Association of Pool and Spa Professionals Technical Committee Report on Suction Outlet Safety and the Effectiveness of ANSI/APSP-7

October 5, 2007

Introduction

Suction Entrapment has gained considerable attention over the last decade. It has been the subject of voluntary standards, building codes, and national legislation. Increased media attention due to tragic accidents has focused industry leaders, health and building officials, and code writers toward making a significant effort to protect bathers from potential entrapments. Unfortunately, the principal cause of various modes of entrapment can be confusing and difficult to understand without careful study of the underlying physical phenomena. This has resulted in widespread misunderstanding of how one can successfully avoid all modes of entrapment. Many code and standard efforts have focused primarily on the easiest of the mode of entrapment to prevent, body entrapment. This oversimplification, if not addressed, could lead to building codes, or even laws, that do not adequately protect bathers from all dangers present in pools and spas and may create a false sense of security.

A survey of the Epidemiological Reports on Suction Entrapment collected by the U.S. Consumer Product Safety Commission by the Association of Pool and Spa Professionals (APSP) Technical Committee yielded 5 distinct modes of Entrapment:

- Hair Entrapment - Hair becomes knotted or snagged in an outlet cover
- Limb Entrapment – A limb sucked or inserted into an opening of a circulation outlet with a broken or missing cover resulting in a mechanical bind or swelling.
- Body Entrapment – Suction applied to a large portion of the body or limbs resulting in an entrapment
- Evisceration/Disembowelment – suction applied directly to the intestines by a circulation outlet with a broken or missing cover.
- Mechanical Entrapment - Potential for jewelry, swimsuit, hair decorations, finger, toe, or knuckle to be mechanically caught in an opening of a suction outlet or cover.

There are three basic underlying physical phenomena that govern all 5 modes of entrapment:

- Suction (or delta pressure)
- Water flow rate through the outlet or cover
- Mechanical binding

The ANSI/APSP-7 standard includes methods for protecting bathers against all modes of entrapment, which include all three underlying phenomena. Unfortunately the focus is typically on only one of the three underlying causes, suction (or delta pressure) because it is very easy to grasp, while the more common cause of entrapments, flow and mechanical, is inadequately addressed. Without addressing all underlying causes, it is very difficult to build redundancy, or backup scenarios, in these latter modes of entrapment, which leads to further obfuscation of the problem. Perhaps the most regrettable legislative and regulatory impediment to protecting bathers is actually created by semantics; the term “layers of protection” has been falsely applied to the various modes of entrapment on circulation components. While this term was first used, correctly, in areas of fencing requirements, it does not apply to entrapment and its use causes widespread misunderstandings concerning effective methods of entrapment mitigation. Extensive use of the layers of protection label just compounds industry, health, and building official's confusion about how various entrapment mitigation scenarios protect bathers.

Table 1 lists a summary of the various standards related to entrapment along with a brief scope and developmental status. These standards basically fall into two categories:

- Device and Component Standards – specific certification and test protocol for devices or field fabricated components
- Pool Construction Standards – describes methodology to construct swimming pools and spas to circumvent and/or mitigate entrapment.

While device component standards are critical for certifying operation of pool components, they address only the specific entrapment areas covered by the standard. For example, ASME/ANSI A112.19.17-2002 covers the testing and certification of Safety Vacuum Relief Systems (SVRS) involving Suction (delta pressure) relating to primarily body entrapment, but does not test or alleviate flow rate or mechanically induced entrapments involving Hair, Limb, and Mechanical categories. In addition, it explicitly excludes protection against evisceration/disembowelment. So this particular standard effectively covers only 1 of the 5 reported modes of entrapment and only attempts to alleviate one of the three root causes of entrapment, suction (delta pressure).

Similarly ASME/ANSI A112.19.8-2007 covers testing and certification for outlet covers tests a full head of hair and adds body block tests. Both of these tests are used to determine a maximum flow rating for the cover. Finger entrapment is evaluated using a probe to determine digit access. An important update to the 2007 version of the standard is the addition of UV weathering exposure prior to structural testing. Since UV degradation plays a significant role in covers breaking, this can significantly reduce the frequency of covers being easily broken or removed.

In contrast, the ANSI/APSP-7 standard addresses methodologies for pool construction that effectively cover all 5 modes of entrapment. It is a systems level approach to pool construction. It describes systems that range from elimination of entrapment hazard through completely removing fully submerged suction outlets from installation, to various methods for constructing and protecting submerges suction outlets by alternate means. It does not mandate or advocate any one method, but rather gives the pool builder the choice of constructing the pool in various modes, all of which effectively circumvent or mitigate submerged suction outlet entrapment. Additionally, it is applicable to both residential and public pools and for flow rates from a few gallons per minute to thousands of gallons per minute.

Since all methods will not work effectively with all installations, it does not mandate any one single installation method. It does not use the erroneous "layers of protection" approach, but rather depends on individual or combination of systems to address all 3 underlying physical phenomena (root causes) and consequently all 5 modes of entrapment.

Recently the "dual drain" approach has come under some criticism for being less than adequate in effectively dealing with entrapment, specifically suction (or delta pressure) entrapment. It has been asserted that when a drain cover becomes broken, missing, or one outlet is blocked, the dual outlet system ineffective and therefore a requirement should be levied for system redundancy. This committee performed testing to investigate this claim and in the process uncovered some alarming issues concerning current SVRS testing protocol. Furthermore, it has the testing confirmed that pools built in conformance with ANSI/APSP-7 do in fact prevent all modes of suction outlet entrapment.

Materials and Methods

Testing was conducted using various piping and suction outlet (drain) configurations. The test facility is pictured in Figure 1a-d. A 5000 gallon test tank is configured with various components used in pool circulation systems. Submerged piping is used on all tests as it closely replicates what one finds in the field. The test tank has a pair of bulkhead fittings that are used to pass water from the tank. It is then connected to a manifold that allows 2" suction side piping runs to be configured in 25 ft increments up to 200 ft as called out in ASME/ANSI A112.19.17-2002. In addition, return side is configurable for 25ft or 100 ft per ASTM F2387-2003. Note that ASME A112.19.17 – 2002 does not include a return side specification.

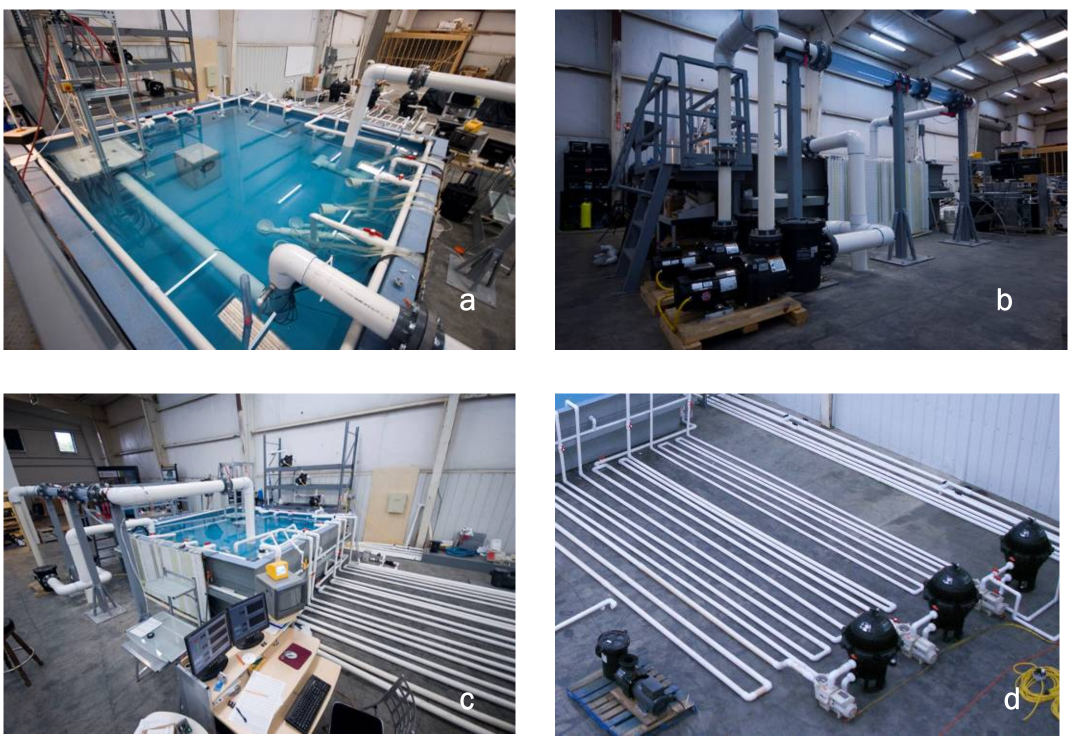

Figure 1 *overall system configuration including pump elevation rack, high flow rate system pumps and parallel equipment testing configuration*

Pumps are located on a rack and allow testing at –3 feet (flooded), ground Level, +3 feet, and +5 feet with distances measured from waterline to center of the pump impeller. With this design, one can rapidly change between various configurations of pipe length and pump elevation to test a wide range of arrangements commonly found in pool and spa installations. In addition to these piping configurations for the ASME/ASTM SVRS testing protocols, there is an additional capability to test situations found outside of the small range of piping and pumps covered by these standards.

For larger commercially oriented systems, a dual 5 HP parallel pump system allows testing flow rates up to 850 GPM with larger size outlet openings. Vent tests can be conducted on extremely high flow rates on single or dual outlets up to 36 x 36 in. Should SVRS technology be developed for such large flow rates as found in large residential water features or commercial installations, the facility will easily accommodate this testing.

Finally, three flooded piping/equipment pad systems are used to make direct comparison tests on piping configurations found in typical pool systems. Each of these systems can be outfitted with identical equipment (filter, heater, pump, etc), and are plumbed with 75 ft of piping on both the return and suction side. The water can be returned through a series of return jets as commonly found in pools and spas or it can be returned through a single open pipe for low back pressure configurations. The three systems are plumbed using 2 ½, 2, and 1 ½ inch schedule 40 PVC. In this way, real time comparative tests of power consumption, flow rate, suction side loss, and system pressure can be performed. In these tests, piping size is the only variable and piping effects can be separated from overall equipment specific dependencies.

The data acquisition system is capable of 16 simultaneous channels at 200 Ksamples/second can be seen in the foreground of Figure 1c. Data is displayed during real time testing and can be stored at a wide range of data rates to be analyzed at a later time. The system includes a Balanced Flow Meter (BFM) developed by NASA, which accurately measures flow rates for all tests. This allows extremely accurate and verifiable flow rates, which are critical when determining the affect of flow rate on various tests protocols. Multiple pressure transducers are available to simultaneously measure sump, line, and pump pressures at varying locations. A complete digital video system also allows for real time recording, above and below water, at 30 frames per second for each test. Once captured with the non-linear editing system, it can be edited and distributed on DVD. The system can be reconfigured for real time streaming to the internet, should remote test viewing be required.

All SVRS testing is accomplished using the Autonomous Suction Outlet Test Apparatus (ASOTA) as shown in Figure 2a. This device allows pneumatically applied 15 lbs buoyant closed cell foam block to a test suction outlet as described in both ASME/ANSI A112.19.17-2002 and ASTM F2387-2003. Blocking element approach speeds and removal speeds are fully adjustable. In addition, it can be reconfigured to apply a known amount of downward force to a blocking element as described in tests found in ASME/ANSI A112.19.8 -2007. In addition to the test protocols of ASME/ASTM for single drains the ASOTA can be configured with a load cell to pull vertically using center or eccentric pull of the blocking element to capture the release force. The test apparatus can also be plumbed to a second outlet so that testing protocol described in both the ASTM and ASME SVRS Standards can be applied directly to dual outlet systems (Figure 2b).

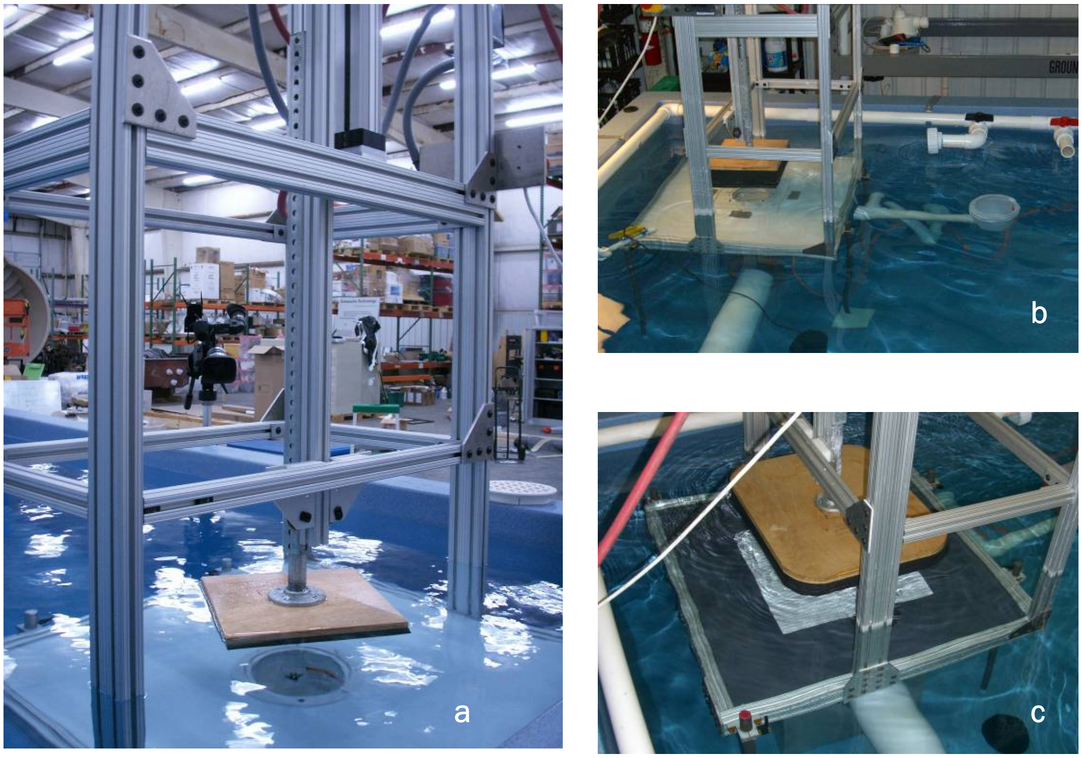

Figure 2 *a) Autonomous Outlet Testing Apparatus (ASOTA) configured to test a single outlet system. b) Configured to test dual outlets analogous to ASME/ASTM SVRS Standards c) Configured for a single outlet 18 x 18 inch cover vent test*

Results

Drain SVRS testing was conducted on the entire range of piping configurations and pump elevations described in both the ASTM and ASME SVRS Standards. In addition, testing was performed in configurations outside of the protocol described in both of these standards. These additional tests included larger flow rates, variable pump size, variable piping sizes, multiple outlets and ground level pump location. This additional testing was completed to verify testing protocol on a wider range of variables than are found in the published SVRS standards, but in configurations that are common in pool installations.

Various commercially available, and some not yet available, manufactured devices were tested. These tests were conducted over several months by members of the APSP Technical Committee, several SVRS manufacturers, and representatives of the Florida Swimming Pool Association (FSPA).

Initial testing, performed at the request of the FSPA, of commercially available SVRS devices produced results in many cases in which the tested SVRS device failed to trip when second outlets (e.g. drains, partially blocked drains, or skimmers) were present.

Testing performed, for the purpose of this study, focused on the underlying technology behind SVRS devices. Three basic types of SVRS technology were evaluated: venting only, venting plus pump power shut down, and pump power shut down only.

Finally, initial qualitative testing was conducted on sump venting (field fabricated vents) as described in ASTM 15.51 currently under development. Venting of various configurations of dual and single drains on flow rates as high as 420 GPM have been successfully demonstrated with various U-tube configurations.

Specifically this report will focus on:

- Single Outlet SVRS Tests with submerged pump
- Dual Outlets – 3, 6, 8, and 10 fps using ASME/ASTM SVRS protocol
- Dual Outlets – with SVRS Backup
- Single 18 x 18 outlet U-Tube venting at 20, 30, and 37 ¾ inch depths

Figures 4, 5 and 6 are graphs representing the results of these tests. The first series Figure 4 a-b illustrates an example of SVRS vent-only system failure on a single 8 inch drain sump. For these tests, a multiple orifice manifold was connected to the drain plug of the pump strainer. Orifice size varied from 0.075 – 0.30 in. Evaluations were made at ground level until the correct orifice size was established that could reliably release the 15 pound buoyant blocking element. In this case the size of the orifice used was approximately 0.30 inch. Once this was effectively established, the tests were repeated at the flooded (- 3 foot elevation) level. Various flow rates were tested until one was established that was right on the edge of passing. The test was repeated until several instances of pass and fail were established. Figure 4a shows a result typical of a passing test. As can be seen from the graph of pump/sump pressure vs. time, pressure (psia) is quite stable as measure at the drain sump, but there is a 0.65 psia fluctuation at the pump. This is typical of measurements at the pump.

One can easily recognize the point at which the drain becomes blocked with a severe depression in pressure. As the SVRS is releasing, one can see a pressure oscillation through the base line pressure and a positive swing that reaches nearly 20 psia. These swings are typical of SVRS releases and are a result of the dynamics of water in the pipe, in particular water hammer. In this case the release is completed in slightly less than 2 seconds and clearly passes the SVRS release standard. The pump begins to prime and the sump pressure returns to its pre test levels.

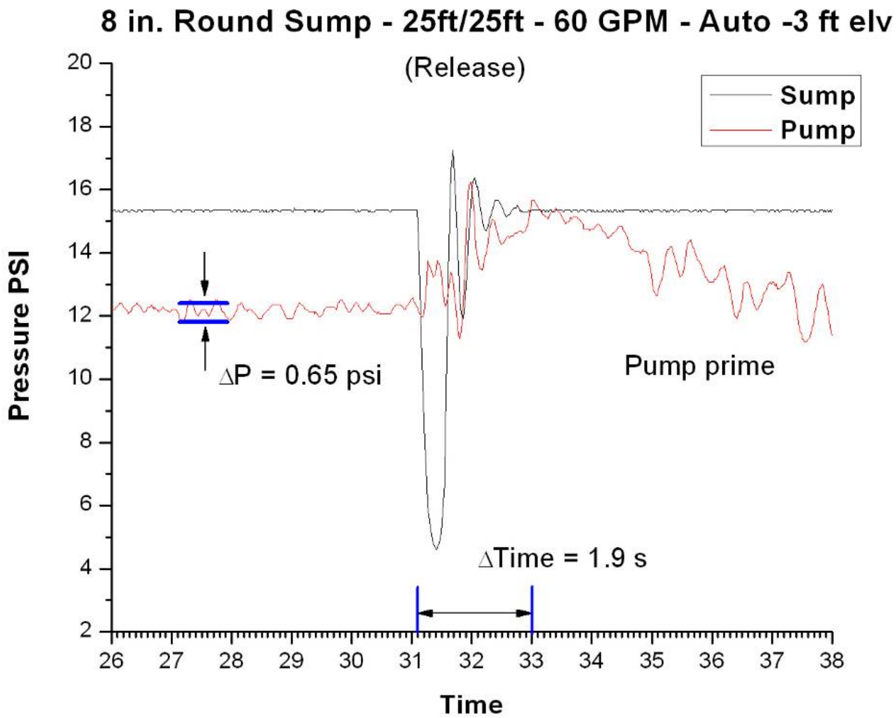

Figure 4a

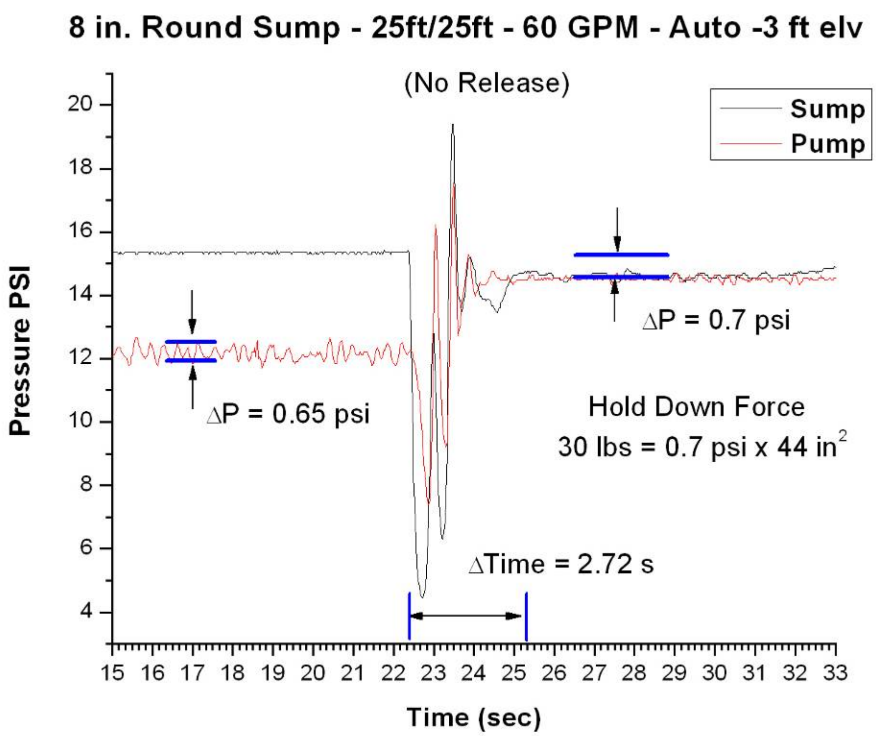

Figure 4b

An Identical test shows a dramatically different result. In this case the blocking element does not release. Baseline pressure levels were identical to the first test. In this case water hammer and dynamic effects continued for 2.72 seconds – nearly as long as allowed for release in the standard. Because the blocking element does not release both the sump and pump pressures end at the same value. What is interesting about this new depressed level, 0.7 psia, is the effect of the pump trying to prime. Even though the SVRS is tripped, the pump continues into remove air from the system at the rate the SVRS allows air into the pump. This results in a hold down force of 30 lbs – double of what is allowed in both the ASTM and ASME standards.

This result could easily be repeated using smaller orifice sizes. What this revealed is that a device can be calibrated and "pass" the limited piping and pump configurations set out in the test protocol then fail as shown in Figure 4 b. This leads to the concern that current standards do not adequately test these devices to the release levels and times called out under the ASME/ASTM standard's scope. The limited, pump size, piping size and flow rates specified in these standards do not approach those found in the field and they do not evaluate piping elevation versus water level.

With this result a similar set of tests were performed using dual-outlet standard 8 inch sumps, 3 ft separation, with one cover missing and the other in place (Figure 5 a-c). The blocking element was applied to the sump via the ASOTA with the missing cover while the remaining drain was allowed to flow. It should be mentioned that this was exactly the test configuration where several SVRS devices certified to the ASME and/or ASTM standards did not successfully detect a blockage. In this case blocking was attempted with the automatic test device as described in the ASME/ASTM standard at line velocities of 3, 6, 8 and 10 fps. In 2 inch pipe this represents 31.4, 62.8, 83.7, and 104.6 GPM. The test allowed the blocking element to be momentarily contacted with the open (uncovered drain) in the analogous fashion to SVRS testing.

In each case during the automatic testing the blocking element is never trapped on the uncovered drain – *even at flow rates that exceed the ANSI/APSP-7 standard maximum of 6 fps*. These were surprising results and so the test was repeated, except that the blocking element was held in place manually for several seconds allowing water dynamics to subside. Figure 5 b shows this result. At 3 and 6 fps, the blocking element releases; however, at 8 and 10 fps the blocking element is held down as can be seen in both the sump and pump depression of pressure (Figure 5 c), after which the blocking element was manually removed. This could be repeatedly performed and underscores an important flaw in the testing protocol of the ASME/ASTM tests. At flow rates greater than allowable rates prescribed in ANSI/APSP-7 the Dual Drain passes the ASME/ASTM test protocol, but in similar tests that allows water dynamics to subside, fails.

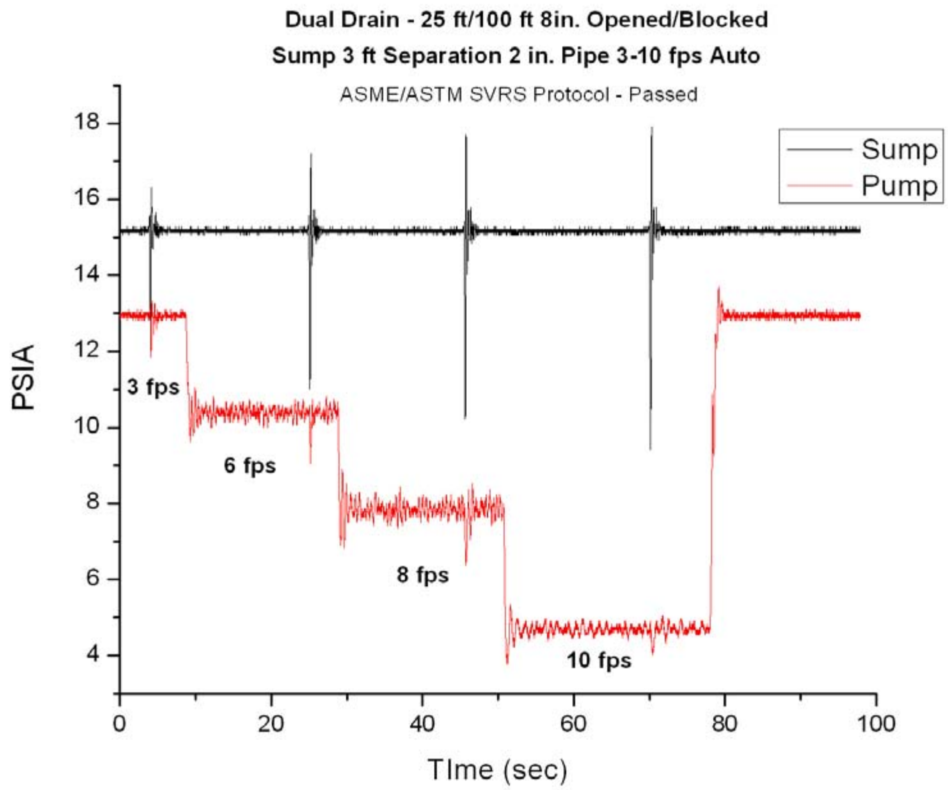

Figure 5a

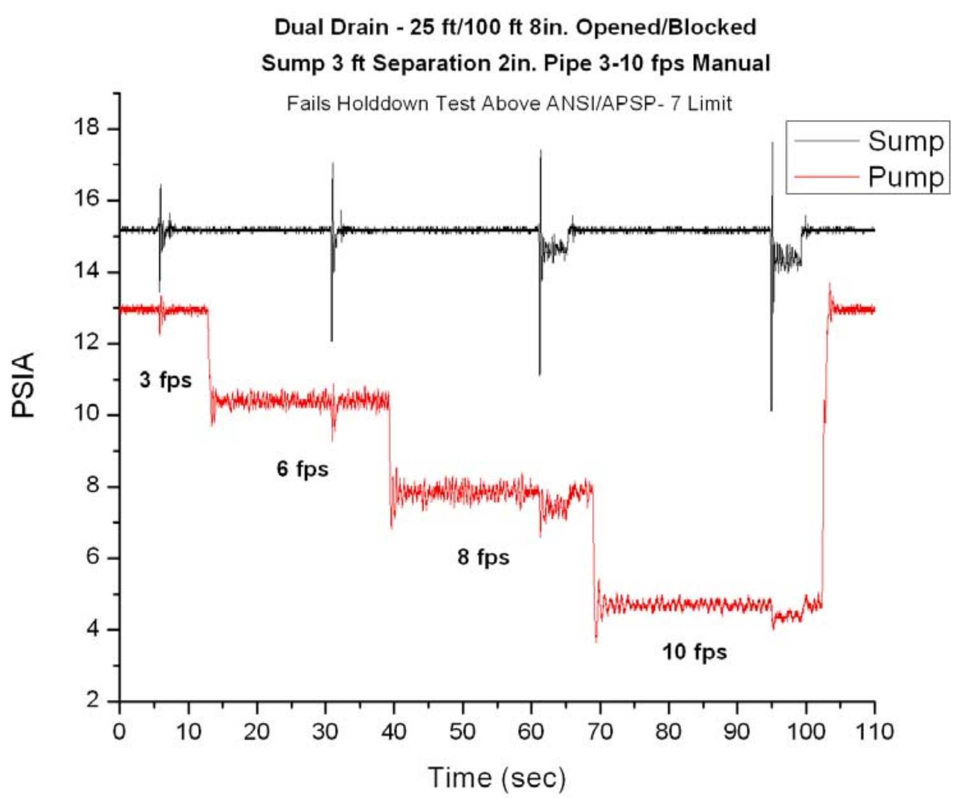

Figure 5b

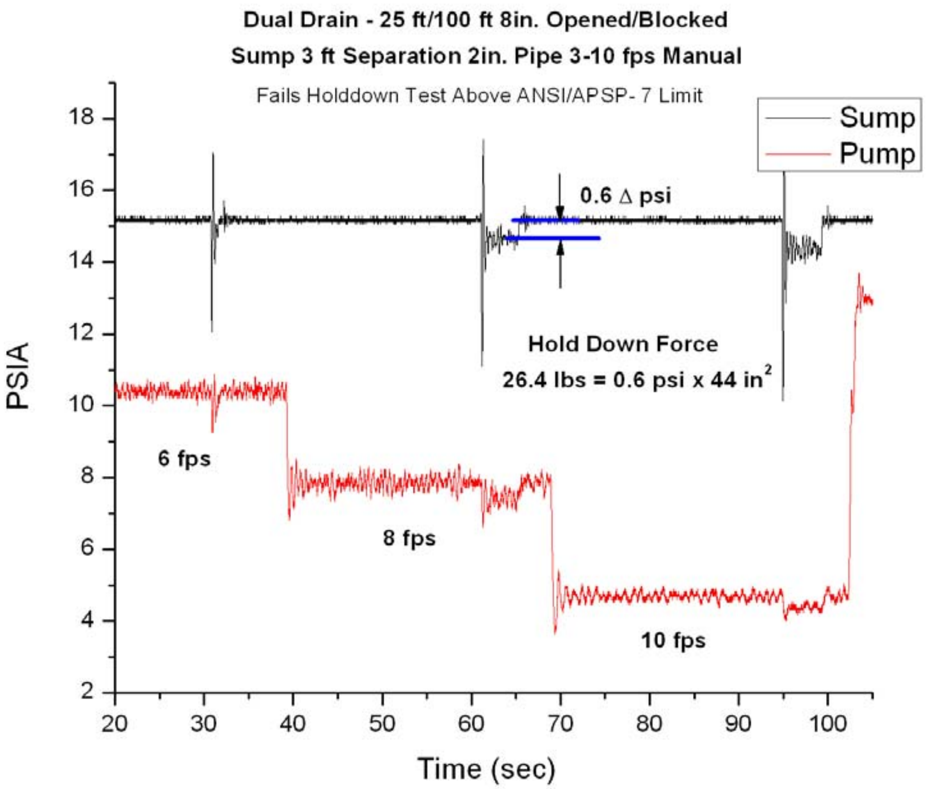

Figure 5c

A series of tests were conducted as a qualitative assessment of vent line designs for very large piping and flow configurations. The ASTM 15.51 writing subcommittee is currently drafting a standard to address field fabricated vent design. This vent test system used 6" piping with a dual 5 HP pumps. Flow rate through the single 18 x 18 inch cover averaged 420 GPM. A 1" PVC U-Tube vent was connected suction side piping approximately 11 feet from the sump, just under waterline. Tests were conducted with the U-Tube depth at 20, 30, and 37 ¾ inches from water level. Maximum drawdown at 37 ¾ depth was 10." Figure 6 a-d show the results of these tests. Test shown in Figure 6 a-c use a larger buoyant blocking (See Figure 2c) to completely block the single suction outlet and in Figure 6 d a Human was used to block the flowing single suction outlet.

In each case using the blocking element, the sump pressure depresses down, trips the vent and in a very short interval (2.5-3.2 sec), the sump returns to the pre-blocking pressure levels. In the case of the Human Blocking attempt (Figure 6d), it was impossible for the test subject to block this large 18 x 18 inch cover alone. The test subject was placed on his back on the flowing single drain with arms down along the sides to seal both edges. The test subject was then forced down on the cover by a second person pressing down on the center of the test subject's chest. According to the test subject the actual blockage was almost imperceptible from a "suction" point of view, but the test subject did report feeling the flow of water around his body, in particular between his arms and torso. It was reported that the actual sensation was no where near the sensation of blocking off an 8 inch single sump. The vent trip, even at 37 ¾ inches of depth, was very fast and efficient at alleviating all delta pressure at the sump.

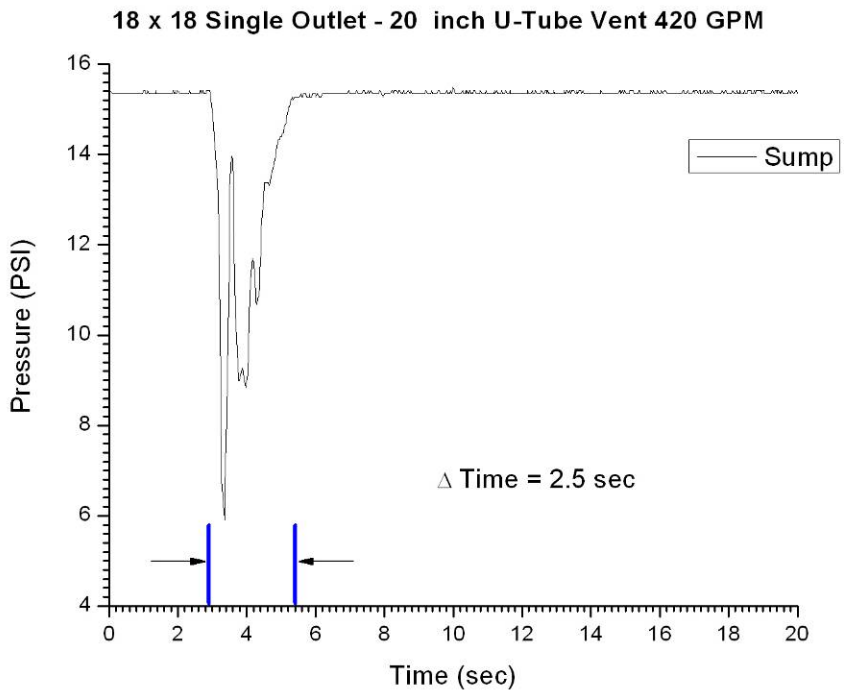

Figure 6a

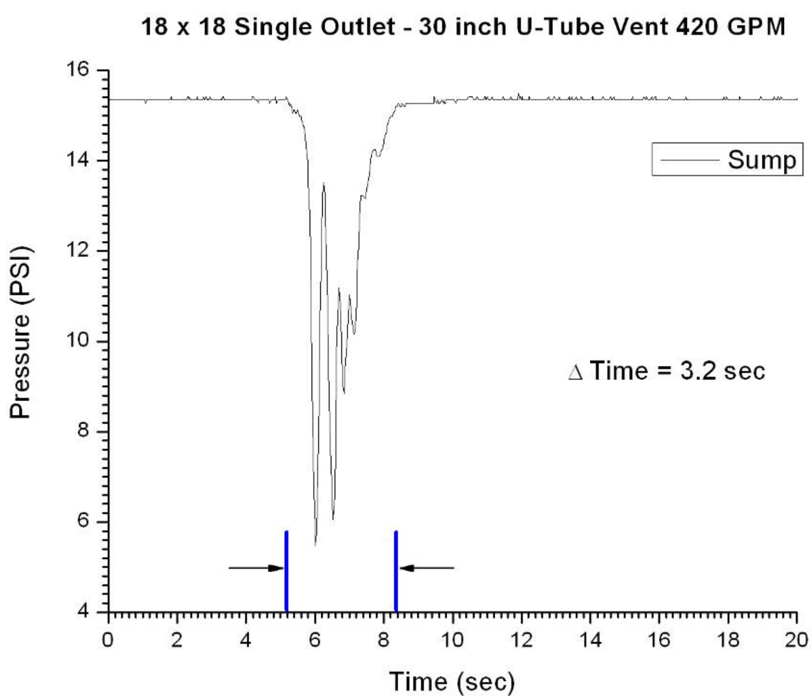

Figure 6b

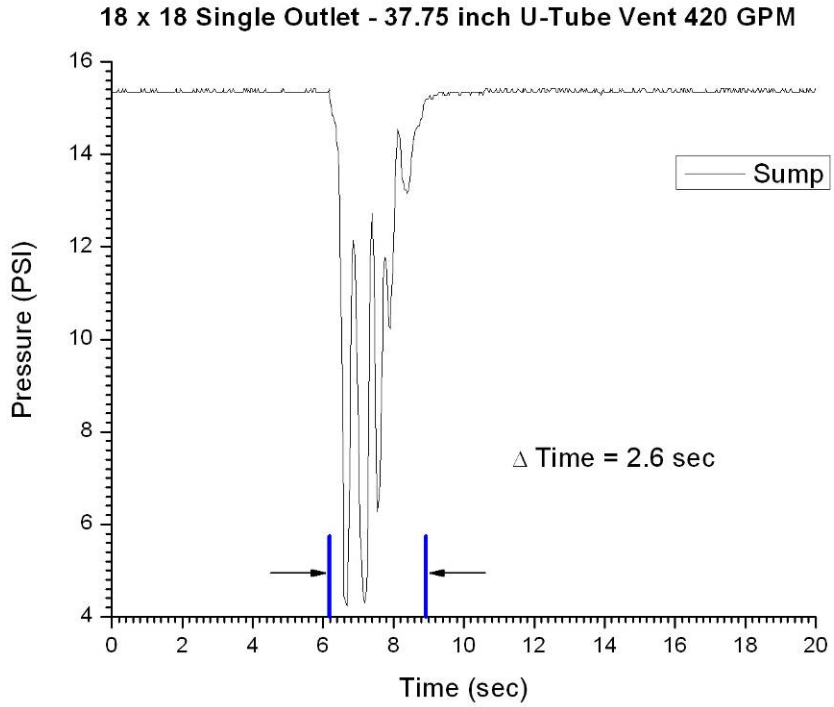

Figure 6c

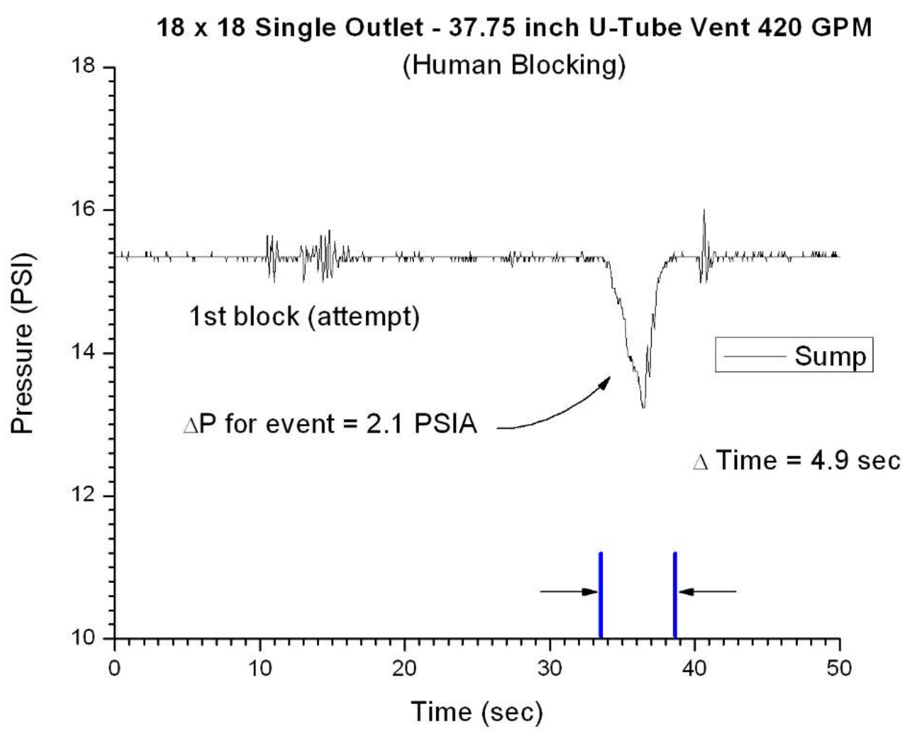

Figure 6d

Conclusion and Recommendations

The APSP Technical Committee Tests have demonstrated the validity and comprehensive approach of the ANSI/APSP-7 standard. It is recommended that in future code and legislative language one move away from the narrow definition of bather entrapment as being dominated by “suction” or delta pressure across an open or improperly covered sump/drain. The solution requires a multi-dimensional approach such as that mandated in ANSI/APSP-7. The assertion that a simple “back-up” or redundancy can protect bathers from improperly installed or maintained pool circulation systems is misleading and dangerous.

The scientific/engineering data presented has clearly moved the basic knowledge beyond the limited approach taken just a few short years ago. The ANSI/APSP-7 is a published American National Standard and has endured numerous levels of scrutiny. It effectively addresses all 5 modes of entrapment and all 3 underlying phenomena that represent the physical root cause. First and foremost ANSI/APSP-7 is a pool construction standard and as such does not include the individual certification of components. The ANSI/APSP-7 is comprehensive where current code language does not address flow and often exempts large suction outlet covers from testing and certification. In addition, this standard contemplates all pools, including large commercial installations, complex residential installations, and provides alternate approaches to achieve safe circulation system construction in all installations.

Tests conducted on dual outlets configured as described in ANSI/APSP-7 demonstrate:

- The size of the outlets and piping do have an effect on safe installation
- Water velocity tested in *excess* of the 6 fps ANSI/APSP-7 recommended maximum *passed* an analogous ASME/ASTM SVRS test protocol, but *failed* testing that included a damping period for water dynamics
- Although data has been circulated that suggest a dual drain cannot achieve the 15 lbs release force, this is very cover, flow rate, and sump specific. When one uses covers that pass the latest revision (ASME A112.19.8-2007) along with piping as described in ANSI/APSP-7 this concern is completely alleviated.
- Multiple submerged outlets, when installed according to ANSI/APSP-7, are a backup for suction outlet entrapment. Multiple outlets pass the same tests; react faster than the 3 seconds described in ASTM/ASME standards, and work properly in combination with skimmers.

Tests conducted on SVRS systems and both the ASME/ASTM SVRS standards demonstrate:

- Not all SVRS tested to the ASME/ASTM SVRS Standards will reliably "trip" when combined with dual outlets and/or skimmers – Those that fail seem to interpret residual flow from the second outlet as a priming pump.
- Not all SVRS tested to the ASME/SVRS Standards “trip" with partial blockage, e.g. towel or deflated toy over drain.
- Venting only SVRS technology may pass the ASME/ASTM SVRS testing protocol, but when used in submerged suction (e.g. raised spas) and with a NSF rated self-priming pump such devices may continue to expose bather to hold down forces in excess of what is currently allowed by the ASME/ASTM SVRS standard.

- All tests conducted by APSP used submerged piping typical of that found in pools and spas in the field. When piping is elevated above waterline, release is artificially assisted by water seeking its own level, a condition rarely found in the field.
- Water dynamics, in particular water hammer can facilitate release. Once the block is forced off the cover by these spikes in pressure, it floats to the surface. Neutrally buoyant blocks have been documented to “hammer” on and off open pipes for several seconds.
- Water dynamics continue for several seconds. The longest on an SVRS test lasted 2.72 seconds and this length of time may call into question the validity of the arbitrary 3 second limit.

Tests conducted on a U-Tube Vent on a single 18 x 18 suction outlet demonstrates:

- A single 18 x 18 drain grate can be successfully vented operating at 420 gpm with a 1 inch PVC vent pipe.
- Release is very fast – shortest release was 2.5 seconds
- While it was difficult to completely block the drain using a Human test subject, it was possible to do so sufficiently to trip the vent. The actual suction sensation of this experience was far less than what is experienced when an 8 inch sump is blocked.

Based on this testing, it is clear dual outlets, vents, and SVRS technology all have a role protecting bathers from entrapment hazards. While not tested or demonstrated for this report, gravity flow systems can also achieve superior levels of bather protection and are allowed by ANSI/APSP-7.Not all current codes address the wide range of requirements for large public pools, residential pools with water features, multi-speed pumping systems, and various elevated spa installations. These all necessitate an inclusive comprehensive approach with the best entrapment mitigation methods from ANSI/APSP-7 used. Sometimes the hazard can be simply eliminated completely by removing all submerged suction outlets. Other times a vent or SVRS can be effectively used. Multiple outlets dramatically reduce the opportunity for hair entrapment by dividing the flow between 2 or more covers rated at 100% of the flow. Unlike SVRS systems, they are not defeated by check valves commonly used on spas and hydrostatic valves necessary for pools installations in areas of high water table. Vents can also be effectively used at extremely high flow rates that are beyond the scope of the current SVRS ASME/ASTM standards.

What is apparent is that codes and legislation can not continue focus on single underlying events, i.e. suction, as the only hazard to address. At the same time one must move away from the notion of “layers of protection” and must move toward a more comprehensive approach that always protects bathers from all 5 modes of entrapment and the 3 underlying root causes of entrapment: Flow rate through the outlet, Suction (or delta pressure), and mechanical. These have been placed in a Venn diagram in Figure 7a. It is evident from this diagram that all modes of entrapment fall into one of the three underlying physical phenomena. The approaches prior to ANSI/APSP-7 were all driven by individual solutions seeking to address one of the five hazards. If properly addressed during pool construction and renovation, all potential hazards can be completely alleviated.

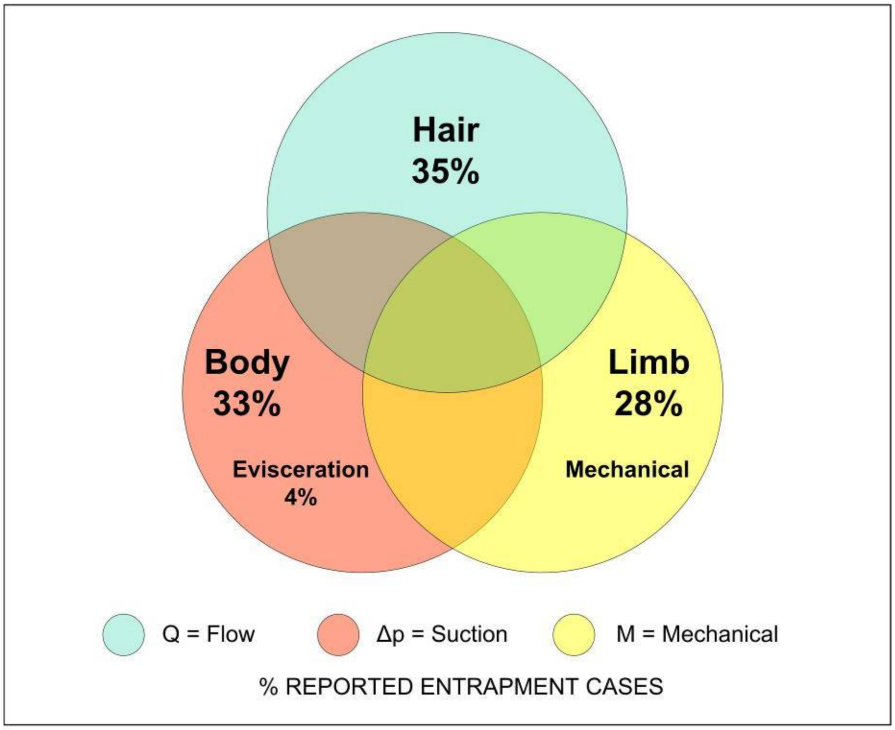

Figure 7a

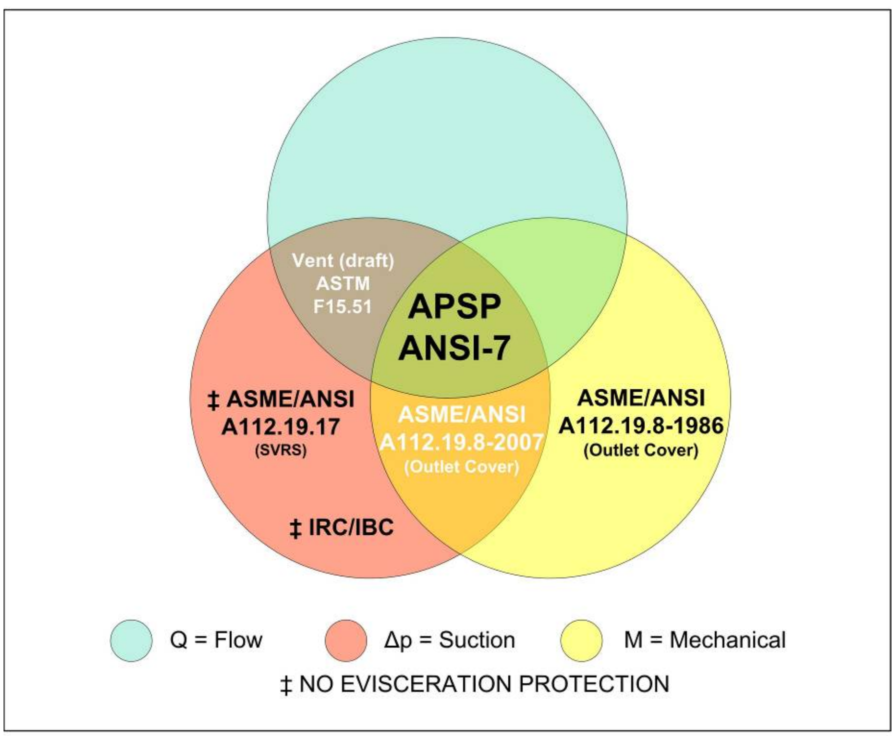

Figure 7b

The regulatory and legislative question is; how can one best protect all bathers from all hazards related to submerged suction outlets? The clear answer, as illustrated above in Figure 7b, is ANSI/APSP-7. What ANSI/APSP-7 has brought to the table is a comprehensive approach to pool construction that prevents, to the maximum extent any standard can, an entrapment from occurring. Figure 7b shows all current standards, published and under development, on a diagram against a backdrop illustrating the three underlying root causes of all entrapments. As can be seen, only ANSI/APSP-7 addresses all 3 root causes and it incorporates by way of reference all the other relevant standards shown. Based on the results achieved in the testing outlined above, the ANSI/APSP-7 *Standard for Suction Entrapment Avoidance in Swimming Pools, Wading Pools, Spas, Hot Tubs, and Catch Basins* stands alone as the only standard offering comprehensive protection against all known entrapment hazards.

Table 1 – Summary of Standards Related to Entrapment

Standard Title	Brief Scope of Standard	Current Status
ANSI/APSP-7 American National Standard for Suction Entrapment Avoidance in Swimming Pools, Wading Pools, Spas, Hot Tubs, and Catch Basins	Building standard covering design and performance criteria for circulation systems, including standards for fittings, safety devices and piping to protect against all suction entrapment hazards.	Approved as an American National Standard September 2006. Reaffirmed by ANSI February 2007 following a Withdrawal for Cause challenge by proponents of competing safety language. Competing language replaced by ANSI/APSP-7 in Florida.
ASME/ANSI A112.19.8M -1987 (Reaffirmed 1996) Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, Hot Tubs, and Whirlpool Appliances	Suction Fitting standard which requires UV stabilizers, flow rating based on Ponytail hair test, structural testing on new parts.	Effectively for 2007, this is the current standard, because the 2007 version published March 30, 2007. The new standard will impact product Listing when they renew annually.
ASME/ANSI A112.19.8 -2007 Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, and Hot Tubs	Updated version tests a full head of hair and adds body block tests both of which are used to determine maximum flow rating. UV weathering now precedes structural testing, and finger entrapment is now evaluated using a probe to determine digit access.	This version was approved March 30, 2007.
ASME/ANSI A112.19.17-2002 Manufactured Safety Vacuum Release Systems (SVRS) for Residential and Commercial Swimming Pool, Spa, Hot Tub, and Wading Pool Suction Systems	SVRS standard which tests vacuum breaking devices on a single, eight inch suction fitting connected to two inch pipe flowing at 60 gpm. This system is then blocked with a 15 lbs buoyant blocking element which is allowed to float free the moment it touches the suction outlet fitting. An American National Standard.	Current version. The ASME Task Group is working on the next version which will address known issues, including large pumps and small flow rates, water hammer and buoyancy of the blocking element.
ASTM F2387-2003 Standard Specification for Manufactured Safety Vacuum Release Systems (SVRS) for Swimming Pools, Spas and Hot Tubs	SVRS standard similar to ASME's SVRS standard. Tests vacuum breaking devices on a single eight-inch suction fitting connected to two inch pipe flowing at 60 gpm through 100ft of suction pipe and 100ft of pressure pipe. This system is then blocked with a 15 lbs buoyant blocking element that is allowed to float free the moment it touches the suction outlet fitting.	Current version. This SVRS standard is not widely referenced or recognized because the ASME standard is an American National Standard which has gone through more structured approval process.
ASTM F15.51 Sub-Committee developing a Vent Line and Vent Line Cap Standard.	This draft vent standard will provide performance criteria for Professional Engineers to design vent systems that limit differential pressure at suction outlets. A second standard addresses the vent termination point, which can be a molded part or even a custom tile.	Draft in progress. This standard will likely be referenced by other standards and within building codes.
NSF 50 – 2005 Circulation system components and related materials for swimming pools, spas/hot tubs	This standard evaluates circulation system components for performance, toxicity and efficacy. Included is a pump self-priming test that requires pumps be able to remove air from the suction piping when place 10 feet above water level.	Current version. Widely referenced in APSP standards and in commercial building codes.