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INTEGRATED ULTRASONIC PULSED DOPPLER SYSTEM FOR MEASUREMENT OF BLOOD FLOW. J. A. Rooney and R. C. Heyser. Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109.

INTRODUCTION. A noninvasive method is needed for measurement of blood flow during STS operations. Methods. An ultrasonic pulsed Doppler unit operating at 5MHz was modified to be self contained and battery powered. It was integrated and interfaced to a data display and storage system. The ultrasonic transducer assembly was redesigned so that it could be easily positioned during operation. An interface to the data storage was developed so that postflight analysis of the data was possible. Results. The ultrasonic Doppler signal has been recorded both as a function of time for a given range and as a function of range for a given position over a blood vessel. Analysis of these data permit the determination of blood vessel dimensions and range as well as blood velocity profiles. Blood flow can be determined by combining the dimensional and velocity data. Conclusions. A self-contained pre-flight prototype system for the measurement of blood flow is being developed based on results obtained to date with integrated ultrasonic-pulsed Doppler modules.

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AN IMPEDANCE DEVICE FOR STUDY OF MULTISEGMENT HEMODYNAMIC CHANGES DURING ORTHOSTATIC STRESS. L. D. Montgomery, H. M. Hanish, and J. T. Webb. SRI International, Menlo Park, CA, 94025.

INTRODUCTION. Definition of blood flow and volume changes in multiple segments of the body is necessary for a more complete understanding of the physiologic responses to various orthostatic stress techniques. METHODS. A self-contained impedance device was designed and fabricated which will permit quantitative values of blood flow (ml/min or ml/100ml of body tissue/min) and volume (ml or ml/100ml of body tissue) to be obtained from six segments of the human during head-up tilt, antiorthostatic bed rest, lower body negative pressure, or acceleration stress tests. RESULTS. The device consists of a body-worn module that contains the electronics for the impedance system and a separate controller/power source. This instrument is linear over a range of 0 to 200 ohms; provides analog outputs of base impedance (Z_o), phase angle (Θ), pulsatile impedance changes (ΔZ), and the first derivative of the pulsatile impedance changes ($\Delta Z/\Delta T$); and utilizes a constant current source of 0.4 mA at 50 KHz. Typical results are presented which illustrate its application in aerospace research. CONCLUSION. This device provides useful information for the study of orthostatic stress and evaluation of proposed countermeasures. An instrument based upon this impedance device could be used to quantify the fluid redistribution that takes place in the body during exposure to microgravity.

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ACQUISITION AND STORAGE OF BIOMEDICAL DATA DURING PROLONGED SPACE FLIGHT, H.M. Hanish, R.K. Dickey, J. T. Webb, L.D. Montgomery, UFI, Morro Bay, CA 93442.

INTRODUCTION: Many biomedical experiments do not require the immediacy afforded by real time data telemetry. Data from these experiments may be stored in numerical form, permitting detailed analysis after the mission. Such a data storage device must: Retain data without power; store data with an accuracy and resolution dictated by the experiment; easily interface directly with most computers to simplify data reduction and analysis; lock in a traceable time line; be easy and simple to use; be highly portable; be easily adaptable to all types of data acquisition tasks. METHODS: A portable data logger (PDL 1000) has been designed, constructed, and certified for space flight. This instrument uses a 1 Mbit bubble memory under CMOS microprocessor and software control. The device requires only two operating controls--an ON/OFF switch and a push button which initiates automatic data logging. A front panel LCD display monitors time, data, battery voltage and other operational function. RESULTS: The PDL 1000 is presently configured to record data on fluid shifts during orthostatic stress. It automatically logs a complete measurement cycle each 20 seconds. Each cycle consists of time (M,D,H,Min), Subject ID#, 12 data points, 4 calibrations (all to 4½ digit accuracy), and 2 battery voltages. The non-volatile bubble memory can hold approx. 1800 such data frames or over 20 hours of actual research data. Stored information is transferrable to any computer having an RS 232 port. CONCLUSION: A flexible new instrument has been developed which facilitates remote data acquisition and storage.

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A HEART RATE INTEGRATED SYSTEM FOR THE ASSESSMENT OF PHYSIOLOGICAL STATUS IN THE SPACE ENVIRONMENT. E. Shvartz. Rockwell International, Space Transportation and Systems Div., Downey, CA 90241.

A heart rate integrated system is presented which enables to assess and predict the physiological status of the crew in intravehicular activity (IVA) and extravehicular activity (EVA). The system is based on continuous monitoring of heart rate (HR) during the awaking hours, and a consideration of individualized percent change in HR from a resting condition (%ΔHR). Several equations were developed, based on an extensive literature review, showing that: Tolerance time (TT) can be predicted, at any point in time, during work in a wide range of work load, climatic, and clothing conditions; the degree of body cooling desired in EVA (to remove metabolic heat) can be set by %ΔHR, and the magnitude of the zero G-induced cardiovascular deconditioning can be estimated (relative to 1 G standards) at any time during which HR is monitored inflight. Such information can be used to predict TT in normal and emergency EVA, and in conditions of heat stress in IVA; to improve thermoregulation in EVA, and to estimate the magnitude of cardiovascular deconditioning and the quantity and type of exercise needed as a countermeasure during each day of flight.

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A METHOD TO PREDICT METABOLIC WORK BASED ON MEASURED SPACE SUIT JOINT MECHANICAL WORK. B. W. Webbon. SRI International, Menlo Park, CA, 94025. H. C. Vykukal. NASA-Ames, Moffet Field, CA 94035.

INTRODUCTION. A method of quantitatively measuring the flexure force vs angle characteristics of individual pressure suit mobility joints has been developed. These data are useful as one means of comparing various joint designs. They can also be used to predict the total metabolic work for different space-suited work scenarios. METHODS. Bench tests of suit joints are performed to determine the flexure force (torque) as a function of flexure angle for various suit pressures and angular rates. The equation, energy expenditure rate = constant X angular rate X torque, is used to calculate the instantaneous mechanical energy required to flex the joint. These values are then summed over the flexure cycle to produce the total mechanical energy for the proscribed joint motion. RESULTS. Typical data show that the energy required to flex the space shuttle suit's shoulder joint increases by nearly 70% as the suit pressure is increased from 4 to 8 psig. Under the same test conditions more advanced joints require significantly less energy at 4 psig and this increases by less than 20% at 8 psig. If the average metabolic efficiency is known from separate exercise experiments, then the metabolic work is given by: metabolic work per flexure cycle = mechanical work/metabolic efficiency. Isometric work against the "springback" of some joints requires careful consideration. CONCLUSIONS. Data from suit joint tests can be used to predict the metabolic work required of a crewman using the method outlined. The data required are joint torque versus angle at various pressures and angular rates and the metabolic work efficiency for the exercise under consideration.

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DEVELOPMENT OF A SAMPLING STRIP FOR AIRBORNE PARTICULATES IN ORBITER AIR. K. Gaiser, J. Dardano, and D. Pierson. NASA Johnson Space Center, Houston, TX 77058.

INTRODUCTION. Inflight monitoring of the Orbiter's air allows evaluation of the environmental control system in maintaining a safe crew environment. The presence of high concentrations of particulates may produce irritation of the mucous membranes of the eyes and upper respiratory tract. Extended exposure may result in conjunctivitis and respiratory tract infections. Previous studies demonstrated that the levels of airborne microorganisms increase progressively during the course of a mission. METHODS. A Biotest RCS air sampler with a modified sample strip was used to collect airborne particulates from both the middeck and flight deck of the Orbiter. Samples were collected on days 0, 2, and 6 of the mission. Quantitation and identification of collected particulates were achieved by a combination of both light microscopy and scanning electron microscopy. RESULTS. Levels of airborne particulates increased about two-fold during the mission. The increase in nonviable particulates paralleled the increases in bacteria and fungi levels observed during the same sampling intervals. Paint chips, hair, threads, food, and table salt were among the sample particulates identified. CONCLUSIONS. The particulates generated during mission activities steadily increased as the mission progresses. The microgravity conditions prevent the "settling out" of particulates, and the environmental control system does not effectively remove particulates of this size range.