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The recent in-flight failure of the treadmill is likely to recur unless some drastic changes are made in the current treadmill management. As a protection to the crew and a means of adoiding the ensuing public flail, a proven ready-to-go alternative exercise would seem desirable. The following is such an alternative which has been studied and demonstrated in-flight and which can meet any level of cardiorespiratory demand and which will meet most of the musculoskeletal requirements. It could also be used alone where a treadmill is not available and as the safe haven exercise.

Background: Early in the Shuttle Program, it was questionable when the treadmill would fly and an alternative was sought. I proposed and investigated jogging-in-place as an alternative and it was successfully demonstrated on Spacelab-2 (see photo). Subsequently, the one-g prototype treadmill was flown on Spacelab-3 and some 8 subsequent missions with difficulty until replaced by the present unit.

Rationale: Locomotion in place (i.e., walking, jogging, running without forward motion) generates vertical forces equivalent to normal over ground locomotion. Since vertical forces are the major forces in locomotion, the required muscle activity and resulting cardiovascular loads closely approximate normal locomotor activity.[1]

Individual foot-ground force and cardiovascular load are a function of mode (walk or run), step-rate and in jogging/running maximum level of knee elevation (as a simple measure). In weightlessness, these loads will also

[1]This is accepted by anyone well versed in exercise theory.

depend directly upon equivalent body weight (i.e., the force applied by a harness-bungee arrangement).

Studies, hardware, and demonstration: It is a trivial matter to demonstrate that work loads of any level can be reach with this exercise by simply walking, jogging, and running-in-place at increasing step-rate and lifting of knee level while recording or counting pulse. Such an experience will demonstrate this exercise's major disadvantage--boredom; however, any motivated person can continue it for an hour or more. The second question of how closely the exercise simulates the forces of locomotion was answered by setting-up a vertical force platform in the dynamics lab at the Johnson Space Center and making a series of comparisons of forces from normal locomotion versus locomotion in place. Two typical examples are shown in Figure___ and ___.

The exercise was demonstrated in-flight on STS-2. The treadmill harness was loaded by a set of 4 bungees attached to Brownline fittings mounted on normal middeck seat studs. It worked as planned.

Proposed implementation: The simplest case, as on the last flight, is to attach the harness and walk/job on the treadmill without belt movement. The treads should be capable of sustaining such usage for a typical flight. In order to insure that levels equivalent to Earth can be reached, the bungee forces must approximate body weight.[2] The simplest way to insure this is to fly a simple mechanical scale for equivalent weight.

A preferred alternative is that shown in Figure ___. Four simple bungees, covering the range of Brownline stud attachments, would be flown with a

[2]This is also tru of the treadmill.

treadmill harness. The force/length characteristics of the bungees would be known and by adjusting the treadmill harness strap attachment length and measuring bungee length the body equivalent weight (BEW) can be obtained from a look-up table.

Proper operation would consist of a warm walk, jog, or run at reduced BEW and then exercising at Earth BEW. The actual work level could be monitored by counting pulse rate or more desirably, by any of the available electronic rate monitors.

A table of step-rates and estimated knee lift heights would be available to provide rough guides to exercise level.

Such an arrangement could be flown for a weight of less than 10 pounds and half a locker. This exercise has been extensively used on Earth, including long use as a recommended exercise in the Canadian Armed Forces exercise program. It is all physiologically and biomechanically sound. Should there by any interest in this, I will be happy to provide additional details.

[3]I built such a scale, which was successfully used on STS-35, also taken by Life Sciences support contractor and has not been subsequently heard from.