The Pool Operators have a responsibility to thoroughly comprehend all aspects of the plant's operation. Throughout the defects liability period Trisley's has an equal responsibility to provide all instruction and advice that is required of them. The Pool Operator has the added responsibility to train any new staff that may be required to operate or maintain the plant. Whilst every attempt has been made to safeguard the equipment provided under this Contract, considerable risk and damage can occur if unauthorised plant access is afforded to inexperienced personnel. Access to the pool plant rooms should be controlled restricted to authorised and trained staff only.

2. THE BASICS

2.1 INTRODUCTION TO HEALTH & SAFETY

Maintaining a safe swimming pool environment involves three major responsibilities:-

- Patrons must be required to conduct themselves in such a manner as to avoid causing personal injury;
- To the best level that is possible, dirt and infective materials must be prevented from entering the pool;
- Dirt and infective material, which does enter the pool must be quickly removed and rendered harmless.

The first of these responsibilities has primarily to do with public safety as distinguished from public health. It relates to the physical conduct and deportment of individuals while at work or play within the pool areas. The disciplines for governing such behaviour have been widely studied and are taught to lifeguards and safety personnel. Since this knowledge is readily obtainable from many sources, this aspect of pool operation is expressly omitted from this Manual.

The second responsibility, like the first, involves the control of bathers. This discipline bears heavily upon the cleanliness of the bathers, the hygienic environment of the pool, and the degree of "management" imposed by the Operator.

The third responsibility involves technical knowledge, special equipment and procedures that embrace the whole science of pool sanitation and disease prevention.

To competently handle all situations, the Operator must develop a knowledge of the chemistry of swimming pool water, the mechanics of filtration, chemical feeding, and the hydraulics of the pool recirculation system.

2.2 FUNDAMENTAL CONSIDERATIONS

2.2.1 Pool Contamination

Quite often the treatment of swimming pools poses many more complex problems than those associated with drinking water. Pool sanitation in general (and water disinfection in particular) begins with bather supervision and discipline. For the most part, the rules governing good conduct

and cleanliness are pure common sense. This however does not detract from their seriousness and or the need for their strict enforcement.

Not until the Operator understands the public health involvement, can he fully appreciate the importance of insisting that patrons comply with all rules, without exception. As an example, an obviously healthy patron wearing a small bandage might seem to present an entirely harmless situation to an untrained Pool Manager. The bandage might cover the most common pimple or sore, yet the affected area might well have festered with staphylococcus bacteria. As a highly localised infection, it presents no serious problem to the person afflicted, but it poses a significant health hazard if these same bacteria are washed from the infection and taken into the system of other bathers.

Although difficult to accept, it is a fact that many overseas countries have legislation that requires nude showers with warm water and soap prior to any Pool use. Be this as it may, organic soil (usually harmless in itself) will impose a serious burden upon the chemical disinfectants and filtration system if allowed to accumulate in the pool. Simply allowing patrons to enter the pool unbathed can impair the efficiency of the disinfection system as much as 50%. Although pre-bathing is difficult to enforce, Management does have opportunities to emphasise the need that their patrons apply some common sense and have a basic respect for the welfare of other bathers. It is unrealistic to expect that any treatment system will totally solve every conceivable problem - the majority of dirt load is after all, carried into the water primarily by the bathers.

Since the contamination of the swimming pool water is inevitable, some method must be provided to treat the water and make it safe for swimmers. Such treatment is accomplished by the operation of three inter-related and interacting systems:-

- An effective means of recirculating the water through the pools that mixes the filtered water with the bather dirt load and mixes any chemicals that are added throughout the pool for sterilisation and or water balance.
- An effective system for the removal of particles by filtration.
- An effective chemical dosing programme.

2.2.2 The Recirculation System

The function of a swimming pool recirculation system can probably be best understood if it is thought of as a transportation system which takes water from the pool where it can be filtered and chemically treated and then returns to the pool. The round trip the water takes is commonly described as “turnover”. Turnover can be expressed as the number of hours necessary to recirculate a volume of water equal to the volume contained within the pool. Alternatively, turnover can be the number of times in twenty four hours that the volume of the pool is circulated, i.e. a turnover of eight hours can also be expressed as a turnover of three per day.

Turnover is only one of many considerations that is required in the design of an effective treatment system. Turnover, is however based upon the widely accepted Law of Consecutive Dilution that suggests that a turnover of six to eight hours would provide 95% to 98% dilution of soiled pool water with water that has been filtered and chemically treated.

In practice the Law of Consecutive Dilution has been largely upheld. As a minimum a 1.5 to 4 hour turnover has generally become an Industry standard for the operation of commercial pools, which are subject to variable bather loads. High density bathing simply requires higher turnover rates.

Turnover rates should always be considered in conjunction with other relevant factors that are related to total system design. This includes filter design rates (ie. m3/hr/m2), specific bather load, standard pollution (load), rated pollution load, proposed process treatment etc., etc.

Whilst it is beneficial that the Pool Operators to have an understanding of recirculation theory, a working knowledge of all flow and return lines is considered to be mandatory. If there is any doubt relating to the function and/or operation of any control valve, reference should be made to the schematic flow diagram mounted within the plant room.

2.2.3 Control of Bather Loads

The Pool Operator should be extremely conscious that water quality and recovery times are directly related to bather loads. Bather load is often explained using the “Bits of Dirt” concept, whereby it is suggested that bathers will introduce 3 to 300M bacteria (as well as fungi and virus) into swimming pools. It has equally been assessed that each bather leaves 0.5 to 1.5g or organic substances in the form of urine, skin remnants, hair, cosmetics and grease in pool water.

Whilst pool patronage in each pool will vary quite substantially, common sense dictates that bather loads should be properly controlled and managed. By keeping a meaningful Pool Log, the Operator will be able to develop a clear profile on the actual carrying capacity of individual pools. Apart from basic safety issues, over-crowding will result in poor water quality, high maintenance, and high operating costs.

2.2.4 Filtration

The removal of soiled particles by filtration is closely related to the function of disinfection by chemical treatment. However each function has a separate and distinct contribution to make to the healthy environment of the pool. These distinctions must be thoroughly understood, if the Operator is to fully comprehend the treatment of swimming pool water.

Whilst the filter plant is of some value for its capacity to remove bacteria and disease producing organisms, its primary function is to remove solids which if not removed, would increase the need for chemical treatment and reduce the germ killing and oxidising power of the disinfection chemical and/or treatment.

Filters perform their function of dirt removal through various principles, either singularly or in a combination with each other. The most apparent filtration principle is that of a screening process whereby dirt particles are separated from the liquid simply because they are too large to pass through the small openings produced in the filtering medium.

The filtration systems at Darwin City Waterfront are based on the use of UFF filtration for both pools.

2.2.5 Disinfection

While filtration is a relative simple process of physically removing solids, disinfection is a considerably more intricate process. Most commonly disinfection is accomplished by introducing a germ killing chemical to the pool water in sufficient strength to nearly instantaneously destroy bacteria. Regardless of the disinfecting agent used, the primary goal is the same; to provide uniformly distributed disinfection and oxidisation residual of sufficient strength to maintain healthy pool water.

Quite apart from any disinfection process, the oxidising properties of the steriliser also attacks many other foreign materials other than bacteria. Many of these materials, if not destroyed by oxidisation, would impart undesirable characteristics to the water such as turbidity, colour and odour. This chemical destruction plays an important part in the complete filtration and disinfection process.

Residual disinfection at Darwin City Waterfront is obtained by the use of a salt chlorination system for both pools. In addition to this there are back up dry chlorine feeders installed for both pools.

2.2.6 pH Control

pH control is possibly the least understood aspect of pool maintenance and is the most likely of the three controls to be treated carelessly or ignored altogether. The skilled Operator will be as concerned with pH control as he is with disinfection and filtration equipment.

pH is a chemical abbreviation used to describe the presence of the hydrogen ion in water. It is somewhat inaccurate to do so, but pH is more often expressed as a measure of the relative acidity or alkalinity of water. pH is measured on a scale of numbers ranging from 0 to 14. The midpoint of seven is said to be precisely neutral, above which alkalinity becomes progressively greater, and below which acidity becomes progressively greater. Swimming pool water is best maintained slightly alkaline at 7.2 to 7.8.

Problems develop when this range is exceeded on either side. A high pH, for example, can cause precipitation of dissolved minerals such as calcium and iron with resulting discolouration and turbidity.

Low pH can cause serious corrosive damage to metals within the recirculation system. Both high and low pH will cause eye irritation. From a public health point of view, the most serious effect of improper pH is the seriously reduced efficiency of some disinfection process.

Notwithstanding, pH should be strictly controlled so as to prevent, clouding and discolouration, eye irritation and serious corrosion damage.

At Darwin City Waterfront, Sodium Bi-Sulphate (Dry Acid) is used as an acid to control pH in both pools.

2.2.7 Bathing in Warm Water Pools

Whilst the pools are not mechanically heated, the Darwin facility is subject to constant high ambient temperatures. Pool Operators should be extremely conscious that these facilities require very strict management and control. In combination with high dirt concentrations and the close proximity of bathers, the risk of cross infection in warm to hot water is infinitely higher than that of a normal outdoor swimming pool. Bacteria in a warm water pool multiplies more rapidly whilst at the same time, free chlorine is more rapidly lost due to the high water temperatures and the possible aeration of the water.

2.2.8 Pool Safety Precautions

Because of elevated water temperatures, prolonged bathing should be discouraged. Elderly people or people with hypertension and or coronary artery disease should use warm water pools with great care and should never bath alone.

Given the potential liabilities that are associated with immersion in warm water, the following signage is commonly recommended:- -

(a) Pregnant women, elderly persons, and those suffering from heart disease, diabetes, high or low blood pressure should not enter the pools without first seeking medical advice.
(b) Use by children is prohibited without adult supervision.
(c) Do not use the pool whilst under the influence of drugs, medication, or alcohol.
(d) Do not use the pool whilst alone.
(e) Do not use the pool for longer than 1 hour. Long exposure to heated water may result in nausea, dizziness or fainting.
(f) To avoid injury and or discomfort, bathers should treat air nozzles and water jets with great caution (if fitted).
(g) With exposure to water temperatures at higher than 39 deg cel, hyperthermia can occur after thirty minutes of use.

2.3 OPERATIONAL REQUIREMENTS

As demonstrated during the training sessions, the Plant operation is quite straightforward. Apart from the general information outlined in other sections of this Manual**,** the Operator should be aware of the following specific factors that relate to plant operation.

2.3.1 Maintaining a Pool Log

It is essential that exact and meaningful information be strictly maintained. Such information will prove invaluable in evolving ultimate management practices and treatments. Ideally, the Operator should use a Time Management Log that effectively records operating hours; number of bathers per hour; type, consumption and frequency of any chemicals addition; all chemical levels at opening time, at mid-time and at closing time; and temperature throughout the day. If this is a problem, water quality should at least be monitored against admissions. Whilst this may not be representative of the number of bathers actually swimming in the pools, it would at least provide a very basic yardstick to monitor water quality against bather loads. The benefits of being able to anticipate bather loads and make appropriate preparations for peak use are obvious.

Reference should be made to the Northern Territory's Department of Health requirements regarding specific testing requirements and procedures. It is also important to note that:-

A sample section of a log sheet has been provided in this manual in section 8.12. The operators may wish to expand this but the headings provided are the minimum requirements for demonstrating acceptable water balance.

THE MAINTENANCE OF A LOG SHEET IS A VERY IMPORTANT TOOL FOR BOTH THE OPERATOR AND SERVICE PROVIDER. IT ENABLES THE MANUFACTURERS TO CONFIRM THAT GOOD WATER BALANCE HAS BEEN MAINTAINED IN THE CASE OF A WARRANTY CLAIM AND ALSO PROVIDES EVIDENCE THAT WATER HYGIENE HAS BEEN MAINTAINED FOR PATRONS.

2.3.2 Microbiological Testing

As outlined within the National Health's Guidelines, microbiological monitoring should be performed on a weekly basis, progressing to a regular three monthly basis, when it can be demonstrated that all management procedures are a satisfactory means of maintaining acceptable water quality.

Rather than rely on an Authority conduct such tests under the NT Public Health Act, regular microbiological testing should be commissioned by the Pool Operators and or the Owners. This service is available from any number of independent, recognised companies and it should be done at least, every three months. Microbiological Testing provides Pool Management with a clear yardstick that readily quantifies the effectiveness of any routine procedures and/or management practices. During the 12 months Defects Maintenance period, the Pool Operators are required to provide Trisley's with copies of all test results upon request. This information is required to alert Trisley's to any potential problems that could in any way be associated with the operation of the pool water treatment plant.

2.3.3 Dilution with Mains Water

European Standards require that not less than 30 litres of raw water shall be added per bather per day. Although there is no obligation to follow the overseas requirement to dump 30 litres per day per bather, the Pool Operator should be aware that a two minute backwashing of all four filters on the wave pool will consume approximately 40,000 litres of waste water, the same procedure for the Toddlers pool will consume 10,000lt.

2.3.4 Routine Vacuum Cleaning

It is imperative that any or all sedimentation be removed from the pool floor on a daily basis. Failure to remove such materials will significantly interfere with the disinfection process and radically affect water quality and appearance. Appreciating that chemical treatment is primarily designed to oxidise all unwanted matter, vacuum cleaning is best done prior to the commencement of each day's activities. Such a regime will at least address overnight sedimentation.

Please Note Carefully:-

(a) Standard Mobile Vacuum Cleaning Cart are customarily equipped with 240 Volt self priming pumps. Although such systems are normally fitted with earth leakage devices, it is important that Mobile Vacuum Carts of whatever type should NEVER be used whilst bathers are using the pool.

(b) Although automatic Pool Cleaners are available to reduce Operator involvement, most models are designed to work on random patterns, which rely on considerable operation time.

The use of automatic appliances does not necessarily obviate the need for manual vacuum cleaning. Regardless of which method of vacuum cleaning is used, it is imperative that all sedimentation be removed daily. European Standards require that pool walls be thoroughly brushed on a weekly basis and that each year the entire pool be drained and thoroughly scoured with disinfectant. Although very few Australian Centres follow this procedure, consistently high bathing loads could dictate that this procedure be adopted according to need.

2.3.5 Pool Operating Temperatures

It should be noted that temperature affects both the rate of exchange of organic matter from the human body to the water and water chemistry in general. Simply, the higher the temperature, the higher the specific dirt load. Pools should not be operated at higher than intended temperature. Apart from higher temperatures encouraging the growth of organism, other infections may be caused by the bacteria of the bathers own skin being enhanced by long exposure to warm water.

2.3.6 Pool Operator's Typical Duties

Apart from filter backwashing and some aspects in maintaining the water treatment plant (both of which are covered elsewhere in this Manual) the following requirements form part of the normal day to day requirements:-

(a) Vacuum clean pool(s) to remove all oxidised materials. Refer comments in **Section 2.3.4.**

(b) Test Pool Water (follow all instructions within your Test Kit), record test results, and make any adjustments that are necessary to preserve proper water balance.

(c) Check and log water temperatures.

(d) Check display of Indicator Lights on all Control Boards. Any abnormalities are to recorded on the daily maintenance log sheets.

(e) Check contents of all Solution Containers. Levels in each tank are to be recorded on the daily maintenance log sheets.

(f) Monitor all vacuum and pressure gauge readings. Record all pressure readings on the daily maintenance log sheets.

(g) Monitor Cl2 and pH readout(s) on all automatic controllers and compare to physical testing as required in Clause (b) - record and report any major deviations. From time to time it may be necessary to re-calibrate the chemical control probes. This change must be recorded.

(h) Check stock of chemical supply - order as necessary.

(i) Check and clean strainer baskets arranged on the suction side of the major recirculating pumps. Vacuum gauge witness connections are fitted on the pre-pump lint filters to indicate the resistance on the suction side of the pump. Any reading above -15 kPa should be promptly investigated.

(j) Conduct a visual and audible check of all items of plant and equipment. Report any water leaks as soon as they become apparent. Check that all drains and floor wastes are clear and operable.

(k) When doing a filter backwash check the effectiveness of the pump-out system. Effective

filtration is dependant upon regular and effective backwashing. This can only happen if the pump-out systems are maintained in peak operating condition. Details on the backwash pump out system is provided elsewhere in this manual.

(l) Check and clean gutter screens.

2.3.7 Plant Operation

During the training sessions provided by Trisley's Hydraulic Services, considerable effort was made to provide the Pool Operators with the opportunity to acquire "hands-on" experience and confidence in operating and maintaining the installed plant. As has been demonstrated to date, the new plant has the ability to provide exceptional water clarity with minimal reliance upon aggressive pool chemicals.

Plant operation is best outlined within **Section 7.0** where specific step by step Instructions are provided. This section provides procedures for all the major functions that will be required by the operator, cleaning strainers, backwashing, stopping and starting plants etc.

Although the installed plant is designed to be run twenty four hours per day, there are occasions where it is necessary to routinely stop the plant (eg. general maintenance, periodic service, etc.).

When stopping a pump it is necessary to follow the manufacturer's instructions. Incorrect procedures can result in excessive and unnecessary surge and water hammer that could result in considerable damage. The correct procedure to shut down or start up a pump requires that the Operator slowly closes or opens the Isolating Valve found on the pump's discharge after the pump is turned on.

Do not electrically turn-off a pump without first closing the pump's flow control valve. Do not run any pump electrically for more than one minute with the discharge valve closed. This is ample time to start or stop the pump at the Control Board. Failure to observe this requirement, will cause over-heating and possible damage to the pump seals which is not automatically covered by warranty. The filter recirculating pumps are fitted with flow switches that have run down timers set to 20 seconds.

Before re-starting any of the main recirculating pumps, double check that any isolating valves that could have been closed during a servicing operation are truly open. When restarting a recirculating pump, make sure that the Pre-Pump Strainer (which acts as a priming chamber) is fully primed with water.

Start the pump, slowly open the valve on the pump discharge - monitor both vacuum and pressure gauge pressures. Trim the discharge valve to the notch plate setting that was established during the commissioning process. This setting will provide the system's design flow.

The main pool control boards and the chemical dosing systems have electrical interconnections that are designed to fail-safe - ie., if a lack of flow were detected any associated plant that relies on

this flow will automatically shut down.

If a plant shutdown is required, the main recirculating pump(s) should be closed down in accordance with the procedures provided within this Manual. The various interlocks provided within the Pool Control Board, heating & chemical dosing systems will effectively shut down all associated items of equipment.

Individual items of plant can be isolated by turning the “ON” switch found on the Pool Control Board to the “OFF” position. All flow and return pipelines are equipped with isolating valves that should be closed in the event of a shut-down. If the Plant is to be closed down for any length of time, turn off the main isolating switches (incoming power) found adjacent to the Pool Control Board. A major plant shut down within the first twelve months of operation will require the attendance of both a Darwin City Waterfront supervisor and a technician from Trisley’s Hydraulic Services.

In the case of plantroom flooding, there are two systems installed to safeguard the installed equipment.

System 1 – This has been installed by the plumbing contractor and consists of a series of submersible pumps that are triggered by float switches located in the center drain sump. More information on this system will be in the Hydraulic Manual.

System 2 – A pump shut down system has been installed by Trisley’s Hydraulic Services. A float level switch has been installed in the center drain sump. If that switch is triggered, the electrical control board powers down all recirculation pumps & ancillary equipment. The electric actuated suction valves are then automatically closed and then the entire plant is shut down. The rationale is to protect the pumps from operating if they are submerged by water.