Target Summary

After all the major functions were broken down in Section 1.3, all sub-functions were assigned targets and metrics. The targets and metrics will be used to determine how proficient each generated design concept meets our customer needs. Table 3.0 shows the major functions and their respective targets and metrics.

Table 3.0: Targets and Metrics for Each Function

Function	**Targets**	**Metric**
Protects Device Against Corrosion	Minimum Number of Dives Before Equipment Needs Servicing	1 year or 25 dives whichever comes first
	Minimum Life Expectancy of Device	5 years
Provide Means to Dive Independently	Minimum Angle of Diver at Surface	90^o
	Maximum Angle of Diver at Desired Diving Depth	0^o
Allows Diver to Reach Controls with Hands	Distance to Controls Must Not Exceed	672 mm
Prevent Interference with Obstacles	Diameter That Will Form Protective Perimeter Around Diver	998 mm
Decreases Drag	Limit Surface Area That Would Affect Forward Moving Diver's Drag to the Area Found Using the Diver's Shoulders as Diameter	# m^2 (Relative to Diver Observed)
Operates Under Various Water Pressures	Maximum Pressure Able to Withstand	222.92 kPa

A description on how and why each target and metric from Table 3 were formulated can be seen in the proceeding text along with how each will be validated.

1.1.1 Function: Protects Device Against Corrosion

There are two separate targets and metrics for this function. One target is the average service interval of the device. The metric for this target was determined by matching the recommended service interval for buoyancy compensators, regulators, and pressure lines. The metric for this was determined to be one year or twenty-five dives, whichever comes first [*Hollis*]. The second target was determined by benchmarking against scuba manufactures' warranties and matching the average warranty time to our device's minimum life expectancy. The metric for this target was set at a minimum of five years [*Hollis*]. To validate that the chosen design will meet or exceed the metrics, each material that is used in the design will be researched to determine their compatibility and life expectancy with the corrosive saltwater environment.

1.1.2 Function: Provide Means to Dive Independently

To provide means for a paraplegic scuba diver to dive independently the diver needs to be able to control their own trim. Trim refers to the horizontal to vertical orientation of the diver in the water. At the water surface, it is best for a diver to be in a vertical position so the diver can hold their head out of the water. To do so, the diver's body needs to be positioned at a 90^{o} angle in reference to the water surface. While descending to various depths the diver needs to be able to transition out of the vertical position. Once the diver has reached their desired diving depth it is best for a 0^{o} to be maintained. While ascending to various depths the diver needs to be able to transition out of the horizontal position and back to the vertical position prior to exiting the water.

1.1.3 Function: Allows Diver to Reach Controls with Hands

To ensure accessible controls of the device for all users, the radial distance of any controls will not exceed 672mm from the diver's shoulder blade. This distance was determined by looking up the average distance from the shoulder blade to fingertips for the 5^{th} percentile of women [*Open Design Lab*]. By using this distance, the device will satisfy the largest number of potential users.

1.1.4 Function: Prevents Interference with Obstacles

To ensure the diver will prevent interference with obstacles, a perimeter around the diver will be assigned. Inside this perimeter a diver will be able to prevent any contact with foreign objects that may surround them. The device will enable the diver to control the location of all body parts and dive equipment within this perimeter. We scaled the 95th percentile of men's shoulder width by a factor of 1.5 to give an additional protection range to account dive equipment. The shoulder width was chosen because it is the widest part of a person.

1.1.5 Function: Decreases Drag

To be certain that drag will decrease while using this device, the Equation 1 for drag force was utilized [*Drag Coefficient]*.

Equation 1 $$F_d = \frac{1}{2} * cd * \rho * V2 * A.$$

The A in Equation 1 represents the area that affects the drag force. To determine if the decrease in drag force will satisfy the goal of decreasing the drag on the diver the area of a forward swimming diver, at desired depth will be observed.

To decrease the overall drag force, the frontal area of the paraplegic diver needs to be considered. When a diver is diving in the vertical position, they are allowing a higher water resistance, therefore increasing the drag. Allowing a paraplegic to dive at a horizontal orientation at the desired depth, the water resistance will be much lower, thus decreasing drag.

For a diver that is vertical in the water, the height and width of the diver was used to determine the area. While a diver is in the horizontal position, the shoulder width will be used as the diameter of a circle to account for any dive equipment to calculate the proper area.

1.1.6 Function: Operates Under Various Water Pressure

The maximum depth that an advance certified diver can swim up to is 39.6 meters [*OSHA*]. To calculate the external pressure at that depth, one must consider the atmospheric pressure and the hydrostatic pressure [*NOAA*]. The atmospheric pressure, which is the pressure exerted by the Earth's atmosphere, is 101.35 kPa (kilopascals) at sea level. Hydrostatic pressure, which is the pressure exerted by the surrounding water, increases by 3.07 kPa (kilopascals) for every 0.305 meter traveled under water. The absolute pressure, or total pressure, is calculated by summing the atmospheric pressure and hydrostatic pressure together [*OSHA*]. This calculation can be made by using Equation 2.

Equation 2 $$P_{absolute} = 101.35(kPa) + d * 3.07(kPa)$$

Equation 2 was used to determine the maximum external pressure that the device must be able to withstand. That pressure is 222.92 kPa. This is the absolute pressure at a depth of 39.6 meters.