AMBB

Development of Mass Measuring Devies for Flight Test

AMR (Colonel A. G. Swan)

1. Local work on a method of measurement of mass under conditions of weightlessness has demonstrated the following: A spring mass pendulum has been shown to have accuracies of greater than ± .005 percent for fixed mass measurements; and indications are that measurements of such items as food, urine, and fecal material will be made to an accuracy of ± .01 percent or better. A man-carrying version of this system is currently demonstrating maximum errors of ± .25 percent, and this figure is being steadily reduced with continuing work. These results are obtained with devices which may be translated into flight hardware without loss of accuracy. In order to logically continue, it is necessary to obtain experience with the system under conditions of weightlessness as soon as possible. With this in mind, the following program is being implemented. In addition, NASA is apparently planning to let a contract for development of such a device for use on a version of the extended Apollo for metabolic balance studies. If possible, it would be desirable to combine our efforts in this area, hopefully, to the extent of our doing the technical development work which NASA currently plans to contract.

2.0 Proposed program for development of prototypes of a spring mass pendulum for testing under conditions of weightlessness: The purpose of this program is the development, constructions, and testing of a small device which will determine the mass of standard weights, food materials, urine, fecal material, and other substances in the range of zero to one-half kilogram. It is currently planned to construct four self-contained "scales" which will occupy a total volume of approximately .2 cubic foot. The first of these "scales" will be used as a prototype to be flown for a total test period of 12 minutes under conditions of weightlessness using the Wright-Patterson flights. Following this, three additional versions suitable for flight use on the extended Apollo missions will be completed, One of these units will be subjected to flight qualification tests. The final two versions will be used for flight tests on the Apollo training missions.

2.1. Current development plans are: Overall technical direction of the program would be under my guidance. Southwest Research Institute will be given a contract to do the detailed design work, oversee and test the construction, do any necessary quality control, make arrangements for interface and flight qualification testing, and in general provide day-to-day detailed control of the program. This organization has already shown itself very well qualified to handle this problem and have demonstrated considerable capability in this given area in the work they have performed for us. The major construction problems may be broken into mechanical and electronic areas. The electronics system will be assembled by Southwest Research from components which are standard off-the-shelf flight tested items which may be assembled as building blocks or as large subassemblies. It is currently planned for the Air Force to buy these items and supply them to Southwest Research for final assembly and test. Mechanical components of the unit will be built in the instrument shop of the School of Aviation Medicine. They have considerable experience in this area and have demonstrated adequate capability. Captain Scoffield, the director of the flights at Wright-Patterson, has been contacted; and he felt that it would be possible to obtain the necessary testing time within the next three months. Another major portion of the program will be flight qualification to NASA specifications. It is currently planned to allow a qualified testing organization such as Wiley Research Labs in Los Angeles to perform this on a sub-contract basis. It is also anticipated that North American Aviation will require an interface study and this, of course, will be handled by North American. Dr. Dietlein of NASA has verbally indicated that it should be possible to fly a "scale" by the first of next year on Apollo missions. This necessary work for formal commitment is in progress. A tentative schedule with major milestones indicated is enclosed.

2.2 Costs. Primarily for the purposes of funding, the program has been divided into two phases. The first will be completion and test of the prototype which will be flown at Wright-Patterson. This will commence with the signing of a contract and end in August 1966. The second phase will be construction and qualification tests of three flight qualified versions. This will include interface studies and should begin 1 July and end in December 1966. The cost figures are broken down on this basis.

Phase I

BOA Contractor

Electronics	
Labor	$11,000
Material	$ 5,000
Mechanical	
Labor	$ 7,000
Material	$ 500
Quality Control	$ 6,000
Documentation	$ 6,000
Miscellaneous including reporting and travel	$ 2,000
TOTAL	$33,000

Procurement by Brooks AFB (?)

Mechanical	
Bar stocks, springs, fasteners, metal components, exclusions, etc.	$ 1,000
Electrical	
Logic modules - 20 each	$ 800
Pulse amplifiers	$ 100
Optical unit mounted	$ 250
Batteries	$ 100
Readout assembly	$ 425
Oscillator	$ 125
Miscellaneous including potting material	$ 125
TOTAL	$ 1,900

SAM instrument shop time - two man months.

Phase II

Design Contractor

Mechanical	
Labor including phone, travel, reports	$15,000
Electrical	
Labor including phone, travel, reports	$25,000
Quality control - reliability and documentation	
Labor including phone, travel, and reports	$52,000
Procurement of Components (?)	
Mechanical	$ 3,750
Electrical	$ 5,700
Flight Qualification testing by Commercial Lab	$20,000
Interface Study by North American Aviation	$10,000

SAM instrument shop time - six man months.

3. It is obvious that the major cost of the program is maintenace of the NASA quality control. We are assuming strict adherence to all phases of this, but if this is relaxed at any point, there may be a major reduction in cost, particularly during the second phase. The first prototype will not adhere rigidly to these procedures but will be designed such that the three later versions can easily meet the specifications without major redesign. Performance should be identical on all units.

4. If the first phase contract can be let immediately, the second phase would be ready to begin at the start of FY67. Since the successful completion of this contract would result in flight-ready hardware for the MOL mission with the tremendous advantage of flight experience behind it, it is hoped that this can be adequately funded. The results obtained will have obvious carryover into any "man-sized" version that we use for the measurement of masses of MOL crew members. With intelligent design, for example, the entire electronic package that would be used here could be used without modification on the "man-sized" version of

a mass measuring device. In addition, development work in Phase I which is currently aimed at elimination of the air bearing, and its attendant complexities would yield a great simplification in any man-carrying version.

WILLIAM E. THORNTON, Captain, MC, USAF
Office of Director for Crew Test & Evaluation

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Tentative Schedule