

# **COMPILING A COMPREHENSIVE EVA TRAINING DATASET FOR NASA ASTRONAUTS**

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## **INTRODUCTION**

Training for a spacewalk or extravehicular activity (EVA) is considered a hazardous duty for NASA astronauts. This places astronauts at risk for decompression sickness as well as various musculoskeletal disorders from working in the spacesuit. As a result, the operational and research communities over the years have requested access to EVA training data to supplement their studies. The purpose of this paper is to document the comprehensive EVA training data set that was compiled from multiple sources by the Lifetime Surveillance of Astronaut Health (LSAH) epidemiologists to investigate musculoskeletal injuries. The EVA training dataset does not contain any medical data, rather it only documents when EVA training was performed, by whom and other details about the session.

## **METHODS**

The first activities practicing EVA maneuvers in water were performed at the Neutral Buoyancy Simulator (NBS) at the Marshall Spaceflight Center in Huntsville, Alabama. This facility opened in 1967 and was used for EVA training until the early Space Shuttle program days. Although several photographs show astronauts performing EVA training in the NBS, records detailing who performed the training and the frequency of training are unavailable. Paper training records were stored within the NBS after it was designated as a National Historic Landmark in 1985 and closed in 1997, but significant resources would be needed to identify and secure these records, and at this time LSAH has not pursued acquisition of these early training records. Training in the NBS decreased when the Johnson Space Center in Houston, Texas, opened the Weightless Environment Training Facility (WETF) in 1980. Early training records from the WETF consist of 11 hand-written dive logbooks compiled by individual workers that were digitized at the request of LSAH. The WETF was integral in the training for Space Shuttle EVAs until its closure in 1998. The Neutral Buoyancy Laboratory (NBL) at the Sonny Carter Training Facility near JSC opened in March 1997 and is the current site for US EVA training. Other space agencies also have used water to simulate weightlessness and train for EVAs. Russia has a training facility similar to the NBL named the Hydro Lab. The Hydro Lab began operations at the Gagarin Cosmonaut Training Center (GCTC) in 1980 and has been used extensively to the present. Although a majority of training in the Hydro Lab uses the Russian Orlan suit, a small number of sessions have been conducted using a NASA suit. The Japanese Weightlessness Environment Test System (WETS) went into service at the Tsukuba Space Center in 1997 but was closed in 2011 due to extensive earthquake damage. Several sessions were performed using a NASA suit, but these sessions were short and considered “development” runs.

LSAH has assembled records from the WETF, NBL and Hydro Lab. Recording of the EVA training data has changed considerably from 1967 to present. The goal of early record keeping was to track use of hardware components, and the person involved was treated as a suited operator, not as a focus of interest. Records from the past two decades are fairly precise with the person, date, suit type and size noted. On occasion the length of the session was listed, but this data is not included on all records. Records were merged from data sources and extensive cleaning of the records was required since the multiple sources frequently overlapped and duplicated records.

## **RESULTS**

To date the LSAH EVA training dataset includes over 12,500 EVA training sessions performed by NASA astronauts since 1981. The following variables are included for most records: Name, Sex, Event date, Event name, HUT type, HUT size, Facility, and Estimated run time. For a smaller subset of records, the following variables are available: Actual run time, Time inverted, and the suit components Waist bearing type, Shoulder harness, Shoulder pads, and Teflon inserts.

## **CONCLUSIONS**

The LSAH dataset is currently the most complete resource for data regarding EVA training sessions performed by NASA astronauts. However, it is not 100% complete since the WETS (Japan) and NBS (Marshall) training facility data were not included. This dataset has been compiled by LSAH to study the relationship of EVA training to musculoskeletal injuries but has many other non-medical applications. This dataset can be provided to other groups in order to respond to program and research questions with appropriate board approvals.