SECTION 10 - REFERENCE

10.1 BASIC WATER CHEMISTRY

The Digital Nano/Nano^{+} is designed to produce chlorine on a daily basis. To monitor the system's efficiency, the water chemistry ranges, and schedule of periodic checks should be followed. See "Water Balance & Chemistry Recommendations" on page 9 for chemistry levels.

 CAUTION - Failure to heed the following may result in equipment damage.

- Excessively high chlorine levels can cause premature cell failure and corrosion damage to pool fixtures and equipment.
- Always follow the instructions on the manufacturer's label whenever handling or using chemicals

CHEMICAL	IDEAL TEST SCHEDULE	EFFECT OF LOW / HIGH LEVELS	CORRECTIVE ACTIONS
Free Chlorine	Weekly	Low free chlorine: Not enough residual chlorine to safely sanitize pool water.	Low free chlorine: Check for combined chlorine level and shock as necessary. Increase chlorine output to maintain a 1-3 ppm (mg/L) residual reading.
		High free chlorine: Corrosive to metallic fixtures in pool water. Can bleach swimwear and hair.	High free chlorine: Decrease chlorine output. Let chlorine dissipate normally until 1-3 ppm (mg/L) is achieved. In extreme cases, pool water can be diluted with fresh water or a chlorine neutralizer added. (Diluting will reduce salt and CYA. Check and adjust as needed.)
pH	Weekly	Low pH: (acidic) Equipment corrosion, eye/skin irritation, plaster etching, rapid chlorine consumption	Low pH: Add sodium carbonate or soda ash
		High pH: (basic) Scale formation, cloudy water, eye/skin irritation, poor chlorine effectiveness	High pH: Add muriatic acid or sodium bisulfate.
Total Alkalinity	Monthly	Low TA: Eye irritation, pH "bounce", stained/etched plaster and metal corrosion.	Low TA: Add sodium bicarbonate.
		High TA: Constant acid demand, difficulty in maintaining pH, and contributes to scale formation or cloudy water conditions.	High TA: Add muriatic acid often or sodium bisulfate, a little at a time (may take a week or more to lower the TA).

CHEMICAL	IDEAL TEST SCHEDULE	EFFECT OF LOW / HIGH LEVELS	CORRECTIVE ACTIONS
Calcium Hardness	Monthly	Low CH: Etching of plaster, equipment corrosion	Low CH: Add calcium chloride flakes.
		High CH: Scale formation, cloudy water. Rapid buildup of scale may exceed the system's self-cleaning capability and require manual cleaning of the Cell.	High CH: Partially drain and refill pool with fresh water to dilute. (Diluting will reduce salt and CYA. Check and adjust as needed.)
Cyanuric Acid (CYA or Stabilizer)	Monthly	Low CYA: destruction of chlorine by the UV rays from the sun.	Low CYA: Add Cyanuric acid (1 lb. per 5000 gallons increases CYA 25 ppm (mg/L))
		High CYA: Requires more chlorine to maintain proper sanitizer levels. **Note: CYA not needed for indoor pools or bromine pools.** CYA can be reduced to 30 - 50 ppm (mg/L) for in colder climate regions.	High CYA: Partially drain and refill pool with fresh water to dilute. (Diluting will reduce salt. Check and adjust as needed.)
Saturation Index	Monthly	+ 0.3: Water is scale forming. Calcium carbonate is falling out of solution. This rapid buildup of scale may exceed the system's self-cleaning capability and require manual cleaning of the Cell.	Balance water as close to equilibrium of 0 as possible. See page 42 for more information.
		- 0.3: Water is corrosive. Water will take away other material it comes in contact with to form a natural balance. These materials can be metallic fixtures, swimwear, etc. Results can also include cloudy water, eye/skin irritation, and poor chlorine effectiveness.	Balance water as close to equilibrium of 0 as possible. See 42 for more information.
Salt	Monthly	Low Salt: Below 2,400 ppm (mg/L) causes premature cell failure and reduces chlorine production	Low Salt: Add salt according to digital display on Pool Pilot unit or salt chart.
		High Salt: Above 6,000 ppm (mg/L) can cause corrosion of metallic fixtures and will taste salty. Note: Digital Nano/Nano$^+$ can safely operate with salt levels up to 35,000.	High Salt: If undesirably high, partially drain and refill the pool with fresh water. (Diluting will reduce CYA. Check and adjust as needed.)

Table 7

10.1.1 Chlorine

The desirable form of chlorine is called Free Chlorine. This form of chlorine is responsible for the actual sanitation activity in pools and spas. Free chlorine is highly reactive and once added to pool/spa water has a tendency to combine with organic matter in the pool/spa. It quickly attacks pathogens as well as other bather wastes. When chlorine combines it chemically changes. The chlorine binds to organic matter is referred to as the Combined Chlorine. Combined chlorine is responsible for eye burn and skin irritations. Total chlorine is the sum of free chlorine and combined chlorine. If a strong chlorine odor is noted, it is due to an excess of combined chlorine. It is important to test Total Chlorine as well as Free Chlorine. If there is a difference greater than 0.2 ppm, a shock treatment should be initiated.

During peak chlorine demand (summer months, rainy season or heavy bather usage) it may be necessary to increase your chlorine output by increasing your output setting. Conversely, during low chlorine demand, you can decrease your output to a lower setting. For extremely heavy chlorine demand or to boost your chlorine residual levels quickly, you can supplement with any type of chlorine or non-chlorine shock containing potassium monopersulfate. *Note: During cold-water conditions (below 60ºF) chlorine demand is reduced significantly. For colder climate regions with sustained low temperatures, contact your local pool Professional for proper pool winterizing instructions.*

10.1.2 pH

pH is a term used to refer to the degree of activity of an acid or base in the water. A low pH, acidotic or corrosive water contributes to eye and skin irritation as well as damage to pool equipment. A high pH will result in scaling, cloudy water and ineffective sanitation. Improper pH also contributes to the strong smell, red eyes and dry itchy skin conditions usually associated with “too much chlorine”.

10.1.3 Total Alkalinity

Total Alkalinity refers to the ability of the pool water to resist a change in pH. It helps manage or control the pH in the pool. The desired range is 80 to 120 ppm (mg/L). Low alkalinity is aggressive or corrosive and causes the pH readings to fluctuate (pH bounce). High alkalinity may cause cloudy water and scale forming conditions. Your Digital Nano/Nano^{+} provides 100% pure sodium chloride, which does not affect Total Alkalinity. Factors changing this measure are ancillary chemicals added to the pool and “out of balance” make-up water.

10.1.4 Calcium Hardness

Calcium Hardness is a measure of calcium content in the water. If the calcium content is too high, calcium can drop out of solution; forming scale on equipment. A low level will cause the water to become corrosive as the water tries to naturally form equilibrium. This means the water will “leach” minerals from everything it meets. Damage to equipment and unpleasant swimming conditions result. Your Digital Nano/Nano^{+} provides 100% pure sodium which does not change Calcium Hardness. Factors changing this measure are ancillary chemicals added to the pool and “out of balance” make-up water.

10.1.5 Cyanuric Acid

Cyanuric Acid acts as water “Stabilizer” or “Conditioner”. This chemical goes by either trade name and allows your chlorine residual to last longer by protecting it from the UV rays of the sun. With low Cyanuric acid, chlorine can be used up just as quickly as it is generated. Check local commercial codes for maximum acceptable Cyanuric acid levels in commercial projects. *Note: For indoor pools, it is not necessary to maintain a stabilizer level to protect the chlorine from the UV rays. However, it is recommended to maintain a minimal 15 ppm (mg/L) to protect metallic fixtures from possible corrosion.*

10.2 USING THE SATURATION INDEX

This index is used by pool professionals to ensure that your total water chemistry does not fall into a corrosive or scaling condition. Either condition can cause premature damage to the cell, any of your other equipment, as well as your cementitious finish.

The Saturation Index is composed of the following factors:

- pH as tested
- Plus the Temperature factor
- Plus the Calcium Hardness factor
- Plus the Alkalinity factor
- Minus the Total Dissolved Solids factor (in this case the bulk of the dissolved solids are salt)

This is expressed in the formula SI = pH + TF + CF + AF – TDSF and uses the following charts:

TEMPERATURE		**TF**
60 F	15.6 C	0.4
66 F	18.9 C	0.5
76 F	24.4 C	0.6
84 F	28.9 C	0.7
94 F	34.4 C	0.8
103 F	39.4 C	0.9

CALCIUM HARDNESS	**CF**
150 ppm (mg/L)	1.8
200 ppm (mg/L)	1.9
250 ppm (mg/L)	2.0
300 ppm (mg/L)	2.1
400 ppm (mg/L)	2.2
600 ppm (mg/L)	2.4

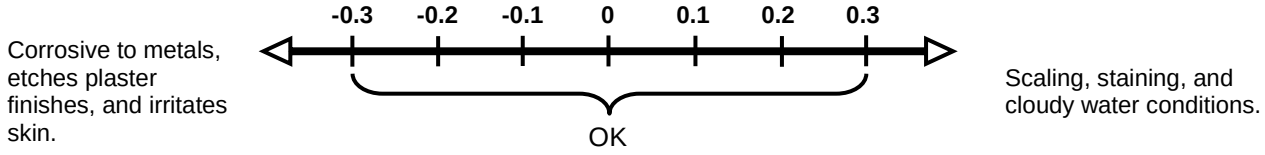
TOTAL ALKALINITY	**AF**
075 ppm (mg/L)	1.9
100 ppm (mg/L)	2.0
125 ppm (mg/L)	2.1
150 ppm (mg/L)	2.2
200 ppm (mg/L)	2.3
250 ppm (mg/L)	2.4

SALT LEVEL	**TDSF**
0000 - 1000 ppm (mg/L)	12.1
1001 - 2000 ppm (mg/L)	12.2
2001 - 3000 ppm (mg/L)	12.3
3001 - 4000 ppm (mg/L)	12.4
4001 - 5000 ppm (mg/L)	12.5
5001 - 6000 ppm (mg/L)	12.6

Table 8

Example:

WATER TEST RESULTS	FACTORS	WATER SATURATION
pH = 7.8	pH = 7.8	SI = 0.8 Water is scale forming and needs to be balanced
Temperature is 84°F	TF = 0.7	
Calcium Hardness is 600 ppm (mg/L)	CF = 2.4	
Total Alkalinity is 200 ppm (mg/L)	AF = 2.3	
Salt is 3500 ppm (mg/L)	TDSF = 12.4	



If adjustments need to be made to balance the water, the recommended sequence is as follows:

1) Test and adjust Total Alkalinity. This may reduce pH so wait at least 8 hours before proceeding.
2) Test again and adjust pH, then
3) Adjust Calcium Hardness.

10.3 SALT ADDITION CHART

The following salt charts are included for reference only; once programmed to the correct water volume, the controller will automatically indicate how much salt is required to achieve optimum water salinity.

The salt in the pool is constantly recycled during normal operation. Loss of salt during a swimming season should be minimal. Filter backwashing, draining due to rain water overflow, splashing, bathing suit drag out, and leaks are typical ways salt is lost. Salt does not leave the pool when water evaporates.

1) Determine pool/spa volume in (Gallons or Liters).
2) Find current salt level in the pool. Many pools will already have a significant salt residual, so always test water before adding salt (This can be obtained from the Control display or by testing water.)
3) Using Table 9, find the current salt level in the left column.
4) Determine and locate the pool/spa volume in the top column.
5) Locate the intersection of the row and column to find the amount of salt needed to bring the pool to the ideal level.
6) For volumes other than what is shown, use combinations of various columns.
   Example:
   For an 11,000 gallon pool with a salt level of 500 ppm (mg/L), the column value for 1000 gallons is added to the column value for 10,000 gallons, which gives a total of 230 pounds of salt needed to bring your pool salt level up to the ideal level of 3000 ppm (mg/L).

Pounds (kilograms) of salt needed to attain 3000 ppm (mg/L)

Current level of salt ppm (mg/L)	**Pool/Spa Volume in Gallons (Liters)**									
	1,000 (3,786)	**2,000 (7,572)**	**5,000 (18,930)**	**10,000 (37,860)**	**15,000 (56,790)**	**20,000 (75,720)**	**25,000 (94,650)**	**30,000 (113,580)**	**35,000 (132,510)**	**40,000 (151,440)**
0	25 (11)	50 (23)	125 (57)	250 (114)	376 (170)	501 (227)	626 (284)	751 (341)	876 (398)	1,002 (454)
250	23 (10)	46 (21)	115 (52)	230 (104)	344 (156)	459 (208)	574 (260)	689 (312)	803 (364)	918 (416)
500	21 (9)	42 (19)	104 (47)	209 (95)	313 (142)	417 (189)	522 (237)	626 (284)	730 (331)	835 (379)
750	19 (9)	38 (17)	94 (43)	188 (85)	282 (128)	376 (170)	470 (213)	563 (256)	657 (298)	751 (341)
1,000	17 (8)	33 (15)	83 (38)	167 (76)	250 (114)	334 (151)	417 (189)	501 (227)	584 (265)	668 (303)
1,250	15 (7)	29 (13)	73 (33)	146 (66)	219 (99)	292 (133)	365 (166)	438 (199)	511 (232)	584 (265)
1,500	13 (6)	25 (11)	63 (28)	125 (57)	188 (85)	250 (114)	313 (142)	376 (170)	438 (199)	501 (227)
1,750	10 (5)	21 (9)	52 (24)	104 (47)	157 (71)	209 (95)	261 (118)	313 (142)	365 (166)	417 (189)
2,000	8 (4)	17 (8)	42 (19)	83 (38)	125 (57)	167 (76)	209 (95)	250 (114)	292 (133)	334 (151)
2,250	6 (3)	13 (6)	31 (14)	63 (28)	94 (43)	125 (57)	157 (71)	188 (85)	219 (99)	250 (114)
2,500	4 (2)	8 (4)	21 (9)	42 (19)	63 (28)	83 (38)	104 (47)	125 (57)	146 (66)	167 (76)
3,000	Ideal									

Table 9