SUMMARY REPORT

Thermal Performance Test of Spas

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FINAL REPORT
Thermal Performance Test of Spas

This Report contains a summary of results from a test conducted by the Alberta Research Council (ARC).

The purpose of this report is to summarize the results of a test with eight spas for comparison of Steady State Power Demand. This measure is useful to the consumer because it is representative of the energy required to operate the spa.

The Alberta Research Council is a wholly owned subsidiary of the Alberta Science and Research Authority technology corporation dedicated to applied science, engineering and technology development.

The services of the Alberta Research Council were utilized to supervise and summarize the test results and every possible means was taken to ensure that the tests were conducted under similar conditions for all participating products.

Please consider the following notes when reviewing the contents of this report:

1. All the spas were purchased at random from retail locations by the ARC and shipped to the testing facility.

2. These tests were performed in a controlled environment and were not intended to represent an actual "field" application where wind, sunlight and product placement could influence the actual performances of the various products. It is felt however that such tests do reflect the relative performance of the tested products and that certain inferences can be safely drawn from the results.

3. ARC does not specifically endorse any of the products tested.

4. Many tests were performed by ARC on these products for research purposes and not all of them were for the expressed purpose of exploring the above hypothesis, but also to provide useful information for manufacturers that could be used to explore future design changes in the various products they manufacture. Only parts of the overall report are thus transferred to this compilation that pertain to specific tests and results namely the Steady State Power Demand testing.

5. There are several differences in the spas that complicate the evaluation. Some of these differences are: variation in the spa volumes (from 1.28 to 1.78 m3); different heating and filtering systems and their modes of operation; and small variations in the air temperatures during the tests.

6. To ensure that there has been no misinterpretation of the data presented herein, ARC has reviewed this abridged report. A copy of their letter of review is provided on page 2.

Summary Report – Thermal Performance of Spas

This page is to confirm that Alberta Research Council Inc. (ARC) verifies the accuracy of the data contained within this Summary Report on steady state power demand of spas. ARC performed this non-standardized test on behalf of Arctic Spas, of Thorsby, Alberta.

A list of comparative spas for evaluation was provided by Arctic Spas and purchased by ARC for testing purposes. ARC researchers developed the test protocols used in the evaluation. Please refer to the following page for notes when reviewing the contents of this report. Performance of these tests does not imply an endorsement or recommendation of any product by ARC.

ARC develops and commercializes technologies to give clients a competitive advantage. A leader in innovation, ARC provides solutions globally to the energy, life sciences, agriculture, environment, forestry and manufacturing sectors.

1. INTRODUCTION

In a typical application a spa is installed outside of the house where it is exposed to significant changes in ambient conditions. In the harsh North American climate, they may be exposed to prolonged periods of freezing temperatures. To prevent energy costs to keep the spa hot, good thermal insulation is required.

Eight spas were selected for testing and are listed in Table 1. The client made the selection of the spa vendors and models, but the independent third party that conducted the research purchased them, as any consumer would purchase them. This includes spas produced by the client, so that no modifications could be made to the spas.

Table 1. Set of Spas Subjected for Evaluation

Spa #	Spa	Size Meters	Water Volume Litres
1	Beachcomber, 740	2.26x2.28x1.05	1,474
2	Sundance, Cameo	2.28x2.30x1.01	1,434
3	Coast Spas, Lanai Silver	2.38x2.36x1.09	1,719
4	Arctic Spas, Kodiak SS-1	2.36x2.36x1.04	1,478
5	Hotspring, Vanguard	2.54x2.31x0.97	1,288
6	Arctic Spas, Coyote C-60	2.35x2.35x0.88	1,287
7	Cal Spas, Atlantic	2.38x2.35x1.02	1,476
8	Arctic Spas, Kodiak SS-2	2.36x2.36x1.04	1,579

2. TESTING SYSTEM DESCRIPTION

For the purpose of spa testing a measuring system was developed as shown in Figure 1 on pg 4.

The measured parameters were:

- Ambient air temperature
- Water temperature in the spa
- Temperature of the spa shell
- Temperature in the equipment enclosure
- The power consumed by the pump; and
- The power consumed by the heater.

To perform the spas evaluation a set of parameters and conditions were established for the testing. The first series of tests were performed at room temperature (about 20°C). The second series of tests were performed in a freezer chamber at a temperature of about minus 15°C.

The temperature data was collected with Fluke HYDRA data logger with 21 channels. An example of data extracted at four simultaneously tested spas is given in Figure 2 on pg 4. A separate example of data loggers were used to collect data for power consumption evaluation. An example of data power consumption is shown in Figure 3 on pg 4.

Figure 1. Measuring system for set of two spas.

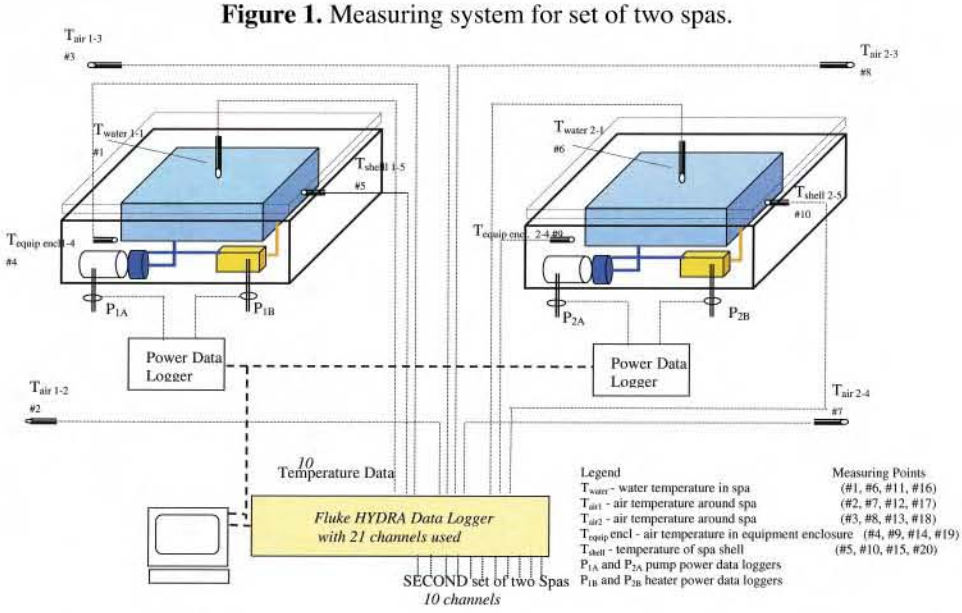

Figure 2. Example of data obtained from the tested system with four spas tested simultaneously.

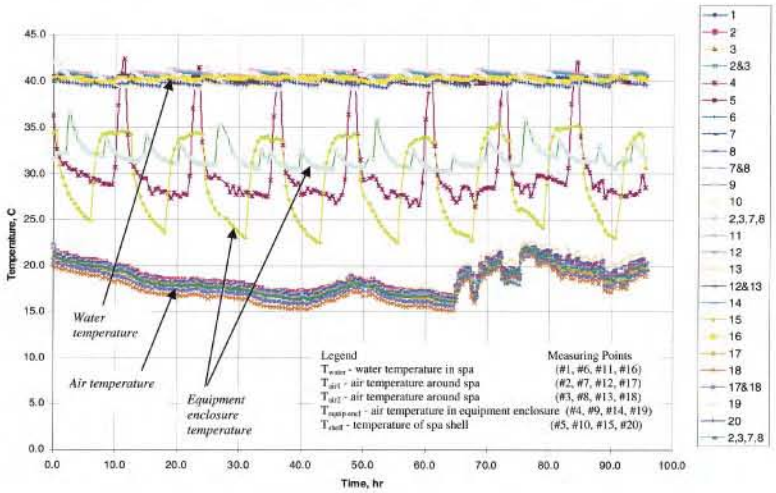

Figure 3. Example of power readings from power recorder for heating and steady state periods.

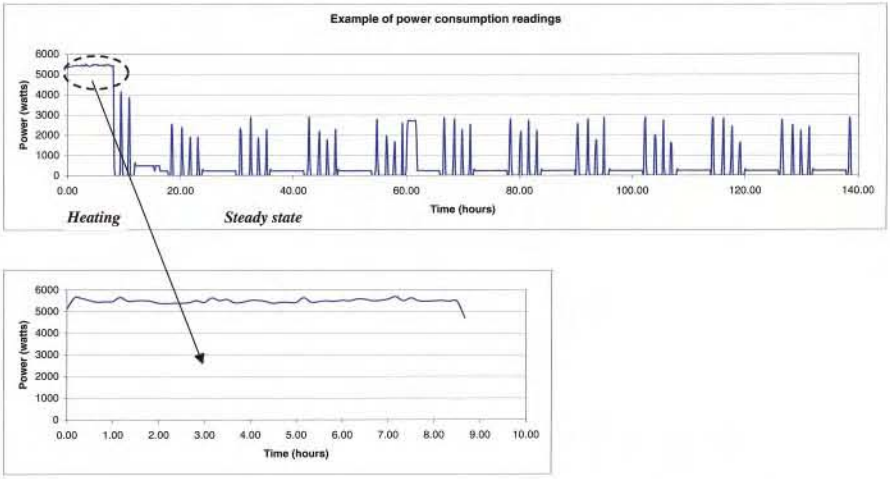

Figure 3. Example of power readings from power recorder for heating and steady state periods.

STEADY STATE PERIOD RESULTS SUMMARY AND CONCLUSIONS

The results of testing at steady state are shown in Table S-1 and Table S-2 on pg 6, and figure S-9.

To determine the long-term energy consumption of the spas two sets of conditions were applied for each spa: room temperature and low temperature. Tests at room conditions were influenced by variations of the surrounding air temperature. The temperature variations are obvious over long testing periods. It should also be noted that some of the room temperature tests were performed in the freezer room. The freezer room has an insulated floor, where as tests performed outside the freezer room were on a concrete floor. The difference in flooring may influence the thermal system since the bottom of the spa represents a significant heat exchange area.

The long term, steady state condition power consumption is one of the critical spa parameters for the spauser. Comparison of the power consumption and specific energy demand is shown in Figure S-9.

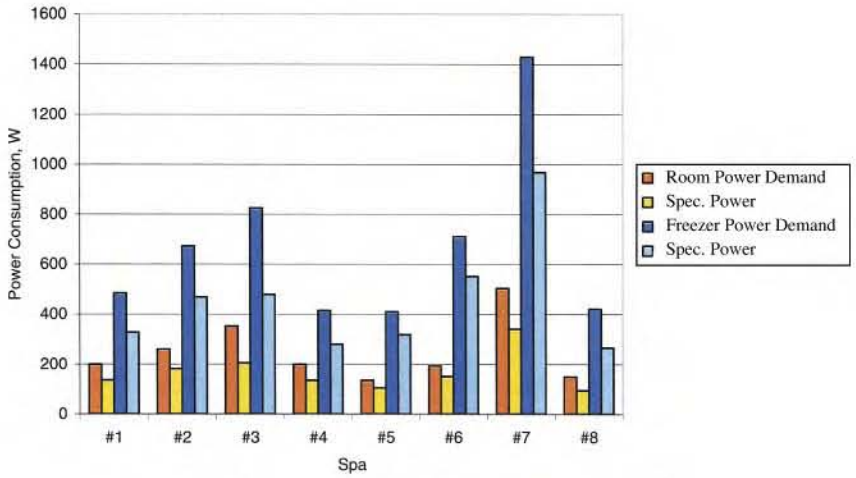

Figure S-9. Comparison of energy usage (power) for steady state for the spa's tested.

It may be concluded from Figure S-9 the energy consumption significantly increases when air temperature is decreasing. When decreasing temperature from 20°C down to –13°C on average the power demand increases 2.7 times indicating increased heat losses.

Assuming that the low temperature (-13°C) tests are more indicative (significantly higher power demand) and considering the power consumption as a parameter for performance evaluation, the best performing spa would be (in order of best performing down):

Spa #8 Arctic Spas, Kodiak SS-2, Spa #4 Arctic Spas, Kodiak SS-1, Spa #5 Hot Springs, Vanguard, Spa #1 Beachcomber, 7-40, Spa #6 Arctic Spas, Coyote, Spa #2 Sundance, Cameo, Spa #3 Coast Spas, Lanai Silver, Spa #7 Cal Spas, Atlantic

Power consumption for steady state is influenced mainly by the overall spa thermal insulation. However, the size and usage frequency of the filtering systems and the way this system is installed also has impact on the spa performance. It is beneficial to the overall thermal efficiency of the system if some of the heat generated by the pump/motor can be retained in the system. In this case the heat will not be wasted energy but will contribute to the heating efficiency.

CONCLUSIONS

- Power consumption evaluated at steady state conditions is a good parameter for spa performance evaluation. This measure is useful to the consumer because it tells the consumer how much energy is required to operate the spa.

Table S-1. STEADY STATE at AMBIENT TEMPERATURE

Spa #	Date	Spa	Water Volume Liters	Ave. Air Temp. °C	Water Temp °C	Test Time h	ΔE kW	Number of heating cycles	Power Demand W	Spec. Power W/m^3	Comments
#1	Apr 24	Beachcomber, 740	1,474	20	41	94.3	18.82	4	200	136	
#2	A29-M 6	Sundance, Cameo	1,434	20	40.5	142	37.15	24	260	181	
#3	Apr 24	Coast Spas, Lanai Silver	1,719	20	42	94	33.20	8	352	205	
#4	Apr 24	Arctic Spas, Kodiak SS-1	1,478	19.5	40	94	18.83	32	199	135	
#5	June	Hotspring, Vanguard*	1,288L*	21	40	60	8.14		135	105	
#6	June	Arctic Spas, Coyote, C60	1287	21	41	84	16.18	7	193	150	
#7		Cal Spas, Atlantic	1476			130	65.62	96	503	341	
#8		Arctic Spas, Kodiak SS-2	1579			128	19.06	12	149	94	

* - No auto-filtering! Filter cycle must be started manually

Table S-2. STEADY STATE in FREEZER

Spa #	Date	Spa	Water Volume Liters	Air Temp °C	Water Temp °C	Test Time h	DE Wh	Heating Cycles Number	Power Demand W	Spec. Power W/m^3	Comments
#1		Beachcomber, 740	1,474	-11	41	60	29,055	14	484	328	
#2	May 1-6	Sundance, Cameo	1,434	-11	41	72	21,145	20	671	468	
#3		Coast Spas, Lanai Silver	1,719	-14	41.5	60	49,465	5	824	479	
#4		Arctic Spas, Kodiak SS-1	1,478	-14	41	84	24,824	15	414	280	
#5	June20-26	Hotspring, Vanguard*	1,288L*	-12	41.5	108	44,214	65	409	318	
#6	June20-26 July 8-15	Arctic Spas, Coyote, C60	1287	-12 -13	40.5 40.5	120 96	87,070 65,946	32 24	726 686	564 533	
#7	July25-28	Cal Spas, Atlantic	1476	-11	41	72	102,864	18	1429	968	
#8	July25-28	Arctic Spas, Kodiak SS-2	1579	-11	40.5	120	50,518	30	420	266	

* no autofiltering

- As an indicator of thermal performance, the tests performed at low temperature are more suitable. The low temperature tests have a larger heat difference, which emphasizes the heat losses making it easier to differentiate the performance of the various spas.

FINAL EVALUATION

For the final evaluation the Steady State Power consumption was selected to best indicate the energy efficiency of the spas.

Results in order from least to most power consumption were:

Spa #8 Arctic Spas, Kodiak SS-2
Spa #4 Arctic Spas, Kodiak SS-1
Spa #5 Hot Springs, Vanguard
Spa #1 Beachcomber, 740
Spa #6 Arctic Spas, Coyote C-60
Spa #2 Sundance, Cameo
Spa #3 Coast Spas, Lanai Silver
Spa #7 Cal Spas, Atlantic

As concluded from Figure S-9 (pg 5).

For the overall thermal performance of the spas three criteria were used, these include:

- Specific steady state power demand (SSSD), W/m3
- Steady state power consumption (SSP), W
- Cooling time (CT), h

Each spa was ranked according to the results for each of the criteria. Points were assigned according to the rank (from 1 to 8) and the points from each test summed to provide a final score. Less points means better performance (1st rank) and more points means lower performance (lower rank).

POINTS	SPA
6	Arctic Spas, Kodiak SS-1
7	Arctic Spas, Kodiak SS-2
9	Beachcomber, 740
9	Hot Springs, Vanguard
14	Sundance, Cameo
19	Coast Spas, Lanai Silver
20	Arctic Spas, Coyote C-60
24	Cal Spas, Atlantic