NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS 77058

REPLY TO
ATTN OF: DF

February 5, 1975

MEMORANDUM

TO: DA/Director of Life Sciences

FROM: DF/William E. Thornton

SUBJECT: Status of Mass Measurement Review

A somewhat dilatory review of mass measurement requirements was undertaken by me and is now gaining momentum. Its purpose was to:

a. Identify as many as possible of the mass measurement requirements for Shuttle and beyond.

b. Investigate the existing hardware and methodology.

c. Perform any simple feasibility demonstrations of hardware required and prepare a report and recommendations.

The following are descriptions of the above three items.

a. It was originally intended to poll all potential users of mass measurement, in-house, domestic and foreign, but in informal discussions with local people, they have viewed such a poll as a futile effort. I should like to submit a simple questionnaire to at least all NASA agencies but request guidance on this.

b. A "paper" review of mass measurement technique has been performed and a list of candidate techniques nominated. These include, in addition to the Skylab SMMD and BMMD,:

(1) A small spring mass oscillator developed by Ames[1] for small animal and small animal organ work. Although they have a prototype apparently they[2] feel a good deal of development remains to be done.

[1] M. S. Gardener. et al, a mass measuring device for use with biological specimens in zero gravity, Medical and Biological Engineering, V. 7, pp. 601-606, 1969.
[2] Personal conversation with Dr. Gardner in January 1975.

(2) An air bearing spring mass oscillator that should cover the range of a few milligrams to a few grams that I took to a feasibility prototype at SAM. I hope to get this tested in the next few months (see item c.(1)(a)).

(3) An inertia balance--This is similar to a scale with known versus unknown masses which will be accelerated; a small version was test flown in the T-38 in zero-G and a larger modified version is under construction for further testing (see item c.(2)(b)).

(4) An electronic inertia balance--A known mass is mounted on a strain element and the force it develops under acceleration will be compared to that of the unknown mass under the same acceleration attached to a second element. Electronic circuitry will compare the forces and calculate and display the unknown mass' magnitude.

(5) A manual centrifuge for measuring liquids or other homogenous materials of known CM. This is completely mechanical (see item c. (2)(a)).

(6) A mechanical,translational "balance wheel" spring mass oscillator for micro-work.

c. Work that is underway or planned to demonstrate feasibility include:

(1) A time and materials contract for $20K to S.W.R.I. is in process to provide technical and test support for the following items.

(a) Performance testing of the small air bearing spring-mass oscillator. I will provide a working air bearing-oscillator and crossing detector which must be interfaced with standard laboratory counters and the like.

(b) Layout a feasibility model of the electronic inertia balance--to conserve funds it is planned to do the construction at JSC.

(c) Provide analysis and support for other aspects of this investigation.

(2) In addition, work has been requested by the mechanical engineering group here on:

(a) Repair and improvement of a manual centrifugal mass measurement device for liquids with a large gas liquid interface. I have a prototype that was built out of pocket during flight

school as an alternative to the ill-fated urine volume measurement but could arouse no interest in spite of simplicity and excellent performance.

(b) Layout and construction of an inertial mass balance for human use. This device may require one or more test/design iterations and the first will be a pendulum modification suggested by Hadjik/Huber.

After tests, including zero-G aircraft parabolas, of the devices and reduction and analysis of the data, a report with recommendations and design details will be given to JSC, DE, and any other appropriate agency. It is hoped that this can be accomplished in six to nine months.

W. E. Thornton

William E. Thornton

cc:
DF/J. P. Kerwin

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