

Problems with NPIRC Pool Plaster Studies

onBalance – Que Hales, Doug Latta and Kim Skinner

The National Plaster Council (NPC) began working with Cal Poly at San Luis Obispo in 2003 to study the causes of various plaster problems. The following information is a critique on the first two reports from professor Kachlakev (from Cal Poly) and the National Pool Industry Research Center (NPIRC), and contains information that they aren't telling you.

1. The primary conclusions or suggestions by Professor Kachlakev are as follows: Aggressive water and certain sanitizers are the primary cause of “etching deterioration,” craze cracking, and discoloration problems. (Phase 2, 2004-2005, Pgs. 23, 39, 43, 45, 85) Our response: Aggressive water will cause etching of course, but it has nothing to do with deterioration of a defective (weak, soft, and porous) plaster surface, which can occur even with balanced water. Does the NPIRC have a scientific basis for using the term “deterioration” exclusively to describe an etching condition, and can they show that deterioration is never from other non-chemistry causes? On what basis do they suggest that salt chlorinators and trichlor sanitizers increase the amount or severity of craze cracking and discoloration on plaster surfaces? On what basis do they only “point the finger” at sanitizers or improper water chemistry for the cause of these plaster problems?

2. In Phase 2, the professors stated that the “plastering application” for all test pools was performed identically. (Pgs. 32, 40, 44, 48, 85, 86) Since the test pools were troweled by different plastering companies and finishers with different training and experience, what evidence or proof backs up that claim? That unfounded claim is part of what enables the NPIRC to avoid addressing workmanship issues for discoloration, craze cracking, and deterioration of the plaster and conclude that imbalanced water chemistry was the only cause. What part of the project documented that different crews, with different backgrounds and experience levels generate zero variability in product quality?

3. Low pH, low alkalinity and low calcium hardness were all included as parameters in the NPIRC investigations. All of these parameters are known causes of etching. However, high water:cement ratios, high calcium chloride content, premature filling, excessive late hard troweling... there are many workmanship factors that are also known to cause premature deterioration and discoloration of a cement-based surface. It is highly questionable for the NPIRC to rule out variable workmanship issues as a possible and major player in early deterioration.

4. Drs. Kachlakev and Pal co-wrote an independent report (given to the cement industry, but not to the pool industry) stating that their study (Phase 1, 2003-2004) did not control the fluctuations of water balancing properly, and did not monitor and record the readings in their test pools sufficiently to make specific, causative conclusions. To quote from the report, “While the observations from this study are useful in showing different stages and mechanisms of SA (spot alteration, or etching deterioration) in pools, they do not link SA to a specific set of construction practices or water chemistry conditions... (27th International Conf. on Cement Microscopy –

Rothstein, Kachlakev, Pal, - April 2005) In other words, no conclusions on causes of deterioration should be made from their Phase 1 study. Yet Dr. Kachlakev, Pal, and other NPC members announced to the pool industry that the Phase 1 study “**concluded**” that water chemistry was the primary cause of etching deterioration. (Phase 1 June 2004 pg. 82, P&SN 9-3-04 & 1-17-04, IPSSAN Nov. 2006) Why did the professors make these two conflicting statements – one to their peers and a different one to the pool industry?

5. Why did the NPIRC Phase 1 report dismiss variable water:cement ratios as relevant to the durability of plaster? (Pg. 22) It is a known fact that a high water:cement ratio on a cement surface negatively affects durability. (ACI Guide to Durability)

6. The Phase 1 report indicated that too many plaster coupons were placed in water tanks that were too small – making it impossible to properly maintain water chemistry within targeted parameters (some tanks to be aggressive and some to be balanced), which resulted in water that fluctuated from very scale forming (pH readings higher than 9.0) to very aggressive (pH below 7.0 and TA below 60 ppm) in all water tanks. Yet, the NPIRC continued to compare and make conclusions based on these flawed results and insist that water chemistry is the major player in the deterioration of pool plaster. (Pg. 19) Why? Even though it is a fact that water chemistry can cause aggressive attack or etching of cementitious surfaces, the NPIRC did not adequately define “deterioration” nor did they show causation in this particular experiment.

7. The Phase 1 report states that a high content of chlorine is “directly connected to discoloration of pool materials and could initiate etching deterioration.” (Pg. 36) There is no data in the report to support such a claim. On what basis do the professors make that statement?

8. In Phase 1, the sections in the pools with 2% calcium chloride added (for fast hardening) were done first and allowed to harden for about 6 hours before submerging in water. In contrast, the sections without any calcium chloride added (which means they should have been allowed many more hours to harden before submerging in water) were done second, and not given any time to properly harden and hydrate before submerging in water. (Pg. 9) That plaster surface was far too soft and unhardened to be submerged in water, and it most likely suffered because of that fact. Certainly, when the inspection was done, the sections with calcium chloride looked and fared better than the other sections without any calcium chloride added. Anyone can see that was an unfair comparison. Yet the NPC and NPIRC announced that adding calcium chloride is a benefit and reduces “etching” of the surface. Of course, this contradicts ACI and PCA research and the conclusions by the RJ Lee Group and Construction Technologies Laboratories (CTL).

In contrast to the NPC/NPIRC conclusions, and in agreement with RJ Lee and CTL, onBalance published a research report five years ago demonstrating that plaster (with and without calcium chloride) needs a few hours to properly harden before being submerged in water, otherwise the plaster surface gets dissolved and becomes very porous and leaches away (even by balanced water). That onBalance report was given to the NPC in 2004. No one with the NPIRC or NPC will address this obvious flawed protocol, and the conflict concerning the use of calcium chloride.

9. In Phase 2 (2004-2005), calcium hardness readings in some pools occasionally fluctuated up and down 75 ppm to 150 ppm from week to week. That is not normal and very unlikely. The

testing, according to the NPIRC report, was done using ASTM Standards (Pg. 15), which we now know is an untrue statement. It is obvious that the calcium readings were not being tested very accurately and were not being maintained within targeted parameters. In fact, between Phase 1 and Phase 2, it was not uncommon for some reported sets of readings (including pH and alkalinity) to be out of the targeted range over 50% of the time. How can conclusions be made when there were so many incorrect readings?

10. Regarding the lack of accuracy, some test kit companies felt that when the NPIRC was comparing (and criticizing) the accuracy of test kits, certain appropriate procedures were not followed, or that there was a casual way with which the testing was done, which questions the accuracy of NPIRC's own testing. In addition, Professor Kachlakev has stated that service techs cannot keep water in balance properly with once-a-week service visits. (IPSSAN November 2006) We disagree. Where is the data that proves this claim?

11. We now know that ASTM Standards were not used by the NPIRC, but only a typical laboratory testing method. This was admitted by Dr. Kachlakev at the 2009 Western Pool and Spa Show, where he claimed that "ASTM" was merely a generic term for "lab method". Obviously the American Society for Testing and Materials (ASTM International) would disagree with this assessment, and Dr. Kachlakev should know better. Should the NPIRC have made such a claim when it wasn't actually using ASTM methods?

12. In Phase 2, the actual readings show that Spa 13 had balanced or positive LSI water readings for the first four months. At the sixth week and fourth month inspection, this spa was reported to have "etching deterioration" and discoloration. Question: How does this spa prove that aggressive water caused these conditions?

13. In Phase 2, the actual readings show that Pool 3 had balanced water, yet had discoloration at the sixth week mark and after eight months including craze cracking. Question: How does this prove that aggressive water caused these conditions?

14. In Phase 2, the actual readings show that Pool 4 had balanced water, yet was reported to be one of the worst "etching deterioration" pools after eight months. Question: How does this prove that aggressive water caused that condition?

15. In Phase 2, the actual readings show that Pool 12 had balanced water, yet after eight months was reported to have heavy discoloration, a significant amount of craze cracking, and etching deterioration. The NPIRC report implies that imbalanced water or certain sanitizers cause these conditions. Question: Where is the proof to support these claims?

16. In Phase 2, the report stated that Pool 7 was one of the best looking pools overall. Yet, the readings indicated that this pool had a slightly aggressive startup procedure, and that slightly aggressive water existed occasionally over the eight month period. Question: Why did Pool 7, which had more aggressive water, look and fare better than Pool 3, Pool 4, and Pool 12, which had more balanced water than Pool 7?

17. In Phase 2, only three of the twelve test pools had recorded chlorine readings for the entire eight month test period. The other nine pools have no recorded chlorine readings for the final six months of their test period. Why aren't there chlorine readings after two months? Is this acceptable research? Does it prove that chlorine is involved in discoloration?

18. In Phase 2, Pool 3 was not to have any cyanuric acid added, which was to be compared to Pool 9 that would have 50 ppm of cyanuric acid added. But according to the data, Pool 3 had 50 ppm of cyanuric acid added just like Pool 9, and the researchers still made comparisons and conclusions – specifically that cyanuric acid is not a player in discoloration or deterioration. This, in turn, contradicts the NPC start-up procedure publication, which claims that cyanuric acid does cause plaster degradation... What happened?

19. In Phase 2, Pool 1 was a "salt" pool and had salt added after 30 days, which would have increased the salt level to over 3000 ppm. But data for that pool shows that the Total Dissolved Solids level (TDS, which of course includes salt) never increased beyond 800 ppm, which seems to indicate that either the TDS readings were made up or that the salt was never added. What happened?

20. The Phase 2 protocol specified complete chemical testing of all twelve test pools and two spas every day for two months, then two or three times per week for the remaining six months, and once a week with ASTM techniques. (Pg. 15) Yet, according to the data provided, the testing wasn't performed as claimed. At times, no testing was performed for 9 to 13 days at a time. Why?

21. For Phase 2, the testing of the carbon dioxide content was performed by titration. A review of the data and using the nomographic method for comparison indicates that the carbon dioxide amounts tested and recorded were often significantly incorrect. Shouldn't the NPIRC know that water with cyanuric acid and boric acid present interferes with the results? We have specifically called this testing incompatibility to the attention of the NPIRC committee's "Technical Advisor" Greg Garrett almost two decades ago. Why was this testing by the NPIRC so inaccurate? Why did neither the NPIRC's staff chemist nor the "technical director" catch the problem?

22. In Phase 2, the NPIRC reported that the "Acid" and "pH neutral" startup procedures proved superior and prevented "etching deterioration" when compared to the traditional startup method, which reportedly resulted in significant etching deterioration. (Pgs. 29, 44, 86) How is it possible that a "Traditional" (balanced) water startup resulted in etching? How is it possible that an "Acid" (a.k.a. Zero Alkalinity) startup procedure did not etch a new "non-hardened or cured" plaster surface? Should not this counter-intuitive result be addressed and explored?

23. In the Phase 2 report, it is suggested that craze cracking, discoloration, and deterioration of the plaster was only related to water chemistry imbalance and certain sanitizers. (Pgs. 23, 39, 43, 45, 85) Yet, it has been documented by the ACI and PCA that improper workmanship and practices (not water chemistry) will lead to increased craze cracking and discoloration. Why did the NPIRC rule out possible workmanship issues and only point to water chemistry and

sanitizers as leading to these plaster problems? Do they have unrevealed information that throws the American Concrete Institute and the Portland Cement Association data in doubt?

24. It has been well documented (in the cement and concrete industry) that calcium chloride additions over 2% of the weight of cement is considered detrimental to the durability of a cementitious product, will increase shrinkage and craze cracking, and will also cause grey mottling discoloration of the cement. Why did the professors state that a “moderate amount of calcium chloride (up to 3.5 %) is beneficial to a cement product?” (Pgs. 63, 66, 68)

25. The NPRIC Phase 1 report mentions that the leaching of calcium hydroxide is what initiates the development of “etching deterioration” and can only be dissolved or etched by aggressive water. (Pgs. 31, 35, 36, 38) That is not true, and the professors should know that calcium hydroxide can be dissolved by what the pool industry considers balanced water, particularly from a porous surface. Water balance predicts over- and under-saturation relative to calcium carbonate... a much more insoluble material than calcium hydroxide.

26. Finally, the NPIRC and NPC are promoting the use of more durable plaster products to sell to pool owners. Their reasoning is that typical white plaster is inherently weak, and that “imperfect” water chemistry and maintenance programs (which the NPIRC says are inevitable) will quickly deteriorate this “naturally” weak product. Their “solution” is to insist on selling more expensive finishes, such as quartz and pebble, to customers, which will supposedly eliminate the problems that result with standard white plaster. Isn't it interesting that there are no specific suggestions (from the NPIRC) on the need for proper workmanship issues to improve durability? This agenda removes incentive for plasterers to perform quality work if they are allowed to blame all investigated plaster defects (discoloration, cracking, and deterioration) on water chemistry maintenance. Obviously, plasterers will benefit by being paid to redo the pool again (much sooner than usual) and with the more costly upgrade. Yet, not surprisingly, the NPC has stated that if problems do develop on their more costly material upgrade, it is most likely caused by improper water chemistry too!

Although not exhaustive and complete, we feel that this list can be a good starting point toward assessing what we can and cannot yet conclude from the Cal Poly research, and what kinds of things need to change in order to make it the learning facility it could be.

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