Better Water Maker
Power Generation System

Test Plan

Version 4.0
April 4, 2014

Version History:

Version #	Implemented by	Revision Date	Approved By	Approved On	Reason
1	Erika Correa	12/16/13			First Draft
2	Erika Correa	1/30/14			Second Draft
3	Jessica Fuss	2/6/2014			Additional Information
4	Liz White	4/2/2014			Formatting/ Proofreading

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Introduction
Purpose of the test plan and test subject criteria

At least 16 volunteers will be required to begin testing of the prototype. Selection of volunteers will be based on height and gender of the individual.

The first part of the volunteer group must consist of individuals that are either female adults or children. To successfully select an appropriate group, women ***and*** children must both be included in this portion of the test group. These volunteers must fall within the following height range: 59 to 65 inches (4'11" to 5'5"). A minimum of 10 volunteers will be selected for this part of the test group.

The second part of the volunteer group will consist of persons that fall outside of the criteria set for the first half of the group. Inclusion of this group serves to measure the difficulty of operating the device for larger- and smaller-than-intended users. A minimum of eight volunteers will be selected for this portion of the test group. Preferably, the group would include children below a height of 4'11" and either women or men taller than 5'5".

Additional tests will be performed to test other metrics aside from usability. These include testing the durability of the device and failure modes. The following tests are necessary to produce results valuable in evaluating the development of a successful device for its intended users.

Resources:

Approx. Height	Max. # of Volunteers	Requirement
4'11" - 5'2"	6	At least 3 volunteers must be adult females
5'3" - 5'5"	4	At least 2 volunteers must be adult females
4'5" - 4'7"	1	Volunteer can either be male or female
4'8"- 4'10"	1	Volunteer can either be male or female
5'6" - 5'8"	1	Volunteer can either be male or female
5'9" - 5'11"	1	Volunteer can either be male or female
6'0" - 6'2"	1	Volunteer can either be male or female

Testing for Ease of Assembly

Engineering Requirement 8: Number of Installers
Engineering Requirement 9: Number of Tools

Test Risks/Issues:

If the device proves difficult to assemble, the number of pre-assembled parts must then be reconsidered against an adjusted estimated shipping cost.

Items to be Tested:

Item	Description
Attachment of bucket to track	Inserting track into correct opening and securing it properly using the tools provided.
Attachment of gearbox to track	Positioning correctly using arrows showing which direction track should face. Properly securing gearbox to track.
Bucket Support Insert assembly	Assembling and inserting into bucket in the correct position, then securing it to the track using the tools provided.
Attachment of pedals to gearbox	Securing pedals to gearbox .
Attachment of seat back to bucket	Securing correctly using tool provided.

Test Approach:

Volunteers will be provided with the product user manual, parts, and tools and asked to assemble the device. In preparation for testing the ease of gearbox repositioning, volunteers will be asked to place the gearbox in a position not in accordance with their leg length needs. Subjects will be timed discreetly in order to obtain final assembly time. In addition, subassembly times will be recorded. Upon completion volunteers will rate the difficulty of each assembly on a scale of 1 to 10 with a short survey.

Test Pass/Fail Criteria:

The test is failed if 75% of volunteers cannot successfully assemble the device within 60 minutes or if the device is assembled incorrectly by 75% of volunteers.

Test Entry/Exit Criteria:

Timing begins once volunteers have all the necessary parts including the user manual. Timing ends once the device has been completely assembled. The test ends once the volunteers has rated the difficulty of the task.

Test Deliverables:

At the end of each test, a total assembly time, subassembly times, and a rating of the difficulty is to be recorded with a user-completed survey.

Test for Ease of Gearbox Repositioning on Track

Engineering Requirement 4: Training Time

Test Risks/Issues

A gearbox that cannot be easily and properly repositioned faces the risk of being damaged due to excessive force or improper use. It can also cause unintended strains on the user.

Items to be Tested/Not Tested:

Item	Description
Wingnut Removal	Removal of wingnut
Eyebolt Removal	Removal of eyebolt with reasonable ease
Movement of gearbox to new location	Gearbox transfer performed with ease to avoid damage
Eyebolts Re-Insertion	Re-insertion with ease
Fastening of Wingnuts	Wingnuts secured

Test Approach

Volunteers will be asked to reposition the gearbox to a location chosen by the tester (based on the optimal position in relation to the individual's leg length). Subjects will be timed discreetly in order to obtain final repositioning time. Upon completion volunteers will rate the difficulty of assembly on a scale of 1 to 10.

Test Pass/Fail Criteria

The test is failed if any volunteers cannot successfully reposition the gearbox and secure it in its new position. At least 50% of volunteers should be able to complete the task within 10 minutes.

Test Entry/Exit Criteria

Testing can begin once timing begins. The test ends once the volunteer has rated the difficulty of the task.

Test Deliverables

At the conclusion of the test, a number should be obtained for the total time required to complete the task.

Test for Ease of Power Generation

Engineering Requirement 2: Generated Power
Engineering Requirement 6: Effort Required

Test Risks/Issues

The most important requirement is for the user to be able to operate the device so that it reduces the effort to the user. Most often, the user will tire before enough water is sanitized.

Items to be Tested/Not Tested

Item	Description
Heart Rate	A heart rate monitor will be attached to the user and the technician will record it during some time interval
Point of Exhaustion	Point in time where volunteer can no longer pedal comfortably
Amount of Water Santized	Quantity of water produced by pedaling for a given period of time
Average Rotations Per Minute	Determine total rotations for a given time period to calculate average

In order to have a baseline, some specific physical measurements will be taken from the user, such as weight, height, age, gender, and body fat percentage. With this information, the heart rate can be compared to a typical person with these specifications (Appendix A).

Volunteers will be first asked to power the device by pedaling until they have reached a point of exhaustion. After five minutes the amount of water produced will be measured using a water pitcher with measurements marked on its side. The final quantity will be measured at the end of the test. The point of exhaustion is determined entirely by the user (they will choose to stop when they no longer feel comfortable pedaling or if the seat is too uncomfortable to allow them to continue).

Test Pass/Fail Criteria

The test fails if the user's heart rate increases to a "high" level of activity within the five minute trial as determined by our target heart rate and measured by the heart rate monitor. The test is failed if the user cannot produced at least half a gallon of water.

Test Entry/Exit Criteria

The test begin once the LED light turns on and timing begins. The test ends once the user indicates he or she no longer feels comfortable pedaling and the timing is stopped.

Test Deliverables

At the conclusion of the test, the amount of time the user pedaled for, the amount of

water produced at five minutes, the total amount of water produced, and the average number of rotations per minute should be obtained.

Test for Comfort

Engineering Requirement 7, Weight
Engineering Requirement 11, Support User

Test Risks/Issues

Seat causes discomfort to the point where seat needs to be redesigned at a possibly higher cost

Items to be Tested/Not Tested

Item	Description
Seat Comfort	Comfort level while pedaling to sanitize water

Test Approach

Users will be asked to rate the comfort of the seat after completing the test for power generation. They will also have the ability to add any additional comments and suggestions for improving the comfort of the seat.

Test Pass/Fail Criteria

The test for comfort is failed if the user stops pedaling due to the discomfort of the seat rather than from reaching a point of exhaustion.

Test Entry/Exit Criteria

This test begins at the completion of the test for ease of power generation. All tests are complete as soon as all questionnaires are completed and turned in to any of the testers.

Test Deliverables

A completed questionnaire from the volunteer.

Appendix

Appendix A: Heart Rate Chart

Age	Max HR	Easy/Recovery Zone		General Aerobic		Steady/Distance Race		Anaerobic Zone		Vo2 Max	
	*Estimated	Low End	High End	Low End	High End	Low End	High End	Low End	High End	Low End	High End
14	196	108	128	129	147	149	161	163	173	175	186
15	196	108	127	129	147	149	160	162	172	174	186
16	195	107	127	129	146	148	160	162	171	173	185
17	194	107	126	128	146	148	159	161	171	173	184
18	193	106	126	128	145	147	159	161	170	172	184
19	193	106	125	127	145	147	158	160	170	172	183
20	192	106	125	127	144	146	158	159	169	171	182
21	191	105	124	126	144	145	157	159	168	170	182
22	191	105	124	126	143	145	156	158	168	170	181
23	190	105	124	125	143	144	156	158	167	169	181
24	189	104	123	125	142	144	155	157	167	169	180
25	189	104	123	125	142	143	155	157	166	168	179
26	188	103	122	124	141	143	154	156	165	167	179
27	187	103	122	124	140	142	154	155	165	167	178
28	187	103	121	123	140	142	153	155	164	166	177
29	186	102	121	123	139	141	152	154	164	165	177
30	185	102	120	122	139	141	152	154	163	165	176

31	185	102	120	122	138	140	151	153	162	164	175
32	184	101	120	121	138	140	151	153	162	164	175
33	183	101	119	121	137	139	150	152	161	163	174
34	183	100	119	120	137	139	150	151	161	162	173
35	182	100	118	120	136	138	149	151	160	162	173
36	181	100	118	120	136	138	149	150	159	161	172
37	180	99	117	119	135	137	148	150	159	161	171
38	180	99	117	119	135	137	147	149	158	160	171
39	179	98	116	118	134	136	147	149	158	159	170
40	178	98	116	118	134	136	146	148	157	159	169
41	178	98	116	117	133	135	146	148	156	158	169
42	177	97	115	117	133	135	145	147	156	158	168
43	176	97	115	116	132	134	145	146	155	157	168
44	176	97	114	116	132	134	144	146	155	156	167
45	175	96	114	115	131	133	143	145	154	156	166
46	174	96	113	115	131	132	143	145	153	155	166
47	174	95	113	115	130	132	142	144	153	155	165
48	173	95	112	114	130	131	142	144	152	154	164
49	172	95	112	114	129	131	141	143	152	153	164
50	172	94	112	113	129	130	141	142	151	153	163