Team Mystic For Testing Plan

1. **List the metrics you have set for your prototype to respond to (from BENG 492). You should have a minimum of three.**
    - Weights: the device should be less than 5lbs.
    - Dimension: its height should be between 2-5 inches, and its width is between 21 to 23 inches.
    - Volume: the device can carry at least 16 ounces of water.
    - Temperature: the device will provide a cooling temperature, which is 10 degrees cooler than surrounding.

2. **List and briefly describe the tests and/or experiments you have already conducted in response to those metrics (if any). If you have not done any tests/experiments, explain why.**

Test #1 *Water Consumption Test (Quantitative)*

The water consumption test refers to the measurement of how much water was consumed in an hour under a 5-volt input. This was to determine an estimate of how much water was necessary for the atomizer needs to provide mist for at least one hour. One hour was the minimum amount of time as in our requirements, we have listed that our device should last for an hour without breaks. We have found that with a 5-volt input, only 15 mL from a 100 mL beaker was consumed in an hour. This test was repeated three times in total with similar results where it varied by less than a milliliter. This is in response to the metric regarding water storage and will be looked upon once again in further detail during testing of the final prototype.

Test #2 *Cotton Filter Stick Test (Quantitative)*

The cotton stick filter test was done in conjunction with the water consumption test to see if adding in a cotton filter stick would change the amount of water that is used by the atomizer. The results showed that the filter sticks did not impact water consumption levels. After doing more research and meeting with our advisor, we decided to remove filter sticks from our product as these sticks increased the risk of mold formation in our device.

Test #3: *Varying voltage (Qualitative)*

This was a test to see the change in the intensity of mist at different voltages. This test was performed with one atomizer connected to the water storage tube on a demonstration hat made from cardboard. The circuit was connected to a voltage generator with a maximum of 12 volts and a minimum of 1 volt. From this test, we learned that the range of 5 to 7 volts showed the best results. From 8 to 12 volts the intensity was very high for one atomizer since the hat will have two atomizers the excessive mist might cause problems like vision and wetness around the user. Whereas from 1 to 4 the mist was not significant enough to help the user with their problems.

3. **What types of tests/experiments will your team conduct to respond to those metrics and validate the functionality of your prototype/product? You should have a minimum of three tests/experiments. At least two that are quantitative.**
   For each of the tests/experiments listed above in (3), complete the following (in detail):
   a. **What question will your test/experiment answer?**

   b. **What assumption/hypothesis will you be testing?**

   c. **Describe the technique/method/equipment/experimental set-up that you will use. Can use drawings/images to help explain the set-up.**

   d. **What would make the test/experiment successful? (i.e. Acceptance criteria?)**

   e. **What are the expected measurements/results?**

Test #1 *Safety Test (Qualitative)*

To test the safety of the hat apparatus, a qualitative survey will be taken from five to seven users. The user will be wearing the hat for at least an hour and can be done while completing the comfortability test and vision test. All the users will be asked to wear the hat without removing the hat and perform their normal day to day tasks. Survey questions will revolve around concerns regarding safety including any suspicious odor from the mist, feeling of the hat heating up, and does the user feels safe using the hat and why. We will also record observations regarding the usage of the apparatus. This will summarize if the apparatus is working properly and that the user understands how to use the apparatus. Each user will only have to wear the hat once and fill out the survey as thoroughly as possible. A successful test will entail no anomalies being produced by the hat (ex. Odor, overheating, etc.) In addition, the written response of the device is positive and displayed no issues when it is in use. We expect that there should be no issue with odor, and expect no signs of overheating within the circuit during the hour use. Such responses will be

based on a 0 to 5 scale and corresponding values can be seen below in Table 1. Values will be averaged to provide a verdict of whether the prototype passes. If the average is above 4, it is considered an acceptable result.

Table 1

Point Value	Corresponding Response
0	Not applicable
1	Very unsafe, not usable
2	Somewhat unsafe, but not quite usable
3	Somewhat unsafe, somewhat usable
4	Minimal safety issues
5	Feels and is found to be safe

Test #2 *Battery Life (Quantitative)*

Battery life test entails how long will the atomizer run for with one set of batteries. The battery life will first be calculated first based on the batteries' amp hours and the estimated amount of amps inputted into the system. We then use the estimated battery life as the basis and if it passes the threshold, we record this fact and allow it to continue to run until the battery life is used up. This is done four times where batteries are replaced with each test. The apparatus is left to run and if for some reason the atomizer turns off, battery life will be checked before validating it as a data point. It will then be recorded based on whether such a test is valid or not. Validity is determined whether it was turned off by the battery life being depleted or if it turned off due to other factors (i.e. not enough water, accidentally pressing the off switch, etc.). Success can be denoted when the batteries are able to power the atomizer for at least one hour whereas the expected result should have the battery life to last 2.3 hours. Such a test will be graphed using a bar graph where battery life will be checked for each type of battery used. The independent variable will be the type of battery and the dependent variable will be the time it takes to be used up. Error bars will be made to determine the error or uncertainty of the values found. Batteries that will be tested are from the following brands: energizer, Duracell, and amazon standard AA batteries.

Test #3 *Comfortability test (Qualitative)*

The comfortability test will be used to determine whether or not the hat will be comfortable to wear for a long period of time. Since comfortably is an opinion it will be difficult to test, to overcome this, we have decided to ask multiple people in addition to ourselves, to wear the hat for one hour and then rate the comfortably from 1-10. 1 being the most uncomfortable and 10 being the most comfortable. We are hoping that the average comfortably rating for this hat will be around 7 out of 10. While we would love for the hat to be at a comfort level of 10, it will be difficult as this hat is intended to be used as a medical device and the number 1 priority is the hat functioning properly to provide relief from MS symptoms.

Test #4 *Temperature test (Quantitative)*

The temperature test will be done to compare the external temperature to the temperature near the users face. This will be done to gather data that can be used to figure out if our hat is creating a cooling environment for the user. This test will be done by turning on the hat and taking the temperature inside the hat (near the users face) at 3 different times: 0 minutes, 30 minutes and 60 minutes. The environment temperature will also be taken at the exact same time. This test will be repeated a total of 3 times and then will be analyzed using a line graph to see if the test was successful. For the test to be a success we would want the internal temperature to be 10 °F less than the external temperature.

Test #5*: Water test (Qualitative):*

The water test will be done to test that the device will be working if it is wet. We will do multiple trials for this test. For each trial, we will pour a different amount of water on the top of the hat. We will increase this amount of water over each trial. We will record at which amount of water the device will stop working, and in how long. The success of this test is when the hat is still working after all trials because the hat will have double layers, and be covered with a waterproof material. Therefore, all the circuits and battery will be protected under any circumstances.

Test #6: *Water storage max time (Quantitative):*

This test is used to measure how much time the storage will run out of water. The set up of this test includes three trials. Since we did the test of what maximum volume the device can carry, we already have the specific amount of water we need to test. In the first trial, we will let the atomizers run continuously, and after 5 minutes, we will record

the amount of water. In the end, we will have the time when the water is completely run out. In the next trial, we will let the device run in 20 minutes, and then be turned off in 10 minutes. The progress will keep going until all the water running out, and the time will be recorded. In the final trial, the device will work in 10 minutes, and then be turn off in 10 minutes. We will record the time after the device runs out of water. After that, we will have data for minimum and maximum time that the devices can work with a specific amount of water in the storage. The test will succeed if the minimum time is more than one hour, and the maximum time is between one and a half hours to two hours.

***Test #7**: Vision test (Quantitative)*

This test will be done to visualize the effect on vision caused due to the mist from the atomizer. In this test, the vision with and without the humidified hat is compared. It will be performed with and without glasses so that users with glasses do not have trouble using the hat. From the test, the obtainable results are the correct angle and location of the atomizer. To perform the test, the user is first asked to read a poster with letters and or shapes from a distance of five and nine feet. The results are recorded. After that, the hat will be worn for 5 minutes, and the user is asked to read the same poster with the same distances from before. For this, we plan to have two sets, one with users with prescribed glasses and others without glasses. Each set will have 3 to 5 different users. The results will be judged with two main concepts, one squinting of the eyes and another accuracy of the letters from the posters. We hope that the mist does not have any issues with vision, but if it does, then we will have to adjust the angle of the atomizer and or location of the atomizer.

***Test #8**: Drop test (Qualitative)*

In this test, the hat is dropped to measure the maximum and minimum damage done to the hat at different heights. The test will be structured in a way so that when the user drops the hat from their head while walking and doing work. The test will provide information about how much more or less protection is needed for the internal parts of the hat. Here the main attention will be given to the circuit, to make sure the drop does not cause the circuit to have any loose connection. The hat will be dropped from three different heights, 7 feet the maximum height, second is the average human's height of 5.6 feet and a minimum height of 3 feet. The test will be done in sets of three and judged on its working condition of the hat after each drop. To judge the results, we will use a scale of 1 through 5, 5-being the least affected by the drop, no internal or external damage, and 1 being most affected by the drop, the most external or internal damage. From this test, we do except the hat to have some internal damage from the 7 feet drop, but small enough that could be fixed with few changes in the protection material covering the circuit.