

HOW TO INSPECT POOLS AND SPAS

Welcome to Module 4

In this final module, the focus will be on the following topics:

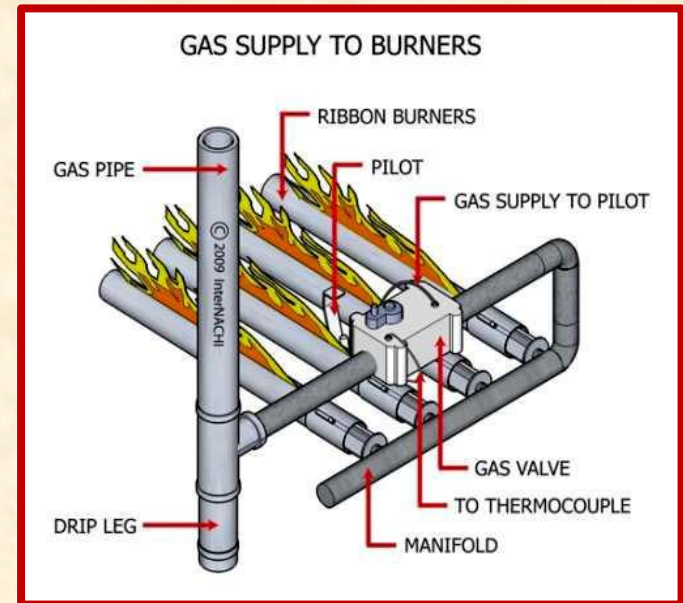
- Pool heaters
- Other components and devices
- Safety barriers
- Water chemistry
- Repairs
- Commercial pools
- Inspection tips
- Maintenance schedule



The value of interactive learning

POOL HEATERS

- Most pool heaters are fueled by either natural gas or propane. Electric heaters are usually used for spas because of the cost of operation, the slow heating and recovery time.
- The heater unit has a high-temperature switch installed on the heat exchanger. This switch keeps the circuit closed while the temperature of the heater is below a certain temperature, typically, 120° F to 150° F.
- Pool heaters need routine inspection and maintenance. The gas burners in particular need regular cleaning.



GAS HEATERS

Ignition Type

Gas heaters can be identified and described by the type of ignition system on the furnace. The different types of ignition systems are:

- *Standing pilot*
- *Intermittent-pilot or direct-spark*
- *Hot-surface ignition*

The older gas furnaces have a standing pilot light that is always burning. Modern furnaces with higher efficiency ratings are slowly replacing these older, conventional gas furnaces.



STANDING-PILOT HEATERS

The standing-pilot is the main distinguishing characteristic of the low-efficiency, conventional gas heater.

Mid-Efficiency

- A mid-efficiency gas heater is equipped with a naturally aspirating gas burner and a pilot light. The pilot light is unlike a standing-pilot.
- It does not run continuously. The pilot light is shut off when the heater is not in operation (as when the thermostat is not calling for heat).



HIGH-EFFICIENCY HEATERS

High-efficiency gas heaters have annual fuel-utilization efficiency or AFUE ratings of 90% and greater. A solid-state control board controls the ignition. There is no continuous pilot light. Condensate is produced when heat is extracted from the flue gases. The temperature of the flue gases is low enough to use a PVC pipe as the vent exhaust pipe. There is no need to vent the exhaust gases up a chimney stack.

There are two different types of high-efficiency furnaces:

- *With an intermittent pilot or direct-spark*
- *With a hot-surface ignition system.*

The production of excessive condensate is the main distinguishing characteristic.

INTERMITTENT PILOT

- When the thermostat on a heater that has an intermittent pilot calls for heat, there is a short ignition period when a high-voltage spark is generated. The spark ignites the pilot.
- If the pilot flame lights, the flame must be confirmed to be lit through a flame-confirmation process.
- If the flame is confirmed, a control module sends a signal to the main gas valve. The valve opens. The gas flows to the burner.
- The pilot flame lights the gas burner. The burners continue to burn until the thermostat is satisfied that it's at a desired temperature.
- The satisfied thermostat signals to stop the ignition process, and shuts off the pilot and burner.



THERMOCOUPLES

- A thermocouple is a device that senses heat. A thermocouple is used in standing-pilot light gas heaters. It determines whether the pilot flame is lit before the main gas valve is opened to supply gas to the burners.
- The flame must be lit before the valve is opened.
- The heat of the pilot flame is converted to electricity by the thermocouple. It turns heat into an electrical current.
- The current is strong enough to open the main gas valve. After being opened, the gas flows to the pilot light.
- If the thermocouple does not detect a pilot flame, it will turn off the gas supply to the pilot. The electrical current from a 24-volt AC transformer operates the main gas valve.



THERMOPILES, SENSORS & REGULATORS

Thermopile

- A thermopile is used in some standing-pilot gas furnaces instead of a thermocouple. A thermopile senses the heat from a pilot-light flame. It is larger than a thermocouple. It operates both the main gas valve and the pilot light. When there is a thermopile, there's no transformer required.

Mercury-Flame Sensor

- A mercury-flame sensor might be used in an electronic ignition system. It consists of a sensor filled with mercury, a capillary tube, and a switch. The burner flame heats up the sensor.

Gas-Pressure Regulator

- The pressure regulator is installed on the main gas valve. It regulates the gas pressure, ensuring a constant gas pressure in the burner manifold. For a propane-gas heating system, the regulator is located between the supply tank and the main gas valve.

SWITCHES, THERMOSTATS & GAS VALVES

Fireman's Switch

- A “fireman’s switch” is a simple on/off switch attached to a timer that shuts off the heater about 20 minutes before the pump.

Thermostats

- There are basically two types of thermostats: mechanical and electronic. The mechanical thermostat has a dial that is set in between a blue and red color-indicator on the dial.
- The mechanical thermostat is set using trial and error. An electronic thermostat uses an electronic sensor that sends signals to a control board.
- Thermostats are set at the factory to prevent the water temperature from exceeding 105° F, but they can be adjusted to higher temperature limits.

Gas Valves

- If the heater is gas-fired, there should be a separate gas shut-off valve installed just before the heater unit no farther than 6 feet from the unit.
- The valve should be installed upstream from the union fitting, connector, or quick-disconnect device it serves. Gas valves must be accessible.
- Check for gas leaks. You can use some special equipment to detect gas leaks, or simply use your nose.

FLUES

- The flue pipe (or vent pipe or vent connector) connects the outlet of the heater to the chimney. The flue pipe should not extend farther than the inner-liner surface of the chimney flue.
- Flue pipes from two appliances should not enter a chimney from opposite sides at the same height. From the point where a flue pipe enters the chimneystack, there should be at least 2 feet of clearance above the chimney cleanout.
- There should be a slope of $\frac{1}{4}$ -inch per linear foot of flue pipe.
- The flue pipe's horizontal run should not exceed 75% of the vertical run. The vent pipe crossovers in an attic should extend at an angle that is at least 60° from the vertical.
- The flue pipe should be at least the same diameter as the outlet of the furnace. The diameter of the flue pipe should never be reduced.



HEATING THE POOL

*It is recommended that the water temperature for a pool be set between 78° F and 82° F, and spas should be no hotter than 104° F. These temperatures may be recommended by your local plumbing code official. Sizing spa heaters is generally based on how fast the spa needs to be heated to the desired temperature during a normal cycle. The table below and in the next slide were adapted from information in *The Ultimate Guide to Pool Maintenance, 3rd Edition* by Terry Tamminen.*

Pool Heater Size			
	10°	20°	30°
200 sq. ft.	21,000 BTUs	42,000 BTUs	63,000 BTUs
400 sq. ft.	42,000 BTUs	84,000 BTUs	126,000 BTUs
600 sq. ft.	63,000 BTUs	126,000 BTUs	189,000 BTUs
800 sq. ft.	84,000 BTUs	168,000 BTUs	252,000 BTUs
1,000 sq. ft.	105,000 BTUs	210,00 BTUs	315,000 BTUs
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HEATING THE SPA

Spa Heater Size (per mins. needed for every 30° temperature rise desired)			
Spa Size	125,00 BTUs	250,000 BTUs	400 BTUs
200 gallons	30 minutes	15 minutes	less than 10 minutes
400 gallons	60 minutes	30 minutes	20 minutes
600 gallons	90 minutes	45 minutes	30 minutes
800 gallons	120 minutes	60 minutes	40 minutes
1,000 gallons	150 minutes	75 minutes	47 minutes

OTHER COMPONENTS & DEVICES

- There are many different types and styles of timers. Hopefully, the instructions will be attached to the timer unit that you are inspecting. If you are not familiar with the timer device, it may be best to leave it alone.
- A time clock is an important part of a pool system. A time clock controls when things turn on and operate during a day, including circulating the water through the filter, heating the water, and turning on lights at night.
- Twist timers are used primarily for spas. The timer can usually go up to 60 minutes.
- Electronic timers are used for many spa and some pool equipment, including electronic thermostats and high-end controls. Electronic timers have backup batteries so that they don't lose their settings, including the time of day.



REMOTE CONTROLS

Typically, 110-volt electrical lines actually activate the equipment, whereas the low-voltage controls use wireless or sophisticated controls to activate certain devices.

There are two types of remote controls. One type uses air; the other uses electronics.

- Air switches (or pneumatic switches) are generally found at the water's edge. There's no danger of electrocution because there are no conductive materials in the switch device.
- Electronic remote controls send signals wirelessly to a receiver that could be more than 1,000 feet away.
- Automatic controls are often complex because they do many things and offer many features to the user.

DIVING BOARDS AND LADDERS

- Check your local building codes to determine the requirements of the pool depth when a diving board is in place. The pool depth needs to be deep and large enough to ensure adequate room for safe diving.
- For small boards, the general rule of thumb is for the pool to be at least 10 feet deep, 15 feet wide, and 30 feet long, but those are very general numbers.
- Check your local codes because a client may look to you for some advice about safety.
- Look for loose connections where the ladder or rail connects to the masonry deck and pool floor. The cups or wedges sometimes come loose. The ladder needs to be sound, safe and able to hold a person's weight.



SAFETY BARRIERS

- An outdoor swimming pool, including an in-ground, above-ground, or on-ground pool, hot tub or spa, should be provided with a barrier that complies with the following standards:
- The top of the barrier should be at least 48 inches above grade, measured on the side of the barrier that faces away from the swimming pool.
- The maximum vertical clearance between grade and the bottom of the barrier should be 4 inches, measured on the side of the barrier that faces away from the swimming pool.
- Where the top of the pool structure is above grade, such as an above-ground pool, the barrier may be at ground level, such as the pool structure, or mounted on top of the pool structure.
- Where the barrier is mounted on top of the pool structure, the maximum vertical clearance between the top of the pool structure and the bottom of the barrier should be 4 inches.

OPENINGS IN THE BARRIER

- Openings in the barrier should not allow the passage of a 4-inch-diameter sphere.
- Where the barrier is composed of horizontal and vertical members, and the distance between the tops of the horizontal members is less than 45 inches, the horizontal members should be located on the swimming pool-side of the fence.
- Spacing between vertical members should not exceed $1\frac{3}{4}$ inches in width. Where there are decorative cutouts, spacing within the cutouts should not exceed $1\frac{3}{4}$ inches in width.
- Where the barrier is composed of horizontal and vertical members, and the distance between the tops of the horizontal members is 45 inches or more, spacing between vertical members should not exceed 4 inches. Where there are decorative cutouts, spacing within the cutouts should not exceed $1\frac{3}{4}$ inches in width.
- The maximum mesh size for chain-link fences should not exceed $1\frac{3}{4}$ inches square, unless the fence is provided with slats fastened at the top or the bottom, which reduce the openings to no more than $1\frac{3}{4}$ inches.
- Where the barrier is composed of diagonal members, such as a lattice fence, the maximum opening formed by the diagonal members should be no more than $1\frac{3}{4}$ inches.

ACCESS GATES

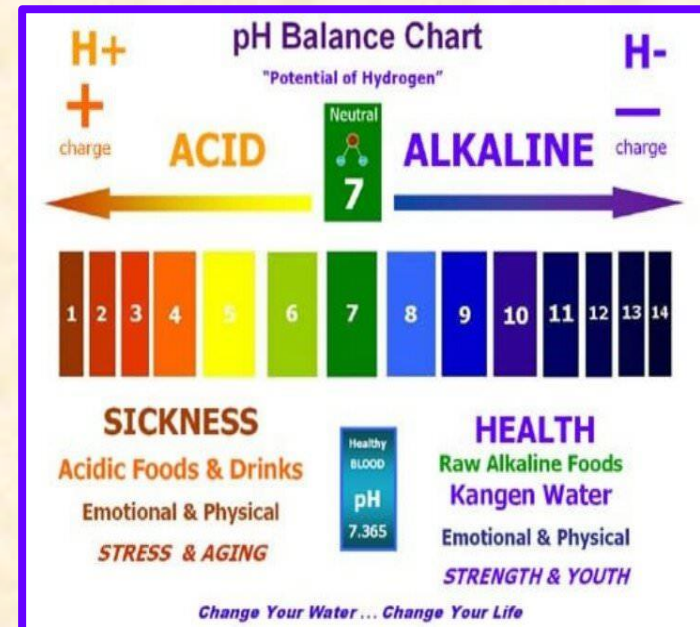
Gates other than pedestrian access gates should have a self-latching device. Where the release mechanism of the self-latching device is located less than 54 inches from the bottom of the gate,

- (a) the release mechanism should be located on the pool-side of the gate at least 3 inches below the top of the gate
- (b) the gate and barrier should have no opening greater than $\frac{1}{2}$ -inch within 18 inches of the release mechanism.



WATER SAFETY

- There are several factors involved in achieving balance. They are: pH; total alkalinity; calcium hardness; temperature; and TDS, or total dissolved solids.
- The pH should be between 7.4 and 7.6. Total alkalinity should be maintained in the range of 80 to 150 ppm. An acceptable level of calcium hardness for a plaster pool is generally considered to be about 250 ppm. The total dissolved solids should be no more than 1,500 ppm for pools and spas.
- The acceptable range for pools is 7.2 to 7.8. In pools and spas, a slightly alkaline pH of 7.4 to 7.6 is most desirable because this range is most comfortable to human eyes, and provides for optimum use of free chlorine while maintaining water that is not corrosive or scale-forming.



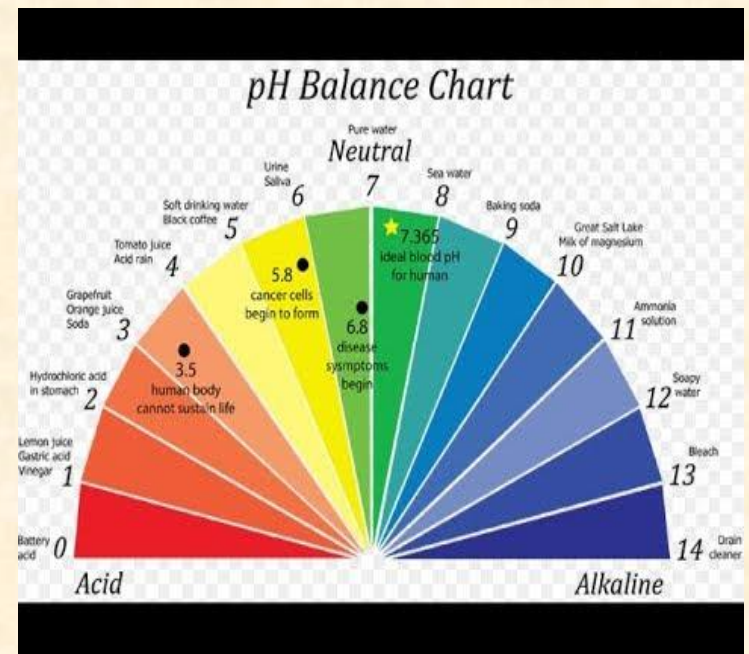
BALANCING pH

- The pH can be raised by adding soda ash or sodium carbonate (Na_2CO_3). Never add more than 2 pounds per 10,000 gallons in a single treatment. Be sure the pump is running when chemicals are added.
- To lower the pH, you need to add acid or acid salts. A common liquid acid used is muriatic acid. Muriatic acid (HCl or hydrochloric acid) or sodium bisulfate (NaHSO_4) lowers the pH. Sulfuric acid (H_2SO_4) is available in some areas.
- Carefully add acid at the deep end of the pool. Try not to pour acid near pool walls or fittings. Remember: When using or diluting acids, add the acid to the water. Never add water to acid.

Factors that Affect pH	
Lowers pH	Raises pH
acid	soda ash
gas chlorine	sodium hypochlorite
trichlor chlorine	calcium hypochlorite
dichlor chlorine	caustic soda
rainwater	bicarbonate of soda
aluminum	swimmer waste
organic litter	algae growth
make-up water	make-up water

ALKALINITY

- Total alkalinity is closely associated with pH. It is the measure of the water's ability to resist changes in pH.
- Total alkalinity should be maintained in the range of 80 to 150 ppm.
- In some cases, soda ash can be used to raise total alkalinity. Pound for pound, soda ash raises alkalinity 60% more than sodium bicarbonate, and it is cheaper than sodium bicarbonate.
- Total alkalinity can be lowered by adding muriatic acid or sodium bisulfate. Acid may be added in doses of up to 1 quart per 10,000 gallons. Total-alkalinity tests can be made and acid can added every two hours.



CALCIUM HARDNESS

- Calcium hardness is a measure of the dissolved calcium salts in the water, or the amount of calcium carbonate (CaCO₃). Total hardness is the sum of calcium and magnesium.
- “Soft” and “hard” water refer to the amount of calcium in the water. Low calcium-hardness levels in spas contribute to foaming. Low calcium hardness in pools causes etching of surfaces.
- An ideal level for calcium hardness is 200 to 400 ppm.
- To raise calcium hardness, calcium chloride (CaCl₂) can be added.
- To lower calcium hardness, anhydrous trisodium phosphate may be used. One pound of trisodium phosphate per 10,000 gallons of water will lower calcium hardness by 11 ppm.

Water Hardness Scale		
Grains/Gal	mg/L & ppm	Classification
Less than 1	Less than 17.1	Soft
1 – 3.5	17.1 - 60	Slightly Hard
3.5 - 7	60 - 120	Moderately Hard
7 - 10	120 - 180	Hard
Over 10	Over 180	Very Hard

Total Dissolved Solids – TDS

- After a pool has been in use for some time, dissolved solids may begin to accumulate. These unfilterable solids include bodily waste, suntan lotion, stabilizers, chlorines, defoamers, algicide, dirt, metal, stain-control chemicals, pollen, etc. TDS is the total weight of all soluble matter in the water.
- Excessively high levels of TDS will cause the water to be “tired” or look dull. Normally, this is less of a problem with outdoor pools because of rainwater and lack of use during winter months.
- Indoor pools sometimes have a buildup of dissolved solids, which requires draining the pool and refilling it with fresh water. Most pools should be drained after three to five years. It is generally recommended that TDS should be under 1,500 ppm.

Testing a Pool

- There are four basic methods used to test pool and spa water: colorimetric, which relies on color matching; titrimetric, which determines the unknown concentration of a chemical by using a concentration of a known re-agent, turbidimetric, which is a measure of how many solids are suspended in the water; and electronic.
- There are many types of tests that can be performed at a pool, but the most common factors to test for are: disinfectant and pH; total alkalinity; calcium hardness; TDS; and many other elements, including nitrates, phosphates and metals.
- The pool industry has developed an index to determine whether the water is balanced in relation to calcium carbonate. The Saturation Index (SI) is a method of finding out whether the water will deposit calcium or maintain it in solution. The SI can be used in testing the water and making adjustments to put the water into a balanced state.

DISINFECTANTS

The most commonly used disinfectant is chlorine. Please refer to the chart below.

Gas Chlorine: 100% Available Chlorine	
Advantages	Disadvantages
cheapest form of chlorine	extremely dangerous
no residue from carriers	special room needed for chlorine
xxx	feed equipment is expensive
xxx	special training and safety equipment are needed
xxx	lowers pH; must constantly add pH increaser

MORE ON CHLORINATION

Free chlorine residual is the amount of chlorine in the pool that has not reacted with substances other than water. It is the chlorine that is available to disinfect pool water and oxidize organic substances. Free chlorine residual should be maintained between 1 and 3 ppm.

Combined chlorine is chlorine in the pool that has reacted with substances other than water and is no longer available in its free state. Some combined chlorines are bactericides, but they contribute little to the disinfection process.

Chlorine combined with ammonia produces chloramines that cause eye irritation and an objectionable chlorine odor. For this reason, combined chlorine residual should be kept to a minimum -- preferably, below 0.2 ppm.

Total chlorine residual is the concentration of free chlorine plus combined chlorine. To determine the combined chlorine residual, test for free chlorine and total chlorine:

Total chlorine minus free chlorine = combined chlorine.

SUPER CHLORINATION & BROMINE

- **Super-chlorination:** In order to prevent buildup of chloramines in the pool, it is necessary to periodically add large amounts of new chlorine in an effort to pass the breakpoint.
- When the combined chlorine residual is not known, super-chlorination is accomplished by adding 10 ppm of new chlorine to the pool. Ordinarily, calcium hypochlorite at a dose of at least 1 pound per 10,000 gallons is used for super-chlorination.
- **Bromine:** The form of bromine most commonly used in pools and spas is the organic chemical bromo-chloro-dimethylhydantoin that contains both bromine and chlorine. It comes in tablet form for use in erosion feeders.



CLEANING ALGAE

- Green algae are very susceptible to chemical treatment, so super-chlorinate with 10 to 20 ppm chlorine in the evening. Keep the filter running, and brush the pool's walls and bottom. Periodically check the chlorine level, and maintain it above 3 ppm until the water clears. Using an algaecide-containing quaternary ammonia the next morning will help prevent the return of green algae.
- Mustard algae are much more resistant to chemical treatment and cling more stubbornly to pool walls than green algae. Adjust the pH and super-chlorinate as similarly done for green algae, then brush diligently. Later, vacuum the pool, check the chlorine level, and super-chlorinate again, if necessary.
- Black algae can usually be controlled with the use of strong algaecides and maintenance with relatively high free-chlorine residual, but complete removal of black algae may require draining and cleaning the pool.



REPAIRS

- Check the pool for plaster cracks, blisters, popped-off areas, and delamination. Some areas can be very small (about the size of a dime) to very big (about the size of a stop sign). These areas can be repaired. If there are damaged areas bigger than that, then re-plastering may be required.
- Sometimes, the rebar inside the concrete will bleed through the concrete and plaster. It will appear as red spots or streaks in the plaster.
- These steel bleeds could occur in the pool floor or walls. It is often the rebar ties that actually cause the problem.
- The ties can be too close to the plaster surface, so the tie will actually wick water toward the rebar.
- Tiles can crack and pop off. Coping tiles and stones can, too.
- A coping stone that is loose or has raised up might be an indication of a significant issue underneath the stone, such as settlement or heaving problems.

INSPECTION TIPS

- There has to be enough water in the pool or spa. Check the level of the water.
- There shouldn't be any water leaks at the plumbing connections or equipment.
- All of the valves should be fully open.
- There shouldn't be any trapped air in the system. Air at the filter tank should be purged routinely.
- The skimmer and main drain should be clear of blockages and debris. Skimmers require cleaning.
- The strainer pot at the pump should be cleaned routinely.
- There might be an imbalance of the water chemistry, causing scaling. Check for scale-causing clogging or restriction of water flow.
- The heater should be on and activated. The gas shut-off valve should be open. The switch should be on. Check for a pilot light, ignition or flame at the fuel-fired heater. Check the level in the propane storage tank.
- The thermostat should be connected, active and set properly.

POOL & SPA INSPECTION LIST

This is an extensive list which can be found at the National Swimming Pool Foundation at: <https://www.nspf.org>



MAINTENANCE SCHEDULE

- Check the water level once a day.
- Check the pH twice a week.
- Check hardness, TDS, and total alkalinity once a month.
- Test for metals once every six months.
- Check the skimmer basket twice a week.
- Check the pump strainer pot once a week.
- Look for leaks every day.
- Vacuum the pool once or twice a week.
- Brush the pool walls and bottom once a week.
- Clean the water line once a week.
- Clean the solar panels once a month.
- Empty and clean the filter every three months.
- Winterize once a year.



END OF MODULE 4

This concludes Module 3. Please proceed to the 10-question quiz. Once you have completed that, you may proceed to Module 4.

