

To: S. Musgrave 1

Comments on Bicycle Ergometer in Zero G flights

The clips and buckles and belts on the restraint harness as well as many shows a relatively low level of attention from Marshall - i.e. they were surprisingly crude lash ups.

From observing you on the ergometer -

Waist restraint only - a great deal of inefficient extraneous and inefficient motion was obvious when pedalling using the handle bars as additional restraint. Without holding the handle bars pedalling ^{appeared} ~~seemed~~ virtually impossible, except as an ext

Waist restraint + horizontal cross tie - same as waist restraint only

Waist restraint + cross tie + shoulder harness - improvement in apparent efficiency but pedalling at these loads

produced a ~~severe~~ ^{large} rearward horizontal force which was not well handled by the restraint system. At this point it was obvious that use of this device under Zero G plus the additional stress of the Zero G maneuvers imposed a very large metabolic load.

All restraints ^{except feet}, plus moving the seat forward - movement of the body ^{long axis} into the line of the leg forces obviously improved efficiency but a great large amount of necessary friction appeared necessary.

Upper body + foot restraints + seat forward. The foot restraints appeared to provide a great increase in effectiveness. This increase could arise from several factors such as improving the side to side

stability since ~~not~~ very little was provided by the narrow base of attachment of the restraints ~~on~~ ~~pass~~ and possibly there was improvement through ability to apply forces throughout ~~the~~ to the pedals in other than one direction. With all the restraints in place it appeared possible to pedal the device although there is a question in my mind as to whether it can be maintained at reasonable rates for 20-30 mins.

From riding the ergometer:

Without any restraint - by leaning over the handle bars i.e. placing the counter force of the arms in the same axis as leg forces the device could be pedalled ~~at~~ although 5 off at low efficiency -

Waist belt only - pedalling was possible but required a good deal of auxiliary arm support via handle bars -

Waist belt + cross tie - as above -

During these runs the legs tired very rapidly and ~~fatigue was set~~ ^{stage} and only a few minutes at most could have been maintained - the fatigue was primarily quadriceps f. and although standing during the pull outs added fatigue this seemed to be limited to the anterior compartment of the lower legs.

All restraints except feet - the shoulder straps sided here and it was possible to pedal more efficiently but hands off pedalling ^{possible though really} was ^{not} practical. At this time I began to rest on the seat ^{to avoid leg forces} during pull ups but the upper legs continued to fatigue rapidly.

All restraints including feet - foot and shoulder restraints a large increase in effectiveness was afforded by the foot restraints but ~~the~~ it felt that a great deal more effort was being required than one would expect to perform 300 watts work - suspect the inertia of the machine is ~~too~~ too low (will calculate) + the best of the

present ^{tried} probably do
 1 restraint systems, ~~may~~ not allow 1 G
 efficiencies. The upper legs were thoroughly
 fatigued at 30 seconds.

All restraints & the shoulder straps were
 crossed in front. This crossing of shoulder
 straps provided a slight improvement probably
 through increasing lateral support.

It was interesting to note the increased
 cardiac output / blood flow during the exercise
 for there was marked flushing of the face
 during exercise ~~as the~~ as compared to
 resting during 'Zero G'. This plus decreased
 venous return gave me a feeling of ^{cephalic} pressure
 as compared to normal 'Zero G' parabolas.