PROJECT DOCUMENT COVER SHEET

DEFINITIVE EXPERIMENT PLAN

METABOLIC COST

OF INFLIGHT TASKS

REPORT NUMBER	DATE
DB-38-66-M050	December 2, 1966

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REVISIONS					CHG. LETTER
DATE	PREPARED BY	APPROVALS			
		BRANCH	DIVISION	PROGRAM OFFICE	

DB-38-66-M050
REPORT NUMBER

C FORM [illegible] JUL 66)

12 JAN 1968
A3-602-3310-1-CL-6190

Subject: F04695-67-C-0029, MOL DDP CONTRACT
MASS MEASUREMENT EQUIPMENT STUDY
(RFQ 029-0267)

Through: Air Force Plant Representative Office
Attn: CMRXKK-MOL/Mr. C. Cavors, Jr.
Douglas Aircraft Company
Huntington Beach, California

To: Department of the Air Force
Manned Orbiting Laboratory, Systems Program Office (OSAF)
Attn: SAFSL-12D/Mr. L. T. Atkins
Air Force Unit Post Office
Los Angeles, California 90045

Reference: Air Force Letter SAFSL-12D, dated 6 December 1967;
Subject: Same as above (Log 4552)

1. In accordance with request of reference letter, Contractor submits herewith twenty (20) copies of a fixed price incentive proposal [to] perform a Mass Measurement Equipment Study. This proposal consists of [t]wo (2) parts as follows:

Attachment I - Cost/Price Proposal

Attachment II - Proposal Statement of Work

2. The contract price shall be adjusted to reflect an increase [in] target cost of $92,108, an increase in target profit of $11,392, an [in]crease in target price of $103,500, and an increase in ceiling price of [...],250. The target cost variation (CV) set forth in Section 1.2.1 of the [Inc]entive Plan shall be increased by $4,600.

3. The contract modification issued to incorporate subject [stu]dy into the contract should also incorporate the attached AFSC/AFSC [For]m 9 and DD Form 1423 into the contract.

4. It should be noted that the proposed effort is over and [ab]ove the content of the January 1968 Baseline Program and therefore is [be]yond current funding limitations.

C. E. Humphrey, Manager
Contract Administration &
Data Management
Program Control
MOL Sub-division

PJD:dmn
Enclosures: Attachments I and
II as noted (U)

A. Title: METABOLIC COST OF INFLIGHT TASKS

B. Objective: The objective of the experiment is twofold:

1. To determine if man's metabolic effectiveness in doing mechanical work is progressively altered by exposure to the space environment.

2. To determine the metabolic cost of operational activities when man is deprived of the benefits of earth gravity as compared to the cost on earth.

C. Description:

1. Experimental approach and procedures.

The metabolic rate of the crewmembers will be measured during 4 experimental conditions: rest, bicycle ergometry, transport and assembly of modular units, and maintenance tasks. (Note: Either or both of the latter two tasks may be part of another experiment or an operational procedure.)

Each crewmember's resting and exercising (bicycle ergometry) metabolic rate will be measured 5 times during the mission on days 7, 12, 17, 22, and 26. The crewmembers are to be non-suited.

The metabolic rate of each crewmember will be measured during a modular assembly task 8 times during the mission, as will the metabolic rate during maintenance tasks. Both tasks will be done in the same experimental period by each crewmember. Four of these experimental periods are to be in a suited (pressurized) condition and 4 in a non-suited condition, with the alternate mode occurring

during successive experimental periods. The time of the experimental periods for these tasks are days 9, 10, 14, 15, 19, 20, 24, and 25. If it is decided to use operational tasks or tasks of other experiments, these days will be changed accordingly. However, it is required that they adequately represent different portions of the mission. The attached table summarizes the experimental periods and times.

In order to evaluate the effect of zero-G on the above tasks, baseline experiments will be performed, duplicating the number and types of mission experimental periods and tasks. These baseline studies will also serve as training periods.

2. Experiment equipment description.

a. Equipment for measuring metabolic rate: At the present time it is planned to measure metabolic rate with a second generation M019 gas meter. This version will measure the following parameters: Inspired volume, expired volume, sample temperature, and percent of CO_2 expired. From these it will be possible to calculate R.Q., oxygen consumption, and energy expenditure. However, evaluation of the M019 meter is still in progress and, should the results of these tests prove the present concept inadequate for measurement of metabolic rate during the proposed experimental conditions, one of several alternative systems currently under development will be substituted.

b. Equipment for pre-determined workloads: For obtaining a calibrated workload, a bicycle ergometer using electronic resistance loading will be used. This unit will be similar in concept and design to the current laboratory model.

c. Equipment for specific tasks: If it becomes necessary to measure metabolic rate during tasks other than those that are

operational or part of another experiment, two types of equipment will be needed. For work tasks involving the transportation and assembly of large modular units, a package weighing approximately 40 pounds with storage dimensions of 5' X 5' X 1' is proposed. This would consist of 2 cylindrical units which would be connected end to end after assembly. For measuring metabolic rate during specific maintenance tasks, a 30-pound package 4' X 3' X $2\frac{1}{2}$' is proposed.

d. Prelaunch techniques: The metabolic rate measuring device and the bicycle ergometer will require testing and calibration prior to launch. If possible, the flight hardware should be used during the final preflight crew training session. Any equipment needed for specific work tasks will not need to be calibrated.

e. Operational requirements:

(1) Crew-oriented requirements.

(a) Preflight: For crew training and obtaining baseline values of resting metabolic rate and metabolic rate during bicycle ergometry, 5 one-hour periods are planned at F-90, F-60, F-30, F-15, and F-5 for each crewmember. The test at F-90 will be conducted in the Metabolic Laboratory, MSC. The tests at F-60 and F-30 are to be conducted in a suitable mockup at MSC. The final two training sessions should be done at KSC. The training for specific work tasks is to be comprised of 4 morning-afternoon periods at F-85, F-55, F-30, and F-10. Two of these sessions will be non-suited and two will be suited (3.7 psia). One of

the suited sessions should also be underwater training. At F-15 and F-7, exercise capacity tests will be given each crewmember. These can be done either at MSC or KSC.

(b) Inflight: Five times during the flight, on days 7, 12, 17, 22, and 26, each crewmember's metabolic rate will be determined during resting and exercising (bicycle ergometry) conditions. One of the remaining crewmembers will be required to act as an observer during each subject's test. Prior to the start of each resting metabolic rate determination, the subject's vital capacity and expiration reserve will be measured using the volume portion of the gas meter. To obtain a resting metabolic rate, the subject will be restrained in a seated position on the bicycle ergometer . After 5 minutes of complete relaxation during which baseline ECG, respiration, and body temperature are recorded, the subject will breathe into the gas meter for 5 minutes. The observer will then analyze a portion of the expired gases and record the results.

Immediately after completion of the above analyses, the subject will begin a 15-minute exercise period. During the first 5 minutes the ergometer will be set at a load 25% of the subject's maximum capacity (determined in ground studies), at 50% during the second 5 minutes, and at 75% during the last 5 minutes. Also, during the last 5 minutes the subject will breathe into the gas meter. The collected gas will then be analyzed by the observer as during the rest

period. The above procedure will be repeated for each crewmember.

Eight times during the flight, on days 9, 10, 14, 15, 19, 20, 24, and 25, each crewmember's metabolic rate will be determined during 2 operational-type procedures (modular assembly and maintenance). Half of the tasks will be performed suited (3.7 psia) and half non-suited (alternating). Each task will be performed for a 30-minute period.

Additional time has been allowed for experiment preparation and any unforeseen difficulties.

(c) Postflight: At R+12 and R+24 hours after splashdown, each crewmember will be given an exercise capacity test. In addition, if there were any significant changes in metabolic performance during the course of the mission, these changes will be followed until baseline levels are reached.

(2) Flight operational requirements.

There are no special operational requirements other than that the spacecraft be in a drifting mode during the experimental periods.

f. Data requirements: All data will be recorded on the EDS. This includes physiological data of heart rate, respiration, and body temperature, as well as digital output from the gas analyzer.

g. Proposed suit modifications: The suited tasks will require a special helmet which must have provision for an inspiratory and expiratory gas hose connections. These hoses will run from the subject's face mask, through the helmet, and connect with the gas meter. Additional gas meter connections will be made to the suit-PLSS hoses.

M050 EXPERIMENTAL PROTOCOL

Participant		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Total Hours
Resting Metabolism *	A							15					15					15					15				15			
	B							15					15					15					15				15			
	C							15					15					15					15				15			
Exercising Metabolism *	A							30					30					30					30				30			
	B							30					30					30					30				30			
	C							30					30					30					30				30			
Metabolism During Suited Modular Assembly & Maintenance Tasks *	A									60					60					60				60					
	B									60					60					60				60					
	C									60					60					60				60					
Metabolism During Non-Suited Modular Assembly & Maintenance Tasks *	A										45					45					45				45				
	B										45					45					45				45				
	C										45					45					45				45				
Total Minutes: Participants								135		180	135		135		180	135		135		180	135		135		180	135	135			32.25
Observers								135		180	135		135		180	135		135		180	135		135		180	135	135			32.25
Contingencies								60		60	60		60		60	60		60		60	60		60		60	60	60			13.00
TOTAL HOURS								5.5		7.0	5.5		5.5		7.0	5.5		5.5		7.0	5.5		5.5		7.0	5.5	5.5			77.50

* Equal time is to be allotted for Participant and Observer during each experimental period.