BIOL 4931G.04
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COUNTER MEASURES

I. Philosophy

A. Adaptation and recovery

1. Advantages
   a. Increased time on orbit
   b. Decreased hardware
   c. Source of study subjects

2. Disadvantages - general
   a. Potentially dangerous for pilot or escape situation
   b. Crew 'feels' better with exercise
   c. Looks bad
   d. Requires extensive recovery and rehabilitation support

3. Not practical on Shuttle

B. Partial vs. complete (artificial g) counter measures

1. Artificial g
   a. Provides total body protection
   b. Costly,complex, not currently practical
   c. Produces carolis effects
   d. Still requires exercise time and equipment
   e. Crew cannot 'escape' effects

C. Specific counter measures (forces and pressures)

1. Not well understood

2. Requires design expertise

3. More difficult to use

4. Has many limitations

5. Is available now at relatively low cost, weight

6. Appears to be adequate for all missions to date

D. Drugs, electrical stimulation, etc.

1. Drugs have specific, limited actions and side effects

2. Cannot specifically stimulate electrically - thunderbolt effect

3. Muscle stimulation is painful

E. Myths and misunderstandings

1. Partial G - will produce partial counter measure

2. Short radius centrifuge - distorted load distribution (G-gradient)

3. Sleep in short radius centrifuge - equivalent to sleeping while standing plus G gradient

II. Artificial gravity - linear acceleration and gravity are indistinguishable

A. Centrifugal forces: Force (G's)= $\frac{v^2}{32.2R}$

B. Coriolis forces

1. Human effects
2. Human adaptation (rotating rooms)

C. Practical considerations - large radius

1. Radius arm
   a. size
   b. gradient

2. Total spacecraft rotation vs. stabilized section
   a. transfer

3. Design assets/complications

4. Operational assets/complications

D. Practical considerations, short radius

1. Size and gradient

2. Stopping/starting/running

3. Mechanical interfaces

III. Specific counter measures (physics, physiology and biomechanics)

A. Fluid shift and loss

1. Redistribution is a pressure phenomenon
   a. Tissue pressure may be altered by external pressure, positive or negative
   b. A variety of methods may be used to apply positive pressures
      i. elastic sheets
      ii. fluid or gas filled surrounds
      iii. fabrics under tension
   c. Negative pressure can only be applied by reduced ambient gas pressure
   d. Venous pressure may be increased by occlusive pressure

2. Fluid replacement is currently done orally

B. Hardware examples

1. Lower Body Negative Pressure (LBNP)
   a. Fixed chamber
   b. Pneumatic
   c. Pressure gradient

2. Positive pressure garments
   a. Bladder
   b. Capstan

3. Occlusive cuffs

C. Orthostasis

1. Mechanisms
   a. Inadequate fluid available
   b. Excess loss from blood stream
   c. Possible reflex control problems

D. Fluid replacement on orbit

1. Fluid 'loading' is limited on orbit

2. Salt can temporarily expand fluid volume

E. Potential counter measures (physiology)

1. Load fluids pre-entry
2. Shift fluids pre-entry and replace
3. Use counter pressure to elevate blood pressure
4. Use counter pressure to control blood pressure
5. Exercise reflexes prior to entry

F. U.S. program

1. load fluids pre-entry
2. Anti-G suit

G. USSR program

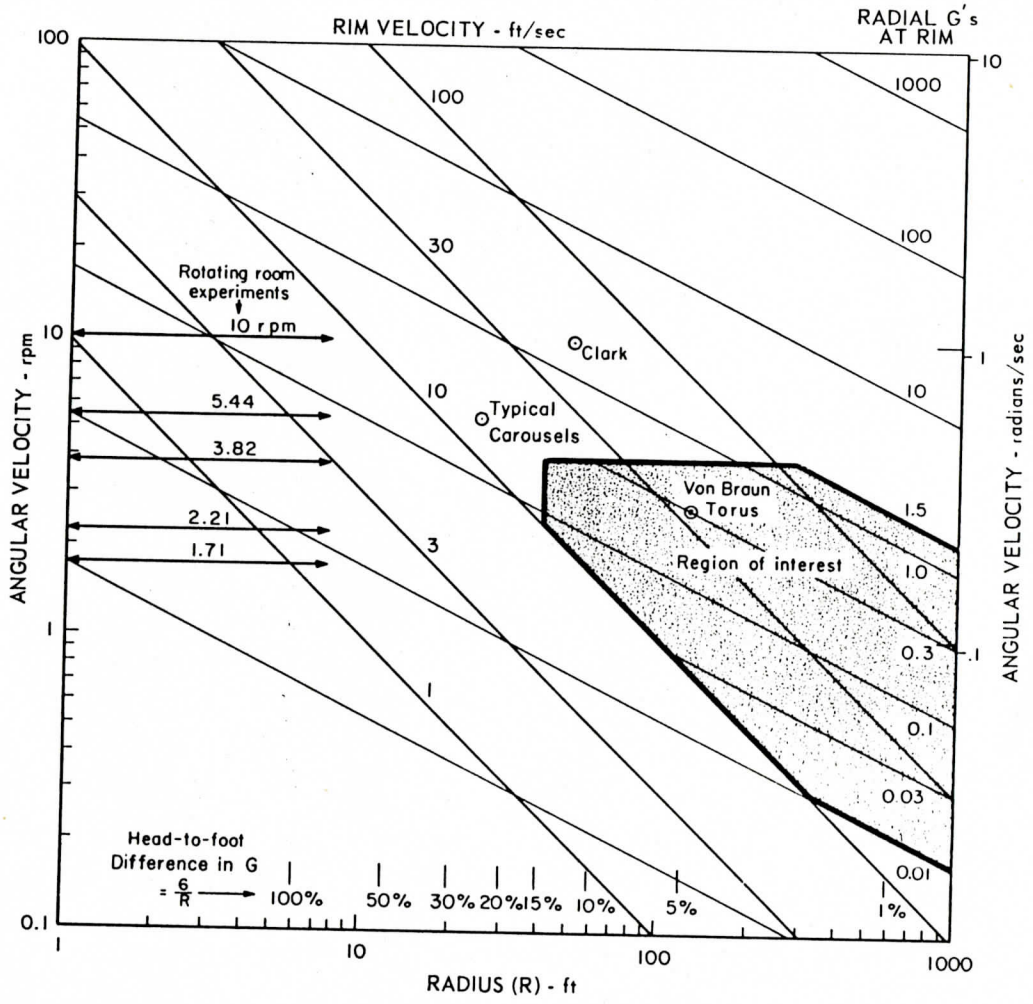
1. Exercise reflexes by LBNP
2. Load fluids
3. Crew are not erect

H. Improved program

1. Load and shift fluids quantitatively pre flight
2. Use multipurpose suit to:
   a. Trap fluid
   b. Control rate of shift
   c. function as counter pressure suit
3. Continue to administer fluid

19-14. ROTATION EFFECTS ON SPACE VEHICLE DESIGN – I.

From: BioAstroNautics Data Book Vol. 1



In the figure are presented results of a study which estimated general limits for the various parameters describing a rotating space station on interplanetary probe.

Maximum G level was set at 1.5 to avoid incurring unnecessary fatigue or loss of agility during body movements. Accelerations of 0.01 G and higher will orient liquids against capillary forces, and remove suspended solids from the atmosphere; that value was thus taken as the minimum useful G level.

Minimum rim velocity was set at 10 ft/sec, three or four times walking speed, so that the increase in centrifugal acceleration when walking in the direction of rotation, and the decrease when walking against it, would be less than 50%. The ratio of Coriolis to centrifugal acceleration when attempting to move a limb radially is also an inverse function of rim velocity, so that the 10 ft/sec limit represents both factors.

The head to foot difference in G's was set more or less arbitrarily at 15%, with a note that more information is needed.

Source: Dole [1].