportation represent a few of these possibilities.

1. Uniforms - provide staff jackets, warmups or windbreakers and allow the guards to keep them at the end of the season.
2. Meal allotment - many pools have snack bars, concession stands or restaurants. Meal incentives can include a fixed amount of money for meals, purchasing items at cost or giving specific menu items at reduced or no cost. It may also be possible to obtain complimentary cards for menu items at local fast food restaurants.

3. Complimentary facility use - establish a policy of allowing guards to use the golf course, water park, fitness center or provide for free use of any other facility owned or operated by the employment entity. Include a guest of their choice as well.
4. Transportation - one of the problems in hiring 15 year old lifeguards is transportation to and from work. Of benefit to many lifeguards in urban and suburban areas would be providing bus passes for free rides on public transportation systems (train, bus, subway).

Recruiting Techniques

An often repeated question among employers is how or where do I find applicants for our lifeguard jobs? The best way to seek out applicants is to put together some application folders (job description, application and job information) and/or announcements and mail them to or visit the local:

1. YMCA/YWCA - swim team practice, lifeguard classes or leaders club meeting.
2. Red Cross chapter - leave copies of application materials at the chapter and post lifeguard job notices on the chapter bulletin board. Perhaps the chapter might include one notice for each student who passed a lifeguard course when the certification cards are mailed to the instructor. A donation to the chapter might be appropriate in recognition of the time spent on processing these applications.
3. High School - make an appointment through the swim coach to visit a team practice each year in February or March. A five minute presentation at the end of a practice session would personalize the need for lifeguards, while applicant information is distributed to interested team members.
4. Colleges - Visit local college swim team practices and/or college lifeguard classes to contact potential applicants. Mail job announcements to the college placement office, aquatic director and the physical education department for use on bulletin boards.

Another successful YMCA and west coast beach technique is the implementation of leadership development programs. For years, YMCA's have had aquatic leaders' clubs. Pool and beach managers should starting a "Junior/Senior Lifeguard Club". Identify boys and girls beginning at age 9 (Junior Lifeguard Club, ages 9-12) and also at ages 13-15 (Senior Lifeguard Club). Hold weekly or monthly meetings centered around lifeguard skills and programs. Have them assist with maintenance, safety programs and swim classes and allow them to assist with lifeguarding as an extra set of eyes (no rescues). Give them a T-shirt or jacket and other types of recognition while attempting to continually motivate them to want to achieve a lifeguard status when they are of age and possess the required certifications.

Retention of Lifeguards

Consideration for retaining lifeguards is fundamental to the continued safe operation of any pool. Experience and familiarity with the facility and its programs are invaluable staff qualities and careful thought should be given to retaining lifeguards who have exhibited quality performance. Staff retention involves in-season and off-season techniques.

In Season Techniques

1. Determine from the first day of employment to treat lifeguards with respect and the dignity that should be extended to people employed in public safety positions.
2. Provide recognition for lifeguards, such as "guard of the week." Post their picture on a bulletin board and attempt to get local restaurants to provide a free meal for the guard and a guest.
3. Lifeguard competition is another method used to recognize lifeguard ability. Organize competitive events among local pools, develop publicity (team pictures in local newspaper) and offer some nice prizes obtained from local merchants.
4. Exit interviews can also be used to encourage lifeguard performance. Managers should spend 5-10 minutes with each guard at the end of the season. Express praise and sin-

cere appreciation for their job performance and give them their bonus check. If they feel good about themselves and their job, it will be much easier to attract them next year.

Off-Season Techniques

Retention should continue throughout the winter and spring. Communication with potential returnees can take many forms.

1. Mail thank you letters repeating comments made during exit interviews so that the letters will arrive prior to Thanksgiving break for college students.
2. A Christmas reunion of all pool staff in the form of a pizza party is a great way to get staff together and to continue expressing appreciation for their previous season's job performance. Turn it into an in-service training program by showing a new water safety video.
3. A spring newsletter complete with W-2 forms and an application form can be mailed to each lifeguard. Time this letter to arrive before Easter break and encourage them to call or visit while they are at home.
4. For lifeguards willing to commit early for the coming summer, offer to pay for specialized training during the off-season. This could include WSI, Pool Operator, EMT, First Aid or CPR professional rescuer certifications.

A well planned retention program will help to ensure that good lifeguards return each year. Lifeguard applicants have been a concern in the past and will continue to he a problem in the future, as problems such as "barrier protection" to protect against H.I.V. and Hepatitis transmission will be the next issue to impact on the applicant pool.

B. Lifeguards

The lifeguard's primary responsibilities are to prevent accidents and drownings. The present law in Pennsylvania relating to qualifications for "lifeguards" can be found in regulations promulgated by the state Department of Environmental Resources. The requirement is a "lifeguard certification" from the Red Cross or YMCA.

However, traditional courses in "lifeguarding" do not cover many areas true "lifeguards" need. These skills include filtration, pool chemistry, pool management, etc. The "standard of care," as defined by the courts in many other states and by the profession, is now "Lifeguard Training." Pool operators, camp directors, and park superintendents will be ethically, morally, and legally judged by this standard.

1. Lifeguard Qualifications

Some personal attributes of lifeguards are as important as the certification requirements. These traits must be investigated during a pre-employment interview and checked through personal references, as the person selected for the lifeguard chair may someday take a seat on the witness stand to give account for his behavior.

These traits include, but are not limited to:

-Reliability — Is the candidate punctual and can he be counted on to carry out his duty thoroughly and follow facility policies?

-Emotional Stability — Is the candidate capable of making quick, rational decisions without giving into the stress of a traumatic incident?

-Tact and Judgement — Can the candidate conduct facility business in a firm, impartial, courteous and positive manner?

-Physical Fitness — Will the candidate be personally responsible for maintaining a high level of performance capability by participating in his own or a pool sponsored fitness program, specifically for lifeguarding?

2. Job Description

In developing a job description, managers must give serious consideration to the four personality traits previously mentioned. The description should also include the following current, minimum certification requirements:

a. Red Cross — Basic Lifeguarding or Lifeguarding, or the YMCA equivalent.

b. Red Cross — Standard, Standard Multimedia First Aid, Advanced First Aid or EMS Certification.

c. Red Cross — Cardiary Pulmonary Resuscitation (CPR).

   Special consideration in hiring should be given to candidates possessing certification or a completion competency certificate as a:

   (1) Pool Operator — YMCA, NSPI, Aquatic Council of AAHPERD

   (2) Aquatic Facility Manager — YMCA, Aquatic Council of AAHPERD

   (3) Instructor of Adapted Aquatics — Red Cross, YMCA, Aquatic Council of AAPHERD

   (4) Scuba Diving — YMCA, or NAUI

   (5) Instructor of Lifeguard Training — YMCA, Red Cross

   (6) If the individual is to teach at the facility, then a water safety instructor certification or equivalent is necessary.

3. Hiring Procedures

When hiring, lifeguard candidates should complete whatever forms are required by the prospective employer with photographic copies of both sides of their lifeguard, first aid, and CPR certificates. A personal interview should then be conducted in which the candidate's attitude and other personality traits should be explored. A simple and short written examination covering cognitive materials studied for lifeguard certification can be given. All candidates should be required to pass a doctor's physical exam. All candidates should then be scheduled for in-water testing to narrow down the applicant pool if too many apply. All candidates should then be scheduled for a water testing session comprised of a CPR test (one rescuer), rescue skills and the timed swims identified in the Red Cross Lifeguard Training text. Following these steps in the hiring procedure, the manager should be able to decide which candidate to hire.

4. In-Service Training, Meetings, and Evaluations

The proper selection of staff, as previously described, is only the beginning in terms of having trained lifeguards on staff. After selection, new staff members must be oriented to their job at the facility. Some of this training might take place daily before the pool opens, but also consider using rainy days as training opportunities. A manual or guide to staff behavior should be given to each staff member, providing detailed information on policies, procedures, and behavior specific to their job. They should then be familiarized with the physical layout of the facility, along with safety, mechanical and program equipment. Potential hazards should be identified along with procedures in managing the accompanying risks.

After orientation, mandatory staff meetings should be held weekly to review policies, and procedures, operational and program problems, and to practice CPR, backboarding, accident management, first aid, water rescue skills, and facility evacuation. There are numerous training resources available and topics to be discussed. Consider bringing in paramedics and emergency room physicians to discuss medical issues such as spinal cord injuries, attorneys to discuss legal issues and aquatic court cases, water safety professionals to cover equipment rescues, and police to discuss crowd control. Physical conditioning of the guards should be required. Timed swims should also be conducted with results posted on the lifeguards' or manager's bulletin board throughout the season to assess progress in training. Minutes of meetings should be typed with one copy filed and one copy posted for staff to review, and to communicate with any members excused from the meeting. Consistent supervision and discipline is crucial.

5. Appearance

Besides being clean and neat in appearance for public relations purposes, all guards should be similarly attired because it is often difficult to distinguish lifeguards from bathers on crowded days. This attire includes a designated bathing suit, shirt, jacket, whistle, hat with a visor, and sunglasses. The hat, bathing suit, shirt, and jacket are necessary for quick identification by both guards and swimmers. Lifeguards should be cautioned about overexposure to the sun during their orientation, warning them of the risks of skin cancer, and advising them to use sun screen or sun block lotions and to wear protective clothing (approved uniform).

6. Work Period and Rotation

While lifeguarding is not physically demanding, the sun, heat, humidity and crowd noise produces stress-induced fatigue and subsequent drowsiness. Lifeguards should remain at a station (chair or tower) for no more than 20 - 30 minutes. A change in location can increase alertness and attentiveness to the job. Rotations can be established to include a combination of time in the chair, followed by walking duty, time again in the chair, a maintenance assignment, and then a break or relaxation period. When possible, a rotation should include a guard coming off a break and one going on break, with all chairs and stations occupied at all times so that there is no lapse in protection.

Note that the law requires that lifeguards "shall not be assigned any tasks that will divert the guards' attention from the safety of the bather." That means that when guards are on duty, they cannot sell memberships, make water tests, give swimming lessons or observe individual swimmers and give tips on how they can improve their swimming strokes, read, write letters, or do anything but guard the bathers. It takes as little as 60 seconds for an adult to drown, 20 seconds for a child. Therefore, any tasks assigned to a lifeguard, while on duty, that takes his or her attention away from the lifeguarding responsibilities is a breach of duty and can cause serious injury or death.

7. Preventive Lifeguarding

A lifeguard's major responsibility is to prevent accidents and emergencies, and that can be done, in part, through preventive lifeguarding. Guards must learn to use their eyes to scan their entire area of responsibility continuously. The speed at which this scanning is done must, on one hand, be slow enough to see what each swimmer is doing and to observe potentially dangerous behavior or potential emergencies. Keep in mind that it take only a moment for a swimmer to cross under and then be jumped on by a diver, and that it takes as little as 20 seconds for a child to slip below the surface. On the other hand, the guard must avoid fixating for too long on one area, person or group. The guard must look for the unusual, the break in routine: did the individual who went under the water come back up; is that novice swimmer staying out of trouble, does he or she seem comfortable and capable in the water, etc. The guard must recognize those swimmers who are especially at risk: the first-time visitor to a facility, the very young and very old, the physically impaired, etc.

Lifeguards need to learn to quickly recognize the signs of a struggling swimmer: the general upright position of the swimmer in the water; the instinctive but unproductive arm movements that move the swimmer up and down vertically, but not forward, in the water; the inability to call out for help; and, the victim's head sinking lower and lower in the water until only the top of the head and the arms can be seen.

8. Conduct

The lifeguard is a symbol of authority and as such must show respect for authority by personally adhering to all facility rules and policies. It is difficult to expect patrons to comply with rules designed for their safety if staff members are not obedient to the same rules. Guards should be courteous and tactful.

9. Guard Assignment Guidelines or Considerations

a. Use a restricted zone approach (roping off a portion of the pool when there are few patrons).

b. There are several rule-of-thumb formulas to follow when determining the number and placement of lifeguards:

    (1) Locate guards based on the amount of time it takes them to get from their station to the farthest point in the area they are required to cover, with the maximum amount of time allowable being 20 seconds.

    (2) 1 guard per 2,000 square feet of water surface area.

    (3) 1 guard per 50 bathers.

    (4) When there is a class (such as a swimming class) or an other activity being conducted in the water, there should be a minimum of one lifeguard on duty in

addition to the class or activity instructor. This guard's sole responsibility is to guard, not to assist in the conduct of the class or activity.

c. On beaches, besides the above, consider these guidelines:

(1) 1 guard per 300 linear feet of beach.

(2) When a class or activity is being conducted on the water, such a sailing, water skiing, canoeing (i.e., activities that take place some distance from shore and would be difficult for a lifeguard to reach where he is stationed on shore), station one guard in a power boat in the activity area so that a reasonable opportunity for rescue is possible. A shore lifeguard cannot be expected to supervise small craft activities.

C. Equipment

1. Rescue Equipment

Rescue equipment for swimming pools in Pennsylvania is specified in the state bathing code and consists of 1) Reaching Devices these "include, but are not limited to: poles, ropes, and any reasonable means to extend a person's reach," and 2) Floatation Devices — "that can support an adult in water." It should be noted that lifesaving equipment specified by the code is not intended to be used by the lifeguard; rather, it is provided for a situation where a non-swimmer or a person untrained in water rescue may have to provide assistance to a person in peril. An adult can drown in 60 seconds and a child in as little as 20 seconds. Therefore, speed is essential, and in most pool situations that will mean a swimming rescue by a lifeguard to prevent a drowning.

Each lifeguard chair should be equipped with a rescue can or rescue tube in the event that a pool lifeguard might have to handle a double drowning. The rescue can or rescue tube can be used to support one victim while the lifeguard handles the second victim. Other than rescue tubes or cans and that equipment required by a bathing code, additional equipment for rescue purposes is not necessary.

2. First Aid Equipment

Each pool should have a first aid room, which may double as the manager's office, as previously mentioned in the section on pool design. This room should be equipped with the following minimum equipment:

Work Area

- Cot
- Blankets
- Cupboard for storage
- Refrigerator
- Clock
- Bulletin board
- Telephone and CB radio

First Aid supplies

- Resuscitator or inhalator
- Extra Oxygen bottles
- 2 Cervical Collars
- 2 spine boards - with ties and foot plate, if necessary
- Splints — various sizes
- Paper towels
- Flashlight
- Paper cups
- Liquid soap dispenser

Record Keeping Supplies

- Accident Report Forms
- Emergency phone numbers and accident report script affixed to the wall near the phone
- First aid and CPR books
- Pens and pencils

In addition, the first aid kit or cabinet should be stocked with:

- Triangle bandages
- Athletic tape — various widths

- Sterile roller bandages
- Sterile gauge pads — various sizes
- Tweezers
- Scissors
- Needle
- Other materials specific to first aid situations at the facility.

3. Gas Masks

If the pool uses a chlorine gas disinfection system, then at least one and preferably two self-contained breathing apparatus (SCBA) units should be available. One should be stored in an area near the chlorine room (not in it), and one should be stored in the first aid room. All staff members should be trained in its use, and any staff member changing tanks or servicing the chlorinator should be required to wear a unit.

It should be noted that cannister-type masks are not reliable and must not be used for the following reasons:

a. They are useless in an environment with less the 19% oxygen. Air contains only 20.8% oxygen in its normal state.

b. Chlorine gas depletes the oxygen in the air, and in a confined space such as a chlorine room, this would not take long. Relying on a canister gas mask can result in death.

D. Pool Rules and Regulations

Well written pool rules, conspicuously and attractively posted, can be an effective asset in the management of patron behavior. The following suggestions are provided to obtain the best results:

1. Post rules at the entrance to the locker rooms, at the entrance to the pool deck, and in several places around the pool.
2. Rules specific to programs or equipment must be posted separately in the area where the program is conducted or the equipment is used.
3. Large letters, visible form a distance, contrasting with the background of the sign, should be used, i.e., red on white.
4. Rules should identify unacceptable behavior and regulate risks identified with potential hazards.
5. Pools located in parts of the state where different languages are spoken or on college campuses should use universal language signs and signs written in a second or third language.
6. Depth markings should be written in metric as well as English units.
7. Each set of rules should also contain the following rules:

   a. The pool staff has complete authority and must be obeyed at all times.

   b. Failure to observe the rules could result in serious injury or death.
8. Rules should be conveyed positively. Listed below are some examples of a positive format.

Swimming Rules

Behavior to be encouraged:

1. Soap shower
2. Proper swim attire
3. Concern for the safety of others

Behavior to be discouraged:

1. Running, pushing, horseplay
2. Shoes on the deck
3. Smoking in the pool area
4. Eating in the pool area

Diving Rules

Behavior encouraged:

1. Checking area in front of board before diving
2. One on the board at a time

Behavior to be discouraged:

1. Diving from the side in less than five feet of water
2. Double bouncing
3. Attempting fancy dives without a coach or proper training
4. Using starting blocks other than during supervised competitive practice.

E. The Need and Basic Structure For Emergency and Accident Procedures

Aquatic facilities and programs differ greatly throughout the United States for various reasons. Despite their location, management, or activities, all have a commonality in the various emergencies and accidents that can occur in their day-to-day operation. The N.E.I.S.S. (National Electronic Injury Surveillance System), comprised of 121 hospitals on a computer hook-up, estimates that the United States averages 168,000 accidents in swimming pools each year that require treatment at a hospital.

What has been done to provide patrons of our aquatic facilities with proper emergency and accident management? Unfortunately, in some parts of the state not a great deal. Some alert professionals in Pennsylvania have identified the need and responded accordingly. Some insurance companies are now requiring emergency and accident procedures in writing before the issuance or continuation of their policies and the courts have spawned these procedures at facilities where traumatic accidents and deaths have occurred. This material may be used to provide basic and essential information in developing similar procedures for all facilities, but should in no way be construed as complete. Special procedures or additional components may be necessary for wave pools, water slides, camp pools and special aquatic activities.

1. Philosophy of Emergency and Accident Procedures

First, it is necessary to determine exactly what constitutes an emergency or accident. Webster's New World Dictionary of the American Language, College Edition, defines an emergency as: *"A sudden, generally unexpected occurrence or set of circumstances demanding immediate action that might lead to immediate injury or death if not attended to.7*

An aquatic emergency, then, is a sudden occurrence or happening that, if not attended to with a quick response and an organized action plan, may result in further injury or death.

An aquatic accident is one in which injury or death has occurred to the patron of an aquatic facility. An unorganized or ill-timed response may cause more extensive injury or misuse the vital four to six minute interval between clinical and biological death. The standard of care, as defined by the courts, is to take care of those who are injured at our facilities. This requires the presence of a guard certified in first aid and that the facility has an organized response to an emergency or accident situation.

Procedures must be established for every known and anticipated emergency or accident that could occur within a facility or its program. Any facility is inadequately operated and unprepared without such plans in writing and in use.

Emergency preparedness must also include an educational program for the staff and the public.

Such plans are also rendered ineffective unless rehearsed and periodically subjected to testing, review and revision by the staff, public, and outside assisting agencies.

Emergency and accident procedures are as important as lifesaving equipment, however, they are not a substitute for standard water safety techniques and accident prevention. These plans of action must be positive, calculated professional actions that become reflexive and instinctive through rehearsal, and must be based on the "worst case" principle.

Emergency situations may take many different forms, depending on the location and circumstances in which they occur. Many emergencies or accidents may be potentially life threatening, such as natural disasters, severe weather, mechanical failures, collapsed buildings, chemical leaks, or explosions. When planning for emergency management, it is important to identify situations as to their life threatening potential.

Some emergencies or accidents are immediately life threatening, such as uncontrolled bleeding, nonbreathing, and poisoning. These emergency situations most often require rapid removal from the accident scene, the administration of advanced first aid, cardiopulmonary resuscitation or the use of a spinal board and rapid transportation to a medical facility.

Uncontrollable fires, gas line leaks, crowd control, and downed power lines require the services of fire companies, police and utility companies to properly control the situations that cannot be controlled by staff members. Other situations may also require the services of an outside agency, though they are of a less serious nature. Serious fractures, or suspected heart attacks fall into this secondary category. Such situations should be treated by the aquatic staff, according to recognized procedures, until assistance arrives.

Practice sessions for the public should take the form of fire drills and evaluation methods, whereas staff drills can double as safety and rescue demonstrations for the public, thus serving the dual purpose of practice sessions and public information sessions.

The public has a role in emergency and accident situations (to understand the procedure for handling these occurrences and to follow the instructions given by the guards). These practice sessions will help inform the public of this role. Further, such sessions will build the public's understanding and confidence in the staff, as they recognize the ability to handle emergencies and accidents.

2. Organizing an Emergency or Accident Procedure Plan

Some preliminary organization must take place before an action plan can be established and implemented. Listed below are the essential elements for organizing such procedures.

The aquatic facility manager must:

a. Develop a table of organization (chain of command) and related procedures that clarify who calls 911 in an emergency, who makes the rescue, who talks to the press, etc.

b. Gain knowledge of local and state ordinances pertaining to his facility.

c. Analyze past emergency and accident records from the last 10 years to determine where in the pool accidents occur, which guards were on duty, etc. (This information can show the staff what is likely to occur and where, which will be invaluable information in developing the plan. Children who are injured at your facility can sue to recover damages until they reach two years beyond majority age (18). (As suing is a process, accident records for children should be kept until they reach age 20).

d. Define every potential emergency situation possible for the facility.

e. Develop an action plan for each potential emergency and accident.

f. Define the impact zone including all persons, equipment, and facilities (including police, fire and civil defence) that could be involved in any accident or emergency.

g. Analyze and identify all equipment, personnel, and facility needs.

h. Establish programs for the recruitment and training of personnel. (Personnel must be trained on-site to become familiar with the intricacies of that specific facility — this is above and beyond the training received in a lifeguard course. Develop a feeder program at your facility whereby junior volunteers or participants in the programs are continually being groomed for positions of greater responsibility.)

i. Rehearse all procedures during in-service training periods and at least every two weeks during periods of peak facility use. This includes having the appropriate rescue bodies, such as fire and ambulance crews, respond and transport a "victim," and emptying the pool of patrons. This will give the staff practice at handling this situation and help some of the facility's regular patrons understand how you want them to respond to such a situation.

j. Develop an accident report system and determine who gets copies of the accident reports.

k. Establish a policy for providing information to the media, police, and other designated persons.

l. Develop an in-service training program, bring in speakers, present new information to the staff, practice CPR, first aid, rescues, timed swims, and use the various equipment, such as self-contained breathing apparatus.

m. Develop and implement a community relations program.

3. General Emergency and Accident Procedure Plan

While each emergency and accident may differ greatly regarding location, number of people involved, severity of injury, first aid requirements, response times, etc. it is clear that the follow-up action plan or procedure has several general components and a corresponding general sequence of events. This general procedure includes:

1. Accident
2. Initial reaction and assessment
3. Initiation of the primary emergency response (lifeguard)
   a. Activation of Secondary Responses
   b. Immediate action by primary responders
4. Secondary Response
   a. Assessment
   b. Action
5. Activation of the impact zone
6. Accident Follow-Up
   a. Investigation
   b. Reports
7. Notification of designated personnel
   a. Chain of Command
   b. Chain of Liability
8. Media statement by designated person
9. Evaluation of accident and procedures used

4. Specific Procedures

It is the responsibility of every aquatic facility manager to identify the emergencies and accidents that can occur at his facility and develop appropriate action plans. Listed below are situations common to most pools, beaches, camps, and aquatic recreation activities that require an action plan:

1. Environmental Conditions
   a. Fog
   b. Waves, current
   c. Thunder and lightening
2. Communications (radio) Failure
3. Failure of Lifesaving Equipment Requiring Back Up
   a. Broken spine board
   b. Empty 0_2 tank
4. Missing Bather
   a. Last seen in the water (immediately life threatening)
   b. Whereabouts unknown (potentially life threatening)
   c. Lost child
5. Rescue
   a. Bather in distress
   b. Mass rescue — more than one victim, or more than one guard
6. Closing the Facility (normal conditions)
   a. Between activities
   b. For the day.
7. Evacuation of Facility
   a. Power failure
   b. Chlorine gas leak
   c. Fire
   d. Weather
8. After Normal Hours — implemented by night watchman
   a. Trespass
   b. Drowning/body in the water
   c. Swimmer in distress
9. Crowd Control and Law Enforcement
   a. Shortening the beach or reducing usable areas in very large pools for diminishing crowd or reduced number of lifeguards.
   b. Water safety check
   c. Riot
   d. Theft
10. Special Medical Emergencies
    a. Spinal cord injury
    b. Severe bleeding, broken bones
    c. Drowning, near drowning
11. Civil Emergencies
    a. Tornado

5. Developing the Plan

Emergency preparedness requires planning and preparation along with education and staff training. Good public relations also include the use of local resources to help in the planning of emergency procedures. The local police, fire and ambulance groups, gas company, power company, water authority and chemical suppliers should be contacted for information on emergency procedures as well as their emergency plans of action. Members of these organizations can be asked to sit on emergency preparedness committees as valuable resource persons. Other available resources, such as government agencies, educational systems, private societies and local community groups, should be contacted for advice in the handling of an emergency.

The following step-by-step approach provides a format for an effective plan:

Organize	1. Form a planning committee.
Define	2. Define every potential emergency possible at your location.
Plan	3. Develop a plan of action for each situation.
Educate	4. Educate the staff and public.
Practice	5. Train your staff and involve the public at every opportunity.
Drill	6. Evaluate and seek better methods.

The success of any emergency procedure plan will depend on the ability of the participants to understand and carry out their assigned responsibilities. After a plan of action has been formulated, an educational program must be designed and carried out to implement the plan. The training program for the staff should include such elements as:

1. Initial training in common expected emergency situations.
2. The review and practice of emergency procedures at regular intervals (Note: Records of these drills, including dates and individual staff performance statistics should be kept on file).
3. Keeping the staff abreast of all updated information when it becomes available.
4. Evaluation and redesign of all existing programs based on new techniques, drills, etc.

After an emergency plan of action has been developed, the staff has been trained, and the participating public has been educated, a written policy for emergency procedures should then be submitted to the administration, the board of directors, and to the owner of the aquatic facility.

This policy should be made a part of the permanent record during an open, public meeting, thus becoming officially a part of the record. It would also be a good idea to involve the pool's insurance carrier in the development of all accident and emergency procedures.

6. Policies for Emergency Procedures

An example of potential policies should include at least eight steps.

1. Information

   Every employee, after training, will be held responsible for knowing the procedures for dealing with an emergency. Emergencies can be handled promptly and efficiently only if every employee knows and understands the procedure to be followed.

2. Prevention
   a. It is the responsibility of all employees to be certain that equipment to be used is in good working condition.
   b. Report any equipment failure immediately in writing to the supervisor. Supervisors are expected to report it immediately to the proper authority.
   c. Do not take unwarranted risks with patrons using a facility or equipment that is not in proper condition.

3. Key Concern
   a. When an accident occurs, the most important problem is the person(s) involved in the accident. He must have immediate, proficient attention, using all the professional help that is necessary.
   b. Be calm, and analyze the situation carefully. Your decision should be based on the regulations outlined below and good judgement. "DO NOT PANIC"

4. Care of the Victim

   a. The victim should be made comfortable and superficially examined to determine injury and the procedure to be followed.

   b. First aid must be provided. First aid kits are kept in the pool office or first aid room and should be used only by certified staff members. NOTE: Treat for shock, as some degree of shock is present in all traumatic accidents. Retain body heat and do not allow victim to move around.

   c. If a person is found not to be breathing, artificial ventilation must be started immediately and continued until relived by medical authorities.

   d. If the accident is in the swimming pool area and if supplementary supervision is not available for the pool, it should be closed immediately. All non-essential personnel, i.e., students, patrons, and spectators, should be sent to the locker room.

   e. Do not send a seriously injured child or an unaccompanied adult home or to the hospital. Have a responsible adult staff member accompany the person.

   f. In cases where the injured needs hospital attention, not requiring an ambulance, send by taxi. Do not send by personal vehicle. IF THERE IS ANY QUESTION ABOUT THE EXTENT OF INJURY, SEND FOR A PHYSICIAN OR AMBULANCE. DO NOT TAKE CHANCES.

5. Call for help

   a. Consult the injured, if possible, about whether he desires you to call the family physician. If the person has no physician and needs medical attention, get his permission to call a doctor or an ambulance.

   b. If the injured is a minor, call his parents for advice in handling any situation beyond first aid. If the parents cannot be contacted, determine from the minor (if conscious) the name of the physician and call him.

6. When an Emergency Occurs

   a. All professional staff persons that are trained in emergency procedures should go to the area to provide assistance as established in the accident plan.

   b. A staff member should clear a telephone line and stand by to get additional help, if needed, such as a doctor, ambulance, police or emergency equipment. Develop and post a script on the wall (next to the phone), and include information to be relayed when reporting an accident or emergency procedure and requesting assistance. This should include the caller's name, the phone number where the caller can be reached, the location of the accident (facility name, floor where help is needed, and door where someone will meet the responding help), and the type of accident or emergency.

7. When the fire alarm rings or a fire is discovered.

   a. The manager should be notified about the location and extent of the fire and the fire department should be notified. Extinguishers should be located in key areas and may be used, if the fire is small in nature.

   b. If the fire is extensive, the fire department must be notified. People present at the pool should be notified by the ringing of the fire alarm and/or a general announcement over the P.A. System (if available). The pool should be evacuated by this announcement. Other emergencies may require prompt evacuation as well (i.e., chlorine leak). In making an emergency announcement, be calm and DO NOT state the nature of the emergency.

8. Follow-up — The accident form is filled out completely by the guard who makes the rescue, as he is, legally speaking, the primary source of evidence. If someone else fills out the report, the information is hearsay, or secondary evidence.

   a. Determine who was present at the time of the accident and record the names and addresses of persons or witnesses.

   b. In case of injuries, accidents, or emergencies, personnel on duty must notify the manager.

   c. The proper accident report form must be filled out. Make proper reports for every injury, no matter how slight. If the victim is not an adult, retain the report for at least two years beyond his or her eighteenth birthday.

d. Do not give any information to anyone except the police and hospital officials. Requests for information from the press and others should be referred to the manager. Do not sign anything.

e. In the event of a serious accident or fatality, a written statement will be prepared by the manager. The supervisor should assist in the preparation and examine the statement immediately after it is prepared. He should review the incident step by step to insure accuracy. Additional copies may be prepared to distribute to other staff, board members, and the press by the manager.

f. Neither supervisory nor first aid personnel should assume any liability, nor encourage persons or parents to assume that the management is in any way liable.

g. The insurance programs should be interpreted by administrative personnel. All information regarding insurance coverage should be referred to the administrators.

Developing emergency procedures should rank high on the priority list of all persons involved in the proper, efficient management of any aquatic facility. A serious emergency may never occur, however, if one does, being prepared may even mean the difference between LIFE AND A LAW SUIT.

SECTION VI

LIABILITY POTENTIAL FOR AQUATIC FACILITY MANAGERS AND LIFEGUARDS

A. Understanding the Liability Concept

Traditionally, millions of bathers and other users of America's aquatic facilities have relied on the "lifeguard" to prevent accidents, respond quickly to emergencies, and to administer and enforce the rules and regulations of a facility. These are the lifeguard's duty or legal responsibility. Such reliance is appropriate. Consequently, the lifeguard's training, certification, and definition of responsibility have been the focus of recent modifications in training manuals and certification procedures.

Historically, attorneys specializing in personal injury have often targeted the lifeguard as an essential witness and defendant in personal injury litigation based on a negligence theory. Although the lifeguard is usually the most visible actor in any aquatic injury related litigation, both plaintiff and defense attorneys will look at all potentially liable parties for recovery. This includes private owners, municipalities, municipal employees, other third party individuals and, becoming more prevalent as a primary target, the aquatic facility manager or supervisor. The attorneys may use the lifeguard as a means to get to the pool owner or someone higher in the organization.

As a result of knowing that swimming pools have many hazards associated with them, lifeguards and all those working at pools have a responsibility to protect the patrons from these hazards. Those working at and managing these facilities must consider the foreseeability of potential accidents and emergencies. Foreseeability is that hazards or act that could be anticipated by a reasonable, prudent professional. In any personal injury litigation seeking to recover damages because of "negligence" by one or more defendants, the plaintiff's lawyer must prove negligence. A cause of action for negligence includes: a breach of that duty; proximate, legal or substantial factor; and actual damage or injury.

To prove a case based on a negligence theory, a lawyer must look to statutory law, administrative proclamations, custom, practices and prior case law. This is necessary to determine whether a duty recognized by the law requiring a person to conform to a certain standard of conduct for the protection of others against unreasonable risks existed in a particular situation. Frequently, plaintiff's attorneys are building their cases on the proposition that aquatic facility managers (in addition to lifeguards) have an equal, if not greater, obligation to facility patrons to protect them against unreasonable risks and harm.

Statutorily, Chapter 193 of Title 25, Public Swimming and Bathing Places (the "Bathing Code") (35 P.S. Section 672 et.seq.; 71 P.S. Section 510-20) sets forth the limited qualifications and responsibilities of aquatic facility managers. Although antiquated and in need of revision, the Bathing Code does require (and thus gives the foundation upon which a case will be constructed against the manager) that:

(a) "A capable manager or caretaker shall be in charge of all public bathing places and shall be responsible for the proper maintenance and use of the public bathing place as provided in the Act of June 23, 1983, P.L. 899 (35 P.S.Section 672 et. seq.) the permit issued for the public bathing place and the provisions of this Chapter.

(b) Such manager or caretaker shall be responsible for maintaining the public bathing continually in good repair and in a clean, sanitary, and healthful manner so that it does not constitute a menace to public health, promote immorality or be a public nuisance."

As a practical and legal matter, the role and responsibility of a facility manager includes ultimate responsibility for total facility operation. This includes personnel hiring, scheduling, and termination, facility maintenance, pool chemistry management, physical plant management and maintenance (including bathhouses, filter rooms, snack bard, stairways and parking lots).

Accordingly, a manager or supervisor must be qualified in all areas of aquatic operations, or risk a charge of negligence, actual or imputed, by breaking a duty of care owed patrons. Acquisition of the necessary skill levels and knowledge of lifeguarding, first aid, plant maintenance, personnel management, and operations and emergency procedures, with the ability to convert such skills and knowledge to daily applications, is essential for effective, efficient and safe facility management. The failure of managers and supervisors to acquire such skills and expertise provides a solid foundation upon which personal injury litigation based on a negligence theory will be laid. Furthermore, ownership entities (private clubs, municipalities, etc.) are subject to liability exposure by failing to employ qualified individuals to manage their aquatic facilities.

A successful lawsuit involving injuries sustained at an aquatic facility will include scrutinization of facility operations from top to bottom, and vice-versa. Unfortunately, many aquatic facility managers would not pass the legal tests applied to them during litigation.

To avoid often tragic accidents and the incredible expenditure of time and money, besides the psychological burdens associated with many negligence lawsuits, aquatic facility owners are urged to confirm that managers, and lifeguards, are qualified to provide the services for which they were hired. To confirm that as much as possible is being done to operate a safe and efficient facility, managers, supervisors. Boards of Directors and all personnel must be aware of their responsibilities and take all necessary actions to meet the same. Although not exhaustive, the following illustrations and suggestions should provide practical, constructive and substantive options on how to best operate an aquatic facility in its entirety so that all personnel will successfully meet the most strenuous examination administered by plaintiff's counsel.

B. Preventing Liability

Facility Design

1. Identify and modify or correct deficiencies in facility design and equipment.
2. Develop and post rules and warnings, and see that they are enforced by aquatic staff.
3. Install starting blocks in the deep end.

Equipment

1. Keep all equipment, i.e., recreation, instruction, competitive, fitness, and safety equipment in good repair.
2. Conform to state and local laws regarding required safety equipment.
3. Use universal signs and multilingual signs.
4. Identify depth markings in feet and meters, i.e., 3 FEET / 1 METER.
5. Maintain a daily pool log with records of chemicals used, water tests, and maintenance activities.

Lifeguards

1. A minimum of 2 on duty always.
2. Add additional guards at a ratio of 1 per 50 bathers or 2,000 sq. ft. of water surface.
3. Require lifeguards to be certified in lifeguarding, CPR-Basic Life Support and Standard First Aid.
4. Require in-service training (practice all rescue, first aid and CPR techniques).
5. Maintain accurate accident and incident reports.
6. Require guards to dress in uniform bathing suits, T-shirts, or jackets and have a whistle with them always. (The idea is two-fold: to make guards recognizable and, therefore, a standard

uniform is desirable; and secondly, to have all guards dressed properly and prepared to perform their required duties.)

7. Require consistency in application of facility rules.
8. Do not permit diving from the side of the docks or decks in less than 5 feet of water.

Emergency And Accident Procedures:

1. Develop, write, and rehearse procedures for every potential emergency and accident that could occur at your facility.
2. Maintain emergency numbers and procedures near the telephone.

Maintenance

1. Develop and use maintenance forms.
2. Establish written policies for proper maintenance.
3. Operate your facility according to established maintenance procedures.

Professional Responsibilities:

1. Read professional materials and keep-up-to-date.
2. Practice skills and maintain certifications.
3. Attend clinics, workshops, conference, and aquatic schools.

Public Relations

1. Promote friendly and courteous attitudes among all staff toward patrons.
2. Be tactful, consistent and firm when determining and enforcing pool rules and discipline.
3. Use the whistle only when necessary.
4. Rehearse emergency and accident management procedures during periods of peak facility use.

   This will:

   a. teach patrons their role in the procedure.
   b. provide patrons with confidence in the facility staff and its procedures.
   c. prepare the staff to deal with crowds and to perform these procedures in more true-to-life conditions.

5. Contact neighbors next to the facility to explain the facility and program, and to answer their questions and respond to their concerns. Treat patrons correctly.
6. Train the staff to act in a prompt, professional, and courteous fashion, showing the patrons and neighbors that the staff is concerned. This should hold true not only for emergency and accident situations, but for regular, daily operations as well. This will help gain the respect of those who use and live near the facility. While it won't make up for poor operating procedures or maintenance, a little tea and sympathy (instead of the cold bureaucratic approach) can go a long way in calming those involved in an accident or emergency. People are less likely to sue if they understand and support your facility, staff, and program, and feel they've been treated fairly.

Hazard Identification and Risk Management

See Appendix C for a check list to aid in hazard identification.

1. Investigate all pool equipment, programs, design, and observe staff to identify potential hazards.
2. Develop specific methods for managing the risks involved with each hazard.

SECTION VII

PRACTICAL MEASURES FOR ENERGY CONSERVATION AND COST EFFECTIVE OPERATION

Pool managers are multipurpose individuals who need knowledge and training in a variety of areas, including water chemistry, filtration, disinfection, water safety, people management and liability to list a few.

Without question, two areas vital to the future of successful pool operations are: 1) Cost effective operation, and 2) Energy and water conservation, as pool managers must now manage energy, water, and money in addition to bathers, lifeguards, and safety. Lack of attention to energy and operational costs will have a profound impact regarding staff size, raises, equipment replacement, program, and possibly the future continuation of facility operation.

The following information provides assistance in managing the valuable resources entrusted to pool managers. While a variety of areas are considered, the list is not exhaustive and each manager should look at his facility with a sense of imagination and creativity toward reducing the total cost of operation.

How the pool energy dollar is consumed.

Indoor pools

1. Heating air 47.5 cents
2. Heating pool water 16.5 cents
3. Heating shower water 14 cents
4. Motors and pumps 11.5 cents
5. Pool lighting 9.5 cents
6. Miscellaneous (hair dryers, etc.) 1 cent

Outdoor pools

The above figures are based on an actual study of indoor pools and there are no comparable figures for outdoor pools. None-the-less, the energy conservation discussion that follows applies equally to outdoor and indoor pools.

A. Heating and Cooling Air (Indoor)

1. Heating Air

Much energy is consumed providing heat for pools, especially during the winter months. A common engineering design calls for the introduction of 50% fresh air into the pool at all times, which means throwing away half the heated air in a pool every ten minutes and heating a similar quantity of fresh air.

a. If heat exchangers were added to a pool's ventilation system, 80 - 85% of the heat could be put back into the incoming air.
b. Tape clear plastic to the inside of window frames.
c. Install more insulation in walls and ceilings. (Pools are typically very poorly insulated buildings). (Look in the walls).
d. Insulate air ducts.

Solar heat is undoubtedly the heat source of the future. Why? Because it never shuts off. Most aquatic directors probably feel that their superiors would never buy it. In that case, try these facts on for size. Based on the current cost of energy sources now used for heating buildings, money allocated for solar heating can be recovered at a fantastic rate compared to:

natural gas - 5.1 years

oil - 4.6 years

electricity - 2.5 years

If the building is heated by gas, savings in 10 years will amount to $13,000.00; Oil, $16,974.00; Electricity, $43,676.00

2. Cooling Air (Indoor Pools)

   a. Most room and office air conditioners are powered by electricity and consume 400 KwH or more each month in the cooling season. Insulating, caulking, and weather-stripping should be implemented to lower the demand on air-conditioning units and reduce operating costs.

   b. Maintenance — room air conditioners

      (1) clean or replace air filters

      (2) oil fan motor

      (3) clean condenser and evaporator coils

      (4) in central systems, adjust the dampers from the heating settings. Be sure that all ducts are fully insulated.

      (5) check for the proper refrigerant level annually

      (6) check for leaks in the refrigerant coil

   c. Operation Tips

      (1) The recommended indoor temperature for normal comfort is 70 degrees F. (25 degrees C). Each degree change is worth about three percent of your cooling costs.

      (2) Adjust the grills to direct the flow of cool air toward the ceiling to promote efficient circulation.

      (3) Where the unit extends outside your window or wall, be sure the air flow is not obstructed by foliage.

      (4) Provide an awning to shade the condenser (outside part of the unit to increase its efficiency by at least two percent).

      (5) Keep the air conditioner off when no one is in the room. It is more economical to install an automatic timer to start the unit a half hour before you start to work.

      (6) For room units, use the lower fan speeds when the heat and humidity are not an extreme.

      (7) For room units, keep the outside air damper closed except to remove offensive odors.

      (8) For central systems locate the thermostat where it can sense the air circulating from several rooms.

      (9) When the weather turns cold be sure to cover the outside of the unit with heavy duty plastic such as 6 mil polyethylene. This will reduce heat loss in the winter and extend the life of the air conditioner.

B. Heating Water (Indoor and Outdoor Pools)

Heaters and Boilers

1. The energy cost for water heating can amount to 20 percent of the total monthly fuel bill.
2. Thermostat — Many water heaters are set on the "high" reading of 145 degrees F (63 degrees C), far above the temperatures actually needed. Establish the temperature at 110 degrees, as each degree reduction saves energy.
3. Insulation — The water heater's label may say "insulated," but if the hearer is warm to the touch, it is still wasting heat and should be insulated further. Wrap the tank with 3-1/2 inch fiberglass batts or buy packaged kits to fit easily over water heaters of different sizes. Be sure that in either case the insulation has a minimum value of R - 11 When applying the installation be careful not to cover the combustion air intake openings on the surface of a gas tank. Insulating the tank and pipes can cut the energy for water heating by 20 percent.
4. Sediment — Water heaters, unlike space-heating boilers, operate all year around. Drain out the sediment every three or four months. The sediment builds up in the bottom of the tank forming a barrier between the heating element and the water. Open the tap near the bottom of the tank and drain the water until it runs only clear.

5. Put timers on heaters and boilers to heat slowly only when the program requires. Turn heat off from 11:00 pm - 7:00 am. Insulate hot water lines.
6. In a new facility, or when remodeling, analyze the location of heaters and boilers in respect to where the water is being used. It could be cheaper to move them and transport water a shorter distance.
7. Shut down all hot water heaters (showers) 8 hours a day or cut down to one boiler. Use of hot water heater timers is another possibility.
8. Check the flow rate or capacity of shower heads. Showers can waste a considerable amount of hot water. Shower heads with a flow of 1 to 2 gallons per minute are recommended. Another energy saver is a push button control that permits a water flow for 60 seconds. It then shuts off automatically. Finally, a mixing valve can be installed to provide a fixed temperature water for showers.
9. Towels, if provided, should be washed in cold water with a cold water detergent.
10. Convert all sink hot water spigots to self-closing with mixing valves, or remove all hot water spigots and have patrons wash their hands in cold water.
11. Teach patrons to wet themselves, stop the water, lather, and then turn on the water to rinse quickly. Have a water control switch put in the pool office or other location that allows a staff member to shut off shower water within 10 minutes after classes or programs have ended.
12. Install an energy recovery system in waste water lines (heat exchangers) to reduce shower and laundry water temperature to less than 40 degrees F when discharged.

C. Prevention of Heat Loss (Indoor and Outdoor Pools)

In January and February of 1973, gas supplies dwindled to nothing in many parts of the country. In Ohio, one YMCA was without gas for eight days. Some local government officials and citizens view pools as luxuries. In Pennsylvania several years ago, state colleges were ordered to lower water temperatures to 76 degrees F. and air temperatures to 72 degrees F. An inspector was sent to check for compliance. This may seem radical, but in European countries such as England this has been standard operating procedure and may become a fact of life in the United States. A good, all-around water temperature is 82 degrees. Swim team members and lap swimmers will prefer 78 degrees, while the elderly and those with arthritis will be more comfortable at 84 degrees.

Compounding our heat and electrical problems is the change from the English system to Metrics. New pools today are broadening in width from the one standard of 36 feet to 42 feet, with 8 lane pools 56 feet wide.

Converting to meters now means building a 25 meter pool instead of 25 yards that increases the length of pools 8.10 feet, necessitating an additional 19,744 gallons of water and increasing filter capacity for the 25 meter by 42 foot pool.

Here are some tips for conserving heat:

1. Screen the exterior of buildings with trees and bushes to resist wind in the winter and to help cool in the summer.
2. Maintain air and water temperatures within three degrees of each other with the air warmer than water (indoor pools).
3. Close rooms that are not being used and close off heating units if possible.
4. Specify triple pane windows when designing or redesigning a building.
5. Keep locker room and other access doors to the pool closed, or attach automatic door closers on all pool access doors.
6. Have maintenance people caulk around windows and doors on outside walls.
7. Consider curtains for pool windows to provide extra heat retention space.

Solar Heat

Solar blankets (long underwear for pools) — cover the pool at night and during times when the pool is not in use. This prevents heat loss and chemical loss by evaporation. This technique can reduce heating costs by 50% in outdoor pools and by 80% for indoor pools. Combine this with solar energy, and heating costs can be cut by 90%. Eighty percent of heat loss from pools occurs through evaporation and another five percent is lost through agitation by bathers. Increase that to 15% for wave pools. Vapor pressure (combination of air and water temperature, air velocity, and relative humidity) is the guide to determining heat loss. Solar blankets have the additional benefits, even in unheated pools, of keeping the water warmer. This means that bathers can more comfortably swim both earlier and later each day as well as earlier and later in the season.

D. Water Conservation (Indoor and Outdoor Pools)

Over the past several years, some areas of Pennsylvania have experienced drought or near drought conditions. As a result some pools have been closed and some communities have been criticized for maintaining their operation through this period. These water conservation suggestions are offered to help prevent future closings and criticisms.

Besides saving money, there are other benefits to water conservation. All the water used in a building becomes sewage and must be treated. If the building is plumbed into a municipal water treatment system, conservation efforts will help minimize treatment loads and may help delay construction of any larger community sewage facilities in the future.

1. Water Losses

Water is lost from the pool in three ways (other than leaks); splashed out, evaporation and cleaning filters. Losses can be significantly reduced through good management.

a. Managing splash out — Establish rules prohibiting splashing, splash type dives from the diving boards (cannonballs), restrict water entry to using ladders (eliminate jumping and diving) and eliminate the use of automatic pool cleaning devices with tile spraying features.

b. Evaporation — Plant trees and shrubs or erect fences or other types of barriers outside the pool area to block the wind. Cover the pool when not in use with a pool cover or solar blanket. A cover will reduce evaporation as much as 75%. For indoor pools, maintain a close relationship between air and water temperature with air temperature three degrees higher than water temperature.

c. Filtration, vacuuming and circulation — Inspect the pool and water circulation equipment for leaks and repair accordingly. Check skimmers and gutter regularly and remove debris that may reduce circulation efficiency. Use vacuum sweepers that return water to the pool or are incorporated into the circulation and filtration system. Reduce backwashing from a regular schedule, i.e., once a week, to only those times when needed as indicated by pressure differentials on influent and effluent gauges or vacuum gauges according to manufacturer's and warranty directions. For pools located in areas that regularly face near drought conditions, initially install a diatomaceous earth system or rehabilitate the present filtration system by converting to diatomaceous earth.

Wise use of this precious resource may also include installing a cistern or holding tank that collects run off water from the pool or a building when it rains. This water can then be pumped to the pool for use as make up water. Another suggestion involves winterizing an outdoor facility by dropping the water line to a point just below skimmer or gutters. Then apply a pool cover.

2. Waste Water

a. A breakdown of the patterns of waste water consumption is as follows:

   (1) Toilet, 99 gallons per day

   (2) Showers, 120 gallons per day

b. Toilets — A conventional water closet holds four gallons of water in its tank, but used close to six gallons per flush.

   (1) Leaky Toilets — To determine if a toilet is leaking, add some food coloring to the water in the tank. If the coloring begins to stain the bowl before the next flush, then there is a problem.

(2) The Plastic Bottle Trick — Many older toilets are overdesigned hydraulically and use more water per flush then is required. Place a combination of weighted plastic bottles in the tank, making sure they don't interfere with the inner workings. If it is necessary, however, to flush more than once to cleanse the bowl, water-saving effect has been eliminated. Decrease the number of containers displacing the water to retain a margin of waste (a 1 - 2 gallon reduction is generally the maximum reduction.)

(3) Modified Toilet Tanks — Several manufacturers sell kits with prefabricated plastic inserts designed to fit into the tank and reduce the amount of water used for flushing.

(4) It is also possible to purchase dual-flush mechanisms to fit into the present toilet tank. The handle of the unit is designed to activate a partial or full flush depending on how it is turned. A turn in one direction activates a 3.5 gallon flush for solid wastes and the reverse motion activates a 2.5 gallon flush for liquids. Ask a plumbing supplier about dual flush devices.

(5) Shallow-Trap Toilets — Shallow trap toilets have redesigned bowls and smaller tanks that give good flushing performance with only 3.5 gallons of water. They retail for sixty dollars and up, cost not more to install than conventional toilets, and are more compact. Most major plumbing manufacturers produce shallow-trap toilets.

(6) Flush-Valve Toilets — These toilets can be installed easily and are usually set for 3 gallons per flush (to conform with American sanitary standards).

(7) Vacuum-Flush Toilets — Vacuum-flush toilets use air as the waste transport medium and require only a half gallon of water to cleanse the bowl.

E. Filtration (Indoor and Outdoor Pools)

If designing a new facility, consider using smaller diameter pipes in the circulation system. This will allow the use of a 15 hp pump in lieu of a 20 hp motor that uses much more electricity. Eliminate elbows in the design wherever possible to lessen resistance A decrease in horsepower means a decrease in electrical consumption. A 20 hp motor equals $500 month; a 25% decrease in motor size equals $125 savings per month.

1. Another cost cutting consideration is shutting the filters down as much as two to four hours a day. This is not recommended through with pools getting heavy use, as these pools need a period of recovery after heavy use. Consider this tactic only on days when use is very light. Note that the required water quality standards must be maintained.

2. Backwashing filters — Many pool operators backwash filters regularly, i.e., once a week. Change the schedule and backwash only when the gauges call for it. This saves heated water and can reduce energy costs significantly.

3. Require patrons to take soap showers before entering pool that extends filter runs. Soap is also cheaper than chlorine (oxidizes organic matter). Unshowered bathers increase the chlorine demand, using chlorine at a faster rate and increasing chemical costs.

4. Filtration system of the future is Diatomaceous Earth.

   a. If planning a new facility, or renovating an old one, specify Regenerative Cycle D.E. or vacuum D.E.

   b. If you have vacuum or pressure D.E., begin using the interrupt process. Turn off the pump one to three times a day for 5 minutes, allowing the pre-coat to fall off. Recycle it back onto the elements and restore circulation to the pool.

F. Lighting (Indoor and Outdoor Pools)

Lights are another source of high energy consumption. If the facility uses no electricity for heating air conditioning, or water heating, lighting will account for 10-20 percent of the monthly electric bill.

1. Fixtures — Incandescent bulbs are like miniature electric resistance heaters. In fact, 90 percent of the energy consumed is given off as heat, while 10 percent of the energy produces light.
2. Long-life incandescent are specially designed to yield less light than a standard bulb of the same wattage. While they may last longer, they ultimately produce the same amount of light and consume the same wattage. They are not energy savers, and should be used only where replacement is difficult.
3. Dimmers or rheostats are rotating or sliding switches that control the brightness of any incandescent lighting fixture. (Dimmers for fluorescent fixtures are too expensive to be cost-effective energy savers).
4. Special sockets are available with built-in dimmers to replace a conventional brass lamp socket.
5. Fluorescent tubes:
   a. They produce four to ten times more lumens per watt.
   b. Last 10 to 15 times longer.
   c. Give off less heat for the same unit of light.
   d. Longer fluorescent tubes are more efficient than shorter ones.
   e. U-shaped tubes are even more efficient than straight ones.
6. Operational Tips
   a. If out of the room for more than five minutes, it pays to turn off light.
   b. Observe the lighting level throughout the facility. Wherever it can be safely reduced, replace bulbs with lower wattage bulbs. Storage rooms are good examples.
   c. If a high-level of general lighting is needed, replace several bulbs with few high wattage bulbs. One 100-watt bulb produces the same amount of light as two 60 watt bulbs and uses 20 percent less electricity.
   d. If the building has security lighting, replace incandescent with HID mercury vapor lights which last about 15 times longer. Also, install an automatic timer control.
   e. For safety, never leave a socket empty. Fill it with a burned out bulb.
   f. Dust and dirt on bulbs, reflectors, and lampshades can reduce lighting efficiency by 50 per cent.
   g. Take advantage of daylight through windows and skylights. Keep in mind that summer heat will increase air-conditioning loads and winter heat gain on southern exposures will reduce heating loads.
   h. Install small indicator lights in the office to signal lights that have been left burning in unoccupied spaces. The wiring is simple and inexpensive compared to the cost of continuous, unnecessary lighting.
   i. When repainting rooms, remember light colors reflect more light than dark colors and reduce wattage requirements.
7. Establish policies at your pool to how many lights should be on during moderate and peak usage times and then follow the policy.
8. Underwater lights — use sparingly or only during special programs. Identify the programs where they are not to be used.
9. Convert to mercury vapor, sodium vapor or halogen (quartz iodide) overhead lighting. Be aware that ceiling temperatures can reach 105 degrees. Determine in advance if new lighting can handle the temperature.
10. Employ more windows when designing a new pool or renovating old ones to take advantage of natural sunlight. This also calls for triple pane windows to avoid heat loss.
11. Dust all lamps and lighting fixtures, regularly, dirt absorbs light. Clean lights use less energy. Lamps become 20% dimmer with age.
12. Use light colored carpets, draperies, and upholstery.

13. Install rheostats (dimmer switches) on all lights.
14. Investigate innovations in lighting by consulting with a good professional engineer experienced in pool design.

G. Miscellaneous Cost Saving Suggestions (Indoor and Outdoor Pools)

1. Bulk purchase and consider shelf life
   a. Consider bulk purchasing of chemicals and materials, but don't buy more than can be used before the shelf life expires. To get a discount price, either: buy in a cooperative with other pool operators; or, sign a contract with the chemical manufacturer or distributer guaranteeing that you will purchase a specified amount of chemicals over the operating season, that you will take delivery as needed, and that the chemicals will be tested for freshness upon delivery.
   b. Beware of the shelf life of certain chemicals. DPD reagents for example are good for 12 months and Phenol Red for 6 months (presuming they're properly stored).
2. Consider cooperative buying with other YMCA's, private, municipal, and high school or college pools. Use intelligent purchasing procedures. Shop for the best prices.
3. Preventive maintenance — best cost saving device.
   a. Drain the pool once a year.
   b. Clean the skimmers and strainers regularly to help maintain flow.
   c. Flush chemical feeders monthly.
   d. Use or convert to the cheapest form of chlorine - gas chlorine!
   e. Require soap showers of all patrons. (Soap removes ammonia (from sweat), germs, body oils, and debris from the body. If patrons don't shower, these substances will be carried into the pool and will require additional chlorine to oxidize them (which will increase operating costs as chlorine is much more expensive than soap).
   f. Maintain good maintenance records and govern the operation accordingly.
   g. Eliminate footbaths.
   h. Keep decks clean.
   i. Purchase an automatic vacuum sweeper, if the pool design permits the use of one.
   j. Painted pools — use a chlorinated rubber base paint.
   k. Safety — employ only personnel with lifeguard certification, first aid, and CPR.
   l. Establish well organized emergency accident management procedures.

SECTION VIII

SPAS AND HOT TUBS: RECOMMENDED STANDARDS AND OPERATION PRACTICES

A. Background

The use of water for therapeutic purposes and relaxation date back thousands of years and circles the globe. Today's health clubs with their whirlpools, saunas, and steam rooms are re-creation of ancient facilities found in Rome, Greece, Japan, Scandinavia, and India, as well as throughout the Moslem world and among many Indian tribes of North and South America.

Therapeutic tanks (whirlpools) have become standard equipment in training rooms of high school, college and professional teams in almost every major sport: football, baseball, basketball, and hockey. Sports' medicine specialists prescribe water therapy as treatment for a wide range of athletic injuries.

Spas with water-activated jets are for the most part an American development, following military use by the French in World War 1. Whirlpool baths began turning up in Veteran Administration Hospitals, and have been used for years in many civilian hospitals with physical therapy departments. Today, spas and hot tubs are being purchased in increasingly larger numbers for use in American homes and apartments.

B. Spa Standards

Many states have enacted regulations to ensure safe and healthful use by operator of these facilities. The Department of Environmental Resources drafted regulations in January of 1991. The U.S. Department of Health and Human Services published its first health and safety guidelines in 1981, while minimum standards suggested by the spa industry were developed in 1978. The single most important safety factor in spa operation is having a trained operator. He should be aware of the physical and biological hazards associated with these facilities and should be stationed so that he can observe and supervise the facilities during operation. This person should be certified in first aid and CPR.

C. Physical Hazards Relates to the Use of Spas

The main physical hazards of spa usage have been identified by the Consumer Product Safety Commission (NEISS-National Electronic Injury Surveillance System) to include drowning, falls and electrocution. An average of over 1000 accidents have been treated in hospital emergency rooms annually since 1980.

Drownings are frequently caused by alcohol, the body's reaction to hot water, hair entanglement in bottom drains and falling unconscious into the spa after striking the head. (Many falls are alcohol related). Electrocution usually involves electrical appliances used near the spa such as radios, record players and video recorders. Human factor's analysis shows that those victims who had consumed alcohol had blood alcohol levels ranging from 0.09 to 0.42 percent. (In Pennsylvania, the intoxication limit for driving is 0.10).

Water temperatures often ranged from 106 degrees F to 114 degrees F. The absolute maximum permissible water temperature from a health standpoint is 104 degrees F., and serious consideration is being given to lower that maximum to 102. degrees F. The recommended high temperature is no more than 100 degrees F. In addition, up to one third of the victims of a spa death are alone at the time of the accident.

Because of these concerns, draft regulations require that controls, accessible only to the spa operator, prevent water temperatures in excess of 102 degrees F.

It is potentially dangerous to mix alcohol, tranquilizers, and sedatives with the use of spas and hot tubs. Hot water can increase the muscle relaxant effects, and produce a general sense of (and actual) substantial weakness. Some people become drowsy enough to lose track of time and stay in too long. Alcohol can lead to the chemical imbalances when consumed prior to or during hot water immersion, which ultimately promotes sweating. It is a diuretic, and can increase loss of trace minerals, such as potassium, which regulate heart beat and other body functions, according to Dr. Gershon Lesser, Instructor in Legal Medicine at the University of Southern California School of Medicine.

For the same reason, individuals using diuretics should also use spas with spas with caution. The elderly and those in poor health should also use spa equipment with caution. As suggested earlier, this is especially applicable to heart patients, people with high blood pressure and certain cardiovascular conditions.

Recommended times for length of stay in spas and hot tubs vary according to the temperature of the water. Generally, at 98 degrees F, no limit is necessary, leaving it up to individual discretion and tolerance. From 100 - 102 degrees F, most health and medial authorities recommend a maximum stay of 12 to 20 minutes. One way to encourage users to be reasonable in the length of their stay is to put a 10 - 15 minute timer on the water jets. The reset button should be placed at least 10 feet away from the tub so user must physically leave the tub to turn the water jets back on. At the higher water temperature, 102 degrees and above, a significant element of danger exists that grows in proportion to higher water temperature and poorer health conditions.

Reddening skin and/or dizziness are definite signals that it is time to get out of the tub at any temperature. Some doctors and therapists take the attitude that "when you've had enough, you'll know it's time to get out of the spa." This is not a good procedure.

Responsible spa operators need to post signs with suggested time limits. Time clocks and thermometers should be placed in easy view of all users. It is also recommended that a precautionary sign against use of the spas, such as the one provided, be posted near the tub. This information, with a warning that long exposure can lead to dizziness, resulting in such problems as impaired judgment and lessened visibility, should be placed in a conspicuous location.

An adjacent pool or shower for cooling off after spa immersion should be provided. Because the health conditions of many users and because of the potential for accidents, spa personnel should be provided. As a result of health conditions of many users and the potential for accidents, spa personnel should be certified in safe operation, in emergency procedures and currently certified in CPR and Standard First Aid.

DER draft regulations require a caution sign with the following wording: "Caution! Any person who's physical condition is such that use of this spa might adversely affect their health should consult a physician before using the spa. Of particular concern are individuals with heart disease or epilepsy and pregnant women. Do not use the spa immediately following exercise or while under the influence of alcohol or drugs. Do not use the spa alone or without supervision. Do not use the spa longer than 10 minutes. Children shall be accompanied by an adult. No diving or jumping into spa."

The following sample wording for a spa warning sign is more complete.

Caution / Warning!

1. Soap shower before entering the Spa.
2. Enter and exit the Spa slowly, cautiously, and use hand rails.
3. Individuals fitting into the following categories should not use the hot tub as they will place themselves in physical danger:
   - Those suffering from heart disease, overweight individuals, diabetes, emotional disorders, high or low blood pressure, circulatory deficiencies, hypertension, stress problems, seizures, and epilepsy.
   - Those who are on diets or are using prescribed or recreational drugs.
4. Pregnant women are permitted to use the spa for up to 15 minutes if the temperature is below 102 degrees F.

5. Unsupervised use by children is prohibited.
6. Children under 5 not permitted to use the spa, under any circumstances, because they are not yet physically capable of coping with the heat.
7. Do not use the spa while under the influence of alcohol, anticoagulants, antihistamines, vasoconstrictors, vasodilators, stimulants, hypnotist, narcotics, or tranquilizers.
8. Never use the spa alone.
9. No diving or jumping into the spa.
10. Observe a reasonable time limit (10 - 15 minutes) then shower, cool down and if you wish, return for another brief stay. Long exposures may result in nausea, dizziness or fainting (which can lead to falls and/or submersion and death.)
11. Use of body lotions or oils is prohibited.
12. Street shoes may not be worn in spa area.
13. No food or drink permitted.
14. Do not submerge to the bottom of the spa as hair may become entangled in the drain and result in drowning.
15. Failure to follow these rules may result in serious injury or death.

Design Concerns

The immediate area around the spa must be designed to guard against accidents and falls. Copings should have slip-resistant surfaces, preferably of a type embedded into the tub surface. A slip-resistant surface should be provided on steps leading into the spa as well as on the spa bottom. Marking the steps in a contrasting color from the tub provided an additional measure of safety.

Proposed and other existing standards require steps, ladders, or recessed treads where the Spa is deeper than 24 inches, and that seats are no deeper than 24 inches below the water's surface. Each separate set of steps must have at least one handrail.

Depth marking should be placed on or within 18 inches of spas and tubs, regardless of it's size and shape, and shall indicate depths in feet and inches; meters may also be indicated. "No diving or jumping" signs must be placed every 15 feet or at least twice around the perimeter of the spa. The spa must be protected by some kind of enclosure, fence or wall, if they are located outdoors, to prevent young children from getting into them if unsupervised. The fence or barrier should be at least four feet high and having a self-closing, latching gate, with no external handholds or footholds. In addition, spas must have a structurally sound, locked cover which is able to withstand tampering and support weight. Indoor spas must meet the same conditions if they are located in rooms where activities unrelated to the spa use may occur.

Covers are available to serve as further back-up. These serve both as protection against unauthorized use and against accidental falls, and may also serve as thermal aids, retaining heat in the spa. Most manufacturers offer both thermal and safety covers as optional items and some covers serve both purposes. Safety covers are more important for spas located outdoors. This is also true of thermal covers, since indoor temperatures are likely to be high enough to hold heat loss down relative to potential losses in outside areas.

Bottom drains must be covered with protective grates or covers that cannot be removed without the use of tools and should be designed to prevent the entrapment of fingers and toes. Drains must be of an anti-vortex type and pose no tripping or stubbing hazard.

An accident management procedure should be written and rehearsed by the staff and a sign should be located near a telephone in the spa area with emergency phone numbers: rescue or ambulance unit, fire, doctor, and hospital.

D. Biological Health and Disease Hazards

While spas and hot tubs are useful for relaxation and stress reduction, they are a breeding ground for many harmful types of bacteria. Hot water, high density usage, low disinfectant levels and infrequent draining provide an excellent growth environment for harmful bacteria.

User density is a little understood factor until spa use is compared with swimming pool use. Two persons in a 400 gallon capacity spa are equivalent to 1,050 persons immersed in a swimming pool 75 x 45 with 210,000 gallon capacity. In attention to disinfectant levels, infrequent draining and refilling are the two primary reasons for outbreaks of spa-related diseases.

Health Related Problems

Health hazards for spa users are often related to prescription medicines. Patients using diuretics, anticoagulants, antihistamines, vasoconstrictors, vasodilators and tranquilizers should use a spa only with advice from their personal physician.

Hyperthermia is a serious problem that includes symptoms such as headaches and dizziness. Some people like to exercise in hot water and should know that once their surrounding temperature increases to 85 - 90 degrees F they are risking hyperthermia. When the body temperature increases to 110 degrees F from exercise of prolonged immersion (beyond 15 minutes), the metabolic rate increases, the brain becomes greatly depressed, sweating decreases and heat stroke results.

Persons who have sustained any type of injury such as sprains, which are treated with ice should avoid the spa. Hot water will increase swelling and delay recovery from the injury.

Another non-disease related spa problem is Dermatosis. According to the British Medical Journal about 5% of spa users will develop a skin rash from spas that use bromine sticks (hydantoin bromine) as a disinfectant. While the reaction is not believed to be serious, a physical should be consulted if a rash occurs.

Pregnant women should use spas carefully. Maximum use has been defined as 15 minutes at a temperature no higher than 102 degrees F. Lower temperatures are recommended. At temperatures above 102 degrees F damage may occur to the fetus. A similar problem exists with children under 5 year of age, as their thermoregulatory mechanism is not fully developed until approximately age five. (This is not a precise age, it varies by a year or two on both sides of the scale by child.) Brain damage may result from prolonged immersion.

Pool ventilation in the spa area can produce "Coughing Diseases" - a non-bacterial problem that causes coughing spells while in the spa. The disinfectant and nitrogen — ammonia compounds vaporizing at the water's surface produce an irritating condition for the mucous membranes of the nose and throat that results in coughing until the person leaves the spa area.

Disease Related Problems

Since hot water is conducive to bacteria growth a wide variety of diseases can be contracted from improperly maintained spas and hot tubs. Common problems range from staph infections, which cause boils, to vaginitis and urinary tract infections. Other more serious diseases that occur with some frequency include Pontiac Fever and Hot Tub Folliculitis. At this time the medical profession does not believe that AIDS can be transmitted through spa or hot tub water as the virus is extremely susceptible to even low levels of chlorine and bromine disinfectants. It is also believed that the virus cannot exist outside the human body.

Pontiac Fever, first identified in Pontiac, Michigan, is a hot water disease with flu-like symptoms. Nausea, dizziness, headache, vomiting and fever are the prominent symptoms. The bacteria that caused Pontiac Fever (Legionella Pneumophilia) is the same virus that causes Legionaires' Disease and that is also thought to be able to be transmitted in spas and hot tubs.

A test for the presence of Pseudomonas should be conducted weekly during a heavy use period. Coliform organisms are also found in hot tubs. Coliform tests should be conducted at least once per week during a heavy use period.

Hot Tub Folliculitis (Pseudomonas Aeruginosa) is another common spa disease. Pseudomonas bacteria is carried on the skin and enters the water when people do not shower before using the spa. Heat dilates the pores and the inlet jets jack hammer the skin, forcing bacteria into the pores. Symptoms usually begin to occur within 24 hours and consist of fatigue, swollen lymph glands, redness, tenderness and swelling of the breasts (men and women) and open pustule-type sores that ooze, itch and then turn painful. The disease can cause blood poisoning, infect the urinary tract and cause pneumonia. While it usually lasts only 7 days, it can linger for 2 - 3 weeks.

E. Spa Filtration

Filtration circulation pumps for whirlpool systems are usually 1/2 hp in size.

Regenerative cycle diatomaceous earth filters provide the best quality water for the least amount of operational dollars spent. In addition, these filters can remove matter down to 1 micron (1 one millionth of an inch) in diameter, the size of some viruses. Cartridge filters also provide excellent water quality, but are more expensive to operate. The least appropriate filtration application for hot water use is sand filter, necessitating replacement of the sand.

The system must be able to return the water to a turbidity of 0.50 Jackson Turbidity Units (JTS's) within four hours following peak user load.

Spa heaters permit a vast range of temperatures. Some manufacturers include a two-thermostat arrangement that allows for a range of 50 degrees to 100 degrees F. A desirable safety feature necessary for each spa is a thermostat that automatically shuts down the heater when water temperatures reach 104 degrees F.

Once the spa has been brought up to the desired temperature, most of the heat lost occurs at the water's surface. Heater size, therefore, should be based on surface losses. For outdoor spas, the factors to be considered, once the desired temperature is determined, are average temperature of the coldest month in which the spa will be used, the surface area of the spa and the average wind velocity. The enclosed table developed by the Council for National Cooperation in Aquatics indicates the heat lost from the surface for outdoor spas. The correct heater size, requires a BTU output that must exceed the heat loss. Heater output is determined by dividing the output by the actual efficiency of the heater.

For indoor spas, the air temperature should be maintained close to that the spa's water temperature. A heat loss factor of 100 BTU/hour can be expected indoors. Spa covers can reduce loss by as much as 50 percent or more.

Filtration and disinfection equipment areas usually measure about 4' x 6' or 5' x 7', and should be located no more than 20 feet from the spa.

Heat Loss from Spa Surface (BTUs Per Hour)

Surface Area of Spa Square Feet	Temperature Difference (degrees F) Between Average Air and Desired Water Temperature					
	10 deg.	20 deg.	30 deg.	40 deg.	50 deg.	60 deg.
20	2,100	4,200	6,300	8,400	10,500	12,500
30	3,150	6,300	9,500	12,600	15,800	19,000
40	4,200	8,400	12,600	16,800	21,000	25,200
50	5,250	10,500	15,750	21,000	26,250	31,500
100	10,500	21,000	31,500	42,000	52,500	63,000
200	21,000	42,000	63,000	84,000	105,000	126,000
300	31,500	63,000	94,500	126,000	157,500	189,000
400	42,000	84,000	126,000	168,000	210,000	252,000
500	52,500	105,000	157,500	210,000	263,000	315,000

Note: these heat losses are based on an assumed wind velocity at the water surface of 3 1/2 mph. For a velocity of 5 mph, multiply these losses by 1.25, and for 10 mph, multiply by 2.0.

Source: Minimum Standards for Public Spas, April 1, 1978, Spa and Tub Association of the National Swimming Pool Institute.

F. Spa and Hot Tub Chemistry

The following standards are recommended by the U.S. Department of Health and Human Services (Public Health Services - Centers for Disease Control) with some modifications by increasing slightly the recommended levels of halogen disinfectants.

Public Spa and Hot Tub Operational Parameters

Disinfectant Levels	**Minimum**	**Recommended**	**Maximum**
Free residual Chlorine	2.0 ppm	3.0 ppm	4.0 ppm
Bromine	2.0 ppm	3.0 ppm	4.0 ppm
Iodine	2.0 ppm	3.0 ppm	5.0 ppm
Shock tub daily to 5.0 ppm chlorine, and weekly from 5.0 to 10.0 ppm.			
Chemical Values			
pH	7.2	7.4 - 7.6	7.8
Total Alkalinity	60 ppm	100 ppm	120 - 150 ppm
Total Dissolved Solids	—	< 300 ppm	1500 ppm
Calcium Hardness	50 ppm	100 - 300 ppm	400 - 500 ppm
Heavy Metals (Copper, Iron, Manganese)	0		
Biological Values			
Algae	none	Bacteria	none
Temperature Values			
Temperature	—	100 deg. F (38 deg. C)	102 deg. F (39 deg. C)
Check the water temperature 1/2 hour before opening, and then hourly during daily use.			
Water Clarity			
Jackson Turbidity Units		0	1.0

Additional procedures include shocking daily by raising halogen levels to 5.0 ppm and shocking weekly to levels of 10.0 ppm. Temperature should be checked 1/2 hour prior to opening and hourly there after unless an automatic shut off occurs when water temperature reaches 104 degrees F. Bacteriological tests must be conducted weekly with samples taken during a period of heavy use for coliform organisms and Pseudomonas.

It is recommended that tests for the presence of residual halogens be made hourly each day. Tests for other chemical levels and water clarity should be made as often during the day as is necessary to assure that the water is balanced and clear. A Langelier Saturation Index should be calculated weekly or after each refilling, followed by whatever necessary corrective steps need to be taken to maintain a balance between -0.3 and +0.3. The water level must be maintained at mid-skimmer level so that oils and floating matter are constantly removed 24 hours a day.

APPENDIX A

Hazards and Risks of Pool Management

1. The Unfelt Fatigue

Component A: The staff is tried. It's been a long, crowded, hot busy day. Staff alertness is not at its peak. Not being aware of the declining alertness is the trap which fatigue induces.

Component B: The kids are tired. It's been a long, crowded, hot, busy day. Kids' alertness is not at its peak...etc.

2. The Unusual Occurrence

This is something that is not dangerous in itself. It might be a big wind storm, a fully dressed person appearing at swim side, a police car zooming past with a siren howling, a maintenance man fixing something in the area near the participants — it may be anything that detracts the attention of personnel or participants.

3. The Noble Duties

The honorable and laudable function of explaining to a youngster that it is a rule to walk while you are supposedly watching the swimmers. The honorable and laudable function of checking for cleanliness while you are supposedly watching the swimmers. The honorable and laudable function of...

4. The False Assumption

This hazard is present when two or more guards are on duty. It is almost a subconscious assumption that the other guy is watching the pool. Hence I can...(help this kid with his stroke, talk with that mother who has some questions, visit the washroom). Care to guess what the other guard may be assuming?

5. The Lone Practicer

This happens during instruction. A student is told to practice by himself for a few minutes while the instructor takes the class through another skill. Four instructors are each watching their own four little classes. No one is watching the lone practitioner.

6. The New Participants

An unusually large number of accidents involve people who are:

A. New members

B. Guests

C. First week campers

D. New staff members

E. Members of rental groups

7. The Obscured Water

Cloudiness and glare. The latter prohibits a guard from seeing someone under the water even though people on top are visible.

8. The Perfect Record

Lethargy sets in after things go well for a period. Even within the same day guards relax when the initial hours go well.

9. The Assumed Ability

He was a navy frogman. He's obviously qualified to teach our SCUBA classes. (The following have nothing to do with it:)

A. He'll be working with guys in poor shape.

B. He'll be working with women and girls.

C. He has no teaching experience.

D. He has no lifesaving ability.

E. He never heard of the National YMCA SCUBA Program.

10. The Unfollowed Policy

"It just isn't convenient to get everybody certified in CPR or to hire people with lifeguarding certifications. The people I did hire are all pretty well qualified. Besides our director got his instructor's card. Even though it expired, he knows the ropes. That "Manual of Good Practices in the Operation of Swimming Pools" or whatever it is, just isn't practical."

11. The Unchecked Equipment

"We inspect our resuscitators, diving boards, and all other aquatic equipment every year whether it needs it or not."

12. The Good Intention

"I'll have to have a staff meeting one of these days soon and go over these hazards with them."

APPENDIX B

28 Reasons Why Your Aquatic Program and/or Facility May Not Be Liability Free!

Safety cannot and must not be taken lightly. One serious accident can permanently disable a youngster, destroy a person's professional career, and create a lifetime of guilt.

The following check list is provided to help you in evaluating your performance with respect to the safety of your program. It will give you an insight to the adequacy of your professional preparation.

1. Have you, as an administrator of an aquatic program, achieved a personal level of competency as it relates to an understanding of safety and hazard prevention in all aquatic activities?
2. Have policies with regard to safety been established by your agency and distributed to all persons involved in the aquatic program?
3. In the development of safety policies and procedures, were all levels of leadership involved in the process?
4. Is there a program for updating safety policies?
5. Have you an understanding and a genuine concern for the potential legal implications resulting from an accident that might occur in your pool?
6. Have definite steps been taken to assure that participants in your aquatic program are aware of this responsibility for their safety and the safety of others?
7. Have you familiarized yourself with the activities that your instructors or coaches are conducting in terms of their potential risk to participants?
8. Have you satisfied yourself that every precaution has been taken in high risk activities to prevent the occurrence of an accident?
9. Have you established a standard system for reporting accidents that happen in your pool?
10. Have you developed, written, and rehearsed a complete emergency procedure to assure prompt attention for the injured person?
11. Do you conduct emergency drills regularly?
12. Do you make available current published safety material to staff under your supervision?
13. When an accident is reported, do you carefully investigate the circumstance surrounding the accident and when indicated take corrective action?
14. Do you convey to the manufacturer or local supplier of pool equipment any defect or deficiency in the equipment that you have observed that might contribute to an accident?
15. Do you conduct safety workshops with your staff regularly?
16. Are you acquainted with state laws, bathing codes, and all local ordinances and regulations that in anyway affect the conduct of your aquatic program?
17. When you become involved in rehabilitating an existing facility or in planning a new one, do you make certain that all aspects of safety are incorporated into the plans? In this connection, do you review the final architectural plans to assure that the recommendations you made initially have been carried forth?
18. Have you established evaluative criteria for assessing the need for repair or replacement of equipment at the end of the season or program?
19. Do you involve yourself sufficiently in equipment procurement to assure that the equipment not only is of high quality, but that is possesses all the essential safety features?
20. Have safety rules governing the use of equipment been conveyed to all staff and where desirable posted for all to see?

21. Have you reviewed and rehearsed your emergency procedures with local hospital authorities and any physician who has been designated as a liaison with your program?

22. Are all students who participate in your program covered by accident insurance? Are you and your school or your agency covered by liability insurance for any wrongful acts committed by employees that result in injury to a participant?

23. Do you insist that all participants in your organized program have an examination by a physician to determine fitness for participation?

24. Have safety rules governing the use of equipment such as diving boards, slides, scuba gear, floatation devices, etc. been established and are they conveyed to all participants and staff in an appropriate manner?

25. Do you insist that your staff inspect and examine equipment each day before they use it to assure it is safe?

26. Are you aware of the high risk activities in the field of aquatics?

27. Do you employ only those persons who are currently certified in first aid and CPR basic life support?

28. Is your pool presently equipped with the essential first aid, life support, and lifeguarding equipment?

APPENDIX C

Swimming Pool Safety Check List

Area	Date	Pass	Fail	Comments
Parking lot	Pavement			
	Lighting			
Walkways	Pavement			
	Lighting			
Fencing	Intact/Secure			
	Rust-Free			
Entrance way	Locks			
	Lighting			
Office	Floor			
	Ceiling			
	Lighting			
	Electrical			
	PA systems			
Telephone				
Locker rooms	Floor-nonslip			
	Clean			
	Drainage			
	Sanitized			
	Benches-secure			
	Smooth surface			
	Electrical outlets			
	Switches			
	Lighting			
	Exit signs			
Restrooms	Floor-nonslip			
	Clean			
	Drainage			
	Sanitized			
	Lighting			
	Electrical			
	Toilets-functioning/sanitized			
	Sinks-functioning/sanitized			

Area	Date	Pass	Fail	Comments
Showers	Floor-nonslip			
	Clean			
	Sanitized			
	Drains-clean			
	Functioning			
	Lighting			
	Plumbing-leaks			
	Water temperature control			
Pool entrance	Shallow end			
	Unobstructed			
Pool deck	Non-slip			
	Clean			
	Proper slope-drainage			
	Proper deck markings/readable			
	No obstructions			
	Benches intact			
	Smooth surface			
Diving boards	Board intact			
	Sanitized			
	Board secured			
	Standard intact			
	Standard anchored			
	Steps intact			
	Steps-nonslip			
	Handrails-sturdy			
Pool ladders	Firmly attached			
	No sharp edges			
	non-slip steps			
Guard chairs	Proper location			
	Proper Height			
	Steps and seats intact			
Pool walls	Smooth surface			
	No protruding areas			
	Depth markings			
Pool bottom	Smooth surface			
	Marked for depth perception			
	Markings at breakpoint			
	Proper grate on drain cover			
Pool water	Proper depth			
	Proper temperature			
	Water chemistry			

Area	Date	Pass	Fail	Comments
Filtration area	Warning signs			
	Lighting			
	Non-slip floor			
	Drainage			
	Overhead cleaner			
Chlorine room	Warning signs			
	Locations			
	Ventilation			
	Lighting			
	Tanks secured			
	Storage area			
	Gas masks			
	Ammonia bottle			
Other chemicals	Proper storage			
	Handling method			
	Warning signs			
Storage area	Accessible			
	Clean			
	Ventilated			
	Lighting			
First aid room	Sanitized			
	Unobstructed entrance			
	Clearly identified			
	Lighting			
	Plumbing			
	Electrical			
	Non-slip floor			
	Cot			
	Blankets			
	First aid supplies			
	Resuscitator			
	Telephone			
Safety equipment	Extension poles			
	Ring buoys			
	Rescue tubes			
	Backboards			
	PFDs			
	Gas masks			
	Lifelines			
	Telephone			

Area	Date	Pass	Fail	Comments
Exits	Clearly marked			
	Unobstructed			
Misc.				

APPENDIX D

Daily Pool Log

Date ______________________________

I. Pool Checked and Opened By: ____________________________________ Time: _______________

Witnessed By: ____ Time: _______________

II. Staff on Duty

Name	Duties	Check In Time	Check Out Time	Time Off	Hours Worked
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					

III. Water Conditions

Time	Chlorine Residual	Chlor-amines	pH	Total Hardness	Water Temp	Air Temp	Backwash	Heater on	Bather load
9:00 am									
10:00 am									
11:00 am									
12:00 pm									
1:00 pm									
2:00 pm									
3:00 pm									
4:00 pm									
5:00 pm									
6:00 pm									
7:00 pm									
8:00 pm									

IV. General Weather Conditions

Morning____________________ Afternoon ____________________ Evening____________________

V. Chemical Used

Chemical	Purpose for adding	Quantity	9	12	2	4	6	8
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								
11.								
12.								

VI. Vacuum Cleaning

Staff	Time	Section of pool cleaned
		____Deep ____Intermediate ____ Shallow ____ Wading Pool
		____Deep ____Intermediate ____ Shallow ____ Wading Pool

VII. Miscellaneous Maintenance

Staff	Time	Job
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		

APPENDIX E

Condensed Emergency Response Procedure Examples

	Pool - Neck Injuries Accident	Pool - Drowning/Near Drowning Accident
PRIMARY RESPONSE	1. Leaves chair with two (2) whistle blows	1. Leaves chair with two (2) whistle blows
SECONDARY RESPONSE WATER ACTIVITY	1. Clear pool	1. Clear pool
	2. Aids 1st guard	2. Contact victim
	3. Brings backboard	3. Brings victim to side of shallow end
	4. Brings cervical collar	4. Helps get victim onto deck of pool
	5. Takes victim to shallow water	5. Begins AR/CPR
	6. Helps put victim on backboard	6. Brings auxiliary equipment
	7. Helps remove victim from the water	7. Helps treat for shock
	8. Helps treat for shock	
SECONDARY RESPONSE LAND ACTIVITY	1. Clear Pool	1. Clear Pool
	2. Calls EMS	2. Alert EMS
	3. Guide EMS to pool	3. Guide EMS to pool
	4. Alert nurse/administration	4. Alert nurse/administration
	5. Identify victim	5. Identify victim
	6. Calls parents/hospital/physician	6. O_2 administered by trained person
	7. Write incident reports	7. Call parent/hospital/physician
	8. Get each participant to write a report.	8. Write incident report
	9. Complete investigation	9. Get each participant to write a report
	10. Notify media	10. Complete investigation
	11. Evaluation of incident	11. Notify media
		12. Evaluation of incident

APPENDIX F

Sample Emergency Procedure

Indiana University of Pennsylvania Aquatics Emergency Procedure

A. GUARD No. 1

1. Staff member closest to the accident sounds: 3 LONG BLASTS on his whistle.
2. Makes the rescue - if necessary
3. Initiates whatever first aid, CPR, etc. is necessary

B. GUARD No. 2

1. Staff member working the desk clears the pools and sends EVERYONE into the locker rooms.
2. Checks the pool bottom by circling the pool.
3. Proceeds to help GUARD No. 1

C. GUARD No. 3

1. Staff member guarding the pool not involved in the first 2 steps moves quickly to the scene accident, makes a quick assessment of the situation and goes to the telephone in Men's Lookout or Zink Office and calls infirmary (2555). Reports his assessment and requests aid.

D. GUARD No. 4

1. Staff member not involved in above steps proceeds to scene of the accident to help GUARD No. 1 in first aid or moving the bystanders. After victim is removed to the ambulance GUARD No. 1 fills out 2 copies of an IUP accident report.

F. Either GUARD No. 2, 3, or 4, goes to phone to notify Mr. Johnson and/or others on AUTHORITY LIST.

G. No guard is to make any comments or statements to reporters, witnesses, or bystanders.

H. Reports can be made to anyone on the School of Health Services AUTHORITY LIST - NO ONE ELSE.

SCHOOL OF HEALTH SERVICES AUTHORITY LIST

Name and Address	Position	Office Phone No.	Home Phone No.
1.			
2.			
3.			
4.			

APPENDIX G

Aquatic Area Accident Report

Fill out in duplicate and submit to (pool manager) at (address).

1. Personal Information: (Injured Party)

   Name: ______________________________

   Birthdate: ______________ Social Security Number: ______________

   Home Address: ______________________________

2. Pool accident occurred in (insert pool name): ______________
3. Date of accident: ______________
4. Time of accident: ______________
5. Pool activity at time of accident: ______________
6. What specifically was the person doing at the time of the accident? ______________
7. Was there supervision at the time of the accident? ___Yes ___No

   By whom ______________________________

8. Part of the body injured? ______________
9. Type of injury or accident? ______________
10. Detailed description of accident? ______________

    ____

    ____

11. What First Aid was administered? ______________
12. Person referred to Hospital? ____ Yes ____No

    Which Hospital? ______________________________

    Accompanied by: ______________________________

Witnesses

1. Name ____________________

   Home Address: ____________________

   Home Phone No.: ____________ Social Security No.: ____________

2. Name ____________________

   Home Address: ____________________

   Home Phone No.: ____________ Social Security No.: ____________

3. Name ____________________

   Home Address: ____________________

   Home Phone No.: ____________ Social Security No.: ____________

   Person completing report: (Signature) ____________________

   Date: ____________ Time: ____________

Person(s) notified of accident/injury

1. Name: ____________________

   Title: ____________________

   Home Address: ____________________

   Home phone No.: ____________________

2. Name: ____________________

   Title: ____________________

   Home Address: ____________________

   Home Phone No.: ____________________

3. Name: ____________________

   Title: ____________________

   Home Address: ____________________

   Home Phone No.: ____________________

APPENDIX H

Lifeguard Spot Check Evaluation

1. Date of Observation______________________________

2. Pool ______________________________

3. Guards Scheduled:

   1. ______________________________
   2. ______________________________
   3. ______________________________
   4. ______________________________

4. Guards on Duty:

   1. ______________________________
   2. ______________________________
   3. ______________________________
   4. ______________________________

5. Position of guards on duty when supervisor entered pool. Identify location of guard by number: (Insert diagram of the pool(s).

   1. ______________________________
   2. ______________________________
   3. ______________________________
   4. ______________________________

6. Proper Attire - yes or no

	Shirt	Bathing Suit	Whistle
Guard 1.			
Guard 2.			
Guard 3.			
Guard 4.			

7. Lifesaving and first aid equipment report

Reaching Poles ____________________

Buoys ____________________

Back Boards ____________________

First Aid Materials ____________________

Oxygen Equipment ____________________

8. Pool Rules Being Enforced - Yes or No ____________

9. Alertness to Duty - OK - Problem (be specific)

Guard 1. ____________________

Guard 2. ____________________

Guard 3. ____________________

Guard 4. ____________________

10. Lifeguard Attitude - OK - Problem (be specific)

Guard 1. ____________________

Guard 2. ____________________

Guard 3. ____________________

Guard 4. ____________________

11. Other Problems (be specific)

Guard 1. ____________________

Guard 2. ____________________

Guard 3. ____________________

Guard 4. ____________________

12. Comments: ____________________

____

____

I certify the above information is true.

Supervisor Signature ____________________

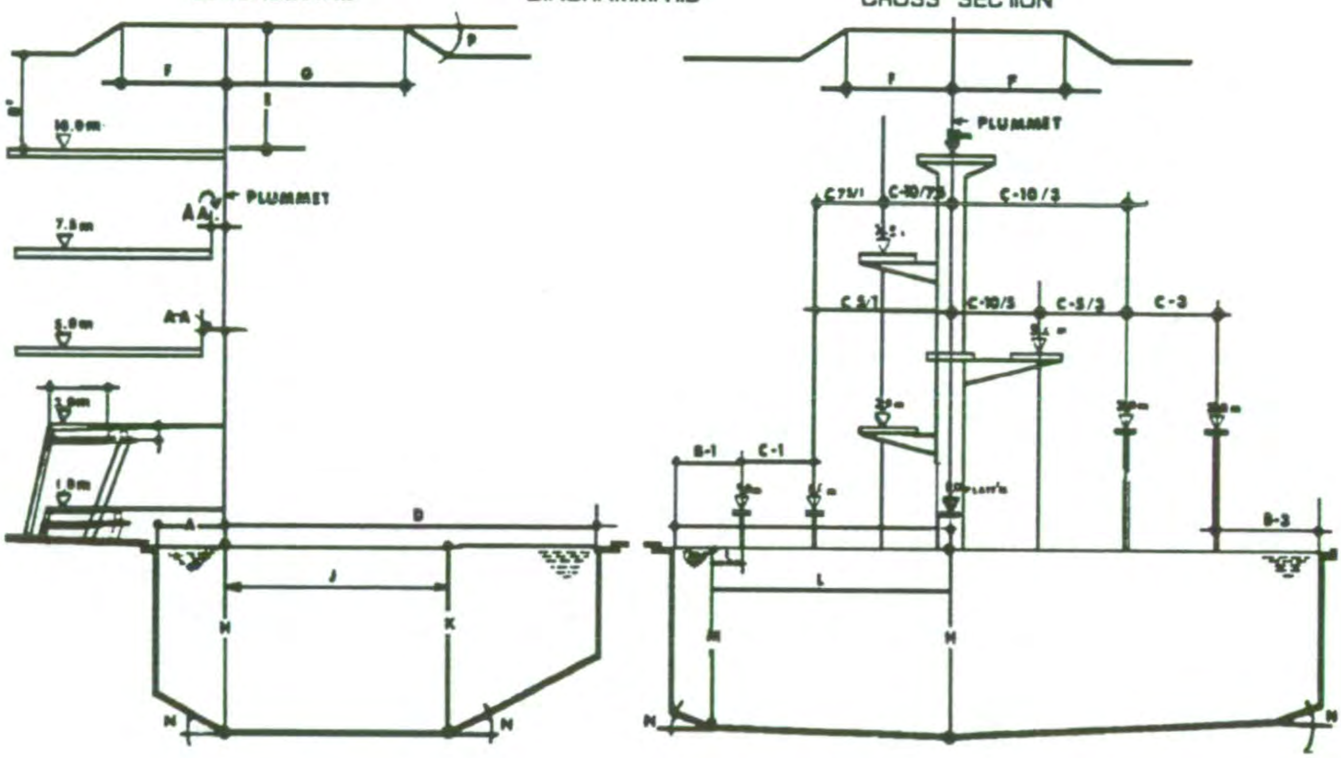
Date: ____________________ Time: ____________

APPENDIX I

Professionally Accepted Standards for Diving Area Design

NCAA Standards

(From "Swimming Pools: A Guide To Their Planning, Design and Operation," by the Council For National Cooperation In Aquatics, 1987



FINA International Amateur Swimming and Diving Federation and AAU of USA Dimensions for Diving Facilities *Revised January, 1981*		Less Than 1 Meter Springboard	1 Meter Springboard	3 Meter Springboard	1 - M Platform	3 - M Platform	5 - Meter Platform
	Length		16'	15'	15'	16'	20'
	Width		1'-8"	1'-8"	1'-8"	2'-6"	5'
	Height		3'-3"	9'-10"	3'3"	9'-10"	16'-5"
A From Plummet Back To Pool Wall	Designation		A-1	A-3	A-1 platfm	A-3 platfm	A-5
	Min. Dimension		6'	6'	4'	4'	5'
	PA Req.	3'			5'	5'	

FINA International Amateur
Swimming and Diving Federation
and AAU of USA
Dimensions for Diving Facilities
Revised January, 1981

		Less Than 1 Meter Springboard	1 Meter Springboard	3 Meter Springboard	1 - M Platform	3 - M Platform	5 - Meter Platform
B From Plummet To Pool Wall At Side	Designation				B-1 pl	b-3 pl	
	Min. Dimension		10'	12'	7'6"	9'6"	13'
	PA Req.*	10'	12'	12'	10'	10'	
C From Plummet To Adjacent Plummet	Designation				C-1 pl	C-3 pl	
	Min. Dimension		8'	8'			
	PA Req.*	10'	12'	12'	10'	10'	
D From Plumment To Pool Wall Ahead	Designation				D-1 pl	D-3 pl	
	Min. Dimension		29'	34'	26'	31'	34'
	PA Req.*						
E Plummet From Board To Ceiling Overhead	Designation				E-1 pl	E-3 pl	
	Min. Dimension		16'	16'	10'	10'	12'
	PA Req.*	16'					
F Clear Overhead Behind and Each Side Plummet	Designation				F-1 pl	F-3 pl	
	Min. Dimension		8'	8'	9'	9'	10'
G Clear Overhead Ahead of Plummet	Designation				G-1 pl	G-3 pl	
	Min. Dimension		16'	16'	16'	16'	16'
H Depth of Water at Plummet	Designation				H-1 pl	H-3 pl	
	Min. Dimension		12'	13'	11'	11'	14'
	PA Req.*	10'	12'	13'	12'	13'	
I Bottom Distance Ahead of Plummet	Designation				J-1 pl	J-3 pl	
	Min. Dimension		20'	20'	16'	20'	20'
	PA Req.*	16'			17'	20'	
K Bottom Depth Ahead of Plummet	Designation				K-1 pl	K-3 pl	
	Min. Dimension		11'	12'	10'9"	10'-9"	12'-9"
L Bottom Distance Each Side of Plummet	Designation				L-1 pl	L-3 pl	
	Min. Dimension		8'	10'	7'	9'	12'
M Bottom Depth Each Side of Plummet	Designation				M-1 pl	M-3 pl	
	Min. Dimension	12'	12'	13'	10'-9"	10'-9"	14'
N Maximum Angle of Slope to Reduce Dimension	Pool Bottom	1:2	1:2	1:2			1:2
O Beyond Full Requirements	Ceiling Height	1:2	1:2	1:2			1:2
P Maximum Board Length		12'	16'	16'	16'	16'	16'

* - Pennsylvania Requirement via regulation.

APPENDIX J

Reference List For Pool Managers

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Pennsylvania Department of Environmental Resources. *Public Swimming and Bathing Places.* 1977.

APPENDIX K

Glossary of Terms and Abbreviations

Common Material Safety Data Sheets and Warning Label Terms

ACGIH - American Conference of Governmental Industrial Hygienists. An organization of professional personnel in governmental agencies or educational institutions engaged in occupational safety and health programs. ACGIH develops and publishes recommended occupational exposure limits (see TLV) for hundreds of chemical substances and physical agents.

ANSI - American National Standards Institute. A privately funded, voluntary membership organization that identifies industrial and public needs for national consensus standards and coordinates development of such standards.

Asphyxiant - A vapor or gas that can cause unconsciousness or death by suffocation (lack of oxygen). Most simple asphyxiants are harmful to the body only when they become so concentrated that they reduce oxygen in the air (normally about 21 percent) to dangerous levels (18 percent or lower). Asphyxiation is one of the principal potential hazards of working in confined spaces.

ASTM - American Society for Testing and Materials. A voluntary membership organization with members from a broad spectrum of individuals, agencies, and industries concerned with hazardous materials. The world's largest source of voluntary consensus standards for materials, products, systems and services. ASTM is a resource for sampling and testing methods, health and safety aspects of materials, safe performance guidelines, effects of physical and biological agents and chemicals.

Autoignition Temperature - The temperature at which a substance willstart to burn without any source of ignition (spark or flame).

Boiling Point - The temperature at which a liquid changes to a vapor state at a given pressure. Flammable materials with low boiling points usually present special fire hazards.

Carcinogen - A carcinogen is a substance or agent that causes cancer in humans. There are approximately 12 substances commonly used in industrial processes which are known to cause cancer in man. Almost all of these substances occur in nature.

A potential or suspected human carcinogen is a substance or agent that can be shown to cause cancer in laboratory animals. Whether or not it will cause cancer in humans is not known.

Chemical Family - A group of single elements or compounds with a common general name. Example: acetone, methyl ethyl ketone (MKE) and methyl isobutyl ketone (MIBK) are of the "ketone" family; acrolein, furfural, acetaidehyde are of the "aldehyde" family.

Combustible - Any liquid having a flashpoint at or above 100 degrees F (37.8 degree C) but below 200 degrees F (93.0 degrees C). They do not ignite as easily as flammable liquids; however, they can be ignited under certain circumstances and must be handled with caution.

Concentration - The relative amount of a substance when combined or mixed with other substances.

Corrosive - A liquid or solid that causes visible destruction or irreversible alterations to human skin tissue at the site of contact, or in the case of leakage from its packaging, a liquid that has a severe corrosion rate on steel.

Cutaneous Toxicity - See "Dermal Toxicity".

Decomposition - Breakdown of a material or substance (by heat, chemical reaction, electrolysis, decay, or other processes) into parts or elements or simpler compounds.

Dermal - Used on or applied to the skin.

Dermal Toxicity - Adverse effects resulting from skin exposure to a substance.

Effects of Overexposure - Includes both acute (short-time exposure) and chronic (long-time exposure) effects. Acute effects usually appear immediately and are caused by very high concentrations. Chronic effects may not appear for months or years. Staying below the TLV should prevent both acute and chronic effects.

Epidemiology - The science that deals with the study of disease in a general population.

Evaporation Rate - The time it takes a substance to evaporate, compared to a "standard material". (The standard materials used are typically ethyl, ether, or butyl acetate.) For example, an evaporation rate of "2" means that the substance takes twice as long to evaporate as the standard material. The higher the number, the slower the substance evaporates.

Flash Point - The temperature at which a liquid will give off enough flammable vapor to ignite. There are several flash point test methods, and flash points may vary for the same material depending on the method used. The test method is indicated when the flash point is given. Tag Closed Cup (TCC), Pensky-Martins Closed Cup (PMCC), and Setaflash (SETA) are some examples.

Flammable Liquid - Any liquid having a flashpoint below 100 degrees F (37.8 degrees C).

General Exhaust - A system for exhausting air containing contaminants from a general work area. Also see "local exhaust".

g - Gram - a metric unit of weight. One U.S. ounce is about 28.4 grams.

g/kg - Grams per kilogram; an expression of doses used in oral and dermal toxicology testing to indicate the grams of substance doses per kilogram of animal body weight. Also see "kg" (kilogram).

Hazard - A danger. Whether or not a toxic substance is a hazard depends on its chemical and physical form, and the amount and time of exposure. In the past, chlorine was used as a deadly war gas. Today, chlorine (in very low concentration) is used to kill harmful bacteria in drinking water. Chlorine, chemically combined with sodium, is table salt, which is also naturally present in most foods, is necessary in proper amounts for good health, and is not dangerous in any practical sense.

When you exhale, your breath contains about 4 ppm of carbon monoxide (CO) which is manufactured in your own body. Inhaling 50 ppm of CO for 8 hours can give you a headache. Inhaling 1500 ppm CO for 1/2 hour can make you unconscious, and if you are not removed from the exposure, will kill you.

Hazardous Chemical - The Hazard Communication Standard definition is "any chemical which is a physical hazard or health hazard".

Hazardous Decomposition Products - Hazardous materials produced from a reaction by burning, oxidation, heating or reaction with other chemicals.

Hazardous Material - In a broad sense, a hazardous material is any substance, or mixture of substances, having properties capable of producing adverse effects on the health or safety of human beings.

Incompatibility - Conditions to avoid (i.e., temperature extremes, jarring, inappropriate storage, etc.) Incompatible materials are those that could cause dangerous reactions from contact with one another.

Ingestion - The taking in of a substance through the mouth.

Inhalation - The breathing in of a substance in the form of a gas, vapor, fume, mist, or dust.

Inhibitor - A chemical that is added to another substance to prevent an unwanted chemical change from occurring.

Irritant - A substance that, by contact in sufficient concentration for a sufficient period of time, will cause an inflammatory response or adverse reaction to the eye, skin or respiratory system.

kg - Kilogram - a metric unit of weight, about 2.2 U.S. pounds.

LEL, or LFL - Lower explosive limit or lower flammable limit of a vapor or gas; the lowest concentration (lowest percentage of the substance in air) that will produce a flash of fire when an ignition source (heat, arc, or flame) is present. At concentrations lower than the LEL, the mixture is too "lean" to burn. Also see "UEL".

Local Exhaust - A system for capturing and exhausting contaminants from the air at the point where the contaminants are produced. Also, see "general exhaust".

Melting Point - The temperature at which a solid substance changes to a liquid state. For mixtures, the melting range may be given.

Mutagen - A substance or agent capable of altering the genetic material in a living cell.

Olfactory - Relating to the sense of smell.

Oral - Used in or taken into the body through the mouth.

Oxidation - In a literal sense, oxidation is a reaction in which a substance combines with oxygen provided by an oxidizer or oxidizing agent.

Oxidizer - An oxidizer or oxidizing material is a substance that yields oxygen readily to stimulate the combustion of organic matter.

PEL - Permissible Exposure Limit. The permissible exposure limit established by OSHA, similar to the TLV. However, TLV's often represent more current information because they do not require the formal legal rule-making required by a PEL.

% Volatile - Percent volatile by volume; the percentage of a liquid or solid (by volume) that will evaporate at an ambient temperature of 70 degrees F (Unless some other temperature is stated).

Polymerization - A chemical reaction in which one or more small molecules combine to form larger molecules. A hazardous polymerization is such a reaction which takes place at a rate that releases large amounts of energy. If hazardous polymerization can occur with a given material, the MSDS usually will list conditions which could start the reaction.

PPM - Parts per million (by volume). 10,000 ppm is 1% by volume in air. Examples of one part per million are: one inch in sixteen miles; one minute in two years, (one drop of vermouth in 80 fifths of gin.)

Reaction - A chemical transformation or change; the interaction of two or more substances to form new substances.

Reactivity - A description of the tendency of a substance to undergo chemical reaction with the release of energy. Undesirable effects, such as pressure buildup, temperature increase, formation of noxious, toxic or corrosive by-products, may occur because of the reactivity of a substance to heating, burning, direct contact with other materials, or other conditions in use or in storage.

Sensitizer - A material that causes an allergic condition in some individuals, such that even extremely small exposures to that material will cause a reaction. It is like an artificially induced allergy.

"Skin" (Absorption) - A notation, sometimes used with PEL or TLV exposure date. Indicates that the stated substance may be absorbed by the skin, mucous membranes, and eyes (either airborne or by direct contact) and that this additional exposure must be considered part of the total exposure to avoid exceeding the PEL or TLV for that substance.

Solubility in water - A term expressing the percentage of a material (by weight) that will dissolve in water at ambient temperature. If a substance has low solubility in water, water alone will not work well for cleaning up spills or for washing the substance off your skin. Solubility information is useful in determining effective fire extinguishing methods and spill cleanup procedures.

Species - A biological type. On MSDS's, species refers to the test animals (usually rats, mice, or rabbits) which were used to obtain the toxicity test data reported.

Specific Gravity - The ratio of the weight of a volume of material to the weight of an equal volume of water. In other words, how dense (heavy) the material is in comparison to water. For insoluble materials, a ratio of less than one means the material is lighter than water and will float on the surface. If the ratio is greater than one, the insoluble material will sink. Most flammable liquids are lighter than water.

Stability - An expression of the ability of a material to remain unchanged. For MSDS purposes, a material is stable if it remains in the same form under expected and reasonable conditions of storage or use. Conditions which may cause instability (dangerous change) are stated.

Synonym - Another name or names by which a material is known. Methyl alcohol, for example, is also known as methanol, or wood alcohol.

TLV - Threshold Limit Value; a term used by ACGIH to express the air-borne concentration of a material to which nearly all persons can be exposed day after day, without adverse effects. ACGIH expresses TLV's in three ways:

TLV-TWA - The allowable Time Weighted Average concentration for a normal 8 - hour workday.

TLV-STEL - The Short-Term Exposure Limit, or maximum concentration for a continuous 15-minute exposure period (Maximum of four such periods per day, with at least 60 minutes between exposure periods, and provided that the daily TLV-TWA is not exceeded).

TLV-C - The Ceiling exposure limit - the concentration that should not be exceeded even instantaneously.

Toxicity - The degree to which something is poisonous in living organisms. Toxicologists use the term to mean "having some detectable abnormal effect" on the organism which may or may not have a significant health effect. Almost all known chemicals have some degree of toxicity. Table salt would kill a person if too much was swallowed and could be kept down.

Trade Name - Generally, the name the product is sold by.

TWA - Time Weighted Average exposure. The airborne concentration of a material to which a person is exposed, averaged over the total exposure time. Also see "TLV".

UEL, or UFL - Upper explosive limit or upper flammable limit of a vapor or gas. The highest concentration (highest percentage of the substance in air) that will produce a flash of fire when an ignition source (heat, arc, or flame) is present. At higher concentrations, the mixture is too "rich" to burn. Also see "LEL".

Unstable - Tending toward decomposition or other unwanted chemical change during normal handling or storage.

Vapor Density - The weight of a vapor or gas compared to the weight of an equal volume of air-an expression of the density of the vapor or gas. Materials lighter than air have vapor densities less than 1.0. Materials heavier than air have vapor densities greater than 1.0. All vapors and gases will mix with air, but the lighter materials will tend to rise and dissipate (unless confined). Heavier vapors and gases are likely to concentrate in low places where they may create fire or health hazards (along or under floors, in sumps, sewers, and manholes, trenches and ditches).

Vapor Pressure - The pressure exerted by a saturated vapor above its own liquid in a closed container. When quality control tests are performed on products, the test temperature is usually 100 degrees F. and the vapor pressure is expressed as pounds per square inch (psig or psia). Vapor pressures reported on MSDS's are in millimeters of mercury (mmHg) at 68 degree F. (20 degrees C), unless stated otherwise. Three facts are important to remember:

1. Vapor pressure of a substance at 100 degrees F. will always be higher than the vapor pressure of the substance at 68 degrees F.
2. Vapor pressures reported on MSDS's in mmHg are usually very low pressures; 760 mmHg is equivalent to 14.7 pounds per square inch (standard pressure).
3. The lower the boiling point of a substance, the higher its vapor pressure.

Ventilation - See "general exhaust" and "local exhaust".

APPENDIX L

Swimming Pool Chemical Adjustments I

Table A: Calcium Hardness Increase

Increase in ppm *	To Increase Calcium Hardness Using Calcium Chloride Dihydrate ($CaCl_2$ - $2H_2O$) Gallons in Pool													
	1,000		5,000		10,000		15,000		20,000		25,000		50,000	
	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz
10 ppm		2		10	1	4	1	14	2	8	3	2	6	4
20 ppm		4	1	4	2	8	3	12	5	0	6	4	12	8
30 ppm		6	1	14	3	12	5	10	7	8	9	6	18	12
40 ppm		8	2	8	5	0	7	8	10	0	12	8	25	0
50 ppm		10	3	2	6	4	9	6	12	8	15	10	31	4
60 ppm		12	3	12	7	8	11	4	15	0	18	12	37	8
70 ppm		14	4	6	8	12	13	2	17	8	21	14	43	12
80 ppm	1	0	5	0	10	0	15	0	20	0	25	0	50	0
90 ppm	1	2	5	10	11	4	16	14	22	8	28	2	56	4
100 ppm	1	4	6	4	12	8	18	12	25	0	31	4	62	8

Table B: Total Alkalinity Increase

To Increase TOTAL ALKALINITY using SODIUM BICARBONATE (Baking Soda)							
Increase in ppm	Gallons in POOL						
	1,000	5,000	10,000	15,000	20,000	25,000	50,000
10 ppm	0.15 lb	0.75 lb	1.50 lb	2.25 lb	3.00 lb	3.75 lb	7.50 lb
20 ppm	0.30 lb	1.50 lb	3.00 lb	4.50 lb	6.00 lb	7.50 lb	15.00 lb
30 ppm	0.45 lb	2.25 lb	4.50 lb	6.75 lb	9.00 lb	11.25 lb	22.50 lb
40 ppm	0.60 lb	3.00 lb	6.00 lb	9.00 lb	12.00 lb	15.00 lb	30.00 lb
50 ppm	0.75 lb	3.75 lb	7.50 lb	11.25 lb	15.00 lb	18.75 lb	37.50 lb
60 ppm	0.90 lb	4.50 lb	9.00 lb	13.50 lb	18.00 lb	22.50 lb	45.00 lb
70 ppm	1.05 lb	5.25 lb	10.50 lb	15.75 lb	21.00 lb	26.25 lb	52.50 lb
80 ppm	1.20 lb	6.00 lb	12.00 lb	18.00 lb	24.00 lb	30.00 lb	60.00 lb
90 ppm	1.35 lb	6.75 lb	13.50 lb	20.25 lb	27.00 lb	33.75 lb	67.50 lb
100 ppm	1.50 lb	7.50 lb	15.00 lb	22.50 lb	30.00 lb	37.50 lb	75.00 lb

Swimming Pool Chemical Adjustments II

Table C: Total Alkalinity Reduction

LOWER TOTAL ALKALINITY USING SODIUM BISULFATE (Approximate Dry Acid)							
Decrease In ppm	Gallons in POOL						
	1,000	5,000	10,000	15,000	20,000	25,000	50,000
10 ppm	0.16 lb	0.80 lb	1.60 lb	2.40 lb	3.20 lb	4.00 lb	8.00 lb
20 ppm	0.32 lb	1.60 lb	3.20 lb	4.80 lb	6.40 lb	8.00 lb	16.00 lb
30 ppm	0.48 lb	2.40 lb	4.80 lb	7.20 lb	9.60 lb	12.00 lb	24.00 lb
40 ppm	0.64 lb	3.20 lb	6.40 lb	9.60 lb	12.90 lb	16.00 lb	32.00 lb
50 ppm	0.80 lb	4.00 lb	8.00 lb	12.00 lb	16.00 lb	20.00 lb	40.00 lb
60 ppm	0.96 lb	4.80 lb	9.60 lb	14.40 lb	19.20 lb	24.00 lb	48.00 lb
70 ppm	1.12 lb	5.60 lb	11.20 lb	16.80 lb	22.40 lb	28.00 lb	56.00 lb
80 ppm	1.28 lb	6.40 lb	12.80 lb	19.20 lb	25.60 lb	32.00 lb	64.00 lb
90 ppm	1.44 lb	7.20 lb	14.40 lb	21.60 lb	28.80 lb	36.00 lb	72.00 lb
100 ppm	1.60 lb	8.00 lb	16.00 lb	24.00 lb	32.00 lb	40.00 lb	80.00 lb

Table D: Total Alkalinity Reduction

LOWER TOTAL ALKALINITY USING MURIATIC ACID (Approximate Liquid Measure)							
Decrease in ppm	Gallons in POOL						
	1,000	5,000	10,000	15,000	20,000	25,000	50,000
10 ppm	1/4 cup	1 1/3 cup	1 1/3 pts	2.00 pts	2 1/2 pts	3 1/4 pts	6 1/2pts
20 ppm	1/2 cup	1 1/3 pts	1 1/3 qts	2.00 qts	2 1/2 qts	3 1/4 qts	6 1/2qts
30 ppm	3/4 cup	2.00 pts	2.00 qts	3.00 qts	4.00 qts	1 1/4 gal	2 1/2gal
40 ppm	1.00 cup	1 1/3 qts	2 1/2 qts	4.00 qts	1 1/3 gal	1 1/2 gal	3 1/4gal
50 ppm	1 1/3 cup	1 1/2 qts	3 1/4 qts	1 1/4 gal	1 1/2 gal	2.00 gal	4.00 gal
60 ppm	1 1/2 cup	2.00 qts	4.00 qts	1 1/2 gal	2.00 gal	2 1/2 gal	4 3/4gal
70 ppm	1 3/4 cup	2 1/4 qts	1 1/2 gal	1 3/4 gal	2 1/4 gal	2 3/4 gal	5 1/2gal
80 ppm	1.00 pt	2 1/2 qts	1 1/3 gal	2.00 gal	2 1/2 gal	3 1/4 gal	6 1/2gal
90 ppm	1 1/4 pts	3.00 qts	1 1/2 gal	2 1/4 gal	3.00 gal	3 1/2 gal	7 1/3gal
100 ppm	1 1/3 pts	3 1/4 qts	1 1/2 gal	2 1/2 gal	3 1/4 gal	4.00 gal	8 1/4gal

Table E: Chlorine Reduction

Reducing Free Chlorine Residuals with Sodium Thiosulfate Penta Hydrate (Dry Crystal)
2.7 oz/10,000 gallons reduces free Cl_2 by 2.0 ppm
1.7 lbs./100,000 gallon reduces free Cl_2 by 2.0 ppm
.017 lbs./1000 gal. reduces Cl_2 by 2.0 ppm