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- Scientific chemical and microbial analysis of pool and spa water.
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- REPORT -

INITIAL TRIAL

EFFECT OF HEAT\$AVR TREATMENT

ON A

HEATED INDOOR SWIM-SCHOOL POOL

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On Behalf of Hydro Flexible Solutions

Date Submitted: 3rd February, 1999

EXECUTIVE SUMMARY

An on-site field trial was conducted by Aqua Science Consultants Pty. Ltd. on behalf of Hydro Flexible Solutions, at a Victorian regional swim school, to determine the effects of Heat\$avr in a commercial pool application. The pool facility was investigated over a five- week period. A conventional, accepted water treatment method was in operation throughout the trial.

The trial compared no Heat\$avr, with the addition of Heat\$avr. Existing operations, and procedures maintenance levels were continued throughout the trial, including use of a thermal blanket in periods of non-use.

Application of Heat\$avr caused no detrimental effects to any of the general chemical water quality parameters investigated. Microbial quality remained exceptional both prior to and during Heat\$avr addition.

Condensation levels were reduced by 10 % with addition of Heat\$avr. Gas consumption was consistently reduced by over 18%. The pool operator in control of the pool, will continue to utilise Heat\$avr, to minimise future condensation problems and reduce heating costs.

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1. INTRODUCTION

Requirements of the Victorian Public Health Regulations, (1990), for commercial pools, have been established to meet certain microbial objectives. Chemical levels are specified to minimise public health risk caused by microbial contamination.

Heated water can potentially be a health risk if Regulations are not adhered to. Chemical treatment and filtration are currently utilised to achieve this purpose. Apart from the challenging conditions constantly faced by pool operators in meeting with the Regulations' criteria, heated pool water can cause a range of associated problems in indoor environments.

Such problems include high energy costs and evaporation/condensation issues. The product Heat\$avr has been developed to reduce these problems.

Use of the product Heat\$avr in a heated pool application has been proposed as potentially suitable to minimise evaporation losses. Effects on other water quality indicators must also be measured.

An on-site field trial was undertaken at a regional Swim School exhibiting an historical record of Regulatory compliance, together with an existing condensation problem. The effect of Heat\$avr in a commercial application, on a range of indicators, was subsequently measured and compared against control conditions.

2. AIMS

This trial aims to establish the effect of Heat\$avr in a commercial pool environment on:

- 2.1. Microbiological quality
- 2.2. Sanitiser consumption
- 2.3. Stability of sanitiser level
- 2.4. Demand for water balance chemicals
- 2.5. Stability of pH
- 2.6. Filter characteristics
- 2.7. General water clarity
- 2.8. Condensation levels
- 2.9. Gas consumption (pool water heating)
- 2.10. Bather comfort

3. MATERIALS AND METHOD

3.1. Pool Details

Location:	Irrewillipe, Victoria
Type:	Commercial, indoor, heated
Finish :	Fibreglass
Volume:	60,000 litres
Bather load:	215 per week (maximum 70 per day - 5 days per week)
Filtration:	Waterco Micron 5T02 (150 kg sand)
Pump:	1 x Poolrite SF100
Sanitiser.	Salt Chlorinator
Superchlorination:	Sodium Hypochlorite, Calcium Hypochlorite
Other chemicals:	Sodium Bicarbonate, Hydrochloric Acid, Rock Alum
Back washing:	Backwash five nights per week for 4 minutes plus 30 seconds rinse

The facility was operated by a trained operator. A conventional water treatment method was in operation throughout the trial, as required by Purification Standards for Public Swimming Pools and Spa Pools (Victoria, 1990). Automatic chlorine dosing occurred.

The operator had added the Heat\$avr product just prior to the trial commencement. Initial results in condensation reduction were so noticeable that the operator/owner wished to continue using the product.

3.2. Treatments

The trial compared no Heat\$avr, with the addition of Heat\$avr, in conjunction with existing operations, procedures and maintenance levels.

Usual operating procedures and maintenance levels were employed throughout the trial. Heat\$avr was added by the pool operator in accordance with the supplier's instructions at a rate of 46 ml per 60 m surface area of pool water. A total of 80ml was initially added. A further 80ml was added on Mondays, Tuesdays, Thursdays, Fridays and Saturdays, for the trial duration, to replace backwash dilutions.

3.3. Trial Duration

The trial commenced in early September, 1998. It incorporated four one-week replicates with completion of the trial at the end of October, 1998. The trial was interrupted for four weeks due to school holidays and the Victorian gas crisis.

3.4. Sampling Procedure

The sampling site was chosen during a site inspection conducted by Aqua Science Consultants. The sampling point, near the skimmer box, was chosen to represent overall water quality throughout the pool.

The sampling procedure used for the sample collection was based upon the *APHA recommended methods. The criteria for the selection of sample containers was based upon the Australian Standard (AS 2031.2).

Two samples were taken at the sampling point - one in a Decon-washed polyethylene bottle for chemical analysis, and the other in a sterilised bottle treated with sodium thiosulphate for microbiological analysis. All samples were collected from approximately 30cm under the surface of the pool water. Samples collected for both the chemical and microbiological analyses were stored on ice prior to testing.

All chemical analyses were carried out at Aqua Science Consultants' Laboratory in Braeside. The type of chemical analysis performed and the methods used will be discussed further in Section 3.6.1. Microbiological analyses were conducted by a NATA (National Association of Testing Authorities) Registered laboratory. All results were compared to requirements of the Standards. The chemical and microbial requirements of the Standards are summarised in the tables below.

Chemical Standards for Swimming Pools

Parameter	Standards
Free Chlorine	1.0 - 8.0 ppm
Total Chlorine	1.0 - 8.0 ppm
Combined Chlorine	Not over 1.5 ppm
pH	7.2 - 8.0 .
Total Alkalinity	Not under 60 ppm

Microbiological Standards

Parameter	Standards
TPC	Not greater than 100 Colony-forming-units cfu per ml
Ps. aeruginosa	Not detected in 100 ml (N/D)
Coliforms	Not detected in 100 ml (N/D)

* Standard Methods for the Examination of Water and Waste Water, 18th Edition, 1992, American Public Health Association.

3.5. Sampling Times

Laboratory samples were collected once per week at a specified time, from time (t) = 0 to (t) = four weeks. Each week represents one replicate. A total of five samples were collected during the trials.

On-site results were recorded by the pool operator on a four-hourly basis, as required by Regulations. Further observations were recorded on a daily and twice daily basis.

Retrospective data collection for historical records provided details of the "Control" conditions (minus Heat\$avr), which allowed comparison of results.

3.6. Measurements

The following measurements were recorded at each sampling time:

3.6.1. Chemical Analysis (Laboratory)

1. Free Chlorine (ppm) using Colorimetric Photometer - Lovibond DPD No.1 Method
2. Total Chlorine (ppm) using Colorimetric Photometer - Lovibond DPD No.1 plus No. 3 Method
3. Combined Chlorine - read-out from the photometer (subtract (4) from (5))
4. pH using a digital Radiometer PHM 95 pH/ ion meter (+/- 0.01 unit accuracy) with combined pH electrode
5. Total Alkalinity (ppm) using Colorimetric Photometer - Lovibond Alka-M-Photometer Method
6. Redox (mV) using a digital Radiometer PHM 95 pH/ ion meter (+/- 20 mV) with combined platinum electrode
7. Total Dissolved Solids (ppm) using analogue Conductivity meter (+/-50 ppm) with combined carbon electrode
8. Sodium Chloride (Salt) (ppm) using a digital Radiometer PHM 95 ion meter (+/- 5 mV) with combined platinum electrode
9. Calcium Hardness (ppm) using Colorimetric Photometer - Lovibond Calcheck Method
10. Copper (ppm) using Colorimetric Photometer - Palintest Coppercol Method
11. Iron (ppm) using Colorimetric Photometer - Palintest Iron LR Method
12. Saturation Index (SI) calculated from above using Langelier Scale

3.6.2. Microbiological Analysis (Laboratory)

Microbiological determinations were conducted by a NATA Registered laboratory as required by the Standards. Analyses included:

- (i) Total Plate Count (TPC)
- (ii) *Pseudomonas aeruginosa* (*Ps. aeruginosa*)
- (iii) Coliforms

3.6.3. On-Site Records and Observations

Data sheets were provided by Aqua Science Consultants and collected on a weekly basis. The following daily tests and observations were requested from the pool operator at four-hourly intervals:

1. Free/Total/Combined Chlorine levels
2. pH
3. Redox
4. Clarity
5. Filter pressure
6. Bather load
7. Bather effect (0-5)
8. General comments

These additional factors were also recorded:

1. Chemical additions required (daily)
2. Backwashing frequency and duration (daily)
3. Total Alkalinity (daily)
4. Calcium Hardness (daily)
5. Condensation level (0-5) (twice daily)
6. Temperatures (pool water, pool hall, outdoor) (twice daily)
7. Gas consumption for pool heating (weekly)

Means and Standard Deviations were calculated and results tabulated using a Microsoft Excel package.

4. RESULTS

See Appendix for Raw Data Tables

A summary and comparison of results is provided in Tables 1 - 4

4.1. **TABLE 1: COMPARISON OF WEEKLY LABORATORY RESULTS
(MINUS/PLUS HEAT\$AVR)**

Treatment	CHEMICAL											MICROBIAL			
	Chlorine (ppm)			pH	Total Alk	Redox mV	TDS (ppm)	NaCl (ppm)	Cal Hard	Cu (ppm)	Fe (ppm)	SI	TPC ch/ml	P. aeru. / 100ml	Coll. / 100ml
Free	Total	Comb													
Minus Heat\$avr															
Mean	3.69	5.62	1.93	7.55	217	736	4500	3120	38	<0.01	<0.01	-0.3	N/D	N/D	N/D
Std Dev ±	3.32	2.80	0.52	0.25	73	58	424	141	13	0.00	0.00	0.21	0	0	0
Plus Heat\$avr															
Mean	3.84	4.75	0.91	7.26	181	776	4020	3258	66	<0.01	<0.01	-0.3	N/D	N/D	N/D
Std Dev ±	0.85	0.76	0.12	0.02	11	17	672	719	4	0.00	0.00	0.1	N/D	N/D	N/D

*Closed from 19/9 - 12/10 due to school holidays and gas crisis

When no Heat\$avr was added, the average free chlorine laboratory result recorded was 3.69 ± 3.32 ppm. There was very little variation to the average result of 3.84 ± 0.85 ppm obtained during the addition of Heat\$avr. Less free chlorine fluctuation was observed with Heat\$avr added (Table 1A).

Laboratory results showed the average combined chlorine level (minus Heat\$avr) was 1.93 ± 0.52 ppm. At both sampling times, the combined chlorine level was found to exceed Regulations (Table 1A).

Combined chlorine levels in laboratory samples were found to comply with Regulations during the trial (plus Heat\$avr). The average level was 0.91 ± 0.12 ppm (Table 1A).

The average laboratory result for pH (minus Heat\$avr) was 7.55 ± 0.25 . The average result for plus Heat\$avr was slightly lower (7.26 ± 0.02).

The average total alkalinity result plus Heat\$avr was 181 ± 11 ppm which was slightly less than the minus Heat\$avr average of 217 ± 73 ppm. Laboratory results showed very little fluctuation in total alkalinity levels during the time Heat\$avr was used, with levels ranging from 161 - 189 ppm.

The average laboratory redox value obtained (plus Heat\$avr) was slightly higher (776 ± 17 mV) than that obtained minus Heat\$avr (736 ± 58 mV).

There was little difference in the average salt and TDS values obtained for both minus / plus Heat\$avr. The average salt and TDS results (minus Heat\$avr) were 3120 ± 141 ppm and 4500 ± 424 ppm respectively. The average salt and TDS results (plus Heat\$avr) were 3258 ± 719 ppm and 4020 ± 672 ppm respectively.

The laboratory SI results obtained (minus Heat\$avr) was -0.3 ± 0.21 . The average SI of laboratory samples (plus Heat\$avr) was -0.3 ± 0.1 .

4.2. TABLE 2 - COMPARISON OF ON-SITE FOUR-HOURLY RECORDS (MINUS/PLUS HEATSAVR)

Week	Chlorine (Ppm)			PH		Redox	Clarity (1-5)	Filter Pressure	Bather Load	Bather Comfort
	Free	Total	Combined	Manual	Elect.					
WEEK A	Mean Std Dev ±	2.1 0.3	2.3 0.3	0.2 0.2	7.6 0.1	7.8 0.1	5.0 0.0		69 48	5.0 0.0
WEEK B	Mean Std Dev ±	2.0 0.2	2.3 0.2	0.3 0.1	7.5 0.1	7.7 0.1	5.0 0.0		69 48	5.0 0.0
Minus HeatSavr	Mean Std Dev ±	2.0 0.1	2.3 0.2	0.2 0.1	7.5 0.1	7.7 0.1	5.0 0.0		69 48	5.0 0.0
WEEK 1	Mean Std Dev ±	2.1 0.3	2.2 0.3	0.2 0.2	7.5 0.0	7.6 0.1	5.0 0.0	110 0	64 45	5.0 0.0
WEEK 2	Mean Std Dev ±	2.1 0.4	2.8 0.4	0.6 0.3	7.5 0.1	7.6 0.1	4.9 0.3	110 0	101 23	5.0 0.0
WEEK 3	Mean Std Dev ±	2.3 0.5	2.9 0.4	0.6 0.3	7.4 0.1	7.5 0.1	4.9 0.2	110 0	70 49	5.0 0.0
WEEK 4	Mean Std Dev ±	2.3 0.6	3.0 0.5	0.7 0.3	7.5 0.1	7.6 0.1	5.0 0.2	110 0	65 46	5.0 0.0
Plus HeatSavr	Mean Std Dev ±	2.2 0.2	2.7 0.1	0.5 0.1	7.5 0.0	7.6 0.0	5.0 0.1	110 0	75 11	5.0 0.0

On-site chlorine results obtained from the retrospective data (minus HeatSavr showed little difference to results obtained during the addition of HeatSavr. The average free chlorine level for Weeks A and B (minus HeatSavr) was 2.1 ± 0.3 ppm and 2.0 ± 0.2 ppm respectively (Table 2A). The average free chlorine level for Weeks 1, 2, 3 and 4 was 2.1 ± 0.3 ppm, 2.1 ± 0.4 ppm, 2.3 ± 0.5 ppm and 2.3 ± 0.6 ppm respectively (Table 2B).

In Weeks A and B (minus HeatSavr), on-site observations recorded an average clarity of 5. The average water clarity during the weeks when HeatSavr was added, ranged from 4.9 to 5.0. There was no significant effect of HeatSavr on pool water clarity. No reduction in clarity was observed.

The average bather load in the weeks prior to HeatSavr addition (Weeks A and B) was 69. During the weeks when HeatSavr was added, the average bather load for Weeks 1 - 4 was 75.

4.3. TABLE 3. COMPARISON OF ON-SITE DAILY CHEMICAL ADDITIONS (MINUS/PLUS HEATSAVR)

Week	Chemical Additions				Backwash Details Frequency (min)	Total	
	Sod Hypo (L)	Cal. Hyp (g)	Rock Alum (g)	Bicarbonate (kg)		Alkalinity (ppm)	Calcium Hardness (ppm)
A	Total	2150					
	Mean					225	70
B	Total	1950					
	Mean					225	70
Minus HeatSavr	Mean	2050	800			225	70
	Std Dev ±	141	489			0	0
One	Total	2625.00	1200	2.0	45		
	Mean					207	70
Two	Total	1250.0	600.0	0.0	17.0		
	Mean					213.3	73.3
Three	Total	2150.0	1000.0	5.00	36.0		
	Mean					196.0	82.0
Four	Total	2650.0	1200.0	0.0	42.0		
	Mean					200.0	83.3
Total Plus HeatSavr	Mean	2166.75	1000.0	1.8	35.0	204.0	77.2
	Std Dev ±	664.3	282.8	2.4	12.6	6.0	
HeatSavr	RSD %	30.2	28.3	136.0	36.9	2.9	
	RSD %						

There was no variation in the quantity of Alum used either prior to or during the addition of HeatSavr. For both minus and plus HeatSavr, the average amount of Rock Alum used per day, following backwash, was 200 grams (Tables 3A & 3B).

The amount of Calcium Hypochlorite added (minus HeatSavr) of 2.05 kg was very similar to the amount of 2.17 kg added during HeatSavr addition.

4.4. **TABLE 4 - COMPARISON OF ON-SITE, DAILY OBSERVATIONS
(MINUS/PLUS HEAT\$AVR)**

Week	Condensation level (0-5)		Temperature (oCelsius)		
			Water	Air	Outside
Week A	Mean	4.6	33.0	22.0	9.1
	Std Dev ±	0.6	0.0	0.0	6.8
	RSD %	13.6	0.0	0.0	74.6
Week B	Mean	4.4	33.0	22.0	10.3
	Std Dev ±	0.9	0.0	0.0	5.2
	RSD %	19.8	0.0	0.0	50.5
Minus Heat\$avr	Mean	4.5	33.0	22.0	9.7
	Std Dev ±	0.2	0.0	0.0	1.1
	RSD %	4.0	0.0	0.0	11.6
Week 1	Mean	4.9	33.0	22.4	10.9
	Std Dev ±	0.3	0.0	2.2	4.7
	RSD %	7.1	0.0	9.8	43.2
Week 2	Mean	5.0	33.0	23.5	13.5
	Std Dev ±	0.0	0.0	2.1	4.0
	RSD %	0.0	0.0	8.9	29.5
Week 3	Mean	4.9	33.0	23.1	14.9
	Std Dev ±	0.3	0.0	3.2	8.2
	RSD %	6.6	0.0	13.7	54.9
Week 4	Mean	4.8	33.0	22.6	12.5
	Std Dev ±	0.4	0.0	2.5	5.3
	RSD %	8.2	0.0	11.3	42.5
Plus Heat\$avr	Mean	4.9	33.0	22.9	12.9
	Std Dev ±	0.2	0.0	0.5	1.8
	RSD %	3.7	0.0	2.1	14.2

Pool water temperature remained constant throughout the trial, at 33°C. Air temperature was recorded between 18 - 28°C.

Average outside temperatures ranged from 9.1 to 14.9°C throughout the trial. Average outside temperature (minus Heat\$avr) was 9.7°C and reached 12.9°C (plus Heat\$avr).

During periods of no Heat\$avr addition, condensation levels ranged from 3 - 5, with an average of 4.5. Average condensation level (plus Heat\$avr) was 4.9, with the lowest level of 4, during this time.

4.5

TABLE 5 - COMPARISON OF FORTNIGHTLY GAS CONSUMPTION (MINUS/PLUS HEAT\$AVR)

		Gas Delivered (litres)	Gas Consumption
Minus Heat\$avr	Mean	813.9	317.5
	Std Dev±	2.8	9.2
	RSD %	0.3	2.9
PLUS Heat\$avr	Mean	659.85	258.80
	Std Dev±	133.30	60.91
	RSD %	20.20	23.53

NB: The pool was closed from 21-9-98 to 4-10-98

During the minus Heat\$avr period, an average 813.9 litres of gas was delivered over each two-week period. Throughout Heat\$avr addition, an average of 659.9 litres of gas was delivered over each two-week period. This represents a saving of \$58.70 per fortnight, or \$26.35 per week. An overall reduction in gas consumption of around 18.5% was measured.

5. DISCUSSION

Laboratory samples were collected once per week at a specified time. Eleven chemical tests and three microbiological parameters were measured. A total of seventy analyses were undertaken.

On-site results were also recorded by the pool operator on a four-hourly basis, as required by Victorian Public Health Regulations, 1990. Data detailing on-site procedures was also recorded, for comparison of the effects of minus/plus HeatSavr.

5.1. Sanitiser Level

5.1.1. Free Chlorine

According to Public Health Regulations, free chlorine must be maintained between 1.0 - 8.0ppm, in indoor commercial pools in Victoria. Stability between 2.0 – 3.0 ppm is recommended.

Discrepancies were evident between on-site and laboratory results, with higher levels consistently recorded in the laboratory results. Free chlorine levels fluctuated slightly throughout the trial.

5.1.2. Combined Chlorine

The maximum combined chlorine level allowed in Victorian commercial pools is 1.5 ppm, Combined chlorine level is responsible for chlorine odour and sore, red eyes. Low levels are preferred (< 0.5 ppm).

5.2. Other Chemical Parameters

5.2.1. pH

A pH range of 7.2 – 7.8 applies to Victorian commercial pools, according to Regulations. A pH of 7.6 - 7.8 is generally recommended.

pH results obtained for both minus and plus Heat\$avr were within Regulations. The pH results recorded were lower than the preferred levels of 7.6 – 7.8. Very little variation was evident in the pH results obtained during Weeks A and B (minus Heat\$avr) and Weeks 1, 2, 3, and 4 (Heat\$avr added).

5.2.2. Total Alkalinity

Total alkalinity acts as a buffer to prevent pH fluctuations. Regulations require a minimum of 60 ppm but no maximum is specified. The recommended level for this pool is 150 - 200 ppm.

Little variation was evident in the total alkalinity results obtained during Weeks A and B (minus Heat\$avr) and Weeks 1, 2, 3, and 4 (Heat\$avr added). At all times total alkalinity was within specified health Standards.

5.3. Microbial Quality

Tests were carried out for the specified micro-organisms and results compared with requirements of the Standards - (refer section 3.4). No microbial failures occurred in any samples obtained during the routine quarterly sampling (minus Heat\$avr) or during the Heat\$avr trial (plus Heat\$avr).

No microbial presence was detected at any time. Microbial quality was well within requirements at all samplings.

5.4. Non-Regulated Parameters

Seven non-regulated, waterquality parameters were included in the investigation:

- 5.4.1. Redox (mV) – Oxidation Reduction Potential
- 5.4.2. Sodium Chloride (Salt) and Total Dissolved Solids (ppm)
- 5.4.3. Calcium Hardness (ppm)
- 5.4.4. Copper /Iron (ppm)
- 5.4.5. Saturation Index (SI)

5.4.1. Redox

This measurement is used for continuous monitoring of chlorine levels, thus allowing automatic dosing. Stability is important to ensure uniform sanitiser levels. Fluctuations in redox are affected by many parameters. Slightly less fluctuation was observed when HeatSavr was added.

5.4.2. Salt (NaCl) and Total Dissolved Solids (TDS) Salt level is measured to ensure that the salt-chlorinator can function correctly.

TDS is partly made up of salt and unaccounted for T.D.S (uTDS). If uTDS levels accumulate, inadequate water replacement is indicated.

u TDS levels were generally lower during addition of HeatSavr, than with no HeatSavr. No changes were recorded in rate of water replacement or bather load.

5.4.3. Calcium Hardness

The recommended calcium hardness range for an indoor, heated, salt chlorinated pool is 60 - 90 ppm. Levels were below recommendations with no HeatSavr and within recommendations with HeatSavr added.

5.4.4. Copper and Iron

Presence of these metals can act as an indicator of corrosion. Corrosion is unexpected under proper water balance conditions. No copper and iron were detected in any of the samples collected (either minus or plus HeatSavr).

5.4.5. Saturation Index (SI)

Saturation Index (SI) is a derived value, which measures the corrosive capacity of the water. The Langelier Scale is used. To prevent corrosion SI is preferably maintained between -0.2 - +0.5.

Regardless of whether HeatSavr was added, the SI observed was lower than preferred and pool water was slightly corrosive.

5.5. Observations

5.5.1. Clarity

Water clarity was recorded by allocation of a numerical value from 1 - 5, where 1 was cloudy and 5 was exceptionally clear.

No reduction in clarity was observed, with addition of HeatSavr.

5.5.2. Filter Pressure

Filter pressure increases as suspended solids are filtered from the system. Recorded filter pressure was very stable throughout the trial at 110kPa. Unfortunately, no filter pressure was recorded during Weeks A and B (minus HeatSavr) for any comparison to be made.

5.5.3. Bather Load and Bather Comfort.

Bather loading is the primary factor affecting water quality. Loads were slightly higher during the period when HeatSavr was added.

Bather comfort was recorded, by allocation of a numerical value from 1 - 5, where 1 means badly affected and 5 indicates no effect. Bather comfort remained consistent prior to and during the addition of HeatSavr with a consistent value of 5. No bather effect was observed, with the addition of HeatSavr.

5.5.4. Chemical Additions

Backwashing occurred five times per week according to operator records, on Monday, Tuesday, Thursday, Friday and Saturday. Chemicals were added following each backwash (Table 3).

No variation in the quantity of Rock Alum used was observed prior to and during the addition of HeatSavr .

5.5.5. Condensation Levels

Condensation levels were recorded on-site, by allocation of a numerical value from 0 - 5, where 0 was heavy condensation and 5 was nil condensation.

Measured reduction in condensation occurred. Around 10% improvement was observed. Variation in results would be expected, at different temperature differentials.

The most significant outcome of the trial, is the operator's determination to continue using the product. Results achieved were very favourable from the pool owner's perspective.

5.6. Gas Consumption

It should be mentioned that the pool was closed from 21-9-98 to 4-10-98 due to school holidays. This would have an impact on the amount of gas consumed.

However, when comparing the amount of gas consumed during the first two weeks of the trial (Heat\$avr added) to that prior, there appeared to be a reduction in the amount used (Table 5).

6. CONCLUSION

8. Free and combined chlorine, pH and total alkalinity (regulated by Health Standards) remained stable throughout the trial. No increase in fluctuations of the parameters was observed.
Chemical parameters stayed within requirements of the Standards during the addition of Heat\$avr.
9. No microbial indicators were detected at any time and microbial quality was consistently exceptional for both minus/plus Heat\$avr treatment.
3. Non-regulated parameters monitored during the trial indicated no observable changes or fluctuations in the levels of Redox, Sodium Chloride, Calcium Hardness, Total Dissolved Solids or corrosion products (copper and iron).
4. A reduction in condensation levels of 10% was recorded on-site by the operator, with addition of Heat\$avr.
5. Gas consumption was reduced by around 18.5%, reflecting savings of between \$25 - \$30 per week.
6. Indoor, heated pools in buildings with inadequate air handling systems may benefit from addition of Heat\$avr, by minimising condensation and reducing heating costs.

7. RECOMMENDATIONS

Any further trials incorporating use of Heat\$avr, need not include additional microbial investigation.

Further trials to measure effects of Heat\$avr in outdoor heated pools during winter, are strongly urged.

TABLE 1A: COMPARISON OF WEEKLY LABORATORY RESULTS (MINUS/PLUS HEATSAVR)

Week/Date	CHEMICAL					MICROBIAL								
	Free Chlorine (ppm)	Total Chlorine (ppm)	pH	Total Alk.	Redox mV	TDS (ppm)	NaCl (ppm)	Ca Hard	Cu (ppm)	Fe (ppm)	S	TPC (cfu/ml)	Pen. / 100ml	Coli / 100ml
Week A 18/03/98	1.34	3.84	7.73	268	695	4800	3220	29	<0.01	<0.01	-0.1	N/D	N/D	N/D
Week B 3/06/98	6.04	7.6	7.37	165	777	4200	3020	47	<0.01	<0.01	-0.4	N/D	N/D	N/D
Minus HeatSavr Mean Std Dev ±	3.69 0.32	5.62 2.80	7.55 0.25	216.50 72.83	726.00 57.98	4500 424.26	3120 141.42	38 12.73	<0.01 0.00	<0.01 0.00	-0.25 0.24	N/D 0.0	N/D 0.0	N/D 0.0
Week 0 8/09/98	4.03	4.88	7.29	183	792	3600	2840	61	<0.01	<0.01	-0.3	N/D	N/D	N/D
Week 1 9/9-15/9	3.37	4.43	7.27	187	762	3400	2420	66	<0.01	<0.01	-0.3	N/D	N/D	N/D
Week 2 16/9-22/9	5.24	6.01	7.26	161	774	5100	4330	72	<0.01	<0.01	-0.3	N/D	N/D	N/D
Week 3 13/10-19/10	3.42	4.3	7.24	186	796	4200	3240	66	<0.01	<0.01	-0.4	N/D	N/D	N/D
Week 4 20/10-27/10	3.12	4.12	7.23	189	757	3800	3460	66	<0.01	<0.01	-0.4	N/D	N/D	N/D
Plus HeatSavr Mean Std Dev ±	3.84 0.85	4.75 0.76	7.26 0.02	181 11	776 17	4020 572	3236 279	66 4	<0.01 0.00	<0.01 0.00	-0.3 0.14	N/D N/D	N/D N/D	N/D N/D

*CLOSED FROM 19/9 - 12/10 DUE TO SCHOOL HOLIDAYS AND GAS CRISIS

TABLE 2A: ONSITE FOUR HOUR RECORDS WEEKS A & B

Date	Time	Chlorine (ppm)			pH		Redox	Clarity (1-5)	Filter Pressure	Bather Load	Bather Comfort
		Free	Total	Combined	Manual	Elect.					
24/08/98	t = opening	2.3	2.3	0	7.4	7.6	not taken	5	not taken		5
	t = 4 hours	1.8	1.8	0	7.4	7.7	not taken	5	not taken	80	5
	t = 8 hours	1.8	2	0.2	7.6	7.8	not taken	5	not taken		5
	t = closing	1.8	2	0.2	7.6	7.8	not taken	5	not taken		5
25/08/98	t = opening	2.5	2.8	0.3	7.5	7.7	not taken	5	not taken		5
	t = 4 hours	2.3	2.5	0.2	7.5	7.7	not taken	5	not taken	36	5
	t = 8 hours	2.3	2.5	0.2	7.5	7.7	not taken	5	not taken		5
	t = closing	2.3	2.5	0.2	7.6	7.8	not taken	5	not taken		5
26/08/98	t = opening	2.8	2.8	0	7.5	7.6	not taken	5	not taken		5
	t = 4 hours	1.8	2.3	0.5	7.6	7.8	not taken	5	not taken	96	5
	t = 8 hours	1.8	2.3	0.5	7.6	7.8	not taken	5	not taken		5
	t = closing	1.8	2.3	0.5	7.6	7.8	not taken	5	not taken		5
27/08/98	t = opening	2.5	2.5	0	7.5	7.6	not taken	5	not taken		5
	t = 4 hours	2	2	0	7.6	7.8	not taken	5	not taken	127	5
	t = 8 hours	1.8	2	0.2	7.6	7.8	not taken	5	not taken		5
	t = closing	1.8	2	0.2	7.6	7.9	not taken	5	not taken		5
28/08/98	t = opening	1.8	2	0.2	7.6	7.8	not taken	5	not taken		5
	t = 4 hours	2	2.3	0.3	7.6	7.8	not taken	5	not taken	6	5
WEEK A	Mean	2.1	2.3	0.2	7.6	7.8		5.0		69	5.0
	Std Dev ±	0.3	0.3	0.2	0.1	0.1		0.0		48	0.0
	RSD %	16.7	12.8	82.8	0.9	1.1		0.0		69.8	0.0
31/08/98	t = opening	1.9	2.1	0.2	7.3	7.5	not taken	5	not taken		5
	t = 4 hours	1.9	2.3	0.4	7.4	7.6	not taken	5	not taken	80	5
	t = 8 hours	1.9	2.3	0.4	7.5	7.7	not taken	5	not taken		5
	t = closing	1.9	2.3	0.4	7.5	7.7	not taken	5	not taken		5
1/09/98	t = opening	2.3	2.5	0.2	7.5	7.6	not taken	5	not taken		5
	t = 4 hours	2.3	2.5	0.2	7.5	7.6	not taken	5	not taken	36	5
	t = 8 hours	2	2.3	0.3	7.5	7.7	not taken	5	not taken		5
	t = closing	2	2.3	0.3	7.6	7.8	not taken	5	not taken		5
2/09/98	t = opening	2.3	2.5	0.2	7.4	7.6	not taken	5	not taken		5
	t = 4 hours	2.3	2.5	0.2	7.4	7.6	not taken	5	not taken	96	5
	t = 8 hours	1.8	2	0.2	7.6	7.8	not taken	5	not taken		5
	t = closing	1.8	2	0.2	7.6	7.8	not taken	5	not taken		5
3/09/98	t = opening	2.3	2.5	0.2	7.5	7.6	not taken	5	not taken		5
	t = 4 hours	2	2.3	0.3	7.6	7.8	not taken	5	not taken	127	5
	t = 8 hours	2	2.3	0.3	7.6	7.7	not taken	5	not taken		5
	t = closing	1.9	2.5	0.6	7.6	7.7	not taken	5	not taken		5
4/09/98	t = opening	1.75	2	0.25	7.5	7.7	not taken	5	not taken		5
	t = 4 hours	1.8	2	0.2	7.5	7.7	not taken	5	not taken	6	5
	t = 8 hours	2.0	2.3	0.3	7.5	7.7	not taken	5.0	not taken		5.0
WEEK B	Mean	2.0	2.3	0.3	7.5	7.7		5.0		69	5.0
	Std Dev ±	0.2	0.2	0.1	0.1	0.1		0.0		48	0.0
	RSD %	9.7	8.2	38.0	1.1	1.1		0.0		69.8	0.0
Minus HeatSavr	Mean	2.0	2.3	0.2	7.5	7.7		5.0		69.0	5.0
	Std Dev ±	0.1	0.2	0.1	0.1	0.1		0.0		0.0	0.0
	RSD %	4.5	10.5	59.2	1.1	1.2		0.0		0.0	0.0

MINUS HEAT\$AVR

TABLE 2B: ON SITE FOUR HOURLY RECORDS (PLUS HEATSAVR)

Date	Time	Chlorine (ppm)			pH		Redox	Clarity (1-5)	Filter Pressure	Bather Load	Bather Comfort
		Free	Total	Combined	Manual	Elect.					
8/09/98	t = opening	2.5	2.6	0.1	7.4	7.6	700	5	110		5
	t = 4 hours	2.4	2.5	0.1	7.4	7.6	685	5	110	36	5
	t = 8 hours	2.0	2.2	0.2	7.5	7.7	650	5	110		5
	t = closing	2.0	2.2	0.2	7.5	7.7	645	5	110		5
10/09/98	t = opening	2.0	2.2	0.2	7.4	7.5	700	5	110		5
	t = 4 hours	2.0	2.2	0.2	7.4	7.6	680	5	110	96	5
	t = 8 hours	2.0	2.2	0.2	7.5	7.7	640	5	110		5
	t = closing	2.0	2.2	0.2	7.5	7.7	640	5	110		5
11/09/98	t = opening	2.0	2.2	0.2	7.4	7.5	680	5	110		5
	t = 4 hours	s	2.2	0.2	7.5	7.6	650	5	110	127	5
	t = 8 hours	1.9	2.5	0.6	7.5	7.8	625	5	110		5
	t = closing	1.9	2.5	0.6	7.5	7.7	615	5	110		5
12/09/98	t = opening	2.0	2.0	0.0	7.5	7.5	670	5	110		5
	t = 4 hours	2.0	2.0	0.0	7.5	7.5	670	5	110	6	5
	t = 8 hours	2.0	2.0	0.0	7.5	7.5	650	5	110		5
14/09/98	t = opening	3.0	3.1	0.1	7.5	7.5	710	5	110		5
	t = 4 hours	1.9	2	0.1	7.5	7.6	670	5	110	80	5
	t = 8 hours	1.9	2	0.1	7.5	7.7	660	5	110		5
	t = closing	1.9	2.0	0.1	7.5	7.7	660	5.0	110		5.0
15/09/98	t = opening	2.3	2.4	0.1	7.5	7.6	695	5.0	110		5.0
	t = 4 hours	2.0	2.1	0.1	7.5	7.6	680	5.0	110	36.0	5.0
	t = 8 hours	1.9	2.2	0.3	7.5	7.7	670	5.0	110		5.0
	t = closing	1.9	2.2	0.3	7.5	7.7	660	5	110		5
WEEK 1	Mean	2.1	2.2	0.2	7.5	7.6	665	5.0	110	63.5	5.0
	Std Dev ±	0.3	0.3	0.2	0.0	0.1	24	0.0	0	45.1	0.0
	RSD %	12.8	11.6	85.2	0.8	1.2	4	0.0	0	71.1	0.0
17/09/98	t = opening	3.2	3.6	0.4	7.3	7.4	710	5	110		5
	t = 4 hours	2	2.4	0.4	7.4	7.5	695	5	110	96	5
	t = 8 hours	2	2.5	0.5	7.5	7.6	660	5	110		5
	t = closing	2	2.5	0.5	7.5	7.7	650	5	110		5
18/09/98	t = opening	2	2.4	0.4	7.4	7.5	670	5	110		5
	t = 4 hours	2	2.5	0.5	7.5	7.6	635	5	110	127	5
	t = 8 hours	2	2.5	0.5	7.6	7.7	625	5	110		5
	t = closing	2	2.5	0.5	7.6	7.7	610	5	110		5
12/10/1998	t = opening	2	3	1	7.4	7.4	655	5	110		5
	t = 4 hours	2	3	1	7.5	7.5	640	5	110	81	5
	t = 8 hours	2	3	1	7.5	7.6	640	5	110		5
	t = closing	2.5	3.5	1	7.6	7.7	645	4	110		5
WEEK 2	Mean	2.1	2.8	0.6	7.8	7.8	662.9	4.8	110.0	101.3	5.0
	Std Dev ±	0.4	0.4	0.3	0.1	0.1	28.2	0.3	0.0	23.5	0.0
	RSD %	18.9	15.4	41.7	1.3	1.5	4.3	5.9	0.0	23.2	0.0

TABLE 2b: ON-SITE FOUR-HOURLY RECORDS (PLUS HEAT\$AVR)
continued

Date	Time	Chlorine (ppm)			pH		Redox	Clarity (1-5)	Filter Pressure	Bather Load	Bather Comfort
		Free	Total	Combined	Manual	Elect.					
13/10/98	t = opening	3.5	3.5	0	7.5	7.6	680	5	110		5
	t = 4 hours	3	3.0	0	7.5	7.6	670	5	110	35	5
	t = 8 hours	2.5	3.0	0.5	7.5	7.6	655	5	110		5
	t = closing	2	2.5	0.5	7.6	7.7	625	5	110		5
15/10/98	t = opening	2.2	3.0	0.8	7.2	7.4	660	5	110		5
	t = 4 hours	1.9	2.75	0.85	7.5	7.4	630	5	110	106	5
	t = 8 hours	1.9	3.0	1.1	7.5	7.6	580	5	110		5
	t = closing	1.9	3.0	1.1	7.5	7.6	580	5	110		5
16/10/98	t = opening	3.2	3.5	0.3	7.3	7.4	650	5	110		5
	t = 4 hours	1.9	2.5	0.6	7.3	7.4	610	5	110	124	5
	t = 8 hours	2	2.5	0.5	7.5	7.6	555	5	110		5
	t = closing	1.9	2.5	0.6	7.5	7.6	535	5	110		5
17/10/98	t = opening	2.2	2.5	0.3	7.4	7.5	610	5	110	6	5
	t = 4 hours	2.0	2.3	0.3	7.5	7.6	600	5	110		5
	t = opening	3.0	3.6	0.6	7.3	7.3	700	5	110		5
19/10/98	t = 4 hours	2	2.5	0.5	7.3	7.4	670	5	110	81	5
	t = 8 hours	2	3	1	7.5	7.6	645	5	110		5
	t = closing	2	3	1	7.5	7.6	645	4	110		5
WEEK 3	Mean	2.3	2.9	0.6	7.4	7.5	628	4.9	110	70	6.0
	Std Dev ±	0.5	0.4	0.3	0.1	0.1	45	0.2	0	49	0.0
	RSD %	22.8	13.6	57.8	1.5	1.5	7	4.8	0	70	0.0
20/10/98	t = opening	3.5	4.0	0.5	7.3	7.4	715	5	110		5
	t = 4 hours	3.0	3.75	0.75	7.3	7.4	695	5	110	35	5
	t = 8 hours	2.0	2.75	0.75	7.4	7.6	665	5	110		5
	t = closing	1.9	2.75	0.85	7.5	7.7	645	5	110		5
22/10/98	t = opening	3.0	3.5	0.5	7.3	7.4	700	5	110		5
	t = 4 hours	2.0	2.5	0.5	7.4	7.5	650	5	110	106	5
	t = 8 hours	1.9	2.75	0.85	7.4	7.6	635	5	110		5
	t = closing	1.9	2.75	0.85	7.5	7.7	635	5	110		5
23/10/98	t = opening	3.5	3.5	0	7.3	7.4	680	5	110		5
	t = 4 hours	1.9	2.5	0.6	7.4	7.6	630	5	110	124	5
	t = 8 hours	1.9	2.75	0.85	7.4	7.6	615	5	110		5
	t = closing	1.8	3.0	1.2	7.5	7.7	590	5	110		5
24/10/98	t = opening	3.0	3.5	0.5	7.4	7.5	660	5	110	6	5
	t = 4 hours	2.0	2.8	0.8	7.5	7.6	640	5	110		5
26/10/98	t = opening	2.0	2.5	0.5	7.4	7.6	665	5	110		5
	t = 4 hours	1.9	2.75	0.85	7.5	7.7	650	5	110	81	5
	t = 8 hours	1.9	2.75	0.85	7.6	7.7	645	5	110		5
	t = closing	1.9	2.75	0.85	7.6	7.8	640	4	110		5
27/10/98	t = opening	3.5	4.0	0.5	7.5	7.6	690	5.0	110		5.0
	t = 4 hours	2.0	2.5	0.5	7.5	7.7	665	5.0	110	35.0	5.0
	t = 8 hours	2.0	3.0	1.0	7.6	7.8	630	5.0	110		5.0
	t = closing	2.0	3.0	1.0	7.6	7.8	630	5.0	110		5.0
week 4	Mean	2.3	3.0	0.7	7.5	7.8	653	5.0	110	65	5.0
	Std Dev ±	0.6	0.5	0.3	0.1	0.1	30	0.2	0	48	0.0
	RSD %	26.8	16.0	38.3	1.4	1.7	5	4.3	0	72	0.0
Plus	Mean	2.2	2.7	0.5	7.5	7.8	649.5	5.0	110.0	74.9	6.0
HeatSavr	Std Dev ±	0.2	0.1	0.1	0.0	0.0	9.1	0.1	0.0	11.8	0.0
Wks 1 - 4	RSD %	7.2	3.6	14.2	0.4	0.2	1.4	2.6	0.0	15.8	0.0

TABLE 3A: ON-SITE DAILY PROCEDURES (WEEKS A & B) MINUS HEAT\$AVR

Date	Chemical Additions				Backwash Details			Total Alkalinity (ppm)	Calcium Hardness (ppm)
	Sod Hypo (L)	Cal Hypo (g)	Alum (g)	Sucarbonate (kg)	Time	Frequency (min)			
Week A									
24/08/98	2.5	500	200		9:30 pm	5	225	70	
25/08/98	3.25	650	200		9:30 am	10	225	70	
27/08/98	2.5	500	200		6:00 pm	5	225	70	
28/08/98							225	70	
29/08/98		500	200		12:30 pm	10	225	70	
Week A TOTAL	8.25	2150	800		Mean A		225	70	
					Std Devt		0	0	
					RSD %		0	0	
Week B									
31/08/98	2.5	500	200		9:30 am	5	225	70	
1/09/98		500	200		9:30 am		225	70	
3/09/98		450	200		6:00 pm	5	225	70	
4/09/98							225	70	
5/09/98		500	200		12:00 noon	10	225	70	
Week B TOTAL	2.5	1950	800		Mean B		225	70	
					Std Devt		0	0	
					RSD %		0	0	
Minus Heat\$AVR									
Mean		2050	800		Mean A B		225	70	
Std Devt		141	0		Std Devt		0	0	
RSD %		7	0		RSD %		0	0	

NB: Sod. Hypo values are shown converted to equivalent quantities of Cal. Hypo (1 Litre Sod Hypo = 200g Cal. Hypo)

TABLE 3B: ON-SITE DAILY PROCEDURES (WEEKS 1 TO 4) PLUS HEATSAVR

Date	Chemical Additions			Back Wash Details		Frequency (min)	Mean Std Dev ± RSD %	Total Alkalinity (ppm)	Calcium Hardness (ppm)
	Sod Hypo (L)	Cal. Hypo (g)	Rock Alum (g)	Bicarbonate (Kg)	Time				
Week 0-1:									
8/09/98		500	200		9:30 pm	10		210	70
10/09/98		450	200		6:00 pm	5		210	70
11/09/98		400	200		9:00 pm	5		210	70
12/09/98		425	200		12:00 noon	10		180	70
14/09/98		400	200	2	9:30 pm	5		210	70
15/09/98		450	200		9:30 pm	10		220	70
Total week 1		2025.0	1200.0	2.0		45.0	Mean Std Dev ± RSD %	207	70
								14	0
								7	0
Week 1-2:									
17/09/98		450	200		6:00 pm	7		220	70
18/09/98		400	200		9:00 pm	5		220	80
12/10/98		400	200		9:30 pm	5		200	70
Total week 2		1250.0	600.0	0.0		17.0	Mean Std Dev ± RSD %	213.3	73.3
								12	6
								5	8
Week 2-3:									
13/10/98		400	200		9:30 am	10		200	70
15/10/98		400	200		6:00 am	6		200	80
16/10/98	2	400	200		8:30 am	5		200	80
17/10/98	2	500	200	3	12:00 noon	10		180	90
19/10/98	2.25	450	200	2	9:30 pm	5		200	90
Total week 3	6.75	2150.0	1000.0	5.0		36.0	Mean Std Dev ± RSD %	196.0	82.0
								9	8.4
								4.6	10.2
Week 3-4:									
20/10/98	2.25	450	200		9:30 pm	10		200	90
22/10/98	2.25	450	200		6:00 pm	5		200	90
23/10/98	2.25	450	200		8:30 pm	5		200	90
24/10/98		450	200		11:30 am	5		200	70
26/10/98		400	200		9:30 pm	5		200	70
27/10/98		450	200		9:30 pm	8		200	90
Total Week 4	6.75	2650.0	1200.0	0.0		42.0	Mean Std Dev ± RSD %	200.0	83.3
								0.0	10.3
								0.0	12.4
Plus Heatsavr									
Mean		2168.75	1000.0	1.8		35.0		204.0	77.2
Std Dev ±		654.3	267.8	2.4		12.6		7.6	
RSD %		30.2	28.3	135.0		35.8		3.7	

**TABLE 4A - ON-SITE TWICE DAILY OBSERVATIONS WEEKS A & B
(MINUS HEAT\$AVR)**

Week	Date	Condensation Levels (0-5)	Temperature (°C)			
			Water	Air	Outside	
Week A	24/08/98	am	5	33	22	
		pm	4	33	22	
	25/08/98	am	5	33	22	5
		pm	3.4	33	22	16
	27/08/98	am	5	33	22	3
		pm	5	33	22	15
	28/08/98	am	5	33	22	3
		pm	4	33	22	18
	29/08/98	am	5	33	22	4
		pm				
	Mean	4.6	33.0	22.0	9.1	
	Std Dev ±	0.6	0.0	0.0	6.8	
	RSD %	13.6	0.0	0.0	74.6	
Week B	31/08/98	am	5	33	22	5
		pm	5	33	22	17
	1/09/98	am	5	33	22	7
		pm	3	33	22	15
	3/09/98	am	5	33	22	6
		pm	4	33	22	16
	4/09/98	am	5	33	22	7
		pm	3	33	22	15
	5/09/98	am	5	33	22	5
		pm				12
	Mean	4.4	33.0	22.0	10.3	
	Std Dev ±	0.9	0.0	0.0	5.2	
	RSD %	19.8	0.0	0.0	50.5	
Total Weeks A & B	Mean	4.5	33.0	22.0	9.7	
	Std Dev ±	0.2	0.0	0.0	1.1	
	RSD %	4.0	0.0	0.0	11.6	

**TABLE 4B - ON - SITE TWICE DAILY OBSERVATIONS
(PLUS HEAT\$AVR)**

Week	Date	Condensation Levels (0-6)		Temperature (°C)		
				Water	Air	Outside
Week 1	8/09/98	7:30 am	5	33	20	8
		4:00 pm	5	33	22	12
		8:00 pm	5	33	22	7
		9:30 pm	4	33	22	7
	10/09/98	9:00 am	5	33	20	5
		1:00 pm	5	33	23	21
		5:00 pm	5	33	26	14
		6:00 pm	5	33	26	14
	11/09/98	9:00 am	5	33	22	5
		1:00 pm	5	33	26	18
		5:00 pm	5	33	26	16
		9:00 pm	5	33	24	13
	12/09/98	8:00 am	5	33	23	5
			5	33	23	14
	14/09/98	7:00 am	5	33	19	6
		11:00 am	5	33	22	19
		3:00 pm	5	33	24	14
		7:00 pm	5	33	23	10
		10:00 pm	5	33	21	6
15/09/98	7:30 am	5	33	20	6	
	3:00 pm	5	33	19	11	
	7:00 pm	4	33	21	8	
	9:30 pm	4	33	21	8	
Week 1	Mean	4.9	33.0	22.4	10.9	
	Std Dev ±	0.3	0.0	2.2	4.7	
	RSD %	7.1	0.0	9.8	43.2	
Week 2	17/09/98	7:00 am	5	33	20	5
		10:00 am	5	33	23	10
		2:00 pm	5	33	25	20
		8:00 pm	5	33	26	14
	18/09/98	9:00 am	5	33	23	12
		12:00 noon	5	33	26	20
		4:00 pm	5	33	26	20
		8:00 pm	5	33	24	13
		9:00 pm	5	33	24	13
	12/10/98	11:00 am	5	33	20	12
		3:30 pm	5	33	24	12
		6:00 pm	5	33	24	12
		9:30 pm	5	33	21	10
	Week 2	Mean	5.0	33.0	23.6	13.6
		Std Dev ±	0.0	0.0	2.1	4.0
	RSD %	0.0	0.0	8.9	29.5	

**TABLE 4B - ON - SITE TWICE DAILY OBSERVATIONS
(PLUS HEAT\$AVR) continued**

Week	Date	Condensation Levels (0-5)		Temperature (°C)		
				Water	Air	Outside
Week 3	13/10/98	7:30 am	5	33	20	8
		3:00 pm	5	33	19	10
		7:00 pm	4	33	22	8
		9:30 pm	4	33	22	8
	15/10/98	8:00 am	5	33	21	9
		12:00 noon	5	33	28	28
		4:00 pm	5	33	28	28
	16/10/98	6:00 pm	5	33	26	20
		8:00 am	5	33	18	4
		12:00 noon	5	33	26	25
	17/10/98	4:00 pm	5	33	26	26
		8:30 pm	5	33	20	15
		8:00 am	5	33	21	16
	19/10/98	12:00 noon	5	33	26	24
10:00 am		5	33	20	10	
2:00 pm		5	33	23	14	
6:00 pm		5	33	22	9	
Week 3	9:30 pm	5	33	21	8	
	Mean	4.9	33.0	23.1	14.9	
	Std Dev ±	0.3	0.0	3.2	6.2	
	RSD %	6.6	0.0	13.7	54.9	
Week 4	20/10/98	8:00 am	5	33	18	9
		3:15 pm	5	33	20	17
		7:30 pm	4	33	22	10
		9:30 pm	4	33	22	10
	22/10/98	8:00 am	5	33	19	7
		12:00 noon	5	33	25	19
		4:00 pm	5	33	25	14
	23/10/98	6:00 pm	5	33	25	12.5
		8:00 am	5	33	20	10.5
		12:00 noon	5	33	25	17
		4:00 pm	5	33	26	16
	24/10/98	8:30 pm	5	33	24	9
		7:30 am	5	33	20	17
		11:30 am	5	33	26	28
	26/10/98	10:00 am	5	33	21.5	12
		2:00 pm	5	33	24	11
		8:00 pm	5	33	24	6
		9:30 pm	5	33	22	6
27/10/98	8:00 am	5	33	18	4	
	3:15 pm	5	33	22	20	
	7:15 pm	4	33	24.5	15	
	9:30 pm	4	33	24	12	
Week 4	Mean	4.8	33.0	22.6	12.6	
	Std Dev ±	0.4	0.0	2.6	6.3	
	RSD %	8.2	0.0	11.3	42.6	
Weeks 0 - 4	Plus Heat\$avr	Mean	4.9	33.0	22.9	12.9
		Std Dev ±	0.2	0.0	0.6	1.8
		RSD %	3.7	0.0	2.1	14.2

TABLE 5 A - FORTNIGHTLY GAS CONSUMPTION (MINUS/PLUS HEAT\$AVR)

		Gas delivered (Litres)	Gas Consumption (\$)
MINUS HEAT\$AVR	11/08/98	815.9	323.95
	26/08/98	811.9	310.95
	Mean	813.9	317.5
	Std Dev ±	2.8	9.2
	RSD %	0.3	2.9
PLUS HEAT\$AVR	7/09/98	651.4	249.45
	22/09/98	685.6	262.55
	6/10/98	489.3	187.4
	20/10/98	813.1	335.8
	Mean	659.85	258.80
Std Dev ±	133.30	60.91	
RSD %	20.20	23.53	

NB: POOL WAS CLOSED FROM 21- 9-98 TO 4-10-98

end