4. Chemicals **18.** Covers **26.** Filters **47.** Heaters
62. Pumps and Motors **84.** Spas **99.** Tools **104.** Vinyl Liners

PSN

POOL AND SPA NEWS

2017 ULTIMATE Tech Manual

www.poolspanews.com

PleatcoPure®
THE CLEAN WATER COMPANY

Pleatco AdvancedSPA™
PREMIUM FILTER CARTRIDGES

PleatcoPureSTART™
DISPOSABLE PRE-FILL SEDIMENT FILTER

100% EXCLUSIVE & UNIQUE!

At Pleatco we strive to bring great new products and technologies to the market that truly provide the cleanest water filtration possible for the health, safety and happiness of every pool and spa owner. We pride ourselves on quality, service and innovation. Pleatco carries over 800 products with rapid shipping and a 100% customer satisfaction guarantee. Today, we are an industry leader, working every day to find new solutions to help you and your customers.

NEW Pleatco
FILTERWASH™
FILTER CARTRIDGE CLEANER

Sold in individually branded Dispenser Boxes - Pre-filled with product
Great for counter or shelf display

Separate Pool / Spa Tablets
Individual formulas for each application

The awesome little cleaning tablet that does the work for you!

Leaders in science and innovation.

PLEATCO.COM

New Beginnings

Cold weather can make it tempting to hibernate. For me, it's the reason I migrated to Los Angeles from the East Coast. But spending more time indoors has its perks. With many pools closed, January can be a time of learning and development in preparation of the next busy season.

As a new member of the editorial team, I join those from the younger generation who are making their way in this industry. The Ultimate Tech Manual is a compilation of dos, don'ts, and how-tos. I've found it to be a valuable resource in helping me understand the many components that go into pool and spa maintenance.

This year, UTM turns 15. To honor the milestone, we've gone digital so information can be at your fingertips wherever a job takes you. We've also reviewed and updated the sections on chemicals and covers.

The manual couldn't exist without the help and input of several knowledgeable industry players. I want to personally thank those industry veterans who have taken the time to speak with me and offer a crash course in the technical components of the profession, as well as what it means to be a service professional.

In the coming years, I look forward to learning along with the next generation and providing content that's helpful to you.

Rena Goldman
rgoldman@hanleywood.com

CONTENTS

CHEMICALS
4 Pool Water Testing
6 Basic Pool Water Tests
9 Reading Water Tests
11 Spa Water Testing
13 Specialty Chemicals Chart
14 Building a Buffer
15 Servicing with Salt

COVERS
18 Servicing Auto Covers
21 Facing the Obstacles

FILTERS
26 Filter Sizing
28 Filter Sizing II
30 Filter Efficiency
31 Filter Installation
33 Troubleshooting
36 Backwash Valve Repair
39 DE Filter Care
42 Cartridge Filter Care
44 Sand Filter Care

HEATERS
47 Options
48 Sizing Techniques
51 Installation Tips
53 Troubleshooting
58 Heat Pump Basics
60 Solar Heater Care

PUMPS & MOTORS
62 Pump Selection
66 Variable Speed Pump Basics
68 Replacing Seals
72 Pump Troubleshooting
73 Common Fixes
75 Motor Troubleshooting
77 Motor Repair
81 Upping Efficiency
83 Electrical Examination

SPAS
84 Electrical Issues
86 Spa Pack Troubleshooting
90 Electronic Control Basics
93 Spa Heater Issues
95 Spa Blower Basics
98 Diagnosing Spa Problems

TOOLS
99 Tool Organization
100 Useful Tools

VINYL LINERS
104 Vinyl Basics
107 Vinyl Repairs
110 Liner Replacement
113 Replacement Alternative

EDITORIAL

JOANNE McCLAIN	Editor-in-Chief jmcclain@hanleywood.com
REBECCA ROBLEDO	Senior Editor rrobledo@hanleywood.com
NATE TRAYLOR	Senior Editor ntraylor@hanleywood.com
DANA ROBINSON	Senior Editor drobinson@hanleywood.com
RENA GOLDMAN	Content Producer rgoldman@hanleywood.com

SALES

RAY GIOVINE	Vice President/Sales rgiovine@hanleywood.com
GARY CARR	Sales Manager gcarr@hanleywood.com
MELISSA SKLENAR	Senior Strategic Account Manager msklenar@hanleywood.com
LISA HEITNER	Strategic Account Manager lheitner@hanleywood.com
PAMELA SINGLETARY	Account Manager psingletary@hanleywood.com
THERESA WONG	Marketing Manager twong@hanleywood.com

ART

AUBREY ALTMANN	Chief Design Director aaltmann@hanleywood.com
TINA TABIBI	Art Director ttabibi@hanleywood.com
RYAN McKEEVER	Graphic Designer rmckeever@hanleywood.com

PRODUCTION

STEPHANIE FISCHER	Production Manager
TERRY RINELLA	Production Coordinator
ANNIE CLARK	Production Coordinator

AUDIENCE DEVELOPMENT

MARY BETH McCOY	Account Manager — Directory

OPERATIONS

LENA RAGUSA	Human Resources Manager

HANLEY WOOD MEDIA

DAVE COLFORD	President
TOM ROUSSEAU	Executive Vice President/Strategic Marketing Services
JENNIFER PEARCE	Senior Vice President/Strategic Marketing Services & Consumer Media
SARAH WELCOME	Senior Vice President/Audience Operations
RICK STRACHAN	President/Contractor Group
RIZWAN ALI	Vice President/Product Development
MARI SKELNIK	Vice President/ Client Operations
CATHY UNDERWOOD	Senior Director/Print Production

PUBLISHED BY HANLEY WOOD

PETER GOLDSTONE	Chief Executive Officer
FRANK ANTON	Vice Chairman
MATTHEW FLYNN	Chief Financial Officer
DAVE COLFORD	President/Media
ANDREW REID	President/Digital
JEANNE MILBRATH	President/Marketing
CHRISTOPHER VEATOR	President/Metrostudy
SHEILA HARRIS	Senior Vice President/Marketing
MICHAEL BENDER	Vice President/Corporate Development & General Counsel
RON KRAFT	Vice President/Business Planning & Analysis
KEITH ROSENBLOOM	Vice President/Corporate Controller

EDITORIAL AND ADVERTISING OFFICES: 6222 Wilshire Blvd., Suite 600, Los Angeles, CA 90048-5100 ▪ (323) 801-4900; SUBSCRIPTION INQUIRIES & BACK-ISSUE ORDERS: (888) 269-8410; fax, (847) 291-4816; e-mail, psn@omeda.com; REPRINTS: Wright's Media, (877) 652-5295; e-mail, hanleywood@wrightsmedia.com
ADVERTISER BILLING QUESTIONS: (202) 729-3522; LIST RENTALS: The Information Refinery, Brian Clotworthy 800.529.9020; email, brian@inforefinery.com; PRIVACY OF MAILING LIST: We rent our subscriber list to reputable companies. If you do not wish to receive promotional materials from other companies, please call us, toll free, at (888) 269-8410. POSTMASTER: Please send address changes to PSN Pool and Spa News, P.O. Box 3494, Northbrook, IL 60065; PSN Pool and Spa News will occasionally write about companies in which its parent organization, Hanley Wood, has an investment interest. When it does, the magazine will fully disclose that relationship.

Pool Water Testing Methods

An explanation of the water tests on the market, and how they work

Some service technicians visit their customers' pools frequently and think they know them so well that they may be tempted to occasionally skip the tests. If they're in a hurry, they might perform fewer tests or take dubious shortcuts.

Big mistake. Experts say such shortcuts lead to long hours solving the problems they create. If you test consistently and interpret the results correctly, the water will remain balanced, and your job will be much easier.

TESTING METHODS

Here's a rundown of the water tests available, and how to complete them accurately.

Titration test: This test utilizes reagents (chemicals) that are dropped into the water sample and cause a change in color. The variable here is not the hue of the color, but rather the number of drops needed to change the color. Each drop correlates to a specific level of the factor being tested. This method typically measures pool water's total alkalinity (TA) and its calcium hardness. The FAS-DPD method, which tests free and combined chlorine, also is a titration test.

Colormetric test: Perhaps the most common type of test, it's designed to measure the amount of sanitizers, such as chlorine or bromine, in the water as well as determine pH levels. Here, reagents are added to a water sample. The resulting color is compared to a chromatic scale known as a color comparator. This scale will indicate the pH or chlorine level of the water.

Test strip: This method also is quite popular with residential pool service techs. The strip is dipped into the water sample, enabling the reagents on the strip to react with chemicals in the water. The reaction will change the color of the pads on the end of the strip. Again, a color comparator quickly shows the level of the factor being tested. Test strips can measure sanitizer, pH, acid and base demand, calcium hardness, cyanuric acid, TA and metals.

Turbidity test: Commonly used to measure CYA levels, this test relies on reagents, too. The reagent reacts with the chemical being tested to create turbidity rather than a color. The relative cloudiness of the water is used to generate a reading.

Electronic test: This is basically a meter with an electrode, designed to read levels of specific chemicals or other pool water factors. It's often used to test sanitizer levels, TDS and, most commonly, pH. The meter must be constantly calibrated and the electrode kept clean to ensure accurate results. It's more expensive than a test kit, but some techs say it saves time and is worth the money.

SOUTHERNWIND POOLS / APSP

A CHECKLIST FOR POOL WATER CARE

Every pool is different. So pool and spa service technicians must have adequate arsenals of water-treatment chemicals in order to respond to any and all water emergencies — and even to conduct routine maintenance.

Here's a checklist of essentials that service professionals say they need for the pools in their charge:

- Algaecides and algae solutions
- Balancers
- Cleaners and enhancers
- Oxidizers
- Sanitizers
- Stain preventers
- Test kits
- Winterizers


PENTAIR
WE'VE GOT YOUR BACK
The products you want, the support you deserve.
Variable Speed Pumps
Filters
Heaters
Colored Lighting
Automation
Sanitizers
Automatic Pool Cleaners
©2016 Pentair Water Pool and Spa, Inc. All rights reserved.
WWW.PENTAIRPOOL.COM

Basic Pool Water Tests

Understanding the basic methods for testing pool water

Service techs can use three methods to measure chlorine residuals in pools:

DPD (diethyl-p-phenylene diamine): This chemical reagent reacts with free, or active, chlorine. Sample water is combined with the DPD reagent in a test vial. Between 1 and 3 ppm (industry-recommended chlorine levels), the sample will turn varying shades of red.

One note of caution when doing DPD tests for chlorine: With high chlorine residuals (10 ppm and up), the reagent will bleach out, and the test actually will resemble low chlorine. At this point, a tech is likely to add even more chemicals to the pool, though the levels are too high already.

If you suspect this is an issue with a pool you're testing, simply dilute the test sample by 50 percent with tap water and re-test. Now, a reading of 3 ppm is actually 6 ppm.

OTO (ortholtolodine): This has fallen out of favor recently due to its inability to distinguish free chlorine from total chlorine, but it still has advocates. To test for total chlorine, add the specified amount of OTO to the sample of water in the test cell. Cap the test cell, and invert it to mix (do not use your finger to cover the top of the test cell). A color change (from light yellow to a deep orange) will result. Compare the color of the test sample to the color comparator provided with the kit.

FAS-DPD: This variation of the traditional DPD method allows users to measure free and combined chlorine levels as low as 0.2 ppm — the maximum allowable level for combined chlorine, according to most health authorities and APSP — and as high as 20 ppm. By contrast, color comparators with the standard DPD test generally allow readings at the low end of 0- and 0.5 ppm and at the high end of 5- or maybe 10 ppm.

In the FAS-DPD titration test, buffered DPD indicator powder is added to a water sample and reacts with chlorine to produce the pink color characteristic of the standard DPD test. Ferrous ammonium sulfate solution (FAS) is added drop by drop until the pink color completely and permanently disappears, signaling the reaction's endpoint.

To get the reading, the number of drops used to cause this color change is multiplied by the appropriate factor for the size of the water sample (supplied by the manufacturer).

The distinct change from bright pink to no color at all eliminates the need for color matching. This means when testing samples with high sanitizer levels, the user doesn't have to distinguish between relatively close gradations of color or worry that any color has been bleached out. It's also helpful to the 6- to 8 percent of the population with red-green deficiencies in their color vision.

The second part of the test determines the amount of combined chlorine present (that is, mono-, di- or trichloramines) by the number of drops needed to again turn the sample from bright pink to colorless.

The cost per test is a little higher and the procedure takes longer than other tests. But many keep it on hand for problem pools

MARLIG INDUSTRIES, INC.
FIX A LEAK
The Only One
Specializing in leak repair since 1980
www.fixaleak.com
FIX A LEAK
For
Swimming Pools
Spas & Hot Tubs
Under The Same Leak Conditions
FIX A LEAK will Outperform the Rest
Pour
les bains tourbillons
bains de vapeur et piscines
SPECIALIZING IN LEAK REPAIR
SINCE 1980
A Product Of
MARLIG INDUSTRIES, INC.
PATENT NO. 1161206
3308 Fairway Road, Niagara Falls, ON L2J 3R6
USA Mailing Address: PO Box 117, Niagara Falls, NY 14304-0117
Tel: 905-374-2560 · Fax: 905-356-6807

or if they are "color challenged." Look for FAS-DPD in combo kits and as a standalone test.

BROMINE

If the pool or spa you're testing uses bromine, you can still test residuals with OTO, DPD, or FAS-DPD. Follow the same procedures you would when measuring chlorine and multiply the results by a factor of 2.25.

CYANURIC ACID

If you're measuring for chlorine residuals, you'll likely be tracking the stabilizer levels too. Industry-recommended levels are between 30 and 50 ppm for cyanuric acid.

To test CYA levels, a reagent called melamine is used. The melamine will cause the water to become more or less cloudy (the aforementioned turbidity test). Low CYA will produce small particles that give the water a hazy appearance. Higher concentrations produce far more particles and turn the water very cloudy. The turbidity is then measured against a comparator chart depicting the relative visibility of a dot in the test vial, thereby indicating the corresponding CYA reading in parts per million.

pH

Because chlorine only works effectively in certain pH ranges (low 7s to low 8s), it's just as important to regularly monitor the water's pH level.

The reagent for testing pH is phenol red — or phenolsulfonephthalein. This is an organic dye that comes in both liquid and tablet form. In a small sample of water, five drops, or one tablet, are added. The resulting colors — yellow (low), red (middle) and purple (high) — will be accurate in a pH range of 6.8 to 8.4.

Two other reagents also are used in pH testing: bromythol blue, with a range of 6.0-7.4, and cresol red, with a range of 7.2-8.8. Phenol red remains the most popular, though, because it closely reflects the pH levels recommended for pools.

Again, be aware that a high sanitizer residual (more than 10 ppm for chlorine, 20 ppm for bromine) can create false pH readings. At these high levels, the sanitizer reacts with the phenol red, resulting in false colors. Many test kits include a special neutralizing reagent that, when added prior to testing, ensures accurate results.

If your tests show that the pH needs to be raised or lowered, another test should be done to determine exactly how much adjuster should be added. To lower pH, perform an acid demand test; to raise it, perform a base demand test.

The number of drops required to cause a color change in the water sample correlates to a chart that prescribes the amount of muriatic acid (to lower pH) or soda ash (to raise it) needed to move the pH.

TOTAL ALKALINITY

Total alkalinity (TA) is the water's ability to neutralize acid, also known as the system's "pH buffer." To test for TA, two reagents are required. First, neutralize the chlorine in the sample; most test kits include a chlorine neutralizer. Then add the end-point indicator — that is, the chemical that changes colors during the test. The second reagent, titrant, is an acid used to trigger the end-point reaction. It's important to perform this test carefully. To properly mix the titrant, the test vial should be gently swirled after each drop is added.

When the titrant is added and just exceeds the water's ability to neutralize it (it's an acid, remember), the end-point indicator will change the water color. The color change happens fast, so pay close attention. Count the number of drops needed to generate an end-point reaction. This determines the concentration of the water's TA.

According to APSP's Basic Pool & Spa Technology Manual, Third Edition, the ideal TA level for pool water is 80- to 120 ppm as calcium carbonate. But the proper range will vary with the type of sanitizer used.

CALCIUM HARDNESS

Testing for calcium hardness is particularly important if you use calcium hypochlorite as the sanitizer, or if the source water is high in calcium. If this is the case, initially test both pool and tap water, then test continually for 30 days. After that, remain current on the water's calcium hardness.

To measure calcium hardness, use a titration method. First, add a special pH buffer to the water sample. This raises the sample's pH to approximately 10, the level at which the test is most accurate. Next, an organic dye is added that turns red when it reacts with calcium. Finally, add the titrant: EDTA, also known as ethylenediamine tetraacetic acid.

Add it one drop at a time. When the titrant has combined with all the calcium, it will turn the water blue. The number of drops required to turn the sample blue correlates to hardness in ppm.

METALS

While regularly testing chlorine and pH makes sense, certain tests, such as those for metal, only need to be performed periodically, or if the tech senses trouble and wants to do a little investigation.

There is always going to be some sort of metal in pool water, but if you think the levels may be high — if you see staining, for instance — performing a few metal tests would be in order.

Copper and iron are the two most likely culprits. Copper can find its way into pools through copper-based algaecides as well as the corrosion of copper heat exchangers and heat sinks. Iron is usually introduced from source water — particularly well water.

If you think there's high metal content (as little as 1 ppm metal can cause staining), it's best to consider a metal kit.

Typically, kits are colorimetric tests that require two or more reagents. Bicinchoninic acid is popular when testing for copper. It produces shades of purple in the water sample when that metal is present. The common reagent for detecting iron is phena-troline, which produces shades of orange and red.

Reading Water Tests

A look at what causes inaccurate water-test readings and how to remedy the problem

Though you think you're using the most accurate water-test kit available, it still may read incorrectly or differently than expected. To save yourself confusion, time and money, you need to understand the test equipment you're using and what causes it to sometimes report false readings.

Here's a look at the top causes of inaccurate readings for liquid kits, test strips and electronic devices.

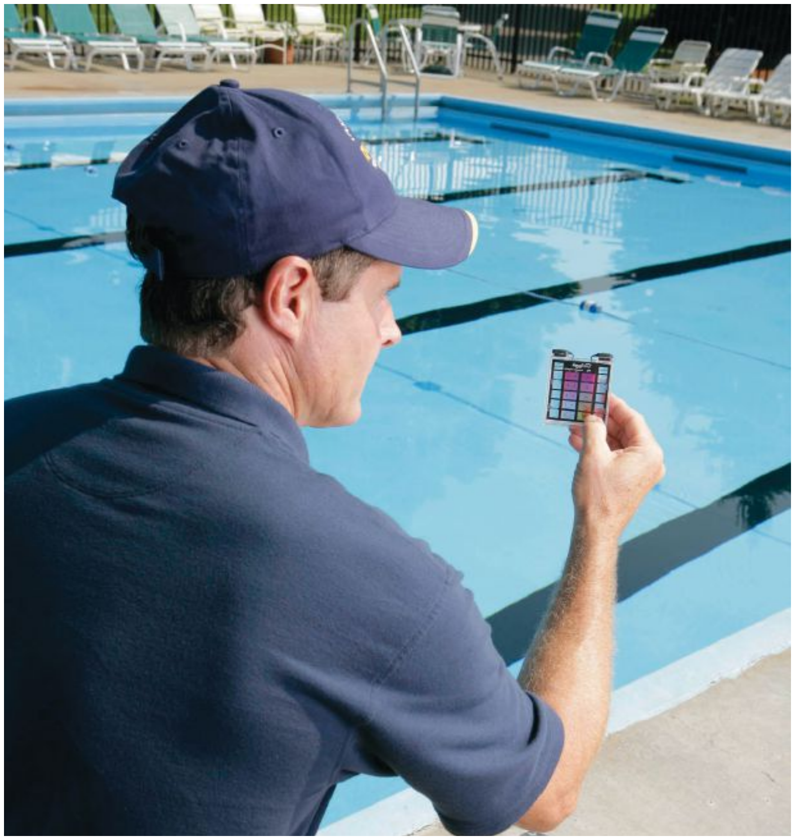


PHOTO: HACH CO.

True or false: Liquid test kits are vulnerable to false readings when combined chlorine is allowed to build up. The key is to see how long it takes the chlorine reaction to appear when the DPD indicator is added.

LIQUID KITS

Most liquid test kits use a chemical indicator called DPD to measure free chlorine. However, high levels of combined chlorine (chloramines) can cause false positives with these kits.

Low to moderate levels of combined chlorine are neutralized in most DPD kits. But combined chlorine occasionally will build up to such a point that it seems to indicate a level of free chlorine is present when, in fact, there may be none.

A strong chloramine odor may confirm that there's a high level of combined chlorine present. Otherwise, pay close attention to the chlorine reaction when adding the DPD indicator (usually DPD No. 2). Free chlorine reacts immediately with DPD to turn pink, while combined chlorine generally takes longer to produce a result. Therefore, if color develops within a few seconds or minutes, you are likely seeing combined chlorine reacting with the DPD indicator.

Elevated sanitizer levels can cause problems for liquid test kits, too. First, high levels of chlorine (greater than 15 ppm) or bromine (greater than 20 ppm) can cause the pH indicator to turn purple, which does not match the pH color scale. This is similar to the high pH colors, 8.0 to 8.4 ppm, so be careful not to mistake it for a high reading and then add acid when it's not necessary.

If chlorine or bromine levels appear to be on the high side and the pH is reading purple, the best thing to do is wait for the sanitizer level to drop and test again. If you're pressed for time, you could add a drop of sodium thiosulfate to neutralize the chlorine. This is a less than ideal practice because thiosulfate solutions have a high pH. Thus, you are increasing the pH of the sample and again getting potentially high results.

Another problem caused by high sanitizer levels is when the DPD indicator is "bleached out." A flash of color occurs when the indicator is added and then quickly becomes colorless. If you see this happening, dilute the sample and retest. For example, you may use half sample water from the pool and half fresh water — ideally, distilled water because it contains no chlorine, and little or no chlorine demand.

You can then run the test again using

the same procedure. This will provide you with a result that is half the actual value, so you will need to multiply it by 2 to get the correct reading. Higher sanitizer levels may require greater dilution to get an accurate reading.

TABLET TEST KITS

Tablet test kits are another method of testing pool and spa water. These kits are similar to liquid kits, and many of the chemical reactions are the same. Therefore, you can expect to get inaccuracies similar to what is reported in the liquid section.

Additionally, you can usually determine if a tablet is unusable by inspecting the tablet before using it. If a tablet appears to be more powder than tablet, or if it is discolored, it usually indicates that the reagent within the tablet has been contaminated and is no longer usable.

TEST STRIPS

Similar to DPD kits, elevated sanitizer levels also can cause problems for test strips. Because test strips and liquids use the same pH indicator — phenol red — high levels of chlorine (greater than 15 ppm) or bromine (greater than 20 ppm) can cause the pH indicator to turn purple, which does not match the pH color scale. This problem tends to be more obvious with test strips, which form a shade of purple that does not closely resemble the high-end color blocks.

Total alkalinity may be affected as well. Like the pH reading, elevated sanitizer levels can cause a color that does not match anything on the scale, in this case, a royal blue. Generally, the royal blue alkalinity accompanies the purple pH, making it easier to determine when this problem is occurring. The best thing to do is wait for the sanitizer to drop to an acceptable level and test again.

Another common issue for test strips is faded or "washed out" results. You can identify this situation when test strips react to form colors that appear to be in the same family as the ones on the chart, but are significantly lighter or less intense. Often, this happens when test strips have been contaminated, generally by heat or humidity.

Test strips should be stored at room temperature. Use dry fingers when handling them to prevent moisture from entering the bottle. Seal the bottle immediately after use.

Note: Most state pool and spa codes for public facilities do not permit the use of test strips as a testing method.

ELECTRONIC DEVICES

Electronic devices don't provide the same kind of indicators as liquid kits and test strips to let you know when you're getting inaccurate readings. When using them, you need to be aware when false readings occur.

There are two things to consider with most electronic devices: First, are they calibrated correctly? Most units require a single-point calibration. This means you have a single solution of a known concentration by which to set your meter, thus ensuring it is reading accurately. Some devices require a multiple-point calibration with two or three solutions. If you're getting questionable readings with your meter, calibrate it to be sure. Some units are factory calibrated and don't require periodic adjustments.

Second, determine if the device and its accessories are clean. For example, test tubes or vials used with a handheld colorimeter might become discolored or faded over time. Recalibrating can help, but it may not prevent this from causing false high and/or low readings.

Faded or discolored vials or tubes should be replaced, especially if the coloration is not uniform across the entire surface. Cleaning the device can help, but be sure to follow manufacturer's recommendations. If not done properly, it can damage the device.

Regardless of which type of water-test kit you're using, you can still rely on a proven method to verify the accuracy of a questionable result. Double-check the readings you're getting against another type of test to confirm that they are in the same general ballpark. If one method tells you the chlorine is low while the other shows that it's acceptable, one of them is not reading accurately.

Author: Joe Sweazy is a national sales manager at AquaChek/Hach Co. in Elkhart, Ind.

Spa Water Testing

How higher temperatures and smaller volumes affect spa water testing

Due to their higher temperatures and smaller volume, spas must be monitored and maintained differently than pools.

The higher temperatures will cause faster chemical reactions and evaporation rates, increased scale formation, more organic waste in the water, and accelerated bacteria growth.

On the other hand, smaller water volume will result in heavier bather loads with precise chemical dosages needed; higher filtration (turnover) rates; faster depletion of sanitizer residual and more abrupt changes in pH.

HIGH WATER TEMPERATURES

Pools usually operate between 76- and 86 degrees Fahrenheit, while spas fall in a range of 96- to 104 degrees. This difference in temperature changes the water chemistry in important ways.

Chemical reactions occur much faster in hot tubs than in pools. For every 18-degree increase, the chemical reactions proceed twice as fast. For example, chemical reactions in a hot tub heated to 102 degrees occur in half the time of a pool heated to 84 degrees. Any chemical adjustments happen more quickly. The water comes to equilibrium sooner, and water treatment can be completed in a shorter period of time.

The water in a hot tub also evaporates at a higher rate due to high water temperature, rapid water circulation and aeration. As the water evaporates, the spa owner adds fill water to refresh the system. Any water that evaporates is pure, leaving behind everything else — the stuff that we call total dissolved solids (TDS). Makeup water also contains minerals, salts and other things that increase the TDS, so adding fresh water increases the TDS level as well. High levels of TDS decrease the effectiveness of some chemicals and may cause cloudy water.

Higher temperatures in spa water will cause most chemicals to dissolve faster than in lower temperatures, except for calcium carbonate. This form of hardness works in the opposite way: It's actually more insoluble in hot water. Therefore, calcium carbonate scale is more likely to occur in hot spa water.

The hot water in spas also makes people sweat. The average bather sweats a pint in just 20 minutes. In addition, the jets in a hot tub can scrub off dirt and dead skin very quickly. All this means that the filter and chemical sanitizer in a spa have to process a high percentage of waste. Consequently, paying close attention to the sanitizer level is critical in a spa.

If not cared for properly, a hot tub creates a perfect incubator for bacteria. Hot water promotes the growth of most types of bacteria.

SMALLER VOLUME

Hot tubs contain a much smaller volume of water than pools. This glaring fact leads to some other differences that may not be as obvious.

For one thing, the bather load is heavier for spas because of its much smaller size. A

SPA WATER-CARE CHECKLIST

Here's a handy checklist of essentials that service pros say they need for the spas in their charge:

- Anti-foaming agents
- Bromine
- Clarifiers
- Filter cleaners and degreasers
- Scalers
- Sodium bisulfate
- Sodium carbonate
- Sodium dichlor-isocyanurate
- Sequestering agents (aka chelating agents)
- Potassium monopersulfate

SPA SERVICE TO-DO LIST

Testing: Test the sanitizer (chlorine or bromine) and pH levels with every visit and adjust accordingly, so that levels fall within industry standards. Also test for total alkalinity, calcium hardness and stabilizer. Once you get consistent results for these variables after several visits, testing can be reduced to once a month.

Shocking: Because spas are often left covered when not in use, the right time to shock depends largely on frequency of operation and bather load — the higher the temperature and the larger the load, the more shocking will be necessary.

Most spa techs agree that at minimum, a spa should be shocked weekly. Ideally, the water should be shocked after each time the spa is used. The choice of a shocking chemical is a matter of preference. Some prefer mono-persulfate, because it destroys wastes but does not cause a large increase in chlorine or bromine levels. Others prefer chlorine, because it adds extra sanitizer; however, the type of chlorine you use is crucial. Sodium dichlor is a popular choice because it dissolves rapidly in warmer water and has a neutral pH. Some stay away from liquid bleach because of concerns that salt and hardness level build up too quickly, and that maintaining pH levels will be a challenge.

Algae control: If regular shock treatments don't reduce the algae presence, veteran service techs recommend increasing the amount of chlorine or adding an algaecide to the water one hour after shocking. Follow product directions carefully because some algaecides, if not used properly, can cause foaming water in spas.

Avoid algaecides that contain ammonia because they can cause foaming, techs say. Remind spa owners that sanitizer and algaecides will take care of the issue, but if a cover is used, algae spores should never get in there in the first place.

Scale and stain control: Most sequestering agents can control metal staining and scaling in spas. If you're worried about the impact such chemicals could have on the spa shell, call the spa maker and ask what's recommended to remove stains.

Foaming: Several things can cause sudsy or foamy water in a spa: algaecides, high TDS levels, soap residue (from clothing or hair) and improper water balance.

The first step is to make sure the spa water is balanced. Take the appropriate tests (pH, TA, calcium) and use the Saturation Index. Make adjustments if the water is unbalanced and see if the foaming subsides.

If using an algaecide, be sure it is of the nonfoaming variety.

Assuming that the water is balanced, the filter is working efficiently, and the bromine levels are at least 3 ppm, you can also try shocking with chlorine at 20 ppm. Chlorine will recharge the combined bromine back into active bromine.

Draining and refilling is another option. If the water is balanced and no algaecide has been used, it could be a matter of increasing draining frequencies. Reexamine the customer's bather load patterns and use the industry formula to determine how often the water should be changed (see sidebar below).

Or, take a preventive approach: In addition to a defoamer, use a clarifying agent on a weekly basis; that should keep the foam down.

To drain or not to drain?

For spa-service techs who want to follow the industry's standard formula to determine when to change spa water, here it is:

Gallons in spa ÷ 3 ÷ average daily bathers = number of days between drainings.

For example, if you have a 500-gallon spa with an average daily bather load of two, the formula would work this way:

500 ÷ 3 = 166.66 / 2 = 83 days

According to the formula, this particular spa's water should be drained and changed approximately every three months.

common load in a hot tub would have one person in 100- to 400 gallons of water. Pools tend to have at least 10 times that amount of water for every swimmer.

Consider this: Two bathers in a 400-gallon spa are roughly equivalent to 150 people in a 30,000-gallon pool.

This significant bather load can decrease the sanitizer levels very quickly. Chemicals need to be measured precisely, and the water needs to be tested weekly. Misjudging the required dosage can drastically alter the chemistry in a small volume of water. For this reason, there are chemicals specifically designed and labeled for treating spas. These lower the risk of adding too much or not enough of a particular chemical.

Spas use up the sanitizer residual very quickly, which is why a higher level of sanitizer needs to be maintained in spa water than in pools. Industry standards reflect this fact, requiring sanitizer levels to be higher in hot tubs.

Lastly, the spa's water volume means that even small additions of sanitizers and other chemicals can have an immediate effect on the pH of the water. If the wrong amount of a chemical is added to a pool, there's a little time before the chemical circulates throughout the entire system. In the case of a spa, that reaction time is lost completely. To avoid equipment damage, the sanitizer should be measured carefully and the pH tested frequently.

Author: Joe Sweazy is a national sales manager at AquaChek/Hach Co. in Elkhart, Ind.

SUNDANCE SPAS

Specialty Chemicals

Product	Why use it	How it works
Algaecide/algaestat	Different products treat various algae types, including yellow/mustard, green, brown or black (actually blue-green). Algaecides kill algae; algaestats proactively inhibit algae growth.	
chelated copper compound	treats all algae types	the copper destroys the algae's ability to consume food by disrupting enzymatic activity in its cells; the chelating agent prevents risk of copper staining
colloidal silver	affects all algae types	works much like copper, starving algae by disrupting its enzymatic processes
quaternary ammonium	effectively treats green algae	similar to polyquats, but work faster due to their smaller size; electrical charge isn't compound (quat) as strong as polyquats; can cause foaming if agitated
polyquat	affects all algae types, but treats green algae best	its strong, positive electrical charge is attracted to algae, suf focating it; nonfoaming; also acts as clarifier; less effective on black and yellow algae
Alternative algae fighters	Treat algae and other water problems; may not have EPA registration for this task.	
anhydrous (aqua) ammonia	treats yellow/mustard algae or large green algae blooms	acts as a chlorine booster to kill algae from inside out
borate compound	treats algae	interferes with algal photosynthesis by disrupting enzymatic activity
Balancers	Help pool water maintain its chemical equilibrium.	
calcium chloride	calcium level too low	increases calcium hardness
carbon dioxide	pH level too high	lowers pH; raises total alkalinity
muriatic acid	pH level too high	reduces pH; lowers alkalinity
sodium bisulfate	total alkalinity level too high	reduces pH; lowers alkalinity
sodium bicarbonate	total alkalinity level too low	increases alkalinity more than pH
sodium carbonate/soda ash	pH level too low	raises pH
Clarifiers	Bind together tiny particles so they can be filtered or vacuumed out, remedying water cloudiness.	
polymer	treats hazy water	polymers have a positive charge that coagulates particles
chitin	treats hazy water	shellfish polymer acts as both a flocculant and chelating agent
Defoamers	React on surface tension of water, reducing foaming caused by organic contaminants.	
Enzymes	Break down oily substances so they accumulate in the filter, rather than on the water's surface	
Flocculants	Coagulate tiny particles, making them large enough to be vacuumed out; considered filter aids.	
aluminum sulfate (alum)	treats hazy water	joins together small particles so they can be vacuumed out
polyaluminum chloride	treats hazy water	coagulates particles
Metal controllers/ stain removers	Neutralize the effect of metals in water, appearing to lift metal stains and remove metal discoloration from water. Chelating agents resolve the problem when it appears; sequestering agents are preventive.	
chelating agent	treats metal-discolored water	forms a bond with metal ions, allowing them to be filtered out
sequestering agent	treats metal-discolored water	holds the metals in solution so they don't precipitate and form stains

Building a Buffer

Bicarbonate alkalinity is often the easiest to maintain; it is the predominant, naturally occurring form of alkalinity in tap water.

However, cyanurate (from cyanuric acid) is also a common buffer in the water. Borate also can be used as a buffer.

Utilizing each type of alkalinity can help steer a pool's pH with increased precision.

Bicarbonate: The least expensive, most convenient path to a steady pH is usually bicarbonate, also called "bicarb." In addition to the naturally occurring bicarbonate alkalinity from water, you can add this kind of alkalinity in the form of sodium bicarb to increase total alkalinity (TA); or, if you're aiming to raise the pH as well, soda ash.

One reason for using bicarbonate is its fast results; it dissolves quickly and provides an immediate buffer. It's also less likely to cloud calcium-rich water than the less expensive, but stronger soda ash.

Bicarbonate is an excellent buffer for mid-range pH levels.

Cyanurate: With its peak pH resistance of 6.8, cyanuric acid allows you to create a higher buffering zone for the pool or spa if necessary.

If enough acid is added to push the pH past the peak cyanurate resistance of 6.8, the pool's bicarbonate alkalinity will still provide additional buffering through its greatest strength zone at 6.2. This means that cyanurates and bicarbonates can work together as a dual buffering system.

Borate: Another alternative to strictly bicarbonate alkalinity is using sodium tetraborate, known as "borax," which can serve as both an algastat and a buffer. Borax has an even higher peak resistance level than cyanurates and bicarbonates.

At normal pH levels, most borax will transform into boric acid. But borax may be ideal for trichlor and gas chlorine pools, whose creation of hydrochloric acid continually drives down the pH and alkalinity. Trying to reduce the pH level for more effective sanitation can be especially difficult in water that's been heavily treated with borax. Still, some techs like having this option, especially with low-pH water that tends to drift toward the 7.0 mark.

Servicing with Salt

Here are some tips to help ensure your salt systems achieve peak performance

Homeowners nationwide are embracing the convenience of salt pools, but these systems still need to be monitored by trained technicians. The most common problem — increased scaling — requires chemical adjustments and old-fashioned elbow grease. In the meantime, a routine check of the salt cell will uncover most other snags. Even less frequent byproducts of salt pools, such as corroded decks and equipment, come with relatively simple solutions. The key lies in knowing what you're up against.

SCALING IN THE ECG

Salt-chlorinated pools are vulnerable to scale formation for two main reasons.

First, in an electrolytic chlorine generator (ECG), electricity is created by a negative electrode called an anode and a positive electrode called a cathode; the chemical reactions around the cathode produce sodium hydroxide (a strong base) as a byproduct of the electrolytic chlorine generation process, and this leads to scaling on the cathode. Second, not all salt added to pools is 100 percent pure. Within the ECG, tiny chemical impurities in the salt can break down into byproducts, such as orthophosphates, which feed algae and can contribute to scaling. Many units come with indicator lights that notify you when it's time to check the salt cell for excessive scaling. To rid the cell of calcium deposits, use a solution that's one part acid and either two- or three parts water. Others may opt for a weaker solution. For heavy calcification, spray the cells with water from a hose, to dislodge any scale or debris. In the most extreme cases, multiple acid washes and an overnight soak may be necessary; but this practice risks damage to the cells, so use it only as a last resort.

WATER BALANCE

Weekly doses of muriatic acid are necessary to keep the water's pH in balance, and to prevent surface scaling. A chelating agent also may help prevent calcium from coming out of solution.

Cloudy water and scaling are signs of high pH and TA levels. If you detect these symptoms, return alkalinity to its proper range of 80- to 120 ppm. Add muriatic acid or sodium bisulfate to lower the TA. The higher the TA levels, the more difficult it becomes to change pH. (pH greatly varies when TA is low.) Once an ideal TA level is reached, consider keeping an artificially low pH level of 7.2 to compensate for a pH rise until your next visit. A regular dose of muriatic acid should keep pH and TA levels in check.

CALCIUM HARDNESS

Ideal calcium hardness levels are between 200-400 ppm. Higher levels mean more calcium is likely leaving the solution, which will increase scaling — especially in the ECG. To lower the calcium levels, dilute the water.

Also, consider adding a chelating agent to combat high hardness. This chemical will bond to the calcium and keep it in solution, adding another layer of protection. However, if the pool is already showing calcium deposits, it's probably time to deploy the brush.

CLEAN WITH CARE

Removing scale or salt residue is often a matter of preference. Some use abrasive media blasting, while others would rather brush with a muriatic acid solution. Either

way, avoid causing damage to any rockwork around the pool. Tile soap can take the paint off of artificial rock, and even real rocks can become discolored with acid. When salt comes out of solution, the safest solution may simply be brushing.

LOW CHLORINE

Though a salt system requires minimal upkeep, remember that it is often your sole source of sanitation on this type of pool, and produces a fixed amount of chlorine per day. If a cell becomes scaled and electrolysis fails to generate adequate chlorine levels, water chemistry suffers. What's more, low chlorine readings could indicate a damaged unit or blown fuse. Thus, regular inspection and cleaning of the salt cell, while relatively simple, are essential for effective maintenance. Still, some types of scaling, such as phosphate scale, are difficult to detect visually. That's why it's important to use an anti-scalant regularly.

CLOGGED CELLS

Provided the pool doesn't show exceedingly high hardness levels, the cell shouldn't require cleaning more than once or twice a year. Consider adding a water softener as a preventive measure against calcification.

LOW SALT

If you don't replace the pool's salt, splash-out or backwashing eventually will lower your salinity levels. If salt levels drop too low, the generator may be unable to produce enough chlorine. Many units will indicate low salt levels, often when salinity dips below 2,500 ppm. When adding salt manually, pour it in the deep end of the pool, and stir it with a brush to speed up the dissolution. Another technique involves dissolving the salt in a 5-gallon bucket of water, then pouring it in as you walk around the pool.

CORROSION

Galvanic corrosion occurs when two dissimilar metals come into contact through an electrolyte solution, namely saltwater. Though rare, it's seen most often with high levels of total dissolved solids. The TDS level found in salt pools typically is three times greater than in vessels using traditional chlorine. Also, make sure any metal equipment can withstand higher salt levels.

HIGH TDS

Acceptable TDS in a traditionally sanitized pool is around 1,500 ppm or lower, depending on the type of fill water and the last time the pool was diluted. By contrast, the water in a salt-chlorinated pool contains 3,000- to 3,500 ppm of dissolved salt, in addition to the usual TDS of calcium and other metals. This combination can take the pool above 5,000 ppm of TDS, which is increasingly fertile territory for conductivity and galvanic corrosion.

As a general rule, dilute the pool water as soon as TDS levels exceed 1,500 over source or fill water. Most salt systems operate at a salinity level of 3,000 ppm, so consider dilution at TDS levels above 4,500 ppm. Fortunately, many salt systems include high-salt indicator lights and self-regulating mechanisms. When the unit detects excessive salinity, it shuts down automatically to avoid damaging the pool.

SALT CHECK

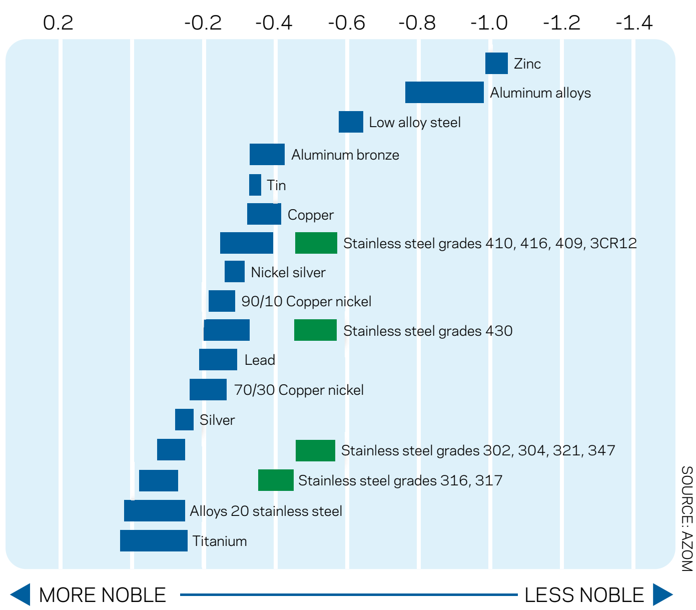
Several systems display salt levels via a digital readout. However, these readings measure salt content by the amount of electrical conductivity of the water, and the water's temperature. As a result, you'll never learn the actual number of chloride ions present. Outside interference can affect the water's conductivity and produce false readings, too. That's why it's encouraged to verify the system's reading with an independent salinity test.

You may also use a test strip, titration test or electronic meter for salt.

COMPATIBLE EQUIPMENT

Some products and equipment, such as aluminum tracks for an automatic pool cover system, perform poorly in high-salt conditions. Certain stainless steel filters also could be at risk because of galvanic corrosion. Check with the manufacturer to ensure each product is compatible with a salt pool.

VOLTAGE IN HIGH-SALT ELECTROLYTE



Mixing metals

Dissimilar metals, when separated by more than 0.2 volts in an electrolytic solution, may be susceptible to galvanic corrosion. The least noble — or corrosion-resistant — of the two metals will experience oxidation and deterioration.

Choose your wingman

THE SERVICE-21™
(includes vehicle mount—not shown)

THE SERVICE-30™
(includes vehicle mount—not shown)

and prepare for takeoff.

The sky's the limit when you choose a portable cleaning unit by Hammer-Head! Our rechargeable 12-volt Hammer-Head system launches your cleaning session instantly. There's no set-up time, no valves to switch, no pumps to prime, and no dangerous power cords or outlets. You can clean a pool even when electrical and water service are unavailable. Swift, silent, and safe, this speed machine can save you as much as 50% in cleaning time per pool. Use the time you'll save to grow your business, *or just give yourself a break!* Hammer-Head pool cleaning units feature interchangeable parts, pressure-sealed motors, debris bags in four different grades, and are made with pride in the U.S.A. *Are you feeling the need for speed?*

Ask your dealer about Hammer-Head or visit us at hammerheadvac.com to find a dealer near you.
866-887-7983 or info@hammerheadvac.com

HAMMER·HEAD®

BEST OF AQUATICS SUPPLIER 2016

Servicing Automatic Covers

How to handle an ailing automatic pool cover

Significant growth in the automatic pool cover market means that you'll likely encounter them more often on the route. Because covers keep dirt and debris out of the pool and allow chlorine residuals to last longer — thereby making your job easier — you'll want to do all you can to keep these service allies in tip-top condition.

Here are some repair tips from experts to help you keep your customers' automatic covers in peak operating condition, and help grow your bottom line as well.

1. COVER WON'T OPEN/CLOSE

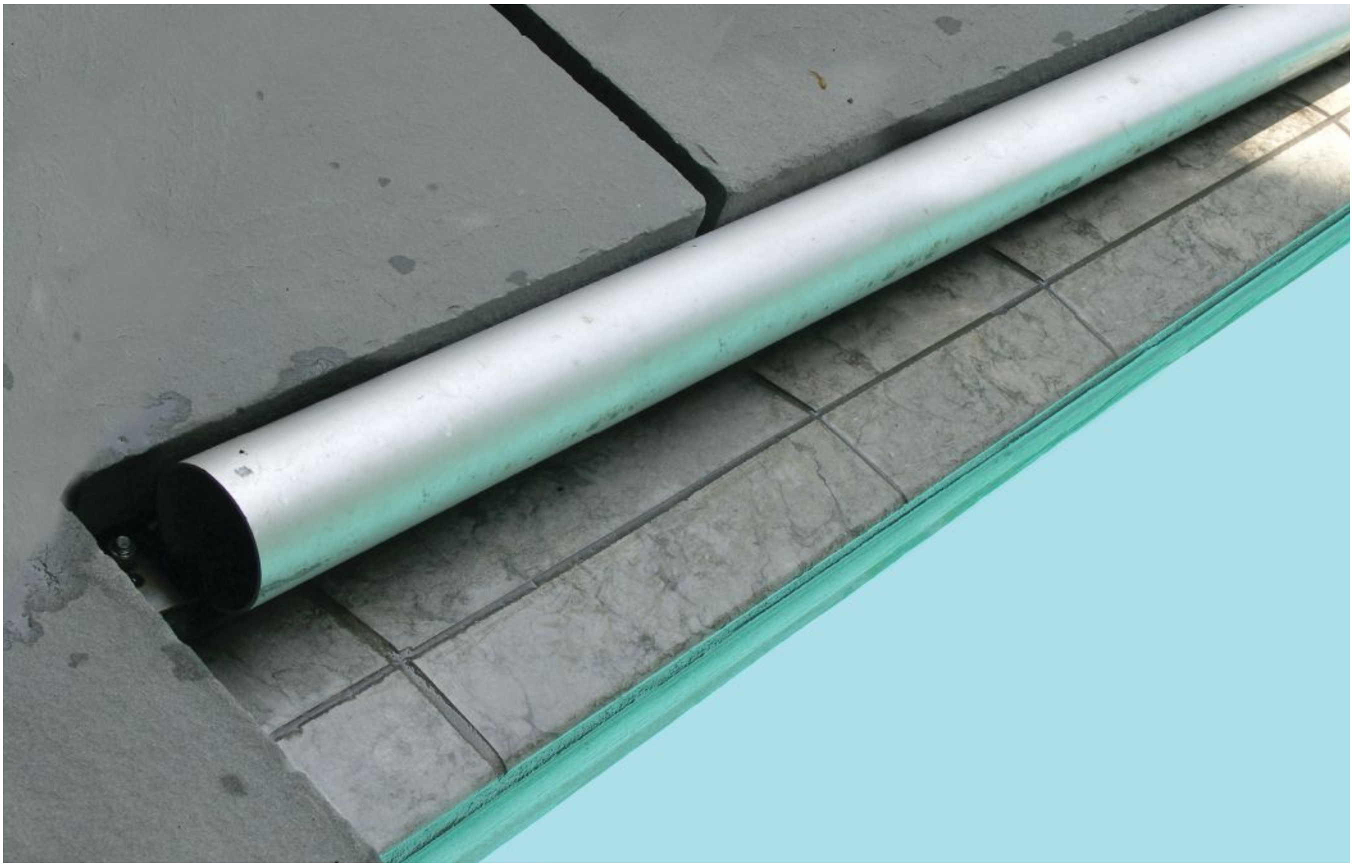
The most common problem with automatic covers is that they won't open or close. When this happens, cover experts say the first thing to check is the motor and all its connections.

Often these issues can be settled over the phone by asking clients a few questions and having them perform a few simple tasks. A common culprit could be a tripped GFCI or breaker. Some of the motors have reset buttons on them that need to be checked as well.

Having customers inspect these while you're on the phone with them could save you a house call and save the client some money. Many times, it's simply a matter of pushing a button.

If the breakers or reset button don't start the motor, techs should make a house call and look over the motor's internal connections.

The first thing to do is disconnect the key switch and then touch its wires together to jump-start it, experts say. If it turns on, then it's getting power.



Next, follow the line up to see if there is a bad wire.

If the key switch doesn't turn on, then it's time to check the amperage with a multimeter to see if power is getting to the motor in the first place. If not, the problem may be with the power lines, and the electric company may need to be notified. However, if power is getting through and the motor still doesn't operate, it's time to replace the motor.

One test that technicians can attempt is to try turning the motor shaft by hand. If you can't turn it by hand, electricity won't be able to turn it either. It may be seized up from water damage, which is typically caused by drain-pit flooding.

Flooding occurs when the owner fails to clean off the cover before opening it, dumping all the debris in the pit and clogging the drains.

More recently, manufacturers have been making submersible motors that won't break down if they get wet. But even that extra precaution can't save every motor from water damage.

Experts recommend letting the motor dry out before attempting to work it again. If it has been dried and still doesn't work, it probably needs to be replaced.

Another possibility for a stubborn automatic cover may be a broken shear pin or, for newer covers, a slipped clutch. Both are used to prevent a cover from putting pressure on the system if it malfunctions. A shear pin is designed to break if the gearing system, which engages the rope reels, has too much pressure as it works back and forth.

It's important to find out what caused the shear pin to break, or it's likely to happen again and again. Sometimes the pin breaks just from normal wear and tear. But a broken pin also is a sign that something else could be problematic. Excess water on the cover, dirt in the tracks and pulleys, or the cover being forced in some way will make a pin snap.

Another cause could be the cover itself. It could just be old and there may not be

Keeping the cover in prime working order


1


2


3


4


5

1. When the rope breaks, the cover's seams must be torn open, and then the rope can be replaced. Good sewing skills come in handy when it's time to sew the rope back into place.

2. It's important to keep the cover's track free of debris or it may cause the cover to deploy improperly. Clean both sides of the track, using a screwdriver to lift it off the deck to expose the bottom groove and then spray with the hose.

3. Keep the box (or recessed pit) free of leaves and other debris. When debris builds up in the box, it can cause all kinds of mischief, from holes in the cover to broken ropes.

4. Keep the mechanism (drive assembly, roll-up tube and motor) well-lubricated. Use marine-grade grease. A small squirt of grease is all that's needed to keep the mechanism shifting properly.

5. Keep the pulleys well-lubricated. However, it's very important to use a Teflon-based spray. Grease-based products such as WD-40 will actually attract dirt and grit, and cause damage.

Ripping and tearing are some of the most common cover problems. This is usually due to unnecessary stress from water weight, or people walking across the surface.

enough slack to operate it anymore due to shrinkage.

A slipped clutch performs a function similar to that of a shear pin. But rather than breaking, it slips and prevents the cover from operating farther. A broken pin or a slipped clutch also can cause a motor to make loud grinding noises.

Sometimes a cover opens in a jerky manner. This may eventually lead to it not working at all. The culprit behind the unsteady movement is dirty tracks. To clear them, take a hose with a high-pressure nozzle and flush the debris from the tracks.

Another reason an automatic cover won't move could be a problem with its pulley and/or ropes. If you discover one of the ropes has broken, repairing it isn't that difficult, especially if you have some basic sewing skills.

To repair a broken rope, remove the cover from the pool. Then, 1 foot from the front edge of the cover, pull out the stitches that hold in the rope. Seam rippers and box cutters work well for this job. Cut off the rope at that point. Insert the new rope and resew the stitches back together.

When the rope isn't the troublemaker, it's often the pulley. The bearings frequently wear out — and bad pulleys can result in broken ropes.

2. OUT OF ALIGNMENT

If the motor, ropes and pulleys seem to be in good working order, alignment may be to blame. Ropes can expand over time. Or they can get tweaked slightly and fall out of alignment.

To fix the problem, techs suggest loosening or applying more brake on the rope wheels depending on the situation, or tying or freeing up a tension spring. This helps adjust the ropes to the wheels, so they pull on both at the same time.

Another reason for a cover "running out of square" is a buildup of dirt and grime in the cover's tracks. To solve this problem, flush the debris from the tracks. Techs recommend that this should be done at least twice a year, especially in areas with high winds or where the landscape is not complete.

If the cover is in good shape and its tracks are clear, the problem may be something more ominous: a bad installation. A slightly misshapen rectangular pool, for example, will cause the cover to operate irregularly.

Techs should recheck all the track measurements; it must be a perfect rectangle. If you don't have one, you can never make the cover run completely straight. In an underdeck system in which the tracks are mounted on a large rectangle, the pool walls need to be similar in size as well.

How can that problem be fixed? The pool itself needs to be corrected. Otherwise, you're trying to make it work in a situation that it's not designed for.

3. TEARS AND HOLES

Ripping and tearing are some of the most common cover problems. This is usually due to unnecessary stress from water weight, or people walking across the surface.

Holes also can be caused by chemical damage. A lower pH level not only bleaches the underside of the cover, but it also can take the elasticity out of the fabric and shorten its life.

If you're going to work on automatic covers — any kind of cover, for that matter — it's important to keep a patch kit on your truck.

While big tears likely mean having to replace the cover, small and modest-sized holes are easily fixed. Smaller rips can be repaired by applying a glue patch. You just clean the surface, put the glue on the cover, some glue on the patch, and push it down.

A couple of other options: Sew the patch on or do a vinyl weld. If the cover fabric is appropriate for a welding repair, it will require a heat gun, handled by a trained technician. The fabric around the tear is heated until it turns to a gel-like substance. A liquid vinyl is applied to the area until the hole is gone. It can then be air-brushed with an opaque pigment to blend in with the original fabric color. Vinyl welds usually are requested by high-end clients or owners of relatively new covers.

4. LACK OF KNOWLEDGE

Educating pool owners about the proper ways to maintain and operate automatic covers is the key to avoiding many problems. Experts advise instructing customers about the dos and don'ts of automatic cover operation after installation. Here's a quick checklist:

- Maintain pool water at a proper level. Low levels may prevent the cover from operating.
- Pump excess water off the cover before opening it. Extra weight may cause a strain or rips in the ropes.
- Clear debris off the pump and out of the drains. Do not flood the drain or motor damage may occur.
- Do not force an automatic cover to open if it won't.
- A cover is not designed to be a walkway from one side of the pool to another. The product is strong enough to withstand the weight in an emergency situation, but extra pressure may cause strain.

Service technicians should check on automatic covers about twice a year. They need to make sure that the systems are running smoothly and properly, the ropes aren't frayed and the pulleys are turning. A drain should be monitored regularly as well.

Installations also should be serviced for strength and durability as they age.

Facing the Obstacles

Experts discuss the art of fitting safety covers over and around high-end features

MERLIN INDUSTRIES

With the intricacy of some pools today, measuring and installing a safety cover can be much more complex than in the past.

Frank Christiana knows this firsthand. He sometimes goes to extreme lengths to measure around, say, the front of a large rock waterfall.

"I have pictures of me hanging upside down on a waterfall, literally heels over head to measure a pool," says the owner of Safety Cover Specialists and Liner Specialists in Holmes, N.Y. "I also have photos of myself in a kayak or hip waders on ice, because sometimes you can't even hang over the waterfall, they're just so large."

Projects with raised walls, waterfeatures, caves or anything above deck level can be tricky. A number of methods must be used to measure and secure the cover.

MEASURING THE COVER

When dealing with obstacles inherent in a complicated pool, you can't just use the simple A-B triangulation method.

For one, you may need more chalk marks around the vessel than normal. Any time the pool's outline changes direction — whether for a beach entry, waterfall or other feature — you'll need one mark on either side of the element, then at least one more in the middle, says Brian Balbo, vice president of sales and marketing at Gorlin Pools and Spas in Lakehurst, N.J. This last mark is skipped by many installers, he adds, but it's crucial to show how far into the pool the item protrudes so the area can be padded properly and the cover attachment can be determined.

For larger, complex or unusually shaped features, even more points may be necessary. When in doubt, add more. Too many markings will never pose a problem, but too few can force the cover manufacturer to guess the exact dimensions. This can result in a cover that doesn't fit.

Measuring complicated pools may also require more stakes. As usual, each mark around the pool must be measured from two places. But when a pool is surrounded by rockwork, planters and the like, professionals must measure in such a way that

Special attention

When you cover a pool that's more complex than the average rectangle, certain features present their own challenges.

1. Islands

For islands, columns or anything else protruding higher than deck level, you'll need to order the cover with a boot cut. This is a hole that accommodates the feature. A slit runs from the boot cut to the edge of the cover, and installers will close this incision with D rings or clips after the cover is in place. The cover is attached to the island using a cable assembly or special hardware provided by the manufacturer.

When measuring the cover, you'll need to plot out points all around the island, which may require additional stakes. It's a good idea to measure from at least two sides of the feature.

2. Planters

If a planter sits directly adjacent to the pool, use extension straps. They stretch up to 8 feet and are adjustable. Simply weave them through the foliage, and anchor into the deck on the other side.

3. Caves

When the pool is closed, caves must be shut off as well. One method of doing this is to run the cover inside the cave and attach it with a cable assembly. Another option is pulling the cover over the cave opening and anchoring it onto the outside surface. This requires installing a cable to hold the bottom part of the cover and an anchoring system above it.

4. Vanishing edges

These features can be handled with a version of the up-and-over method or cable assembly. For up-and-over, drape the cover over the vanishing-edge weir wall, and use it to envelop the catch basin entirely. The cable assembly allows you to hook the cover directly to the back of the vanishing-edge wall. The advantage here is a cleaner, more attractive look. But this system also leaves the catch basin uncovered. Be sure to explain this to the customer.

Measuring for this feature will be different. For the rest of the aquascape, you supply the pool measurements. Then the producer knows how much overlap to add to the cover so that it sits securely on the deck. Because vanishing edges are so unique, you must decide how much overlap you need around it, and tell the manufacturer what size to make the section of cover that goes over the vanishing edge.

5. Paver decks and lawn

On its own, a regular deck anchor can't grab into soil or the soft sand bed underneath pavers. Instead, you'll need to install aluminum tubes into the ground. This product, provided by the manufacturer, goes directly in the lawn or between the pavers. A standard anchor then sinks into the tube and sits flush with its top.

The tubes measure 7/8 inches in diameter, but Frank Christiana likes to use a 1-inch drill bit when creating a hole for them. "With a 7/8-inch hole, if there was just a little piece of stone sticking out, the tube would not go into it," says the owner of Safety Cover Specialists and Liner Specialists in Holmes, N.Y. "So we make it slightly larger to give us enough wiggle room to get the tube down without cutting it and compromising the integrity."

Aluminum tubes go down 18 inches, which may not be deep enough for sand or loose soils. In that case, take a 3-foot-long piece of rebar, pound it into the ground and slide the tube over it, Balbo says.

6. Wood decks

Because wood decks are generally only 2 to 3 inches deep, these surfaces need a special anchor. Called a wood deck anchor, it has a flange around the top, with four to six screws to hold it in place. You'll need two to three drill bits — at least one for the main body of the anchor, then another for the screws.

When ordering the cover, be sure to

let your supplier know the deck is wood. If the project is a combination of wood and another material such as concrete, indicate where the wood begins so the vendor knows what kinds of hardware to provide.

7. Artificial rock

Some artificial rock is hollow, which prevents proper securing of an anchor. If the feature is short enough, use the up-and-over method and anchor it to the deck.

If you need a cable assembly, there are two options for setting the eye bolts or eyelets. The first is to find a place below the rock to install them. "Instead of going into the vertical rock wall, we go down into the deck so the eyelet stands up instead of jutting out toward the cover," Christiana says. The other choice is to set the anchors in the rock using an epoxy.

8. Glass or glazed surfaces

To prevent damage, don't use a regular rotary hammer to drill into deck material with a hard glaze on top. Instead, stick with a rotary masonry bit. If you have to drill into glass tile for the cable assembly, use a glass-cutter drill so the material doesn't shatter.

9. Rock waterfalls

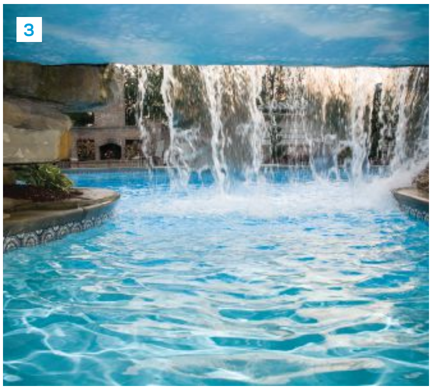
Choosing how to place the cover around a stack of rocks is highly subjective. Be sure to consult with the homeowner to learn their preference. "Sometimes you have to make a choice and ask the homeowner, 'Would you like the cover to be tucked under that large stone, or would you like it over that?'" Christiana says. They may want to leave as much of the rock exposed so they can still enjoy it during winter.

10. Dive rocks

You may decide to tuck the cover underneath a dive rock. If so, be sure to order padding and place it between the rock and the cover. That way, when the cover flaps in the wind, it won't become worn from the surface of the rock.

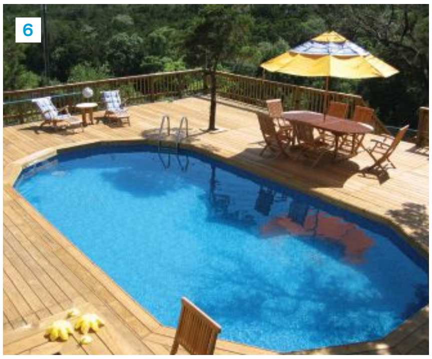

1


2

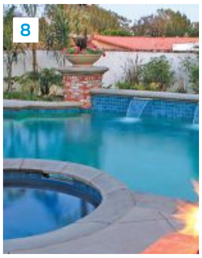

3

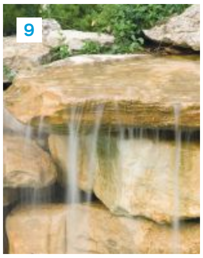

4


5


6


7


8


9


10

the raised elements don't get in the way.

"If you use a tape measure and just go up and over a rock or around a rock, you won't get an accurate measurement of that distance," Balbo says.

You may have to add more stakes in order to run the measuring tape cleanly to every point. "Some pools require an A, B, C, D and E [for] measurements for the backsides of bars, rock formations, slides and waterfalls," Balbo says.

In these cases, you don't need to measure from every stationary point to every chalk mark. Each chalk mark should be measured from two stakes. "So if you look at the points on a piece of paper, normally you just have a column for A and a column for B," Balbo says. "Now you're creating columns C, D and E, if that's what it takes. But column C may only have four points on it; and column D may only have eight."

When measuring, remember that the cover won't just hug the pool perimeter. Instead, the fabric will overlap onto the deck by 12- to 18 inches. Provide measurements for anything within that space.

With measurements complete, you must accurately communicate them to the manufacturer. Take the extra time to fill out a printed form, and provide photos from all angles. This helps verify that you haven't left anything out. "Go out and buy a $100 camera or an iPad," Christiana advises. "If you mess up one $1,500 cover, you'll say, 'I wish I had 15 cameras!'"

Finally, dealing with an elevated spa can trip up a lot of builders. Though it's tempting to only measure to the outside of the raised wall, don't be fooled. Run the measuring tape to the inside of the spa, where the water meets the concrete. Be sure to indicate the locations of all spillways because the manufacturer probably will want to include padding, stitched pads or perimeter padding on that section to help protect the cover from the sharp edge created by the weir.

ATTACHING THE COVER

When ordering a cover, you must decide how to attach it to any raised features that sit on or near the pool wall. A safety cover has to be completely secure, but you can't rely on straps to do the job. Without coping and deck to which they can adhere, you must use a different option. Here are two methods that work in these situations.

Up and over: Here, the cover is extended over the obstacle; regular anchors and straps are attached behind.

While this is the simplest, least expensive solution, there are drawbacks to consider. When installed over a higher surface, the cover forms a sort of ramp, allowing dirt, water, debris, snow and ice to slide down and congregate at the bottom. The extra weight puts stress on the cover at the spot where it's attached to the feature, causing it to wear prematurely even with padding.

For this reason, cover manufacturers put limits on up-and-over installations. Some will go as high as 2 feet, if done in increments; others cap it at 18 inches.

Bob Huss won't elevate a cover more than 12 inches. "We have a lot of wind in our area and, if you make the cover too high, debris can blow underneath," says the owner of Pool Care Specialists in Chadds Ford, Pa. "No matter what you do, you can't keep the cover tight enough to stop debris from blowing under."

Without the right precautions, an up-and-over cover can wear out in a single season. It doesn't lay flat on the deck, so it will rub against the raised corners and surfaces. For this type of installation, use the highest-grade material available, and order padding for those spots where it will rub.

Pro tip: Use remnants of carpet. When closing the pool, the carpet can be laid over raised features, plush side up.

Another problem with elevating the cover is the gaps that are created along the sides of the feature. This makes it possible for children and pets to get inside. It's important to close these spaces with a step-riser kit, wedging triangular-shaped pillows into the open gaps.

"They have little tabs on them to drill the anchors into the deck to hold the pillow into place," Christiana explains. The pillows are filled with pieces of cover scrap that can be added or removed to help fit the space tightly.

Cable assembly: For this system, the cover is clipped to a cable that wraps around the feature. Raised spas or water-feature basins receive a separate cover.

To do a cable assembly, first install a series of lag shields along the pool wall using a special tamping tool. The shields work like a Molly screw in a house wall — several "claws" spread out and firmly grip the wall.

Eye bolts or eyelets (depending on the manufacturer) then are placed inside the lag shields. Some can be removed when it's time to open the pool, while others remain in the wall. When positioning these components, look for grout joints, darker spots or other areas where the hardware will be less conspicuous. This is especially important when the pieces are going to stay put during swim season.

A stainless steel aircraft cable measuring about 1/4-inch thick then goes through the eyelets or eye bolts. The cable will be removed when the pool is opened. The cover attaches to the cable using clips that the manufacturer sews into the fabric.

Unlike the up-and-over method, this assembly is placed deck level so the cover won't envelop the raised features. Instead, it attaches along the front of them, extending 1 foot on either side. "Usually, if there is a 10-foot waterfall, you'll have a 12-foot length of cable," Christiana says. "You'll have a 1-foot overlap, so it's basically like wrapping a string around your belly, where you anchor it by the back of your hips."

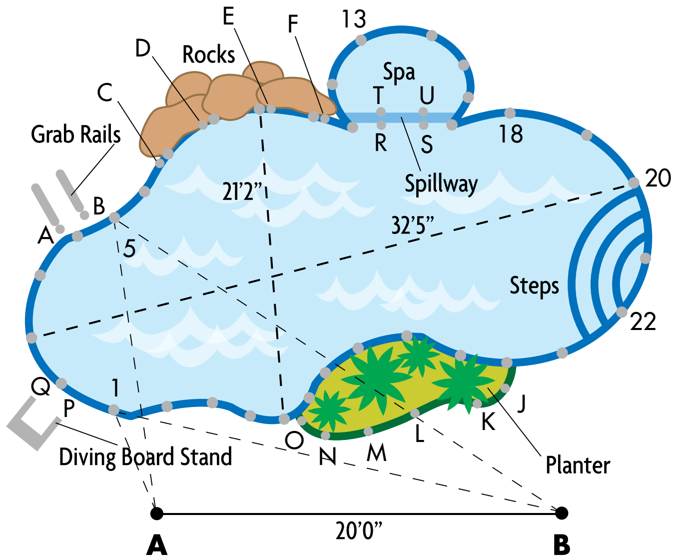
While many professionals like cable systems, some prefer a modification called the direct hookup. This involves setting the same hardware into the waterfeature. But rather than running a cable, you attach the cover clips directly onto the individual eye hooks or eyelets. Some believe that the cover fits more tightly because if it were on a cable, it might sway.

But others think this method doesn't hold up. When snow, water and winds place extra weight on the cover, the additional tugging can pull the hardware out of the wall over time, Balbo says.

The modified system also requires more eye bolts — one for each cover clip. And you can't always choose where to place the anchors. On stacked rock, for instance, they must go in grout joints or parts of the stone strong enough to hold the hardware and soft enough to allow drilling. This makes it more difficult to line up the eye bolts so that the straps stay straight. "If your anchoring point is off a little bit, the strap lines start getting crooked, and it can throw off the 3-foot grid on top of the cover," says Paul Wahler, former manager of Poolservice Co. in Arlington, Va.

The cable assembly method and its direct hookup sibling can be expensive. Extra hardware and exacting measurements mean the cover costs more to produce. Installation takes more time and tools. Even openings and closings get pricier.

"In the time it takes you to do one anchor, you could do half the pool with a normal deck installation," Balbo says.



Measuring the pool

With all its curves and features, this pool requires many measuring points. They are especially close together around the craggy rock fall and planter, to account for all changes in direction. Notice how points around the pool are numbered, while those around special features are lettered.

Filter Sizing

Selecting the best filter for your pool is found in the equations

A good filtration system for a pool or spa depends on your ability to properly size and select the filter.

To accomplish that, you must calculate the vessel's volume, capacity and flow rates, and some other key factors — including the type of pump. After all, the filter fits into the equipment sequence after the pump, so regardless of whether you're replacing an old filter or installing a filter on a brand-new pool or spa, you'll need to match the filter to the pump and the size of the vessel.

Below is a step-by-step guide that explains how to correctly assess filtration needs.

1. CALCULATE THE VOLUME

In order to properly identify the correct filter model it's important to determine how much water has to be filtered. There are smartphone apps that will perform these calculations for you. Otherwise, use these simple formulas when calculating the volume of a swimming pool:

Rectangular pool: length x width x average depth = pool volume

Circular pool: radius x radius x 3.14 (pi) x average depth = pool volume

Oval pool: ½ length x ½ width x 3.14 (pi) x average depth = pool volume

Irregular shapes: For pools that are not truly rectangular, circular or oval, calculate the volume using the following method:

Make a scale drawing of the pool on a piece of square-grid graph paper, with each square representing one square foot. (Note: The drawing can be made to any scale you want as long as you keep it uniform.)

Now count the number of squares. Don't forget to estimate how many complete squares all of the partially filled squares would amount to since that provides a close estimate of the pool's area.

Multiply the area by the approximate average depth of the pool, and you will find the volume in cubic feet.

2. CALCULATE THE CAPACITY

Capacity is defined as the number of gallons of water that the pool will hold (as opposed to volume, which is a spatial measurement).

Capacity formula: Pool volume x 7.48 = pool capacity in gallons

Example: Say you have a rectangular pool that is 40 feet long and 20 feet wide, with an average depth of 5 feet. First you'd need to figure out the pool volume, so simply plug these numbers into the volume equation and multiply: *40 x 20 x 5 = 4,000 cubic feet (pool volume).*

Now plug the volume into the capacity equation and multiply: *4,000 x 7.48 = 29,920 gallons (the pool's capacity).*

3. FIND THE FLOW RATE

The flow rate is the volume of water flowing past a given point during a specific period of time, measured in gallons per minute (gpm) or gallons per hour (gph).

CALIFORNIA POOLS & SPAS IN ARIZONA / APSP

Flow rate formula:

Capacity ÷ turnover time (in hours) = flow rate per hour

Flow rate per hour ÷ 60 = flow rate per minute

Example: Say you want to set up the pool to have an 8-hour turnover rate. The equation to find the flow rate for a 29,920-gallon pool (regardless of its shape) is: *29,920 ÷ 8 = 3,740 gph*.

To calculate the flow rate per minute in this case: *3,740 ÷ 60 = 62.3*. That's the rate at which you'd want the filter to work.

Stating this situation another way; the calculations for your 29,920-gallon pool show that you require a flow rate of 62.3 gpm to filter the pool's capacity in eight hours. Therefore, your goal is to determine which model of filter can handle 62.3 gallons of water per minute — resulting in the desired complete turnover every eight hours.

4.DETERMINE THE FILTER FLOW RATE

Next, determine if the filter you want to use can handle the flow rate you require. The filter flow rate is defined as the amount of water filtered over a given period of time, expressed in gallons per minute.

Filter flow rate formula: *Filter area x filter rate = filter flow rate in gpm*.

The "filter area" is the surface area of the filter medium. It is measured in square feet. The "filter rate" is the number of gallons of water that flows through one square foot of effective filter medium per minute during the operation of the circulation system.

Example: Say you have a filter area of 5 square feet and a filter rate of 12.5 gpm. (These numbers are based on a model of sand filter.) To calculate the filter flow rate: *5 x 12.5 = 62.5 gpm*. That's awfully close to the desired flow rate of 62.3 in the example of Step 3.

Tip: If determining the filter flow rate seems a bit daunting, just get both figures — the filter area and rate — from the manufacturer. With their figures, you'll be better able to select the correct filter to suit your needs.

5. MAKE YOUR FILTER CHOICE

Do you prefer sand, diatomaceous earth or cartridge filters? Pressure or vacuum filters? If you have narrowed your filter choice down to a preferred manufacturer, it will make it even easier to perform your calculations and select a filter that will do the job.

The example we've been using refers to characteristics of a sand filter. It's important to note that both DE and cartridge filters have notably lower filter rates. (Typically, high-rate sand models filter water at a rate of 20 gpm per square foot, DE models work at 2 gpm/sq. ft. and cartridge units at 1 gpm/sq. ft.) Nevertheless, the mathematical relationships between filter area, filter rate and filter flow rate will remain the same.

6. OVERSIZE THE FILTER

That's right. When matched with the proper pump, you can and should oversize the filter. This is because a larger filter area will lower the flow rate per square foot of media, enabling the filter to capture even more debris and thus increase its efficiency.

Filters that are larger than indicated by calculations are particularly necessary for pools with heavy bather loads and for backwashing (because the filter requires additional size for backwashing).

How oversizing works: Referring back to our earlier example, you could either select a model with a larger filter area or a model with an increased filter rate. To allow for debris buildup and backwashing, you might select a model with a filter area of 5 square feet and a filter rate of 20 gpm. That would yield a filter flow rate of 100 gpm — well beyond the desired rate of 62.3. Alternatively, you could choose a filter with 4 square feet of filter area and a filter rate of 25 gpm per square foot.

Note: If you size your sand or DE filter too large, there won't be enough pressure to backwash it clean. So, be sure to maintain the necessary backwash flow.

7. LIMIT THE FILTER RATE AND ADJUST THE FILTER AREA

Filter rates on pools are regulated in many locations. The National Sanitation Foundation sets maximum filter rates to ensure effective filtration because the faster the water passes through the medium, the less effectively it is cleaned.

Filter rate ceilings are imposed most often for commercial facilities. If this is the case where you live, you may have to compensate by selecting a model with a larger filter area. By doing so, you can achieve the same flow rate without exceeding the maximum filter rate.

8. SELECT THE CORRECT FILTER

Taking all the above calculations and factors into consideration, you're now ready to select the proper filter for your particular pool.

AQUATIC SYNERGY / APSP

Filter Sizing II

The key to sizing commercial sand filter systems is all in the details

When selecting the correct sand filtration system for a commercial project, you must pay close attention to every step of the process. Whether the project is a new waterpark or renovation of a smaller commercial pool, certain aspects of the job require a detailed plan of action.

SIZE AND SPACE

Available space plays a key role. The floor plan of a filter room should begin with a layout of the filter footprint. In an existing filter room, you must consider access to the area, with doors and stairways being major factors. With a new facility, construction costs become the main issue.

However, in either case, don't allow space limitations to force you into using an inadequate filtration system.

To begin sizing the filter, you need to determine how many gallons of water are in the pool. For a list of formulas for calculating the volume and capacity of the various pool shapes, turn to the prior article.

In a rectangular pool that's 75 feet long and 45 feet wide with an average depth of 5.6 feet, you would calculate the formula as follows: *75 x 45 x 5.6 x 7.48 = approximately 141,370 gallons.*

THE TURNOVER RATE

Next, establish a turnover rate. This represents the time it takes for all the pool water to circulate through the filtration system. State and local health departments govern this rate, and they can decree that it runs from 30 minutes to eight hours, depending on the type of pool.

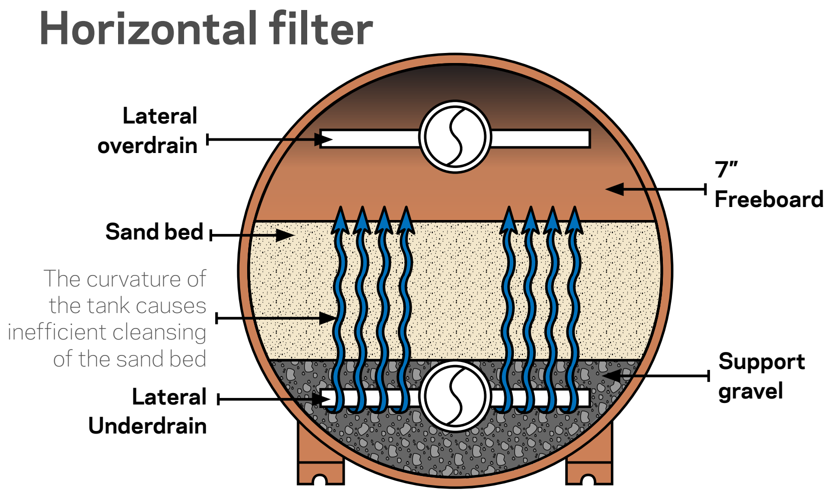
Make careful calculations when it comes to a waterpark pool that has a zero-depth or beach entry. The beach entry may have a different turnover rate (usually two hours) than the rest of the pool. The splashdown area in this type of pool usually has a turnover rate of four hours. For this information, you need to check with your local health department.

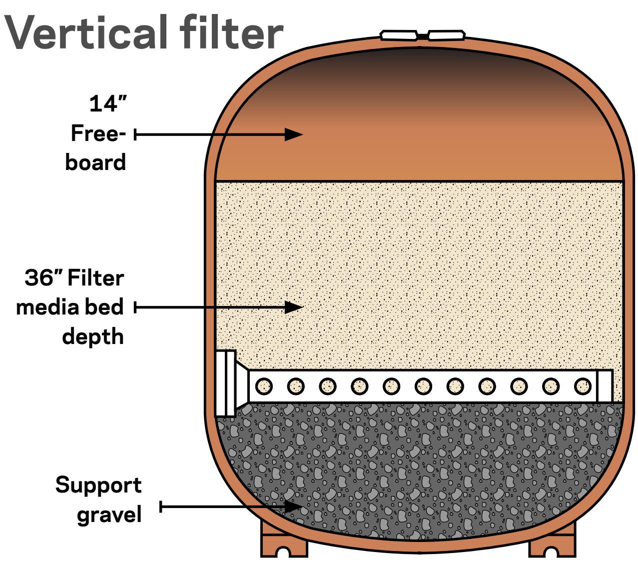
THE FLOW RATE

Turnover rate determines the gallons per minute (or flow rate) for the pool. It will then be used to figure out the final number of square feet of filter area needed.

Local health departments determine the gpm per square foot of filter area. This number is usually 15 gpm per square foot, but can be as high as 20 gpm per square foot.

The lower the gpm per square foot, the less time the end user will spend back-





Deep concern: The ability to trap dirt should be measured by the depth of the sand bed, not just the surface area of the filter. Consequently, a vertical filter becomes a better choice than a horizontal one for most applications.

ILLUSTRATIONS BY TARIQ KAMAL/SOURCE: ASTRAL PRODUCTS washing in the filter room. This saves time, water and chemicals.

The formula for determining "gallons per minute" works out thusly: *number of gallons ÷ turnover rate*. Using the previous example of a 141,370-gallon pool, let's assume the health department has given you a turnover rate of six hours. Because you want to find the flow rate in gpm, you must change the six-hour turnover rate to 360 minutes (6 hours x 60 minutes). Then you must divide the gallons by the numbers of minutes: *141,370 ÷ 360 = 392.7 gpm.*

SIZING THE FILTER

Once you know the gpm flow rate, divide it by the gpm per square foot as determined by your local health department. Using 15 as an example, here's the formula: *392.7 gpm ÷ 15 gpm per square foot = 26.18 square feet of filter area required.* Keep in mind that multiple filters may be used to obtain the proper amount of filtration area.

Now you have the size of the filter based on the square footage needed — not by the turnover rate alone. This is the most important lesson to remember. Don't be afraid to use the gpm per square foot of 13.5. In the long run, you and your customer will benefit.

Remember, the lower the gpm per square foot, the longer the filter cycle you will have before backwashing. Slowing down the gpm per square foot will produce better water quality, too.

DEPTH OF FILTRATION

We have discussed the importance of using a lower gpm per square foot, but you also need to examine something often overlooked in the past few years: depth of filtration. You must choose a filter that reduces your customers' time in the filter room and conserves water by lengthening the cycles.

Equipment makers know the importance of depth of filtration vs. surface or shallow filtration. A deeper sand bed will produce better water quality by allowing a longer contact time with the filter media. It drives the dirt farther into the sand bed, which lengthens the time between backwash cycles and reduces the possibility of channeling.

When choosing a high-rate sand filter, it's important that the ability to trap dirt is measured by the depth of the sand bed, not just the surface area of the filter. Therefore, when considering a filter for your project, a vertical filter becomes a better choice than a horizontal one. Consider horizontals only for renovations or when verticals will not fit due to space limitations.

Author: Tim Warren was formerly vice president of manufacturing and commercial sales at AstralPool, a brand of Fluidra, a filter manufacturer based in Jacksonville, Fla.

Efficiency in Filtration

Choosing the right filter can go a long way toward saving your customers money on their electric bills

When talking about energy efficiency, pumps usually take the main stage, but filters also play an important role in conservation. But before we can discuss why filter selection affects energy consumption, it's important to understand the role of resistance in the system.

RESISTANCE

Water encounters resistance as it moves through the skimmer, fittings, pipe, pump, valves, filter, check valves and heater. The sum of these resistances is measured in feet of head, which is the equivalent column of water that would cause the same resistance.

Consider that 1 psi = 2.31 feet of head. If a filter gauge reads 23 psi, then it can be calculated that 23 X 2.31 = 53.13 feet of head. This means that the resistance to push water through the filter and back to the pool is equivalent to a pump raising a column of water up 53.13 feet, regardless of the size of the column.

The electrical effect of lowering resistance may depend on the pump. Reducing the head or resistance in a system with a variable flow pump (one that varies the speed to maintain a constant flow) will allow the pump to run at a lower speed, which reduces the electricity consumed.

However, reducing the resistance in a system with a standard induction motor pump will cause the pump to move more water and consume more electricity. With an induction motor, you have to reduce the pump's runtime to save money and use a flow meter to ensure the water quality isn't compromised.

In very low head situations, induction motor pumps (which have been traditionally designed for systems that operate in the 40-60 feet of head range) could run at the end of their pump curves (very high flow) and exceed their maximum amperage rating. This is most often seen with waterfeatures where the pump incurs little resistance and eventually overheats.

A good practice when installing a single-speed feature pump is to perform an amp check and add resistance via a valve or other method to reduce flow to keep the pump from overheating.

CARTRIDGE FILTERS

Using a constant flow pump is not the only way to improve efficiency with lower resistance. Different kinds of filters add different amounts of resistance to the system, so selection between cartridge, DE and sand plays an important role.

Cartridge filtration offers the least amount of resistance to flow. In the 30 gpm range, a cartridge filter creates about 0.7 to 2 feet of head. At 60 gpm, a cartridge filter sized for that flow capacity creates 2-5 feet of head.

Also, cartridges conserve water and chemicals by not requiring the backwashing of other types of filters. Another advantage of cartridge filters is that they offer more square footage of filtration area. Some have upwards of 400 square feet of media, as compared with DE filters, which max out in the 100-square-foot range, and sand, which offers between 3 and 7 square feet.

A larger area for the water to pass through means it takes less energy to move the water through it.

Also, the resistance to flow increases at a slower rate because it takes more dirt to reach an accumulation level that reduces flow.

DE AND SAND

Most DE and sand filters add resistance to a system by requiring a backwash valve. However, not all backwash valves are created equal. Multiport valves create much more resistance to flow; in fact, California's Title 24 has banned 1.5-inch multiport valves from use.

Slide valves, also called push-pull valves, add much less resistance than multiport valves because the water passes through them more directly.

Other kinds of backwash valve styles have been designed to add even less resistance to the system by using larger openings for the water.

The reliance of some diatomaceous earth (DE) filters on backwash valves to occasionally remove used DE from the grids is one reason DE filters are not always the most energy efficient. Of course, DE is a great filter media when it comes to fine particle removal.

In terms of resistance, a DE filter without a multiport valve creates around 1.5 to 2 feet of head at 30 gpm; add about 3 feet for a 2-inch multiport and about 7 feet of head for a 1.5-inch valve. At 60 gpm, a DE filter creates about 5-6 feet of head, plus about 12.5 feet for a 2-inch multiport valve, and 18 feet for a 1.5-inch valve.

Some builders choose to install DE filters without multiport valves to reduce resistance, which requires that the DE filter be taken apart to remove the used DE. These filters may present a good alternative for customers who want the polish of DE with the energy efficiency and maintenance ease of cartridge.

Of the three filter designs, sand adds the most resistance to the system. Most

continued on page 46

Pool Filter Installation

A step-by-step guide to installing filtration systems

When it comes to filters, some of the most fundamental considerations can make the biggest differences. Where the unit is located, how neatly it is incorporated into the overall circulation system and how it's tied into the pool's electrical circuitry are all very important. We'll cover all that and more in this basic filter installation guide.

SAFETY FIRST

Safety must be a primary consideration every step of the way. It is particularly crucial for units outfitted with pressure-clamp assemblies, which can fly apart with tremendous force under certain conditions. In fact, flying parts from a "blown" filter often are the source of property damage and the cause of severe, sometimes fatal, injuries.

Clamp assembly: One of the best ways to avoid such mayhem, experts say, is to get the clamp assembly and O-ring seated properly on the tank before pressure testing or starting the circulation system. Filter makers often recommend tightening the clamp to specifications using a torque wrench.

Extra care in placing the assembly around the tank and tightening it is critical. Some manufacturers recommend partially tightening the clamp and then, with a rubber mallet or hammer handle, tapping the assembly into place around the perimeter of the tank.

Improper application of the clamp assembly may result in a poor seal that could cause the filter to separate. Alternatively, the uneven seal might slowly force some tanks out of round over time and create serious problems in future servicing — and further increase the chance of blowout. (Safety tip: Always stand away from the filter while it is filling.) Most filters now have a spring assembly, which aids techs in knowing when the clamp is properly tightened. Open the air bleed valve and let the air out after the pump is turned on to test that the filter is assembled properly. When water emerges from the bleed valve, close the valve.

Electricity: Whenever any repairs are done on a filter or related components, shut off all the pool's electrical circuits at the source. And, if necessary, pull the circuit breakers.

EQUIPMENT PAD READINESS

Next, it's time to get down to the hands-on part of filter installation.

Equipment pad: There are several ways to go here. Prefabricated slabs are popular in some quarters nowadays. But if you go the traditional route, be sure the equipment pad is a flat, level slab of poured concrete, brick or concrete block. Never install a new filter on wood because it can warp or decay beneath the filter's footings and compromise the position of the unit.

Three things to watch: (1) Filters should always be installed on a level surface; if things aren't square, the unit may vibrate or not operate at its optimum. (2) Filters should be located as close to the pool as possible. (3) The filter should have adequate drainage and, in the best of all worlds, should be positioned to provide plenty of room for service access and maintenance.

Plumbing: The plumbing should be designed and installed with the shortest lines and the least number of fittings needed to achieve optimum water-flow efficiency in the circulation system.

If the filter is most conveniently installed away from the pool, however, increasing the pipe size between the filter and the pool will decrease the head resistance and compensate for a longer run.

Inspect the plumbing so you can be prepared with the proper fittings and materials when you arrive. Extra trips to the distributor to pick up unanticipated supplies can drive your job costs way up.

Electrical hookup: Although the filter is not directly connected to electrical power,

the pump motor runs on electricity, which means the filter must be grounded, if metal. Also, the electrical wiring and hookup of the motor must have been completed by a licensed professional in accordance with local and national electric codes.

FILTER SETUP

Now that the pad is ready for the new filter, it's particularly important to refer to the filter manufacturer's installation manual for instruction regarding the specific make and model of the filter you're installing.

Filter placement: Once you've read the manufacturer's manual, place the filter on the pad. Consider bolting the unit to the pad, although it's not necessary.

Filter connection: Connect the filter to the plumbing. Every filter has two basic plumbing connections: the influent and effluent lines. The influent line supplies water to the filter; the effluent line provides an outlet for water after it passes through the filter.

A gate valve should be installed on both the influent and effluent lines of the filter if it is located below the surface of the pool. Some techs opt for a ball valve or diverter valve instead. Standard practice calls for installing a flap check valve (a union flap check valve is preferred) between the pump and filter on all pools with equipment positioned above the pool water. This will permit you to close the lines when it's necessary to service, remove or replace the filter.

The plumbing lines are connected directly to the filter's multiport valve (some models have a push-pull valve) either by hand-tightened union connections or, if appropriate, by bonding with an adhesive such as a PVC cement. It is recommended that Teflon tape or other types of approved sealants be applied to the threads before connecting the pipes.

Be sure the O-rings on all valve fittings are clean, and that each O-ring and O-ring groove is lubricated with silicone lubricant or a nonaggressive/nonpetroleum-based lubricant. Install O-rings in their grooves and tighten with the appropriate union collar.

Before applying any adhesive, be sure all connecting points are clean and dry. Use the recommended primer before applying PVC pipe joint cement.

Allow an appropriate drying period before pressure testing or operating the equipment. Take into account the fact that temperature and humidity may affect the drying time of some adhesives.

STARTING THE CIRCULATION SYSTEM

Once the filter is installed on the pad, all of the plumbing connections are set and the unit is properly grounded, it's time to put the circulation system into full operation. The three main types of filters require different start-up procedures. The following are general guidelines; manufacturers' manuals will give you the specific help you need.

Sand filters: Most sand filters in use today are high-rate models that use No. 20 silica sand. In other models, water typically passes through a number of layers of sand and gravel that have been carefully placed in the tank. Check the specs provided by the filter maker before adding any materials.

The size of the sand particles used as the filter medium is key for optimum efficiency. If the sand granules are too big, filtering efficiency is decreased. Conversely, if the sand particles are too small, the filter will clog up quickly and the sand may pass through the laterals, ending up in the pool.

If you do use the layering method, fill the tank with layers of coarse, medium and fine gravel followed by the silica sand layer on top as directed. The silica sand, commonly used as the top layer, has a diameter between 0.35 and 0.45 millimeters, with a typical uniformity coefficient of 1.4.

Also, plan to leave a space between the sand bed and the overdrain. This space is known as freeboard, and most manufacturers suggest it should amount to half the depth of the filter bed.

Flocculants often are used to improve the performance of sand filters. Most filter "flocs" are alum-based and form a gelatinous layer on the top of the sand. As an alternative, diatomaceous earth can be used: Add ½ cup of DE for each 3 square feet of filter area after the unit has been filled with sand. Experts note that the DE could wind up back in the pool, so it's best not to add it after backwashing.

DE filters: These units filter the water by passing it through a layer of diatomaceous earth, which coats grids inside the filter tank. The DE is added as a precoat to the grids, attaching itself on the grid-covering mesh known as the septa. Common practice calls for adding 2 ounces of DE per square foot of filter area, with a typical variation of a ½ cup either way, depending on the unit's specs.

The DE often is mixed with water and fed into the filter as a "slurry," or suspended mixture. After turning on the circulation system, add the slurry via the skimmer at a rate as steady as possible to permit even coating of the septa. Ideally, the DE will form a uniform "cake" between 1⁄16- and 1⁄8-inch thick.

DE also can be introduced to the filter by using either a precoat pot, a solution feeder or an erosion feeder that is specifically designed for precoating.

Cartridge filters: Setup of cartridge filters is simple. Just insert the filter cartridge per instructions and turn on the circulation system. You can use a flocculating agent for these filters — however, it may require more frequent cleaning of the cartridges.

FINAL STEP

The final step in this process — regardless of filter type — is to open the filtration unit's air release valve and turn on the pump. When a steady stream of water shoots out, close the valve. The system is now working.

Be advised that, in many cases, this step has been rendered unnecessary. Most modern filters have an automatic air relief built into them to prevent any damage on start-up. If that's the kind of unit you're working with, your job is even easier.

A final note: If you're starting up a filter on a new or replastered pool, be sure that the plaster dust is removed or it can cause damage to the elements.

Troubleshooting

A handy guide for service technicians working on pool or spa filters

The call comes in — the pool's filtration system is on the blink. What to do? In this troubleshooting guide, some common symptoms of ailing filters are presented with practical tips on how to bring them back to good health.

Before you dive in, please take note of this general rule: When assessing an operating filter's performance, check the pressure gauge first to make sure it's working properly. Some techs carry an extra gauge, and will test it on the filter to ensure it's working well. Others suggest tapping the face or casing of the gauge firmly to make sure the needle is not sticking. A gauge that fails to indicate a rise in pressure not only compromises your ability to monitor filter cycles, but it also can be hazardous.

Keep in mind as well that many symptoms of a malfunctioning filter system can be brought on by inadequate running time. The first step in troubleshooting is to simply be sure the system is running enough to stay on top of filtering demand.

Finally, it is important to point out that these guidelines are for general information only. You should always consult manufacturer literature for specific recommendations and operating guidelines for each filter model you encounter in the field.

PENTAIR AQUATIC SYSTEMS

Reading up: Always refer to the manufacturer's literature when you troubleshoot filters in the field.

THE POOL CO.

MULTIPORT VALVE TO THE RESCUE

If you're unable to perform immediate repairs on a sand or DE filter equipped with a multiport valve, the following tip may come in handy:

Manual feeding of the sanitizer will maintain clean water for approximately seven to 10 days, depending on bather load and other factors. Experts suggest turning the multiport valve to the "recirculate" position, which will keep the skimmers working as well as the automatic chlorinator, if the pool is equipped with one. The water clarity may suffer a bit — and people may want to avoid swimming at this time — but with sufficient sanitizer, it should not turn cloudy or green for several weeks.

HAYWARD POOL PRODUCTS

Symptom: Reduced flow of water through the filter.

General tips: As dirt accumulates on the filter media, water flow is restricted — and pressure within the tank rises. When the pressure rises to a level specified by the manufacturer, it is time to backwash a sand or DE filter, or to clean the elements in a cartridge filter. The ranges of operating pressures for filters vary, depending on the type.

Gradual pressure rises are normal in the course of any filter cycle. If the rise in pressure is fairly consistent, then normal backwashing will suffice. If pressure begins to rise more rapidly than normal (called short cycling) or if the automatic cleaner stops working, it's time to look at the filtration system.

Sand filters: A typical range for high-rate sand filters, for example, may be 10 to 15 pounds per square inch at the beginning of the filter cycle (that is, the period between routine backwashings or cleanings) on up to 20 to 25 psi when backwashing is required.

DE filters: Some filter systems — mainly DE filters on large commercial installations or large high-rate sand filters — have pressure gauges installed on both the influent (inlet) and effluent (outlet) lines.

As the media become clogged with dirt, the influent pressure will become higher than the effluent reading.

When the differential between readings reaches a specified level, it's time to backwash the filter.

Symptom: Low flow rates in the system.

Proper flow rates: If you get a low reading with a flowmeter, but a high reading on the pressure gauge, something is restricting the flow. It could be one of several issues: a plugged filter, closed jets in the pool, or an issue with the heater. In rare cases, this problem is caused by plugged piping or a broken piece of equipment lodged upstream of the filter.

Low flow rates and low pressure could be a restriction or air leak in the suction piping or problems with the pump.

Generally, the maximum flow rate through a 1½-inch PVC pipe is 55 to 60 gallons per minute. Through 2-inch plumbing, it should be 95 to 100 gpm. These figures are based on a standard hydraulic specification of an 8-feet-per-second maximum velocity, although many prefer 6-feet-per-second or less through the suction line.

Clogged baskets: A drop in the return flow may be traced to a clogged pump strainer or skimmer basket, so clean the baskets. Clogged impeller vanes also will reduce the return flow; disassemble the pump and clean the impeller.

Pump: If both flow and pressure readings are low, the pump may be undersized — or you may have a plugged pump impeller or lint trap. Pump or motor trouble can lead directly to filtration problems, so keep that in mind as you troubleshoot the system.

Symptom: Inadequate filtering action.

Cartridge filters: Poor filtration without a rise in pressure may indicate torn or worn-out cartridges that are allowing water to pass through without filtering. Replace cartridges as needed.

Sand filters: Charging: In a sand filter, if the media have been charged improperly or inadequately, channels may have formed in the sand and gravel bed and may be allowing water to pass through unfiltered. Look for evidence of channeling or tunneling — and recharge the filter, if necessary.

Mudballs: If the unit has not been backwashed thoroughly, mudballs may have formed on the surface of the sand bed, thereby limiting filtering action. Or, in extreme cases, the sand may have calcified and will no longer filter out dirt. Look for mudballs or evidence of calcification and, if found, backwash or remove the old sand and recharge the filter as necessary. With proper maintenance, filter sand normally has to be replaced every four to five years, though it may last longer.

DE filters: Coagulation: Poor filtration from these units often results from coagulation or solidification of the DE. If you see hardening of the DE cake, remove and clean the elements per the manufacturer's instructions and recharge the filter with fresh DE.

DE introduction rate: If DE is fed to the unit by slurry feeder, the unit may not be feeding enough DE into the filter to adequately coat the septa. Conversely, an inconsistent filter cake may result from feeding DE too quickly into a skimmer when recharging the system. The trick here is to watch DE introduction rates and adjust them as needed.

Coating the filter: If you have an oversized DE filter or an under-rated pump, there may be inadequate pressure within the filter to properly coat the septa. Here, you need to check the manufacturer specs and replace equipment as needed.

Sand and DE filters: Backwashing: If backwashing isn't performed frequently enough or for adequate periods when it is performed, the media will not be cleaned sufficiently. It always pays in these cases to follow manufacturer specs — and to avoid shortcuts that may turn into headaches later on.

Backwash lines: Watch out for inadequate or plugged backwash lines that might not be allowing sufficient flow out of the filter during backwashing. Although rare, if a portion of the backwash discharge is retained in the tank because of inadequate flow, the backwash line will clog over time with caked media. To address this, check the lines for clogs and clear as necessary.

Symptom: Short cycle between backwashes.

General tips: Flow rate: Most often, short filter cycles indicate excessive flow rate through the filter. This indicates that the filter may be undersized or that the pump may be too powerful for the system. If you're comfortable with filter-sizing equations, do a quick check of the numbers to be sure equipment is sized correctly. A manufacturer's technical representative should be able to help. Once that's all fine, install a properly sized system.

Contaminants: In other cases, short filter cycles suggest large amounts of dirt, debris, body oil, lotions, hair or algae. Very high bather loads (or pet usage or excessive fertilizing of plants and lawns) lead to overworked filters. Discuss your observations with the pool owner to see if changes in routines are necessary. Backwash the filter as needed.

DE filters: Clogging of the vertical grids in a DE filter — whether by rust, calcium buildup or soda ash — may increase the pressure and compromise effective filtration. If you suspect this problem, clean the filter elements and check for clogging of the fine nylon mesh covering the septa. Treating the septa to a light acid wash and hosing with a strong stream of water will usually relieve the problem.

Sand and DE filters: With sand filters, and DE filters to a lesser extent, you can get into trouble when soda ash or coagulants are fed into the skimmer too fast.

In these caes, some chemicals do not have sufficient opportunity to dissolve. Rather than passing through the bed in solution, the chemicals clog the media and raise the pressure. The key is to introduce these agents more slowly, or dissolve them before introducing them to the skimmer.

Note: Alum should never be used with a DE filter. It will only solidify the filter cake.

Symptom: Sand or DE is entering the pool.

Sand and DE filters: One suspect with sand- or DE-clouded water is the push-pull valve. If it is left in an intermediate position, media can flow back into the pool. If this obvious answer doesn't suffice, you'll need to look for solutions inside the tank.

Sand filters: Broken laterals or undersized sand that is smaller than the manufacturer's recommendation are common culprits here. Replacement of components and/or the sand itself is recommended.

DE filters: The first suspect is torn or worn-out septa, which will allow DE to flow into the pool. The nylon mesh on the septa can be repaired, depending on how large a hole or tear is present. And think small: A hole the size of a pencil lead will allow DE to escape.

Tip: Always check the points where the mesh is sewn to the frame of the grid. Even slight unraveling will allow DE to enter the pool.

DE may be migrating back to the main drain or skimmer when the pump shuts off. Excessive flow rate through the filter also can force sand or DE into the pool. Again, filter and pump sizing should be checked. A damaged internal airbleed also will allow DE back into the pool.

Make sure there is a check valve between the filter and the pump if you open up the DE filter. DE will flow back through the pump into the pool through the skimmer.

Symptom: There's a build-up of air.

General tips: Firstly, air present in the filter tank can compromise filtering action. In sand filters, it's a prime suspect in channeling. In DE units, it may disrupt the filter cake.

More importantly, however, air pressure buildup in a filter can be hazardous. Anyone who has seen a filter fracture knows the potential for damage and possible injury.

Air in the filter tank: If there's a problem with air in the tank, check for hairline cracks or leaks in plumbing connections on the suction side of the pump. A low water level in the pool is another suspect: Air may enter through the skimmer.

Releasing the air: It's always important to release any air present in the filter tank. (Note: Many filters are equipped with automatic venting devices.) Not only will the presence of air inhibit good filtration, it also can increase the hazardous pressure.

Air is easily released by opening the pressure release valve and allowing the air to escape. When a steady stream of water comes out of the valve, then all of the trapped air has been released.

Pool & Spa News thanks Hayward Pool Products for its assistance in preparing this guide.

Backwash Valve Repair

Use this guide when working with backwash valves on sand and DE filters

Few things can frustrate a technician more than getting ready to conduct routine pool or spa service only to encounter a broken, leaky or jammed backwash valve.

When operating properly, the backwash valve keeps water flowing through the filter in the right direction. However, O-rings and seals inside the valve body wear out, leading to a drip, or even a small stream of water running out of the backwash line.

A backwash valve leak can mean a dirty pool, or much worse. Water loss that drains the pool can, over time, run the pump dry, risking burned-up seals and other costly repairs. And if it is an open backwash line, when the pump turns off for the day, water can drain out of the filter, draw air into the line and reverse the flow direction, leading water to run back into the pool and bring dirt and even DE with it.

Fortunately, fixing a backwash valve isn't all that technical. A variety of valves have been designed for backwash functions, but the repair task is made somewhat easier by the fact that there are only three basic types of backwash valves: rotor, push-pull and multiport.

BEFORE YOU START

For guidance in backwash valve repair, start with this step-by-step pictorial. Before beginning, take some precautionary steps:

On multifilter installations, isolate the filter in question using other valves available in the system.

Open the air-relief valve while the pump is running to release the pressure in the filter tank and eliminate the potential for serious injury.

Buy only correct replacement parts. For more information about the valve, consult manufacturer guides or a representative.

Push-pull valves

1. The most common type of backwash valves in use — push-pull valves — have been around for years. They can be found on sand and DE filters, and a number of manufacturers offer them.
For most DE models, the valve is down for filter and up for backwash. On most sand varieties, it's the opposite: up for filter and down for backwash. Most manufacturers have changed their push-pull valves from brass to plastic (PVC and ABS) — O-rings for an old brass valve may not fit the new plastic valves — but the basic repair procedures for these valves has stayed about the same.

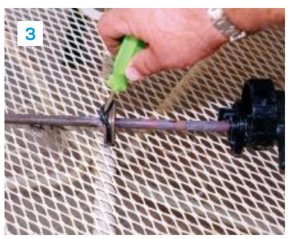
The stem of the push-pull valve has four O-rings on it. The two piston O-rings keep the water flowing in the right direction. The cap O-ring and stem O-ring keep water from leaking out from under the cap and around the stem. All four should be replaced when rebuilding. As the valve gets old, it can be difficult to remove the cap by hand. When this happens, a strap wrench or tongue-and-groove pliers, gently applied, may be the only way to open the valve.

2. Pull the stem out of the valve body.

3. Use a small-blade screwdriver or an O-ring pick to remove the O-rings from the stem. If the stem is metal, use a small piece of sanding cloth to clean the groove before rolling a new O-ring into place. Clean the top of the stem to help it slide more easily.

4. Apply a layer of lube to the O-rings and put the stem back into the backwash body.

5. When reassembling the valve, always follow the manufacturer's instructions and "hand tighten only."



Multiport valves

The multiport valve, so named because it can perform several tasks in addition to filtering and backwashing, has a drain for removing excess water, a bypass port for waterfeatures, and other options, depending on the manufacturer.

1. Use a screwdriver to remove the machine screws around the cover of the backwash valve. There is a nut (and sometimes a washer) underneath. Be careful not to drop them — they're easily lost.

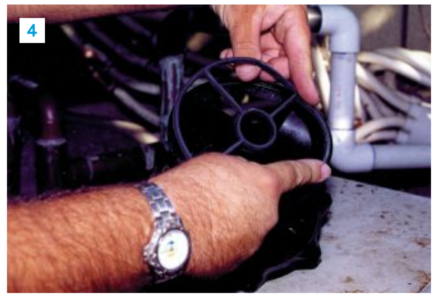
2. Remove the cover of the multiport valve.

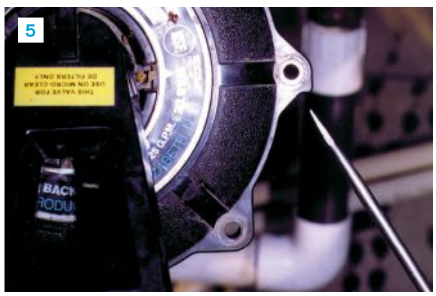
3. Use a small blade screwdriver or O-ring pick to remove the valve seat gasket. There also will be an O-ring under the cover. To ensure against leaks, remove and replace this O-ring. Note: When the valve seal gasket is on the key assembly or diverter, the two often must be purchased together (the gasket is installed on the key in the plant).

4. Clean debris from the grooves with a screwdriver, run beads of adhesive into the grooves and then set the new gasket in place. Apply a layer of lube on the gasket and the O-ring before placing them back in the valve body.

5. The valve cover and body have alignment indicators (a square edge indicated by the screwdriver) to ensure that the cover is replaced in the proper position.

6. Tighten the valve cover back down with a screwdriver on the top and an open-end wrench (usually 7/16 inch) underneath to hold the nut. If you use a cordless screwdriver, use slow speed or a low torque setting so you don't overtighten and damage the valve cover.

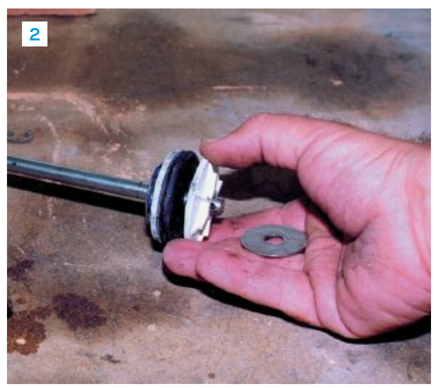




Old-style push-pull valves

1. Even though no longer manufactured, old-style valves can still be found on many swimming pools. They work basically the same way, but have more parts and use gaskets or washers instead of today's O-rings.

2. Older backwash valve stems were not a single molded part. They were one piece of stainless steel with a metal washer, retaining washer and E-clips to hold the O-rings together.



Rotor valves

Built-in, rotor-style valves — a design appearing in old Triton filters — are located deep inside the filter, at the bottom. The only way to access them is by removing the entire filter, grids, manifold, tank, etc. Due to the hassle and these filters' age, many techs advise against repairing them.

1. Try to find out the year the filter was manufactured before you start, so that you have the proper model of replacement valve on hand. If it was before 1980, the filter will have a brass rotor and port seals. If it was made in 1980-81, it will have a Noryl rotor with a straight seal. Anything after 1982 will have a Noryl rotor and a tapered seal. Bring parts for all three rotor valve types with you.

2. Backwash the filter. Remove the grids and manifold. At the bottom of the filter are six cap screws and the compression ring that holds the filter tank to the backwash valve. Use a ratchet wrench with a 7/16-inch socket and a 36-inch extension to remove the cap screws. That done, the filter tank will lift off.

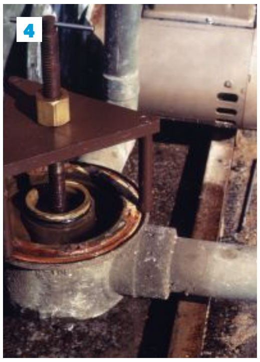
3. Remove the filter tank to reveal the rotor valve. (Before removing the rotor, be sure to remove the brass extension handle from the bottom of the valve body.)

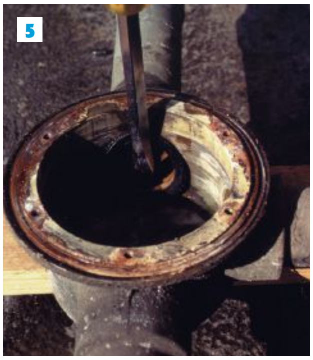
4. Using a rotor puller, remove the rotor from the valve body.

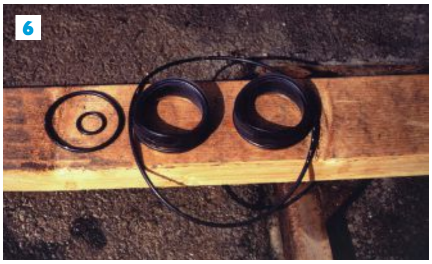
5. On the old-style valves, push down and pry out the old port seals with the blade of a screwdriver. Apply even pressure — do not force the port seal with a hammer because this could damage the body and cause it to leak. Be sure to remove the small stem O-ring in the bottom of the valve body. Place some small wooden blocks underneath the valve body to support it. Once removed, use sand cloth to clean the rotor as well as the brass valve body. Be sure to thoroughly clean the groove on top of the valve body because most leaks will occur here.

6. You will now need a new set of brass port seals, valve body O-ring, stem O-ring and the manifold O-ring to finish the job.

7. The new-style built-in valves don't have port seals built into the valve body. They use a Noryl rotor with a one-piece seal around it. Use the same procedure to remove the filter tank and gain access to the valve. Remove the old seal, clean the Noryl rotor by removing old lubricant, DE and other debris, and clean the brass valve body the same as above. Install the seal by pulling it over the top of the rotor, lining the seal up in the groove. Use needle-nose pliers to gently pull the tabs through the hole in the rotor.







Be prepared

Most backwash valves are not very difficult to repair once you have done it once or twice. However, if you don't have the right parts with you when the time comes, it can result in a frustrating, time-consuming trip back to the office. Many service techs carry an O-ring kit in the truck with them at all times.

An O-ring kit is a small storage box or fishing tackle box with compartments. It contains a collection of various-size O-rings and other small parts.

Label each compartment with the brand, style and part number for the O-rings it will hold. The O-ring kit shown here contains parts for all major brands of push-pull valves.

Author: Robert H. Foutz Jr. is owner of Purity Pool Service in Huntington Beach, Calif.

DE Filter Care

Practical tips and advice on caring for diatomaceous earth filters

Diatomaceous earth (DE) filters have the lowest micron rating of any style of pool filter — 1- to 6 microns. To put it into perspective, a grain of ordinary table salt is approximately 100 microns. A sand filter has a micron rating of 20 to 40, and cartridge filters come in at 5- to 20 microns.

The simple fact is, a DE filter can remove more and smaller pieces of dirt and debris from pool water than any other filter and thereby keep the water sparkling clean for swimmers.

Once you learn how a DE filter works, you can better understand how and why they need cleaning and re-earthing. A DE filter makes no sense when you think about it: You backwash the filter to clean it, then you put some kind of powder junk back into the filter. The most common question people ask when I re-earth a filter is: "Doesn't the DE just clog the filter up again?" No, the DE is what does the filtering.

Inside all DE filters are grids — some round, some square, most semicircular — and these grids have a cloth-covered, plastic frame. Most people think it is this cloth that does the filtering, so what do you need the DE for? The answer is that it's the DE, which packs up tightly onto the grids, that does the filtering. The DE on the grids is called a "filter cake," and the water is filtered as it passes through the filter cake. The woven polypropylene cloth on the grid is specifically made to hold the DE in place.

Another misunderstanding about DE filters is that if you backwash them long enough, it is as good as opening the filter tank and cleaning the filter by hand. Wrong. All backwashing does is run the water backward through the filter. Because water takes the path of least resistance, backwashing will remove only part of the filter cake. To really clean a filter, you must open it and clean it all.

Though all DE filters work the same way, some can be backwashed while others cannot.

A non-backwashable filter is much harder to clean because every piece of dirt that filter has trapped since the last time it was cleaned is still in there.

A backwashable filter is the easiest to clean because you can backwash the filter into the sewer before starting to clean it. It's hard to believe, but thousands upon thousands of pools were built with no way to run the dirty backwash water into the sewer as it came out of the filter. In the days those pools were built, you could just run a vac hose out to the street and dump your dirty water there. Not anymore.

Now, in most cities, you can get fined for running clean pool water down the street, let alone dirty backwash water.

Remember, many cities and counties have specific regulations controlling the disposal of spent DE, with some even requiring that the dirt be stored in a container and disposed of at a designated location.

To avoid legal issues for yourself and your customer, get up to speed with local ordinances. A quick call to your local health department should give you the information you need.

Finally, I would like to point out one major misconception that many new pool technicians and homeowners have when it comes to filters. A filter can only remove solid particles from water — it cannot purify the pool water. Bacteria and other contaminants are smaller than one micron and can pass right through the filter. To purify water, you must use a sanitizer such as chlorine.

HAYWARD POOL PRODUCTS

How to clean a DE filter

1. Backwash the filter (if possible). Then, with the pump motor off, remove the tank clamp.

2. If you have a non-backwashable filter, scrape off as much of the diatomaceous earth as you can. It may be illegal to run DE down the street, but it's not illegal to throw it away. Because wet DE is very heavy, it is advisable to put a little into several trash bags, then carry them out to the customer's trash can at the curb for pickup. Hint: Wear rubber gloves when cleaning DE filters.

3. This is the same filter, but after five minutes of backwashing.

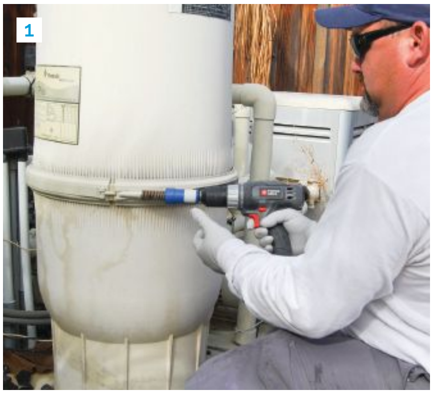
4. Wash off as much DE and muck from the grids as possible while they're still in the filter canister.

5. Lift the grids straight up from the filter and avoid pinching them against the sides. If the filter has a bottom drain, open it before lifting the grids out. The dirty grids weigh enough with the added water weight, so you might as well make it easier on yourself. Also, be sure there is an appropriate place for the dirty water to flow into before opening the bottom drain.

6. If there is nowhere to put the dirty water, you could scoop it and the DE into a bucket or trash-bag-lined barrels.

7. Using needle-nose vise grips to hold the tie rod, remove the nut and washer that hold the grids together.

8. This filter is backwashable, so wash off the grids in the filter canister, and the dirty water will go down the backwash line to the sewer. Remove any chunks before washing to avoid plugging the backwash line.


1


2


3


4


5


8


6


7

9. If the filter is non-backwashable, find a spot to wash off the grids. Some techs use a secured spot in the yard (with the homeowner's permission); however, others are concerned about children coming into contact with the left-over material. Another option is to place the grids in a plastic bag and take it to a DIY car wash (check with the attendant first). Wash the grids using a hose, then use a commercial preparation (shown) to remove oils. Rinse the grids again with the hose before reassembling the filter.

10. Wash the manifold and inspect it for cracks. Years of wear can cause small hairline cracks, which can allow the DE to shoot back into the pool. Also check for damage to the internal airbleed.

11. Inspect the O-ring. If it's out of round or you get a lot of black residue from the O-ring, it's time to be replaced.

12. Reassemble the grid bundle, making sure the grids are evenly spaced. This allows better filtration and a more even filter cake. When reassembling the filter tank, it's a good idea to tighten one nut assembly on one side, tap the filter band with a wrench, then tighten the other side about 10 turns. Then tap, tap, tap and 10 turns on the other side. This will allow the filter band to cinch up evenly and apply uniform pressure to the filter.

13. Add DE to the skimmer slowly and swirl it with your hand after every scoop. This will help the DE disperse evenly in the water and form a uniform cake on the filter grids. It is very easy to under-earth a DE filter and extremely difficult to over-earth one. So on the initial re-earthing after a filter cleaning, be very generous with the DE. Finally, leave the yard clean. Wash up the spilled DE and muck.

THE ACID TREATMENT

If the grids have become plugged with suntan oils or covered in scale (scale shows up on the grids as a yellow tinge or discoloration), soak them overnight in a solution of TSP or dishwasher detergent and gently clean with a hose. Rinse completely.

Add a drop or two of muriatic acid to the grids; if they foam and bubble up, there is scale on the grids, and they will need to be washed in a mild muriatic acid solution (in a 5-gallon bucket, mix 10 parts water to 1 part acid). Place the grids in the bucket and, using a scoop, pour the solution over the grids. Note: There also are solutions on the market that contain a detergent as well as acid.

When the bubbling stops, rinse the filter completely with water, neutralize the acid water with soda ash, and dispose of the solution in an eco-safe manner. Turn the filter on immediately after reassembly or the residual acid will rust the filter.

Warning: If you acid-wash the grids before soaking them, the oils will become permanently attached to the grids, and they will need to be replaced.

Author: Robert H. Foutz, Jr., is owner of Purity Pool Service in Huntington Beach, Calif.

Cartridge Filter Care

Cleaning and maintaining cartridge filters can be a simple process

Cartridge models use a synthetic, spunbond polyester material as the filtration medium. When water passes through the medium, the unique design of the fibers traps the debris. Finer particles are filtered out as the pores of the element become covered by the larger debris.

Cartridges for pools do not filter as finely as diatomaceous earth, which can go down to 1- to 6 microns. Instead, their abilities lie in the 5- to 20 micron range, while sand filters work in the 20- to 40 range (after cleaning; however, after half their filter run, they typically can filter in the range of 8- to 15 microns).

Cartridge filters do not have a backwash valve, which makes the hydraulics of the system fairly simple.

More importantly, cartridge filters do not require additional plumbing to remove the waste water generated from backwashing. In fact, cleaning cartridge filters is a breeze. The cartridge element can be cleaned by pressure washing it in combination with the use of a filter cleaner. Just remove the cartridge elements, hose them off, soak them and then put them back into the tank.

WATCH THAT GAUGE

Manufacturers have designed filters with enough surface area (300- to 600 square feet), so they only need cleaning once or twice each year. However, as with all types of filter media, you can determine the need for service with cartridges by watching the tank pressure gauge.

Whenever you replace a filter element, observe the start-up pressure on the tank gauge, indicated in pounds per square inch (psi).

Some manufacturers now provide a convenient dial on the pressure gauge for monitoring pressure levels. If that is not available, take a grease pencil or magic marker and draw a line on the face of the gauge at that point, marking the "base-line" or "starting" pressure.

Now mentally add 8- to 10 psi to the reading and make another little mark accordingly on the gauge.

The space between those two marks is the "normal operating pressure" for that cartridge filter system.

As long as the filter operates between those two marks, all is generally well. Clean when the pressure gauge hits the higher mark. To simplify things, add the cartridge-filter readings to your own records or route sheet.

Note: If you let the filter go too long before cleaning, you will blind-off pleats and can even collapse the filter element. This will result in a damaged filter, which will need to be replaced.

DIRT CAN BE A GOOD THING

While it may seem contradictory to its purpose, a somewhat dirty cartridge is actually more efficient than a clean one, say cartridge manufacturers. Why? Because the dirt that accumulates on filter fibers makes the filter material an even tighter web, capturing finer particles than it could when clean. At this point, the trapped dirt is basically working like the diatomaceous earth does in a DE filter.

That is not to say that cartridge filters don't need cleaning, of course. Rather, it's to make the point that a brand-new element is not as effective at removing debris from the water as one that's more "seasoned."

For pools with heavy bather loads or other conditions hostile to effective filtration, some technicians prefer replacement rather than cleaning. It's a judgment call.

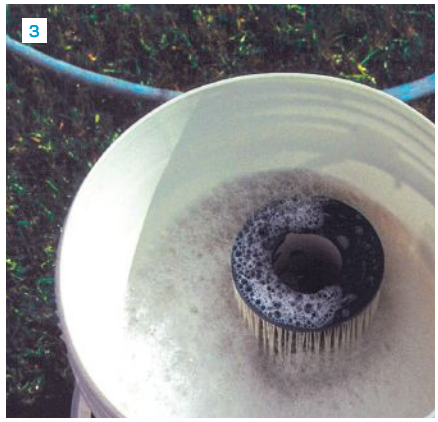
Carrying a spare cartridge or two in your truck may come in handy. That way, you can replace the customer's cartridge while taking the old one in for a more thorough cleaning.

Note: Richard Howell, the former national sales manager at Filbur Manufacturing and current vice president of sales, pool division for Waterway Plastics, contributed to this article.

THE ACID TREATMENT

If you think the filter suffers from scale or mineral buildup, you'll need to add one more task after Step 3 (see page 50). Drizzle a couple of drops of muriatic acid on the cartridge; if you see foaming and bubbling, the element needs to be washed in a mild acid solution.

In a 5-gallon bucket, mix a mild acid solution (20 parts water to 1 part muriatic acid). Place the cartridge in the bucket and, using a scoop, pour the solution over the element. When the bubbling stops, rinse the filter completely, neutralize the solution, and dispose of the acid solution in an ecologically safe manner. Note: You must soak the element before acid-washing it, or the oils will become permanently attached to the cartridge surface, and it will need to be replaced.



How to clean a cartridge filter

1. Remove the cartridge.
With the pump turned off and the pressure-release valve open, unscrew or otherwise loosen the clamp fittings and remove the lid. In systems with a single cartridge (shown), all you have to do is lift the cartridge out of the tank. In systems with multiple cartridges, unscrew the fasteners that hold the cartridges on the manifold assembly.

2. Rinse the element thoroughly.
Wash very thoroughly, using a high-pressure nozzle. Be careful not to damage the bands of the cartridge when spraying between the pleats. The cartridge should return to a white or light-gray color. (If the cartridge is extremely dirty, let it thoroughly dry out and then tap the debris loose.) This is a good time to check the cartridge for damage, such as large tears or holes that would compromise filtration.

Note: Many technicians advise against cleaning these on site; rather, they prefer leaving a spare cartridge in place, and taking the dirty ones to a car wash or their shops for cleaning.

3. Soak the cartridge.
APSP recommends washing the element with a solution of sodium or calcium hypochlorite to destroy any bacteria trapped on the cartridge. If the media has collected an inordinate amount of oils, it also may need a good soak. Place the cartridge in either a cartridge-soaking solution, a solution of water and trisodium phosphate (1 pound of TSP per 10 gallons of water) or any strong powdered dishwasher detergent overnight. The next day, rinse thoroughly again.

4. Inspect the O-ring.
The system shown here includes a top-mounted manifold and O-ring. Inspect the assembly for damage prior to reinstalling the cartridge. If there is any sign of wear on the O-ring, replace it — and always add a proper lubricant to the new O-ring if the contacts twist to make a seal.

5. Return the cartridge to the tank.
Having restored the cartridge to a sparkling-clean state (shown), it's time to return it to the tank. Be sure the unit is seated in the tank and that the manifold is properly reconnected to the element. See that the manifold is securely connected to the filter's internal fittings. Use lubricant to ease assembly.

Sand Filter Care

With proper charging and maintenance, these pool filters deliver years of trouble-free service

A high-rate sand filter that's backwashed regularly can go many years without needing fresh sand.

High-rate sand filters clean water via a process known as depth filtration, meaning that dirt penetrates the sand bed and is captured in the tiny spaces between grains of sand.

BACKWASHING IS KEY

How do you know when it's time to backwash?

One obvious clue is cloudy water. When the pool becomes murky, the filter may be dirty, the circulation may be poor or there may have been a chemical reaction. A far better clue, however, can be found with the filter's pressure gauge(s).

If the system has inlet as well as outlet pressure gauges, you will note only minor pressure differentials — perhaps 3 psi — when the filter is clean. As the sand bed begins to load up with dirt, that differential will begin to increase. In most high-rate sand filters, it's time to backwash when the pressure differential reaches 18 to 20 psi.

But if the system has only an inlet pressure gauge, you should backwash when the pressure increases by 8- to 10 psi from initial post-backwash readings. The best idea is to mark the pressure gauge with a grease pencil right after a good backwashing — or maintain a record of the running pressure on a route sheet as you monitor filter cycles.

These filter cycles can be affected by different factors, ranging from heavy bather load and algae to wind-blown dirt and debris. In addition, a sand filter on a newly plastered pool will clog quickly with plaster dust, which often precipitates out of new plaster during start-up procedures.

This fine plaster particulate can easily clog a sand bed and greatly reduce the length of initial cycles. In fact, when first starting a sand filter on a fresh pool, it may be necessary to perform an extended backwash of two to three times the normal duration to rid the sand bed of the bothersome dust.

WATCH THAT WATER FLOW

Backwashing is a simple matter of reversing the flow through the filter by sending water up through the underdrain or laterals and diverting the outlet water to waste.

The procedure is simple: Turn off the pump to avoid damage to plumbing or valving, then turn the control valve to the backwash position and restart the system.

Given a typical flow rate of 15 to 20 gpm per square foot of filter area, most manufacturers recommend backwashing for two or three minutes. As always, it's a good idea to consult manufacturer service manuals for specific backwashing procedures.

After backwashing, with the pump off, set the valve to the "Rinse" setting if you have a multiport valve. Start the pump and operate for approximately 30- to 60 seconds. This assures that all dirty water from backwashing is rinsed out of the filter to waste, preventing its possible return to the pool. Stop the pump, set the valve to "Filter" and start the pump for normal filtering.

Charged up for action

To get a sand filter system off to a good start, proper charging of the sand is essential. Here are the basic steps:

First, get sand of the proper size. Most filters use sand that's typically .45 to .55 millimeters in diameter, also commonly referred to as "pool grade No. 20 silica sand." (Note: Some filters also use gravel in the filter bed. Consult manufacturer for proper gravel specifications.)

To keep sand out of the circulation system, cover vertically exposed plumbing or standpipes with protective caps such as coffee or soup cans. On some models, you'll also need to put the lateral assembly in the tank before adding sand. That way, internal plumbing seats properly when the valve on the filter dome is reassembled.

Just before adding sand, some manufacturers recommend filling the tank bottom with a few inches of water to cushion the sand as it's poured in. Also, cover the lateral assembly with pea gravel before adding the No. 20 silica sand to help prevent damage.

Pour the sand gently through the top of the filter tank. A good rule is to leave 10 to 12 inches of freeboard — that is, the space between the top of the sand bed and the bottom of the diffuser assembly. Adequate freeboard prevents sand loss during backwashing, enabling the filter to work effectively.

Service and installation manuals offer tips to help you charge the filter. For example, some recommend holding down the vertical standpipe so it isn't dislodged as the sand is added. Remove the protective caps and replace the top valve or dome on the filter tank. Some assemblies are threaded into the top of the tank; others are secured by a clamp assembly. All assemblies use O-rings to create a good seal; an appropriate O-ring lubricant will help ensure that seal.

PSN thanks Hayward Pool Products for its assistance in preparing the sand filter articles.

A closer look at valves

Sand filters use one of two types of valves: a multiport valve (which can be top or side mounted) or a side-mounted slide valve (sometimes known as a push-pull valve). A side-mounted model is strictly a two-function valve: filter and backwash modes only. The type of valve used is often dependent on regional differences, but in general, you'll likely find more multiports because they can also appear on DE filters.

So let's take a look at the positions found on a multiport and what they mean:

Filter mode: This is the mode the filter will be set to most of the time. It's for filtering the water. In this mode, the valve directs the water to the top of the filter, where it compresses and flattens down the sand. Contaminants are removed as the water makes its way to the bottom laterals, out of the filter and back to the pool.

Backwash mode: Backwash mode: This is the one you turn to when cleaning the filter and its medium. You know it's time to backwash when the pressure gauge rises 8- to 10 psi above what it normally reads when the filter is clean. In this mode, the valve directs the water to come out the bottom laterals, reversing the flow through the tank. This causes the sand to separate and lift about 7 inches above its normal position while releasing the trapped debris into the water, allowing it to exit from the filter and go out the waste line.

Rinse mode: Water is directed by the valve to the top of the tank, just like the filter mode. The sand is re-seated back in place while still sending water out of the waste line, thereby reducing the chance of particulate blow-back to the pool when the valve is moved back to the filter position after backwashing.

Recirculate: Water is directed through the valve only, not the filter. This is a position to use during certain pool cleanups and chemical treatments, when you don't want the water contaminating the sand.

Waste mode: This position bypasses the filter and sends all the water out the waste line — a great setting for vacuuming pools after an algae treatment, and new sand addition or filter start-ups.

Operation tips

Now that we are clear on which functions the valve modes perform, here are some dos and don'ts that you can follow to help keep sand filters running smoothly:

Do: Be aware of the filter pressure when it is clean. Watch the pressure gauge. Backwash when you see an increase of 5 psi, possibly as much as 10 psi on some filters.

Do: Backwash long enough to get the job done right. Wait until the water is clear coming out of the waste line or shows clear in the sight glass on the side of the valve. Backwashing can use 50 to 300 gallons of water, so pay attention. In addition, be aware of local codes regarding pool water disposal. Many communities outlaw such procedures, and you could be hit with a stiff fine. Check with your local authorities on the accepted methods in your town.

Don't: Moving the valve handle while the pump is operating should not occur. Never move the handle of the multivalve while the pump is pushing water through it. It will damage the valve and possibly other equipment. Fully depress the valve handle when turning it to prevent damaging the valve seat gasket.

Don't: Avoid excessive backwashing. A feature of this filter is that it operates most efficiently during mid-cycle. As it collects particulates in the sand bed, debris caught up in the sand actually helps the filter work more effectively. Too much backwashing will reduce the filter's efficiency.

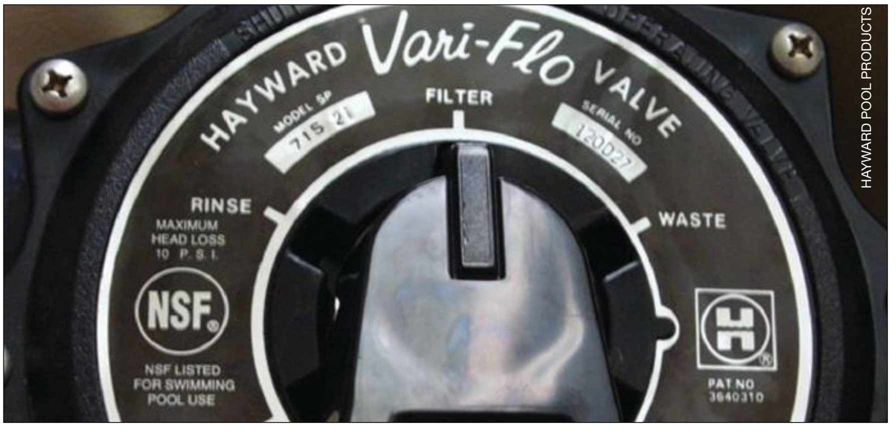
Don't: Avoid vacuuming a pool with the filter in backwash mode. You could plug up the laterals at the bottom of the filter with dust from the new pool surface. This restricts flow to the filter, resulting in inefficient operation. All the sand would have to be removed to unclog the laterals.

Do: Protect the laterals while replacing sand (usually using No. 20 silica). Fill the tank with about a foot of water to shield the laterals and cover the upper diffuser, or stack pipe, so that sand doesn't get inside.

Do: Fill the tank with sand to about half-full and keep it level. Models may vary, but the general rule is 12 inches from the top of the sand bed to the bottom of the valve or top diffuser.

Do: Start the filter in the rinse cycle for 1- to 3 minutes after starting a new filter or after replacing the sand in an existing one. Some small particles and impurities may still blow back to the pool. If this happens, always vacuum the debris to waste or you may keep sending it back to the pool.

— Lawrence Dow, Hayward Pool Products.



HAYWARD POOL PRODUCTS

Multipurpose multivalve: This view of a sand filter multiport valve shows its various modes or functions, from filtering to backwashing to waste.

Efficiency in Filtration

continued from page 30

residential applications include a multiport valve, and moving that water through the multiport and then down through the sand bed requires more pressure.

For the sake of comparison, a residential sand filter (3.4 sq. ft. of filtration area) without a multiport valve creates around 3 to 4 feet of head at 30 gpm and adds about 3 feet with a 2-inch multiport valve. At 60 gpm, the same sand filter adds about 11 feet of head, plus 12.5 feet for the 2-inch multiport valve.

However, sand is the preferred method of filtration for many pool service professionals. Sand filters are the quickest and easiest to clean during routine maintenance even though they have to be cleaned more often than large cartridge filters.

WEIGHING YOUR OPTIONS

If the most important criteria in your filter selection is the resistance generated by the filter, then it is clear that the best choice is a large cartridge, with a very close second being a DE filter without a multiport valve.

However, it is important to recognize that some customers will prioritize the easy maintenance of sand filtration. And some will want the polished water you get with DE and the ease of maintenance you get with the multiport valve for backwashing.

As with any equipment choice, the key thing about filter selection is to understand the pros and cons of each option and give your customers the best advice possible.

Author: Rodney McCall is the global growth process leader for Pentair Aquatic Systems in Sanford, N.C.

A new view on when to backwash

For decades, pool professionals have learned to backwash or clean the filter when the pressure reading increases 10 psi above starting or clean pressure. The growing use of variable-speed pump technology requires a change in this long-understood "rule."

From an energy point of view, think about this: Increased pressure in the filter adds resistance to the system. (A 10 psi increase in the filter, say from 12 psi to 22 psi, adds 23.1 feet of head to the system.) Higher resistance requires the pump to consume more energy. In fact, it would take an additional 200 watts to maintain 60 gpm with a 5 psi increase in pressure and an additional 500 watts with a 10 psi increase in pressure. So what does an additional 500 watts mean in dollars? .5kW X $.15kWH X 12hrs per day X 365 days per year = $328 per year. With commercial systems using 15hp and 20hp pumps, this can mean a lot of money.

With a single-speed pump this could mean that the excess filter pressure causes the pump to fall well below the required turnover rate. With a variable speed pump set at one speed, the 10psi increase could mean that the excess pressure puts the pump at a flow rate that does not satisfy a minimum flow rate for other system components, like a heater or salt chlorine generator, leading to a cold pool, a green pool or an unhappy pool owner.

The speed of the water leaving the peripheral edge of the impeller is what creates pressure in a pump. When the speed of the pump is cut in half, the pump can only create one quarter as much pressure.

The affinity law states this: Speed is directly proportional to pressure squared. At lower speeds the pump curve gets flatter. This means that a high head pump curve looks more like a medium or low head pump curve at lower speeds. So, a small increase in pressure translates into a larger decrease in flow at lower pump speeds. That's both good and bad on a practical level. It's good because friction loss or resistance in a swimming pool also decreases according to the affinity law.

If we decrease the flow in a pipe by half, friction loss or resistance decreases to a quarter. As an example, let's say we had a pump running at 60 gpm and decreased the flow to 30gpm. At 60gpm, let's say the filter pressure was 28 psi. At 30 gpm the filter would read that the system is at one quarter of the pressure or resistance or 7 psi.

Here is the bad news and an example of why we can't use the 10 psi number any more: At 60 gpm, a 10 psi increase in filter pressure, caused by an increased dirt load in the filter (meaning it is working properly), would take the system from 28 to 38psi. That would be a 36 percent increase in pressure. At 30 gpm, a 10 psi increase in pressure (from 7 psi to 17 psi), before backwashing or cleaning, would be a 142 percent increase in pressure. And that could lead to a no-flow situation.

Using the old rule of thumb and adjusting it to the lower flow rates and flatter curve characteristics would tell us that, at 30 gpm, the filter should be backwashed/cleaned before a 2 psi increase is incurred. This could keep us away from the green pool, no-flow situation.

Enter variable-speed technology. Both commercial and residential pools can realize huge electrical savings running the pump at a lower speed when the filter is clean. This can be done without the chance of reaching a no- or low-flow condition. This is how it works: A flow meter can feed information to a variable frequency drive which in turn increases or decreases the speed of the pump to maintain a chosen flow rate throughout the filtration cycle. As the filter gets dirtier and the pressure in the system increases, the flow meter sees a decrease in flow and tells the drive to simply increase its speed to maintain the flow rate.

This not only saves energy but, from a clarity point of view, dirt load in the filter actually helps to filter out finer particles of dirt, so it's OK — actually good — to allow dirt to accumulate inside the filter.

Heater Options

A detailed look at today's heaters and their benefits

As the desire for a longer swim season grows, pool heaters and heat pumps are becoming more popular.

The units have had significant updates. Modern-day heaters are smaller and designed with angled vent lines. A heater today vs. 10 years ago is half the size with the same Btu output, experts say.

Within the heater category, there has been major sales growth among high-efficiency models. And heat pumps, with their emission-free approach and relative cost savings, have received a big boost in U.S. sales.

Many advancements in heater design and technology have been dictated by the environment. With rising fuel and electricity costs, and greater consumer awareness of eco-related issues, manufacturers have focused on increasing efficiency, automation and functionality. Thus, low-NOx emission heaters are standouts on the market. In addition, solar heating options are more popular.

Following is a basic look at the heating systems on the market and their benefits.

FOSSIL-FUEL SYSTEMS

The workhorses of the industry, these heaters typically run on natural gas or propane. While higher fuel prices have had an impact on this market, the products' technological innovations have helped improve their efficiency — allowing them to remain an attractive option for consumers. These benefits also influence fossil-fuel heater sales:

Rapid response: Gas heaters are engineered to provide on-demand heating. They can bring the pool or spa up to temperature quickly or maintain the heat, depending on user needs.

Tough action: When sized right, these heaters typically can perform well under extreme weather factors, such as drops in nighttime temperatures and high wind.

Greater efficiency: In recent years, there have been significant improvements in the products' design — including fan-assisted combustion/exhaust technology, electronic control systems, low NOx emissions and more — that have increased their efficiency. Most offer heater efficiencies in the 80 percent to mid-90 percent range.

ELECTRIC SYSTEMS

Electric heaters are typically reserved for heating spas or aboveground pools, especially in installations where there is no access to fossil fuels. Most consider them cost prohibitive and an inefficient way to warm larger vessels, but experts say these heaters have unique benefits:

Generous: Electric units transfer all of the heat they generate directly to the vessel, manufacturers say.

Swift heating: Because of their concentrated heat output, electric units quickly can warm and sustain the temperature of spa water.

User-friendly: Most models are made to be long-lasting, easy to install and compact.

HEAT PUMPS/EXCHANGERS

Heat pumps have surged in popularity throughout the U.S. While they cost more initially, they have overall lower operating costs and easy installation. Heat pumps offer design improvements and other benefits:

Year-round usability: In areas where temperatures don't dip below 45 degrees, heat pumps can provide heating all year long. At colder temps, there isn't enough heat in the air to pass along to the water. These units also are made to automatically maintain the water at the desired temperature, without requiring many adjustments.

Reliability: Heat pumps now carry longer warranties. Plus, newer compressor designs have made these units far more efficient. A typical heat pump now delivers five to seven units of heat for every unit of electricity used, say manufacturers.

Cooling down: Heat pumps, which are basically air conditioners in reverse, derive their heating action from the use of a refrigerant to draw heat out of the air and into the pool water. Because of this design, many units offer a cooling setting that can be used to "refrigerate" the water, lengthening the swim season in high heat areas.

Space savings: While heat pumps are larger, heat exchangers take up little space on the equipment pad.

SOLAR SYSTEMS

Since 1997, the number of sun-warmed pools has soared an average of 13 percent annually, according to the Solar Energy Industries Association. Two types of pool solar systems are in use: electric or thermal, though the latter is the most popular. Obviously, these systems need plenty of sunlight, and the pool should be covered when not in use to aid in heat retention. The following factors have influenced this product segment's growth:

Cost savings: Solar collectors may cost more initially to buy and install, but operating costs are dramatically lower because solar energy is free.

Looks: Roof-top solar collectors have become sleeker-looking and lower-profile. In some cases, the panels appear seamless instead of segmented. Technological advances also have reduced the number of rooftop collectors needed.

Environment/safety issues: Pilot lights, fuels and corrosive metals are eliminated with solar heating.

Sizing Techniques

Tips on how to properly size a gas pool or spa heater

Replacing a defunct pool or spa heater for a customer on your route? Adding a heater to an equipment pad that previously lacked one? Welcome to the world of heater sizing and the art of finding the right unit to provide your customer with a cost- and energy-efficient source of heated pool or spa water.

Doing the job right means the water will heat to the desired temperature in the desired time frame. An undersized heater will heat too slowly and, although heater manufacturers advise that bigger is always better when choosing a heater, a significantly oversized unit will do the job, but also will boost the cost of the installation.

Choosing the right heater will please your customers and provide you a trouble-free heating system on your service route.

WARMING UP

Before selecting a heater, you must determine the customer's needs. For example, is the heater going to warm a pool or a spa? Although many units can be used for either vessel separately, the thought process behind selection differs for pools and spas.

Take a pool: One of the primary factors used in calculating heater size is heat loss from the surface. In a spa, however, surface area is far less a factor because so many spas are covered, which greatly reduces surface heat loss. Instead, heat-up time relative to the spa's gallonage is the critical factor.

Now find out if the customer plans to use the heater for maintenance heating or only occasionally for intermittent or demand heating. Although figuring the heater size for both types of heating strategies is the same, maintenance heating is typically calculated using surface area, while heaters used for intermittent heating often are sized by factoring total volume.

If your customer isn't sure on this point, it breaks down to a question of usage: If the pool is used nearly every day during the swim season, maintenance heating is the best strategy. If the vessel is host to bathers only occasionally, it's more cost-effective to heat the water only when needed.

Next, determine exactly which fossil fuel will be put to use — natural gas, liquid propane or heating oil. In some areas of the country, natural gas is either unavailable or excessively expensive, making one of the other fossil fuels more desirable.

Find out if there are codes in your area governing the type of pilot-ignition system used in heaters. In some states, continuous pilots (or millivolt systems) are banned for all new installations. Intermittent ignition systems requiring an electrical hookup are required in these jurisdictions.

Next, determine whether the available utility hookup provides adequate pressure to run the heater. Gas piping, meters and other delivery equipment must be sized correctly to ensure an adequate gas supply.

DEFINING THE VARIABLES

To properly size a heater, you need to know the following information.

Surface area: The main job of a heater is to offset the heat that is lost from the water's surface. This is especially true for maintenance-style heating. Here's a rundown of the basic surface-area calculations:

Rectangular pool: length x width
Oval pool: 1/2 length x 1/2 width x 3.14
Rectangular pool with rounded ends: length x width x .8
Kidney-shaped pool: length x width x .75

Things get a bit trickier with free-form pools. Here, you must carefully draw an image of the pool's perimeter on standard 1/4-inch grid paper. Using a scale of 1/8-inch per foot, for example, means that each of the 1/4-inch squares on the grid will equal 2 feet on each side, giving each grid square an area of 4 square feet.

Now count the squares that fall entirely within the drawn perimeter of the pool. Then count all of the squares that fall approximately 3/4 within the surface area of the pool as 3 square feet, those with half in the pool surface area 2 square feet and so on. Add up the value of all of the squares.

Volume: For spas and pools in which a demand-heating technique is to be used, total water volume is used rather than surface area in calculating heater size.

To figure volume, use the surface-area data derived above and multiply it by the average depth, thus developing a cubic-foot measurement of the vessel. To determine total gallonage, multiply the pool's or spa's cubic water footage by 7.48 — the number of gallons in a cubic foot of water.

Temperature differential: In most sizing charts for pools, temperature differential is primary factor along with surface area or volume. Before you can determine temperature differential, however, you must first peg the desired water temperature. For pools, the American Red Cross recommends a range of 78- to 82 degrees Fahrenheit — a range that seems to satisfy most bathers. In a spa, the temperature should not exceed 104 degrees.

Once you know the desired temperature, you need to determine the average ambient air temperature. Most experts recommend taking the average daily temperature during the coldest month when the vessel will be used. When you subtract the average ambient air temperature from the desired temperature, you've found the necessary temperature differential.

Heater efficiency: Expressed as British thermal units (BTUs), the heater output is the energy that a heater transfers to the water. The heater input is the energy (again in BTUs) used to generate that heat. Heater efficiency (HE) is the ratio of the output to the input, expressed as a percentage. All modern pool heaters are above 80 percent efficient, experts say. Typically, 84 percent to 87 percent efficiency is common in the pool heater market.

Heater-sizing charts often express the required heater output necessary to achieve the desired temperature rise for the pool's surface area or volume (see Chart 1 below for a generic example). Because heaters are rated by their input, however, you must know the heater efficiency to determine what size heater is required to do the job. In other words, if you divide the required output by its efficiency (for instance, .80), you'll have the proper heater input rating.

Manufacturers do part of the work for you in their heating charts by replacing the required output with the appropriate heater model number for the desired temperature rise and surface area or pool volume.

Heat-up time: For spas, in particular, the time required to heat the water to the desired temperature is important when sizing the heater. In fact, many spa-heater sizing charts use required heat-up time as a primary factor and assume a given temperature differential.

For intermittent heating, heat-up time also can be very important, although many sizing charts assume a 24-hour heat-up time.

PLUGGING IN THE NUMBERS

Once you've determined these factors, selecting a heater is a matter of plugging the numbers into sizing charts. Although they are typically easy to use, the charts are formatted in varying ways. Some plot the temperature differential on one axis with the pool volume on the other. In that case, you would cross-reference these two key factors to determine the proper heater output, which is listed in columns across the chart.

Other charts, most of them provided by manufacturers, list model numbers on one axis, with the temperature differential on the other. Cross-referencing the heater model with temperature rise then leads to the pool sizes listed in columns on the chart.

Finally, some manufacturers offer easy-to-use sizing slide rules. In that case, select the pool volume and temperature rise to determine the model heater.

For spas, heat-up time often is critical. In these applications, sizing charts typically assume an increase in water temperature — say, 30 degrees — with models (or input ratings) listed on one axis and spa gallonage listed on the other (see Chart 2,

Generic heater sizing chart: maintenance heating method

Temp. rise	10°	15°	20°	25°	30°
Pool Size (sq. ft.)	Heat loss = Required heater output (BTUs/hour)				
200	21,000	31,500	42,000	52,500	63,000
300	31,500	47,300	73,000	78,800	94,500
400	42,000	63,000	84,000	105,000	126,000
500	52,500	78,800	105,000	131,000	157,000
600	63,000	94,500	126,000	157,000	189,000
700	73,500	110,000	147,000	184,000	220,000
800	84,000	126,000	168,000	210,000	252,000
900	94,000	142,000	189,000	236,000	284,000
1,000	105,000	157,000	210,000	263,000	315,000

SOURCE: APSP

CHART 1: The heat loss/output figures are based on an assumed wind velocity 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. These numbers need to be divided by the heater efficiency to find the required input rating.

below). Simply pick the spa volume and the desired heat-up time to find the appropriate heater model or rating.

To determine the heater model on a chart that lists required heater output, divide the output by the efficiency to find the heater input. (All heaters list their heater input ratings on their faceplates and in specification manuals. You can use this simple, generic calculation to double-check the accuracy of the manufacturer's charts.)

TIPS FOR DO-IT-YOURSELFERS

For those who prefer to size the heater based on their own calculations, the following formula is the basis for most heater-sizing charts used in the industry and can be easily applied to either pools or spas:

Number of gallons x 8.33 (pounds per gallon) x the temperature rise = the number of BTUs required to heat the vessel.

For example, consider a 40-degree temperature rise in a 400-gallon spa — that is, 400 x 8.33 x 40 = 133,280 BTUs.

This number can either be divided by the desired heat-up time to give you the required heater output, or it can be divided by the heater capacity to give you the heat-up time a given model will provide.

Let's assume, continuing the previous example, that you have a heater with an output of 266,000 BTUs. Here, 133,280 divided by 266,000 yields a heat-up time of .5 hours, or 30 minutes. Conversely, if the customer has a specific heating time in mind — say, 30 minutes — the formula works thusly: 133,280 ÷ .5 = 266,000 BTUs.

In other words, a 400-gallon spa would need a heater with an output of 266,000 BTUs to heat the water in 30 minutes.

REMEMBER THE 'INTANGIBLES'

When it comes to sizing a heater, it's not all numbers and formulas: Variables thrown in by Mother Nature and the location of the vessel need to be factored in. Following are issues that can affect heater size.

Wind: The wind can dramatically increase the surface heat loss from a pool or spa. By making waves across the water, the wind effectively increases the surface area of the pool. The basic rule: In a pool with an 11-mph wind, you need to increase the heater size by 25 percent.

Altitude: Where the vessel is located is another factor that calls for a bigger heater. For each 1,000 feet above sea level, the heater needs to be 4 percent larger.

Shade: If the pool is in the shade, you may need to upsize the heater. Although there's no precise rule, you should throw in a small "fudge factor" to be on the safe side.

In this and other areas, it pays to contact heater manufacturers or your local supplier for expert guidance. After all, customer satisfaction is at stake.

Typical spa heater sizing chart

Heater input (BTU/hr.):	125,000	175,000	250,000	325,000	400,000
Spa volume (gal.)	Minutes required for each 30° temperature rise				
200	30	21	15	12	9
300	45	32	23	17	14
400	60	43	30	23	19
500	75	54	38	29	23
600	90	64	45	35	28
700	105	75	53	40	33
800	120	86	60	46	37
900	135	96	68	52	42
1,000	150	107	75	58	47

SOURCE: APSP

CHART 2: Typical spa heater sizing — intermittent heating, volume method, temperature rise of 30° F

Installation Tips

Guidelines for gas heater installations

A well-done heater installation ensures years of trouble-free satisfaction for customers and techs. But installed incorrectly, a heater can become a service nightmare, subject to a variety of operational problems.

More importantly, these heaters pose a risk to customers and techs that must be dealt with — even if the techs had nothing to do with the installation. If you service a pool with an improperly installed heater and an injury occurs, you could be held liable whether you had anything to do with the accident or not. If you see installation-related problems, you must notify your client of the situation, preferably in writing. This will help you stay off the liability hook.

To do so, you must know what to look for when evaluating an installation. Although most requirements tend to be consistent among suppliers, you must always closely follow each manufacturer's own installation guidelines at the job site.

KEEPING YOUR DISTANCE

The first step in a good installation concerns the heater's placement relative to its surroundings — specifically, its clearances.

The American National Standards Institute helps out here by offering guidelines (ANSI Standard 2223.1), designed to keep heaters, whether installed indoors or out, at a safe distance from all combustible materials contained in nearby walls, landscaping or structures. (Because this standard sets clearance requirements based on the external temperatures of heaters, clearances may vary.)

• The rear and nonplumbed sides of the heater should have at least 6 inches of clearance.

• The water-connection side should have a minimum of 12 inches of clearance — 18 inches is recommended.

• The front of the heater should have at least 24 inches of clearance.

Moreover, the following clearances are based on the National Fuel Gas Code and are universal for all gas-heater models:

• When installing a heater under an overhang, there must be at least 4 feet of vertical clearance from the top of the heater to the overhang, and the heater must be open on three sides.

• The top of the heater must be at least 5 feet below, or offset 4 feet from, the nearest opening to a building, such as a window or door; in addition, the top of the heater must be at least 3 feet above any forced-air inlets located within 10 feet of the unit.

All heaters must be installed at least 5 feet from the inside wall of a spa unless it is separated from the spa by a fence, wall or other permanent barrier.

A SECURE HEATING PAD

The heater must be installed on a level, noncombustible base such as brick or concrete. If a new pad must be built, there should be a minimum of 1 foot of clearance on the pad for all sides of the heater.

If concrete cinder block is used as a base, it must be aligned so the cells all point the same way; the end should be left open. When hollow masonry is used, the pad must be at least 4 inches high — and covered with a 24-gauge (or heavier) piece of sheet metal. Another option: Check with your distributor for a synthetic, lightweight, noncombustible pad to set the heater on.

Next, consider the elements. If the heater is placed in an area exposed to high winds, the unit either must be installed at least 3 feet from the nearest wall, or a wind block must be constructed to help minimize the effect of wind reflecting into the heater. (Most manufacturers provide recommended wind levels at which a device known as a vent cap also is required. Some manufacturers now also equip their heaters with low-profile vent assemblies.)

Without proper air flow around the heater, efficient combustion is impossible and burnt fossil fuel cannot be safely vented. While this is an obvious concern outdoors, indoor installations are even more sensitive to such considerations — particularly with respect to venting.

INSIDE INSTALLATIONS

The ground rules for heaters with sealed combustion chambers installed indoors are straightforward and rigid:

• If the heater is installed in a place where vented air comes from another interior room, the space where the heater is located must be connected to the additional airspace by two vents, and the combined area of the space where the heater is located and that additional room must represent at least 50 cubic feet per 1,000 BTUs of heater input. (The BTU input of any other gas-burning appliances in that space, such as a home water heater, also must be factored into this calculation.)

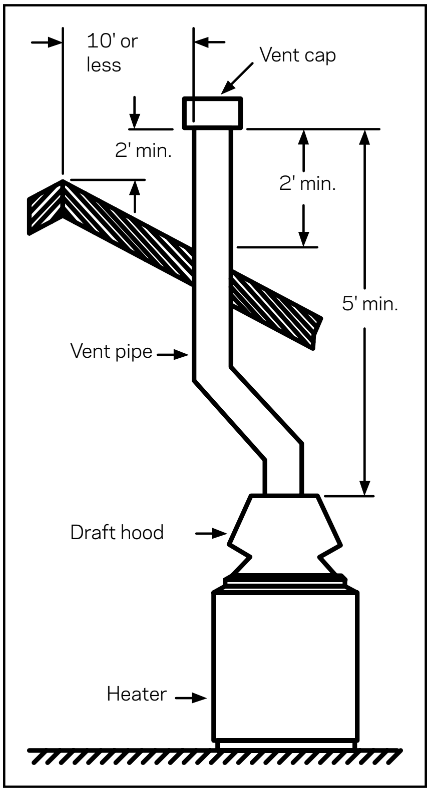
• The space must have two openings, one beginning 12 inches above the floor, the other 12 inches from the ceiling, per the code. The top opening is for replacement air (ventilation), while the bottom is for combustion air (what the heater uses).

• Each heater model has specific venting requirements to ensure proper combustion and prevent sooting. Manufacturers express venting requirements as square inches of net free air. A typical requirement is 1 square inch per 1,000 BTUs of input for an unobstructed opening. When venting heaters, don't guess. Always consult the manufacturer or read the manual for venting sizing requirements for the specific model being used.

• For spaces vented to the outside, the space also must have top and bottom vents for the confined space. The openings must connect directly or be connected by ducts to the outdoors. Alternatively, the vents must connect to an area such as an attic or crawl space connected directly to the outdoors.

• Regardless of where the unit gets its air, indoor heater installations require a draft hood that sends combustion byproducts — particularly carbon monoxide — outside the building. Failure to meet this requirement can result in fire or carbon monoxide poisoning. (Some models have a built-in draft hood design that does not require an additional draft hood externally.)

The diameter of the draft hood is based on the National Fuel Gas Code and may vary from model to model. Connected to the draft hood is the vent pipe, which vents products of combustion to the outside air;



Rising up: Proper venting for indoor heaters is spelled out in various codes and standards.

it must have a diameter equal to, or greater than, the draft hood.

While blower heaters don't require as much room, the discharge opening in the vent pipe for other heater models must be at least 2 feet above the roof surface and at least 2 feet above the highest point on the roof within a l0-foot radius of the pipe location. Because the vent pipe is exposed to the elements, it also must be topped with an approved vent cap, which keeps wind and air from forcing products of combustion back down into the ventilation system.

In reaching this safe venting point, installers are urged by manufacturers to avoid horizontal piping runs if possible. If horizontal runs are inevitable, the vent pipe must have a minimum 1-inch rise for every foot of horizontal run and be supported at least every 5 feet. Go soft on angles, too, say manufacturers: 90-degree elbow connections should be kept to a minimum. Finally, there must be a piping clearance of at least 4 feet from all electric and gas meters.

UNDER PRESSURE

Once venting needs are accommodated, consider whether the unit is getting an adequate supply of fuel. To answer this question, look at the line running from the gas meter to the heater and determine whether it is properly sized for the job.

Gas pressure is measured in inches of water-column pressure, or WCP, a special measure of pressure per square inch. It takes 28 inches of WCP to equal 1 psi. Generally, heaters running on natural gas require between 4 and 10 inches of WCP while the heater is operating to ensure smooth performance. Heaters on liquid petroleum require greater delivery pressures.

Manufacturers offer handy pipe-sizing charts for their customers, concentrating on sizes from 3/4- to 2-inch diameters and working with runs of up to 300 feet. (For longer runs, contact the manufacturer.)

One more factor: Most heaters are fitted for operation at altitudes of less than 2,000 feet above sea level. For guidance on installations at higher elevations, contact the maker for special high-altitude models.

Next on the fuel list, determine the basic installation requirements for the gas connection, namely:

• A main gas-shutoff valve and union must be installed within 6 feet of the heater and outside the heater jacket.

• Gas piping should have a sediment trap upstream of the heater's gas controls.

• Rigid gas-line piping must be used. (Never should flex line be used.)

Once the piping is installed, the system must be pressure-tested to ensure integrity. In testing, gas piping is disconnected from the heater to avoid damaging the heater's gas-control equipment. Here, the pipe is capped at the connection point and pressure is applied, with a soap solution applied at all joints. (Never test for a gas leak with a match or any flame. Also, some local codes may have even more testing requirements.)

If bubbles form when the soap solution is applied, there's a leak that needs repair. Testing continues until there are no leaks.

Some manufacturers suggest the above procedure to test the burner and pilot's tubing. Here, care must be taken to keep the test pressure below 10 inches of WCP to avoid damaging the gas-control valve.

WATER, COOL TO WARM

The heater should be installed downstream of the pump and filter and ahead of any automatic sanitizing equipment. That is, the water should be free of particulates or dirt when it enters the heater, and contact with corrosive chemicals should be kept to a minimum by their downstream placement.

It also should be installed as close to the pool or spa in the plumbing run as possible to prevent unnecessary heat loss.

The heater is best located level with the surface of the pool — or as close to level as possible — because manufacturers pre-set their pressure switches for heater installations that are typically 3 feet above or below the pool's surface. Consult the manufacturer for specific recommendations for elevated or subsurface installations.

continued on page 61

Troubleshooting

Basic troubleshooting techniques to aid in servicing and maintaining gas heaters

There's nothing worse than a lukewarm spa or a cold pool. So what do you do when the heater won't heat?

Like any other appliance, one day everything is running smoothly and the next day, the heater might not run at all. But don't panic over the fact that it's more complicated to work on than a pool filter or pump. That doesn't mean you can't learn to do the repair.

A pool heater is composed of switches, components and other devices that turn the heater on and off, and keep the water at the desired temperature. When one of these fail, the heater may shut down permanently until it is fixed. Once you find out which part is keeping the heater off, it can be repaired or replaced.

EVALUATE OUTSIDE FACTORS

It may take some sleuthing to discover the cause of a heater malfunction. Often the culprit is not in the heater itself. Thus, the first step to troubleshooting is not actually looking in the heater, but outside it. Evaluate these things first:

Check the circulation system. The No. 1 reason a heater will not fire is inadequate water flowing into it. Most heaters need a minimum of 40 gpm passing through before they will fire. (Some will fire at 10 gpm, but they wind up overheating or cycling.) Start the pump and check the pressure gauge; if the reading is higher than normal, backwash or clean the filter.

If the pressure-gauge reading is too low, check and clean out the pump pot and skimmer basket or even the eye of the pump impeller. If the pressure gauge reads "normal," proceed.

Check the on/off switch. Gardeners or others may have turned the unit off.

Check the thermostat. It may be turned down too low. In an older heater that has not been used for several months, the contacts in the thermostat may be dirty. Try moving the knob back and forth several times to clean the contacts. (This does not happen in newer models.)

Check the gas valve. The last of the checks, make sure gas can go into the heater. Sometimes when a heater is shut down for winter, the gas to the heater will be turned off at the gas valve.

EXAMINE THE HEATER

If all of the above items check out, you should begin to examine the heater itself. Note: These are general guidelines; the techniques for troubleshooting pilot, ignition and safety control circuits are presented only to illustrate the logic behind heater troubleshooting; manufacturer literature must always be consulted before approaching any specific heater model.

Circuits in heaters are not difficult to troubleshoot once you understand that the components are wired in series, like a string of Christmas lights. Finding the bad "bulb" is a matter of progressing through the system and testing suspect parts in sequence until you locate the problem.

First, you must ascertain which type of pilot the heater uses. There are two basic types: millivolt systems and IID systems.

With the millivolt system, the pilot is on continuously as a standing pilot; the heater uses heat from that standing pilot to generate electricity to run its safety and control systems. These millivolt systems have no outside electrical hookups.

Check the pilot. Use a pocket mirror to see if the pilot is burning; never put your face or eyes where you could possibly get burned. Is it clean and free of obstructions that would prevent proper operation? If the answers are yes, dig a bit deeper.

Check the switches. If the pilot lights and all external functions and factors have checked out, the millivolt system's inability to fire is likely to be caused by a malfunctioning component along the electrical path in the heater. Then the suspect parts are the pressure switch, high-limit switch, thermostat, gas valve and pilot generator. Here's a four-step procedure:

1. The first step along this diagnostic line involves sidestepping the gas valve by clipping a jump wire across the valve's terminals (see Figure 1). This enables you to bypass the chain of control devices wired along the same circuit as the valve and to check the performance of the gas valve and pilot generator. Note: After troubleshooting any component, always remember to remove the jump wire!

The control components you're bypassing (the pressure switch, the thermostat and the high-limit switch) are designed to prevent the gas valve from delivering gas to the main burner when an unsafe or improper condition exists.

To jump the gas valve, first turn off the main gas valve so the burner doesn't come on. Then attach one end of the jump wire to the terminal connecting the thermostat and gas valve, the other to the connection between the gas valve and pilot generator; these may be labeled TH, TH-TP, thermostat or identified by color, depending on the manufacturer. If the burner lights, you know that the gas valve and pilot generator are good and the problem lies somewhere along the string of control devices.

If, however, the main burner doesn't light, you have either a problem with the pilot generator, a wiring problem in connections for the pilot generator or a bad gas valve.

Manufacturers offer specific diagnostic recommendations for testing electrical current between these devices using a voltmeter. Usually, the pilot generator's output should be anywhere from 250mv to more than 500mv with the circuit open — that is, when the heater is not running. The connection between pilot generator and gas valve should read more than 200mv with the heater firing. If it's less than these levels, you probably have a bad pilot generator; more than that, the failure to light is usually attributable to a faulty gas valve.

Note, however, that a low reading also may be the result of faulty wiring. Again, a preliminary wiring check will help you avoid unnecessary effort in troubleshooting these components.

2. Next, jump across the pressure-switch terminals, thus electrically bypassing the pressure switch. If the burners fire, then you know that the pressure switch is not sensing proper water flow. If you know there's proper flow in the system, then the switch is either out of adjustment or defective. Consult manufacturer literature for adjustment procedures.

3. If the burners do not fire when the pressure switch is jumped, move on to the thermostat. The first thing to check is that the toggle switch is in the ON position.

Depending on the unit, the thermostat may need to be removed from a mounting to access its terminals. In any case, the procedure is the same: Jump from one terminal on the thermostat to the other. If the burners fire, then you have a bad thermostat and it needs to be replaced. If they don't, you need to move on.

4. The last diagnostic step with millivolt systems is a check of the high-limit switch or switches. If all of the previous checks have been performed properly, then jumping this switch (or set of switches) should result in the heater firing. If you replace the high-limit switch and still have a problem, check for proper water flow through the heat exchanger.

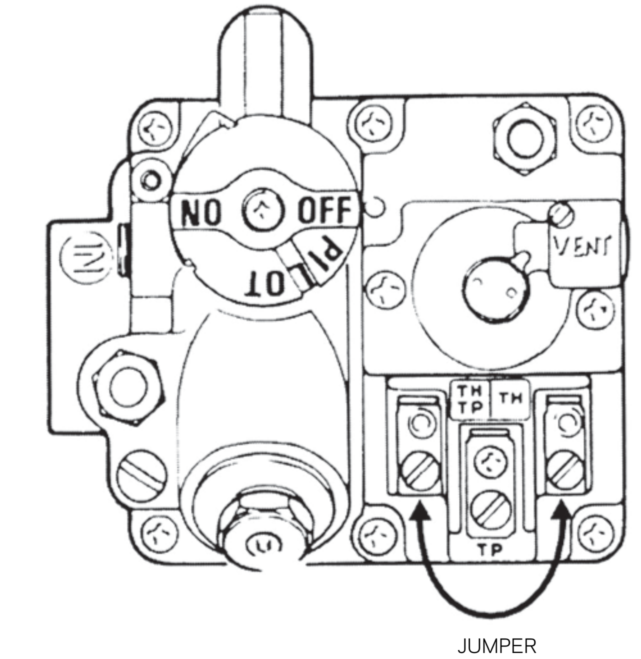


Figure 1: Sidestep the gas valve by clipping a jump wire across the valve's terminals.

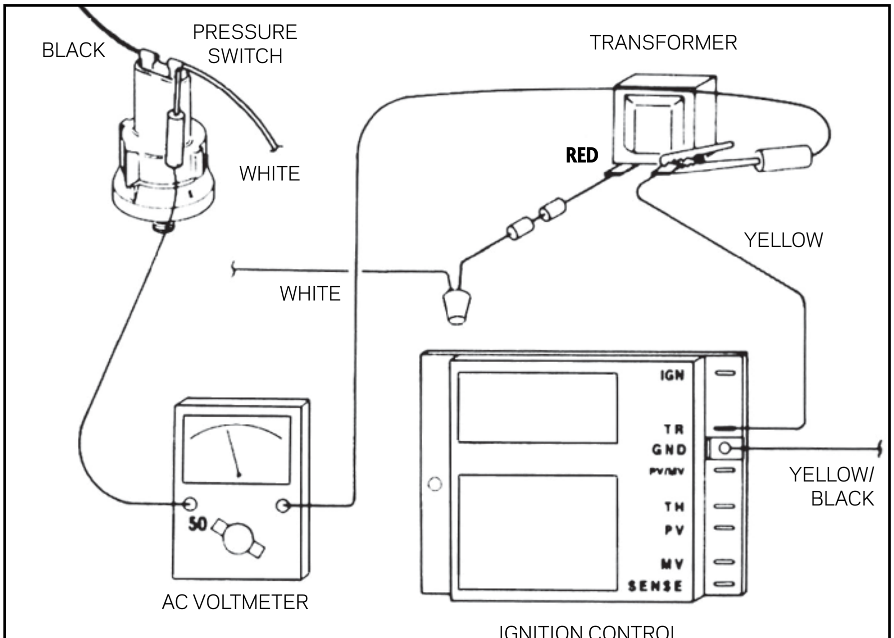


Figure 2: Pressure switch test in an IID system

ILLUSTRATIONS COURTESY JANDY

DEAL WITH THE DEVICES

Intermittent ignition devices differ from millivolt devices chiefly in the fact that IIDs require an external electrical source to power their functions. Here, the pilot is sparked electrically only when it is needed to fire the burners.

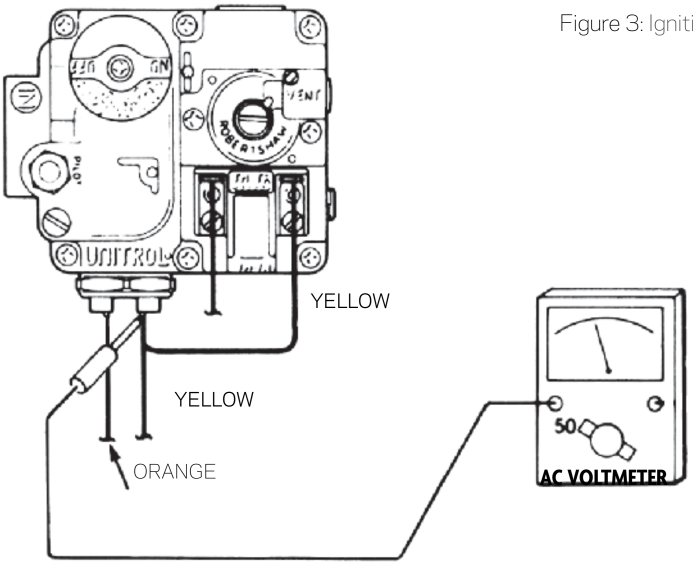


Figure 3: Ignition control

As with the millivolt system, once external checks have been made, you can be fairly certain the heater's failure to fire stems from a faulty component in the control circuit.

Troubleshooting an IID control system calls for an AC voltmeter with a 220-volt range or greater. As with the millivolt system, you'll be testing a series of components to locate the faulty part. Set your voltmeter for the proper voltage — that is, above 24 volts.

• **Check the transformer.** Attach a voltmeter lead to one of the terminals for the system's 24-volt transformer, then probe the other terminal with the second lead. When you make contact with both terminals, you should get a reading of 20-30 volts. If it is low, you may have a voltage problem or faulty transformer.

• **Check the circuitry.** With the lead from the voltmeter still in contact with the ground or common terminal on the transformer, check for voltage along the circuitry, starting with the safety fuse; use the other lead as a probe. Then move to the fusible link, the high-limit switch and the pressure switch (see Figure 2). If there's voltage at these points, the parts are good. If not, they need replacing.

• **Check the temperature control**. Perform the same test on the temperature control, making sure that the control is in the ON position and that it is set to a temperature high enough to call for heat. If there's voltage, the unit is fine.

If the heater is equipped with an electronic temperature control, the control's sensor or probe should be checked following procedures recommended by the manufacturer.

• **Check the ignition control.** When an IID heater won't fire, the ignition control is another suspect. Electrically, the ignition control is tested in the same fashion as the safety devices. First, verify that it's receiving 20- to 30 volts. Then make a visual inspection of the unit and test for a spark at the pilot-burner electrode. Use caution around the electrode: It has low amperage, but a high voltage! (see Figure 3).

• **Check all electrical connections.** You want to be sure these connections are tight. Also, make sure the igniter electrode has a proper spark gap; this not unlike checking for the same in an automobile spark plug. Consult manufacturer literature for a proper spark-gap spacing.

• **Check for a spark.** With the thermostat set high enough to call for heat, you should have a spark at the pilot-burner electrode if all the controls are good.

If there's no spark, some manufacturers recommend that you pull the wire off the ignition control and hold it approximately 1/8-inch away from the ground terminal. If there is no arc across the space, the ignition control should be replaced.

If you do have a spark, but the pilot doesn't light, a good bet is that you have a plugged pilot assembly or a bad gas valve.

HANDLE AN OVERWORKING UNIT

A heater that just won't shut off can be particularly alarming. It may result in extremely high water temperatures and constitutes an extreme danger. To get to the root of such problems, you should:

• **Check the gas valve.** To do so, remove the wire running between the gas valve and the thermostat. If the heater doesn't shut off, you have a faulty valve that must be replaced. If the heater does shut off, the gas valve is OK, but you know you have a control problem.

• **Call for backup.** At this point, heater manufacturers recommend that you bring in a specialist to troubleshoot the system because of the seriousness of the problem.

CHECK THE PANEL

Troubleshooting heaters has been simplified with diagnostic lights, which some manufacturers include in their latest designs. Whether installed on the heater exterior or in its internal circuitry, the lights provide instant diagnostic information about the status of important system functions, including water flow, pressure, thermostat and gas-valve operation.

In all cases covered in this article, there's a logical progression of checks and tests that will lead to a proper diagnosis — and cue you to quick action to bring the heater back up to speed.

Author: Robert H. Foutz Jr. is the owner of Purity Pool Service, based in Huntington Beach, Calif.

Troubleshooting low gas pressure issues

Another reason for heater failure is insufficient gas supply. Service techs can try using three sequential gas pressure tests — static, load and manifold — to correctly identify insufficient gas pressure and its source.

Addressing basics

Gas pressure readings are obtained by removing one of the valve's two 1/8-inch pipe-thread test plugs with an Allen wrench. Then, thread the manometer test fitting and hose into the plug. A test plug is located on the valve's inlet side, and another on the manifold/outlet side.

Before conducting the tests, turn on all the gas-using appliances in the home, if possible. While you may never run all the gas appliances at the same time, having them on while testing will help verify that the heater won't be robbed of gas when other "loads" activate during the pool-heating cycle.

Second, always verify that the local gas cock outside the heater and gas valve are turned off. When removing the manometer from the test port, replace the gas valve's test plug before moving on to the next step.

Test 1: Static pressure

This test measures the baseline pressure of gas at the inlet. The manometer is attached to the inlet side of the gas valve, and the heater should be turned off. Once the manometer is connected, turn on the local gas cock outside the heater. If the static reading is too low based upon the manufacturer's data plate found inside the heater cabinet, you will need to inspect the following possibilities:

The household gas meter size may be too small. Gas meters are rated in cubic feet per hour (CFH). In general, the meter's capacity is stamped on the data plate. 1,000 Btu = 1 CFH. Based on this capacity, a 250,000 Btu heater should have a 250 CFH meter. Ideally, your meter should be at least 100 CFHs larger to handle the remaining house supply. If the meter rating is smaller than the heater's Btu, contact your local gas company to get it upsized or consider downsizing the heater.

The gas line size may be too small. Propane and natural gas have different pipe size requirements. Follow the pipe sizing requirement chart located in the owner's manual. The pipe diameter is based on the type of gas supply and distance it needs to run. The correct size of pipe should be visible at the main gas supply connection.

There should be a dedicated gas supply line for the heater. The connection point should be a full-service one. The valves in most heaters are 3/4-inch connections.

Once you're 2- or 3 feet from the heater, there can be a reducer bushing to bring the pipe diameter down to 3/4 inch. If the pipe diameter is incorrect, you can change the heater for a smaller one or run a new gas line.

Assuming the gas meter is the right size and the pipe diameter is correct, there may be a restriction in the gas supply line. Verify that any and all gas supply valves are fully open.

Should you still encounter a supply problem, contact the local gas company. It will be able to handle an obstruction in the gas line or any problems with the gas-line regulator if it is damaged or not properly set.

Test 2: Load pressure

This test measures the inlet gas pressure under load (while the heater and other appliances are operating).

Keep the manometer attached to the inlet of the gas valve. However, this time the heater and all gas appliances should be turned on and operating. Make sure you turn the gas valve inside the heater cabinet to the "on" position.

If the load reading is low, review the steps under the static test. If the heater will not fire, record the manometer reading as it attempts to activate. A drop in static pressure indicates the control loop is closed and the gas valve is open — even if the heater doesn't fire. Since there is flow, the heater should be shut off immediately. If the reading is acceptable, proceed to the manifold test.

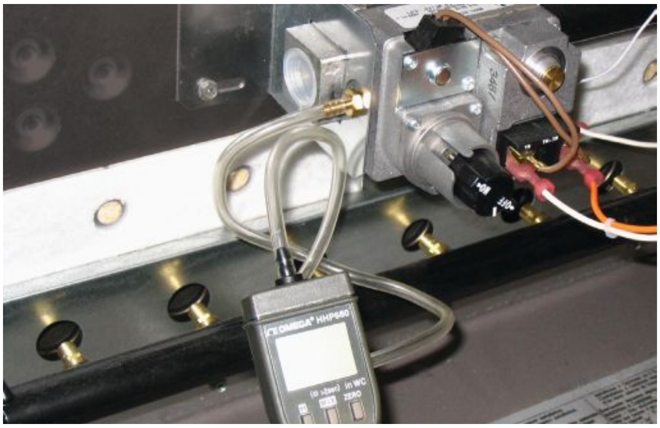
Test 3: Manifold pressure

This test measures the gas pressure going to the burners. With the local gas cock and heater gas valve off, remove the manometer test fitting from the inlet tap and replace the test plug. Attach the manometer to the outlet/ manifold side of the gas valve. Make sure you turn the heater on (local gas cock and heater gas valve), along with all appliances attached to the same gas supply.

The gas valve may need to be adjusted if the reading is low or high. All gas valves have an adjustment screw. To increase, turn it clockwise with the heater running and manometer attached. Turn it 90 degrees and read the manometer until you've reached the proper pressure. This adjustment screw should not be tightened or loosened completely (bottomed out). If the heater will not fire, record the manometer reading as it attempts to activate.

If the manifold pressure is correct (per owner's manual), the heater problem isn't related to the gas supply. Instead, the problem is in the ignition or combustion system.

John F. Ott is a consultant in Southern, Calif.



Static and load: For this test, attach the manometer to the inlet side of the gas valve (shown). Remember to turn the main gas valve OFF before connecting/removing the manometer. And replace the Allen head plug before moving to the next test.

Symptom: Pool not heating or slow to heat.

Cause:	Procedure:
The system is not running long enough	Reset the time clock.
A dirty filter is keeping the heater from firing	Backwash the filter.
The thermostat is faulty or out of adjustment	Test and replace the thermostat as needed.
The pressure switch is inoperative	Given a clean filter, test the switch and replace it if necessary.
The heater is too small	Consult a heater-sizing chart and upsize the unit.
The gas system is undersized	Check gas-pipe sizing charts and upsize the plumbing. Check the meter and the supply shut-off valve for proper sizing as well.

Symptom: Soot has formed in the combustion chamber.

Cause:	Procedure:
Excessive water is flowing through the heater	Correct water flow and clean the heat exchanger.
The air supply is inadequate	Check the installation for proper clearances and/or venting. (On indoor applications, verify the adequacy of the air supply and venting.)
The air inlet or venturi for the burner is plugged	Check for debris, dirt, insects or small animals and clean the passage.
The time clock prevents the heater from running long enough to heat the water	Adjust the time clock and clean the exchanger.
The gas valve regulator is out of adjustment	Test for proper gas pressure and adjust the regulator as needed or replace the gas valve.

Symptom: The heater goes on and off repeatedly.

Cause:	Procedure:
The filter is dirty	Backwash the filter.
The pool's water level is low	Raise the water level.
The manual bypass is out of adjustment	Adjust the bypass.
The pressure switch is out of adjustment	Adjust the pressure switch and verify that the heater shuts off when the system's pump shuts off.
Gas volume is low	Adjust the gas level/pipe sizing to ensure there is an adequate supply.

Symptom: Scale is forming in the heat exchanger.

Cause:	Procedure:
The pool or spa water is excessively hard	Bring total alkalinity, pH and calcium hardness within acceptable levels.
The heater is staying on when the water flow has diminished because of debris in the filter	Adjust the pressure switch.
The manual bypass is out of adjustment	Adjust or repair the bypass valve.

Symptom: Heat exchanger is corroding/eroded.

Cause:	Procedure:
The water chemistry is acidic	Balance the water.
Excessive flow	Check the bypass valve as well as the pump sizing. You may need to install a manual bypass.

Symptom: A lazy burner flame.

Cause:
Low gas pressure

Procedure:
Check gas pipe and meter sizes and/or adjust gas pressure as needed.

Cause:
Debris, dirt or insects are plugging the burners

Procedure:
Clean the burners.

Symptom: The heater makes knocking or whining noises.

Cause:
The water flow is too low

Procedure:
Adjust or replace the pressure switch.

Remove the blockage and flush the system. (This is rare.)

Descale or replace the heat exchanger.

Adjust the pressure switch.

Adjust water flow to ensure adequate flow

Pool & Spa News thanks Raypak Inc. for the technical assistance provided in this troubleshooting chart.

Heat Pump Basics

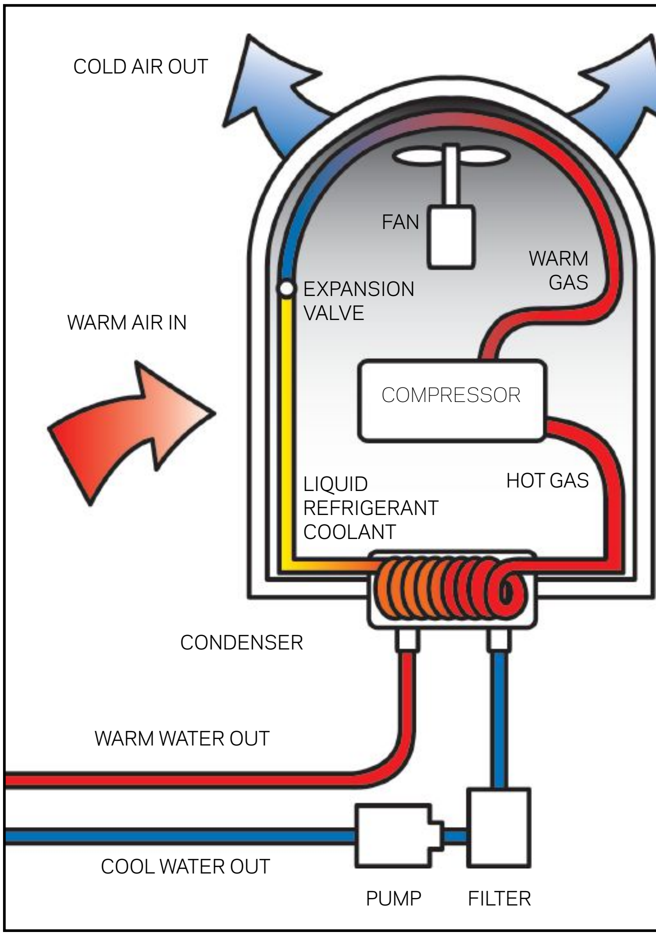
A look at how a heat pump works, what it can do and tips on how to install it

The heat pump has established itself as a viable product in the pool industry. Using a compressor, a refrigerant and an evaporator to cool the air, it essentially acts as an air conditioner.

The warm, humid climate of Florida has become the fastest-growing market for heat pumps. It's estimated that approximately 50,000 units are being installed each year, with the vast majority sold in the Sunshine State.

Until recently, heat pumps have not been especially energy-efficient because that was not a critical factor in their design. Therefore, little effort was made to produce a heat pump with a high coefficient of performance.

But since the 1970s, people have become increasingly concerned about the cost of fuel. More and more nations work toward becoming self-sufficient in energy. The result has been a dramatic improvement in the efficiency and design of heat pumps. This has significantly increased performance.



Inside view: This cutaway drawing of a heat pump shows how the device captures warm ambient air and passes that warmth on to the pool water. The diagram also illustrates how superheated liquid refrigerant plays a key role in the process.

HOW IT WORKS

A heat pump works by capturing heat in the air and transferring it to the pool water. Air temperature and humidity play important roles in creating a heat source. The more moisture in the air, the more heat the pump can extract.

The heat pump process begins by compressing and superheating the refrigerant. This superheated refrigerant moves through the heat exchanger and passes heat on to the swimming pool.

In refrigeration terms, the heat exchanger is the system's condenser. As the refrigerant gas condenses into a liquid, it gives off most of the heat it has absorbed. After condensing and then releasing its heat into the pool water, the refrigerant passes through an expansion valve. This valve controls the flow of the refrigerant from the high-pressure side of the system into a low-pressure zone.

As the pressure is released, the refrigerant turns into a gas. As it expands into a gas, the refrigerant cools rapidly. The cool refrigerant is then circulated through the evaporator. The evaporator coils surround most or all of the surface areas, creating the main structure of the heat pump.

As the fan draws warm air across the evaporator coils, the cold refrigerant gas is pre-heated. It's during this phase of the heat pump's operation that "free" heat is captured. The warmer the air, the more heat the evaporator can absorb.

As the heat is drawn out, the moisture will change from its vapor form into a liquid. The liquid that is createdduring this process is called condensation. The condensation collects in the base of the heat pump, where drainage is provided to channel the water into a specific line or other suitable location.

SPECIAL FEATURES

For heat pumps to operate effectively in lower temperature climates, the refrigeration effect must be controlled sufficiently to prevent frost from building up on the evaporator coil. In most cases, this is accomplished by running the fan with the compressor shut down. The flow of air over the evaporator will remove the frost.

In areas where the temperature frequently drops below 55 degrees Fahrenheit, it is recommended to use models featuring hot-gas bypass. This feature reverses the flow of compressed refrigerant through the evaporator. The hot, compressed refrigerant gas quickly melts any accumulated frost and the heat pump can switch back to its normal mode, heating the pool.

The same feature used in cold weather also can be utilized by heat pumps to chill pools in the hottest climates. Operating a heat pump in the "chiller" mode keeps pools in hot climates refreshing. It also helps reduce the peak sanitizing loads often created by higher temperatures.

PICKING YOUR HEAT PUMP

Selecting the proper heat pump size is not as easy as picking the right natural gas or propane appliance. Because the ambient temperature plays such a critical role in a heat pump's operation, the local weather must be taken into account to determine the correct heat pump capacity. Most major manufacturers have spent considerable time developing sizing software programs that help identify the proper model for specific regions and pools.

It's important to remember that a heat pump works by using the surrounding air. Avoid installation locations that will restrict the flow of air around the unit. Keep in mind that a heat pump cools and expels chilled air. Locations that recirculate this chilled air around the unit operate far less efficiently than installations that provide unrestricted circulation of fresh air.

Exposure to direct sunlight also provides measurable heat absorption by the evaporator. A sunny, open area will work best in every case.

Symptom: Heat pump not running.

Cause:	Procedure:
The power is out	Ensure the main breaker at the power supply panel and the disconnect switch, located near the heat pump, are on. Check for a tripped breaker.
The thermostat is set too low	The actual pool water temp may be higher than what's set on the thermostat. Adjust the thermostat higher.
There is diminished water flow	Make sure all water valves are in the correct position, and that the filter and pump basket are clean.

Symptom: Heat pump running, but not heating.

Cause:	Procedure:
Air flow is compromised	Ensure all air coil surfaces are free from obstructions (low roof overhangs, landscaping, walls, fences, etc.). The heat pump needs good air flow to operate at peak efficiency.
Heat pump cycle is too short	Extend the pool pump hours. If temperatures are low, the heat pump needs additional time to run properly.
The heat pump is in defrost mode	Wait. The heater will remain in defrost until the evaporator is free of ice.

Symptom: Water is coming from the heat pump.

Cause:	Procedure:
Normal condensation	Shut the heat pump off, leaving the circulation pump running. If the puddle dries, the water is probably harmless condensate. It's typical for the heat pump to emit up to 8 gallons of water per hour.
The unit has a leak	Test the water for the presence of sanitizer. If it tests positive, a leak is present, and must be pinpointed and eliminated.

Symptom: Heater is short cycling.*

Cause:	Procedure:
Water flow is compromised/water pressure is low	Make sure all water valves are in the proper position, and that filter and pump skimmer baskets are clean. Ensure the water level in the pool is above the skimmer.
Fan is not operating properly	Inspect the fan motor/capacitor as needed. Be sure the evaporator is clean and free of air-restricting obstructions.

* Warning: Before removing the heater access panel, be sure you are properly certified. Many manufacturers require that only authorized service personnel perform this task.

Pool & Spa News thanks AquaCal for the technical assistance provided in this troubleshooting guide.

Solar Heater Care

Typical issues that arise with solar pool-heating systems, and how to fix them

Solar heating systems are growing in popularity among pool owners. Thermal systems, where water is circulated through panels on the roof using the pool's pump, especially have made inroads in the market. Here is a brief explanation of how thermal systems work and some typical problems you may encounter.

PANEL DISCUSSION

Over the years, solar panels and coils have been composed of a variety of materials, primarily copper, rubber or plastic. Today, copper has become rare because of its cost and tendency to corrode. Plastic dominates an overwhelming portion of the market.

There are many plastic panel configurations. The system involves two large tubes that frame a series of smaller perpendicular ones through which the water flows.

To calculate the number of square feet of solar panels needed, many experts simply match the square footage of the surface of the pool. If the roof faces south or west, however, they may use less.

The majority of installations are done atop the roof. If it is too steep or shady, however, an independent structure must be built to accommodate the panels.

Once on the roof, the panels can be attached with a variety of hardware. Most drill through the roof's tiles/shingles to hold the brackets in place and then inject a UV-protected silicon into every hole. The silicon helps deter leaks, and the brackets keep the panels in place. To guard against the wind, the panels are strapped down. And, adjustable header clips are attached to the tops and bottoms of the panels.

Then, the panels are plumbed into the pool's circulation system. This step may vary, depending on the manufacturer and the distance of the pool to the house. Lastly, the system is automated via a control pad. Sensors on the rooftop panel and at the controller monitor the temperature of the water in the tubing and in the pool, so adjustments can be made accordingly.

TYPICAL ISSUES

While the technology used in solar heating has been around for ages, the systems themselves still can fall victim to the occasional glitch. For detailed information on your specific system, refer to the manufacturer's manual. Following are six typical solar system problems that service techs may encounter, along with tips on how to fix them.

1. Controllers

As is the case with most controllers, whatever can go wrong with an actuator valve can go wrong with these systems as well, experts say.

A common culprit is the pool owner, who often will leave the toggle switch in the wrong position. When this happens, the pump won't operate even if the sensors indicate it should.

To remedy the situation, some simply glue the switch in place so it can't be moved. If the pool needs to be shut down for maintenance, the tech can bypass the switch by going directly through the control panel.

At the control panel, you'll find the thermostat and a switch that reads "automatic,"

Warming up: Most solar collectors are installed on the roof, as long as they're not too steep and there's not too much shade.

SOLAR HEATING SPECIALISTS

"on," "off" and so forth. All you need to do is turn it to the off position when necessary; for instance, when you're backwashing.

2. Sensors

The 10k-ohm sensors these systems use can wear out. If you suspect this is the case, attach your meter to the sensor. It should indicate that it's getting at least 10k ohms. If it's not, it needs to be replaced.

3. Vacuum-relief valves

Vacuum-relief valves are plumbed into the system on the roof and allow water to drain back into the pool. Because the valves open and close, over time they can wear out.

Debris also can get inside and clog them. You can easily tell that you have a problem when you notice water is coming off the roof, experts say.

Some models are engineered with the valve threaded in place. Others use a clamp to hold it.

4. Panel connections

Rubber couplings or O-rings connect the panels. They have the potential to leak if they loosen. Use a screwdriver to tighten up the stainless steel clamps that surround them.

5. Isolation valve

Make sure the isolation valve is on. Turning it off while the solar system is in automatic mode can cause severe damage to the pump in the event the system turns on. If you need to service the pool equipment, shut off the valve. But be careful to turn it back on when you're finished.

6. Panel problems

Modern polymer panels are made to last 25 years, but eventually the tubing can split. Sometimes this may require a whole new panel. Other times the individual channels that are broken can be plugged off with a stainless steel screw, dowel or tapered rubber plug.

Installation Tips

continued from page 56

Once again, sizing is critical: Manufacturers provide specific pipe-sizing recommendations or pipe-sizing charts based on flow rates and distance of run.

One key consideration: When using PVC piping, position a heat sink between the heater and the piping — typically a metal pipe approximately 2- to 4 feet long. For best performance of the resulting PVC/metal connections, use a metal male fitting and a PVC female fitting. Where allowed by codes and manufacturer's instructions, CPVC — a high-temperature version of PVC — can be connected directly to the heater. To compensate for pipe expansion, a flexible sealant should be used on all piping connections.

Note: Some heaters now are designed to allow for direct PVC connections.

To avoid damage to plastic filter elements that might be caused by backsiphoning of hot water into the filter, a check valve should be placed in the line between the filter and heater. Likewise, to prevent water with high concentrations of chemicals from backing up into the heater and possibly corroding the heat exchanger, there should be a special chemical-resistant check valve between an in-line chemical feeder and the heater.

The installation may or may not require use of an external bypass valve and a pressure-relief valve: Be sure to check the installation manual for each model's requirements and other conditions that may require such control devices.

WIRED FOR HEAT

Millivolt (or continuous pilot) systems do not require electrical service to the heater. To enhance energy conservation, however, some areas have required heaters to use intermittent-ignition systems, which do require electrical hookups or line voltage.

For most applications, a qualified, licensed electrician must perform or evaluate this part of the job — from the circuit breaker panel to the heater, or from the load side of the time clock to the heater.

Most heater models accommodate either 120-volt or 240-volt power. The National Fuel Gas Code requires 14-gauge copper wire for electrical service to gas heaters. Electrical wiring should be run in a waterproof conduit and hard-wired into the unit.

If the circulation system is run with a timer, older heaters should be equipped with a low-voltage switch that deactivates the heater before the pump is turned off. This circuit is known as the heater's fireman switch.

On a millivolt heater, the length of wire between the heater and the timer should not exceed 30 feet. Resistance on longer runs will reduce the millivoltage to a level that will not support reliable operation of the gas valve.

Finally, all such high-voltage circuits require grounding and bonding in accordance with the National Electric Code.

Pool & Spa News thanks Raypak Inc. for their assistance with this article.

Latest innovations

The technology for solar systems hasn't changed much over the years, but there have been refinements. One has been the addition of fluting to the top of the tubes to increase the surface area and decrease reflectivity.

Other improvements include using stainless steel hurricane straps to increase wind resistance. These are an upgrade over the nylon or rayon straps that can deteriorate in the sun, experts say. Fabric straps tend to lose tensile strength, and a 40- to 50-mph wind gust can pull the panels loose.

Another development is wind ventilation slots on some solar panels. This also is designed to help fight wind resistance, and obtain equal flow throughout the panels.

The idea is to have metered flow, which means that the openings are set by the manufacturer to provide proper flow throughout the whole system.

Pump Selection

Tips for choosing the best pump for the pool

As unique as each installation is, all pools require the same basic calculations before a pump can be chosen. First, you must determine factors such as the pool's volume and capacity, the required water flow rate for proper water turnover and the system's total dynamic head. Then, you must ensure that the suction pipe size can handle the flow at a safe velocity.

Even if you're replacing a pump in an existing system, it's best to go through the simple calculations provided here to be sure you're installing the right pump for that pool.

Pool volume: To determine pool volume (the amount of space measured in cubic feet), you'll need the basic pool dimensions. If you don't have the specs handy, measure the pool. Don't be too concerned about absolute accuracy because close estimates will be adequate for these equations. (If you must estimate, be sure not to underestimate.) For simplicity, make your measurements in feet and tenths of feet to keep the calculations in easy decimal form.

Naturally, the pool's shape will determine which equation to use to calculate the volume in total cubic feet. To figure the volume of oval, circular, square or rectangular, and irregular or free-form pools, see "Formulas" (below) or use a smartphone app.

Pool capacity: Next, determine the pool capacity (the number of gallons it will hold), keeping in mind that there are 7.48 gallons in 1 cubic foot of water. Simply multiply the volume of the pool by 7.48.

Flow rate: Now it's time to determine the flow rate needed to circulate the pool water in a timely manner. The flow rate is simply how many gallons of water per minute the pump moves. It is tied into the turnover rate, that is, the amount of time it takes to move the entire capacity of the pool through the system. The recommended turnover time varies depending upon region and individual preferences, but eight hours can be considered an adequate turnover time. (To calculate the flow rate, see "Formulas.")

Total dynamic head: Total dynamic head (TDH) is the sum of the resistance encountered by water flowing through the pool's circulation system. Resistance is applied throughout the system, such as when water flows through elbows, fittings, valves, equipment and even through straight lengths of pipe. The TDH will affect

Formulas

How to figure pool volume:

Rectangular or square pool:
length x width x average depth* = pool volume

Oval pool:
1/2 length x 1/2 width x 3.14 (pi) x average depth = pool volume

Circular pool:
radius x radius x 3.14 (pi) x average depth = pool volume

Free-form or irregular pool: Use the equation for an oval or rectangle, as needed. To be more precise, measure the pool with a planimeter, but that's not necessary; a close estimate is all that's needed.

* To find the average depth of a slope-floored pool, measure the depths at both ends, add them together and divide by 2 .

How to measure pool capacity:

Pool volume x 7.48 = pool capacity in gallons

How to determine water flow rate:

Capacity ÷ turnover time (in hours) = flow rate per hour

Flow rate per hour ÷ 60 = flow rate per minute flow rate and therefore is an important factor in selecting the right pump. Match the TDH of the system with the TDH of the pump.

All components in the circulation system, from the skimmer and main drain to the return inlets, must be factored into TDH calculations. Referring to the circulation system blueprints, list every component and dimension, including the total length and size of PVC pipe and copper pipe, the skimmer and drains, 45-degree elbows, 90-degree elbows, gate valves, backwash valves, and the size and type of filter and heater.

The TDH will affect flow rate and therefore is an important factor in selecting the right pump.

Friction flow chart for Schedule 40 rigid PVC pipe

	1 ½-in. pipe		2-in. pipe		2 ½-in. pipe	
U.S. Gals. per min.	Velocity feet per second	Loss in feet	Velocity feet per second	Loss in feet	Velocity feet per second	Loss in feet
1						
2						
3	0.47	0.07				
4	0.63	0.12				
5	0.79	0.18				
6	0.95	0.25	0.57	0.07		
8	1.25	0.46	0.76	0.14	0.54	0.05
10	1.58	0.69	0.96	0.21	0.67	0.09
15	2.36	1.45	1.43	0.44	1.01	0.18
20	3.15	2.47	1.91	0.74	1.34	0.30
25	3.94	3.80	2.39	1.11	1.67	0.46
30	4.73	5.20	2.87	1.55	2.01	0.65
35	5.52	7.00	3.35	2.06	2.35	0.88
40	6.30	8.90	3.82	2.63	2.64	1.11
45	7.09	11.10	4.30	3.28	3.01	1.39
50	7.88	13.50	4.78	4.00	3.35	1.69
60	9.46	18.09	5.74	5.60	4.02	2.36
70	11.03	25.10	6.69	7.40	4.69	3.14
80			7.65	9.50	5.35	4.00
90			8.60	11.80	6.03	5.00
100			9.56	14.40	6.70	6.10
125			11.95	21.80	8.38	9.20
150					10.05	12.80

SOURCE: HAYWARD POOL PRODUCTS

CHART 1: A portion of a sample manufacturer chart showing friction loss of water in feet per 100-foot-length of pipe. Based on Williams & Hazen Formula, using constant 150. Complete manufacturers' charts will include additional pipe sizes.

Friction loss in fittings

	½ in.	¾ in.	1 in.	1 ¼ in.	1 ½ in.	2 in.	2 ½ in.	3 in.
Elbow 90°	1.50	2.00	2.20	4.00	7.50	8.60	10.00	10.00
Elbow 45°	0.75	1.00	1.40	1.75	2.00	2.50	3.00	4.00
"T" Straight	1.00	1.40	1.70	2.30	2.70	4.30	5.10	6.30
"T" Side	4.00	5.00	6.00	7.00	10.00	12.00	15.00	16.00
Insert Coupling	0.50	0.75	1.00	1.25	1.50	2.00	3.00	3.00
M-F Adapter	1.00	1.50	2.00	2.75	3.50	4.50	N/A	6.50
Gate Valve	0.30	0.40	0.60	0.80	1.30	1.50	1.50	2.00
Swing Check Valve	8.10	8.90	11.12	13.10	15.20	19.10	27.10	38.20

SOURCE: HAYWARD POOL PRODUCTS

CHART 2: Typical manufacturer chart identifying the friction loss caused by various fitting styles. Sizes of standard pipe in inches.

Consult the pump manufacturer's head-loss charts to find the appropriate value for each component. Most manufacturers have developed their own methods for interpreting a pool's needs, so contact them to obtain charts showing their preferred techniques (see sample charts on this page). Once your list of values is com plete, add them together; their sum is the total dynamic head of the system.

If you do not know what's under the deck, there is another option to calculate the TDH. Just use a pressure meter and this simple formula:

1. Check the influent pressure of the filter tank and multiply that number by 2.31.

2. Next, use the meter to take a vacuum reading on the pump suction line and multiply that number by 1.13.

3. Add these two numbers together to get the system's TDH. For example, if the pressure reading is 12 psi, multiply that by 2.31 to get 27.72. If the vacuum reading is 5" mercury, multiply that by 1.13 and you'll get 5.65.

4. Add the two results together: 27.72 + 5.65 = 33.37 total feet of head.

CONSULT THE CHARTS

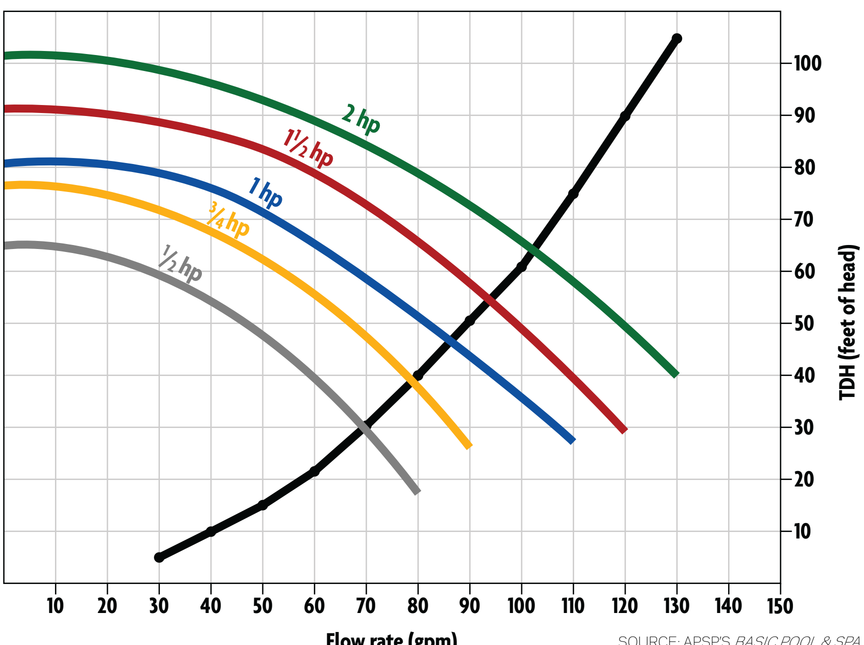
After making these calculations, the rest is easy. Consult the pump manufacturer's performance curve chart (see "System Head Curve" below). Using the flow rate and TDH numbers, determine the pump model with the appropriate horsepower.

Keep in mind, however, that these charts vary from manufacturer to manufacturer. You cannot consult a pump curve chart from Company A and then use that information to buy the same horsepower pump from Company B. It's unlikely they'll be the same.

While you'll need a pump big enough to do the job, be careful not to exceed the maximum flow rate recommended for the plumbing, filter and heater. If water is pumped through the system at too high a velocity, it may damage the equipment, cause cavitation that may harm the pump,

System head curve

Once service technicians know the flow rate and feet of head for any given pool, they can consult a manufacturer's chart, such as this one, to select the right horsepower pump for the job.



SOURCE: APSP'S *BASIC POOL & SPA TECHNOLOGY, THIRD EDITION*

Updating the pump

Pumps today are far more efficient than they were a decade ago. That can prove to be an issue when trying to replace an older pump.

Horsepower is no longer related to power output, according to pump manufacturers. Flow dynamics have improved considerably. If you have a 15-year-old pump that is 2-horsepower and compare it with a contemporary 2-horsepower pump, you'll have wildly different flow rates. The newer pump will move substantially more water.

Consequently, service technicians can make serious errors if they simply replace old pumps with new ones of identical horsepower. It could result in having too much velocity in the pipe.

New designs and materials have been responsible for the improvements in pool pumps. Falling by the wayside is the old bronze, open-face impeller. In its place are models that use closed-face impellers.

The older, open-faced impeller pumps used the front part of the pump housing, aka "the volute," to create the actual pump action. As the impeller wore from friction and/or low pH, a bigger gap would form between the fins and impeller, and it would begin to pump less and less water.

Oddly, on pools where an open-faced impeller pump was oversized to begin with, the wear and tear actually would bring the flow-rate specs to where they should be. However, this stroke of luck should not be relied on when sizing pumps today. Because the modern plastic impellers are relatively impervious to wear, it's even more important to get it right the first time.

Symptom: Noisy pump.

Cause:	Procedure:
Undersized influent piping	Compare pump size to pipe size; downsize the impeller and defuser if possible.
Blockage in influent line/full pump strainer basket	Check the line and basket; remove any obstructions.
Air lines leak in influent line	Find and repair leak.
Unsecure/unlevel base	Ensure pump sits level; secure it to equipment pad to avoid vibration.

Symptom: Noisy pump.

Cause:	Procedure:
Insufficient electric voltage	Check voltage with voltmeter at the motor terminals, the ground wire and the meter while pump is running; check wiring instructions and consult electric company, if necessary.
Loose electrical connections	Disconnect power and check for loose electrical connections.
Two-speed pump in low speed	Switch pump to high speed.

These guidelines were prepared from materials provided by Hayward Pool Products Inc., ITT Marlow Leisure Products, and Pentair Aquatic Systems.

or strip the metal from copper pipes, producing leaks and copper stains.

Pool piping must be of the correct size to handle the needed flow rate without causing the water to flow too fast. Water velocity should not exceed 8 feet per second for discharge (pressure) piping or 6 feet per second for suction piping when PVC piping is used. (This complies with the new California Standards, which went into effect in January 2008.) In the case of copper piping, the velocity should in no case exceed 8 feet per second, according to APSP's residential pool standard.

UP TO SPEED

Just a few more points to ponder before deciding which pump brand you want.

Two-speed pumps, which are popular in the spa sector, also are being used on residential pool systems for increased energy efficiency. Such pumps typically are run on low speed for normal circulation and filtration, then switched to high speed to operate an automatic cleaner or when a heavy bather load dictates increased filtration is necessary.

New on the market are variable-speed pumps. These pumps have three main components: a wet end, a motor and a drive. The drive separates this pump from standard pump models. The drive is engineered to find the optimum flow for a given task — whether it requires high flow such as when operating spa jets, or a lower level such as what's needed to perform basic circulation. Using the optimal flow minimizes energy consumption.

Regardless of the pump type used, the pump and electric motor typically are sold as a single unit. If you need to replace just the pump — or just the motor — be sure to keep three factors in mind: the mounting face, the shaft and the horsepower (which will be regulated by the energy draw needed by the pump impeller).

Acknowledgements: Technical information was provided by Baker Hydro, Hayward Pool Products Inc., Jacuzzi, Pentair Aquatic Systems, and Premier Spring Water Inc.

Variable-Speed Pump Basics

How to properly work with the EcoStar variable-speed pump

To ensure the correct installation and programming of the EcoStar Variable Speed Pump, it's critical to read the owner's and installation guides. The EcoStar should be installed in accordance with all federal, state and local codes and regulations.

INSTALLATION

Before removing the existing pump (if one is already installed), take readings from pressure (discharge) and vacuum (suction) sides of the pump to help with the installation of the EcoStar. These readings can be taken from the two drain plugs: one in the suction part of the basket and the other in the area of the impeller or pressure side. After removing the old pump, follow the wiring requirements in the EcoStar installation guide. In most cases, the existing breaker will not need to be removed and replaced; the EcoStar only needs a 15-amp breaker.

Note: if being installed on a Hayward/Goldline control, the high voltage to the pump should come directly from the breaker and not the filter pump relay. If you're using a third-party control, the high voltage to the pump should come from the filter pump relay.

MAXIMIZING FLOW

Now that the EcoStar is installed, thread in the pressure and vacuum gauges, and ramp up the speed of the EcoStar manually until the readings from the original pump are matched as closely as possible. This gives us a base line or maximum flow setting for the EcoStar. (In other words, we are closely matching the flow of the old pump.) From this reading, a sound assessment can be made when programming the circulation time and other pool functions, such as the cleaner, spa and water features.

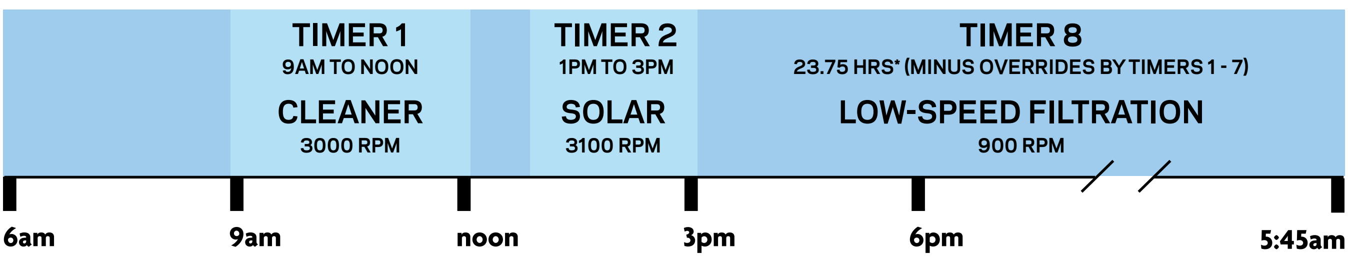
Another way to determine the maximum flow rate is to ramp up the speed of the pump until it cavitates. (Cavitation occurs when the suction side cannot provide enough water for the discharge.) Reducing the speed until the cavitation stops gives us the maximum setting. Getting the minimum setting is a little tricky. It important to provide enough water to fill the filter while operating other elements, such as a salt cell. Make sure your minimum speed fills the filter with water (which will be dripping out of the air relief), and that other items required during circulation are operating properly.

PUMP AFFINITY LAW

Let's touch briefly on the Pump Affinity Law. In essence, when you cut the speed of a pump in half (from any speed) you

Prioritizing the timers

The EcoStar's built-in programming allows you to set up to eight timers. Timer 1 overrides timer 2, which overrides timer 3, etc. Therefore, follow these two basic steps:



1. Think of timer 8 as the background environment, and set timer 8 to the lowest speed that will ensure one full turnover of the pool/spa's hydraulic system every 24 hours (900 rpm in our example avove).

2. Tasks needing high-speed operation can then be assigned higher priority timers. In our example, the cleaner needs 3 hours at 3000 rpm, and the solar heater is given a 2-hour window at 3100 rpm.

Note: task durations and rpm's depend on system-specific factors, and therefore must be customized for each system. *Maximum daily cycle is 23 hours, 45 minutes (if the on and off time is set the same, that specific timer is turned off).

will flow half the water at a quarter of the head pressure along with an eighth of the electrical usage. Note that when you apply the law again, the savings continue. Having the ability to set the right speed has benefits other than energy savings.

1. Each piece of pool or spa equipment that has a recommended flow rate to operate can be set for a specific speed and time.

2. Running the water slower through the filter will typically capture smaller particles.

3. Better distribution of chemicals occurs since you are running for a longer period of time.

4. Reducing the flow of water helps to reduce the wear and tear on equipment.

5. Last but not least, low-speed operation yields quiet pump operation.

PROGRAMMING

Let's address programming the EcoStar standalone model. When you start to program the EcoStar you will instantly notice that it is like programming a Hayward/Goldline control. Fortunately, there's no learning curve required for understanding a new method of programming.

The EcoStar comes with all you need to control the time settings and speeds you are looking for in a variable-speed pump. It has eight timer/speed settings that can be set for circulation, cleaner, heater, spa, and water feature-operation, along with other features you may need for flow control. In line with setting the lowest speed possible for filtration, refer to the illustration. It shows that shows a typical pool setting to help with programming your EcoStar. To help with timer/speed settings 1-8, 8 is the least dominant with dominance increasing to 1. As an example, setting the circulation to be timer/speed setting 8, and all the other functions 1-7 will override the circulation setting for cleaner, heater, spa or water feature operation as needed. The control panel on the EcoStar can be positioned four different ways along with remote placement up to 500 feet away.

CONTROL

Controlling the EcoStar through a Hayward/Goldline controller is accomplished through a two-wire connection between the two. High-voltage wiring for this connection is between the breaker and pump. Do not run the high voltage from the filter pump relay. With a simple set-up in both the pump and control, the Hayward/Goldline control will take over and provide the same functionality as does the standalone.

The EcoStar pump can also communicate with third-party controllers. Please refer to the installation and technical guide for more information and instruction. As stated earlier, the high-voltage wiring to an EcoStar pump from a third-party control would need to come from the filter pump relay for proper operation.

Author: Scott Petty is the product manager for pumps and above-ground equipment for Hayward Pool Products in Elizabeth, N.J.

Promoting energy-efficient options

With energy costs on the rise, many pool owners seek products that are more energy efficient and can save them money. In some cases, state governments have imposed regulations in an effort to conserve energy. California's Title 20, for instance, regulates the operation of inground filter pumps and pump motors by requiring lower speeds, which leads to less energy consumption.

Most pool pump motors operate at 240 volts and generate 3,450 rpm when running at full speed (based on standard U.S. electricity, which is 60hz). A variable-speed pump motor offers an operating range of 172 rpm to 3,450 rpm. Where a regular pump operates on standard single-phase power, a variable-speed pump comes equipped with a converter box to alter the current to three-phase power. This gives the variable-speed pump the ability to reduce the power in 5 percent increments, allowing the pump to be programmed for multiple tasks — drawing just enough energy to complete each one.

Installation info

Once you've selected the proper replacement pump, it's time to install it. Check out the old installation because the pump may not have been placed in the most efficient and/or safe location. Here are a few more tips, offered by the Association of Pool & Spa Professionals' *Basic Pool and Spa Technology, Third Edition* textbook:

- Place the pump and motor in the driest location possible, and be sure there's plenty of room for free circulation of fresh air.
- Install the pump on a firm, level foundation to keep vibrations to a minimum. Then secure the pump to the base, if necessary.
- Arrange the pipe into and out of the pump to meet connections freely and squarely. Do not strain or torque the pipe to line it up with the pump.
- Place the pump as close to the source as possible. Run piping directly and use as few fittings and elbows as possible.
- Air in the system can hamper pump and filter operations. To prevent that from happening, make sure the suction line joints are airtight.

Replacing Seals

How to repair and replace seals on pool pumps

The pump is the most important part of a swimming pool's circulation system. When the pump isn't working, nothing else does either.

PUMP PARTS

Pool pumps consist of the same basic parts: the pump pot, pump basket, vacuum chamber (or volute), impeller and seal. They work in unison so the pump can generate suction. The pool water enters at the pump pot, which holds the pump basket and keeps a reserve of water that the pump needs to prime itself.

The water that enters the pump first must pass through the pump basket. The basket sits inside the pump pot and catches any debris that gets sucked in while vacuuming or from around the skimmer basket. It prevents the debris from clogging the impeller.

The pump action takes place in the vacuum chamber, which houses the impeller that moves the water. The impeller attaches to the motor and spins inside the vacuum chamber. The impeller will either be an open-faced, which has visible vanes, or a closed-faced model, which is plastic and has a cover over the vanes with an opening in the center to allow the water to enter. Last in line is the seal. The seal has an important job to do: Prevent water from leaking out of the vacuum chamber and air from leaking in. The seal must keep the water in the wet end of the pump so the dry side does not get damaged.

Now, how can water leak out from a vacuum chamber? Inside the pump, a vacuum is created at the eye of the impeller. Water is thrown out of the impeller creating velocity within the diffuser, which is converted to pressure. If the motor shaft seal is bad, this water under pressure will leak out through the seal.

REPLACING THE SEAL

Replacing a leaking seal is one of the first repairs a service technician learns. The following pictorials will provide a series of tips and tricks to make this repair easier and faster.

Robert H. Foutz Jr., is the owner of Purity Pool Service in Huntington Beach, Calif.

Pump seal replacement

Pumps have the same basic parts: pump pot, pump basket, vacuum chamber (or volute), impeller and seal. This guide illustrates how to properly disassemble a pump when required for maintenance and service.

1

2

1. Begin disassembly by removing the bolts or clamp assembly that hold the pump body (volute) to the motor.

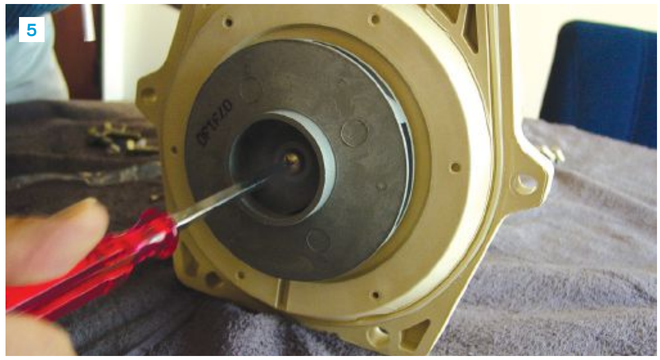
2. Pull the motor out and away from the volute.

3

4a

4b

5



6a

6b

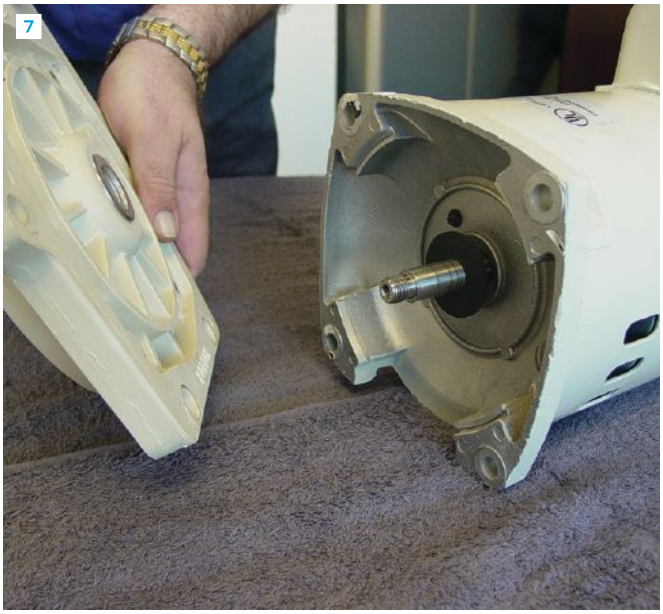
3. Pumps have a diffuser that covers the impeller; remove the diffuser to gain access to the impeller.

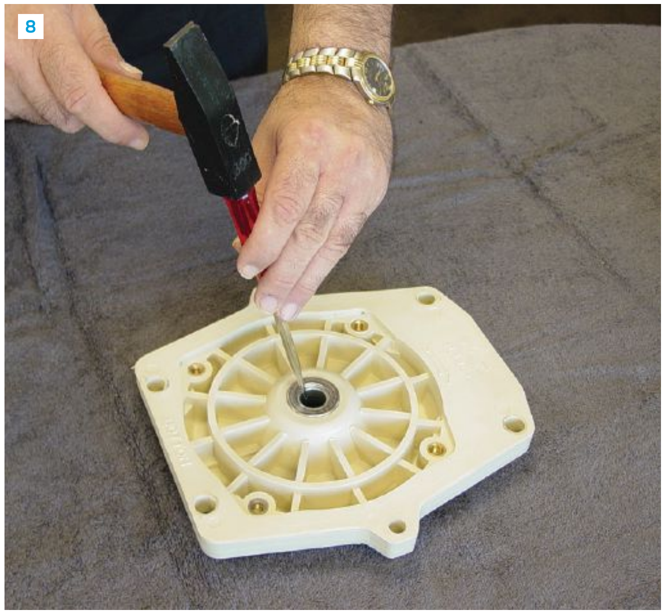
4. Using a small-blade screwdriver, remove the shaft cap from the back of the motor. Note: Some motor shafts are exposed by removing the motor cap. The back of the shaft is the only place on the pump where you can hold the shaft to remove, and later tighten, the impeller. Most motors use either a 1/2- or 7/16-inch open-end wrench (a few require a large-blade screwdriver) to hold the shaft.

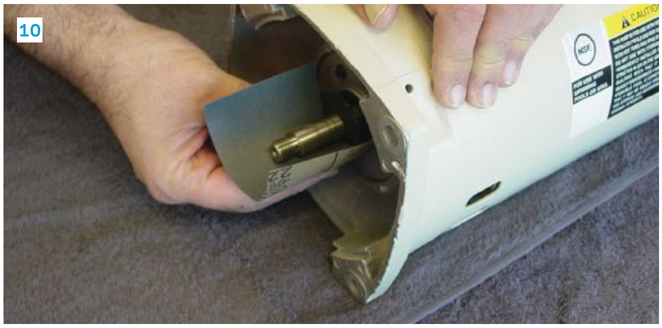
5. The set screw is in the eye (middle) of the impeller. Remove the set screw in the front of the pump while holding the shaft at the back of the motor. The set screw is a left-handed thread, so to loosen it, you must turn it in the opposite direction (as if you were tightening it). Note: Impeller screws are model-specific; some pumps may not have a screw.

6. Remove the impeller by holding the shaft in back of the motor and using a strap wrench on the impeller. This is the wrong wrench (left). Never use a metal wrench, such as a pipe wrench, or tongue-and-groove pliers. A strap wrench (above) applies even pressure around the entire impeller, but a metal wrench does not and can crack the impeller. Note: The impeller is a standard right-hand thread.

Pool & Spa News thanks Pentair Aquatic Systems for providing the pump featured in this article.







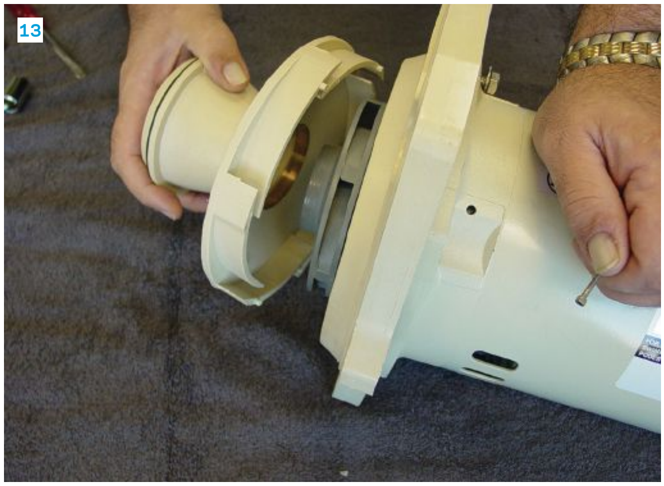
7. The pump is completely disassembled. Remove the seal plate from the motor.

8. Extract the seal by tapping it out with a hammer and screwdriver. Trying to remove the seal in one big blow could crack the seal plate.

9. The seal needs to be tapped in gently, applying even pressure. Place a 1-1/4-inch PVC coupling over the seal and tap it in. This will help provide even pressure around the seal and prevent you from hitting one side harder than the other, thus denting the stainless steel on the seal, causing a leak.

10. Clean the motor shaft with emery cloth.

11. Replace the seal plate. Note: On some models, the seal plate is held in place once the impeller is screwed into place.



12. Hold the shaft at the rear of the motor spin on the impeller and hand-tighten only. Install a locking screw (remember, it's a left-hand thread) and tighten. Replace the shaft cap.

13. Replace the seal plate gasket before putting the diffuser back on (shown); a thin layer of silicone lubricant will help hold it in place.

14. Replace the diffuser and the O-ring; a layer of lubricant will help this piece slide into place in the volute.

15. Put the motor assembly back into the pump body (volute).

How a pump pumps

Swimming pool pumps use centrifugal force to move water through the circulation system.

"Centrifugal force" is defined as a force pulling an object outward as it rotates around a center. A good example of that is a looping roller coaster. The loops always turn into themselves; that way the riders are facing into the loop. As the roller coaster enters the loop, centrifugal force then pushes the riders (the object) away from the center of the loop and safely into their seats. The riders are actually at their safest when they turn upside down.

A pool pump works the same way as the roller coaster. When water enters the middle (eye) of the spinning impeller, it is forced out through the impeller's vanes. This action creates centrifugal force, an object moving away from the center. As the water is thrown out to the edges of the impeller, there is a reduction of pressure in the eye of the impeller. This creates a vacuum and draws more water into the impeller.

— R.H.F.

Pump Troubleshooting

A problem-solving guide to diagnosing issues with the pool system's heart

Symptom: Pump is hard to prime or loses prime.

Cause:	Procedure:
No water in pump	Fill pump with water and prime again.
Low water level in pool	Raise water level above skimmer mouth.
Closed valve	Open all valves in the circulation system.
Plugged line	Check strainer basket, skimmer basket and pump; clean if necessary. Blow out the line to clear any obstructions.
Strainer pot cover not sealed	Examine strainer pot lid and O-ring or gasket; clean, lubricate or replace as needed.
Air leak in influent line	Tighten all pipes and fittings on line. Also, pressure-check line to locate leak; make necessary repairs.
Vertical suction lift from drain to pump is more than recommended by manufacturer	Move pump vertically to within 15 feet (or the distance recommended by manufacturer) of the water source.
Seal flange positioned incorrectly	Correct alignment of seal flange.
Worn pump seal	Check pump seal and replace if necessary.
Impeller out of alignment	Replace the impeller.
Impeller plugged or jammed	Examine impeller and remove any obstructions.

Symptom: Leaking pump.

Cause:	Procedure:
Defective pump seal	Replace seal.
Defective housing O-ring	Replace O-ring.
Defective strainer lid (O-ring/gasket)	Replace O-ring or gasket, as needed.

Symptom: Motor runs, but the pump won't prime.

Cause:	Procedure:
Plugged pump impeller	Clear debris from impeller; spin impeller and motor shaft by hand to ensure free movement.

Common Fixes

How to repair three typical motor problems

Here are three of the most common motor problems and step-by-step instructions on how to fix each one:

HUMMING AND GROWLING

Humming is usually a smooth, electrical noise; it's not metallic-sounding. Growling sounds like two pieces of metal grinding together. You can hear the shaft trying to turn.

For growling, pop the motor's center cap (opposite shaft end) and expose the end of the shaft. Look for excessive movement. The shaft should be able to rotate freely, but not side to side.

If the growling is caused by the bearings spinning in the housing or the rotor spinning the bearings, it means you've lost the bearing journals.

The bearing journals are the part of the shaft on which the bearings press. If the bearing journals on the shaft are lost, you'll need to replace the entire motor. However, if the problem is in the end housing, you likely can swap it with an end housing from a used motor.

If the motor howls, it's likely the bearings themselves are worn out, and it's time to disassemble the motor to replace the bearings.

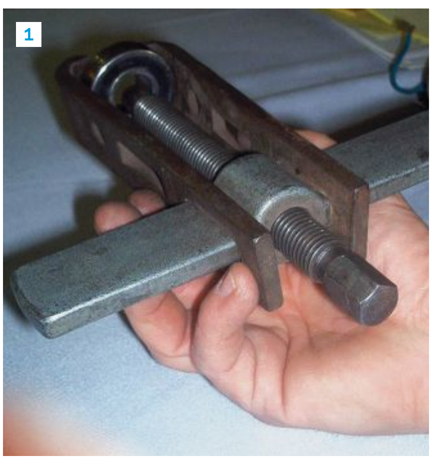
Photo 1: Use a bearing puller to remove the two bearings. Determine the size of the bearings and get replacements. When ordering, note the number on the bearing. These are generic parts, and no brand name is necessary.

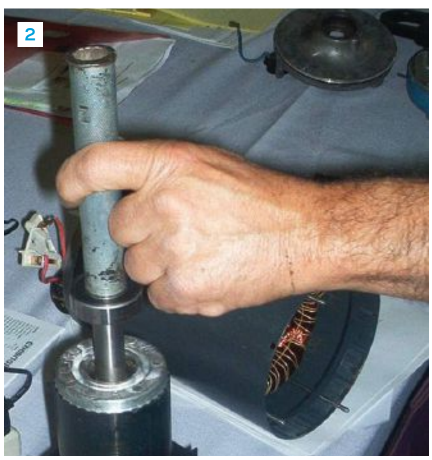
To replace the bearings, you'll need a bearing installer, which is essentially a piece of pipe the same size as the bearing. It's used to press in the bearing.

When pressing the new bearing in, do it on the inside "race" — the part of the bearing on which the balls ride. If you pound on the outer edge, you can put a flat spot on the ball, and the motor will make a loud noise when turned on.

Photo 2: Slide the bearing installer over the shaft up to the bearing and pound the installer with a hammer (use one with weight; for instance, try a 2-pound hammer). The bearing is then pushed on the race and over the motor shaft.

When doing a bearing job, always replace the seals in the pump as well. After all, the most common reason the bearings were damaged originally is because the seals leaked.





If the motor hums when you turn it on, check to see if the shaft is frozen, the same way you did when troubleshooting the growling motor.

If the shaft spins freely, but the motor still won't work and only hums, then you've likely got a bad start capacitor. (Keep a few spare capacitors on your truck.)

The points might also be dirty, or the windings could be bad. Identify the style of motor you have: capacitor start/induction run, capacitor start/capacitor run, or permanently split/capacitor run. The first two use an electrolytic start capacitor that has a variable microfarad rating, so replacing these capacitors doesn't have to be exact.

On A.O. Smith motors, for instance, screws hold a set of points in the six o'clock position. To clean them up, slide a small piece of sandpaper between the points and let the spring load close on it. Rub the sandpaper gently back and forth. Afterward, make sure the points are still connecting. Tighten them if necessary.

Retry the motor. If it still hums, replace the capacitor switch. If there are no positive results, it's time to replace the entire motor.

NO SOUND, NO MOVEMENT

The opposite of humming and growling is when you turn the motor on and nothing happens — there's no sound or movement. Use a process of elimination to discover the problem.

Put the equipment controls in the manual mode (not automatic), so you can turn them off and on at will. On older systems with manual time clocks, visually check to see that the time clock is running. If it isn't running, either the clock is bad or no power is getting to it. Check the breakers.

Turn the pump motor on. If it does nothing, usually no power is getting to the motor.

Examine the motor connections to the terminal board. Check to see if a wire is loose at its connection. Sometimes, a wire can burn right off the terminal board (known as a high-resistance connection). If the connection seems OK and the motor still does nothing, turn the system off again.

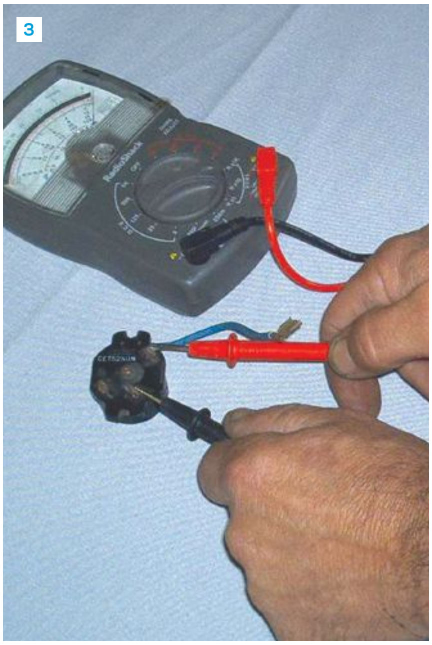
Disconnect the motor wires from the terminal board and isolate them so they don't touch anything. Turn the motor back on and use the voltage meter to check if any power is coming through. Touch one leg of the meter to one of the motor lines, and the other to the ground or neutral wire. This will show you power to ground. On a 240VAC system, both lines will show you 120VAC to ground. On a 120VAC system, you will only have power from one leg to ground.

Once you've determined that there is power to ground, check to see if it's the correct voltage. Touch one leg of the voltmeter to each of the two motor power lines. This will give you the actual voltage, and allow you to determine if one of the lines is open or not. You want it to read within 10 percent of what the motor is rated to do.

If you get a satisfactory reading, use your ohmmeter (or set your multimeter to "ohms") to test for continuity. Touch each of two line terminals on the motor with one of the terminals of the ohmmeter. If the meter registers no continuity or high ohms (in a range from 0-200), then either the motor's coils are bad or the overload has been lost. (The overload is a thermal-protection device rated to run within a certain amp range. If the temperature goes beyond those parameters, the overload can die.)

Note: When using the ohmmeter with the motor off, you're actually checking the windings and overload. The windings create a magnetic field. If the meter has no readings, it means the coils have shorted out or the overload has tripped and is not resetting.

3



4

Photo 3: To locate the overload, you may need to take the motor apart. Once you find it, disconnect two of the leads coming from it (there are usually three) and leading to the terminal board. Isolate the overload so you can test the circuits in it. Use the ohmmeter. Put one leg of the meter on one of the three overload leads and place another on the other two leads together. Any post on the overload should indicate a circuit. If not, then replacing the overload can be tough. Getting replacements is nearly impossible through pool supply houses. Your local electric motor shop may have more available sources to track down the part.

You can bypass an overload for test purposes to make sure the motor doesn't draw excessive amps before you order the part. Never leave an overload bypassed; it exposes you to liability if something happens.

If the overload has a complete circuit, turn your attention to the main coils of the motor and search for bad winding — or more precisely, a hole blown in the winding. If you find a hole, you'll need to replace the entire motor.

If the overload has a circuit and the windings appear intact but have no circuit, the chances of you finding a hole are nil. The problem has to be with the coil, but it's in a spot that you can't reach. Once you've determined that the coils are no good, it's time to replace the entire motor. Otherwise, you'd just be wasting your time and that of your customers.

DEAD SHORT

If you turn on the motor and the breakers trip, you have an entirely different problem.

Disconnect the power lines from the motor and turn it on again. If the breakers trip again, you know you have an electrical problem, and it has nothing to do with the motor. It's time to bring in a licensed electrician.

Photo 4: If the breakers don't trip, turn the power off. Place one leg of the ohmmeter to one terminal and another to the motor casing. You are looking for a dead short. If you have a circuit, then you know something went bad (probably the windings blew), and you need to replace the entire motor.

Bob Raymond is the owner of Swimco Electric in Campbell, Calif.

Motor Troubleshooting

How to easily pinpoint motor malfunctions

The motors that power pool and spa pumps are among the simplest devices serviced by the industry's technicians — especially when troubleshooting and repair are performed systematically.

Motors used on pools and spas are small in comparison with those used in other applications — typically in the 1/2- to 3-hp range. But they play a crucial role — effectively the heart of a circulation system. This makes them among the most important parts of the pool/spa package.

Because motors are such basic components of pool and spa service, motor repair is always a popular hands-on topic for service seminars and classes. In fact, this type of equipment repair is usually the first step taken by technicians who are branching out from basic service into equipment repair.

The reason for that business decision is obvious: Quick, effective motor repair can provide a good monetary payoff as well as fill in some spare winter hours of shop time.

Motor service, while straightforward, still requires a solid, systematic approach. With that in mind, manufacturers provide simple, step-by-step troubleshooting tips for service techs. The rules found herein are general enough to be applicable to most models you'll work with.

One last note: Be careful when dealing with electricity. Before you examine the motor or remove its cover, be sure to first turn off the electrical power at the fuse or breaker box!

Symptom: Motor won't start — no sound.

Condition:	Procedure:
Motor is cool	**Check power at motor terminals.** **If there's no voltage, check fuses, circuit breaker, timers and switches.** **If voltage is present, TURN VOLTAGE OFF; check for open protector and open winding.**
Motor is hot	**Check voltage at motor terminals. The voltage should be within 10 percent of nameplate rating. If voltage is low, check at main disconnect. If low at main disconnect, check for proper supply wire size. Contact an electrician, if necessary.** **If voltage is OK at disconnect, TURN POWER OFF and check for loose connections, undersized wiring, overloaded circuit or other causes of voltage drop.** **If low voltage isn't the cause, do more sleuthing. TURN POWER OFF and check the following:** **▪ Starting switch contacts are not closing.** **▪ Capacitor (if used) is shorted or open.** **▪ Motor windings are open or shorted.** **▪ Compare terminal board connections with diagram or nameplate for voltage present.** **▪ Turn motor shaft. If shaft is tight or does not turn, check bearings, look for cracks in end shields, clogged fan, debris in pump or corrosionn between shaft and seal.**

Symptom: Excessive noise and vibration when motor runs.

Cause:	Procedure:
Defective motor bearings	Check for noise while spinning the unloaded shaft.
Loose or binding parts	Inspect the pump and motor.
A bent shaft	Although a bent shaft is a rare occurrence, it is not unheard-of. To see if this is the cause, remove the motor and check the shaft run-out (straightness).
The start switch doesn't open	Turn the switch from "start" to "stop" and repeat as necessary. If the noise disappears, the switch may be defective.

Symptom: Hot or noisy bearings.

Cause:	Procedure:
The end shields are loose or cracked	Check the through-bolts for tightness. Check the frame-to-end shield rabbet fit. Spin the motor shaft; it should turn freely.
A bent shaft	Again, if this rarity is encountered, measure the shaft run-out (straightness).
A defective bearing	Check for noise or "rough" feel while spinning the shaft. Replace the bearing.

Symptom: Motor is smoking, hot or cycling.

Cause:	Procedure:
The motor is overloaded	Check for tightness in pump assembly by turning the motor shaft with a wrench or screwdriver. Check the nameplate. If the maximum load current (in amps) exceeds the motor's rating by more than 10 percent, the pump load might be excessive.
Clogged air openings	Inspect the air openings.
The voltage is too high or too low	Check voltage at motor terminals; it must be within plus or minus 10 percent of the listed nameplate voltage.
Incorrect connections	Refer to the nameplate and control diagrams.
The winding is shorted or grounded	Check the winding for damage. Check the condition of the ground. Measure the winding resistance.
Start switch fails to open	Make sure the start switch is free. Check for welded switch contacts or broken springs. Replace the switch, if necessary.
Run capacitor failure	Use a capacitor meter to evaluate. Or, check for a bulged capacitor (this sometimes indicates failure).

Motor Repair

Step-by-step tips for your customers' motor issues

For some service technicians, motor repair really means motor replacement. After all, if you don't know how to fix a broken motor, changing a malfunctioning unit may be your only option.

For others, repairing the small electric motors that power pool and spa pumps is a useful way to keep down the cost for the customer while earning a tidy profit.

When it comes to motor service, Elias Duran is an acknowledged expert. When he finishes his weekly service route, his attention often turns to motor repair — and he's been teaching the basics of motor teardown and repair for more than a decade.

The owner of Duran's Pool & Spa Service in North Hills, Calif., offers some pointers for technicians to keep in mind as they approach ailing motors:

Always use quality replacement parts, as recommended by the motor manufacturer.

When tearing down a motor or replacing parts, never force anything — or you may end up replacing additional parts.

If you need help with a motor, take it to a reputable motor-repair shop.

Be safety-conscious when working with electricity. Always be sure the motor is grounded before connecting the power. Another must: The power source needs to be disconnected before you begin working on the motor. Also be sure you are using the correct electric voltage.

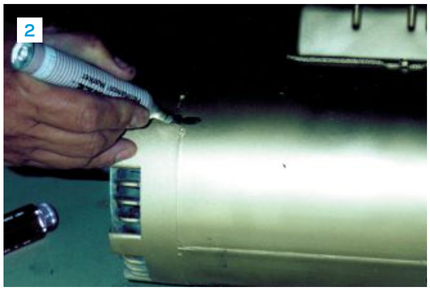
Remember that some slight differences may occur between different motor models. When in doubt, consult the manufacturer's handbook for the specific model you're repairing.

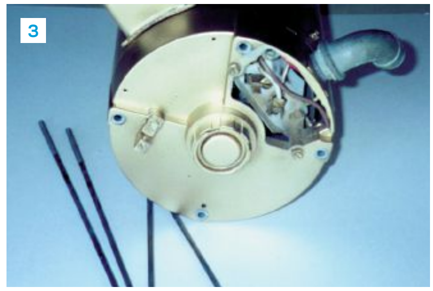
In the accompanying pictorial, Duran offers instructions on how to tear down and reassemble a motor. He also provides detailed troubleshooting tips and instruction on how to replace ball bearings, perhaps the most common form of motor repair.

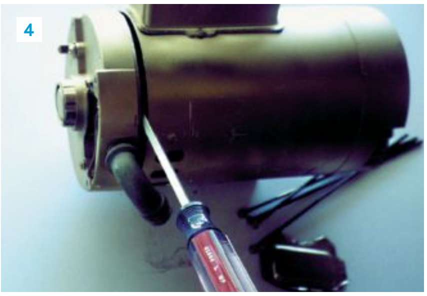
Tools for the job

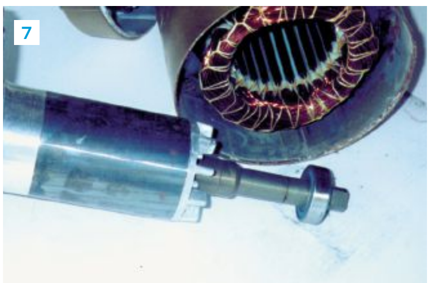
- **Flat-head screwdriver**
- **Small mallet**
- **Socket wrench or nut driver (1/4- to 5/16-inch, as needed)**
- **Bearing puller**
- **Bearing drivers (two sizes)**
- **Ohmmeter**
- **Plumber's sand cloth or emery paper**
- **Red insulating varnish spray (for windings)**
- **Spray paint (for motor housing)**
- **Masking tape**
- **Marking pen**

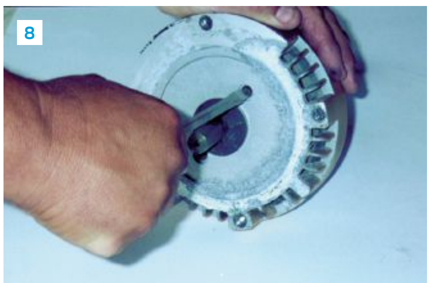
Teardown and repair

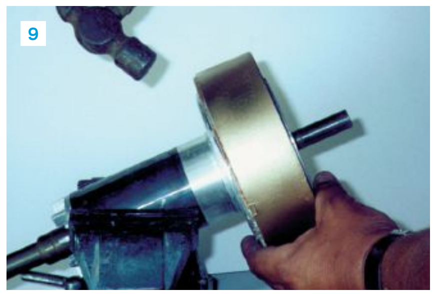












An invaluable skill for any service technician, motor tear down and reassembly are needed for most repairs. Follow these steps for tear-down, bearing replacement and reassembly.

1. Remove the terminal connection cover
Loosen the terminal connection cover's two screws with a flat-head screwdriver and remove the terminal connection cover. Check connections on terminal board. Test the electrical-line leads with an ammeter/voltmeter while supplying electric power; disconnect power before proceeding.

2. Mark the end-bell/stator alignment
Using a marking pen or masking tape, mark the position of both end bells for proper alignment with the stator.

3. Remove through bolts
Remove the four through bolts using the appropriately sized socket wrench or nut driver; bolt heads will vary from 1/4- to 5/16-inches.

4. Remove the REAR-end bell
Remove the rear-end bell (where the power is connected) by inserting a flat-head screwdriver into the appropriate notches and tapping the end of the screwdriver lightly with a mallet. Insert two screwdrivers in the side notches and apply leverage to pry the end bell from the stator. Be careful not to lose the bearing spring, which often pops out as the end bell is removed.

5. Inspection
Inspect the end bell for unusual wear. Also inspect the terminal board, electrical wiring and windings.

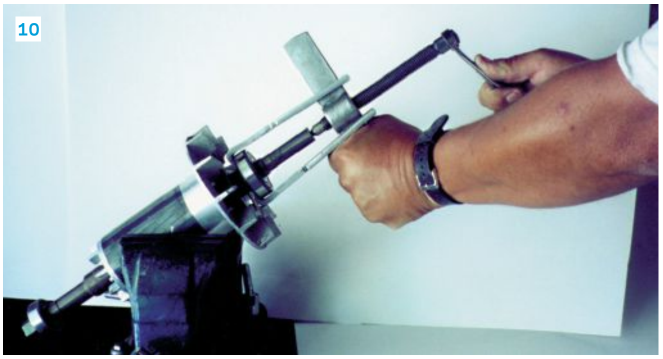
6. Remove the capacitor cover
For motor models that have the capacitor mounted inside a separate capacitor cover, remove the two capacitor-cover bolts using a flat-head screwdriver; then, remove the cover. (Omit this step if the capacitor is installed inside the end bell.) Check the capacitor's electrical continuity and ability to hold a charge with an ohmmeter or multimeter that has a capacitor test function.

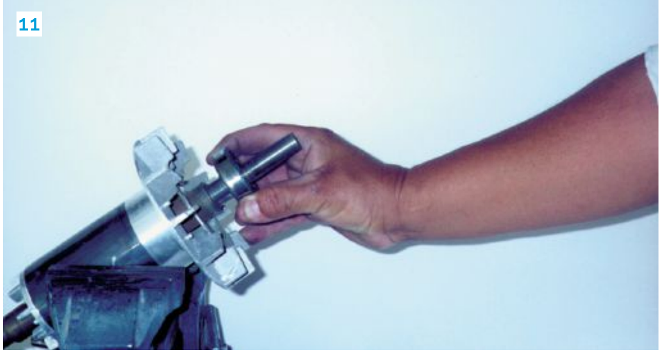
7. Remove the shaft-end bell
Repeat tapping and prying with screwdrivers as described in Step 4 to remove the shaft-end bell. Inspect the end bell for unusual wear; inspect windings for corrosion.

8. Remove the locking-ring screws
Remove the two locking-ring screws from the shaft-end bell using a flat-head screwdriver or 1/4-inch nut driver.

9. Remove the end bell
Carefully secure the rotor in a vise and pull the end bell off the shaft with your hands. If it can't be removed easily, tap it lightly with a mallet, bearing puller or small hammer. Inspect ball bearings. Clean motor parts of dust, grease and foreign matter.

Bearing replacement



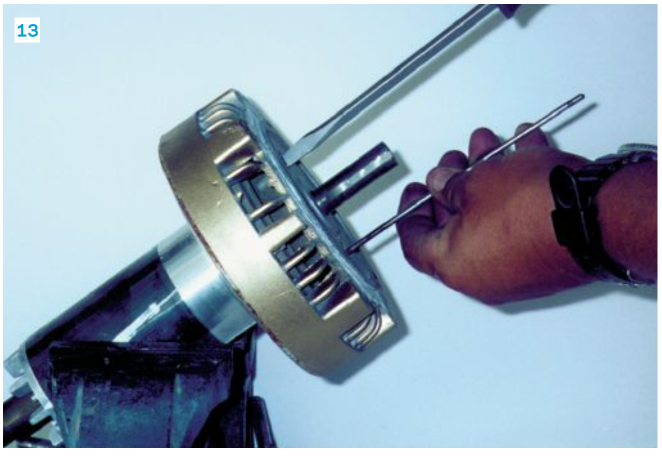


10. Remove the ball bearings
Using a bearing puller, remove the lock collar, ball bearing and backing plate from the shaft end — and the smaller ball bearing from the opposite-shaft end.

11. Replace the front bearings
Reinstall the backing plate on the shaft end. Install the new bearing. The bearing should only be put on with a bearing press or using a pipe or collar piece the same diameter of the inner race (the steel ring of the bearing that makes contact with the motor shaft), tapped lightly by a mallet until seated against the appropriate shaft shoulder or stop. Force should be applied only to this inner race to avoid damaging the bearing.

12. Replace the rear bearings
Refer to the procedure described in Step 11, excluding the backing plate.

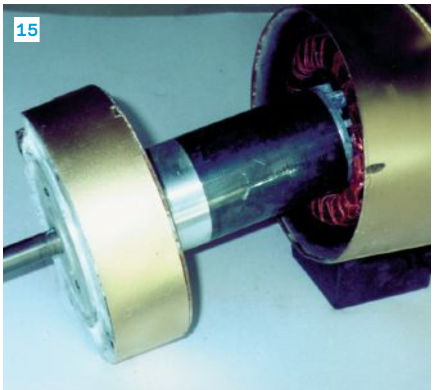
Reassembly

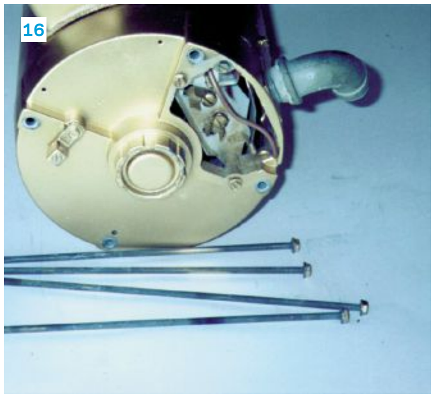


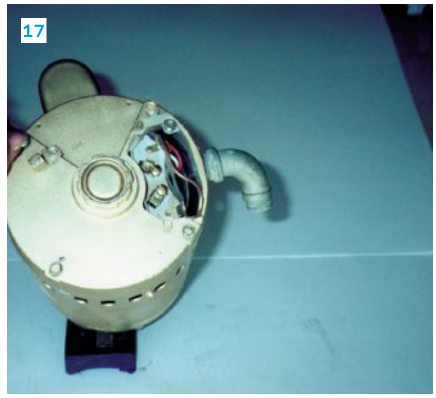
13. Replace the shaft-end bell
Slide the shaft-end bell onto the shaft; tap the end bell with a mallet if necessary. Hint: Thread two appropriately sized through bolts into the locking plate to use as guides when replacing the locking ring screws. (Bolts can be salvaged from an old motor.)

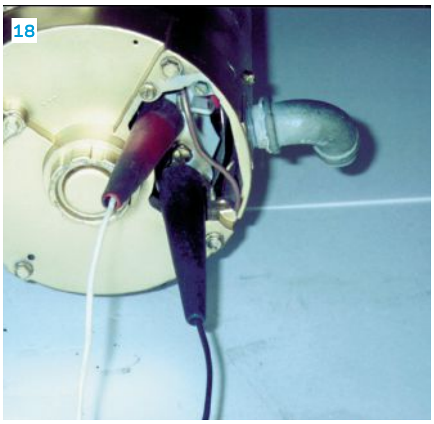
14. Replace the locking ring screws
Replace the two locking ring screws in the shaft-end bell. If you use the hint from Step 13, leave one "guide" through bolt in place while you replace the other; then replace the second screw. Tighten the two screws.

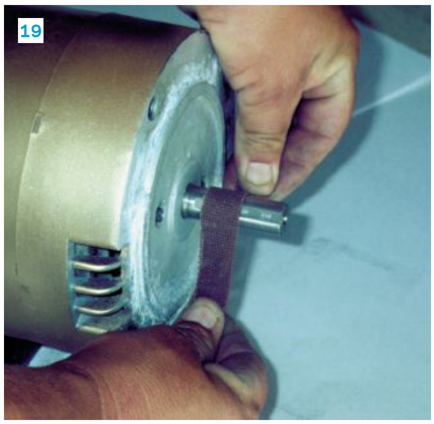
Teardown and repair

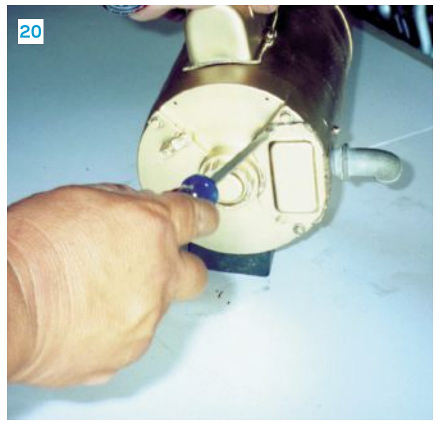












15. Reinstall the end bell

Slide the shaft-end bell back into the motor for reassembly. Be sure to match the alignment marks on the end bell and stator. Tap the end bell lightly with a mallet if necessary.

16. Replace the REAR-end bell

Slip the rear-end bell back into place after replacing the bearing spring. Be careful not to pinch any wires between parts, and match the alignment marks on the end bell and the stator. Tap the end bell lightly with the mallet if needed.

17. Replace the through bolts

Replace the four through bolts and tighten them as you would tighten the lug nuts on a car wheel — that is, a little at a time while rotating from one to another until they are all tight.

18. Test the motor

First, spin the shaft by hand to make sure it moves freely. Then test how the motor runs by connecting electric power, remembering to check for ground before connecting the power. It should run smoothly — like a new motor.

19. Clean the shaft surface

While the motor is running, clean any corrosion from the surface of the shaft by holding a strip of plumber's sand cloth or emery paper against the spinning shaft. Then disconnect the power source. Note: Use extreme caution while the motor is running. You can also manually turn the shaft to clean this surface.

20. Replace the terminal connection cover

Replace the terminal connection cover and tighten the two bolts.

The last step

You've finished the motor reassembly, but before reinstalling the unit, Elias Duran, owner of Duran's Pool & Spa Service in North Hills, Calif., suggests taking one more step: If the motor's cover is scratched, rusted or faded, give it a new coat of paint.

First clean the motor cover, then mask the nameplate and other important labels on the face of the motor with tape. (It's crucial to protect the nameplate before painting because it bears information critical for future troubleshooting or motor replacement.)

Now apply a light coat of spray paint to give the motor a clean, rejuvenated appearance.

A final hint from Duran: Use the original paint color — or, if your customer prefers, use a color that matches the other equipment on the pad.

Upping Efficiency

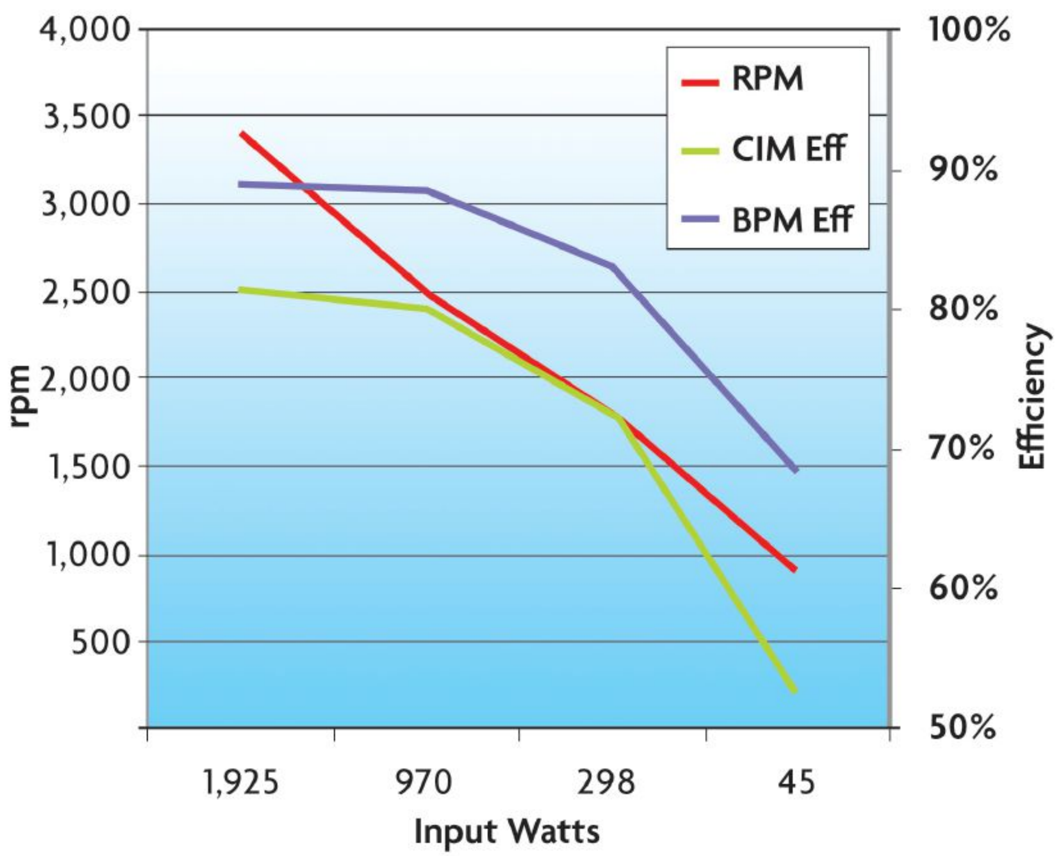
Understanding the math behind variable-speed motors makes it much easier to sell customers on their benefits

In today's economic environment, it's easy to focus on purchasing the lowest-priced item available. But educating the consumer regarding the energy efficiency of variable-speed motors will provide savings the very first year after installation. These motors can use up to 90 percent less energy than single-speed units, and often pay for themselves within two years. They are designed to outlast single-speed motors, and also are much quieter. Here are some details that will help customers understand the benefits these motors can bring.

EFFICIENCY

Variable-speed pool replacement motors are relatively new in the pump industry. This technology type, brushless permanent magnet (BPM) motor, utilizes a magnetic rotor instead of a squirrel cage rotor. BPM technology has seen rapid development in the past few years. These motors with an integrated variable frequency drive (VFD) can convert standard single phase AC power into a DC sine wave and vary the frequency of the motor. Varying the frequency varies the speed as well. The brushless design eliminates the need to transfer power to the spinning rotor and offers longer life spans, minimal maintenance and small size.

Motor comparison



Here is an efficiency comparison chart comparing a standard three phase variable-speed controlled induction motor (CIM) vs. a BPM variable-speed motor being run on the same pool pump using the same VFD. The only difference in this test is the motor type. As the chart shows, BPM efficiency is significantly higher across the speed range.

The VFD on a variable-speed pool pump replacement motor also is key in determining the overall efficiency of the product. The VFD is generally sized to match the motor in terms of performance and requirements. The VFD is the component that allows the motor and pump to run at the slower speeds.

THE LAWS OF AFFINITY

The affinity laws are used in hydraulics to express the mathematical relationship between the several variables such as head (pressure), volumetric flow rate, speed and power involved in pump performance. The affinity laws state the following:

Flow is proportional to shaft speed. $Q1/Q2 = (N1/N2)$

Head (pressure) is proportional to the square of shaft speed.

Power is proportional to the cube of shaft speed.

The key formula for us is the last one, which means that if a pool motor runs at one-half speed, the power consumption (all else being equal) will be ½ x ½ x ½ or one-eighth the original amount of power consumed. For example, if the old pool pump motor drew 1,000 watts and we replaced it with a variable-speed motor, the consumer can expect to pay for 125 watts on their next power bill. Also, because it is the motor that uses the electricity, replacing it with a variable-speed model provides virtually the same energy savings as replacing the whole pump with a variable-speed unit.

OTHER BENEFITS

A variable-speed pool pump replacement motor also is a benefit in other ways.

1. As one might expect, the initial cost of a motor is less than that of a complete pump. The same principle that applied in yesteryear's pool market, where single-speed pool motors were priced less than single-speed powered pool pumps, applies to today's variable-speed market. The difference in price between variable-speed replacement pumps and variable-speed-replacement motors can be as much as 40 percent.

2. Another key advantage of installing a variable-speed motor is that the pool's hydraulics do not need to be changed. This is often a hidden cost involved when replacing the old single-speed pump with a variable-speed pump. Many consumers simply do not need a 2- or 3-horsepower pump. By replacing the motor only with a variable-speed replacement motor, the consumer's pump performance remains properly sized, so no plumbing work is required. Often, the only way to incorporate an oversized pump into an existing hydraulic system is to enlarge the plumbing diameter — for example, changing the piping from 2-inch to 3-inch diameter. Because the installer can only perform this conversion on the visible piping, the piping under the ground or concrete remains undersized, which negates a significant portion of the perceived energy savings. By replacing only the current motor with a variable-speed replacement motor, the energy savings remain intact.

3. In many cases, a given pump is working fine, or the consumer is happy with its performance. So why replace the entire unit? Simply bring it to the latest in energy saving technology by swapping the old motor for a variable-speed replacement one.

4. Replacing the old single-speed motor with a new variable-speed replacement motor can also make the consumer's pool pump run more quietly. The difference is comparable to that between a box fan when running at full speed vs. that same box fan running at half speed. The consumer will notice this difference very quickly, especially if their equipment pad is near the pool, patio or deck.

5. These variable-speed pool pump replacement motors are generally totally enclosed fan cooled or TEFC. TEFC motors, along with the integrated VFDs, are enclosed so the weather elements cannot easily affect the life of the internal electronics. Thus, these motors will generally last significantly longer than traditional pool motors.

The VFD on a variable-speed pool pump replacement motor also is key in determining the overall efficiency of the product. The VFD is generally sized to match the motor in terms of performance and requirements. The VFD is the component that allows the motor and pump to run at the slower speeds.

Energy savings, fewer plumbing complications, reduced running noise and longer life make variable-speed motors an excellent aftermarket choice.

Jim Ellis is a senior market development manager at Nidec Motor Corp., where he is responsible for business development in the pool and spa market.

Electrical Examination

How to diagnose electrical motor problems

When an electric motor stops running, use your ohmmeter or multimeter to check the electrical system. With an ohmmeter, you can check all grounds; measure the resistance of the motor windings and overload protector; test the capacitor and insulation; and troubleshoot the starting switch.

Some ohmmeters provide a true ohm value reading (typically models with digital readouts/auto scale). Others, such as analog models with needle indicators, feature numerical ranges that reach from R x 1 — in which the meter indicates the actual value in ohms — to R x 100K (100,000 times the indicated value in ohms).

When using a variable-range ohmmeter for testing and troubleshooting, follow the meter maker's instructions regarding range selection for each test. If your ohmmeter doesn't have the exact range indicated, use the next higher range. Here, the evaluations are done with analog meters.

BE SAFETY-CONSCIOUS

Whenever electricity is involved, safety must come first. Prior to conducting any tests, review your safety precautions and disconnect all motor leads from the power source.

Also, perform a visual check of the electrical leads, wires, terminals and contacts, checking for any burned, cut, pinched, frayed or disconnected leads or wires. The following procedures outline test and troubleshooting actions you can take for common servicing.

GROUND CHECK

Check: Set the analog ohmmeter to the highest range. Attach one probe to the ground screw and touch the other probe to all electric terminals on the terminal board, switch, capacitor and overload protector.

Troubleshooting: Any ohmmeter reading of less than infinity indicates a ground. If any contact is grounded, check and repair all external electrical leads. If the ground is in the stator, you should replace the motor. Retest the grounds until no readings register on the ohmmeter.

WINDING CONTINUITY

Check: Set the analog ohmmeter on R x 1. Discharge the capacitor by shorting across the terminals with an insulated screwdriver and compare the following readings with the ohmmeter. Note: Leads can be different, depending on the manufacturer and make.

Assuming the leads function as follows:

L1 = one main winding lead

L2 = second main winding lead

L3 = third main winding lead

L4 = phase, auxiliary or "start" winding lead, then the resistance between L1 and L2 must match the resistance between L2 and L3. And the resistance between L3 and L4 must match that between L1 and L4.

Troubleshooting: If the resistance reading for either of the tests differs, check the external leads for repairs. The indicator may point to "open" for shorted windings, which will require rewinding or replacing the motor.

CAPACITOR

Check: Set the analog ohmmeter on R x 1K. Discharge the capacitor by shorting across the terminals with an insulated screwdriver. Attach one ohmmeter lead to each capacitor terminal. The ohmmeter needle should move rapidly to the right, then slowly drift to the left. Note: This test only applies to analog meters. If a digital meter is used, readings should start low and rapidly increase to maximum value. You also can use a capacitor meter to see if it is open or shorted.

Troubleshooting: Replace the capacitor if:

• The capacitor doesn't register an ohmmeter value; or, the ohmmeter reading moves to 0 and stays there.

• The ohmmeter reading remains at a high value, which indicates an open circuit within the capacitor.

• The capacitor's bleed hole looks stressed or shows signs of corrosion.

OVERLOAD PROTECTOR

Check: Set the analog ohmmeter on R x 1. Check the resistance between the overload protector terminals. Resistance between terminals 1 and 2 (disc) should be approximately 0. Resistance between terminals 2 and 3 also should be approximately 0.

Troubleshooting: Replace the overload protector if either resistance value exceeds 1 ohm.

STARTING SWITCH

Check: Set the analog ohmmeter on R x 1. Attach one lead to each switch terminal; the ohmmeter reading should be 0. Flip the rotating switch (governor or actuator) weight into the running position; the ohmmeter reading should be infinity — defined as high resistance/more than 1,000 ohms. Visually check the stationary and rotating switches when the motor is running; switch contacts must be closed when the motor is at rest and open when the motor reaches about two-thirds of full speed.

Troubleshooting: To discount a faulty starter switch, bypass the switch and repeat the above tests. Clean the points with a file or fine sandpaper. Replace the starting switch if it continues to be faulty.

Electrical Issues

Tips on tracking down electrical dangers in spas

A healthy dose of intuition and some analytical ability often go a long way in electrical troubleshooting. Quiz customers as to the specifics of the problem:

- What exactly happened to the spa?
- When was the problem discovered?
- Has the spa ever worked properly?

Be a detective. Delve into details. If customers cite a problem with water temperature, ask if it's too hot or not hot enough. Exactly how hot is the water getting? Does the heater run constantly or intermittently?

The answers can help you determine if electrical woes have caused the problem.

THE EYES HAVE IT

At the job site, begin by putting safety first and cutting off power to the spa. Locate the main electrical distribution panel or sub panel and switch off the circuit breakers feeding the spa equipment — or remove the fuses. Then, using a voltmeter or multimeter, confirm that the lines are dead.

Now begin a visual inspection of the system. Open the equipment doors and observe. This should take 3 or 4 minutes but may be the most important part of the call.

First, look at the product's overall condition. Just stand there and look at it. Is everything intact? Has lightning struck? Has someone tampered with it? Maybe there is a burned wire or other type of degradation.

Next, look inside the spa pack. You still have no need to touch anything. While examining the components, keep your customer's complaint in mind. If it was about a lack of bubbles, look at the blower. Is it corroded? Has a pipe broken? Look over the heater, pump, control panel and so forth.

If you finish the visual inspection with no telltale signs of the problem, investigate the possibility of an electrical problem. For this, you'll need to turn the power back on.

It's on? Check the ground-fault circuit interrupters for proper operation. You will find GFCIs located at the house control panel, subpanel, or on the spa itself. Simply press the test button. (Remember, GFCIs may not always protect a technician from across-the-line shocks. Avoid coming in contact with the hot line and the neutral at the same time in a 120-volt system, or touching Line 1 and Line 2 in a 240-volt system. Doing so will not create a fault to ground for the GFCIs to sense and shut down the system.)

If you run across an older spa that does

Staying grounded

CONDUCTOR COLORS & NOMENCLATURE

	120-Volt Systems	Straight 240-Volt Systems	240-Volt Systems with Neutral
Line 1	Any color other than white, natural gray or green		
Line 2	Not used	Any color other than white, natural gray or green	
Neutral	White or natural gray	Not used	White or natural gray
Ground	Green or green/yellow stripe		
Bonding	No. 8 or larger solid copper		

Part of the visual inspection during spa repairs should include checking the integrity of the ground and bonding system.

Even though the customer's complaint likely has nothing specific to do with these systems, you should protect yourself against physical harm while working on the equipment. So make the following checks and bring any discrepancies to the attention of the spa owner. (This can protect against litigation as well.)

In portable spas, look inside the spa pack and locate the green ground wire, say spa repair experts. It should enter the control panel along with the power wiring and end at a marked ground point, usually close to the input terminal block. Make sure this ground has a solid connection, not cut or loose in any way. Check for the same thing at the main electrical panel at the house and any subpanel in the circuit. Look for charred or melted wires.

When it comes to bonding, portable spas do not incorporate it in the traditional sense. Manufacturers sometimes bond spa pack components by mounting them together on a metal base, not by connecting each one via bonding wire.

Do expect to find bonded components if you're troubleshooting a pool/spa combination. Visually check that the bonding wires are intact and then get out the multimeter. Put it on the ohms setting and take a reading from the bond wire to the metal housing of the component. It should read zero.

If the meter indicates 0.1 ohms or more, the bonding wire's electrical connection has become loose and/or corroded. Double back on the inspection and pinpoint the source.

not have a GFCI in place, advise your customers of the current code requirements, as well as the safety benefits of this device.

THE PYRAMID APPROACH

If you have eliminated the spa's components as the source of the problem and confirmed that the GFCIs are functioning, verify that the power actually comes into the home and arrives at the spa components at the proper voltage levels.

First, techs should ensure that it has the proper voltage, experts say. You have to make sure you're getting the voltage you require or there will be problems everywhere.

To check for proper voltage, first hook the voltmeter up to the input terminal block of the component in question. This reading will tell you if power reaches the unit. Now go back to the home's main control panel and read the voltage there with the spa equipment running, so you get a number against which to compare the first reading. The component terminal reading should be only slightly lower than the one at the house. Note: You can only do this test with the load running; there will be no voltage drop if the equipment isn't running.

Voltage drops come about because wire and every connection add resistance. The longer the wire and the more connections in an electrical service, the greater the resistance. Voltage drop between the input voltage and the voltage at the spa should never exceed 5 percent for any wiring run. If it does, it's a problem. Three percent is ideal.

Several things can cause voltage drops: a defective breassker, a loose fuse, a burned wire at a terminal, an underground wire chopped or sliced by a shovel, or another appliance sharing the same line as the spa.

The spa should have a dedicated line, according to the experts. If something else is on the line at the same time, such as the air conditioning, it can cause a voltage drop.

To test for the lack of a dedicated line, switch off the spa's breaker and see which other appliances turn off as well. Of course, if the air conditioning unit shares the line, you may not notice unless it's summer.

So, how do you check for a dedicated line? It's not always easy. The wiring to the other appliance is frequently inside the house and not readily visible. Examine the wires connecting the circuit breakers to the spa equipment. That could reveal a problem. Some thorough snooping is in order.

Note: You probably will have discovered any other causes of voltage drop, such as burned wires or a defective breaker panel, during your visual inspection.

NOW YOU KNOW

If a component is to blame, you now must diagnose theat piece of equipment and decide if it needs to be repaired or replaced.

Spa Pack Troubleshooting

Tips on how to accurately assess a spa's electrical equipment

For many techs, a failure of one or more spa functions can become a frustrating guessing game. Troubleshooting begins with observing the symptoms and then going step-by-step through the system to resolve the issue.

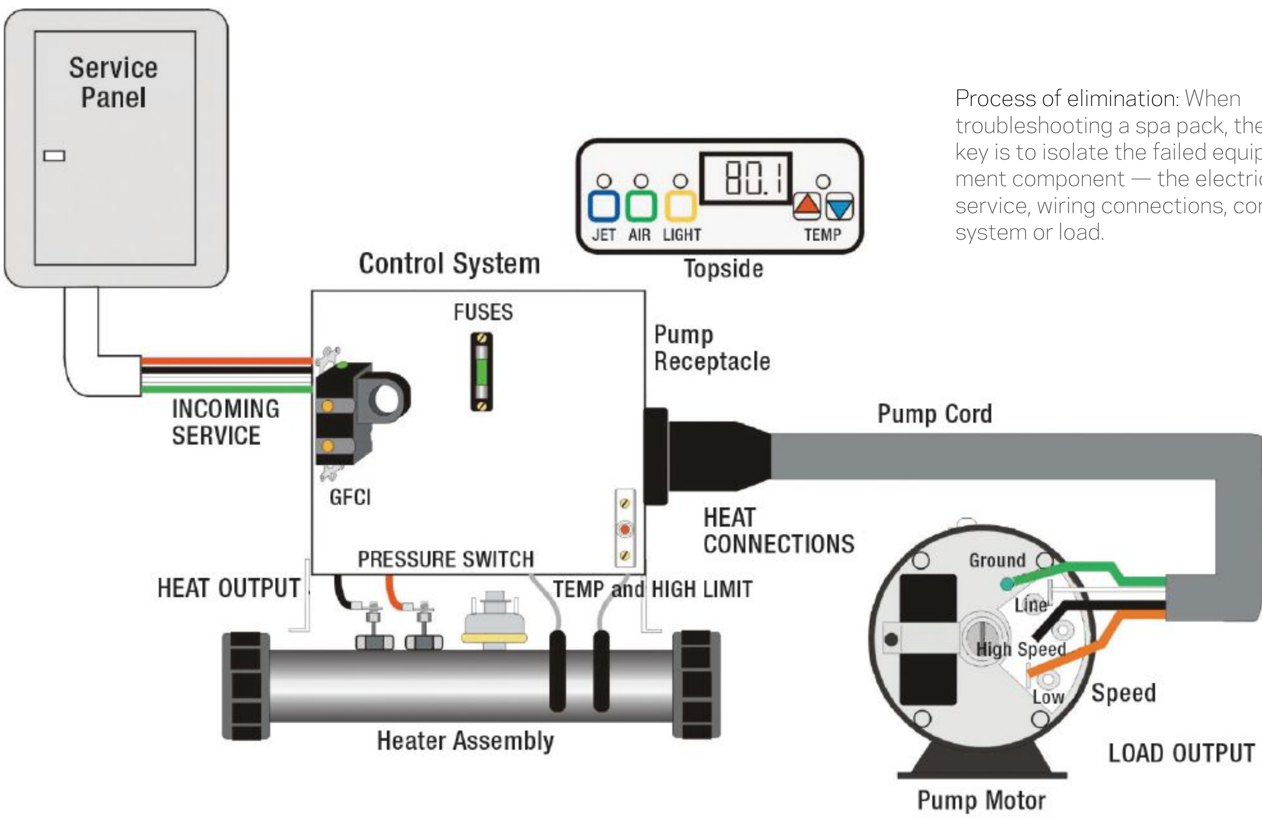
1. KNOW WHAT YOU'RE UP AGAINST

There are three basic types of systems that control portable spas. Within these, there are usually only five or six components that are critical to the basic functions of the spa. It matters little whether the system uses a solid-state PCB, air switches or other electromechanical devices to accomplish control, the functions remain the same.

Everything else in the spa is an accessory (lights, blowers, ozonators, stereos, booster pumps, etc.) and usually has no bearing on these basic functions. That's not to say that accessories can't affect these functions, but recognizing that they aren't critical allows you to isolate them to test the basic operation.

System One: Dual-speed primary pump
In this system, the pump moves water through the manifold during filtration and hydrotherapy. The control determines which speed will be selected, and the service connected determines whether the heater will be selected with only low or both low and high pump speeds.

System Two: Two single-speed pumps
In this system, the circulation pump can be at fractional horsepower (example: 1/10 hp) and run 24 hours a day, if power is applied to the system. There are no filter cycles, and it heats whenever there is a call from the sensor. (Be aware that more and more electronic systems with circuit boards now use what is called "summer settings." When heat rises two or three degrees above a set temperature, the circulation pump turns off. It will turn back on once the temperature dips one degree below the setting. This should be stated in the owner's manual.) Here, the jet pump is not plumbed through the heating manifold and has nothing to do with temperature control.



Process of elimination: When troubleshooting a spa pack, the key is to isolate the failed equipment component — the electrical service, wiring connections, control system or load.

ILLUSTRATIONS COURTESY SPA PARTS PLUS

System Three: One single-speed pump and no heater (heat-recovery system)
These systems use heat from the running pump motor or friction from water in the plumbing to increase water temperature. The pump runs any time the sensor calls for heat. It also runs if there is a filter cycle selected. The operation of the pump is critical to this tub's operation.

2. IDENTIFY THE REAL PROBLEM

Nothing wastes more time than troubleshooting something that isn't actually related to the real problem. To eliminate this possibility, you need to communicate with the customers to understand what they are seeing and also recreate the issue yourself so that you have a firsthand example of the symptoms leading to the failure.

Take the following steps:

1. If possible, have the customer operate the system to demonstrate the issue.

2. Operate the system yourself and run through as many functions as possible to ensure you see "all" the problems (Example: A reported problem of no heat becomes pretty clear if there's no water flow at all, regardless of pump speed selected).

3. Visually inspect the cabinet and tub area for obvious problems (loose or burnt wiring, leaking plumbing, broken or missing hardware, etc.). Even if unrelated, it gives you a good understanding of the condition of the tub and items that likely will need to be corrected at some point.

3. BEGIN TESTING

Test the system to isolate the failed component/components. For the purposes of this article, success will be measured by correctly identifying the failed equipment component (electrical service, wiring connection, control system or load).

Usually the issue can be categorized into one of three types of problems:

1. Nothing works
2. Something doesn't turn on
3. Something doesn't turn off

While it's impossible to cover every scenario one might encounter, the following examples should give a good idea of the flow of tests that are necessary to isolate each of the problems.

Problem 1A: Nothing works
While this issue is often perceived as intimidating because you have only one indication, this really is the simplest to isolate to an equipment component. There are only a few components that can disable every function in a spa.

Breaker, fuse or GFCI fails immediately upon start-up:

1. If the device is internal to the control system:

a. Check for proper voltage from service reaching the control system. If voltage is not correct (240VAC from L1Black to L2Red and 120VAC from Neutral White to L1 and L2, 120VAC from ground to L1 and L2, 0VAC from ground to neutral) and the breaker/GFCI is "set," call a licensed electrician to evaluate service.

b. Remove power and disconnect all load devices from the control system including both heater wires.

c. Replace the fuse or reset breaker/GFCI.

d. If the device stays set, power down and reconnect one load device at a time until the failure recurs. (Remember that you can't heat without a pump running, so connect the pump motor before the element wires.)

e. The last load connected before the symptom recurs is suspect. (Be sure to inspect the wiring between the control and load device before replacing anything.)

2. If the device is external to the control system (service breaker or GFCI):

a. Remove power and disconnect all load devices from the control system including both heater wires.

b. Replace the fuse or reset breaker/GFCI.

c. If the device stays set, power down and reconnect one load device at a time until failure recurs. (Remember that you can't heat without a pump running so connect the pump motor before the element wires.)

The last load connect before the symptom recurs is suspect. (Be sure to inspect wiring between control and load device before replacing anything.)

3. If the device continues to trip with all loads disconnected, remove the service wiring from the control system and isolate it from shorting together or to ground.

a. Reset the breaker/GFCI.

b. If the device stays set, remove the control for evaluation by a qualified technician. Remember to shut off service and tag out the breaker.

c. If the device continues to trip with the control disconnected, call a licensed electrician to evaluate the electrical service.

Problem 1B: Everything works fine for a time, and then nothing works.
This is a little more difficult to isolate because it can be tough to "catch it" when it fails. It's most important to determine what is operating when the problem occurs. Another indicator will be which of the safety devices fails when the issue occurs.

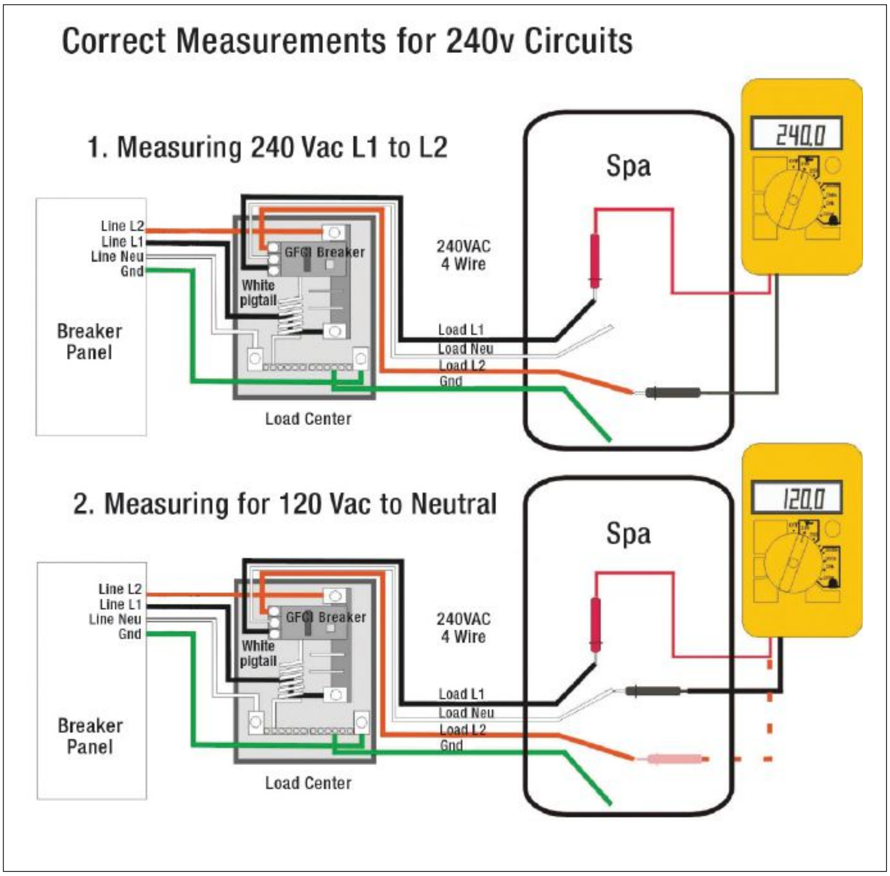
Breaker, fuse or GFCI fails after running for an unspecified time:

1. Check for proper voltage from service reaching the control system.

a. If voltage is not correct (240VAC from L1Black to L2Red and 120VAC from Neutral White to L1 and L2, 120VAC from ground to L1 and L2, 0VAC from ground to neutral) and the breaker/GFCI is "set," call a licensed electrician to evaluate service.

b. If the GFCI or breaker is failing intermittently, but (when set) the voltage is correct reaching the control, then:

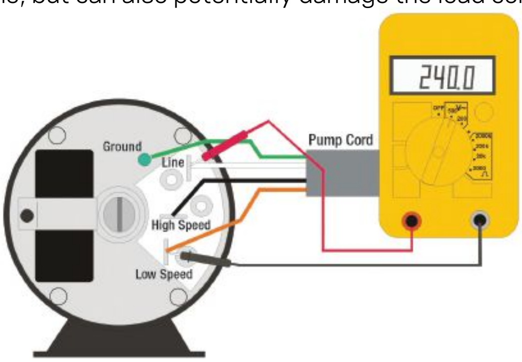
- Remove power and disconnect all loads except for the main pump and heater (blower, ozone, light, etc.).
- Run the unit for approximately the same time. If the unit fails again during this test, the issue is either the heater or the main pump. Disconnect the heater and repeat the test.
- If the GFCI doesn't trip with the heater disconnected, then the heater is likely the issue. If it fails again, then the main pump is suspect. If the unit continues to fail after both have been isolated, check for



Check the flow

It is important to remember that many equipment issues have nothing to do with the control or load devices. The electrical components of a spa pack depend on the ability of water to flow to perform. Clogged filters, clogged or spun impellers, broken or improperly positioned valves, improper water levels and leaks can affect the performance of the electrical components in a tub.

While plumbing or flow issues are actually often the easiest issue to address mechanically, they are also often the first to be dismissed simply because water may be observed moving in the spa. It is important to recognize what the sensors and safety devices indicate and that proper flow is the key. Failure to recognize and address issues related to plumbing will not only waste time, but can also potentially damage the load components in the system.



Voltage check: If something doesn't turn on when it's supposed to, measure for voltage reaching the device. If the voltage is good, then the device should be suspected.

loose hardware or wiring causing a short inside the control. If none are apparent, then the control may need to be evaluated by a qualified repair facility.

- Inspect the suspected load for obvious shorting to ground. (Be sure to include the connecting wiring in your inspection). Replace as appropriate.
- If the unit does not fail with the accessories disconnected, reconnect one device and repeat the test. Continue reconnecting accessory loads until a failure recurs.
- The last load you connect prior to the issue reoccurring is suspect. (Be sure to inspect wiring between control and load device before replacing anything.)

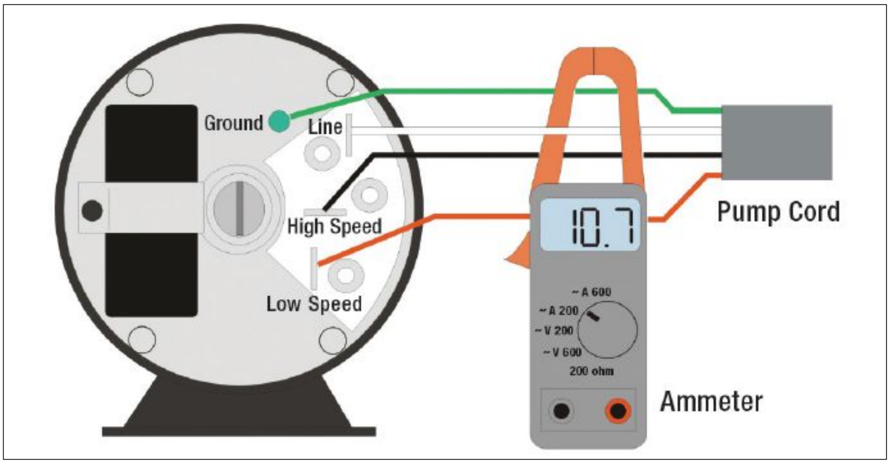
c. If the system fuse is failing and the voltage is correct reaching the control, then:

- Disregard the heater because it's usually not protected by the system fuse.
- Turn off the power and disconnect all load connections and replace system fuse.
- Reapply the power and operate the system. If the fuse fails again, check for loose hardwire or shorted wiring inside the control. If nothing obvious is found, the control may need to be checked out by a qualified repair facility.
- If fuse remains good, reconnect each load and allow the system to run for an appropriate time. Continue connecting loads and running system until the issue recurs.
- The last load you connect before the fuse fails again is suspect. (Be sure to inspect wiring between control and load device before replacing anything.)

Note: An alternate method for evaluating load performance is to perform an amp draw check on the suspected device.

Problem 2: Something doesn't turn on

1. Ensure proper voltage is reaching the control (see previous examples).
2. Identify the device that should be running and ensure the control is calling for it to operate. (Most units with a topside have an indicator that lights when the device is selected.) Also, see that no errors are being reported (errors will have to be cleared for most devices to operate).



Check it out: An alternate method for evaluating load performance is to do an amp draw check on the suspected device.

3. Go to the device and measure for voltage reaching the device.

4. If the voltage is good, then the device is suspect.

5. If the voltage is bad, go to the control and measure for voltage on the wires leading to the control receptacle. (Especially with solid-state controls, you should not attempt to read voltage by disconnecting the load wiring. Many manufacturers now use snubbing circuits that will give a false reading if not connected to a load device.)

6. If the voltage is good at the control receptacle connections, then the receptacle wiring or cable is suspect.

7. If the voltage is bad, the control needs to be serviced by a qualified repair facility.

Problem 3: Something doesn't turn off

1. Ensure proper voltage is reaching the control (see previous examples).

2. Ensure that the control is properly set for the desired operation and that there are no errors reported. (Some errors such as "Freeze" can hold on certain load devices until the situation is resolved.)

3. If the control is properly set and there are no errors, the issue is inside the control. It is impossible for load devices or connections to fail "on." The control may have to be evaluated by a qualified repair facility.

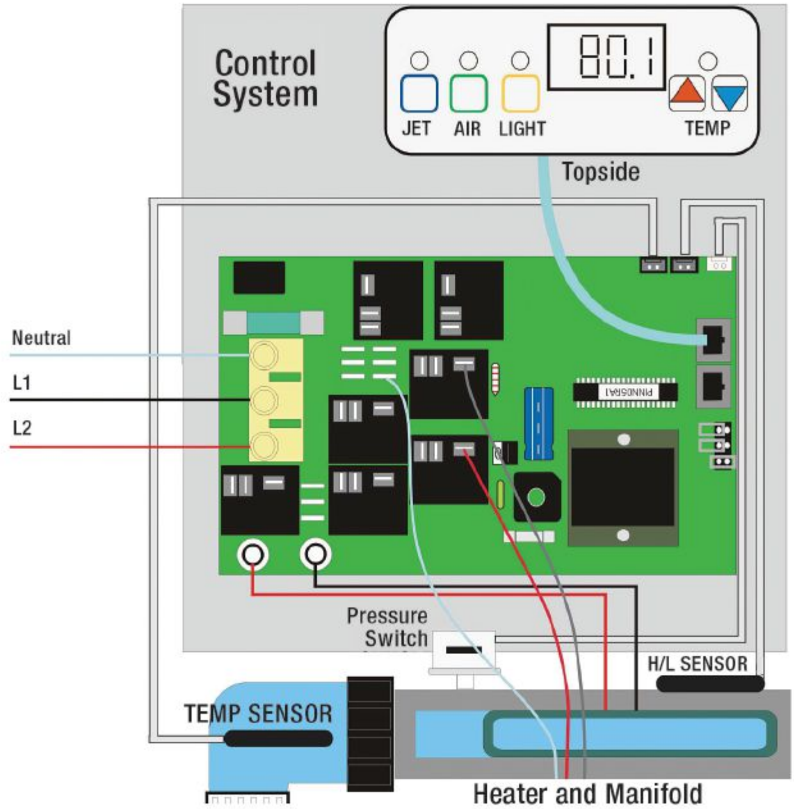
Willie Wise is the former technical director at Spa Parts Plus in Prescott Valley, Ariz.

Electronic Control Basics

Effective steps to take when troubleshooting electronic controls

Since the introduction of controls using Printed Circuit Boards (PCBs), techs have had an increasingly difficult time performing repairs on controls. Field repairs on these types of components are nearly impossible.

However, that's not to say that there's nothing that techs can do to solve the problems. With a little knowledge and a few tests, they can ensure many failures do not recur once the system is again operating.



In control: The heart of any solid-state control is the Printed Circuit Board (PCB) and topside combination. While troubleshooting and repairing these systems may be a challenge, techs still can take steps to isolate a failure.

1. BE SURE THE CONTROL IS THE PROBLEM

Nothing wastes more time than working on the wrong portion of the equipment system. Certain problems can be tied to the control and others can't. Unfortunately, because solid-state controls are misunderstood, they often are blamed for failures before the proper steps have been taken to isolate the true source of the problem.

Another frustration occurs when the PCB is really a symptom of the failure, but not the actual cause. While you may fix the issue temporarily, the failure will recur.

For example: The high-speed pump can't be selected and voltage leaves the PCB. After you replace the circuit board, the unit runs and you return the spa to service. Three days later, the customer calls back with the same complaint. While the PCB needed replacement, the fact that the output relay failed was not the fault of the PCB — the pump caused the relay issue. The pump should have been checked for proper current draw after the PCB was replaced.

2. UNDERSTAND HOW THE CONTROL OPERATES

The functions of spas haven't changed appreciably since they were first introduced. As such, there are still some issues that can be overlooked if techs don't understand the functionality of the specific system they are troubleshooting. For example:

a. Troubleshooting an ozonator issue can be futile if the tech doesn't recognize that the system only turns the ozonator on while in a "filter cycle."

b. Techs fail to see that the temperature of the source water was less than 45 degrees, and the unit believes it is in "freeze" mode.

c. The customer reports that the blower and booster pumps come on and off intermittently. Techs could waste time if they aren't aware of a "purge cycle."

d. Techs may misread an error message. Some systems allow the display to be inverted so that the temperature or messages can be read from inside the spa.

3. ISOLATE THE PROBLEM TO A CONTROL COMPONENT

For the most part, each solid-state system will have a PCB, topside and sensors. Isolating the problem to one of these components is about all techs can hope to accomplish in the field.

Sensors: Most electronic controls built today use at least three sensors: One for temperature control, one for freeze- and high-limit protection, and another for flow detection. They come in as many shapes and sizes as there are controls.

Most manufacturers use the same base component for both sensors (Gecko is an exception). Temperature sensors can't be bypassed to isolate issues.

If all else fails, comparing the resistance of the two sensors in open air should give you an indication if there is an issue with one. Since they are basically the same component, they should read close to the same resistance value.

Some controls also use a flow, vacuum, or pressure switch input to protect the heater. This input is an open or closed type of connection, and can be bypassed to simulate operation if done when the logic of the PCB expects to see that condition.

Some newer spas use a safety feature that disables the spa control if too much suction is detected. However, these also can fail and shut the system off. Most of these systems work with a vacuum switch in the normally open position.

Topsides: These panels also come in myriad sizes and styles. Some are interchangeable and others are not — even with topside models from the same maker. It's impossible to know what is swappable and what isn't without manufacturer information. The best way to evaluate the operation of a suspect topside is to replace it.

Printed Circuit Boards: Some PCBs use on-board transformers to step down the voltage; others have separate transformers that plug in.

Specific to the make and model of the control, the programming of the microcontroller IC determines the functions and sequence of operation. This is usually identified by the code printed on the label pasted to the chip on the PCB.

TROUBLESHOOTING STEPS

1. Always verify that the service voltage reaching the control is correct: 240VAC between L1 and L2, 120VAC from L1 to neutral and L2 to neutral, 120VAC from L1 to ground and L2 to ground and 0VAC from neutral to ground. You can't continue until the service measures properly.

2. Unless the system is completely dead (no display, no functions), verify the reported symptom by operating the unit as thoroughly as possible. By seeing all the problems, you can more accurately choose a point from which to start.

3. If the system is dead (no display, no functions) and the proper voltage is reaching the control, try shutting down the service for 10 seconds and resetting to see if anything operates or if you hear any relays trying to latch. If nothing happens, shut down the service again, and check the system and transformer fuses.

4. If both fuses check out but no functions or relays react when service is applied, then it is likely that either the PCB power supply circuit or transformer has failed.

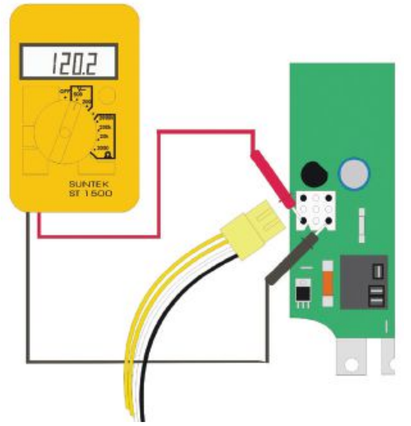
5. If the PCB has an integral transformer, the only options are to send it to a repair facility or replace it.

6. If the transformer plugs into the PCB, check for proper input from, and output to, the PCB by measuring the voltage on the primary (should be either 120VAC or 240VAC depending on the PCB) and the secondary (usually between 12 and 15 volts AC).

In most cases, you'll have to check for secondary voltage while the transformer is plugged into the PCB by making contact with the crimped on the ends of the wires going into the transformer plug.

7. If the transformer primary voltage is bad, recheck the transformer fuse and holder for proper connection. If all checks out OK but no voltage reaches the transformer, the PCB has a bad trace or broken component pin. The only options are to send the PCB to a repair facility or replace it.

8. If the primary voltage check out OK but the secondary voltage is bad, try replacing the transformer. If replacing the transformer doesn't solve the issue, then the only options are to send the PCB to a repair facility or replace it.



Powered up: This is an example of how to check the transformer for voltage reaching the primary.

9. If primary and secondary voltages check out but there's no reaction from the topside or relays when power is reset, then, again, the only options are to send the PCB to a repair facility or replace it.

ADDITIONAL TROUBLESHOOTING

If there is proper voltage reaching the control, the unit comes on and some functions operate while others don't, then it becomes a case of finding out which of the three component types are causing the issue.

Sensor failures: First, look at the topside display for possible error codes or obvious erroneous indications. In most cases, if a sensor is causing the issue, there will be some indication on the topside.

Note: Remember that flow and high-limit errors can indicate an issue with water flowing in the system. Also, verify the issue rather than assuming the device has failed. Failure to recognize such issues can potentially damage the loads or control.

For example, errors such as Sn, Sn1, Sn2, Prr, OP (check the owner's manual to learn error codes) indicate a failure of the temperature or high-limit sensors. Often this locks out all other functions until the issue is fixed. Some spas don't use alphanumeric characters, but have flashing LEDs indicating a failure by the duration or pattern. In some cases, the sensor may not be totally bad, but out of tolerance. In these cases, you may get an abnormally high reading, or an over temp error (OH, HL). The same holds for a spa that continues to heat; indicates a freeze condition (Fz, Fr, ICE); or signals a low temperature when the water is warm.

If you suspect a failed temperature or high-limit sensor:

1. Turn off the service, swap the sensor positions on the PCB (not possible on Gecko systems) and see if the display changes when voltage is reapplied.

2. If the display changes, then one of the sensors is bad and should be replaced.

3. If no change is observed, then it's likely an issue with the PCB. The only options are send the PCB in to a repair facility or replace it. (Note: On Balboa M7 systems, swapping sensors may not change the display indication, even if there is a problem. Compare resistance readings, if in doubt.)

4. If swapping sensors is impractical or impossible, power down and disconnect both sensor connections from the PCB. Compare resistance across the two sensors; they should be close in value. If there is greater than a 500 ohm difference, then there is a large temperature difference in the spa or one sensor is out of tolerance. (Note: This comparison isn't possible on Gecko sensors.)

5. If you can't determine which sensor is malfunctioning by swapping connections or measuring resistance, then replace both sensors, one at a time, until the system returns to normal.

Pressure / Flow Switch Failures Flow errors also can lock certain functions. Some indicators are codes Flo, FL, E4, FLC. Some systems errors are indicated by an LED. These types of errors are often the easiest sensor failure to troubleshoot. Note: There are some systems that do not have an open switch error code, only when the switch is "shorted" or closed.

In the case of a "shorted" or closed flow or pressure sensor:

1. Disconnect the flow device connection. If the error indicates flow without pump operation, then disconnecting the flow/pressure switch connection should change the state of the control.

2. If you see a change, evaluate the operation of the flow/pressure device. (Pressure switches should not require readjustment after initial set up. If the device does not operate correctly or requires adjustment, then something in the plumbing has changed or the device is failing).

3. If no change is observed, then it is likely an issue with the PCB, and the only options are to send the PCB in to a repair facility or replace it.

In an "open" flow or pressure sensor:

1. Once the connection has been removed, ensure that the pump is running.

2. Create a short between the pins of the PCB connection with an insulated screwdriver or pair of pliers.

3. If the system starts to operate correctly, evaluate the operation of the flow/pressure device. (Pressure switches shouldn't require readjustment after initial set up. If it doesn't operate correctly or requires adjustment, then something in the plumbing has changed or the device is failing.)

4. If shorting the flow connection pins doesn't change the symptoms, then it's likely an issue with the PCB and the only options are to send the PCB in to a repair facility or replace it.

PCB or topside failures: Once the sensors have been eliminated as the cause of the issue, next determine whether the PCB or topside is causing the failure.

Techs often can tell the difference between a topside and PCB problem based on the symptoms. The following steps assume that a physical inspection and incoming service voltage have been verified. Depending on the severity of the initial cause of the failure, both the topside and the PCB could require replacement. (This is rare.) There are isolated cases where plugging a bad topside into good PCB can damage the new PCB. In older Vita Spas, it is recommended to replace both topside and PCB if you are not sure which item is faulty.

Note: Unfortunately, the reported symptoms may not always clue you into the problem. If all else fails, it may be necessary to have a spare of each to swap out to isolate the problem or see if the symptoms change. Also, when testing, be sure to inspect the cable and PCB connections for moisture, or broken or bent pins/conductors.

Below are some signs techs can use to determine if the PCB or topside should be suspected as the culprit.

1. No display and no button functions
Suspect = PCB

- If no relays close or loads are selected when service is applied
- If the system and transformer fuses check out OK

Suspect = Topside

- If the relays close and initial loads are selected with service, but no other displays or selections can be made

Tip: If the PCB performs a normal startup routine but the topside never "comes alive," it indicates that the PCB is capable of running.

2. Bad display/no display, but some buttons work
Suspect = PCB

- If display flickers or fades in and out
- If pressing temp up/down doesn't affect the appearance
- If the temp can't be regulated

Suspect = Topside

- If the display is completely blank or wrong, but steady
- If there is a change in appearance when temp buttons are pressed and/or the heater can be set on and off

Tip: The temp/display functions are often separate from the basic buttons and can often be used to verify a display issue.

3. Good display, but unable to select or deselect a single function.
Suspect = PCB

- If an icon or LED appears when a button is selected or if you hear a relay click, but nothing comes on
- If you remove the topside and cycle

continued on page 97

Spa Heater Issues

Factors to consider when troubleshooting spa heater problems

While water temperature is the most common spa customer complaint, it often has nothing to do with the integrity of the heater. Many hot tub components affect its heating ability and should be factored in when searching for a culprit. Understanding the system's capabilities and limitations will determine your success.

In my experience, the most efficient ways to troubleshoot problems are to make a physical inspection, assess the incoming electrical service, check the mode of operation and evaluate the heater.

MAKE A PHYSICAL INSPECTION

If you see/hear/smell a problem, safety dictates the need to correct it before continuing. Whether the issue has anything to do with the heater or not, the corrective action often points you toward a solution.

A leaking pump seal might be overlooked unless you consider that water seldom leaks where air does not replace it in the plumbing. A bubble in the plumbing can cause the pressure switch to remain open or the water to not flow at all (air lock). Melted control input terminals can seem unrelated. However, for the temperature of a wire to rise to the melting point, electrical current must be moving in a circuit and a heater produces the most current in a spa. Depending on which terminal is melted, the heater circuit can be dead while other components might work just fine.

ASSESS THE INCOMING ELECTRICAL SERVICE

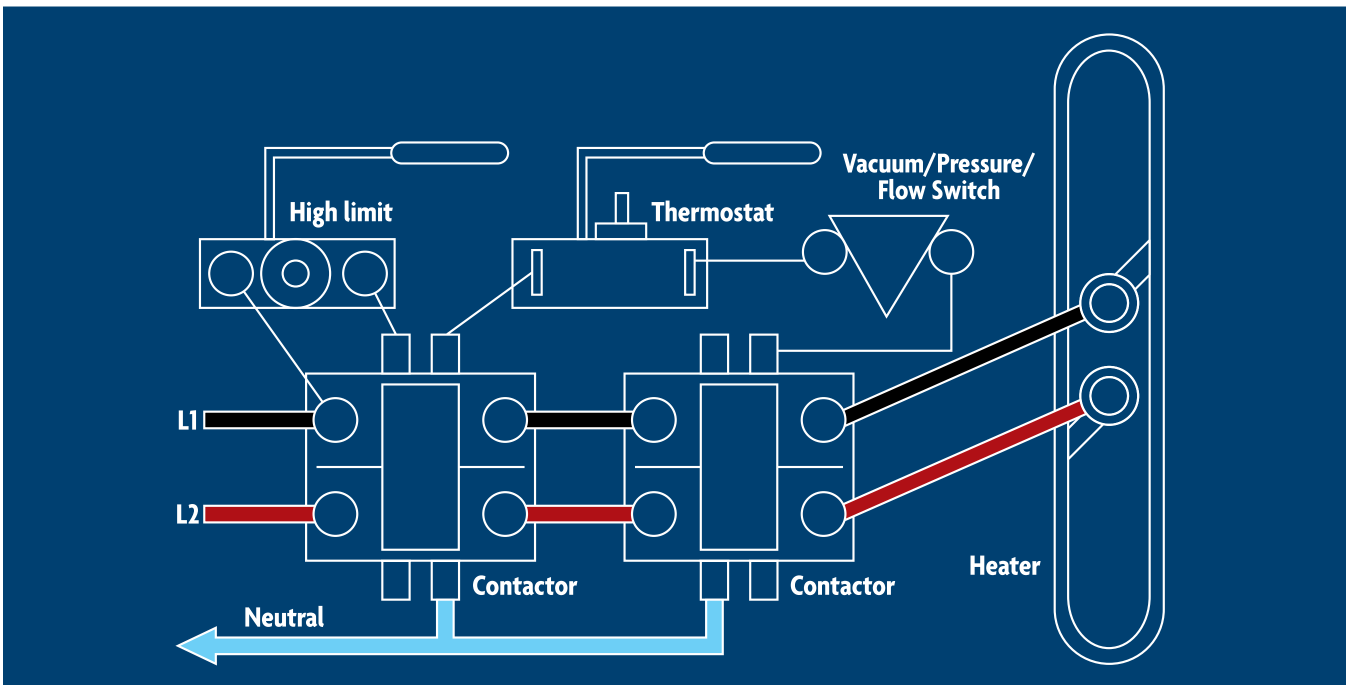
Wire size, type and disconnect considerations are critical to proper heater operation, but often input voltage is overlooked. Even when it is considered, it's not always properly evaluated.

Checks must be performed to measure the exact voltage applied — that is, for a 240VAC reading from L1 to L2. Measuring 120 twice does not necessarily indicate the presence of 240VAC because either phase can feed back through another circuit. Measuring each phase to neutral and ground (120VAC at L1 and L2) is important to completely verify the service applied. Further troubleshooting should not be done until proper voltage to the control is restored.

CHECK THE MODE OF OPERATION

To effectively check the operation requires looking at functions selected to operate at specific times, such as filtration. But heating cannot take place without certain functions, and will be inhibited by others.

Case in point: Most people are aware that heating only takes place when water is circulating. "Circulation" is not the same



from system to system, though. On 120VAC systems, selecting the high-speed or blower functions will eliminate the ability to heat due to service limitations.

In 240VAC systems with a 50amp breaker, heating can take place at the same time as high-speed and blower functions. If the blower is selected, however, the water often moves but does not circulate. On systems using two single-speed pumps, the jet function has a different plumbing circuit than the circulation function. Water moving through the jets does not indicate circulation for heating purposes.

In addition, just because you hear the pump running doesn't mean the water is moving properly. Air locks, clogged or broken impellers, closed valves or jets, and dirty filters all can reduce circulation and affect heating. The inability to circulate correctly usually is indicated by the failure of one or more safety devices, such as the high-limit, pressure and flow switches.

EVALUATE THE HEATER

The heater is easy to verify and can be dropped from consideration in short order. Disconnect the heater wires and test between the terminals using an ohmmeter. A good element will read 9 to 12 ohms. A bad element will test open or infinite.

Remember, an element can have good resistance and still require replacement. Damage to the sheath can allow moisture into the element. Any connection (< infinite) between an element terminal and its sheath indicates that current will leak into the water. Heaters with a short to ground often cause the GFCI to trip. Infinite resistance between the element terminals and any resistance to ground are the only two instances that indicate a bad element.

Reconnect the wires and set the unit to heat. Use a voltmeter to monitor voltage at both heater terminals simultaneously. The right voltage indicates a good heater circuit.

A circuit with good voltage to the element and proper resistance must heat. Note: Insufficient heat can look similar to none at all, depending on the tests' timing.

Losing voltage at the heater before reaching set point indicates a failed or out-of-tolerance switching device or safety (thermostat, pressure switch, high limit and the like). Failure to provide voltage to the element, heater relay or contactor may not indicate a bad device.

For example, poor flow through the manifold can cause the high limit to open. Though the high limit is the cause of the failure, the condition it monitors is actually at fault. Therefore, replacing it will not resolve the issue.

It's always best to believe that safeties are doing their job and evaluate the conditions they monitor. Failing to do so can cause catastrophic problems later on.

Author: Willie Wise is the former technical director at Spa Parts Plus in Prescott Valley, Ariz.

Spa Blower Basics

How to size and troubleshoot the spa's pneumatic system

The pool and spa business primarily concerns itself with the hydraulics branch of fluid mechanics, which specializes in the properties of moving water. But when the focus is on the operation of air blowers, the pneumatics branch — the study of air and other gases — comes into play.

Fortunately, these two disciplines share many basic concepts. In simple terms, think of the air blower as nothing more than an air pump, forcing a thin fluid — air — through a piping system.

In a spa, the piping system may lead to an air channel or air injectors installed in the floor, seat or walls; or, it might be connected to the hydrotherapy jets in a manner that will enhance their hydro-massaging operation. Various valve arrangements allow blowers to serve double duty, feeding an air channel for basic bubbling and acting as a hydrotherapy-jet booster, often referred to as "turbo-charging."

UNDERSTANDING AIR BLOWERS

The air blower pump shares many features with its water-pumping cousin.

An electric motor — directly coupled to an impeller (or impellers, in a multistage design) — adds energy to the flow of air passing through the blower as the motor spins. Result: The velocity and pressure of the air flow increase dramatically.

Water pumps normally operate at 3,450 revolutions per minute. But air blowers typically rotate at 18,000 to 20,000 rpm. This high speed has two side effects: noise and a lot of heat generated within the air blower.

Several manufacturers have successfully reduced noise by using sound-absorbing materials around the blowers and by adding mufflers to the intake and/or exhaust ports. Also, air blowers have been designed for burial in the ground as a noise-reduction measure. Blowers are available in two- and three-speed models, allowing users to select the intensity of the bubbling action, with subsequent adjustments in noise levels.

Heat generated within the air blower is a matter of concern. Air flowing through the blower must carry all the heat away from the motor immediately. Failure to do so leads to the No. 1 cause of blower failure.

Finally, some blowers today feature small electric heaters that preheat the air sent into the spa. This minimizes the temperature differential between the water circulating in the spa and the (often) much cooler air being drawn into the system — increasing user comfort and easing the heating burden on the spa's primary heater.

What is the most critical factor for a spa's air-support system? Proper sizing of the blower to the air piping system. Nearly all blower problems blowers can be traced directly or indirectly to incorrect sizing.

For example, if either the spa's air holes or the blower's distance from the hot tub are inadequate, the blower will work too hard. To remedy that, either replace the blower with a higher-capacity model, or modify the air piping system.

In replacing a blower, you must first consider certain design features: the unit's operating voltage, the orientation of the exhaust, the need for various motor speeds and the blower's position relative to the spa. Beyond that, effective blower replacement depends largely upon proper sizing.

But you cannot always put a larger blower into a system. Oversizing can cause a blower to overheat and melt or simply fail.

SIZING THE BLOWER

Blower sizing isn't all that complicated. Units come in three basic sizes: 1, 1½ and 2 hp. Beyond that, there's a defined set of factors to consider in finding the best-sized blower for a given application:

The total length of the pipe run: The longer the run, the more power the blower needs. For portable spas and spa packs, it's usually not difficult to determine. For component systems, or those in which a spa pack was installed a distance away from the vessel, you need to accurately determine the amount of pipe between the blower and the spa's air piping. Keep the following factors in mind:

The number of 90-degree turns: Remember these turns add to the work a blower must do to force air into the spa.

Water depth: Water pressure bearing down into the air channel or air injectors must be countered by the force of the air pushed through the piping. The deeper the water, the greater the burden on the blower.

The number and size of air holes or air injectors: As mentioned, too few or too small air holes or air injectors can result in an overworked, overheated unit. Manufacturers have found ways of incorporating these factors into their sizing schemes. Many offer helpful tables for proper sizing.

Most blowers in the parts world are designed for light-duty residential applications and are intended to run a maximum of 15- to 20 minutes at a time. These will not last in a commercial environment with long running times or with heavy bather loads. In heavy-use applications, it is best to install a commercial-grade air blower.

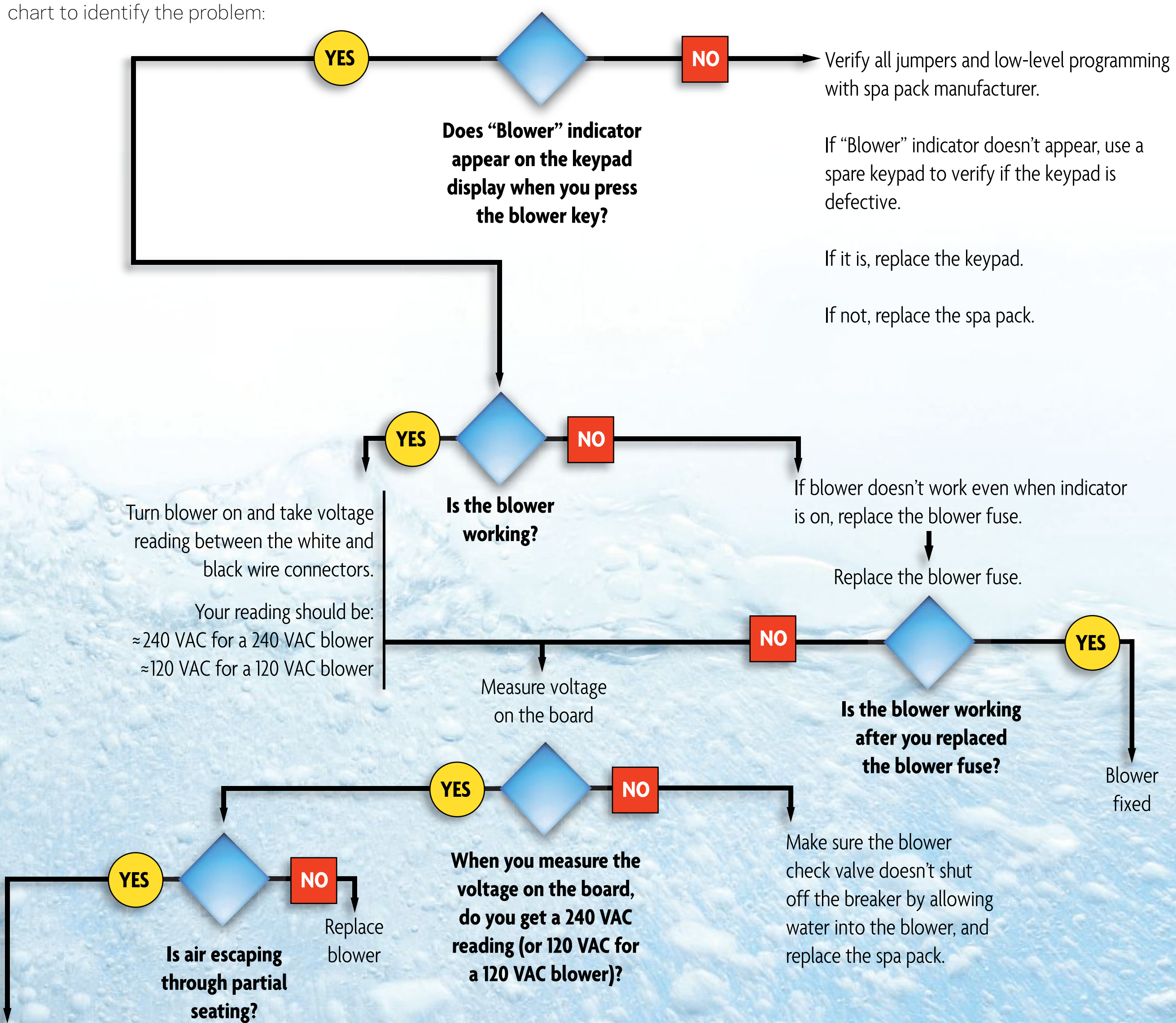
ACCOMMODATING JETS

In well-planned systems, blowers make a dramatic difference in jet action. As a result, many spa and spa-pack systems include booster options that use either a separate blower or special valve configurations.

It's a bit trickier sizing for retrofit or

Troubleshooting flow chart

If the blower doesn't work, follow this troubleshooting flow chart to identify the problem:



If the motor seems to be running, but the air is escaping through partial seating, increase blower horsepower if the spa pack output allows it. If the amperage doesn't allow it, see if it can be converted to a 240VAC motor in order to increase its horsepower.

If the motor seems dead, make sure its check valve is still fully functional, and replace the blower.

If the check valve allows water to return into the motor, replace the check valve (it is what killed the motor).

Pool & Spa News thanks Sophie Tremblay, engineering tech support group manager for Gecko Electronics Inc. in Quebec City, Quebec, Canada, for her assistance with this troubleshooting flow chart.

replacement than, say, for basic air channel or injector applications. Differences in jet orifice size make gauging power requirements difficult, but manufacturers help by including horsepower-per-jet requirements for blowers in booster applications.

For the field tech, however, there are a few basic guidelines to follow based on the number of jets in the system:

- If you have four to six jets, you generally need a 1hp blower;
- Six to eight jets call for a 1½hp blower;
- Eight or more jets require 2hp units.

Beyond that, consider these critical factors: Depending on the location of the blower relative to the plumbing, water can flow back into the blower unit. Blowers installed below the water level require the installation of a check valve mounted above the waterline or a Hartford loop, or both.

Some suppliers incorporate check valves in the jets and injectors themselves to help prevent backflow and keep water out of the air blower piping.

ISOLATING THE PROBLEM

Proper sizing helps you avoid most blower problems, but other factors can have significant impact. Many problems can be traced to improper installation and can be isolated quickly with a few simple checks. Some common symptoms, causes and remedies:

Overheating: When this happens, the blower motor's thermal-protection device usually shuts the unit off. If it fails to do so, however, you may find premature brush wear on the motor or, in extreme cases, melted blower housings. Extreme heat also can lead to bearing failure in the motor.

Overheating indicates a blower working too hard or a restricted air flow. A key sign is inadequate bubbling action. Often caused by back pressure brought on by undersized plumbing, it can usually be fixed with 1½-inch plumbing. For long plumbing runs, however, 2-inch plumbing or larger may be required; check the manufacturer's specs.

Another cause of overheating can be an improper blower check valve. Blower check valves normally have ¼-pound springs in them. Standard check valves usually have much stiffer springs and can be too hard for a blower to open correctly.

If you have an improperly sized blower, one of the best ways to determine the dynamics of the system is to get a reading with a magnehelic gauge with the blower running. The manufacturer can use the reading to help determine the right blower size.

Water damage: You often see this with units installed below the water level. Install a double loop or Hartford loop in the plumbing between blower and spa. Faulty check valves (or those installed backward) also may be the culprits.

When an owner complains of a GFCI tripping, first check the air blower. Water finding a path to the innards of a blower almost always trips a GFCI.

Intermittent operation: Random overheating, poor bubbling action, arcing, sparking, smoking and excessive noise all can result from improper electrical installation of the blower.

One of your first checks here should be with a voltmeter to determine that the line voltage matches the voltage listed on the blower. Sometimes, you'll find an overloaded circuit with too many appliances drawing down its voltage. Other times, you'll discover a 240-volt blower limping along on a 120-volt supply line — or a 120-volt unit running dangerously on a 240-volt line.

Generally poor performance: Check the blower's amp draw, using an ammeter. Determine the amp draw under normal operating conditions, then disconnect the air piping and take another reading to determine its "free flow" amp draw. The free-flow reading will always be higher.

Compare these two readings. For most air blowers, a difference greater than 1½ amps indicaters either a blower that's undersized for the application or an air piping system that's too small or partially plugged.

A final note: If in doubt, call the manufacturer. They'll know about basic blower performance sizing, replacement and troubleshooting and can help keep you out of hot water.

Pool & Spa News thanks Zodiac Pool Systems, ITT Hydro-Air Industries, Air Pro and APSP for their help with this article.

Electronic Control Basics

continued from page 92

power, and the load is still energized

- If neither temp up nor down works

Suspect = Topside

- If icons, LEDs, and relays don't change state
- If you can remove the topside and change the output of the PCB
- If only temp up or only temp down works, or one is selected constantly

Tip: If icons, LEDs or relays react to the buttons, it indicates communication from the topside.

4. Functions cycle or select/deselect themselves

Suspect = PCB

- If no icon or LED changes
- If the condition does not change with topside removed
- If the system locks up or restarts after several buttons pressed in quick succession

Suspect = Topside

- If the LED or icon cycles
- If removing the topside changes condition
- If the symptom occurs every time the same button is hit

Tip: If icons or LEDs react without pressing buttons, it indicates communication from the topside.

Author: Willie Wise is the former technical director at Spa Parts Plus in Prescott Valley, Ariz.

Diagnosing Spa Problems

Simple steps to follow when troubleshooting problem spas

1. INITIAL INVESTIGATION

Many techs start by lifting the cover, which tells all about the water's chemical makeup — discoloration in the cover will show the spa's entire history. For example, water with a low pH level burns the cover, so the center would be white. That should signal to the tech to go directly to the heater to look for chemical damage at the heating point.

Also, the filter should be checked early on. A clogged filter can cause a number of failures. If you suspect that a pressure switch needs replacing, for instance, it really could be the filter's fault. If the filter's dirty, there may not be enough water pressure throughout the system, causing the switch to be triggered. The location of the filter cartridge is helpful to note. A dirty filter cartridge on the suction side of the pump will drop the pressure at the heater, while one located pressure side will often increase it. Also, if you have a sealed canister on a suction-side filter, you can have issues with a bad O-ring or cracked lid that can cause a pressure switch not to engage.

2. PINPOINT THE PROBLEM ACCURATELY

Begin by checking the main component itself. Use a voltmeter or multimeter to determine whether the pump, heater, blower or another piece of equipment is receiving power. If it is, you've found your problem. If not, then a switch or relay likely isn't transferring the current. Be cautious of "ghost voltage" on modern circuit boards. On many of the circuit boards in use today, power output to components can read voltage when the circuits are not turned on. This is particularly a problem when there is nothing plugged into a circuit. If you suspect this is the problem, it is often a good idea to plug it into a circuit you know is functioning to see if it is actually faulty before ordering a replacement.

Depending on the symptom, you may want to consult an electrical schematic for the spa, if one is available. Then you can see which series of switches and relays are involved. Next, work back from the main component, checking each relay or switch in the control box.

Certain areas are tougher to inspect than others. When dealing with a spa that's more than a few years old, it may be difficult to tell when a circuit board is causing the problem or whether it's the topside control.

The diagnostic mechanism will provide a code, but that could apply to either component. For such tricky diagnoses, plug in separate units to see if they work. Many techs bring along additional topsides for testing purposes. They disconnect the client's topside, plug in theirs and, if they get the same reaction, then it's the board that's bad. If it works with the new topside, it's the topside that's bad.

Some brands of spa control will run without the topside control plugged in. If you have something odd going on, try restarting the circuit board with the spaside unplugged and see if things improve. Some modern systems can take a while to start up, so without a screen display you will want to wait about five- to six minutes to see if it starts running on its own.

In some instances, the problem may not be a faulty part at all. If the system doesn't heat, it could be a restricted flow. Check the plumbing for leaves or other debris that may have caused a clog. If the unit contains a pressure switch, a little sand or dirt may also plug it up, preventing the heater from sensing the system pressure.

If the circuit board was recently replaced, make sure to review the positions of dip switches and control jumpers. It's good practice to set them in the same setting as the original board.

3. CLOSE IT OUT

After the repair, conduct a full diagnostic assessment of the spa. Among other items, check chemical balance, the heater terminal at the bulkhead fittings, the air-check valves, jet selectors and buttons. Look for burned wires. Evaluate every screw in the pack to make sure they're all tight. Make sure all the wire connections are proper.

Finally, remember to test the ground fault protection system during each visit. If you notice something that could cause another failure, notify the customer.

Tool Organization

Tips for properly storing the gear on your truck

As any good mechanic will attest, the right tool for the job is essential. But if service technicians can't find their tools quickly and easily, they'll have a hard time getting any job done.

That's why it's crucial to keep everything on your truck organized. It will save you time, aggravation and money.

To keep everything close at hand — yet still secure — I've arranged my truck in the following rows.

ROW 1

In the first row (the one closest to the cab), I keep a cross-body bed box.

This is essential for storing hand and specialty tools, spare parts and other small cleaning gadgets. In the bed box, I keep an 8-inch brush that gets into the nooks and crevices of above-ground fiberglass spas.

Be sure to bolt your tool box down to prevent theft, and use stainless-steel screws to prevent rusting. A padlock on the side wouldn't hurt either to keep things safe and secure.

ROW 2

Directly behind the bed box, I keep liquid chlorine and acid.

Be aware that some states require a barrier between the chlorine and acid to prevent one from splashing into the other. This can be done by physically moving them away from each other or by using a board — for example, a piece of plywood — to separate them.

Also in Row 2 is my net and two wall brushes. I use an 18-inch wall brush for residential pools and spas, and a 24-inch brush for big commercial pools. You can see as well that the net, brush and pole are on the driver's side of the truck, making them easy to grab and go.

ROW 3

The third row is made up of white buckets. The first is a trash bucket. The second is for diatomaceous earth. The third is for dry chlorine (I use a mixture of dry chlorine and liquid on my route). I clearly mark the top of each barrel so that the contents are easily identified in case of an accident or spill.

ROW 4

In this row, I've organized all the specialty chemicals, such as tile soaps, small chlorine and bromine tabs, foam reducers, clarifiers, algae fighters, soda ash and the like. Next come chlorine tabs, a leaf bagger and a floating garden hose.

Floating hoses cost more, but are worth it in the long run. It's easier to clean the pool without having the hose lying on the bottom, getting in your way. Tip: If the floating hose causes the leaf bagger to drift off the pool bottom, bolt a lead weight from an old vacuum head to the leaf bagger.

Hidden behind the chlorine tab bucket is a 15-foot vacuum hose, which is extremely useful for spas. On the far right side of the truck, I keep a small pole for cleaning spas and my tile pole.

CARGO HOLD

For added storage, I tow a pool cart behind the truck. These carts come in all shapes and sizes. In the cart, I carry a vacuum head, a 50-foot hose, a test kit and another wall brush (you'll never have too many wall brushes). In the bucket, I keep old-style skimmer diverters, tile soap and a hose connector.

For safety reasons, you should not carry chemicals in the cart. For one, the weight of the products can damage your truck. Chlorine weighs 10 pounds to the gallon — you don't need an extra 10 pounds bouncing off your truck's bumper. This extra weight can fatigue the metal and cause cracks.

Secondly, and most important, you're more likely to be rear-ended than any other form of vehicle accident. Being rear-ended is bad enough without having to have a visit from the hazmat team.

Author: Robert H. Foutz Jr. is the owner of Purity Pool Service in Huntington Beach, Calif.

Useful Tools

Turn to these indispensable tools when on your route

Service technicians rely on a variety of specialty tools, including nets, vac hoses and lid wrenches. But it's the range of tools not made specifically for the pool industry that form the backbone of their fix-it arsenals.

See what service experts say should be found in your toolbox — and how these tools come in handy on the job.

GENERAL TOOLS

Allen wrenches

A set of Allen wrenches can come in a plastic case or in the "jackknife" style, where each wrench folds out of a case one at a time.

Veteran tech Bob Blade carries both. "The jackknife style ... keeps them all together. But sometimes you just need the single wrench, and the jackknife style can be cumbersome," says the owner of Aloha Pool & Spa Service in Pacific Grove, Calif.

Allen wrenches are important because they're often needed for brand-name-specific jobs. "I use a 1/16-inch for the Laars heater thermostat knob, and the 1/8-inch for the old Sta-Rite motor," Blade says.

Chisels

Experts recommend an array of chisels: metal, stone, wood, and even a putty knife.

"Wood chisels are for scraping old gaskets off pumps, or calcium off tiles," Blade says. "A cold steel chisel is for cutting bolts and other metal cutting."

A carbide tile and masonry chisel can be used for chipping work and cutting out tile.

Files

Although most of today's equipment is plastic, techs still suggest having a 10-inch, half-round mill file for metal work. It can come in handy when dealing with bronze pump bodies, to clean off burrs, or to fix bent or corroded lids.

Goggles and gloves

Purchase splash-proof goggles for chemical handling, and vented ones to prevent fogging. Experts recommend goatskin or deerskin gloves.

Grooved-joint pliers

These pliers often are referred to as "Channel Locks," a common brand name. They're good for grabbing onto pipes and twisting, as well as loosening filter nuts. Don't use them to tighten PVC unions and filter unions, or you'll crack the nut, says Blade.

David Hawes, owner of H&H Pool Services in Dublin, Calif., says his pair of grooved-joint pliers is essential. "If I have to grab only a couple tools off the truck to go do some troubleshooting, it's my screwdrivers and Channel Locks," he says. "They get me through a lot of things."

He brings several sizes, including a small model and the standard 12-inch size. "I have a huge one to loosen filter bulkhead fittings. You can use them instead of pipe wrenches. It is a very universal tool," he explains.

Hammers

Most techs have a collection. Blade uses a hammer and a long block of wood to remove old-style steel filter band clamps or to loosen fitted pump lids.

Rubber mallets also come in handy. "I use a rubber mallet to put filter-lid clamps in place and hit anything that might be damaged by using a conventional hammer," says Steve Jones, owner of Anglo-American Pool Service & Repair in Torrance, Calif.

Avoid wood-handled hammers because the wood can decay over time when constantly exposed to moisture. Steel, graphite and fiberglass handles are good alternatives.

Leatherman Wave

For all-purpose tools, look for something called the Leatherman. "By far, the best tool for every service [tech] would have to be the inimitable Leatherman Wave," Blade says.

The device includes two switchlike blades, four screwdrivers (including a Phillips), a sharp saw that can cut up to 2-inch PVC, a hacksaw with an industrial diamond-fused file, scissors, a can opener, wire strippers and needle-nose pliers.

"It's what most paramedics, firefighters, military and other service trade workers have on their belts as the compact multi-tool of choice," Blade says.

Needle-nose pliers

"Every toolbox needs a pair of needle-nose pliers," Blade says. "But be sure it's equipped with wire cutters."

Experts suggest two styles: long and narrow for getting at hard-to-reach places, and short ones to use primarily as wire cutters.

"Needle-nose pliers are good for holding wires onto relays, so you can tighten them down," Hawes says. "Mine probably gets used more than any other tool in my box, other than the screwdriver."

Blade says longer pliers are good for removing leaves, hair and other debris from pump impellers.

Pipe wrenches

Commonly known as monkey wrenches, they're good to have on hand, even with the advent of plastic pumps and PVC plumbing. "I think Ridgid makes the best, no substitutes," Blade says. "I have a 24-inch lightweight aluminum type with offset 'bulldog jaws.' I don't used it much anymore except on 1-inch gas lines and big brass pumps."

PVC pipe cutters

These are essential to getting clean cuts on PVC piping, where a hacksaw won't give an even cut. They come in several sizes.

Screwdrivers

Sometimes the most basic tool is also the most essential.

"I have three different sizes of the flat blades, and two sizes of Phillips," Hawes says. "I carry one for lock screws on pumps and for the motor shaft. I use a big one like a chisel or pry bar. I use a very skinny one, about 1/8-inch wide, for electrical work — things like faceplate screws. I also carry very tiny screwdrivers for working on terminals inside controllers."

Blade has been using a 6-in-1 combination screwdriver set available from hardware stores at a cheap price.

He says: "You can leave a set at all your commercial pools," he says. "They're cheap, so I buy one just about every time I go into the store."

It's important to replace screwdrivers if they get even the slightest bit worn, Hawes says, or the screws can be easily stripped.

Standard nut drivers

Veteran service technicians say that the 1/16- and 1/4-inch tools are crucial sizes to carry for pool work.

"The 5/16 is the standard nut size on most terminal connections," Hawes points out.

The tools are important for removing motor bolts, radiator hose clamps and heater tops.

"I generally use nut drivers to dismantle heaters because the variety of the drivers make the job easier than using an ordinary screwdriver," Jones says. "Hex nuts and screws can be removed and tightened easier with nut drivers."

Toolmakers also are making them user-friendly. "They come color-coded nowadays," Hawes says. "For example, I know that the yellow is 5/16 and the red is 1/4 -inch."

Standard wrenches

Although many manufacturers make filters and pumps that technicians can take apart without tools, experts say plenty of the old-style equipment is still out there, and that requires wrenches.

Experts suggest carrying stock wrenches in sizes from 3/8 through 9/16, as that should cover most motor bolts and the like.

"I also carry a 1/4 -inch and 5/16, open and box end," Hawes says. "These are good for getting into places where there is no clearance and you can't use a nut driver.

"Many techs also carry an adjustable crescent wrench, in case they're not sure of the size of the nut," he adds.

Wire brushes

Brass or stainless steel brushes won't rust and are good for cleaning around brass pumps.

Brushes designed to work on plastic and PVC are available, so look for those with nylon bristles, or use an actual toothbrush on those kinds of jobs.

Basic pool tools

Service techs turn to these trusty tools time and again when on their routes:

Bucket This is as basic as it comes. Most techs carry a variety of essentials (net, test kit, lube and the like) to the pool in a bucket of some sort. Also, if you need to add algaecide (such as a copper-based one) to the water, you can dilute it in the bucket before adding it to the pool — and avoid staining the plaster.

Hose Available in 10- to 100-foot lengths most techs carry several lengths, especially if they care for pools of varying sizes.

Hose adapters These come in handy when your hose doesn't fit perfectly into the lines or if you're dealing with larger pools. Cone-shaped adapters work well when you're trying to fit the hose into a smaller opening. Adapters also are used to connect two hoses together — for example, in the event a 50-foot hose isn't long enough to handle a commercial-size pool.

Hydraulic drain flush To remedy a pump that won't prime on its own, you can attach a hydraulic drain flush (also called a hydraflush) to a garden hose and slip the end of it into the skimmer inlet. Then, with the pump turned on, turn the garden hose on high.The higher water pressure jump starts the pump and helps prime it.

Don't keep the hydraflush in a bucket with chlorine tablets. If the concentrated tablets come in contact with water and the chlorinated water comes in contact with the hydraflush, it will eat through its fabric.

In-line leaf trap An in-line leaf trap is a canister with a strainer inside. The canister attaches to the end of the vacuum hose; on the other end is a 3-foot hose, which is plugged into the skimmer. This way, the leaves, dirt and debris you vacuum up are trapped in the leaf trap before they can get to (and fill up) the pump pot.

Leaf bagger This tool uses water pressure from a garden hose to suck leaves and debris into a mess bag similar to that of a net. The device attaches to a pole and is useful during the fall or windy months when large amounts of debris end up in the pool.

Leak repair products If you'd prefer not to call a specialist, leak-detection equipment ranges the gamut in complexity and cost. There are several products on the market, from liquid compounds to patches, designed to permanently seal holes.

Lubricant Many techs lubricate O-rings for optimal results. Always lubricate O-rings on pump lids — and filters if doing a filter cleaning. There are several varieties, including Teflon and silicone styles. Read the product's instructions before applying it to ensure it's right for the job.

Net Sometimes called a skimmer, leaf rake or leaf net. It's attached to a pole and used to skim the water surface, removing debris.

Pole, telescopic The standard two-piece telescoping pole goes from 8 to 15 feet, but can be set to any length in between. A variety of maintenance items attach to the pole, making it a multiuse product. The pole is the first thing pool techs grab when they step out of their trucks.

Pump lid wrench These are specifically designed to open pump lids. Sometimes plastic pump lids that haven't been opened for a while or have had their lube harden become difficult to open without a wrench.

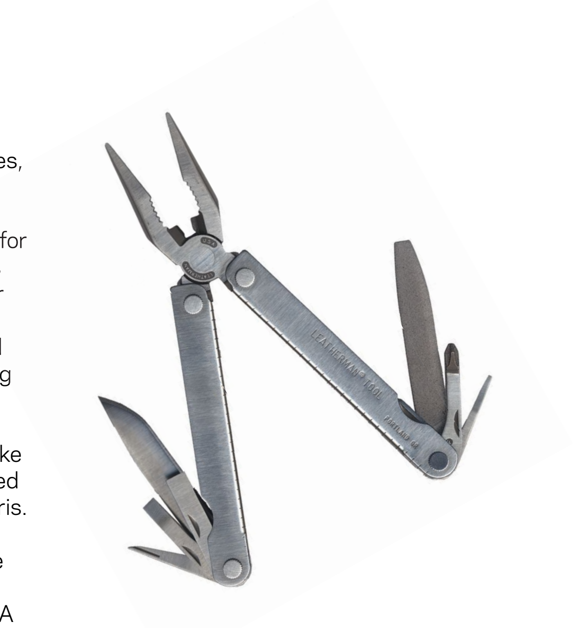
Squirt bottle They have a variety of uses. A nifty trick: Put a little tile soap in the bottle, dilute with water and squirt down the middle of the pool. The suds push debris from the center to the edges, making it easier to net out.

Test kits You can't tell what is going on in the water by sight. No matter how much experience you have, you must test the water each time.

Tile brush Take hot summer days with numerous swimmers, multiply that with sun block, and it equals a lot of gunk on the tile. This tool clicks into any telescopic pole and is designed to remove buildup.

Vacuum head This fastens to a pole and rides along the pool floor to collects leaves, dirt and debris to be sucked into the filter.

Wall brushes These attach to a telescopic pole and come in several sizes and shapes. They all have the same job: remove dirt, algae and other debris from pool and spa walls and floors.



All in one: Service technicians give high marks to the compact Leatherman, which features an array of practical tools.

Upwardly mobile: A pool cart, stocked with essential tools, can be towed behind a tech's truck and then wheeled directly to the job site.

Wire strippers

These are used for removing plastic coating from wires to expose the copper inside. Blade favors GB or Klein brands and likes the new automatic wire strippers — hand-operated, labor-saving devices with springs and levers.

POWER TOOLS

3/8-inch electric drills and bits

These are perfect for installing flow meters, gauges, feed pump tubing and so forth.

"I have three of them," Blade says. "Two are battery-operated and one is [A/C] electric. They have variable speeds, are reversible. Everyone has their favorite."

Jones finds his battery-operated drill very useful. "It's invaluable if you need to drill and tap a new thread into a brass pump pot lid that has worn out," he explains. "It's also good for removing screws and nuts while tearing down old equipment. I use it in place of a power screwdriver."

Hole saws

These are good for cutting into control system boxes and electrical time clock boxes to facilitate electrical conduit connections when there are no longer any knockouts.

Power saws

This is another helpful tool with multiple uses. "I use the reciprocating saw for speed and efficiency," Jones says. "I use it primarily for the removal of pool equipment, and also installations and plumbing repair."

Blade uses a Sawzall brand power saw. "It's great for cutting large pipes and comes with a wide variety of blades, including diamond for cutting tile," he says.

Power screwdrivers

Besides using them on screws, power screwdrivers can be used to drill. They are particularly helpful for drilling holes for temperature sensors.

MEASURING TOOLS

25-foot steel tape measures

Jones calls his tape measure "one of the most essential tools in my kit." Blade keeps a 100-foot, fiberglass measuring tape on hand to determine pool length when he needs to calculate volume or size a new pool cover. High-tech laser measures also are an option.

Marking pens

Indelible marking pens, such as Sharpies, have a variety of uses. "I use a Sharpie for labeling [equipment, valves and meters] in the pump house," Blade says. "It will tell what the multiport valves are for, where the automatic cleaner is, etc."

Hawes uses them to benchmark filter gauges when cleaning filters. "It's good for troubleshooting," he explains. "We note where the clean mark is on the pressure gauge and if there is a problem in the future, we know where that point is."

Vinyl Basics

How to service vinyl-liner pools' specific water care, maintenance and repair needs

If you have spent most of your career working exclusively on concrete pools, it's crucial to learn about the distinct differences between vinyl and concrete before accepting maintenance jobs that involve package pools. Following is a closer look at the care and maintenance of vinyl-liner pools.

WATER CARE

One of the biggest differences between vinyl-liner pools and plaster pools is how sensitive they are to sanitizers and other chemicals. Vinyl-liner pools can be much less forgiving when it comes to water care than plaster or pebble aggregate finishes. So it's important for the water chemistry variables to be regularly maintained within the recommended levels.

Some experts warn that if there is anything under the recommended ranges — particularly calcium, pH and alkalinity — the water can become corrosive and destroy copper. If it's over the proper ranges, scale formation can ensue.

Chemical options With vinyl-liner pools, you have to be more particular about the chemicals you use. Many techs say that chlorine gas should never be applied in these pools because it will lower the pH.

Others also avoid liquid chlorine, or sodium hypochlorite — because it can concentrate and bleach the liner if the product isn't broadcast evenly throughout the pool.

Instead, they'll opt for calcium hypochlorite. If you use cal hypo, though, first mix the powder well with water, broadcast it in the deeper end and be sure to brush the walls and floor afterward so nothing settles or clings to the surfaces. This should reduce the risk of the liner fading.

Others suggest placing the cal hypo in the skimmer to ensure even dispersal, though some warn that this may send too much concentrated sanitizer directly into the plumbing and equipment, which can damage them.

If the source water is high in calcium,

THE POOL DOCTOR

pH	7.2-7.6
Total alkalinity	100-150 ppm
Calcium hardness	200-300 ppm
Cyanuric acid	30-100 ppm
Free chlorine	1-4 ppm

techs recommend avoiding cal hypo and calcium-related products altogether. Why? Calcium will calcify the walls and cause the total alkalinity (TA) to increase.

In such cases, liquid bleach would be a good alternative, as long as it's distributed evenly throughout the pool while the circulation system is on.

The use of stabilized chlorine products in vinyl-liner pools is something experts still debate. Some techs say they use them without repercussions, while others warn that these chemicals can harm the liner.

Trichlor, however, probably won't be strong enough to get the job done if problems such as algae develop. And, be warned that trichlor floaters can bleach the liner if allowed to sit in one place for too long. Also, if your total alkalinity is already low, don't use trichlor tablets because they have an acid base, which will force the TA level even lower.

For customers seeking an alternative sanitizer for package pools, biguanides work particularly well, though they can be expensive.

Chemical ranges Using the right kind of sanitizers and chemicals is all well and good, but if you don't keep the water balanced and all variables in the proper ranges, you can still harm the liner.

The recommended chemical parameters for vinyl-liner pools come in an array of ranges. The chart above shows a compilation of some of the most common ones.

When levels drift from these recommended ranges, the liner can be affected, depending on which direction the levels turn.

For instance, when the total alkalinity goes too far out of range, techs warn that the liner begins to break down and can lose its elasticity.

And while industry standards allow for a chlorine range of 1- to 4 ppm, some techs recommend keeping it as close to "1" as possible to avoid bleaching the liner.

THE SHOCKING TRUTH

If service techs need to pay close attention to which chemicals they put into vinyl-liner pools, then it would follow that shocking the water in such vessels could be a dicey proposition. However, techs say that if you use the right products, it's no more difficult than shocking the water in any other kind of pool.

For superchlorinating (aka shocking) vinyl-liner pools, nothing beats lithium chlorite, say veteran technicians. The advantages are that it won't bleach the liner as readily or calcify its walls. Lithium hypochlorite probably would be the choice of vinyl-liner pool techs for their day-to-day sanitation chores if its high price didn't make it cost-prohibitive.

If you choose to use lithium chlorite for shocking, mix the powder into a slurry and distribute it via the skimmer basket for even circulation throughout the pool.

Before shocking the pool, keep in mind the chemicals you have recently put into the water. Certain combinations of chemicals that, individually, will have no effect can cause bleaching if the concentration is allowed to remain high in the vicinity of the liner, techs warn. You should allow the chemicals to disperse throughout the pool through the circulation system after adding the second chemical.

ROUTINE MAINTENANCE

Dirt and grime that accumulate at the waterline also can play a major role in shortening the life of a liner.

Similar to a "bathtub ring," the phenomenon usually is caused by airborne debris mixing with body and suntan oils and other organics, and collecting on the liner. It's then baked in by the sun, which can

Enemy No. 1: UV

Besides harsh chemicals, one of the worst enemies of vinyl liners is ultra-violet light from the sun.

UV rays hit more on the northern side of the pool, and that can cause bleaching where the sunshine hits it above the waterline, technicians say. To help prevent this, place the water level up higher than you normally would on other types of pools.

UV will do the most damage on pools where the vinyl liner was incorrectly installed. And it especially can affect the liner if it was overstretched when it was put in.

When the vinyl is overstretched, it thins out just above the waterline, and that's where the UV is going to attack it. You end up with premature wear due to faulty installation.

One solution is to convince the customer to add a cover to the pool if it doesn't already have one. If the customer opts for a solar cover, though, don't pull it completely over the edges of the wall. This will physically heat the vinyl it comes in contact with, causing it to degrade.

With any floating-style cover, leave an inch around the pool between the end of the cover and the wall.

Dealing with discoloration

Perhaps the most common liner problem is discoloration.

It can be traced to a number of sources, according to APSP's Basic Pool & Spa Technology: overchlorination, the sun's UV rays, chemicals applied directly on the surface without proper dilution — even stains from a wooden poolside wall.

For aesthetic reasons, a pool owner may want the stain to be covered up, and a patch might be just the thing. However, if you're dealing with a faded area, the liner is more likely to tear and eventually will have to be replaced.

At least stains on pool bottoms caused by fungus growing in the material below the pool are a thing of the past. All vinyl used for inground pool liners now contains a fungicide additive.

cause the vinyl to dry and crack prematurely, especially in the area of the pool where sunlight appears the brightest and longest.

Care must be taken to wipe down the waterline on a regular basis. Use a plain sponge or one in conjunction with a recommended vinyl cleaner to stave off dirt and grime buildup.

Be careful what you use to wipe down the walls. A soft sponge is recommended. Anything abrasive can cause a problem with the liner. You can rub the pattern right off.

In addition, the technique you use when wiping down the liner is important. Don't be overly aggressive. If you rub too vigorously, you can move the liner back and forth. Sand can work its way right through the liner. Some techs say that if the buildup is so bad that you must rub it hard, maybe you just need to replace the liner.

If grime has accumulated, it's important to use only cleaners approved by the manufacturer for use on vinyl. Never use petroleum-based products because they can rapidly deteriorate vinyl. If you decide to go with a vinyl cleaner, though, test it in the pool first. Do it in an inconspicuous area to ensure there are no surprises.

Regular brushing is needed to keep excessive chlorine from clinging to the walls and fading the liner pattern, experts say.

Once the waterline is clean, it's a good idea to add a layer of protection. Many products that are not petroleum or alcohol-based are available. They will protect the liner from further buildup.

Try not to drain the pool unless you're planning to do some major repairs or refitting. But if you find that some draining is unavoidable, do not lower the water less than 1 foot in the shallow end. If water pressure is removed from the liner, even for a short time, it could shrink and become unsightly, or possibly tear around the fittings and in the corners.

When it comes to cleaning equipment (brushes, vacuums and even automatic cleaners), be sure to choose those suited to vinyl-liner pools. Every implement that is made for cleaning swimming pools is also made in a vinyl-liner form. As long as you use the implements made for that type of pool, you should never have a problem. For example, a gunite pool brush has square edges while a package-pool brush will have upturned, rounded edges.

If the pool has an automatic cleaner, or the homeowner is in the market for one, be sure it's designed for use in vinyl-liner pools.

Use a vinyl-liner vacuum, one that has brushes instead of wheels. While the liners are surprisingly durable, you still want to be careful, especially in the corners.

One final tip to help your brushing and stain-fighting regimen: Keep the water level as high as possible. That way, there will only be 2 or 3 inches of exposed vinyl that you'll have to keep clean.

Taming stains

A major factor in vinyl-liner pool care that should be considered is air temperature, which has a profound effect on water. Package-pool veterans say to keep free chlorine levels between 1.0 and 1.5 ppm when the temperature is below 70 degrees, and between 3 and 5 ppm if it is above 70. If the level drops lower than 1.0 ppm, algae blooms and unchecked bacteria growth may occur.

This is not only unhealthy, but it also can cause stains to appear on the liner. The problem can be further exacerbated if it's accompanied by a pH level that drops below the 7.0 mark. This could become a bigger problem when service companies close a vinyl-liner pool for the winter. With the temperature changes, you run more risk of the vinyl cracking. But typically if close it for the winter with the water balanced, it will be the same when you open it back up.

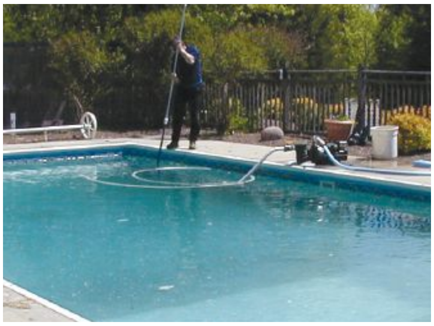
Acids used in pool care — the stabilizing type and those used for pH adjustment — should be taken into account as well. Because chlorine levels are depleted by ultraviolet light, the water needs to be stabilized with cyanuric acid. Recommended ranges are 30- to 100 ppm.

Some experts suggest avoiding the use of muriatic acid for pH adjustments. The acid can attack the liner pattern and make it more susceptible to abrasion wear. Instead, use sodium bisulfate to bring the pH into the desired range.

Just like shotcrete and gunite, vinyl liners are susceptible to staining due to metals falling out of solution and precipitating across the pool surface. Experts say to check for metals in the source water. If metals are present, monitor their levels on a monthly basis. If there are no metals, check every six months.

If your readings indicate that mineral levels — especially copper and iron — are rising, you may need to incorporate a chelating agent to remove the metals from the water. Follow the manufacturer's instructions closely.

If discoloration has already occurred, use a stain remover that has been created for vinyl. Whatever product you use, make sure it states specifically that it can be used with vinyl-liner pools.



PHOTOS COURTESY THE COOL POOL GUY

Vinyl care: Service technicians perform a start-up on a new pool (left), being careful to keep the water chemistry in balance. A tech cleans the walls (right), mindful that special tools are needed to brush or vacuum vinyl liners.

Vinyl Repairs

Tips for fixing some of the most common package pool problems

The sun's ultraviolet light can wreak havoc on vinyl. In addition, the corners and bottom of a pool's vertical wall are inherently vulnerable to deterioration, as are the areas around the cutouts for return lines and skimmers.

In addition, sanitizers and chemicals can inflict their own heavy damage.

Such abuse can result in leaks and ultimately require that the entire liner be replaced. However, savvy service technicians can be proactive if they're well-versed in the art of vinyl patching and other forms of package pool repair.

In this step-by-step pictorial, you will learn how to repair two common problems: "smileys," and rips and tears.

Pool and Spa News acknowledges Bob and James Barci of Ocean Blue Pools in San Jose, Calif., for their assistance with this article.

The smiley repair

Occasionally, the track that holds the liner in place around the pool perimeter can develop a weak point where the liner bead sits in the groove. This can be caused by several factors, including the sun's heating of the plastic track, which causes it to expand. Air also can get trapped behind the liner during the pool-filling process, it then finds its way out via the top of the liner, popping it off the track.

When the track is weakened, the water weight can pull down on the liner and force a portion of it to come loose and sag. It gives the appearance of a grin or a smiley face. But for a pool owner, smileys are no laughing matter.

Fortunately, it's a fairly easy problem to fix. Note: Experts warn techs to never drain the pool to make these repairs. With the water gone, the liner will reshape itself back into the roll from which it came.

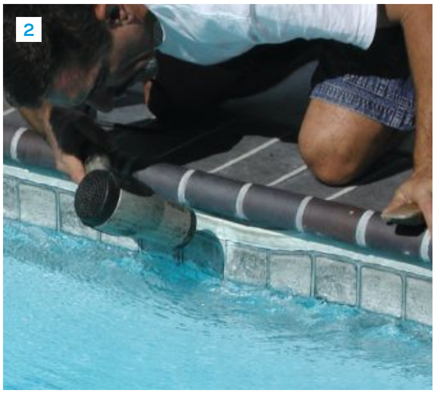
1. The weight of the water has caused a small part of the liner to sag. When the liner bead pops loose from the track, it resembles a grin.

2. Carefully use a blow dryer on the liner section affected by the smiley, to heat up the vinyl and make it more pliable. If it's a warm day, this step may not be necessary.

3. A strip of bead lock that's T-shaped and made from pliable rubber is slid by hand into the liner track to create more tension. It will secure the liner and make the smiley disappear. A wooden wedge can be used to roll the bead lock into place if necessary. On new pools, the bead lock will be tighter and more force may be required. A rubber mallet may be used to do the job.

4. With the liner now back in proper position in the track, it has been pulled taut and the smiley has vanished.


1


2


3


4

PHOTOS BY BOB DUMAS & OCEAN BLUE POOLS

When it's just a little tear

Often a tear can be repaired as follows, according to the APSP's Basic Pool & Spa Technology:

- Lower the pool water level.
- Take stress off the tear.
- Dry it.
- Cut small circles at each end of the tear to stop it from tearing further.
- Using alcohol, clean the liner area to be repaired.
- Go over the area with a fine-grained sandpaper.
- Add glue.
- Use pressure to help it stick together. You may have to add backing so you can press without causing another hole.

Rips and tears

If pool water is kept in balance and protected from the sun, the vinyl will remain in good condition. Yet despite the best of care from the service technician and pool owner, vinyl liners are, by nature, vulnerable to rips and tears.

Most liner manufacturers offer repair kits that include patches and glue. But if you prefer, you can use extra strips of vinyl and your own jar of glue.

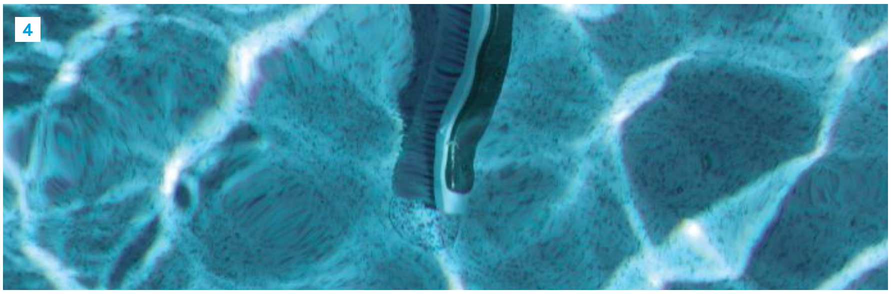
It will be difficult to locate an exact liner pattern match for a damaged pool, especially if it's several years old. Veteran technicians recommend finding a patch that's as close to the existing pattern as possible, or use a clear piece of material.

Check with your local warehouse or distributor to make sure you're using the proper glue. You should only use products that are deemed safe for vinyl applications.

Before beginning the repair, there is one vital factor to consider: the site of the rip. Is it reachable from the deck, such as in the shallow end of a pool or hot tub? If it is, then making the repair by hand will be easy.

If it's in the deep end, you may need to get into the pool or use a telescoping pole to set it in place. Another option is to subcontract an underwater repair specialist, though this can be expensive.

1



1. Use a sharp knife or razor to remove a patch big enough to completely cover the tear.

2. Take some glue that is approved for vinyl-liner repairs and spread it thoroughly on the underside of the patch.

3a. If the tear is reachable from the deck, you can place the patch over the damaged area by hand. Do it quickly because the glue doesn't take long to dry — even under water. Note: Smooth over the edges around the tear with fine sandpaper.

3b. If the rip is in the deep end and you can't get into the water, you can try a clever method to finish the job. After gluing the patch, drop it into the water and let it settle by the tear, guiding it with a pool brush.

4. Once the patch is where it's needed, put pressure on it by pushing down on the brush. This holds it in place until it's dry, and it also helps smooth out any wrinkles.

5. The patch is now in place, and the leak has been repaired.

Vinyl-Liner Replacement

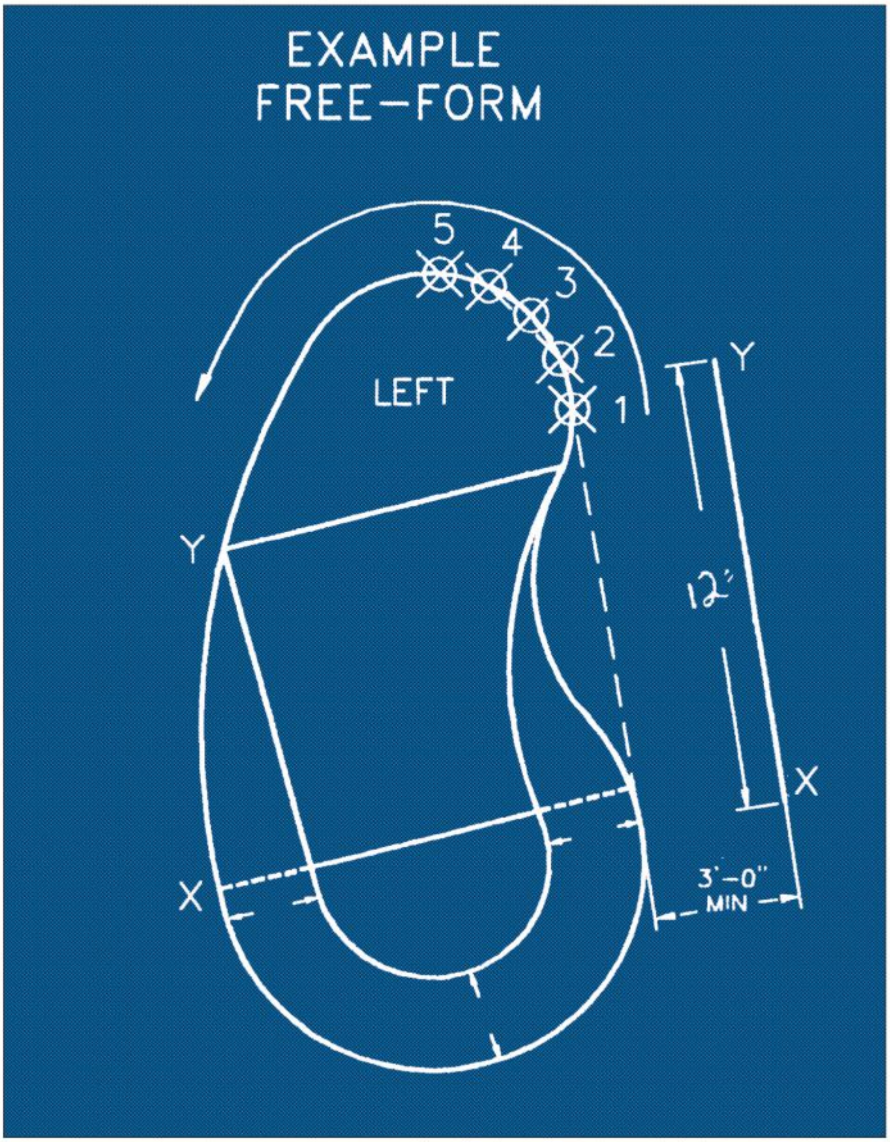
A successful job is all in the technique

In an effort to expand their repertoire of services, some pool-service companies offer vinyl-liner replacement.

With manufacturers making the task easier than ever, the move makes good business sense. Nowadays, manufacturers put arrows on the liner demarking the break line of the pool. That gives you a starting point to put into the track, says a veteran tech.

Although replacement has become easier, techs still must take detailed measurements and carefully follow instructions, as specified on most vinyl-liner manufacturers' order forms. Following are some installation tips from a veteran installer.

Pool & Spa News thanks Michael Ramee, president of Mad River Pool Construction in Orlando, Fla., for his assistance with this article.



1. The first step is to select two convenient locations from the edge (about 3 feet) of the same side of the pool. These will be called points X and Y. If possible, they should be about 12 feet from each other. Be sure to indicate the actual distance between X and Y on the order form that you'll be sending to the vinyl-liner manufacturer.

Next, measure the distance between both X and Y to various points along the edge of the pool. Depending on the size of the pool and the curvatures, select points about 1 or 2 feet apart all the way around the perimeter. Each of these points should be numbered.

In the end, you'll have a series of measurements: the distance between point X and point 1, point Y and point 1, point X and point 2, point Y and point 2, and so on — until you've gone completely around the pool.

Also, take depth measurements in both the shallow end and at various points in the deep end. This is so the manufacturer has an out and down configuration to add to the exterior measurements that the point-to-point, or X and Y measuring system (triangulation), will provide. Without the additional depth measurements, the liner manufacturer will not be able to produce a liner that fits accurately.

From all these measurements, the manufacturer can get an accurate picture of the pool's shape and produce a liner that will fit.

Once you've taken the pool's measurements, the next step is to order its liner replacement. After the new liner has arrived, follow these basic steps to put it on properly.

2. First attach the vinyl liner to the pool's poured concrete steps. A fiberglass step rod is slid through a sleeve that has been electronically welded to the back of the liner. Concrete anchors have been installed where the risers meet the back of the tread of the step. A stainless steel screw is then put through the rod and into the anchor.

3. Align the hole in the step rod with the anchor in the step.

4. The liner has a bead that is slipped into a track — actually, a "top-mount extrusion" — which has been screwed into the tops of the walls. (Traditionally, rim-lock coping is used. It contains a track to hold the liner bead. In this installation, there is brick coping, so the top-mount extrusion was more apropos.) The top-mount extrusion is an aluminum track with no raised profile.

5. Prior to vacuuming (removing the air from behind the liner), be sure the tile border is straight up and down, and is not being pulled in different directions.

After the liner is in place, there may be small wrinkles as a result of packing or the vacuum not having sufficient suction to pull the liner completely into place. These wrinkles should be moved toward the pool walls. Before the pool is filled, installers should remove their shoes and enter in either bare feet or stocking feet to avoid any scuffing or print distortion. Also, with a small amount of water in the shallow end, the liner can be moved by using a plunger to suck and position the liner gently into place.

6. The pool begins to fill as a vacuum is used to remove air from behind the liner for a tight fit.

7. As the pool fills and the shallow end is covered with water, the vacuum is removed and the fittings (light faceplates, skimmer faceplates and the like) can be cut in. The faceplates are locked in now, and you can trim out the vinyl inside the fittings with a sharp knife.

8. The liner's in place, the pool filled with water, and the brick deck has been installed. The project is complete.

2

3

4

8

Replacement Alternative

A closer look at fusion, a welding technique used to repair vinyl liners

What is fusion? In a nutshell, and for our purposes, it is a welding technique used in vinyl-liner repair.

Liner fusion is similar to metal soldering. It uses heat to bond two separate pieces of vinyl together. Fusion experts say the repaired area actually is stronger than it was originally.

The technique can be used to repair everything from holes on pool walls, corners and steps, to relieving tension, to removing folds. And techs can fuse a new waterline area only to avoid a total replacement. Experts say fusion can repair almost anything except for a liner that's too old.

While service techs should receive professional training before undertaking this procedure, it offers an alternative to pool owners who want to avoid replacement of the entire liner.

Pool & Spa News thanks the International Fusion Liners Schools in Montreal, Quebec, Canada, for its assistance with this article.

Fusion repairs

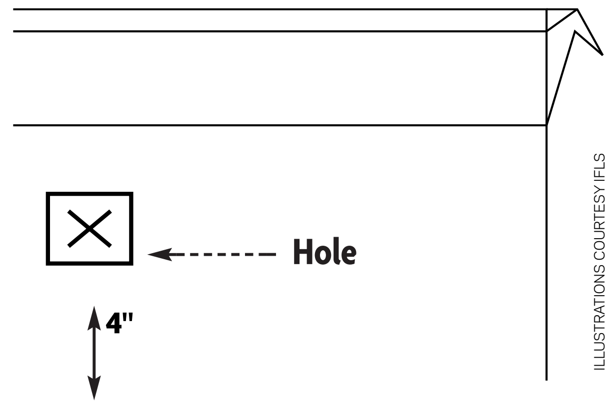
PHOTOS COURTESY IFLS

1. Waterline repair: Sometimes the sun's UV rays damage vinyl above the waterline so severely that replacement of the entire liner seems necessary. But by using a welding technique known as fusion, a trained technician can replace the outline with a new beaded section of wall liner — and save the client an expensive full replacement.

2. Before: A fusion technician has been called in to adjust a liner. Approximately 1 foot of extra liner has gathered in one end of the pool.

3. After: Ideally, such a large fold would be eliminated with a fusion at a seam. But in some cases, such as this one, it is done directly on the pool floor. Here, the technician has carefully cut the liner, removed the extra material and fused the liner back together. Even when the fusion occurs directly on the pool floor, the goal is to make it appear as if the seam done at a vinyl-liner manufacturing plant.

Repairs to holes on walls or steps



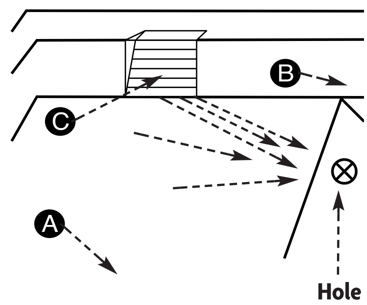
ILLUSTRATIONS COURTESY IFLS

Holes on walls: If the hole is at a reasonable height, ask the pool owner to lower the water level, but no more than 4 inches below the hole. Now water pressure will press the liner to the wall, which is what you want because a flat, hard surface is necessary for a proper fusion. If the wall isn't firm enough, use a plank behind the liner. The liner patch must be 2 inches bigger than the hole to allow you to make a fusion of three passes with the welding gun. Be sure to position the patch behind the liner, never on the front.

Holes on steps: Most of the time, the corners of steps are subjected to tension that originates from the deep end, so you'll encounter this situation with liners 4 years or older. Determine the direction of the tension by finding its spot of origin. There's always one corner that has more tension than the others; and the corner closer to the deep part of the pool usually has less tension.

Once you know which corner has the most tension, you can begin to undo the retaining bars of the steps, leaving a few screws at the top so you don't lose the alignment of the screw holes. Remove the support bar from the bottom and cut the liner from one side to the other — so it can be replaced with a new piece of liner that, by fusing, will allow you to reduce the tension not only in the corner, but also in the center of the step. This will also eliminate any tension below the steps. The older the pool, the more tension there will be. So plan to fuse three pieces of new material into the corners to strengthen the liner covering the steps.

A: Floor
B: Wall
C: Steps



Advertiser	Phone	Website	Page
A&B Brush	626.303.8856	www.abbrush.com	101
Allied Innovations	800.237.9937	www.alliedinnovations.com	85
Anderson Mfg.	800.348.1316	www.leaktools.com	14, 29
Aquamatic Cover Systems Inc	800.262.4044	www.aquatmatic.com	25
Fix-A-Leak	905.374.2560	www.fixaleak.com	7
Hammerhead Patented Performance	866.887.7983	www.hammerheadvac.com	17
Pentair Aquatics Residential		www.pentairpool.com	5
Pleatco LLC	800.866.5160	www.pleatco.com	2