

Equipment from Damec Research Aps

# Keeping the astronauts in good physical shape

Long stays in space breaks down the physical shape of astronauts little by little, but physical activities will in most cases slow down the decreasing that may be caused by lack of physical activities. This is the background for developing technical instruments, and exercises to be used on-board space vehicles.

On the medical field, focusing on preparing people for long stays in space, the Danish Damec Research Aps has played an epoch-marking role. Back in the early nineties the institute was established in close connection to the medical institutions in Denmark. Through the history of Damec Research (and former Innovision), they have developed a long series of medical equipments used by human spaceflights, by both Russian, ESA and NASA astronauts. In fact, the different forms of physical activities onboard have also led to a better physical shape of the astronauts. Unlike some earlier cosmonauts that had difficulties standing upright the first hours after a long stay in space, today's astronauts are not so obviously marked by the stays. At that time, over 2 tons of Damec designed equipment was launched into orbit in the 20 years Damec has existed, not only for exercising the astronauts, but also for medical experiments.

The prime line of development is the respirator equipments. This line of work began with the Respiratory Monitoring system, (RMS), at ESA's Anorthack facility. This system used conventional mass spectrometer for analysis of inhaled and exhaled gasses. With the second generation equipment, the Respirator Monitoring system II (RMS II) the analyzer was changed to the photo acoustics multi gas analyzer. The third generation equipment called the Advanced Respirator



Monitoring (ARMS) featured two parallel photo acoustic multi gas analyzers. A fourth generation equipment has been developed for the international space station and is called Pulmonary Function System (PFS). The system utilizes two upgraded photo acoustic analyzers.

In parallel Damec has produced several bicycle ergo metres for use in space, and these have flown at Space Shuttle, Mir, and the Space Station. Damec has since early 1990 delivered Cycle ergo metres to NASA. This means that the standard Shuttle ergo meter as well as the Station CEVIS unit is delivered by Damec. During the upcoming shuttle mission the CEVIS unit will be exchanged with a new model. The current unit has had 4-5 year operational period on-orbit. The replacement unit is of the same design as the current one. These bicycles should get most credit for the astronauts' good shape, in spite of several months in weightless.

Among other developments, Damec has participated in is Experiment Specific Central Venous Equipment for Danish Scientific experiments. The company has also participated in the development of the Minus Eighty degree Freezers (MELFI) for the International Space

*ISS013-E-17265 (11 May 2006) --- Astronaut Jeffrey N. Williams, Expedition 13 NASA space station science officer and flight engineer, exercises on the Cycle Ergometer with Vibration Isolation System (CEVIS) in the Destiny laboratory of the International Space Station.*

*Photo credit: NASA/ DAMEC Research*



*JSC2004-E-55618  
(21 December 2004)  
--- Astronaut John L.  
Phillips, Expedition  
11 flight engineer and  
NASA ISS science officer,  
participates in Human  
Research Facility (HRF)  
Pulmonary Function  
System (PFS) training in  
the International Space  
Station (ISS) Destiny  
laboratory mockup/trainer  
at Johnson Space Center's  
Space Vehicle Mockup  
Facility. Photo credit:  
NASA/DAMEC Research*

Station, and is currently working on the Cryogenic Freezer, also for the Space Station. For the ESA built MELFI equipment, Damec designed and delivered the trays and various operational tools in the MELFI consortium led by ASTRIUM as main contractor. Damec was also involved in the crew procedure and training preparation for the MELFI use, and the Damec USOC will be involved in the ESA operation of the MELFI in the future on-orbit operation.

Currently Damec continues the development of on-orbit medical instruments in form of the Portable PFS (PPFS). This development will lead to versatile portable equipment that can be used in all parts of the Station. PPFS will become a very useful tool for ESA sciences as well as a standard Crew Health Check. PPFS is expected to be uploaded to Station in the 2007-2008 timeframe.

### Astronaut selection and medical training.

The expertise on medical facilities for astronauts has been further developed through Damec's participation in the selection and medical evaluation of the Danish astronaut candidates in 1991. Furthermore, Damec has conducted the medical examination of the North European candidates after that.

For preparing the astronauts for launch on the D-2 mission Damec supported ESA on the launch/landing activities for mid-deck, white room and pad activities, as well as crew training and crew instrumentation before flight. Damec has also built up experience in astronaut training onboard for



*S114-E-6989 (4 August 2005) --- Astronaut Soichi Noguchi,  
STS-114 mission specialist representing Japan Aerospace  
Exploration Agency (JAXA), floats in the Destiny laboratory of the  
International Space Station. PFS is shown in the top of the rack  
on the right. Photo credit: NASA*

the Spacelab D-2, Euromir-95 and STS 107 mission. The training included introduction to the hardware and concept, nominal procedures and operations and off nominal training. Furthermore DAMEC was responsible for manufacturing of different training equipment and accessories for mid-deck and Spacelab training.

### Support Center for Space Station

## The Danish USOC for medicinal support

Damec established in 1993 an operational User Support and Operations Centre (USOC) during the involvement in the D2-spacelab and the Euromir-95 missions. Here four astronauts from ESA and Russia were supported in all aspects of the Respiratory Monitoring System II (RMS-II) facility, including introduction to the hardware and concept, nominal procedures and operations, and off-nominal training.

The support activities have been performed since 1993, and the centre has been selected by ESA as a Facility Support Centre (FSC) for support to payload operations for ESA's Pulmonary Function System for the International Space Station. The FSC is equipped with a communication room with infrastructure for audio and video conferences and monitoring mission/payload operation. A separate room for the PFS ground model is available for payload preparation etc.

Damec has additionally performed operational support to both ESA Principal Investigator (PI) and Danish PPI's for the Euromir-95 mission through its telecommunication centre, which operated as a Facility Responsible Centre (FRC) for a payload onboard. In preparation for the mission, Damec developed procedures, experiment software and performed pre- and post flight BDC-sessions. During the mission, Damec provided operational support, trouble shooting, and quick-lock analysis of data and repair procedures.

The Damec USCO has now been operational since the "PFS commissioning" October 2005. PFS has been checked-out a couple of times since then and is ready for scientific experiments during the upcoming "Astrolab" mission. During Astrolab PFS will be used for various ESA experiments. One main activity is to use PFS for "Oxygen Uptake Measurements" (OUM) on the ESA astronaut every month he is on-board. These experiments are the first step to make OUM a standard Crew health test to be performed on all astronauts.

Since October 2005 Damec also has supported On-orbit operation in connection with "NOA" instrument. Until today 34 experiments have been conducted on-orbit. The NOA instrument is based on a commercial instrument from Aerocrine AB, Sweden, called "Niox Mino". The commercial instrument was converted into a flight qualified unit by Damec in the 2004-2005 timeframe.