An Evolution of Hypoxia Recognition and Mitigation Training for Naval Aviators: From Hypobaric to Normobaric

EXHIBIT FACT SHEET

Hypoxia, or oxygen deprivation as a result of high altitude flying, can cause rapid loss of mental, physical, and psychomotor abilities by the pilot and crew. Such symptoms have been—and continue to be—a costly problem for the U.S. Navy. While the Navy is actively seeking methods to reduce the probability of an aviator experiencing hypoxia through technical advances to aircraft systems, historical data from the last decade highlight that hypoxia episodes are increasing and account for the majority of annual physiological-based hazard reports.

Due to the potentially catastrophic outcomes of these episodes, training continues to be a necessary part of the solution. Current Navy curriculum uses several approaches to training including annual, biennial, and quadrennial classroom-based and experiential training through the Dynamic Hypoxia Training (DHT), hypobaric chamber or normobaric training devices. While historical data supports the effectiveness of existing training solutions, on-going efforts are focusing on leveraging state-of-the-art technology to increase training effectiveness, reduce logistical requirements, and increase the availability of training through increased portability.

Hypobaric Chamber Training

Hypobaric training provides a dynamic training opportunity within a pressurized chamber, allowing students to experience the symptoms of acute altitude-induced hypoxia. During this exposure, trainees are asked to participate in activities that allow for the recognition of the cognitive impairment associated with hypoxia. While effective for demonstrating the symptomology associated with hypoxia, the system lacks the fidelity for higher level cognitive tasks and decision-making that would be required by an aviator.

Despite the success of this training for naval aviators, the technology lacks realism, poses safety risks to students and instructors (e.g., decompression sickness), requires time delays between exposures and, due to obsolescence, is increasingly difficult and expensive to maintain. These challenges offer opportunities for novel training technologies to advance the state-of-the-practice for hypoxia training.

Normobaric Hypoxia Training (NHT)

Currently, Normobaric Hypoxia Training (NHT) involves the use of a Reduced Oxygen Breathing Device (ROBD) to induce hypoxia at sea level. With an oxygen mask to deliver breathing air, the ROBD device adjusts the concentration of medical grade air and nitrogen from compressed gas tanks to replicate altitude to induce hypoxia. The design of the ROBD enables hypoxia awareness and mitigation strategies to be trained while the student interacts with a simulated flight environment, which greatly improves the fidelity of hypoxia training beyond the hypobaric chamber.

While hypoxia training using the ROBD represents advancement in training fidelity, there remains room for improvement. The ROBD system remains a logistical challenge (e.g., maintenance, gas purchasing) and limits the portability and feasibility of delivering training in high fidelity simulator environments. Additionally, the lack of pressure in the mask can cause air hunger resulting in students falsely identifying hypoxia symptoms.

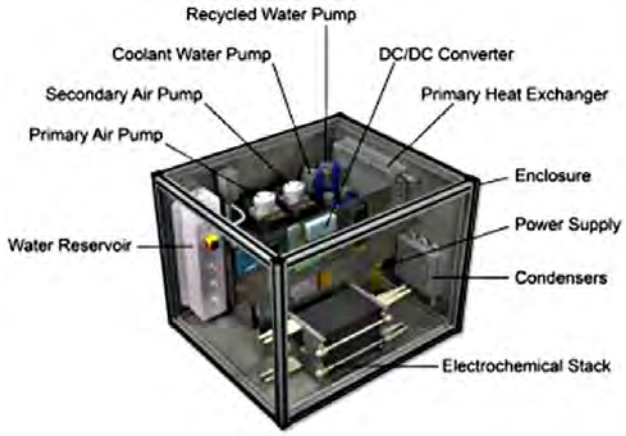
Next Generation Normobaric Hypoxia Training

In response to these challenges, researchers at the Naval Air Warfare Center Training Systems Division (NAWCTSD) and training officers at the Naval Safety Training Institute (NSTI) are leveraging small business research programs to identify novel training solutions.

In FY2013, a topic was released through the Small Business Innovative Research program that sought proposals for developing a tankless, portable hypoxia breathing device. Several promising approaches were identified including:

- Cyclical Fluid Exchange Process
- Electrochemical Oxygen Separator
- Modern Gas Separation/Filtration Technology

As a result of this effort, a prototype system is under development to deliver a compact, portable, pressure on-demand hypoxia training device. The increased portability of the system will support training in a wider variety of flight simulator environments. Further, the design of the system—an Electrochemical Oxygen Separation (EOS) device that is based on liquid water-fed electrochemical cells that utilize a highly efficient Oxygen Evolution Reaction (OER)—should eliminate the risk of oxygen starvation.



Following the development of the prototype, the resulting devices will undergo testing to validate the solution for use in training human subjects' hypoxia recognition and mitigation. If successful, the device would reduce the cost of maintenance relative to the current training system, be small enough to be used in almost any flight simulator and be transported easily—making the training available to a greater population.

Partners

This effort incorporates technologies from several programs of research including:

- Naval Air Systems Command (NAVAIR) Program Management Office (PMA-205 AWTD)
- Naval Air Warfare Center Training Systems Division
- Navy Medicine Operational Training Center (NMOTC) Naval Survival Training Institute (NSTI)
- NAVAIR Small Business Innovative Research (SBIR) Program

For further information on this exhibit, or on business opportunities with NAWCTSD, please contact our Business Support Team by telephone at (407) 380-4903, by e-mail at orlo_businesssupportteam@navy.mil, or by mail at Business Support Team, NAWCTSD, 12211 Science Drive, Orlando, FL 32826.