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DEVELOPMENT OF THE ESA SUBJECT LOADING SYSTEM (SLS) FOR THE NASA SECOND GENERATION TREADMILL T2 ON THE ISS

Abstract

The International Space Station provides a major platform for long-term experiments in Human Physiology under microgravity conditions. In this context, the ISS crewmembers not only represent scientific test subjects for human physiology studies, but for general health and fitness reasons they also have to take adequate countermeasures to compensate the negative effects of weightlessness. Treadmill exercising is believed to be a suitable countermeasure candidate with benefits for both muscles and bones of the lower limbs. A Subject Loading System (SLS) is required to restrain a running astronaut to the treadmill's surface with a force that gives a feeling comparable to what a runner experiences on earth.

Whereas the current available Subject Loading Systems typically consist of bungee or mechanical spring loaded systems (in which the load force is significantly variable with the vertical displacement during the running motion), the ESA developed SLS is based on a pneumatical spring system including a sufficiently large buffer to minimize the force changes resulting from vertical displacement. The advantages of such a system are twofold:

- By adjusting the pressure in the system, the load force on the astronaut can be adapted to his weight
- By correctly sizing the buffer, the load force change with the vertical displacement can be minimized.

Both these effects allow to give the astronaut the same running feeling as if he was running on earth under gravity conditions.

With 6 astronauts in the ISS and the rather heavy training program imposed on them, the SLS has to be able to survive a large number of running cycles making the life time requirements very challenging (together with safety requirements as a failure in the system is not allowed to include a potential risk on crew injuries).

The flight model of the SLS is to be integrated in orbit into the Second generation Treadmill rack (T2), developed by NASA and currently installed in Node 3 of the ISS. The SLS is foreseen to be launched in the second half of 2011.

QinetiQ Space, under ESA contract, has developed and qualified the different SLS models (Qualification, Flight and 2 training models) under very challenging schedule constraints. Furthermore, a prototype of the SLS has flown on the Parabolic Flight Campaign in May 2010. The objective of this paper is to describe the design of the SLS system and show how it works in micro-gravity conditions as verified during the parabolic flight campaign.