VIBRATION

A

1

Ackerman, E. 1952 CELLULAR FRAGILITIES AND RESONANCES OBSERVED BY MEANS OF SONIC VIBRATIONS.
Journal of Cellular and Comparative Physiology, 39(2):167-190, April 1952.

ABSTRACT: Vibrating plate transducers have been developed which have sufficient sonic output to produce cellular destruction from 200 cps to 20,000 cps. These are convenient to use because their frequency can be varied and their sonic output measured.

Using this equipment we find that cellular destruction obeys the equation:
$\log N/N_0 = KVt$
Where:
N_0 = the original cell concentration;
N = the cell concentration after exposure to the sonic field;
V = a number proportional to the space average of the peak velocity of the diaphragm;
t = the time of exposure; and
K = the breakdown constant.

It is found for all cells that K is independent of frequency throughout most of the audible range. Although the absolute value of the breakdown constant, K, has no significance, the relative value for various cells is interpreted as a measure of mechanical fragility. Values of K, based on K = 1 for human r.b.c., range from 0.01 to 16. The values do not depend on the size along; they are a quantitative measure of the mechanical fragility.

Paramecium species and Blepharisma have characteristic frequency ranges in which they are much more sensitive to the effects of the sonic field. Differential counts on mixtures of two species show that these are true cellular resonances and not due to errors in measurement of the sonic ouput. Experiments on a Blepharisma species with and without its pellicle show that the pellicle is not the seat of the resonance. They also show that the pellicle reduces the mechanical fragility by a factor of two.

The cellular resonances can be interpreted in terms of two cell models. One model considers the cell to lack rigidity, but to be surrounded by a membrane with an interfacial tension. This leads to values of 3 to 10 dynes/cm for the interfacial tension. The second model, that of a cell surrounded by a rigid shell, leads to a coefficient of rigidity of about 10^4 dynes /cm^2. Since both the values are plausible the evaluations of these constants are not inclusive. Moreover, overtones predicted by the theories are not yet found.

2

Ackerman, E., J.J. Reid, H. Kinsloe & H.W. Frings 1953 BIOLOGICAL EFFECTS OF HIGH-INTENSITY SOUND WAVES. (Wright Air Development Ctr., Air Research and Development Command, Wright-Patterson AFB, Ohio) WADC TR 53-82, Jan. 1953. ASTIA AD 26848

ABSTRACT: Studies on the effects of high frequency and high intensity sounds on bacteria and living animals and cells carried out by the departments of Physics, Bacteriology, and Zoology and Entomology are described and critically discussed.

3

Ackerman, E., A. Anthony, R. L. Berger, A. J. Campanella, P. A. Danner, R. W. Farwell, H. W. Frings, F. Oda, L. Tu 1957 SOUND ABSORPTION AT THE SURFACES OF SMALL LABORATORY ANIMALS. (Wright Air Development Division, Wright-Patterson AFB, Ohio) WADD TR 57-461; ASTIA AD-130 946.

ABSTRACT: This report describes the theory, equipment and experimental results of the measurement of the acoustic absorption coefficients for the surfaces of rats, guinea pigs, and haired and hairless mice. These coefficients were measured at The Pennsylvania State University by various methods in the frequency band from one to twenty kilocycles per second. All experiments showed that the absorption coefficients rise between six and twenty kc. Those for the haired animals approach ed 100%. Hairless mice, on the other hand, had lower absorption coefficients. These were still appreciably higher than corresponding absorption coefficients for humans. The data for haired rats are consistently higher but in reasonable agreement with those obtained by others. The acoustic absorption coefficients for both haired and hairless animals in a randomly oriented sound field appear to be due at least in part to the excitation of surface waves.

4

Ackerman, E. & Fujio Oda 1962 ACOUSTIC ABSORPTION COEFFICIENTS OF HUMAN BODY SURFACES (Pennsylvania State U., University Park) Contract AF33(616)-27770, MRL-TDR-62-36 April 1962 ASTIA AD 283 387.

ABSTRACT: Reverberation chamber decay times were measured with and without human body surfaces exposed to the sound field. From these measurements acoustic absorption coefficients were computed for human body surfaces. These were all small compared to similar coefficients for laboratory animals. Typica values for the absorption coefficients measured for human body surfaces were in the range of 1 to 2 percent. Little variation was found from 1 to 20 kc. Measurements were not made outside of these limits. The results are discussed and compared with other values obtained by different methods. (Author)

5

Ades, H.W., H.Davis, D.H. Eldredge, H.E. von Gierke, et al. 1953
BENOX REPORT: AN EXPLORATORY STUDY OF THE BIOLOGICAL EFFECTS OF NOISE.
(The University of Chicago) 1 December 1953. ASTIA AD 24685

ABSTRACT: The BENOX group was organized to make a survey of existing information, to conduct preliminary experiments, and to make recommendations as to the course of action to be followed in order that men can continue to perform effectively in situations where intensity levels of noise are very high. Noise levels to which men are now routinely exposed are great enough to produce temporary hearing losses and, if exposures are repeated frequently over a period of weeks or months, to produce permanent damage to the inner ear. Evidence of physiological effects other than loss of auditory acuity has not been clearly demonstrated although excessive fatigue occasional nausea, and loss of libido are common complaints of men working in noise. The use of ear defenders to prevent excessive stimulation of the central nervous system by way of the auditory and, perhaps, vestibular end-organs should provide partial protection, at least, from these more general stress reactions which appear to be taking place.

6

Ades, H.W., A. Graybiel, S.N. Morrill, G.C. Tolhurst and J.I. Niven
NYSTAGMUS ELICITED BY HIGH INTENSITY SOUND.
(U.S. Naval School of Aviation Medicine, Pensacola, Fla.)
Proj. No. NM 13 01 99, Report No. 6, 15 Feb. 1957. ASTIA AD 138 472.

ABSTRACT: In order to study some of the extra-auditory effects of loud noise, deaf subjects were stimulated by high intensity sound, both pure tone of several frequencies and wide band noise. In those showing positive response to vestibular stimulation in one or more standard tests, nystagmus was regular consequence when the noise was of a sufficiently high intensity. Curves are shown, comprising the thresholds at six frequencies of pure tone and for the noise of a jet engine. Dizziness and apparent movement in the visual field were in some cases regular concomitants of nystagmus, in others, less consistent.

7

Ades, H. W. et al 1958 NON-AUDITORY EFFECTS OF HIGH INTENSITY SOUND STIMULATION ON DEAF HUMAN SUBJECTS
J. of Aviation Medicine 29(6):454-467, June 1958

ABSTRACT: Deaf human subjects were exposed to pure tone and wide-band noise at sound pressure levels up to 170 db. Subjective responses reported include vibration, tickle, warmth, pain, and dizziness with some descriptive variants of each. Thresholds for each type of sensation have been determined for several subjects at each test frequency. The most sensitive frequency range for all the aforementioned sensations is that of from 200 to 1000 cps.

Noise of sufficiently high intensity is found to induce nystagmus in subjects having appreciable residual labyrinthine function. Thresholds of nystagmus in serveral subjects have been determined at each test frequency, and frequency-intensity curves for this phenomenon are shown; lowest thresholds (120 to 130 db.) are found in the frequency range of from 200 to 500 cps. Subjective reports related to the nystagmus include feelings of dizziness and observation of apparent movement when instructed to fixate on a luminous vertical line. Hemorrhage of the tympanic membrane is a further consequence of high level noise exposure; the susceptibility to this damage varies individ-

8

Ades, H.W., A Graybiel, et al. 1958 NON-AUDITORY EFFECTS OF HIGH INTENSITY SOUND STIMULATION ON DEAF HUMAN SUBJECTS
(Naval School of Aviation Medicine, Pensacola, Florida) Project No. NM 13 01 99, Rept. No. 5; ASTIA AD-208 011.

ABSTRACT: Noise of sufficiently high intensity (such as that produced by jet engines) is known to affect sensory systems other than the auditory. It is suspected that in some instances this may have adverse effects on various aspects of neural and neuromuscular function. It is necessary that these non-auditory effects of noise be studied systematically. Since it is not feasible to expose normal subjects to high intensity noise to the extent required by such a study, because of the danger of hearing loss, deaf subjects were employed as they have nothing to lose, acoustically speaking.

Several types of subjective responses were reported by deaf subjects exposed to pure tone and wide-band noise at SPL's up to 170 db. These include vibration, tickle, warmth and pain, with some descriptive variants of each. Thresholds for each type of sensation have been determined for several subjects, at each of the test frequencies. In general, when these thresholds are plotted as frequency-intensity curves, it is noted the most sensitive frequency range is from 200-1000 cps, the threshold rising rapidly at successively higher frequencies above 1000 cps, and, in some cases, rising slightly below 200 cps.

Objectively, noise of sufficiently high intensity is found to induce nystagmus in subjects having appreciable residual labyrinthine function. Thresholds of nystagmus have been determined for several subjects at each test frequency, and frequency intensity curves for this phenomenon are shown. The lowest thresholds (120-130 db) are found in the frequency range 200-500 cps, rising rapidly above 500 cps. Subjective reports related to the nystagmus include feelings of dizziness and observation of apparent movement when instructed to fixate on a luminous vertical line.

Incomplete data indicate that damage to the tympanic membrane is a further consequence of high levels of noise exposure, and the degree of this damage varies from one individual to another.

9

Adey, W.R., J.D. French, R.T. Kado, D.F. Lindsley, D.O. Walter et al. 1961 EEG RECORDS FROM CORTICAL AND DEEP BRAIN STRUCTURES DURING CENTRIFUGAL AND VIBRATIONAL ACCELERATIONS IN CATS AND MONKEYS.
IRE Transactions on Bio-Medical Electronics 8:182-188, July 1961

ABSTRACT: Electroencephalographic records have been taken from deep regions of the brains of cats and monkeys with chronically implanted electrodes during centrifugal and shaking accelerations comparable to booster forces. Histological and X-ray controls have indicated that displacement of the electrodes does not occur, and that damage to brain tissue is comparable with nonaccelerated animals. A transistorized EEG amplifier suitable for recording in satellite biopack environments has been developed.

In centrifuge tests, transverse accelerations up to 8 G were associated with rhythmic "arousal" patterns of slow waves in hippocampal regions of the temporal lobe during increasing or decreasing acceleration. Longitudinal accelerations between 5 and 6 G produced blackouts after 30 to 40 seconds, with flattening of EEG records, and frequently with induction of epileptic seizure activity in temporal-lobe leads. Shaking tests suggested that vibrational acceleration may be associated with the intermittent "driving" of the cerebral rhythms, in a fashion resembling photic driving, at shaking rates from 11 to 15 cps, and from 22 to 30 cps.

10

Adey, W. R., W. D. Winters, R. T. Kado and M. R. Delucchi 1963 EEG IN SIMULATED STRESSES OF SPACE FLIGHT WITH SPECIAL REFERENCE TO PROBLEMS OF VIBRATION
Electroenceph. Clin. Neurophysiol. 15:305-320, 1963

ABSTRACT: The effects of shaking on the electrical brain activity as recorded in cortical and subcortical structures of four pig-tailed macaques (Macaca nemestrina) are described.

Shaking was performed over a continuous spectrum from 5-40 c/sec, at a peak acceleration of 2 G over the greater part of the spectrum. Driving of brain rhythms at the shaking frequency was noted in the midbrain reticular formation, the nucleus centrum medianum, the visual cortex and the hippocampal system. An essentially different distribution of driving was produced by photic stimulation.

Control procedures indicated that this rhythmic driving was abolished or greatly reduced by pentobarbital anesthesia in both cortical and subcortical structures. It did not arise through sway artifacts in recording leads nor was it due to magnetic flux leakage in the vicinity of the shaking transducer.

The driving was maximal in the frequency range from 9-15 c/sec. At frequencies from 15-20 c/sec, evidence was found of driving at half the shaking frequency. The driving was frequently dissociated in simultaneous records from adjacent brain structures, and from leads in symmetric bilateral placements.

11

Adrian, E. D. 1943 DISCHARGES FROM VESTIBULAR RECEPTORS IN THE CAT. J. Physiol. (London) 101:389-407.

SUMMARY: 1. The impulses from vestibular receptors can be studied in the cat by a fine wire electrode thrust into the brain stem in the region of the vestibular nucleus. The results are in general agreement with those from cold-blooded vertebrates.

2. Discharges in single units belong to one of two main types, gravity-controlled and rotation-controlled. The former depend on the position of the head in space, the latter only on angular accelerations or decelerations. Discharges controlled by horizontal rotation and by the tilt of the head in the median plane are found near the oral border of the striae acusticae, those controlled by lateral tilt and by rotation in the transverse plane are nearer the aboral border. Responses to vibration have not been found.

12

Aerospace Industries Association & Office of Naval Research 1961 SYMPOSIUM PROCEEDINGS: STRUCTURAL DYNAMICS OF HIGH SPEED FLIGHT, LOS ANGELES, CALIFORNIA APRIL 24-26, 1961 (U.S. Office of Naval Research, Washington, D.C.) ONR ACR-62 Volume I. ASTIA AD 264 140.

ABSTRACT: These proceedings are issued in two volumes. Volume I contains the twenty-five unclassified papers. Volume II contains the five classified talks. Subjects covered are flutter and vibration, missile system dynamics, dynamic loads, high-temperature effects, and environmental vibration.

13

Aerospace Industries Association of America, Inc. 1962 SURVEY OF FACILITIES FOR SPACE ENVIRONMENT SIMULATION.
(Aerospace Industries Association of America, Inc., Aerospace Research and Testing Committee, National Standards Association, Inc., Washington, D.C.) ARTC Project No. 6-60; ATC Rept. No. ARTC-30; April 1962.

ABSTRACT: The main body of the report is separated into 11 secions including acoustic test facilities, vibration test facilities, human factors facilities, and general environmental test facilities. These sections explain the function of specific equipment for space environmental simulation. When practical a summary is given of the characteristics of the equipment. (Author)

14

Agashin, Yr. A., & V. G. Artamanova 1962 [SCIENTIFIC SESSION ON HYGIENIC SIGNIFICANCE OF VIBRATION AND CLINICAL ASPECTS OF VIBRATION SICKNESS.] Gig sanit (Moskva) 27(5):104-106, May 1962 (Russian)

ABSTRACT: A scientific session on the hygienic significance of vibration

and the clinical aspects of vibration sickness, organized by the Leningrad Sanitation Hygiene Medical Institute and the Ministry of Health RSFSR, was held from December 12 to 15, 1962, in Leningrad. More than 200 Soviet scientists, engineers, and industrial-hygiene physicians participated, and more than 50 reports were presented.

15

Aiken, E.G. 1956 COMBINED ENVIRONMENTAL STRESSES AND MANUAL DEXTERITY. (Army Med. Res. Lab., Fort Knox, Ky.) AMRL Rept. No. 225, 7 Dec. 1956. ASTIA AD 89327.

ABSTRACT: Environmental extremes of noise, illumination and temperature were found to depress significantly the motor skills involved in a simulated line maintenance task. Individual prediction for speed and accuracy of performance under stress is poor.

16

Aleksandrov, N. 1960 RETURN FROM SPACE
Sovetskaya aviatsiya P. 3; 30 August 1960

17

Andreyeve-Galanina, Y.T. 1962 THE QUESTION OF PHYSICAL-HYGIENIC EVALUATION OF PULSE OSCILLATIONS. Gigiyeniya i sanit. (Moscow) 67-71 (Joint Publications Research Service, Washington, D.C.) JPRS-14974, 27 Aug. 1962.

ABSTRACT: The study of physical-hygienic evaluation of pulse oscillations in the human organism is discussed. The most important factors in such studies is the establishment of indices which do not cause pathologic changes in the organism and their quantitative expression. For the accomplishment of this taks, it is necessary on the widest scale to set up experimental models, primarily using sinusoidal oscillations. It is also necessary to carry out clinical studies using physiological and biochemical methods for the establishment of the early changes which cannot be detected by ordinary clinical methods The hardness, the duration, the number of shocks per second, and the amplitude of the pulse oscillations should be obtained. It is especially necessary to determine the changes of acceleration with respect to time, since this is a combined index of hardness and is the most stable index.

18

Annenskiy, F.D. 1961 [SPACE PSYCHOLOGY]
Nauka i zhizn' (2): 33-39

ABSTRACT: The article investigates the various psychological problems and stresses which future astronauts will probably have to face. Experiments with animals in the second and third Soviet space ships indicate that the body can withstand the physical stresses of space flight and weightlessness. Man may find it more difficult to orientate himself in space and time during space flight because of the lack of succession of day and night and because of the absence of an "up" or a "down" in a state of weightlessness. At first the astronaut will have difficulty in judging the duration of an occurrence. The experience of the space dogs, however, indicated that they preserved some sense of time and rapidly adjust themselves to the situation. An aiding factor here would be the "time metronome" in the brain, i.e., the regular rhythm of 12 oscillations a second in the bioelectric activity of the brain. The astronaut will not be conscious of motion, noise or (except during the active phase of the flight) vibration. Prolonged isolation of this sort can cause various psychic disturbances and halucinations. The author feels, however, that an astronaut will be assisted by the routine instrument readings and observations he will have to make. Drugs may also be used to combat tiredness or insomnia. The general conclusion is that man is sufficiently adaptable to overcome any

19

Anthony, A. & E. Ackerman 1955 EFFECTS OF NOISE ON THE BLOOD EOSINOPHIL LEVELS AND ADRENALS OF MICE.
Journal of the Acoustical Society of America, 27:1144-1149

ABSTRACT: Physiological changes are described following exposure of mice to single and intermittent noise stimulation (110 db re 0.0002 dyne/ cm^2 cm^2, 10-20 kc) for varying lengths of time. Attention is focused on the degree of adreno-cortical activation as measured by cytological changes in the adrenal gland and fall in the number of circulating eosinophils. Since the observed changes were transient, of short duration and no evidence of systemic pathology could be detected, the noise was described as not harmful. The tendency of certain investigators to regard noise as an injurious, nonspecific stress stimulus without specifying the exact nature of the noise situation does not seem justified.

20

Anthony, A., 1955 EFFECTS OF NOISE ON EOSINOPHIL LEVELS OF AUDIOGENIC-SEIZURE SUSCEPTIBLE AND SEIZURE-RESISTENT MICE.
Journal of the Acoustical Society of America, 27:1150-1153

SUMMARY: The occurrence of a diurnal rhythm in circulating eosinophil levels is described in two strains of albino mice selected on the basis of audiogenic seizure susceptibility. Daily exposure of seizure-susceptible and

seizure-resistant mice to a single short noise burst from 15-50 days of age did not abolish or alter this rhythm, provided a recovery period was allowed between the last stimulation and time of testing. A single noise stimulus was followed by a moderate eosinopenia in nonseizure-susceptible mice and a marked eosinopenia in seizure-susceptible mice in about 3 hours; with complete recovery in both cases within 24 hours. A more prolonged eosinopenia occurs with several successive noise bursts- a moderately low level (ca 250 eosinophils/ cu mm of blood) in seizure-resistant mice and to very low levels (ca 100 eosinophils/ cu mm of blood) in mice which went into 2-4 convulsions during treatment.

21

Anthony, A. 1956 USE OF LABORATORY ANIMALS IN NOISE STUDIES
Noise Control 2(2): 83,94. March 1956

ABSTRACT: It is evident that one has to consider two separate aspects when dealing with studies of noise and its effects on humans: one involves the direct effects of sound vibrations on the ear membrane or the inner-ear apparatus; the other involves the analysis of secondary changes in organs other than the ear that may result from the activation of certain endocrine glands by acoustic stimulation or trauma. The reason for choosing laboratory animals rather than humans for noise studies resolves itself simply to the need for doing controlled experiments. Interpretations of how noise affects animals gain validity to the extent that one has information on the following: (a) previous noise history of the animal, (b) description of the noise stimulus, (c) time interval between exposure and autopsy, (d) analysis of tissue changes in various organs, and (e) possible role of extraneous factors in causing these changes. These conditions are usually met by obtainong or rearing animals of known genetic background and studying noise-exposed and unexposed control animals simultaneously under controlled laboratory conditions. Since humans are ill suited as experimental subjects for basic studies of this sort, the laboratory animal will continue to be indispensible in providing us with sound approaches to the solution of many human problems

22

Anthony, A. 1956 CHANGES IN ADRENALS AND OTHER ORGANS FOLLOWING EXPOSURE OF HAIRLESS MICE TO INTENSE SOUND. J. Acoust. Soc. Amer. 28(2):270-274, Mar. 1956

ABSTRACT: The systemic effects of local abdominal and scrotal skin exposure to moderately high (150 db., 18 kc., without skin heating) and high (160-168 db., 20 kc., with skin heating) levels of air-borne sound were studied in hairless mice. Areas of the body not under study were protected from noise exposure by shielding. Examination of control mice revealed that 10 minute daily immobilization for one to three months was sufficiently stressful to cause hypertrophy of the adrenal cortex and involution of the thymus. The adrenal response was increased in immobilized mice exposed to moderately high levels of sound. The absence of gonadal damage and the occurrence of only slight changes in the hemopoietic system in both groups indicated that the animals were exposed to only mild stress stimuli. The local and systemic response to more intense sound was similar to that observed after ordinary skin burns, and was attributed to the stress of heating rather than sound. (AUTHOR)

23

Anthony, A., & E. Ackerman 1957 BIOLOGICAL EFFECTS OF NOISE IN VERTEBRATE ANIMALS (Wright Air Development Division, Wright-Patterson AFB, Ohio) WADD TR 57-647; ASTIA AD-142 078.

ABSTRACT: This report deals with the stress effects of noise on bodily functions other than hearing. It includes physiological, biochemical and behavioral effects of intense acoustic noise at low and high frequencies. Specific approaches employ ed are as follows: (1) flame spectrophotometric analyses of serum electrolytes, (2) serum ascorbic acid and blood sugar changes, (3) changes in adrenal and plasma cholesterol, (4) behavioral changes in noise exposed rats, mice and guinea pigs, (5) relationship of seizure-susceptibility to noise stimulation and (6) design and construction of a corona speaker for use in bioacoustic studies. It was demonstrated that short daily exposures to intense noise of about 132-140 db pressure levels can act as a physiological stress to which rats, mice and guinea pigs can satisfactorily adapt. These studies have also helped clarify the nature of the normal physiological defense mechanisms to excessive noise stimulation. By investigating the factors determining the severity of noise as a stress stimulus and using objective measures of the limits of endurance of animals to different types of intense noise situations, one can more intelligently cope with the problem of preventing noise from becoming a serious health menace to man.

24

Anthony, A., & E. Ackerman 1959 STRESS EFFECTS OF NOISE IN VERTEBRATE ANIMALS (Wright Air Development Division, Wright-Patterson AFB, Ohio) WADD TR 58-622, September 1959 ASTIA AD 230 976

ABSTRACT: Rats, mice and guinea pigs were exposed to noise in two frequency ranges (150-4800 cps and 2-40 kc) at a sound pressure level of 135-140 db. Exposure time was 20-40 hours per week for 2 to 9 weeks. Stress response of the animals was measured by changes in the adrenal glands and other organs. It was most severe in animals exposed for the longest time to high frequency noise.

25

Arduini, A., G. Moruzzi, & C. Terzuolo 1950 ON THE MECHANISM OF THE ELECTRICAL SILENCE FOLLOWING CEREBELLAR STIMULATION. (Paper, The American Physiological Society, Fall Meeting, Columbus, Ohio, Sept. 13-16, 1950.)

ABSTRACT: Using cats decerebrated at the intercollicular level, the anterior lobe of the cerebellum or the bulbar inhibitory reticular formation were stimulated. electrically for 30 sec. using one msec. rectangular pulses at a frequency of 280/sec. Stimuli reaching complete inhibition of decerebrate rigidity and myotatic reflexes were never followed by cessation of electrical activity in the stimulated area of the cerebellum or neighboring regions of the anterior lobe. A short lasting localized electrical silence was obtained only after cerebellar stimuli which were definitely supramaximal for the inhibition of myotatic reflexes and tonus. This effect of supramaximal stimulation was not prevented by mid-pontine transection. The hypothesis (Gualtierotti et al., J. Neurophysiol. 12:363, 1949) that cerebellar extinction following local stimulation is due to reverberating cerebello-ponto-cerebellar circuits, i.e. brain stem inhibition, is thus disproved by these experiments. (American J. Physiology 163:696, Dec. 1950)

26

Aring, C. D., & W. O. Frohring 1942 APPARATUS AND TECHNIQUE FOR MEASUREMENT OF VIBRATORY THRESHOLD AND OF VIBRATORY "ADAPTATION" CURVE. J. Lab. & Clin. Medicine 28:204-207, Nov. 1942.

ABSTRACT: An instrument for the quantitative measurement of the threshold of vibratory appreciation is described.

27

Arkad'evskii, A. A. 1962 [ON THE COMBINED EFFECT OF VIBRATION AND NOISE ON THE HUMAN BODY.] Gig Sanit. 27:25-29, Oct. 1962 (Russian) (United States Air Force, Foreign Tech. Division, Wright Patterson, Ohio) FTD-TT=63-292.

28

Armstrong, J.J.P. 1931 MECHANICAL VIBRATION. Phys. Therapeutics, 49:311-314

ABSTRACT: This paper is a report of the Committee on Mechanical Vibration Therapy and Apparatus read at the fortieth annual meeting of the American Physical Therapy Association, Chicago, October, 1931. Questionnaires were sent to 380 members and over two hundred replied. From the replies, these conclusions were drawn: (1) 116 members use vibrators and 103 do not use vibrators. (2) The vibrator is useful in examination, diagnosis, and for general tonic treatment. (3) Mechanical vibration fills an important place in the aftertreatment of fractures, in the treatment of cardiovascular diseases, and in splanchnic relaxation. It is also valuable in the treatment of conditions amendable to massage.

29

Arnould, P., & R. Blanchet 1956 L'ACTION DU BRUIT SUR LA FORMULE LEUCOCYTAIRE CHEZ LE COBAYE. (THE EFFECT OF NOISE ON THE LEUCOCYTE PICTURE IN THE GUINEA PIG). Comptes rendus de la Société de biologie (Paris) 150(11):1972-1974

ABSTRACT: Guinea pigs exposed 6 hours daily for 1 or 5 days to pure tones of 2400 or 520 c.p.s. at 100 db. showed an increase in neutrophils and eosinophils, and a decrease in lymphocytes immediately after exposure. The effect was apparently greater in animals exposed to the higher frequency.

30

Arsen'eva, M.A., V.V. Antipov et al 1961 IZMENENIIA V KROVETVORNYKH ORGANAKH MYSHEI POD VLIIANIEM POLETA NA KORABLE-SPUTNIKE (CHANGES IN THE HEMATOPOIETIC ORGANS OF MICE UNDER THE INFLUENCE OF FLIGHT IN A SPACESHIP) Iskusstvennye sputniki zemli (Moskva) 10: 82-92, 1961

ABSTRACT: The effect of space flight conditions was studied on the hematopoietic organs of 40 black S-57 strain mice and white mice sent up in the 2nd sputnik. An attempt was made to differentiate between the action of vibration, acceleration, and radiation. All animals were returned to earth in good condition. Chromosome disintegration during mitosis in the bone marrow cells was significantly increased in the experimental animals as compared to controls. The findings differed from the results of x-ray studies in that the frequency of chromosome destruction did not decrease prior to the end of the experiment and mosaicism in chromosomal changes was almost completely absent. Thirty days after the return to earth myelopoiesis increased sharply, manifested in an increased number of nyeloblasts, promyelocytes, and myelocytes. Three days after the return the number of megacaryocytes in the spleen decreased. Certain other changes noted in the hematopoietic organs are presumed to be caused by vibration and other adverse factors in flight. (Aerospace Medicine 33(11): 1395-1396, Nov. 1962)

31

Ashe, W.F. 1960 PHYSIOLOGICAL AND PATHOLOGICAL EFFECTS OF MECHANICAL VIBRATION ON ANIMALS AND MAN (National Institutes of Health, Washington, D.C.) RF Project 862, Progress Report No. 3, September 1960.

32

Ashe, W.F., E.T. Carter, G.N. Hoover, L.B. Roberts, E. Johanson, F. Brown and E.J. Largent. 1961 SOME RESPONSES OF RATS TO WHOLE BODY MECHANICAL VIBRATION: PART I. Archives of Environmental Health. 2: 369-377

ABSTRACT: Whole body vibration of unrestrained rats at comparable frequencies and amplitudes shows that the horizontal plane is less stressful than the vertical plane. In any given plane the observed and measured differences to changes in frequency and amplitude indicate that both factors play a role. Calculations indicate that the common denominator is not simply acceleration. No definite evidence of acclimatization to mechanical vibration was demonstratable in these studies.

33

Ashe, W. F. 1961 PHYSIOLOGICAL AND PATHOLOGICAL EFFECTS OF MECHANICAL VIBRATION ON ANIMALS AND MAN. (Ohio State University Research Foundation, Columbus) Progress Rept. No. 862-4; pt. 1, 1 July 60 - 31 Aug. 61. ASTIA AD-265 931

ABSTRACT: Rat Studies: Metabolic and growth responses of unrestrained rats to repeated exposures of vibration and effects of vibration on pregnant rats. Dog Studies: General responses of dogs to whole-body vibration; blood pressure responses to whole-body vibration in anesthetized dogs; and blood flow in arteries of vibrated animals. Human Studies: Human psychomotor performance during prolonged vertical vibration; oxygen consumption during human vibration exposures; respiratory frequency, tidal volume, and respiratory minute volume in human subjects exposed to vertical whole-body vibration; skin resistance (psycho-galvanic response) during whole-body vibration; body surface responses of standing male subjects subjected to vertical vibrations; occupational Raynaud's phenomena due to vibrating tools; and detection, recognition and identification of visual forms as a function of target size and whole-body vibration (ASTIA)

34

Askania-Werke AG (Berlin-Friedenau, Germany) 1956 VERTICAL FLAT SPRINGS SUSPEND OSCILLATING MASS. Design News 11:50, 1 Mar. 1956.

ABSTRACT: Four vertical flat springs and a single helical spring suspend the oscillating mass in a test instrument designed to measure and record deceleration rates of moving vehicles. Attached to the stationary base plate, the spring permits the mass to oscillate in the direction of motion. Natural frequency is approximately 5 cps. The semi-aperiodic damping unit consists of a rubber bellows which expels the air through a rubber hose and a replaceable carburetor jet.

35

Atchison, S.C. 1960 SHOCK DATA HANDLING SYSTEMS AT DAVID TAYLOR MODEL BASIN (Paper, 28th Symposium on Shock, Vibration and Associated Environments, The Departmental and Commerce Auditoriums, Washington, D.C., February 9-11, 1960) In ASTIA AD 244 857

ABSTRACT: The David Taylor Model Basin has recently revamped its methods of handling large quantities of shock data. New methods incorporate high-speed digital computer techniques and types of components which may be useful to others involved in correcting, reducing, and interpreting large quantities of transient data. Computer programs for computing the response of mechanical systems to transient inputs, e.g., shock spectra, are also available.

36

Awaji, Eniro 1944 EFFECT OF VIBRATION ON HUMAN BODY (Tokyo Imperial University JAP-TIU-ARI-RE292, May 1944

VIBRATION

B

37

Balakhovskii, I.S. & V.B. Malkin 1957 BIOLOGICAL PROBLEMS OF INTERPLANETARY FLIGHTS
(USAF Proj. Rand, Santa Monica, Calif.) Res. Memo. RM-1922, 21 June 1957. Pp. 81-86.
Original Source: Priroda 45: 15-21, Aug. 1956
German Translation in Naturwissenschaft Rundschau 10: 173-177, 1957.

38

Barykin, K. 1960 BEFORE THE LEAP INTO SPACE
Sovetskaya Rossiya P. 4; 17 May 1960.

39

Beaupeurt, J.E., 1960 HUMAN VIBRATION PROBLEMS ASSOCIATED WITH LOW ALTITUDE FLIGHT. (Paper, presented at Armed Forces-National Research Council, Committee on Hearing and Bio-Acoustics Annual Meeting, Washington, D.C., November 16, 1960)

40

Beckhardt, A.R., J.A. Harper & W.L. Alford 1950 A PRELIMINARY FLIGHT INVESTIGATION OF THE EFFECT OF SNAKING OSCILLATIONS ON THE PILOTS' OPINION OF THE FLYING QUALITIES OF A FIGHTER AIRPLANE.
(NACA, Langley Aeronautical Lab., Langley AFB, Va.) NACA RM-L50E17a, 26 Sept. 1950. ASTIA AD 88079

ABSTRACT: A preliminary flight investigation of the effect of small-constant-amplitude snaking oscillations on the pilots' opinions of the general flying qualities of a fighter airplane was made. The test airplane, which was equipped with a device for varying the damping in yaw, was a typical high-speed low-wing fighter.

The results showed that, in general, the pilots' perception of the snaking oscillation was mainly dependent on the transverse acceleration which the oscillation produced. As soon as the transverse acceleration during the snaking oscillation reached a value that the pilots could perceive, the oscillation became objectionable from the standpoint of pilot comfort. In this airplane an amplitude of $\pm$.0.02 g was not always perceptible to the pilot, but on occasion was noticed. An amplitude of $\pm$0.08g was considered very unsatisfactory for any mission that this aircraft might perform.

The effect of the snaking oscillation on the efficiency of the airplane as a gun platform and the results of a check on the present service requirements for dynamic lateral directional stability are also discussed A brief discussion of the design characteristics of the test apparatus used to vary the damping in yaw is also presented.

41

Beckman, Merl R. 1960 A CRITIQUE OF THE TECHNIQUES USED IN THE MEASUREMENT, ANALYSIS, AND SIMULATION OF MISSILE VIBRATION ENVIRONMENT
(Paper, 28th Symposium on Shock, Vibration and Associated Environments, The Departmental and Commerce Auditoriums, Washington D.C., February 9-11, 1960) Published in ASTIA AD 244 857.

ABSTRACT: The vibration qualification tests performed on missile equipment in the laboratory typically are very different from actual flight environments. Some causes may be found in the confusion that exists within the fields of vibration measurement, data analysis, and laboratory simulation. Even more important is the lack of coordination that exists between these specialties.

This paper deals primarily with the shock and vibration problem in missiles, but it would not be out of content to apply many of its conclusions to other electromechanical devices.

42

Beech Aircraft Corp. 1952 BIG PLANE TURBULENCE CAN CAUSE A FLIGHT HAZARD. (Beech Aircraft Corp.) Safety Suggestions No. 8

43

Beilin, E. A., & G. Yu. Dzhanelidze 1961 SURVEY OF WORK ON THE DYNAMIC STABILITY OF ELASTIC SYSTEMS. Prikl. Mat. Mekh. 16:635-648, 1952 (Translated by Trirogoff, K. N., & R. M. Cooper, Aerospace Corporation, El Segundo, California) Contract No. AF 04(647)-930; Report No. TDR-930 (2119)TN-2; 15 Nov. 1961

ABSTRACT: This report presents a survey of work published in the USSR on the problem of dynamic stability of elastic systems during the period 1924-1951. The paper is divided into three sections: 1) an analysis of early investigations, 2) an account of certain general theorems, and 3) a discussion of recent work (up to 1951). The problem of dynamic stability is directed to studies of the motions of elastic systems subjected to time-dependent external loads. The generalization of the Euler problem to the case of time-dependent forces is the classical prototype of these problems. The time-dependent external forces are applied in such a way that the corresponding time-independent loads, equivalent in direction and point of application, are able to induce loss of stability. (AUTHOR)

44

Bekesy, G. von. 1939 SENSATIONS OF VIBRATION. (Uber die Vibrationsemfindung) Akustich Zeit. 4: 316-334

ABSTRACT: The diffusion of mechanical vibration and the isolation of resonance in the human body are investigated. From the sensation of pressure and vibration it becomes evident that they occur through two different nerve types which have separated themselves spatially in the vicinity of the fibrous root. The frequency dependence of the vibration threshold is continously measured and it appears, through impedance measurements of the surface of the skin, that the sensation of vibration is not determined by the alternating pressure, but by the magnitude of deformation. Finally, an arrangement for the subjective measuring of vibration force is given.

frequency even smaller masses of the body were displaced in vibration.

By means of a horizontal pendulum the threshold of horizontal vibration were also investigated. At the same time the appearance of the vetebral column could be observed.

-45

Belsheim, R. O., & J. W. Young 1960 MECHANICAL IMPEDANCE AS A TOOL FOR SHOCK OR VIBRATION ANALYSIS. (Naval Research Lab., Washington, D. C.) Project Nos. NS 711-105 and NR 501-000; NRL Rept. No. 5409. ASTIA AD-234 227.

ABSTRACT: This report introduces mechanical impedance to those already familiar with classical vibration theory. The impedance term is defined and discussed in detail. The analog between mechanical and electrical systems is noted and electrical circuit theorems which are especially applicable to mechanical systems are presented. In order to provide an introduction to the impedance concept, several simple mass-spring-dashpot systems are analyzed to obtain their impedance and the results are presented graphically. Since most structures are too complicated to yield to an analytical determination of impedance, methods for experimentally measuring mechanical impedance are discussed. Applications of impedance techniques for the general analysis of some shock and vibration problems are discussed. Material throughout the report is referenced and a fairly complete bibliography is included for those who would like more detailed information. (AUTHOR)

46

Bendat, J.S., L.D. Enochson et al. 1961 THE APPLICATION OF STATISTICS TO THE FLIGHT VEHICLE VIBRATION PROBLEM. Rept. for July 60 - June 61 on Dynamic Problems in Flight Vehicles. (Wright-Patterson AFB, Ohio) ASD TR 61-123, Dec. 1961. ASTIA AD 271 913.

ABSTRACT: A critical analysis is presented of the application of statistics to flight vehicle vibration problems. Analytical engineering procedures are proposed for determining statistical properties of a single vibration record, and for establishing the over-all vibration environment from a collection of

vibration records. Jet aircraft and several categories of missiles are broken down into definite operating phases as regards their vibration environment. Simple statistical techniques are developed for reducing the amount of data to be gathered for later processing. Statistical tests are developed for testing fundamental assumptions of randomness, stationarity, and normality. Mathematical and physical distinctions are explained between different information obtained by measuring numerous important statistical parameters, such as an instantaneous amplitude probability density function, or an autocorrelation function. (Author)

47

Benox Report: 1953 AN EXPLORATORY STUDY OF THE BIOLOGICAL EFFECTS OF NOISE (University of Chicago) Contract Ncori-020, Task Order 44, ONR Project NR 144079, 1 December 1953.

48

Benton, M. 1956 DEVICES FOR DAMPING MECHANICAL VIBRATIONS. (Naval Research Laboratory, Washington, D.C.) Bibliography No. 10. ASTIA AD-119998.

ABSTRACT: This bibliography, covering the period 1924- August 1956, includes references to periodical articles and technical report literature which offer information on damping devices.

49

Berry, C.A., and H.K. Eastwood 1960 HELICOPTER PROBLEMS: NOISE, COCKPIT CONTAMINATIONS, AND DISORIENTATION. Aerospace Med. 31(3):179-190

ABSTRACT: Frequent problems noted in helicopter operations are noise, cockpit contamination and disorientation. The noise envelopes for representative helicopters are described, and the improvement in speech interference levels by acoustical design is outlined and suggested for commercial helicopters, for all are noisy. Adequate protection against temporary threshold shifts is afforded by helmets or headsets for crews, and short flight time for passengers. Carbon monoxide is a possible cockpit or cabin contaminant as the helicopters are reciprocating engine aircraft usually with poorly sealed cockpits. The evidence of high cockpit levels is missing. Various methods of evaluation of the hazard are discussed. Disorientation occurred one or more times to all instructor pilots in a helicopter school. Representative narratives describe episodes at night, in weather and under the hood. A new hazard is the possibility of convulsion after photic stimulation by the sun's rays seen through the rotor blades.

50

Besco, R. O. 1961 THE EFFECTS OF COCKPIT VERTICAL ACCELERATIONS ON A SIMPLE PILOTED TRACKING TASK.
(North American Aviation, Inc., Los Angeles, Calif.)
Contract AF 33(600) 42058, Rep. NA 61-47, April 1961.

ABSTRACT: To determine the effects of cockpit vertical acceleration on pilot performance on a single axis pitch tracking task, an experiment was performed using a dynamic flight simulator. The aerodynamic and flight control response data used were representative of the B-70 as of June, 1960, development. Four engineering test pilots performed the compensatory tracking tasks which were varied in frequency and amplitude of command signal excursions. Tests were made under the following motion conditions: no motion, motion due to aircraft response only, aircraft motion plus mild turbulent air, and aircraft motion plus heavy turbulence. Tracking errors were analyzed. (Tufts)

51

Beyer, D.H., and S.B. Sells, 1957 SELECTION AND TRAINING OF PERSONNEL FOR SPACE FLIGHT. J. Aviation Med. 28(1):1-6. See also School of Aviation Medicine, Randolph AFB, Texas, Epitome of Space Flight, Item 35

SUMMARY: The problems of selection and training of space flight crews have been reviewed with tentative proposals based upon present concepts of the characteristics of the early space craft and its probable mission. Because these proposals must be both general and tentative until they are modified by mockups and actual experience supported by research, emphasis was placed on defining problems and presenting the broad outlines of a plan rather than a blueprint. One conclusion which seems of particular interest as a consequence of this analysis is that space flight is not drastically different from most aspects of aviation which are now familiar. When engineers solve the remaining problems of development, it is expected that personnel will be available with the resources and capabilities to undertake the mission. Space flight may thus be approached as the addition of another dimension to the gradual unfolding of the sciences which have already made magnificent accomplishments in powered flight. However, it is necessary that research and interest in the human factors' aspects keep abreast of progress in engineering.

52

Biancani, E., H. Biancani & A. Dognon 1934 [ULTRASONICS AND THEIR BIOLOGICAL ACTION] Presse med. 1503-1506, 1934
See also Rev. actinol 10:161-177, 1934.

-53

Bianconi, R. & J. P. van der Meulen 1963 THE RESPONSE TO VIBRATION OF THE END ORGANS OF MAMMALIAN MUSCLE SPINDLES.
J. Neurophysiol. 26:177-190, Jan. 1963

-54

Bierman, H.R., R.M. Wilder, Jr., & H.K. Hellems 1946 THE PHYSIOLOGICAL EFFECT OF COMPRESSIVE FORCES ON THE TORSO. (Naval Medical Research Institute) Proj. X-630, Report No. 8, 19 Dec. 1946.

-55

Blake, Ralph E. and Torsten Ringstrom 1960 THE INFLUENCE OF MASS AND DAMPING ON THE RESPONSE OF EQUIPMENT TO SHOCK AND VIBRATION
(Paper, 28th Symposium on Shock, Vibration and Associated Environments, The Departmental and Commerce Auditoriums, Washington, D.C., February 9-11, 1960) Published in ASTIA AD 244 857

ABSTRACT: Much present practice in designing for shock and vibration environments is highly conservative because impedance effects have largely been neglected. Theoretical results are reported on the amount of reduction to be expected from such effects and the way in which mass, natural frequency, and damping will influence design stress.

56

Blake, R.E. 1961 APPLICATIONS OF IMPEDANCE INFORMATION.
In: Shock, Vibration and Associated Environment Bulletin No. 30
(Office of the Secretary of Defense, Washington, D.C., January 1962) pp. 29-42. ASTIA AD-273 514

ABSTRACT: Only a few applications of impedance information have yet been made to the solution of engineering problems. However, engineering research is being carried on by several groups to develop methods, apparatus, and theorems for application to some important problems in shock and vibration. The greatest current effort is on developing more effective sound and vibration isolation systems. Improvements in methods of simulation in the testing laboratory are also being studied. Ultimately, any area of shock and vibration work which deals in complicated linear systems should benefit from applications of the techniques and knowledge being developed.

57

Blanchet, R. 1956 CONTRIBUTION A L'ETUDE DU SYNDROME HUMORAL DU AU BRUIT. (CONTRIBUTION TO THE STUDY OF THE HUMORAL SYNDROME CAUSED BY NOISE). (Thesis: Faculté de médecine de Nancy) (Bar-le-Duc: Du Barrois, 1956)

ABSTRACT: Sonic vibrations transmitted by air produce, by their effect on hearing, a general body syndrome in both man and animals. Hematological changes produced in guinea pigs by two pure sounds, at an intensity of 100 decibels, consisted of neutrophilic leukocytosis and eosinophilia at a frequency of 2400 hertz, with less significant results at a frequency of 520 hertz. It appears that these changes are mediated by the autonomic nervous system and adrenal cortex which play an active role in the general adaptation syndrome. In addition, experiments concerned with noise, its nature, measurement, general physiological effects, and effects on the ear and blood composition in man and animals are reviewed.

58

Blitch, G. R., & J. Green 1961 STUDY OF THE DISSIPATION OF INTERNAL ENERGY IN A VIBRATING BEAM. (Master's Thesis, Air Force Institute of Tech., Wright-Patterson AFB, Ohio) Rept. No. GAE/Mech 61-10. ASTIA AD-269 420

ABSTRACT: Efforts were devoted to the dissipation of internal energy in a vibrating cantilever beam represented by the area of the hysteresis loop formed by the loading and unloading curves. In a cantilever beam undergoing forced transverse vibration, the phenomenon of internal damping appears as a small non-linear term in equation for the energy contained in the beam due to the deflection of the beam. The energy loss per cycle in the beam, measured by experimental techniques, is equal to the area of the hysteresis loop. The equations of the hysteresis loop contain parameters which are characteristic of the material in the beam. A detailed experimental study, based on the present analysis and design, will determine the nature and applicability of the characteristic parameters. (AUTHOR)

59

Blivaiss, B. D., L. M. Renato and P. Inna 1962 PLASMA 17-HYDROXYCORTICOSTEROIDS IN DOGS AFTER WHOLE BODY VIBRATION In Proceedings of International Congress on Hormonal Steroids, Milano, Italy, May 1962.

60

MOTION PICTURE

Boeing Company EFFECTS OF VIBRATION ON HUMAN PERFORMANCE: EXPERIMENT I-JUDGMENT OF VIBRATION. (Boeing Company, Wichita, Kans.) 10 min., 16 mm, Color, Sound

61

Boeing Airplane Company 1957 PRELIMINARY STUDY OF AIRCREW TOLERANCE TO LOW-FREQUENCY VERTICAL VIBRATION. (Boeing Airplane Co., Wichita, Kansas) Doc. No. D3-1189, Issue No. 36, 3 July 1957. ASTIA AD 155 642.

62

Boeing Aircraft Co. 1960 BOEING HUMAN VIBRATION FACILITY. (Human Factors Unit, Boeing Aircraft Co., Wichita, Kansas) D3-3301, 28 Sept. 1960.

63

Boeing Co. 1961 A COMPARISON OF SINUSOIDAL AND RANDOM VIBRATION EFFECTS ON HUMAN PERFORMANCE. Report on Research on Low Frequency Vibration Effects on Human Performance. (Boeing Co., Wichita, Kansas) Tech. Rept. No. 2, Document No. D3-3512-2, 28 July 1961. ASTIA AD 261331

ABSTRACT: Ten male subjects performed a complex task during vertical vibration in a preliminary study to compare performance with sinusoidal, constant period random amplitude, and random (aircraft turbulence) vibration. Performance on the three subtasks varied: performance on a tracking task with delayed control-display feedback was differently affected according to type of vibration; no effect was found for a tracking task without feedback delay; and response time did not change. Results were analyzed for consistent trends in vibration effects which could be correlated with mechanical and psychological definitions of vibration for evidence of a human performance transfer function for vibration. Psychological and amplitude bases for this function could not be found, vibration acceleration (g) effects were not clear, and RMS amplitude power was correlated with constancies in performance. It was suggested that testing combinations of RMS and frequency (and related factors) could lead to a performance transfer function permitting transformation of human performance data from sinusoidal to operational vibrating environments (Author)

64

Boes, Anita 1957 BIBLIOGRAPHY OF RESEARCH REPORTS AND PUBLICATIONS ISSUED BY THE BIO-ACOUSTICS BRANCH (1947-1957). (Wright Air Development Ctr., Wright-Patterson AFB, Ohio). ASTIA AD-140 501

ABSTRACT: This bibliography is a tabulation of publications considered to be of lasting interest as a result of research activities. The 164 references are listed under 12 subject headings pertaining to specific areas in physical and biological acoustics. Technical reports and notes, memorandum reports, and the more important journal publications are included. (ASTIA)

65

Boiten, G. G. 1957 ASSESSMENT OF VIBRATION NUISANCE. (BEORDELING VAN TRILLINGSHINDER). (Instituut T. N. O. Voor Werktuigkundige Constructies, Delft) Rept. No. 345, Sept. 1956 (Royal Aircraft Establishment, Library Trans. No. 695, Oct. 1957) ASTIA AD-161 427

ABSTRACT: A brief statement of methods of analysing a particular vibration spectrum or pattern into zones as a preliminary to assessing the vibrational nuisance level of a particular source of vibration. (AUTHOR)

66

Bolds, P.G. 1961 FLIGHT VIBRATION SURVEY OF JRB-52B AIRCRAFT Report for July-November 1956. (Aeronautical Systems Div., Air Force Systems Command, WPAFB, Ohio) ASD TR 61-507, July 1961. ASTIA AD 269 208

ABSTRACT: The JRB-52B aircraft was surveyed to determine the vibration environment existing throughout the vehicle under all flight condidtions expected in service. Approximately 34,000 data points were obtained from 26 separate locations on the vehicle during 7 test flights. The data obtained were evaluated to determine the adequacy of vibration test requirements for long range bomber equipment contained in MIL-E-527A. The data indicated that the vibration test requirements of that specification were satisfactory to simulate the actual environment existing on the JRB-52B aircraft. (Author)

67

Bontchkovsky, V.F. 1928 [EFFECT OF VIBRATION OF FLOOR ON THE ORGANISM OF WORKERS IN MOTOR FACTORIES] Profess. Pat. i gig (Moskva) No. 3, 65-80.

68

Booth, G.B. 1959 RANDOM MOTION TEST TECHNIQUES 1959 Proceedings of the Institute of Environmental Sciences, Pp. 81-86

69

Bouche, R.R. 1961 INSTRUMENTS AND METHODS FOR MEASURING MECHANICAL IMPEDANCE. In: Shock, Vibration and Associated Environment Bulletin No. 30 (Office of the Secretary of Defense, Washington, D.C., January 1962) pp. 18-28. ASTIA AD-273 514.

ABSTRACT: This paper describes the performance characteristics that affect the accuracy of recently developed mechanical impedance heads. The results of calibrations and evaluation tests performed on an impedance head are described. Tests on a simple structure are made to illustrate the suitability of the head for making impedance measurements.

70

Bouche, R. R. 1961 THE ABSOLUTE CALIBRATION OF PICKUPS ON A DROP-BALL SHOCK MACHINE OF THE BALLISTIC TYPE. In 1961 Proceedings of the Institute of Environmental Sciences National Meeting, April 5, 6, 7, 1961, Washington, D. C., pp. 115-122.

CONCLUSIONS: The drop-ball shock machine of the ballistic type is an inexpensive tool for use in the shock and vibration laboratory. Absolute calibrations and comparison calibrations on anvils that produce known accelerations are performed to evaluate pickups designed for shock motion measurements and other purposes. The principle advantage of the drop-ball machine over other shock machines is its capability of producing high acceleration shock motions completely free of high frequency resonances. Acceleration half-sine wave pulses as high as 15,000g and 50 micro-second duration and as low as 460g and 1.5 milliseconds duration have been obtained. It is expected lower accelerations and longer pulse durations could be obtained with larger anvils and balls and by using soft rubber padding on the anvils. However, the need for performing low acceleration shock motion calibrations is lessened since adequate sinusoidal calibration equipment can be used. Wide spread use of the drop-ball shock machine should be useful in evaluating instruments intended for shock motion measurements. It is also a useful tool for experimentally verifying the performance characteristics of acceleration pickups. (AUTHOR)

71

Bouman, H.D. 1935 THE BIOLOGICAL ACTION OF ULTRASONICS Nederland. Tijdschr Geneesk. 79:4631-4647

72

Bowain, A. 1930 VIBRATION AND VIBRATORY WAVES ON AUDITORY MEMBRANE AND TISSUES.
Arch. Intern. Laryngol. 36:769-782.

73

Bradford, R. S., R. E. Kraus, & C. J. Waters 1957 VIBRATION SIMULATION (Jet Propulsion Lab., Calif. Institute of Tech., Pasadena, Calif.) Progress Rept. No. 20-312; Contract DA 04-495-ORD-18. 15 Jan. 1957 ASTIA AD-119 152.

ABSTRACT: Two complex-wave and noise-vibration simulation systems are in operation at this Laboratory. Primarily, these systems simulate the complex-noise vibration environment to which most airborne components are subjected. Through their proper use as a tool in environmental design and research, these systems have become invaluable in increasing the reliability of all such airborne components. Each system basically consists of a programmed input, power amplifier,

vibration shake table, and system equalizer. Successful development of the first of these systems, a 5-kw system, driving a shake table of 600-lb vector force, led to the development of a much larger 40-kw system driving a 3500-lb vector-force shake table, the output acceleration of which duplicates an input-program voltage recorded on FM tape to ±3 db in the frequency band of interest and within the limits of amplifier-grid current and plate dissipation and shake-table excursion. System equalization to obtain this correspondence is provided by peak and notch filters and a graphic equalizer. (AUTHOR)

.74

Bramwell, J. C. & A. V. Hill 1922 THE VELOCITY OF THE PULSE WAVE IN MAN. Proc. Rov. Soc. 93:298-306, series B

. 75

Brennan, J.N. 1957 BIBLIOGRAPHY ON SHOCK AND SHOCK EXCITED VIBRATION. VOL. I (INTRODUCTION AND ABSTRACTS OF TECHNICAL PAPERS) (Pennsylvania State U. College of Engineering and Architecture, University Park) Technical Rept. No. 3, Contracts DA 19-129-qm-386 and DA 19-129-qm-804, September 1957. ASTIA AD 200 830

ABSTRACT: This bibliography consists of three parts. The body of the test consists of an introduction and abstracts of 1168 technical papers on subjects related to shock motion and its measurement. This is followed by Part II, which consists of 6 summaries of abstracts related to subdivisions of the field: Dynamic Behavior of Materials Under Impulsive Loads: Dynamic Behavior of Structures Under Impulsive Loads; Impact Testing Devices; Instrumentation for easuring Impulsive Forces and Motions; The Shock Spectrum Approach to Impact Problems: Mathematical Methods for Investigating Dynamic Behavior of Structures Under Impulsive Loading. The final part consists of an appendix that includes an author index, subject index and the details of the scope of the search that resulted in these abstracts. The final part consists of an appendix that includes an author index, a subject index and the details of the scope of the search that resulted in these abstracts. The abstracts are mainly of papers that have been published in technical journals and of patents. A few government reports are also included. Originally, it was planned to include abstracts of all pertinent government documents in this publication. However, it now appears desirable to publish these separately in a subsequent volume, due to the bulk of the material involved and the necessary time that will be required to process it. (Author)

76

Brennan, J. N. n.d. SHOCK AND VIBRATION. ASTIA AD 138 777.

77

Bridgland, T. F., Jr., W. A. Hijab, & W. A. Nash 1957 FINAL REPORT, AN INVESTIGATION OF GUNFIRE-INDUCED VIBRATION IN AIRCRAFT. (Air Research & Development Command, Air Force Armament Ctr., Eglin AFB, Fla.) Contract No. AF 08(616)-36; Task 2; Part I; April 1957

ABSTRACT: A summary of the results of an investigation into vibrations induced in aircraft by firing of multigun installations. Part I presents a general theoretical treatment of the problem, based on use of the so-called generalized shock spectrum and the fatigue-equivalent acceleration; and the theory and physical description of an electronic special purpose analog simulator constructed for utilization in solution of certain equations derived from the shock spectrum analysis. This simulator, in essence, analogizes a single-degree-of-freedom mass-spring-damper system, a wide range of values of the frequency and damping parameters being available for use. Part II of the report presents the theory and design as well as operation and maintenance procedures of the analog simulator described in Part I.

78

Brissenden, R. F., D. C. Cheatham, & R. A. Champine 1961 TOLERABLE LIMITS OF OSCILLATORY ACCELERATIONS DUE TO ROLLING MOTIONS EXPERIENCED BY ONE PILOT DURING AUTOMATIC-INTERCEPTOR FLIGHT TESTS. (National Aeronautics and Space Administration, Washington, D.C.) NASA TN D 810, April 1961.

ABSTRACT: A limited amount of data on the levels of oscillatory accelerations found to be tolerable and intolerable by one pilot during flight tests of a prototype automatic interceptor was presented. The data analyzed were taken from accelerations imposed at the pilot's head. The pilot was an observer only during flight with no complex task to perform. (Tufts)

79

Broadbent, D. E. 1956 EFFECTS OF NOISE. Inst. Av. Med., Farnborough). FPRC 961.1

80

Brody, A.W., D.H. Lewis and B.F. Burgess Jr. 1954 RESPONSE OF CHEST WALL, ABDOMEN AND DIAPHRAGM TO FORCED OSCILLATIONS OF VOLUME. Fed. Proc. 13:38

ABSTRACT: Previous studies tested the frequency response of the lung-thorax system to sinusoidal air pumping at the mouth by comparing airflow into the mouth with transthoracic pressure. This permits separation of the total impedance to breathing into resistive, elastic and inertial components. To test whether the chest wall, abdomen and diaphragm move together or as separate

systems, velocity pick-ups (magnet and coils) were placed on the body surface during such sinusoidal pumping. At 7-11 cycles/sec., velocity over the upper anterior chest was in phase with mouth pressure in 10 supine subjects and a maximum occurred in velocity and displacement (.11 to .24 mm at a pump stroke 14 cc). At 5-8 cps, the abdomen showed a maximal amplitude (1.3-1.9 mm at pump stroke 56 cc), and at 3.4-4.1 cps the body had a maximum head-foot displacement measured by the Dock ballistocardiograph in 6 subjects (.14 to .29 mm at pump stroke 56 cc). At 1-2 cps the anterior chest and abdominal surface moved nearly together, in phase. At higher frequencies, the surface motion of the abdomen lagged the upper chest and this lag increased caudally. Above 4 cps the lower chest also lagged the upper.

81

Brody, A.W. & A.B. DuBois 1956 DETERMINATION OF TISSUE, AIRWAY AND TOTAL RESISTANCE IN MAN.
J. Appl. Physiol. 9(2):213-218

ABSTRACT: Tissue resistance has been directly measured in a group of cats and found to vary from 1.3 to 3.3 cm H_2O/l/sec. The average value of 2.55 cm H_2O/l sec. amounted to an average of 28% of the total resistance. This agrees well with the figure of 69% for airway resistance obtained using a different method. Neither method depends on changing the viscosity or the density of the gases breathed.

82

Brody, A.W., A.B. Dubois, O.I. Nisell, and J. Engleberg. 1956 NATURAL FREQUENCY, DAMPING FACTOR, AND INERTANCE OF THE CHEST-LUNG SYSTEM IN CATS. Am. J. Physiol. 186: 142-148. July 1956

ABSTRACT: A study of the local surface velocity of the chest and abdomen as a function of the frequency of sinusoidal pressure waves introduced into the airways via the trachea, was made in 15 cats. The study confirmed and extended the observations DuBois et. al. had previously made in human beings and demonstrated that the effects seen were not produced by any part of the airway above the trachea. Comparison is made of this data with the averaged data obtained by using a plethysmograph to integrate the surface responses of the cat. The natural frequency (9.6 ± 0.6 cps), damping factor (2.0 ± 0.25), resistance (K_1 13.5 ± 2.3; K_2 76 ± 21 cm H_2O/L/ec)^2, and elastance (230 ± 26cm H_2O/L) were measured and the inertance (0.09 ± .008 cm H_2O/L/sec 2) was calculated.

83

Brooks, G. W. & S. A. Clevenson 1960 CONSIDERATION OF VIBRATION ENVIRONMENTS IN SPACE FLIGHT SYSTEMS. 1960 Proceedings of the Institute of Environmental Sciences, 81-90

84

Brown, Roy, H.M. Jacklin, S. Zand et al 1948 VEHICLE VIBRATION (Society of Automotive Engineers)

ABSTRACT: The seven discussions include criticism and complimentary comments on R.N. Janeway's "Vehicle Vibrations to Fit the Passenger."

85

Buchmann, E. 1961 SHIP VIBRATION
In 1961 Proceedings of the Institute of Environmental Sciences National Meeting, April 5, 6, 7, 1961, Washington, D. C. (Mt. Prospect, Ill.: Institute of Environmental Sciences, 1961). pp. 189-196.

ABSTRACT: Knowledge of the vibration characteristics to be expected of ships during any operation and in any sea conditions is necessary for the designer of shipboard equipment. The sources of vibration and the corresponding vibration levels are discussed for two classes of Navy ships, the 692 class destroyer and the ESSEX class carrier. (Author)

86

Buchmann, E. 1962 CRITERIA FOR HUMAN REACTION TO ENVIRONMENTAL VIBRATION ON NAVAL SHIPS. (Paper, Annual Meeting of the Institute for Environmental Sciences, Chicago, Ill., 10 April 1962) June 1962. ASTIA AD 404 834

ABSTRACT: A search of existing literature on human reactions to vibrations was made to obtain a guide for establishing norms for crews on naval ships. Such norms are recommended as a result of this study. Further research programs are outlined. This report defines levels of motions and vibrations to which crew members are exposed during surface ship operations. The levels of vibration are also compared with those for structural items and machinery. No attempt is made to evaluate all work in this field; only that considered pertinent to problems arising from shipboard vibration is included. (Author)

87

Buchmann, E. 1962 CRITERIA FOR HUMAN RE-ACTION TO ENVIRONMENTAL VIBRATION ON NAVAL SHIPS. (David Taylor Model Basin, Washington, D. C.) Rept. 1635, June 1962

88

Bugard, P.J. 1952 MESURE DES SEUILS DE SENSATION VIBRATOIRE CHEZ L'HOMME (MEASUREMENTS OF VIBRATORY SENSATION THRESHOLDS IN MAN) Journal de Physiologie (Paris), 44(2):230-233.

ABSTRACT: Human thresholds of vibrations perception were measured with the aid of a specially designed electrovibrator producing frequencies from 50 to 1,200 cycles per second and a hyperecho generator of ultrasonic vibrations. Sensitivity varied from one person to another. Threshold values changed according to body regions affected. Local anesthesia did not affect vibratory sensation thresholds. Sensations changed from a tickle (500-900 c.p.s.) to a stinging sensation (900-1,200 c.p.s.), which became quite intense(at 1,500 c.p.s.) and persisted after the stimulus had ceased. At 19,600 c.p.s. the threshold sensation was that of a velvety feeling, which changed into a prickling sensation and was finally perceived as intense heat. At very high frequencies (936,000 c.p.s.) perception was retarded for about 10 to 20 seconds and ended in a burning sensation.

89

Burger, E. J. Jr., 1960 THE EFFECTS OF VIBRATION ON THE HUMAN ORGANISM (Presented to the Seminar in Aviation Medicine, Harvard School of Public Health; Reproduced by the Guggenheim Center for Aviation Health and Safety.) April, 1960.

ABSTRACT: The need for considering vibration as a hazard was illustrated with vibration spectra of present-day and future vehicles. The fundamental physical properties of a mechanical system were outlined. Experimentally determined effects of vibration on the human organisms were examined under the headings of mechanisms of perception, physiological effects, psychological effects and organic injury. The use of impedance measurements in increasing human tolerance to vibrations was noted.

90

Burgess, J. C. 1958 VIBRATION ISOLATION OF HIGH SPEED TRACK VEHICLES (U.S. Air Force Flight Test Center, Edwards AFB, Calif.) AFFTC TR-58-19, April 1958. ASTIA AD 152 143

Summary: Track tests were conducted to develop critieria for the design of resilient slipper mounts (isolators) for high speed track vehicles. The following criteria are applicable: (1) the isolating mechanism must be designed

to operate under the action of downward as well as upward reaction forces at the slipper, and (2) the natural frequency of the isolators is fixed by the track operational requirements of (a) a 19-g dynamic load factor and (b) a ±0.25-in. maximum allowable vertical vehicle displacement. Cantilever single-leaf springs were chosen to fulfill the first of these criteria. Results indicate that track irregularities are a major cause of the severe vibration environment of the track vehicle. Resilient slipper mounts are effective in reducing the contributions of track irregularities to the vehicle vibration environment. Vibration environments at any location in the vehicle are related to the natural frequencies and inherent damping of nearby structural components. Internal damping in the vehicle structure was very high. Water brake entry provides the most severe load factors (up to 20g.). Other slipper load factors were less than 10g.

91

Burris-Meyer, H., T. W. Forbes & W. L. Woolf 1942 EFFECT OF SOUND ON MAN AND MEANS FOR PRODUCING SUCH SOUND. (Stevens Institute of Technology, Hoboken, New Jersey) Contract No. OEMsr197 Proj. 17.3-1, Nov. 9, 1942. ASTIA ATI 27 438.

ABSTRACT: This is the answer to the question of what sound as a military weapon can do to men. The breadth and scope of the investigation, and the personnel and equipment available to it, constitute an assurance that, except as hereinafter indicated, the field is exhausted.

Noise intense enough to knock a man out cannot be produced under combat conditions by any device which cannot more readily perform a more effective military task.

No non-associative sound can accomplish a tactical task until its intensity is high enough to make its spectrum of secondary importance.

Non-associative sound has tactical value as a means of interfering with communication at locations not easily reduced by conventional weapons, and as a panic breeder.

Associative sound has military value as a means of deception, and of building up or deteriorating morale.

Meaningful and non-meaningful sounds may be sueful in selection, training and indoctrination of military personnel. (ASTIA)

92

Burton, Ralph 1958 VIBRATION AND IMPACT (Reading, Mass.: Addison-Wesley Publishing Co., Inc., 1958) Lib. Cong. Card No. 58-5055

Contents:

3. Vibratory Systems Commonly Found in Machinery
4. Damping
5. Steady Forced Vibration
6. Impact
7. Nonlinear Vibration
8. Measurement: Instruments and Analogs.
9. Systems with Two Degrees of Freedom
10. Numerical Computation of Natural Frequencies for Systems with Many Degrees of Freedom.
11. Waves
12. Vibrating Beams and Related Subjects
13. Analysis of Control Systems
14. Fatigue

93

Busnel, R. C., 1957 SOME EXAMPLES OF ULTRASONIC FREQUENCY SENSITIVE AND FREQUENCY INSENSITIVE BIOLOGICAL REACTIONS. In E. Kelly, ed., Ultrasound in Biology and Medicine (Washington: American Institute of Biological Sciences, 1957) Chap. 9, pp. 156-164.

94

Busnengo, E. 1959 ALCUNI EFFETTI DELL'ESPOSIZIONE DELL'UOMO AI RUMORI E ALLE VIBRAZIONI DI MOTORI A TURBO-PROPULSIONE. II. EFFETTI SULL'ELETTROCARDIOGRAMMA (SOME EFFECTS OF EXPOSING MAN TO NOISE AND VIBRATION OF TURBOJET ENGINES II. EFFECTS ON THE ELECTROCARDIOGRAM)
Rivista di Medicina Aeronautica e Spaziale (Rome), 22 (2): 73-84, April-June, 1959
(In Italian, with English summary)

ABSTRACT: Cardiovascular reactions to acoustic and vibratory stimuli (noise and vibration in jet prop-aircraft) were electrocardiographically studied in twenty-three normal men whose work exposed them to these stimuli daily. Elevated vagal tonus was exhibited in both ECG and examination of cardiac frequency and rhythm. Cardiovascular response is related to the intensity and duration of the stimuli, vago-sympathetic equilibrium, breakdown of part or one of the neuro-regulatory systems, and the humoral transmission mechanism of sympathetic and vagal stimuli. Basedoon ECG recordings, the author concludes that the effects of jet engine noise and vibration are of a physiologic rather than pathologic nature.

VIBRATION

C

95

Caldwell, W. W., Jr. 1959 REVIEW OF SOME PROBLEMS OF CREATING A RANDOM VIBRATION ENVIRONMENT IN THE LABORATORY. In 1959 Proceedings of the Institute of Environmental Sciences, Annual Technical Meeting, April 22-24, 1959, La Salle Hotel, Chicago, Illinois (Institute of Environmental Sciences, Mt. Prospect, Ill.) pp. 87-90

ABSTRACT: Random vibration testing is imperative since no equivalent periodic wave test truly simulates random environments. It is important, however, to know what can be expected of a random vibration test. Know the problems before you begin and do not try to deliver test results which are unrealistic. It is up to the environmental engineer to inform those who are responsible for writing test specifications just what can be done. (AUTHOR)

96

Campbell, H., 1957 ASCORBIC ACID LEVELS IN TISSUES OF NORMAL AND NOISE EXPOSED ANIMALS. (Masters Thesis, Pennsylvania State University, June 1957)

97

Carome, E.F. 1950 ELECTRONIC VIBRATION METER
Trans. Amer. Geophys. Union, v. 31, pp. 529-530

ABSTRACT: A completely portable electronic instrument which appears to have wide application in the field of vibration measurement has been developed. The circuit is such that a meter responds to the maximum amplitude of a transient or continuous voltage input. The instrument provides a simple means of measuring accelerations in structures.

98

Carrote Voga, M. 1946 [VIBRATIONS AND NOISES IN AIR MEDICINE] Gac. med. espan. 20: 284

99

Carter, C.W. 1960 INTERNATIONAL LIST OF HUMAN FACTORS FILMS. Human Factors. 2 (2): 62-69, May 1960

ABSTRACT: This annotated bibliography presents 54 references to films dealing with human factors problems in man-machine design. The subjects covered include emergency escape and survival systems, zero gravity studies, medical aspects of high intensity noise, illumination and dark adaptation, anthropometrical techniques, simulated decompression studies, aircrew fatigue problems, and the effects of whole body vibration on human performance. The references are categorized by source in order to facilitate procurement of certain films desired by the reader.

100

Carter, E.T., E.J. Largent, and W.F. Ashe. 1961 SOME RESPONSES OF RATS TO WHOLE BODY MECHANICAL VIBRATION: II. METABOLIC GAS EXCHANGE. Archives of Environmental Health. 2: 378-383

ABSTRACT: A total of 64 rats were subjected to mechanical sinusoidal vibration Measurements of respiratory gas exchange were performed at regular intervals during exposure to the vibration and during a comparable control period. No increase in gas exchange was observed at any frequency for a vibration amplitude of .062 inch. At an amplitude of .125 inch a rise in gas exchange was noted at frequencies above 15 cps, and at an amplitude of .25 inches a rise appears above 5 cps.

101

Castellanos, F.J. 1948 ACCION DE LAS VIBRACIONES SOBRE EL ORGANISMO (The effect of vibration on the organism) Rev. san. aeronaut. 1: 121-124

102

Castor, J. G. 1945 AERO-MEDICAL RESEARCH. II. BASIC STUDIES ON VIBRATION. (Far East Air Force, Air Tech. Intelligence Group, Tokyo) Report No. 111, 11 December 1945. ASTIA ATI 55 510.

ABSTRACT: An outline is given of research conducted by the Japanese Naval Aero-Medical Research Division on the effect of vibration and the part it might play in fatigue, visual acuity, and efficiency and comfort of flying personnel. Results indicated that in general there is a relation between factors of vibration and visual acuity. Various shock absorbers were also studied, and the air cushion was found to be best when inflated to 30-50 mm Hg pressure. Vibration begins to be felt at about 100 cycles per minute at an amplitude of 0.2 to 1.3 mm, and discomfort to vibration begins at 800 cycles and becomes unbearable at 1200 cycles per minute. An attempt was made to determine the effects of vibration on fatigue and results were calculated in terms of calories expended per hour.

103

Catterson, A. D., G. N. Hoover and W. F. Ashe 1961 HUMAN PSYCHOMOTOR PERFORMANCE DURING PROLONGED VERTICAL VIBRATION
Aerospace Medicine 32(3):225, March 1961.

ABSTRACT: In a pilot study of human performance under vibration, Fraser, Hoover, and Ashe found that the ability of subjects to accomplish a tracking task while subject, tracking equipment, and visual display all vibrate is affected by frequency, amplitude, and plane of vibration. To further study this effect of vibration on performance, volunteer subjects were exposed to vibration in the vertical plane for twenty minutes at each of six selected frequencies from 2 cps through 15 cps, and at two amplitudes, 0.06 in. and 0.12 in. The subjects used a control stick to center a moving light on a square panel display for two five-minute periods near the beginning and end of each twenty-minute vibration exposure. Error was electronically summed with respect to time. Each subject served as his own control, and a learing curve was obtained for him during his successive experiences with the task. Results were statistically analyzed and revealed changes in performance relating to frequency, amplitude, and time duration of vibration.

104

Chambers, L.A. 1935 THE ACTION OF INTENSE SONIC VIBRATION ON PEPSIN AND TRYPSIN
Am. J. Physiol. 109; 19
See Also Biol. Abstr. 9; 17974, 1935

105

Chambers, L.A. 1935 THE ACTION OF INTENSE SONIC VIBRATION ON PEPSIN AND TRYPSIN
Biol. Abstr. 9; 17974,
See also Am. J. Physiol. 109; 19

106

Chambers, L.A. 1935 THE EFFECT OF INTENSE SOUND WAVES ON SOME BIOLOGICALLY IMPORTANT CHEMICAL REACTIONS Am. J. Med. Sci 190; 857
See also Chem. Abstr. 30; 6774, 1936

107

Chambers, L.A. 1937 THE INFLUENCE OF INTENSE MECHANICAL VIBRATION ON THE PROTEOLYTIC ACTIVITY OF PEPSIN J. Biol. Chem. 117; 639-649

108

Chan, G.S. 1948 THE EFFECTS OF ULTRASONIC VIBRATIONS ON MAN(Naval Research, Navy Dept. Sands Point, Port Washington, Long Island, N.Y.) Contract No. N6ori-151, Task Order No. 1, 15 April 1948. ATI 41233 or ATI 54 744 Report No. 151-1-15 Project No. 20-M-1b

ABSTRACT: The effects of ultrasonic vibrations on man were investigated. The literature contains somewhat contradictory reports about the physiological and psychological effects of exposure to engines, to devices used to produce ultrasonic vibrations experimentally, and of participation in high speed flight. The effects upon man are alleged to involve nausea, equibrial disturbances, fatigue, mental confusion, headache, auditory, visual and motor disturbances. The effects are said to be transient. Some of the effects of ultrasonic energy when applied locally to man have been demonstrated. Under the conditions studied, sonic components exceed the ultrasonic vibrations in intensity, and intensity levels appear to be reduced as engine speed decreases. With increasing airspeed, the overall intensity level of noise increases and strong energy component may appear at ultrasonic frequencies as well as in the audible range

109

Chandler, R.F. 1962 DETERMINATION OF EQUIVALENT NATURAL FREQUENCY INDICATED BY ACCELEROMETERS MOUNTED OVER THE STERNUM DURING HUMAN IMPACT IN THE G$_x$ DIRECTION. (Aeronautical Research Lab., Holloman AFB, New Mexico) Report No. ARL-TDR-62-29, December 1962.

110

Chauchard P, H. Mazoue 1960 ACTION OF VIBRATIONS ON NERVOUS EXCITABILITY. C. R. Soc. Biol. (Par)154:329-30

111

Chilton, Ernest G. 1946 DYNAMIC CHARACTERISTICS OF RUBBER SUPPORTS FROM VIBRATION TABLE DATA Journal of Applied Physics 17:492-5

112

Christensen, R.J. and R. Samisch 1934 EFFECT OF HIGH FREQUENCY SOUND WAVES ON OXIDASE ACTIVITY Plant Physiol. 9: 385-386
See Also Chem Abstr. 28; 4758, 1934

113

Ch'U, C. H. 1960 [EFFECT OF GENERAL VERTICAL VIBRATIONS ON CERTAIN PHYSIOLOGICAL FUNCTIONS IN MAN.]
Tr. Leningrad Sanitarnogig Med. Inst. 61:159-167, 1960

114

Chu, Wen-Hwa and H.N. Abramson 1961 APPLICATION OF THE GENERALIZED PHASE-PLANE-DELTA METHOD TO MULTI-DEGREE-OF-FREEDOM VIBRATING SYSTEMS. (Southwest Research Inst., San Antonio, Tex.) Technical rept. no. 4, ASTIA AD-261 740, 1 June 1961.

ABSTRACT: The phase-plane-delta method of Jacobsen is extended to multi-degree of-freedom systems governed by differential equations of second order. Applications to initial value problems of two-degree-of-freedom systems are presented as demonstrations of the practical utility of the method. Agreement with exact solutions for linear systems (free and forced oscillations) and with approximate solutions for nonlinear systems (free and forced oscillations) is excellent. A practical truncation error analysis is included as an appendix, which shows that the method is a second order process. (Author)

115

Clark, C.C. 1962 HUMAN CONTROL PERFORMANCE AND TOLERANCE UNDER SEVERE COMPLEX WAVEFORM VIBRATION WITH A PRELIMINARY HISTORICAL REVIEW OF FLIGHT SIMULATION. (Paper, NASA Symposium, St. Louis Missouri, 30 April - 2 May 1962) Martin-Baltimore Engineering Report 12406

116

Clark, C., B. Cooper, & C. Blechschmidt 1963 HUMAN VIBRATION AND IMPACT ISOLATION WITH A PROTOTYPE FULL LENGTH AIR BAG RESTRAINT SYSTEM. (Paper, 34th Annual Meeting of the Aerospace Medical Association, Statler-Hilton Hotel, Los Angeles, Calif., April 28 - May 2, 1963)

117

Clark, W. S., K. O. Lange & R. R. Coermann 1962 DEFORMATION OF THE HUMAN BODY DUE TO UNI-DIRECTIONAL FORCED SINUSOIDAL VIBRATION.
Hum. Factors 4:255-274, Oct. 1962

118

Clarkson, B. L., & R. D. Ford 1961 EXPERIMENTAL STUDY OF THE RANDOM VIBRATIONS OF AN AIRCRAFT STRUCTURE EXCITED BY JET NOISE. (Wright Air Development Division, Wright-Patterson AFB, Ohio) WADD TR 61-70; ASTIA AD-258 591; March 1961.

ABSTRACT: Recordings have been made of the strains induced in a full scale rear fuselage test structure of the Caravelle air-liner when one jet engine is running at maximum take-off thrust. The analysis has been concentrated on the strains in the centers of panels. Correlation measurements indicate that the larger panel strains occur above 500 c. with the frames acting as boundaries. The main resonance peak in each panel has been identified with the fundamental stringer-twisting mode but the mode-shapes for the two smaller peaks have not been completely determined. An attempt has been made to calculate the panel resonant frequencies theoretically. (AUTHOR)

119

Clemedson, C. J. 1962 MEDICOBIOLOGICAL EFFECTS OF MECHANICAL VIBRATIONS AND RADIATION. I. VIBRATIONS.
In Svensk. Lakartidn 59:866-884, March 22, 1962 (Sw)

120

Clevenson, Sherman A. and George W. Brooks April 1960 CONSIDERATIONS OF VIBRATION ENVIRONMENTS IN SPACE FLIGHT SYSTEMS.
1960 Proceedings of the Institute of Environmental Sciences, 81-89.

ABSTRACT: This paper briefly discusses several factors which govern vibration environments in space flight systems such as structural properties and the vibratory components of loads resulting from engine thrust, separation shocks, and acoustic noise. Some data on vibration levels measured during past flights are given and the results of a trend study of possible vibration levels of future space payloads are shown. Some vibration and spin-balacing test setups for projects SHOTPUT, ECHO, and MERCURY are shown. Samples of measured data on the internal and external noise levels of a space capsule during static firing are given together with a flight time history of internal noise levels from launch to reentry. The paper also presents a discussion of type approval and flight acceptance tests and shows sample specifications aimed at improving the reliability of space payloads.

121

Clevenson, S. A., D. A. Hilton, & W. T. Lauten 1961 VIBRATION AND NOISE ENVIRONMENTAL STUDIES FOR PROJECT MERCURY. In 1961 Proceedings of the Institute of Environmental Sciences National Meeting, April 5, 6, 7, 1961, Washington, D. C. (Mt. Prospect, Ill.: Institute of Environmental Sciences, P. O. Box 191) pp. 541-546

SUMMARY: Several of the vibration and noise studies conducted for the Mercury

capsule and its components are described. Particular attention is given to the experimental techniques used and the main results obtained.
Laboratory vibration data for a full-scale capsule both on a large vibration exciter and in the presence of a noise field are presented along with vibration measurements obtained during the flight readiness firing at Cape Canaveral and during a portion of an actual flight.
Acoustic measurements are presented of internal and external noise environments during the launch and free-flight conditions of the capsule. Particular attention is given to a discussion of a unique series of noise environmental tests of a full-scale manned capsule. These environmental tests were accomplished by utilizing the exhaust of a large blowdown-type wind tunnel as the noise source to simulate the rocket motor noise at liftoff and the aerodynamic noise during the exit flight phase. Other topics dealt with briefly are capsule noise transmission characteristics, surface shingle sonic fatigue tests, and exploratory communication studies in the presence of intense noise. (AUTHOR)

122

Coermann, Rolf N. D. EFFECT OF VIBRATION AND NOISE ON THE HUMAN ORGANISM. (Die Wirkung von Erschuetterungen and Laerm..auf den Menschlichen Organismus)
(Royal Aircraft Establishment, Farnborough, Hants) ASTIA ATI 55 041; ASTIA ATI 55 001.

ABSTRACT: The effects of vibration and noise on the human organism were investigated in order to eliminate any deleterious influences which may impair the efficiency of flying personnel. The physiological and psychological aspects of the transmission of vibration, and the possible impairment of the auditory organs as a result of noise are discussed. Vibrations of small amplitude have been shown to be detrimental to vitality and the ability to concentrate. The purely mechanical effect of vibration on eyesight is also discussed. Deafness as a result of aircraft noise is possible, but the physiological and psychological effects of noise are more important. Effective protection of flying personnel is considered imperative.

123

Coerman, R. R. n.d. THE EFFECT OF VIBRATION AND NOISE ON THE HUMAN ORGANISM (Dept. of Commerce, Washington, D. C.) WADC Translation No. 349, PB 24679T.

ABSTRACT: In the face of high demands today made on aircrews it is imperative to eliminate as far as possible all influences which may prejudice their efficiency. Mechanical vibration and noise represent such injurious factors. Not only are they subjectively extremely unpleasant, but they also produce a marked physiological effect. Apart from the directly deleterious effect of hearing, resulting from noise, maximum efficiency also is impaired as a result of vibration and noise. It is therefore a matter of prime importance for aircrews to have the most extensive protection against these influences.

124

Coermann, R. 1931 DIE EMPFINDLICH KEIT DES MENSCHEN GEGEN ERSCHUTTERUNGEN (EFFECT OF VIBRATIONS ON THE HUMAN SYSTEM) Zeitschrift des Verein deutscher Ingenieure 1526, 19 Dec. 1931.

125

Coermann, R. 1937 EQUIPMENT USED TO DETERMINE EFFECT OF SOUND AND OSCILLATIONS ON THE HUMAN BODY. (Untersuchungen ueber die Einwirkung von Schall und Erschuetterungen auf den menschlichen Organismus) ASTIA ATI-27030, November 10, 1937.

ABSTRACT: Detailed description is given of experimental equipment used to determine the effect of sound and oscillations upon the human body. It was to be determined with the aid of systematic experiments the manner in which oscillations act upon the human body, as well as the functions chiefly affected the most harmful frequencies, the physical magnitude upon which this effect depends, and the maxima permissible for practical application. The apparatus required to furnish the answers to the problems is required to transmit mechanical oscillations of 30 to 1000 cps and amplitudes up to 2 mm to the human body. The design of oscillographs, shock-meters, etc., and their mode of application is explained.

126

Coermann, R. 1938 UNTERSUCHUNGEN UBER DIE EINWIRKUNG VOL SCHWINGUNGEN AUF DEN MENSCHLICHEN ORGANISMUS (Investigations Regarding the Effects of Vibration on the Human Organism) Jahrb. Deutch. Luftfahrtforschung, 3: 111-142. WADC Translation No. 349
See also: Luftfahrtmedizin, 4: 73-117, 1940

127

Coermann, R. 1938 [EFFECT OF MECHANICAL VIBRATIONS.] Luftfahrtmed. 2:295.

128

Coermann, R. 1939 LAERM EINWIRKUNG IM FLUGZEUG Deutsche Versuchanstalt fuer Luftfahrt E. V., Forschungsbericht Nr. 1102. September 12, 1939.

129

Coermann, R. 1939 DIE WIRKUNG VON ERSCHUTTERUNG UND LARM AUF DER MENSCHLICHE ORGANISMUS. (THE EFFECTS OF VIBRATION AND NOISE ON THE HUMAN ORGANISM.) R.A.E. Library Translation No. 121
From Ringbuch der Luftfahrttechnik, Part VF1, GDC. 10/7686, 1946.

130

Coermann, R. 1939 INVESTIGATIONS ON THE EFFECT OF VIBRATION ON THE HUMAN ORGANISM
Ind. Psychotech 16; 169-206
See also Psychol. Abstr. 14; 1286 (1940)

131

Coermann, R. 1940 UNTERSUCHUNGEN ÜBER DIE EINWIRKUNG VON SCHWINGUNGEN AUF DEN MENSCHLICHEN ORGANISMUS (Investigation of the Effects of Vibration Upon the Human Organism)
Luftfahrtmedizin 4:73-117.
Also available as R.A.E. Library Translation No. 217 (1947). ASTIA AD 266 614.

132

Coermann, R. 1940 INVESTIGATIONS ON THE EFFECT OF VIBRATION ON THE HUMAN ORGANISM. Psychol. Abstr. 14:1286
See also Industr. Psychotech. 16:169-206

ABSTRACT: A study of the effects of mechanical vibrations ranging from 15 to 1000 cycles. Various physiological and psychological tests were applied before and after a 2-hour exposure to the vibrations, and the frequency of maximal influence was determined. Visual acuity was the only sensory function to be disturbed. The more "mental" functions were especially affected by small amplitudes of vibration. An interference with the patellar reflex is the most striking of the physiological effects. Vibrations above 140 cycles are not mechanically transmitted to the head, provided the amplitude is not too great. For every subject there are resonance frequencies at which the visual disturbance is especially great.

133

Coermann, R. 1946 EFFECTS OF VIBRATIONS AND NOISE ON HUMAN ORGANISM. (Lib. Trans. No. 121, RAF,) (Dept. of Commerce, PB 24679-T)
ASTIA ATI 55 001.

ABSTRACT: From the results obtained, the sort and degree of effect to be expected as a result of noise and vibration, are clearly established. It is

shown that a main effect lies in the province of nervous physiology. Mainly vibrations of small amplitude in particular have been shown to be detrimental to the vitality and ability to concentrate. The purely mechanical effect of vibration on the eyesight has been explained and necessity of a vibration free place for the observer pointed out. The appearance of deafness as a result of aircraft noise is regarded as possible, but it has been shown that the psychological and physiological, effects of noise are much more important. Effective protection for flying personnel against noise and vibration is therefore demanded.

134

Coermann, R., 1959 THE RESPONSE OF THE HUMAN BODY TO LOW FREQUENCY VIBRATIONS. (Paper, presented at the Society of Experimental Stress Analysis Annual Meeting, October 21, 22, 23, Detroit, Michigan)

135

Coermann, R.R., G.H. Ziegenruecker, A.L. Wittwer & H.E. von Gierke 1959 THE PASSIVE DYNAMIC MECHANICAL PROPERTIES OF THE HUMAN THORAX-ABDOMEN SYSTEM AND OF THE WHOLE BODY SYSTEM. (Paper, Meeting of Aero Medical Association, Statler Hilton Hotel, Los Angeles, April 27-29, 1959)

ABSTRACT: The vibration dynamics of the thorax-abdomen system and of the whole body system have been studied more extensively with sinusoidal vibration excitation. The new results to be reported are combined with previously published data and observations on the dynamics of the system under various types of load: whole body vibration, transient acceleration, blast exposure, respirator excitation and rapid decompression. An attempt is made to give a generalized, unified model of the mechanical system with approximate values for its constants, so that it can be used to calculate the dynamic mechanical response to different loadings. This model should serve as a guide in future experimentation, in the planning and interpretation, of physical measurements, in the interpretation of physical measurements, in the interpretation of the various types of damages and in develop-

136

Coermann, R. 1959 MECHANICAL IMPEDANCE OF THE HUMAN BODY IN THE SITTING AND STANDING POSITION AND ITS SIGNIFICANCE FOR THE SUBJECTIVE TOLERANCE TO VIBRATIONS. (Paper, presented at the 3rd Annual Meeting of the Biophysical Society, Pittsburgh, Pa., February 1959)

137

Coermann, R. A., G. H. Zieguerecker, A. L. Wittwer, & H. E. von Gierke 1960 THE PASSIVE DYNAMIC MECHANICAL PROPERTIES OF THE HUMAN THORAX - ABDOMEN SYSTEM AND OF THE WHOLE BODY SYSTEM. Aerospace Medicine 31(6):443-455, June 1960

ABSTRACT: The physical and physiological effects of vibrations and impulsive forces applied to the body depend on the dynamic mechanical properties of the body. In order to obtain quantitative insight into the parameters of the mechanical body system, mechanical impedance measurements on sitting subjects were performed; the results of these measurements, which exhibit resonance maxima for the impedance at 5 and 11 cps., are presented with respect to the effective parameters of the circuit and the forces and energy transferred to the body.

Since vibration and impact injuries as well as subjective tolerances indicate that the thorax-abdomen subsystem of the body is very sensitive when excited by mechanical forces, a detailed study of this system on subjects in the supine position was made. Abdominal wall displacements, oscillating changes in chest circumference and periodic air flow through the mouth were measured for periodic, longitudinal vibration excitation. The resonance of all these response curves is between 3 and 4 cps

A generalized unified model of the total thorax-abdomen system is derived with approximate values for its constants. This model can be used to calculate the dynamic mechanical response to different types force application: whole body vibration, respirator excitation and slow rising blast waves and decompression. Steady state as well as impulsive loadings can be studied on the circuit. This model may be used as a guide in future experimentation, in the interpretation of physical measurements and various types of damage and in developing and understanding protective measures.

138

Coermann, R.R. 1961 MECHANICAL IMPEDANCE OF THE HUMAN BODY IN SITTING AND STANDING POSITION AT LOW FREQUENCIES. (Aerospace Medical Lab., Wright-Patterson AFB, Ohio) ASD TR 61-492, September 1961

ABSTRACT: The theory of mechanical impedance of systems with one or more degrees of freedom is applied to the human body. A method of measuring mechanical impedance and determining parameters of the vibrating system is developed. Impedance curves for longitudinal vibrations of a sitting and standing subject are established for the frequency range of 1-20 cps. The influence of varied posture and restraining systems is investigated. Dynamic movements of body parts are measured directly or indirectly, and compared with the impedance curves. The responsible elements in the body for the apparent resonances are identified. Correlations between the impedance function of the body and the subjective tolerance curve to vibration are found and the reasons for the tolerance limits are elucidated. The variability of subjective tolerance due to varying posture, restraining systems, cushions, duration of exposure and vibrations are discussed, and conclusions for the development of protective devices are drawn. The correlation between the steady state response of the human body system and the effects of impact are discussed.

139

Coermann, R. R. 1962 THE MECHANICAL IMPEDANCE OF THE HUMAN BODY IN SITTING AND STANDING POSITION AT LOW FREQUENCIES.
Hum. Factors 4:227-253, Oct. 1962

140

Coermann, R. R., E. B. Magid & K. O. Lange 1962 HUMAN PERFORMANCE UNDER VIBRATIONAL STRESS.
Hum. Factors 4:315-324, Oct. 1962

141

Coermann, R. 1962 COMPARISON OF THE DYNAMIC CHARACTERISTICS OF DUMMIES, ANIMALS AND MAN
(In: Impact Acceleration Stress: Proceedings of a Symposium With a Comprehensive Chronological Bibliography, National Academy of Sciences, National Research Council, Publication No. 977, pp. 173-184)

ABSTRACT: The effect of extrinsic transient forces on the living organism is greatly dependent upon the relative displacement of tissues and organ complexes caused by the accelerative forces within the body. The magnitudes of these displacements are not only a function of the magnitude and time characteristics of the applied force, but also a function of the dynamic characteristics of the system being excited. In the investigation of the effects of impact on man, comparative experiments using dummies and animals have necessitated the consideration of their dyanmic characteristics relative to those of man. The frequency spectrum of such a characteristic can be determined by excitation with steady state sinusoidal forces utilizing the concept of "steady state" mechanical impedance. However, since such systems do not have linear parameters throughout the range of acceleration occurring during impact, it is necessary to determine also the "transient" impedance by definite abrupt decelerations.

"Steady state" impedances were determined for men, bears, m onkeys and dummies in the frequency range 1 to 20 cps. at low accelerations. Each showed different resonant frequencies and damping factors. Resonances of inner organs and portions of the skeleton were measured by other methods on men and dogs. A device to produce definite deceleration patterns with variable magnitude and duration was developed. A program to determine the "transient" impedances of men, bears, monkeys and dummies was initiated and preliminary results are shown.

142

Cohen, A. A. 1961 DEVELOPMENT OF SIMULTANEOUS SHOCK AND VIBRATION ISOLATION
In 1961 Proceedings of the Institute of Environmental Sciences National Meeting, April 5, 6, 7, 1961, Washington, D. C. pp. 663-666

ABSTRACT: A stiff or high resonant frequency isolator may be satisfactory for shock but unsatisfactory for vibration isolation. There is an obvious need for

an isolator that will protect equipment against shock as well as vibration. A material with a non-linear spring constant and one that could utilize the total height allowed an isolator could have the capacity to absorb energy due to shock and also isolate vibrations. A study was made of several materials which might meet these requirements, and flexible plastic foam was selected as a possibility.

143

Cohen, L. H. & S. B. Lindley 1938 STUDIES IN VIBRATORY SENSITIVITY. Amer. J. Psychol. 51:44-62, Jan. 1938.

144

Cole, E. B. 1950 THE THEORY OF VIBRATIONS FOR ENGINEERS 2nd Ed. (London: Crosby Lockwood, 1950)

145

Constant, H. 1932 AIRCRAFT VIBRATION. J. Roy. Aeronautical Soc., 36:205-250

146

MOTION PICTURE

Cooper, B., K. McCluskey, & C. Clark 1963 PERFORMANCE DURING LAUNCH VEHICLE VIBRATIONS. (Martin Company, Baltimore, Md.) Life Sciences Technical Film Rept. No. 3, Aug. 1963

147

Cope, F. W. & B. D. Polis 1957 CHANGE IN PLASMA TRANSAMINASE ACTIVITY OF RHESUS MONKEYS AFTER EXPOSURE TO VIBRATION, ACCELERATION, HEAT, OR HYPOXIA. (Naval Air Development Center, Johnsville, Pa.) Rept. No. NADC-MA-5718, ASTIA AD 209 173.

ABSTRACT: Significant increases in plasma glutamic-oxalacetic transaminase levels were observed in monkeys exposed to vibration, acceleration, heat, hypoxia, or noise and confinement stress. In all but 1 of 17 animals, no specific tissue damage was evident. The increase in plasma transaminase is interpreted as a non-specific stress effect. The data suggest that caution should be exercised in basing clinical judgments on serum transaminase levels.
(Author)

148

Cope, F. W., & B. D. Polis 1957 SOME EFFECTS OF PROLONGED LOW FREQUENCY VIBRATION ON THE MOLECULAR AND CELLULAR COMPOSITION OF BLOOD. (Naval Air Development Ctr., Johnsville, Pa.) NADC-MA-5715; 6 Nov. 1957 ASTIA AD 209 172.

See also; J. Aviation Med. 30:90-96, 1959.

ABSTRACT: Rhesus monkeys were exposed to vertical sinusoidal vibration of amplitude 0.1 inch and frequency 20 cps for 3 hours a day for 8 - 12 successive days. The monkeys were strapped, in a sitting position, on a vertically vibrating table top. Control monkeys were placed nearby. The vibrated monkeys showed no grossly visible abnormalities. On the first day of vibration, the neutrophile counts and plasma transaminase levels rose abruptly, and then gradually decreased as the vibration was repeated on successive days. These changes were interpreted as nonspecific changes such as may be characteristic of the General-Adaptation-Syndrome and do not necessarily indicate any specific tissue damage such as myocardial infarction of the monkey. Similar changes of lesser magnitude were produced by merely handling the monkeys. Plasma glucose and ascorbic acid levels and eosinophile counts which are known to change with stress, were maximally depressed by the mild stress of handling the animals. No additional effect on these determinations could be ascribed to vibration. The data obtained with monkeys suggest that a rise in transaminase activity merely reflects a general response to a stressful state. (AUTHOR)

149

Cope, F.W. 1958 ELASTIC CHARACTERISTICS OF ISOLATED SEGMENTS OF HUMAN AORTAS UNDER DYNAMIC CONDITIONS. (Naval Air Development Ctr., Johnsville, Pa.) NADC-MA-5809, 13 Aug. 1958. ASTIA AD-209 084.

See also J. Applied Physiol. 14(1):55-59, Jan. 1959

SUMMARY: When isolated segments of human descending thoracic aorta were caused to change their volume rapidly and continuously in sinusoidal fashion with pulse pressures and pulse rates maintained in the physiological range, the resulting pressure-volume curves showed slight but consistent increases in stiffness, compared to pressure-volume curves obtained on the same specimens when inflated stepwise. There was introduced into the pressure measuring system a time lag of sufficient magnitude to eliminate the hysteresis loop. The extent of hysteresis in the aorta was not determined because time lags in the aorta could not be distinguished from time lags in the measuring equipment.(Author)

150

Cope, F. W. 1958 EFFECTS OF AGEING, DRUGS, EXERCISE AND OTHER STRESSES ON THE ELASTIC CHARACTERISTICS OF THE INTACT LIVING HUMAN AORTA. (Naval Air Development Center, Johnsville, Pa.) NADC-MA-5815, 19 Nov. 1958.

SUMMARY: A method was developed by which aortic distensibility characteristics can be computed in the intact living human, if systolic and diastolic

arterial pressures, heart rate and cardiac output are known. In this way the aortic characteristics of a large series of normal men of different ages were computed. Comparing these results with measurements on excised aortas, a more pronounced trend toward increasing aortic stiffness with increasing age is evident in living than in dead aortas. Norepinepherine and exercise apparently cause the living aortas to constrict but to become more distensible. The same change occurs after 30 min. of high spinal anesthesia. The ganglionic blocking agents hemamethonium pentamethonium, and tetraethylammonium usually cause the living aorta to become stiffer, presumably due to dilation. The aortas of patients with pulmonary disease usually react in different fashion to exercise or tetraethylamnonium. The increased aortic distensibility that occurs with the hypertension induced by norepinepherine or exercise acts as a compensatory mechanism by decreasing systolic pressure (Author)

151

Cope, F.W. 1959 PROBLEMS IN HUMAN VIBRATION ENGINEERING. (Naval Air Development Ctr., Johnsville, Pa.) NADC-MA 5902, 6 March 1959. ASTIA AD 216 507.

See also Ergonomics 3(1):35, Jan. 1960.

ABSTRACT: Vibration is considered to include the oscillatory motion of traveling vehicles. The predominent linear sinusoidal component of this motion is usually in the vertical direction and of 0-50 cps in frequency. A human or animal, subjected to vibration, may exhibit a variety of symptoms and anatomical damage. These effects may be diminished by shielding the operator from the vibration of the vehicle by means of an elastic device. A variety of suitable devices are available. However, excessive shielding is undesirable in that it will increase the relative motion of the operator with respect to the vehicle which may be expected to cause performance decrements. (Author)

152

Cope, F.W., and D. Polis. 1959 INCREASED PLASMA GLUTAMIC-OXALACETIC TRANSAMINASE ACTIVITY IN MONKEYS DUE TO NONSPECIFIC STRESS EFFECT. J. Aviation Med. 30(2):90-96.

ABSTRACT: Significant increases in plasma glutamic-oxalacitic transaminase levels in monkeys have been found after exposure to vibration, acceleration, heat, and noise and confinement stress. In all but one of fourteen animals, no specific tissue damage was evident. Repeated exposure of the same monkey to the same intensity of vibration stress produced progressively smaller mean increases in the plasma transaminase levels. The data suggest that an increase in plasma transaminase activity can occur as a nonspecific stress effect. It follows that caution should be exercised in basing clinical judgements on serum transaminase levels.

153

Cope, F.W. 1959 ELASTIC CHARACTERISTICS OF ISOLATED SEGMENTS OF HUMAN AORTAS UNDER DYNAMIC CONDITIONS.
J. Applied Physiol. 14(1):55-59, Jan. 1959
See also (Naval Air Development Ctr., Johnsville, Pa.) NADC-MA-5809. 13 Aug. 1959. ASTIA AD 209 084.

SUMMARY: When isolated segments of human descending thoracic aorta were caused to change their volume rapidly and continuously in sinusoidal fashion with pulse pressures and pulse rates maintained in the physiological range, the resulting pressure-volume curves showed slight but consistent increases in stiffness, compared to pressure-volume curves obtained on the same specimens when inflated stepwise. There was introduced into the pressure measuring system a time lag of sufficient magnitude to eliminate the hysteresis loop. The extent of hysteresis in the aorta was not determined because time lags in the aorta could not be distinguished from time lags in the measurement equipment. (Author)

154

Cope, F.W. & B.D. Polis 1959 SOME EFFECTS OF PROLONGED LOW FREQUENCY VIBRATION ON THE MOLECULAR AND CELLULAR COMPOSITION OF BLOOD.
J. Aviation Med. 30:90-96
See also U.S. Naval Air Development Center Rept. No. NADC-MA-5715, Nov. 6, 1957.

ABSTRACT: Rhesus monkeys were exposed to vertical sinusoidal vibration of amplitude 0.1 inch and frequency 20 cps for 3 hours a day for 8-12 successive days. The monkeys were strapped in a sitting position on a vertically vibrating table top. Control monkeys were placed nearby. The vibrated monkeys showed no grossly visible abnormalities. On the first day of vibration, the neutrophile counts and plasma transaminase levels rose abruptly, and then gradually decreased as the vibration was repeated on successive days. These changes were interpreted as nonspecific changes such as may be characteristic of the General-Adaptation-Syndrome and do not necessarily indicate any specific tissue damage such as myocardial infarction of the monkey. Similar changes of lesser magnitude were produced by merely handling the monkeys. Plasma glucose and ascorbic acid levels and eosinophile counts, which are known to change with stress, were maximally depressed by the mild stress of handling the animals. No additional effect on these determinations could be ascribed to vibration. The data obtained with monkeys suggest that rise in transaminase activity merely reflects a general response to a stressful state.

155

Cope, F. W. 1959 PROBLEMS IN HUMAN VIBRATION ENGINEERING
(Aviation Medical Acceleration Lab., Naval Air Development Center, Johnsville, Pa.)
BuMed Proj. mo. NM 18 01 12.4, rept. no. 2; (TED ADC AE 1409);
Rept. no. NADC-MA-5903 6 March 1959 ASTIA AD 216 507

ABSTRACT: Vibration is considered to include the oscillatory motion of

traveling vehicles. The perdominent linear sinusoidal component of this motion is usually in the vertical direction and of 0-50 cps in frequency A human or animal, subjected to vibration, may exhibit a variety of symptoms and anatomical damage. These effects may be diminished by shielding the operator from the vibration of the vehicle by means of an elastic device. A variety of suitable devices are available. However, excessive shielding is undesirable in that it will increase the relative motion of the operator with respect to the vehicle which may be expected to cause performance decrements. (Author)

156

Cope, F.W. 1960 PROBLEMS IN HUMAN VIBRATION ENGINEERING.
Ergonomics 3(1):35, Jan. 1960
See also (Naval Air Development Ctr., Johnsville, Pa.) NADC-MA-5902, 6 March 1959. ASTIA AD-216 507.

ABSTRACT: Vibration is considered to include the oscillatory motion of traveling vehicles. The predominent linear sinusoidal component of this motion is usually in the vertical direction and of 0-50 cps in frequency. A human or animal, subjected to vibration, may exhibit a variety of symptoms and anatomical damage. These effects may be diminished by shielding the operator from the vibration of the vehicle by means of an elastic device. A variety of suitable devices are available. However, excessive shielding is undesirable in that it will increase the relative motion of the operator with respect to the vehicle which may be expected to cause performance decrements. (Author)

157

Corso, J. F. 1952 EFFECT OF NOISE ON HUMAN BEHAVIOR.
(Wright-Patterson AFB, Ohio) WADC Tech. Rept. 53-81, Dec. 1952.
ASTIA AD 18259

ABSTRACT: The present report is a comprehensive summary of a program of research undertaken in the Dept. of Psychology of the Penn. State College from 24 March 1949 to 31 October 1952 on the effects of high intensity noise on human behavior. In all, six major studies were conducted and are reviewed, with the following information provided for each study; abstract, purpose, procedure, results and conclusions, and summary statement. In general, the results of this series of studies show that noise has no marked effect on mental performance.

158

Corti, U.A. 1959 VIBRATION MEASUREMENTS ON LIVING SUBJECTS.
Schweiz Med Wschr 89:576-81, 30 May 1959

159

Coulter, N.A. and J. C. West 1960 NONLINEAR PASSIVE MECHANICAL PROPERTIES OF SKELETAL MUSCLE
(Wright Air Development Division, Wright-Patterson Air Force Base, Ohio) Proj. 7232; Task 71784; Contract No. AF 33(616)-5780, WADD TR 60-636

ABSTRACT: The nonlinear, passive mechanical properties of skeletal muscle were investigated. The response of frog gastrocnemius muscle to sinusoidal displacements over a frequency band of 0.5 to 25 cps was determined. From the experimental data a nonlinear differential equation characterizing the passive mechanical behavior of muscle was constructed

160

Coussoulakos, A., H. Maschas, and G. Yannoulis 1962 PATHOLOGICAL DISORDERS CAUSED BY VIBRATIONS IN NON-FLYING PERSONNEL OF ATHENS AIRPORT. (Troubles pathologiques provoques par les vibrations concernant le personnel non navigant de l'aerodrome d' Athenes)
Revue de medecine aeronautique, (Paris), 1 (4): 18-20. July-Aug. 1962

ABSTRACT: Airport noise produces not only stato-acoustic disorders, but also general disorders (fatigue, irritability, weakness). It is also responsible for mental, behavioral, and neurological disorders (insomnia, concentration difficulties, headaches, vertebral pain, depression, visual disorders), cardiovascular disorders (tachy-cardia, extrasystole, bradycardia), digestive disorders (dyspepsia, nausea, vomiting, duodenal ulcer), and blood disorders (poly-nucleosis with eosinophilia). Etiopathogenesis is related to the terrain, hearing acuity, the frequency, character, and duration of exposure to noise, former disorders, heredity, and hormono-vegetative factors. Special medical and audiometric selection criteria, and personal protective devices (ear plugs, helmets) are recommended for nonflying personnel exposed to noise daily.

161

Cramer, R. L., P. J. Dowd, & D. B. Helms 1963 VESTIBULAR RESPONSES TO OSCILLATION ABOUT THE YAW AXIS. (Paper, 34th Annual Meeting of the Aerospace Medical Association, Statler-Hilton Hotel, Los Angeles, Calif., April 28 - May 2, 1963)

ABSTRACT: Nystagmus varies systematically in amplitude and phase with the frequency of oscillation. The relationships can be expressed in terms of a simple analog. Both these relationships can be altered by repeated stimulation in a conditioning program. (AUTHOR)

162

Crampton, G. H., & F. A. Young 1953 THE DIFFERENTIAL EFFECT OF A ROTARY VISUAL FIELD ON SUSCEPTIBLES AND NON-SUSCEPTIBLES TO MOTION SICKNESS. J. Comp. Physiol. Psychol. 46:451-453

SUMMARY AND CONCLUSIONS: 1) Two groups of Ss, one susceptible and the other not susceptible to motion sickness, were subjected to a rotating room situation in which they remained stationary. The resulting nausea symptoms were categorized on an arbitrary four-point scale. 2) The results indicate that individuals susceptible to motion sickness are also susceptible to nausea in a rotary visual field situation, and, conversely, nonsusceptibles are resistant. 3) It is concluded that some of the individual differences in regard to nausea found in previous studies utilizing rotary visual fields may be related to the motion sickness susceptibility of the subjects. (AUTHOR)

163

Crede, C.E. 1955 VIBRATION AND VIBRATION ISOLATION IN AIR-CRAFT AND GUIDED MISSILES. (Barry Controls, Inc., Watertown, Mass.) Progress rept. no. 257 ASTIA AD- 118 627

ABSTRACT: "This report reviews some of the latest developments in vibration and in vibration and shock isolation with particular reference to piloted aircraft and guided missiles. The use of discrete and continuous spectra to define environmental conditions is discussed, and the significance of these concepts in the design and testing of equipment is reviewed. Mention is made of certain effects which may be important in the isolation of high frequency vibration, including standing waves in vibration isolators and the resilience of structural members of the mounted equipment. The problems introduced by the requirement of isolation during sustained acceleration are discussed, and graphical means for predicting the change in natural frequency of a particular non-linear isolator during sustained acceleration is included. Reference is made to shock transmissibility of isolators, and to limitations on isolator deflection as governed by available space. Finally, the report includes a discussion of techniques for selection of optimum characteristics for isolators by use of an analog computer, and gives an example of the application of this technique." (BCI abstract)

164

Crede, C. E. 1957 PRINCIPLES OF VIBRATION CONTROL. In C. M. Harris, ed., Handbook on Noise Control (New York: McGraw-Hill, 1957) Chap. XII.

165

Crisman, R.B., & C.L. Forrest 1957 HUMAN FACTORS IN THE DESIGN OF HIGH PERFORMANCE AIRCRAFT. (Paper, SAE National Aeronautical Meeting, April 1957)

166

Critchlow, E.F. 1944 MEASUREMENT AND PREDICTION OF AIRCRAFT VIBRATION. S. A. E. J. 52:368-378

167

Crocco, G.A. 1951 LA SOPPORTAZIONE FISIOLOGICA NEI MISSILI A REAZIONE (PHYSIOLOGICAL ENDURANCE AND ROCKET FLIGHT.) Aerotecnica, (Rome) 31:55-59

168

Crook, Mary C. 1960 SUMMARY OF REPORTS ON VIBRATION SURVEYS ISSUED DURING 1959. (David Taylor Model Basin, Washington, D.C.) Report no. 1402; ASTIA AD-232 642

ABSTRACT: Tests on the USS Skipjack (SSN-585) showed that the hull vibration was not excessive when compared with levels on other submarines. The hull vibrated in its fundamental 2-noded mode whenever the rudder or stern was predominantly in the athwartship direction, and it was not nearly as much in evidence at speeds in excess of 10 kn as at lower speeds. It is believed that the rudder-ram-hydraulic system has a natural frequency near that of the 2 noded hull mode (3.3c submerged, 3.7c surfaced) when the ship advances at low speeds, but that the rudder frequency changes with speed, due to the spring-like effect of the hydrodynamic lift and moment. Blade frequency hull vibration at a submerged 105 rpm was twice that previously reported; this condition is attributed to increased excitation arising from resonant whirling vibration. This large blade frequency resonant whirling vibration (center of shaft moving in an elliptical path) was measured near 105 rpm. At this speed the shaft vibrated with an amplitude of the order of 40 mils peak-to-peak, 5 vibrations per shaft revolution. There were strong indications that the floodhole cover in no. 4 ballast tank was open, possibly giving rise to Helnholtz-type excitation. A list of formal reports published during 1959 is appended.

169

Cummings, S. B. 1938 THE EFFECTS OF LOCAL ANESTHESIA ON TACTILE AND VIBRATORY THRESHOLDS. J. Exp. Psychol. 23:321-338.

170

Curry, B. and Hsi, E. 1949 BIBLIOGRAPHY ON SUPERSONICS OR ULTRASONICS 1926-1949 Oklahoma Agr. Mech. Coll., Research Foundation, Stillwater, Oklahoma. See also: Chem. Abstr. 44:4298d (1950)

171

Curtis, A. J. 1958 RANDOM VIBRATION TESTING SIMPLIFIED. S.A.E. Journal 66(11):127, Pt. 2

ABSTRACT: Fatigue damage in actual environments can be found in accelerated lab tests by using an "equivalent peaks" technique. The effect of low-intensity long-time random vibrations can be found by testing a part at a short-time high-intensity vibration level. This is done by calculating the number of times a damaging peak acceleration is applied to a part. The same number of peaks are then applied in an accelerated lab test. Since the vibrations being considered are of the random type, probability density functions for the distribution of the magnitude of the peaks are used. Narrow-band random vibration is assumed since most fatigue damage occurs at resonant frequencies.

172

Cyriax, E. 1948 MANUAL VIBRATIONS AND NERVE FRICTIONS, WITH SPECIAL REFERENCE TO PERIPHERAL FACIAL PARALYSIS Brit. J. Phys. Med. 11, 144-146

VIBRATION

D

173

Danilin, B. 1959 LIFE IN SPACE
Takhnika molodezhi 7: 34-36

174

Danowski, T.S., C. Moses Jr., and H.M. Margolis 1960 VIBRATORY SENSE AND OSCILLOMETRIC INDEX IN GOUT AND IN RHEUMATOID ARTHRITIS.
Amer. J. Med Sci. 239:295-300, March 1960

175

Davis, H. 1942 FINAL REPORT ON PHYSIOLOGICAL EFFECTS OF EXPOSURE TO CERTAIN SOUNDS (Office of Scientific Research & Development, Wash., D. C.) OSRD 889. OTS PB 19786.

176

Davis, H. 1948 BIOLOGICAL AND PSYCHOLOGICAL EFFECTS OF ULTRASONICS J. Acoust. Soc. Am. 20:605-607

177

Davis, H., 1948 VIBRATION AND ITS PHYSIOLOGICAL EFFECTS.
Medical News Letter, Aviation Supplement, 9: 1-4

178

Davis, H., H. O. Parrack and D. H. Eldredge 1949 HAZARDS OF INTENSE SOUND AND ULTRASOUND
Annals of Otology, Rhinology and Laryngology 58:732, September 1949.

179

Davis, H. 1951 NOISE: EFFECTS ON HUMAN BEHAVIOR AND COMMUNICATION. American Medical Assoc. Arch. Indus. Hygiene & Occupational Med. 3:227-231

180

Davis, H. and Associates 1953 ACOUSTIC TRAUMA IN THE GUINEA PIG J. Acoust. Soc. Amer. 25:1180-1189

181

Davis, H., D.H. Eldredge, et al. 1954 HIGH-INTENSITY NOISE AND MILITARY OPERATIONS: AN EVALUATION(Armed Forces NRC Committee on Hearing and Bio-Acoustics, Wash, D.C.) CHABA Rept. No. 1, 25 Jan. 1954

182

Davis, H., ed. 1958 AUDITORY AND NON-AUDITORY EFFECTS OF HIGH INTENSITY NOISE. (Naval School of Aviation Medicine, Johnsville, Pa.) Res. Proj. NM 130199.1. 7., 6/58

183

Davis, H., Chairman 1962 PANEL DISCUSSION: ENVIRONMENTAL EFFECTS ON CONSCIOUSNESS. In Schaefer, K. E., ed., Environmental Effects on Consciousness. (New York: The MacMillan Co., 1962) Library of Congress Catalog Card No. 61-9079, pp. 132-146

184

Deily, W.H., I. Glassman & D.B. Houghton 1952 A DYNAMIC AIRCRAFT SIMULATOR FOR STUDY OF HUMAN RESPONSE CHARACTERISTICS. (The Franklin Institute Laboratories for Research and Development, Philadelphia, Pa.) Final Report No. F-2169, Sept. 30, 1952. ASTIA AD 52 725.

ABSTRACT: This report covers the design and construction of a dynamic simulator of an aircraft in flight with which "human frequency responses" to visual signals may be measured for the purpose of determining optimum characteristics of an aircraft's controls.

The dynamic simulator comprises an aircraft cockpit, a program unit which presents visual input stimuli on a cathode-ray tube in view of the pilot an electronic analog computer which computes the aircraft equations of

...tion and resultant stimuli (target) motions, and a recorder to record ...ilot responses and other desired quantities. The aircraft simulated is ... F-80A jet fighter.

...lidation of the simulator indicates that the device "flies" like the ...-80A. A separate report on the validation phase is under preparation.

...5

...lla Monica, F. . 1939 ULTRASOUNDS IN BIOLOGY: REVIEW OF LITERATURE ... Ann. med. navale e coloniale 45; 356-362

186

Den Hartog, J. P. 1947 MECHANICAL VIBRATIONS. 3rd ed. (McGraw-Hill, 1947)

187

Denisov, V. & M. Klevtsov 1962 BIOTELEMETRY (Trans. of Radio, Moscow (USSR) (10):16-17, 1961) (Office of Technical Services. Washington, D. C.) 62-11106

188

Dennis, J. P., & M. A. Elwood 1958 THE EFFECTS OF VIBRATION EXPERIENCED IN DIFFERENT SEATING POSITIONS. (Ministry of Supply, Clothing and Stores Experimental Establishment) Rept. No. 78

189

Dennis, J. P. 1960 THE EFFECT OF WHOLE BODY VIBRATION ON A VISUAL PERFORMANCE TASK (Directorate of Physiological & Biological Research, Clothing & Equipment Physiological Research Establishment) Rept. No. 104; ASTIA AD-247 249; Aug. 1960

ABSTRACT:
Introduction & Object: These experiments are concerned with the relationships between a range of vibration conditions (from 5-37 c.p.s.) experienced by subjects sitting on an ordinary tank seat, the amounts of movement at the head and the associated losses in visual performance.
Summary: (1) Visual performance was significantly affected at all conditions when the motion of the table approximated to $\pm\frac{1}{2}$ peak g and at all but one condition (19 c.p.s.) when the table motion approximated to $\pm\frac{1}{4}$ peak g. Vibration at the $\pm\frac{1}{4}$ peak g level increased errors over the non-vibration condition by 25%; at $\pm\frac{1}{2}$ peak g this increase in error was 55%.

(2) Rate of change of acceleration of the head is shown to correlate with visual performance r=0.61. This relationship is not necessarily consistent over the experimental conditions. (AUTHOR)

190

de Vries, G. 1942 A CARRIER-FREQUENCY INSTRUMENT FOR MEASURING VIBRATION, ESPECIALLY IN FLIGHT TESTS
Jahrbuch d. Deutschen Luftfahrtforschung 1942 pp. I794-I803
10/13106)
R.A.E. Translation No. 180

191

Dias Campos, F. 1945 INFLUENCIA DAS ACELERACOES SOBRE O ORGANISMO,EN AVIACAO (Acceleration; Influence on Organism)
Rev. med. RioGrande do Sul. (Brazil) 1: 278-287, May-June 1945

192

Dieckmann, D. 1955 THE EFFECT OF MECHANICAL VIBRATION ON MAN: A REVIEW AND SUMMARY OF RESEARCH TO DATE. (Report from the Max-Planck-Institute of Occupational Physiology, Dortmund. Available as a British Railways Research Translation)

193

Dieckmann, D. 1957 EINFLUSS VERTIKALER MECHANISCHER SCHWINGUNGEN AUF DEN MENSCHEN (Effects of Vertical Mechanical Vibration Upon Man)
Int. Z. Angew. Physiol. (Berlin) 16: 519-564.

194

Dieckmann, D. 1957 A STUDY OF THE INFLUENCE OF VIBRATION ON MAN.
Ergonomics, 1: 347-355

ABSTRACT: The influence of mechanical vibration of the human body was studied in the standing and sitting positions. The range of frequencies was up to 100 cps. At the lowest frequencies of the movement of the body follows that of the platform. Near 4 to 5 cps there is a resonance maximum of body movements. Higher frequencies induce lower amplitudes of body vibrations. If the vibration of the shoulder is taken as 100% and compared with the head,

aximum relative amplitude occurs between 20 and 25 cps. A scale of
in was developed, K the degree of strain from 5 to 40 cps strain is
uately measured by velocity of vibration, below this acceleration is
uate. Above 40 cps the amplitude serves as a standard of strain. The
ents of the head of a subject standing on a horizontally vibrating table
elliptical. With an increase of frequency the elipse becomes more
tical, so that at 4 or 5 cps the movements are mainly vertical although
vibration is horizontal. The large elliptical form at 2 cps results from
nance.

eckman, D. 1958 EINFLUSS HORIZONTALER MECHANISCHER SCHWINGUNGEN AUF DEN MENSCHEN (Influence of Horizontal Mechanical Vibrations on Humans) Internat. Zeitschrifte Angew. Physiol. 17:67-83

6

ieckmann, D. 1958 EINFLUSS HORIZONTALER MECHANISCHER SCHWINGUNGEN AUF DEN MENSCHEN, (Influence of Horizontal Mechanical Vibrations on Humans) Internat. Ztschr. angew. Physiol. 17: 83-100

197

Dieckmann, D. 1958 MECHANISCHES MODELL FUR DEN VERTIKAL SCHWINGENDEN MENSCHLICHEN KORPER. (Mechanical models for the vertically vibrating human body.) Internat. Ztschr. angew. Physiol. 17:67

198

Dieckmann, D. 1958 EIN MECHANISCHES MODELL FÜR DAS SCHWINGUNGSERREGTE HAND-ARM SYSTEM DES MENSCHEN. (A mechanical model for the hand-arm system of men stimulated by vibrations.) Internat. Ztschr. angew. Physiol. 17:125

199

Dieckmann, D. 1958 STUDY OF THE INFLUENCE OF VIBRATION ON MAN. Ergonomics 1(4):347-355, Aug. 1958

ABSTRACT: To study the influence of horizontal and vertical mechanical vibrations (up to 100 cycles per second) on the human body in standing and sitting positions, physical and physiological methods as well as subjective assessments were employed. Resonance phenomena are described and a strain scale is given for these vibration excitations. Using these techniques, a man sitting on a seat in a rail-motorcar is described.

200

Dieckmann, D. 1959 EFFECTS OF MECHANICAL VIBRATIONS OF AUTOMOBILES ON HUMANS. ATZ Automobiltechnische Zeitschrift (Germany) 59 (10):297-302. SLA Trans. No 59-17397

201

Di Macco, G. 1938 PATHOLOGICAL ACTION OF ULTRASONIC WAVES: A REVIEW OF LITERATURE Arch. ital. med. sper. 2, 66-86

202

Dindinger, H. 1956 UNTERSUCHUNGEN UBER EIN EMPFINDUNGSSTARKEMASS FUR VIBRATIONEN DES MENSCHLICHEN KORPERS: DIE VIBRONSKALA. (RESEARCH ON A MEASURE OF THE INTENSITY OF SENSATION OF VIBRATIONS OF THE HUMAN BODY: VIBRON-SCALE) (Thesis: Medical Faculty of Friedrich-Alexander University, Erlangen) (München: Mikrokopie, 1956)

ABSTRACT: A scale was developed for the measurement of sensations of vibration in the frequency range of 50-200 c.p.s. at threshold to medium intensities. The Vibron-scale follows in general the Veg-Scale developed by S. S. Stevens for the perception of weights. If the vibron values are arranged in a geometric series, the progression follows Stevens' law (sensation increases as the cube root of stimulus energy). Practical application of this scale is envisioned for the quantitative measurement of vibration stress on the human organism during flight and car travel.

203

Dmitriyevskiy, Sergey Yevgen'yevich 1960 SOME THEORIES OF VIBRATIONS WITH SELF-DAMPING AND THEIR EVALUATION FROM THE POINT OF VIEW OF EXPERIMENTAL DATA. Nekotoryye Teorii Kolebaniy S Sobstvennym Zatukhaniyem i Ikh Otsenka s Tochki Zreniya Opytnykh Dannykh (Moscow: 1957) PP. 1-85 (Aerospace Technical Intelligence Center, Wright-Patterson AFB, Ohio, Translation No. MCL-684) ASTIA AD-256 614; 21 Nov. 1960

ABSTRACT: The different dependences of vibration damping on the internal resistance in the material is examined. It is customary to call such vibrations vibrations of elastic bodies with self-damping. A new theory is proposed in which vibration damping is considered as a function of both velocity and displacement. The theory also considers damping as being proportional to the second degree polynomial of deformation. (AUTHOR)

204

Document Service Center, Armed Services Technical Information Agency 1957 SHOCK AND VIBRATION. ENTRIES SELECTED BY DR. J. NORTON BRENNAN, PENNSYLVANIA STATE UNIVERSITY, IN CONJUNCTION WITH CONTRACT DA 19-129-qm-804. REPORT BIBLIOGRAPHY. (Document Service Center, Armed Services Technical Information Agency, Dayton, Ohio) ASTIA AD-138 776

...non, A. and E. Biancani 1938 PHYSICOCHEMICAL AND BIOLOGICAL EFFECTS OF ULTRA-VIOLET RAYS AND ULTRA-ACOUSTIC SOUNDS. Ann. inst. d'actinol 12; 61-64

...gnon, A. and E. Biancani 1938 ULTRASONICS AND THEIR BIOLOGICAL ACTION Radiologica (Berlin) 3; 40-54

207

Donskaia, L. V. and M. F. Stoma 1960 [PHYSIOLOGICAL ANALYSIS OF THE EFFECT OF VIBRATIONS ON THE ORGANISM.] In Tr. Leningrad Sanitarnogig Med. Inst. 61:37-48, 1960 (Russian)

208

Douvillier, J.G., Jr., H.L. Turner, J.D. McLean, & D.R. Heinle 1960 EFFECTS OF FLIGHT SIMULATOR MOTION ON PILOTS' PERFORMANCE OF TRACKING TASKS. (National Aeronautics and Space Administration, Washington, D.C) NASA TN D-143, Feb. 1960. ASTIA AD 231 341

ABSTRACT: The effect of motion of a flight simulator on pilots' performance of a tracking task has been investigated by comparing the air-to-air tracking performance of two pilots in flight, on a motionless flight simulator, and on a flight simulator free to roll and to pitch. Two different attack displays were used.

It was found in tracking a maneuvering target that: (1) the results from the moving flight simulator resembled the results from flight much more than did those from the motionless si ulator; and (2) that in flight the conventional circle-dot display was superior to a drone display. For simpler tracking tasks it was not possible to detect these differences.

209

Draeger, R.H., D.E. Goldman, & C.B. Cunningham 1947 SHOCK AND VIBRATION BULLETIN NO. 2 - MARCH 1947. (Office of Naval Research, Naval Research Laboratory, Washington, D.C.) ASTIA ATI 75123

ABSTRACT: Topics covered at a symposium on shock and vibration are presented. A committee was set up to clarify and unify ideas and to report such terminology, definitions, and standards as will help in the uniformity, understanding, and progress in the field of science. The effects of personnel shock, blast, and vibration were also discussed. It was demonstrated that the purpose of such investigations was to provide protection for human beings and structures involved in Fleet operations. In addition, a detailed description together with photographs is given of the German Askania vibrograph.

210

Drazin, D.H. 1959 EFFECTS OF LOW-FREQUENCY HIGH-AMPLITUDE WHOLE-BODY VIBRATION OF VISUAL ACUITY
(Flying Personnel Research Committee, Air Ministry) FPRC Memo 128 Nov. 1959
AD- 317 619

ABSTRACT: Four subjects were tested for visual acuity in 10 conditions of vertical sine-wave vibrations at frequencies between 1 and 3 cps and amplitudes between 1.125" and 4.5". Visual acuity test material vibrated in phase with the subject was found to decrease as either amplitude or frequency increased. At frequencies between 1 and 2.5 cps acuity was found to regress linearly on peak acceleration. A more marked decrement of acuity at 3 cps is attributed to body resonance.

The results are discussed with special reference to their bearing on aircrew performance in high-speed low-level flight.

211

Drazin, D. H. 1960 THE EFFECTS OF VIBRATION ON VISION. (Ergonomics Res. Soc. Annual Conf., March 1960.)

213

Drazin, D. H. & J. C. Guignard 1960 SOME EFFECTS OF LOW FREQUENCY VIBRATION ON VISION.
Proc. 5th Euro. Cong. Aviation Med., London, 1960.

214

Drazin, D. 1960 OSCILLATORY MOTION IN FLIGHT.
Proceedings of the 5th European Congress of Aviation Medicine

215

Drazin, D. H., & J. C. Guignard 1962 SOME EFFECTS OF LOW FREQUENCY VIBRATIONS ON VISION. In Barbour, A. B., & H. E. Whittingham, eds., Human Problems of Supersonic and Hypersonic Flight (New York, Oxford, London, Paris: Pergamon Press, 1962) pp. 339-342

216

Drechsler, B. and V. Styblova 1957 ELECTROMYOGRAFICKA STUDIE U PRACUJICICH VYSTAVENYCH MECHANICKYM OTRESUM. (Electromyographic study of workers exposed to mechanical vibrations.) Pracovni lek. 9:292-298

217

Drogichina, E. A. & N. B. Metlina 1959 K KLINIKE VIBRATSIONNOI BOLEZNI (The Clinical Picture of Vibration Sickness).
Klinicheskaia Meditsina (Moscow) 37(1):104-110, Sept. 1959 (In Russian, with English summary)
(Translation Services Branch, Foreign Technology Div., Wright-Patterson AFB, Ohio) Translation FTD-TT-62-539/1, 20 April 1962. ASTIA ATI 280 946

ABSTRACT: The clinical picture of vibration sickness is extremely diverse. The symptomatology includes local vasomotor derangements of the axon reflex type, and a genreal systemic reaction evoked by the effect of vibration on reflexes. Foue stages of the disease are distinguished. The first two stages are characterized by reversible vasomotor disorders, while in the third and fourth stages the pathologic process becomes stabilized and may lead to more or less permanent damage. The severity and course of the disease depends not only on the duration and intensity of the vibration, but also on the individual sensitivity of the organism to that particular vibration. High frequency vibration ahs the most adverse effects on the human organism. Experimental findings show that the extent of injury varies with the individual and is related to a deficiency in the endocrine and autonomic nervous systems. Current concepts in the treatment and prophylaxis of vibration disease are discussed.

218

Drogichina, E.A. & N.B. Metlina 1962 K KLINIKE VIBRATSIONNOI BOLEZNI, VYZVANNOI VOZDEISTVIEM OBSHCHEI VIBRATSII (ON THE CLINICAL PICTURE OF VIBRATION SICKNESS CAUSED BY THE ACTION OF GENERAL VIBRATION)
Gigiena truda i professional'nye zabolevaniia (Moskva), 6 (7): 19-22. July 1962. In Russian, with English summary (p. 22)

ABSTRACT: Vibration sickness provoked by whole-body vibration manifests itself in a specific syndrome: autonomic polyneuritis accompanied by sympathalgia, disturbances of the vibration sense,and other sensations received by skin receptors, disturbances of the autonomic nervous system, and changed capillary circulation in the fingers. Diagnostic importance is attached to the lateration of the pulse in the arteria dorsalis pedis, resembling endarteritis. Other symptoms include vestibular pathology with lateral nystagmus, functional disturbances characteristic of neurotic reactions, and hyperthyroidism. Vibration disease is reversible and amenable to treatment.

219

DuBois, A.B., A.W. Brody, D.H. Lewis, and B.F. Burgess 1954 RESPONSE OF CHEST WALL, ABDOMEN AND DIAPHRAGM TO FORCED OSCILLATIONS OF VOLUME.
Fed. Proc. 13: 38

ABSTRACT: Previous studies tested the frequency response of the lung-thorax system to sinusoidal air pumping at the mouth by comparing inflow to the mouth with transthoracic pressure. This permits separation of the total impedance to breathing into resistive, elastic and inertial components. To test whether

the chest wall, diaphragm and abdomen move together or as separate systems, velocity pick-ups (magnet and coils) were placed on the body surface during such sinusoidal pumping. At 7-11 cps. Velocity over the upper anterior chest was in phase with mouth pressure in 10 supine subjects and a maximum occurred in velocity and displacement, (.11 to .24 mm at a pump stroke of 14 cc.) At 5-8 cps the abdomen showed a maximal amplitude (1.3-1.9 mm at pump stroke 56 cc), by the ballistocardiograph in 6 subjects (.14- .29 mm at pump stroke 56 cc.) At 1-2 cps the anterior chest and abdominal surface moved together, in phase. At higher frequencies, the surface motion of the abdomen lagged the upper chest and this lag increased caudally. Above 4 cps the lower chest also lagged the upper.

220

DuBois, A.B., A.W. Brody, and D.H. Lewis. 1956 OSCILLATION MECHANICS OF THE LUNGS AND CHEST IN MAN. J. Appl. Physiol., 8:587-594

ABSTRACT: The chest was driven by an oscillating air pump which generated sinusoidal pressure waves at the mouth or around the body and the over all impedance of the chest was measured by a pressure gage and flow-meter, at frequencies from 2 to 15 cps. The frequency response characteristics of the chest wall were measured with velocity transducers and indicated probably resonant frequencies of 7-15 cps. The frequency response characteristics of the diaphragm and abdomen were indirectly deduced from measuring velocity of the abdominal surface and headward-footward velocity of the body with respect to the table, and was found to be about 6 cps. The airways can probably be characterized as a resistance-capacitance system leading to the chest wall and diaphragm which may be represented as a visco-elastic massive surface exhibiting both perpindicular and transverse surface waves in response to the driving thoracic pressures.

221

Duffner, L. R., & L. H. Hamilton 1960 EFFECTS OF LOW-FREQUENCY HIGH-AMPLITUDE VERTICAL SINUSOIDAL VIBRATION ON RESPIRATION IN HUMAN SUBJECTS. Fed. Proc. 19:374

ABSTRACT: Although man is exposed to low-frequency whole-body vibration whenever he travels, little is known of the physiological effects of this environmental factor. The effects of sinusoidal vibration on respiration were investigated with 10 normal male subjects. Vital capacity, minute ventilation, breathing frequency, and expired air composition were measured before, during, and after a 4 minute exposure to vibrations of 2 to 7 cps at accelerations of 0.15 and 0.35 g. Oxygen consumption increased during vibration and dropped toward control values during the recovery period. Minute ventilation and tidal volume increased while breathing frequency decreased immediately after vibration began, remained unchanged during the entire period of exposure and returned to control values as soon as vibration ceased. Vital capacity was not significantly changed during the vibration or recovery periods.

222

Duffner, L. R., L. H. Hamilton & M. A. Schmitz 1962 EFFECT OF WHOLE-BODY VERTICAL VIBRATION ON RESPIRATION IN HUMAN SUBJECTS. J. Appl. Physiol. 17:913-916, Nov. 1962.

223

Durand, F.L., 1960 AN EVALUATION OF A PROTOTYPE NOISE EXPOSURE. (Masters Thesis, Ohio State University) June 1960

224

Dvorak, Josef 1958 ZDRAVOTNICKE PROBLEMY LETU V KOSMICKEM PROSTORU (Health Problems of Flights in the Cosmic Space) Prakticky lekar 38(10): 401-403

VIBRATION

E

225

Earmark, N. O. 1951 VIBRATION, SONIC AND MECHANICAL, ACTION ON AIR FORCE PERSONNEL. (Aero Med. Lab., Wright-Patterson Field, June 1951.

226

Echlin, F. and A. Fessard 1938 SYNCHRONIZED IMPULSE DISCHARGES FROM RECEPTORS IN THE DEEP TISSUES IN RESPONSE TO A VIBRATING STIMULUS. J. Physiol. 93:312.

227

Eckel, W. 1954 ELEKTROPHYSIOLOGISCHE UND HISTOLOGISCHE UNTERSUCHUNGEN IM VESTIBULARISKERN GEBIET BEI DREHREIZEN (Electrophysiological and Histological Investigations in the Field of the Vestibular Nucleus During Rotary Stimuli)
Arch. Ohren- Nasen- u. Kehlkopfh. (Berlin) 164: 487-513

228

Edwards, D. A. W. 1948 REPORT ON SUBJECTIVE SENSATIONS RECORDED BY AN OBSERVER EXPOSED TO HIGH INTENSITY AIRBORNE VIBRATION WITH NOTES ON OTHER PHYSIOLOGICAL EFFECTS.
(Flying Personnel Research Committee, Farnborough, England) FPRC 688(a), May 1948. ASTIA ATI 46 724.

ABSTRACT: Subjects were exposed to several noise and vibrations sources including three athodyds, a modified gas turbine, several gas turbines installed in aircraft, propeller and engine noise from high-powered reciprocating engines and synthetic aircraft noise generated by a loud-spea ker. The observer used various types of ear protection which consisted of ear plugs and helmets. Several simple neurological tests were made plus a few recofdings of the pattern of respiratory rate and minute volume. The observers efficiency was tested at different noise levels of each source and his physiological reaction noted, also the sensations felt by him. Tinnitus and temporary loss of hearing resulted in several cases. The most aggravating symptom was a superimposed tinnitus pitch of 2000 cps. Uncomfortable body sensations were experienced only during a "rough" run of the athodyds.

229

Edwards, D.A.W. 1948 FIRST REPORT ON THE EFFECT OF HIGH INTENSITY VIBRATIONS ON SOME ANIMALS (Flying Personnel Research Committee, Institute of Aviation Medicine, Farnborough, England) FPRC 688(b) May 1948, ATI42768

ABSTRACT: A series of experimental exposures of rats, mice and guinea pigs to vibrations, both air and structure borne, and covering a range of frequencies from subsonic to ultra-sonic and intensitites up to 135 db were conducted, and the reactions of these animals are described and discussed. In view of the peculiar susceptibility of rats to audiogenic stimuli they are considered to be unsuitable animals for these experiemtns. The reactions of the mice and guinea pigs used, although they may throw some light upon the psychology and physiology of these animals, do not contribute in any positive manner to a knowledge of the effects of such sources of vibration upon human beings

230

Edwards, D. A. W. 1950 SOME OBSERVATIONS ON THE EFFECTS ON HUMAN SUBJECTS OF AIR AND STRUCTURE BORNE VIBRATIONS OF VARIOUS FREQUENCIES. (RAF, Institute of Aviation Medicine, Farnborough) FPRC Rept. No. 753; ASTIA AD-115 863; Sept. 1950

ABSTRACT: A number of ground engineers working daily at test beds for gas turbines and ram jets were questioned about their experiences and sensations when exposed to the radiation from the power units. A group of civilian test pilots exployed by two firms on testing Derwent and Nene jet engines were similarly questioned. Two pilots and one ground engineer who complained of bizarre symptoms were questioned and examined in detail. A detailed study of subjective impressions of exposure to high intensity structure borne and air borne vibrations was carried out by the author. During this study attempts were made to estimate the changes, if any, in respiratory pattern and oxygen consumption associated with exposure to the vibrations. During the development of the investigation it became obvious that an improvement in the sound attenuating capacity of the standard flying helmet was an urgent need, and that a suitable method of ear protection was necessary for the comfort and welfare of aircrew and ground engineers. The principles of the design and development of ear defenders were reviewed and an attempt made to improve the existing patterns. (ASTIA)

231

Eijkman, E. & A. J. H. Vendrik 1960 DYNAMICS OF THE VIBRATION SENSE AT LOW FREQUENCY.
J. Acoust. Soc. Amer. 32(9):1134-1139, Sept. 1960.

ABSTRACT: The dynamic properties of the vibration sense in the human skin were investigated in a series of experiments. By means of psychophysical methods, threshold values with different time courses and durations were determined.. Sinusoidal deformations and deformations linearly increasing with time were used. The results were described by a simple model yielding

232

Eldred, K.M., W.J. Gennon & H.E. von Gierke 1956 CRITERIA FOR SHORT TIME EXPOSURE OF PERSONNEL TO HIGH INTENSITY JET AIRCRAFT NOISE (Wright Air Development Center, WP-AFB, Ohio) WADC T 55-355

233

Eldred K., William Roberts, and R. White 1961 STRUCTURAL VIBRATIONS IN SPACE VEHICLES. (Northrop Corp., Hawthorne, Calif.) WADD TR 61-62; ASTIA AD-273 334; Jan 1961

ABSTRACT: Study was made of forcing functions and their characteristics, methods of estimating a combined response, and proof tests required to qualify structure and equipment. The report is presented in three parts. Part One discusses the various sources of vibratory energy which can result in vehicle vibration including rocket noise, aerodynamic pressure fluctuations, wind shear and gust, meterorites and direct mechanical coupling. Part Two discusses the prediction of vibratory response through both empirical and analytical approaches, and includes a thorough discussion of the single degree of freedom system, resonance-on-resonance, panels, shells, mobility, generalized force, joint acceptance, correlations and other statistical tools. Part Three contains a discussion of fatigue and mal-function, the properties of an ideal test, implications of and methods for obtaining a simplified composite response and an examination of various test equivalences. (Author)

234

Eldredge, D. H., H. O. Parrack and H. F. Koster 1948 PHYSIOLOGICAL EFFECTS OF INTENSE SOUND. (USAF, AMC, Wright-Patterson AFB, Ohio) MCREXD Report 695-71B, May 1948.

235

Eldredge, D. H. and H. O. Parrack 1949 BIOLOGICAL EFFECTS OF INTENSE SOUND. J. of Acoustical Soc. of Amer. 21:55.

236

Eldredge, D. H., & H. O. Parrack 1950 SOUND PROBLEMS IN THE AIR FORCE U. S. Air Force Medical J. 1(4):449-461, April 1950

237

Eldredge, D. H., H. O. Parrack, & H. Davis 1951 SOME RESPONSES OF THE EAR TO INTENSE HIGH-FREQUENCY SOUND. (USAF, W-PAFB, Ohio) TR 6564, Sept. 1951

SURE

m, D.G. and L. Wheeler Jr. 1951 RESONANCE IN THE HUMAN OPERATOR. (USAF Aero Med. Lab.) Tech. Report no 5834, April 1951

ner, I. E. 1960 O BIOLOGICHESKOM DEHSTIVII ULTRAZVUKOVYKH VOLN (Biological Effect of Ultrasonic Waves) (Trans. of Zhurnal Obshchey Biologii (USSR) 15(1):18-30, 1954) (Office of Technical Services, Washington, D.C.) 60-21118

pele, K. R., & G. D. Shipway 1959 CORRELATION STUDIES OF RANDOM AND SINE WAVE VIBRATION TESTS. In 1959 Proceedings of the Institute of Environmental Sciences, Annual Technical Meeting, April 22-24, 1959, La Salle Hotel, Chicago, Illinois (Institute of Environmental Sciences, Mt. Prospect, Ill.) pp. 45-49

rnsthausen, W. 1950 SOUND AND VIBRATION IN AIRCRAFT. German Aviation Medicine, World War II (Washington: Dept. of the Air Force, 1950) Vol. 2, Chap. VII-A

ABSTRACT: This paper shows the range of amplitudes and frequencies of mechanical vibration energy to which man is exposed in aircraft, and the properties by which his organs handle this stress. The resulting effect can be greater than first seem possible.

Each impulse of energy from without is usually conveyed to the cerebral cortex and reflex centers. Sympathetic and parasympathetic fibers innervate not only the smooth musculature, but each organ, each muscle, spinal cord and spinal ganglion. Marked interference with the vegetative process is indicated by the pupillary and eyelid reflexes originating in the hearing organ; the abrupt tonus variations of the skeletal muscles during exposure to impact-like sound stimuli; the nausea, nystagmus, loss of tendon reflexes, and changes in circulation and respiration due to vibration; the paralytic phenomena due to detonation waves and the effect of high-speed shells on the nervous plexi of the abdominal cavity.

The insight gained thus far is mostly based upon independent partial results A survey devoted especially to the central coupling functions has not yet been made.

242

Ernsthausen, W., & W. W. von Wittern 1950 MEASUREMENT OF SOUND AND VIBRATION WITH REFERENCE TO PHYSICAL AND PHYSIOLOGICAL PROBLEMS OF AVIATION. German Aviation Medicine World War II (Washington: Dept. of the Air Force, 1950) Vol. 2, Chap. VII-B

ABSTRACT: This chapter discusses the theory and technique of measuring the parameters of sound and vibration. Detail of some specific transducer elements particularly of the differential transformer type is given.

243

Ernsting, J. 1961 RESPIRATORY EFFECTS OF WHOLE BODY VIBRATION. (Flying Personnel Research Committee, Gr. Brit.) Rept no. FPRC/ 1164, ASTIA AD-263 854, May 1961

ABSTRACT: The respiratory effects of vertical sinusoidal vibration applied to the buttocks of a seated subject have been investigated over the frequency range 1.7-9.5 c/s at acceleration amplitudes of up to + or - 1 g. Vibration at certain frequencies and accelerations caused a significant increase in pulmonary ventilation. At the highest frequency there was an increase in oxygen consumption. Under all the conditions investigated, however, there was a true hyperventilation as evidenced by the reduction in end-expiratory and arterial carbon dioxide tensions. At all the frequencies investigated there was modulation of the respiratory flow by the vibration. The oesophageal and gastric pressures also oscillated at a frequency equal to that applied to the subject. When a constant acceleration was applied at all frequencies the gastric pressure oscillations were greatest at a forcing frequency of 3c/s. The addition of external resistances to respiratory flow reduced the volume of gas oscillating in and out of the respiratory flow reduced the volume of gas oscillating in and out of the respiratory tract. It also reduced the degree of hyperventilation produced by a given combination of vibration frequency and acceleration.

244

Ernsting, J. and J. C. Guignard SOME EFFECTS OF LOW-FREQUENCY VIBRATION ON RESPIRATION (R.A.F. Institute of Aviation Medicine)

ABSTRACT: Pulmonary ventilation and respiratory gas exchange have been measured in man during whole-body sinusoidal vibration at frequencies from 1.7 to 9.5 c/s and acceleration-amplitudes up to 1 g. The changes observed are discussed relation to physical resonance phenomena in the seated body.

245

Ernsting, J. 1961 THE EFFECT OF WHOLE-BODY VIBRATION ON RESPIRATION. (Ergonomics Res. Soc., 1961 (In Press).

246

Errebo-Knudsen, E.O. 1953 MENNESKELEGEMET OG RUMMET (THE HUMAN BODY AND SPACE) In: Errebo-Knudsen, E.O., et al, Verdens-rummets erobring (Conquest of Space) (Copenhagen: Reitzel) Pp. 51-67

247

Errebo-Knudsen, E.O., et al 1953 VERDENS-RUMMETS EROBRING (CONQUEST OF SPACE) (Copenhagen: Reitzel, 1953)

248

Errebo-Knudsen, E.O. 1960 RUMFARTSMEDICM: DE BIOLOGISKE PROBLEMER RED OPHOLD UDEN FOR JORDENS ATMOSFAERE (SPACEFLIGHT MEDICINE: BIOLOGICAL PROBLEMS OF TRAVELING OUTSIDE THE EARTH'S ATMOSPHERE) Naturens Verden (Copenhagen), pp. 1-8, 30-32, Jan. 1960, in Danish

ABSTRACT: The results of Russian and American studies in spaceflight, as presented in papers at the 2nd World and 4th European Congress of Aviation Medicine in Rome, October, 1959, are summarized in this paper. The potential dangers in space flight are reviewed with details of Project Mercury. Various biological, neurological, and psyciological problems are reviewed. The possibility of human life on other planets in our solar system is discounted.

VIBRATION

F

249

Fanucchi, F. and L. Bussi 1943-1944 THE BIOLOGICAL ACTION OF ULTRASONICS Sperimentale 97:251

250

Faubert, D. B., B. S. Cooper, & C. C. Clark 1963 TOLERANCE AND PERFORMANCE UNDER SEVERE TRANSVERSE (±Gx) VIBRATION. (Paper, 34th Annual Meeting of the Aerospace Medical Association, Statler-Hilton Hotel, April 28 - May 2, 1963)

ABSTRACT: Seven male subjects, exposed to vertical vibration while in the supine position in a prototype Mercury couch, made 115 runs at peak couch accelerations ranging from $1G_x \pm 1G_x$ to $1G_x \pm 3.5G_x$ at 11, 22, 140 and 22 + 70 cps, and ($1G_x \pm 0.5G_x$) at 11 cps + ($1G_x \pm 4G_x$) at 140 cps. Tasks consisted of: (1) push button responses after detecting changes of two linear meters, parallel to the body y and z axes, which moved with the subject; (2) reporting meter number changes; and (3) response times to a panel abort light requiring manual operation of a panel switch. After familiarization runs, mean meter change response times were 0.5 seconds at rest, 0.7 seconds at $1G_x \pm 1G_x$ at 11 cps, 1.0 second at $1G_x \pm 2G_x$ at 11 cps, and greater than 1.5 seconds at $1G_x \pm 3.5G_x$ at 11 cps, for a short durations, after which time subject discomfort precluded further meter response. Accelerometers located on the couch and also on the chest, helmet, and hip showed acceleration ratio amplifications (to 4x at the head) which can occur in this restraint system. Blurring of the vision was judged less severe than when under equivalent G_z vibration conditions. Blurring and body acceleration ratios decreased progressively at the higher frequencies. At $1G_x \pm 2G_x$ at 11 cps, some subjects experienced severe chest pains and headaches even when straining. At $1G_x \pm 1G_x$ peak at 11 cps, which we recommend designating as $1G_x \pm 0.7G_x$ RMS with an accompanying power spectrum, here all at 11 cps, simple adequate performance was maintained for 60 seconds. Problems of vibration isolution are discussed.

251

Faubert, D.B., B.S. Cooper & C.C. Clark 1963 TOLERANCE AND PERFORMANCE UNDER SEVERE TRANSVERSE (+Gx) VIBRATION. (Life Sciences Department, Martin Company, Baltimore, Md.) Rept. ER 12838, Feb. 1963.

ABSTRACT: Seven male subjects, exposed to vertical vibration while in the supine position in a prototype Mercury couch, made 115 runs at peak couch accelerations ranging from 1Gx+1Gx to 1Gx+3.5Gx at 11, 22, 140, and 22 +70 cps, and (1Gx± 0.5Gx) at 11 cps + (1Gx±4Gx) at 140 cps. Tasks consisted of: (1) push button responses after detecting changes of two linear meters, parallel

to the body y and z axes, which moved with the subject; (2) reporting meter number changes; and (3) response times to a panel abort light requiring manual operation of a panel switch. After familiarization runs, mean meter change response times were 0.5 seconds at rest, 0.7 seconds at 1Gx±1Gx at 11 cps, 1.0 second at 1Gx±2Gx at 11 cps, and greater than 1.5 seconds at 1Gx±3.5Gx at 11 cps, for a short duration, after which time subject discomfort precluded further meter response. Accelerometers located on the couch and also on the chest, helmet, and hip showed acceleration ration amplifications (to 4x at the head) which can occur in this restraint system. Blurring of the vision was judged less severe than when under equivalent Gz vibration conditions. Blurring and body acceleration ratios decreased progressively at the higher frequencies. At 1Gx±2Gx at 11 cps, some subjects experienced severe chest pains and headaches even when straining. At 1 Gx±1Gx peak at 11 cps, which we recommend designating as 1Gx±0.7Gx RMS with an accompanying power spectrum, here all at 11 cps, simple adequate performance was maintained for 60 seconds. Problems fo vibration isolation are discussed. (Aerospace Medicine 34(3):254, March 1963)

252

Peddersen, W. E. 1962
THE ROLE OF MOTION INFORMATION AND ITS CONTRIBUTION TO SIMULATION VALIDITY
(Bell Aerospace Corporation, Bell Helicopter Company Division, Fort Worth, Texas)
Rep. No. D228-429-001 April ASTIA AD 281 855

ABSTRACT: The use of a motion simulator in the evaluation and testing of those display and instrumentation concepts which are central to the objectives of the Army-Navy Instrumentation Program (ANIP) poses the same question that is asked of any testing device; namely, to what extent does the device allow a valid evaluation of the developments under consideration. The ultimate in validity in such a situation would be achieved when operator behavior in the simulator corresponds precisely to control behavior in the system being simulated which, in this case, is a helicopter in all of its different flight modes. Since it is unrealistic to expect exact behavior correspondence in the two situations the task is one of determining the extent or degree of approximation.

This report summarizes the results of a series of three investigations, both simulator and flight test, designed to determine the relative proficiency allowed by motion information in the simulator in a hovering flight mode and, secondly, to determine with appropriate measures the degree to which control behavior in the helicopter is approximated by behavior in the simulator when the tasks are equivalent.

The proficiency results are reported in terms of integrated absolute error scores about the various axes defining the hovering task, and the behavioral data, that is, the data indicative of the way in which the helicopter and simulator are controlled by the operator, are presented in the form of auto-correlation functions.

253

Federov, E.K. 1962 THE DECISIVE STEP IN THE CONQUEST OF COSMIC SPACE Science and Culture (Calcutta) 28(1): 11-14, Jan. 1962

ABSTRACT: Soviet space efforts preparatory to manned space flight included studies dealing with: (1) the conditions encountered during space flight (accelerations, temperature changes, weightlessness, radiations) and means of protecting the astronaut from their effects; (2) providing normal living conditions in the space cabin; and (3) medical selection techniques and training format for astronauts. The system devised for the constant medical supervision of both the pilot's health and working capacity in all stages of flight is discussed. Y.A. Gagarin's orbital flight (April 12, 1961) is briefly mentioned.

254

Fedorov, Ye. 1961 ACCOMPLISHMENT OF THE CENTURY Izvestiya 4 cols.; 13 April 1961.

255

Fedotov, Yu. 1960 BEFORE TAKE-OFF INTO SPACE Krasnaya zvezda P. 3; 18 May 1960.

256

Fedotov, Yu. 1960 EARTH-SPACE-EARTH Krasnaya zvezda Pp. 3-4; 2 December 1960

257

Ferguson, G.H. 1940 NOISE AND VIBRATION CONTROL Can. Pub. Health J. 31:613-618

258

Finkle, A. L., & J. R. Poppen 1948 CLINICAL EFFECTS OF NOISE AND MECHANICAL VIBRATION OF A TURBO-JET ENGINE ON MAN. J. Applied Physiol. 1:183-204, Sept. 1948

9

ishbein, W.I., and L.C. Salter 1950 THE RELATIONSHIP BETWEEN TRUCK AND TRACTOR DRIVING AND DISORDERS OF THE SPINE AND SUPPORTING STRUCTURES. Reprint from Industrial Medicine and Surgery 19(9):444-445, Sept. 1950

STRACT: At least 15,000,000 persons in the United States daily or intermittent y operate trucks, farm tractors, buses, taxicabs, locomotives and construction quipment, exclusive of the huge number of operators of rough-riding equipment n the Armed Forces.

review of medical literature reveals few references to the possible etiologic ontributions of truck and tractor driving to various disorders of the spine nd supporting structures.

o far as could be determined no formal study of the occupational hazards of ruck drivers was undertaken until 1938. Even in that study the "ride problem" as completely ignored. From findings available it appears that the question f how much of a medical aspect there is to the occupational conditions inherent n the operation of rough-riding vehicles, except possibly in the field of eronautics, is one that has not received the attention and study it deserves, especially when the number of such operators is considered.

or more information on the relationship between disorders of the spine and supporting structures and the driving of trucks and tractors this survey was ade.

0

itts, Paul M. 1947 PRELIMINARY STUDIES OF THE EFFECT OF VIBRATION, ILLUMINATION AND TYPE SIZE ON LEGIBILITY OF NUMERALS
ngineering Division, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio) Serial No. TSEAA-694-1F June, 1947. ASTIA ATI 64 451 or ASTIA ATI 6672

BSTRACT: Preliminary studies were made of the effects of vibration, illumination, and type size upon the speed and accuracy with which numerals could be differentiated from one another. On a reading task requiring judgments of the similarity or difference of numerals, the effect of vibration amplitude is generally comparable to that of brightness and type size within the range of values used in the experiment. Observers can adjust effectively to different values of amplitude, brightness, or type size within fairly wide limits. However, a combination of unfavorable values may go beyond the capacity to adjust and produce significant impairment.

261

Fitts, Paul 1948 STUDIES OF THE EFFECT OF TYPOGRAPHICAL SPACING ON THE LEGIBILITY OF NUMERALS UNDER VIBRATION, BY M.N. CROOK, G.S. HARKER, A.C. HOFFMAN AND J.L. KENNEDY, TUFTS COLLEGE
(Aero Medical Laboratory , Engineering Division, Wright-Patterson AFB, Dayton, Ohio). Memorandum Report No. MCREMD-694-15 ASTIA ATI 139 063

ABSTRACT: The purpose of this report is to present the results of further

research conducted by the authors of the Institute for Applied Experimental Psychology, Tufts College under contract with the Air Materiel Command. The present study constitutes a continuation of exploratory studies of the effect of a number of interacting variables on the legibility of instruments, tables and printed matter used in aircraft. It was found that no serious difficulty should be experienced in new-type aircraft by crew members who have to read tables and charts printed according to standard practice, unless a combination of unfavorable conditions, such as poor lighting, excessive vibration and small type size, is encountered.

262

Flamme, A.L. 1931 INFLUENCE ET LIMITES PHYSIOLOGIQUES DE LA VITESSE ET DE SES DERIVES(ACCELERATIONS, CHOCS, TREPIDATIONS)(INFLUENCE AND PHYSIOLOGICAL LIMITS OF SPEED AND ITS DERIVATIVES (ACCELERATION, IMPACT, AND VIBRATION) Arch. Med. mil. 95:263-302

263

Fleisch, A. 1931 VENOMOTORENZENTRUM UND VENENREFLEXE. II. MITTEILUNG. BLUTDRUCKZUGLER UND VENENREFLEXE. (Venomotor Centers and Venal Reflexes Bloodpressure Regulator and Venal Reflexes)
Pflüg. Arch. ges Physiol. (Berlin) 226: 393-410

264

Floyd, J. 1957 BEHAVIORAL AND METABOLIC EFFECTS OF NOISE IN MICE (Master's Thesis, Department of Zoology and Entomology, Pennsylvania State University, September 1957.)

265

Flume, J. L. 1962 EFFECT OF VIBRATION AND TEMPERATURE ON THE SPECIFIC REACTIVE CAPACITY OF ANTISERUM. (School of Aerospace Medicine, Brooks AFB, Texas) SAM-TDR-62-48; March 1962

ABSTRACT: The effect of heat and shaking on the specific reactive capacity of antiserum was investigated by both precipitation and passive hemagglutination. Results indicate that, while the capacity of the antiserum to precipitate with homologous antigen is destroyed by heat, the antiserum is still capable of causing agglutination of red blood cells sensitized with the antigen. It is possible that in the heat-treated preparations of antiserum there exist protein molecules of various degrees of denaturation which are detectable by passive hemagglutination but not by the less sensitive precipitation technic. The increase in precipitability observed when antiserum is vigorously shaken might be due to a change in molecular configuration with resulting exposure of antibody reactive sites. (AUTHOR)

n, P. D. 1950 ELASTIC RESPONSE OF SIMPLE STRUCTURES TO PULSE LOADINGS. (Ballistics Research Laboratory, Aberdeen, Md.) BRL Memo Rept. No. 525

es, A. R. 1960 THE EFFECTS OF WHOLE-BODY VIBRATION ON COMPENSATORY TRACKING PERFORMANCE. (Royal Air Force, Inst. of Aviation Med., Farnborough) I. A. M. Report No. 144. May 1960.

TRACT: Two experiments are described in which subjects performing a cking task were exposed to vibrations the frequency range of which was same as that in which the bulk of vibrations recorded in aircraft during ght through turbulent air are found.

was found that exposure to vibration caused a significant impairment tracking performance, although it was not possible to derive a linear lationship between the parameters of the vibration stimulus and performance is concluded that the factors affecting performance included shoulder-dle resonance and degraded visual acuity as well as julting of the bjects' arm and hand during vibration.

rkois, H.M. and R.W. Conrad. 1953 A LARGE DISPLACEMENT AMPLITUDE MACHINE FOR PHYSIOLOGICAL APPLICATIONS. (Naval Research Laboratory, Wash.,D.C.) Report no. 4151, June 1953 ASTIA AD 15594

BSTRACT: A direct drive mechanical vibration machine was designed which roduces vertical sinusoidal excursions up to 4 inches and handles loads up o 200 lb at accelerations not exceeding 15 g. The frequency range is from 2 to 50 cps. The calibration of the amplitude scale was accurate to within % for small loads and to within 6% for large loads at high accelerations. Records are presented of the wave form of the steady state motion and of the starting and stopping transients.

Forster, F. and A. Holste 1937 THE BIOLOGICAL EFFECTS OF ULTRASONICS Naturwissen schaften 25:11-12

Foster, J. E. 1961 CORRELATION BETWEEN RANDOM AND SINUSOIDAL VIBRATION EXCITATION BY MEANS OF COMPARING ELECTRICAL NOISE GENERATED RATHER THAN THROUGH FATIGUE FAILURES. (Proceedings of the Institute of Environmental Sciences National Meeting, April 5, 6, 7, 1961, Washington, D. C.; Paper not available at publication)

271

Foster, J.E. 1961 RANDOM-SINUSOIDAL VIBRATION CORRELATION STUDY. (Collins Radio Co., Cedar Rapids, Iowa) WADD TN 61-43, ASTIA AD-267 509, July 1961

ABSTRACT: Avionic equipments were tested to determine if a correlation exicted on the basis of electrical degradation of the output signal. Two electro-mechanical equipments were used in conducting this correlation study. A description of test procedures and major components of testing equipment is given. Typical plots of empirical data are shown of each equipment indicating electrical noise response generated at particular levels of sinusoidal and random excitation. To show whether or not correlation exists between the two means of excitation, cross-plots of data at distinct frequencies were made in every plane of excitation, where feasible. The results show that no well-defined correlation exists between sinusoidal and random excitation. In some cases there was not even a distinguishable reproduction of frequency from one mode of excitation to the other. (Author)

272

Fournier, E. 1957 EFFETS PATHOLOGIQUES DES SONS, ULTRA-SONS, BRUITS ET VIBRATIONS INDUSTRIELLES (Pathological Effect of Sounds, Ultra-Sounds Noise and Industrial Vibrations)
Bulletin médical (Paris) 71: ii

273

Fowler, R.C. 1955 DAMAGE TO ANIMALS DUE TO VIBRATION. In U.S. Assistant Secretary of Defense (Research and Development) Washington D.C., Shock and Vibration Bulletin No. 22 Supplement. Pp. 16-19, July 1955.

ABSTRACT: As part of the basic problem of determining the mechanical and biological properties of the human when subjected to sinusoidal motion of varying amplitude and frequency, Navy Medical Research Laboratory has conducted an experimental survey of possible pathological consequences to small animals when subjected to severe, controlled, continous vibration. The results reported herein are preliminary, and must in no way be considered binding or conclusive.

274

Franke, E. K. 1948 MEASUREMENT OF THE MECHANICAL IMPEDANCE OF THE BODY SURFACE. USAF, Air Materiel Command, Memo Rept. No. MCREXD-695-71C, June 1948.

nke, E.K, H. Oestreicher and W.W. von Wittern 1950 PROPAGATION OF SURFACE WAVES OVER THE HUMAN BODY. Fed. Proc. 9:42

TRACT: A well established wave pattern appears on a body surface, such as t overlying the rectus femoris, when the surface is in firm contact with and ven by a small piston (diameter 1 in.) at frequencies near 100 cps. This ttern is easily observed and photographed by stroboscopic light. The wave- gth was determined by measuring through several wavelengths, the change of se of the deflection as a function of distance from the center of the piston. this purpose the vibrations were detected by a capacitative device which d the body as one electrode and a small disc at a suitable distance as the er. This arrangement did not disturb the wave propagation. Changes of pacity due to the vibrations are converted into electrical signals by operat- the condenser in a high frequency resonant circuit. The propagation veloc- y was found to be constant at about 160 cm/sec. in the frequency range 15-150 s. When the amplitude of the exciting piston is held constant, 1) at any requency the wave amplitude varies inversely with the square of the distance, d 2) at any distance the wave amplitude varies inversely with frequency. eoretical considerations concerning the wave propagation in viscous-elastic dia give a general picture of the mechanism of the waves and their relation to the elastic properties of the medium. Such considerations show also that he waves are essentially shear waves in this frequency range.

276

Franke, E. K. 1950 MECHANICAL IMPEDANCE OF THE SURFACE OF THE HUMAN BODY. J. Appl. Physiol. 3:582-590.
See also: Wright Air Develop. Center, Wright-Patterson AFB, Ohio. Tech. Rept. No. 54-24.

ABSTRACT: By means of methods previously developed for the investigation of acoustical and mechanical vibrations, the impedance of the body surface was measured. It is shown that it is possible to calculate the stiffness constant of the muscle from the results obtained. A non-linear relation between stiffness and applied pressure was established experimentally. From the impedances measured, contact time and rebound of a hammer striking the body were calculated. In this way, the results of the impedance method could be checked against those obtained with a ballistic method published recently. The agreement was satisfactory.

277

Franke, E.K. 1951 MECHANICAL IMPEDANCE MEASUREMENTS OF THE HUMAN BODY SURFACE (USAF, Wright-Patterson AFB) TR 6469
See also J. Appl. Physiol. 3:580-590

278

Franke, E. K., H. E. von Gierke, H. L. Oestreicher, H. O. Parrack & W. W. von Wittern 1951 PHYSICS OF VIBRATIONS IN LIVING TISSUES. (Aero Medical Laboratory, Air Materiel Command, Wright-Patterson AFB, Ohio) AF TR No. 6367, Feb. 1951. ASTIA ATI 108 737.

ABSTRACT: The experimental data about the behavior of vibrating body tissue for the frequency range zero to 20 Kcps are summarized. The results show that the vibratory energy is absorbed by the body surface in several ways and that for the distribution of the energy inside the body tissue in the different frequency ranges different types of wave propagation are important. The results suggested a theory where the propagation of vibratory energy in soft human body tissue is compared to the wave propagation in a viscous elastic compressible medium. The general physical conclusions of this theory are briefly outlined and the three types of wave propagation to be expected, the shear waves, the compression waves and the surface waves are characterized. By applying this theory specifically to the cases experimentally investigated where the vibrating force is applied prependiculary to the body surface it is shown that the simplified model of a vibrating sphere in a viscous elastic medium describes entirely the mechanical behavior of the body tissue. The qualitative agreement between the calculated and measured characteristics in terms of impedances was found to be sufficiently good, that it is possible to determine out of this agreement approximate values for the shear elasticity and the viscosity of the body tissue, the most important of the unknown physical constant involved in the theory. With these constants known the mechanical behavior of the body surface can be calculated for the whole frequency range from zero to about 10^6 cps in the ultrasound range. The theory enables us also to estimate from the impedance characteristic measured on the body surface, the kind of wave propagation inside the body. That is, it shows how much of the total energy entering the body is distributed in the body in the form of shear waves and how much as compression waves.

279

Franke, E.K., H.E. Von Gierke, H.L. Oestreicher, H.O. Parrack and W.W. von Wittern. 1951 PROPAGATION OF SURFACE WAVES OVER THE HUMAN BODY. (Wright Air Development Center, Wright-Patterson AFB, Ohio) A.F. Technical Report No. 6464, June 1951

Abstract: Waves propagating over the surface of the human body are theoretically and experimentally investigated. They are photographed by means of synchronized stroboscopic light and their propagation velocity and amplitude determined by an accurate electrical measuring method.

The comparison of the measured values with the results of the theoretical analysis allows the determination of the coefficient of elasticity of human tissue.

...e, E. K. 1951 MECHANICAL IMPEDANCE MEASUREMENTS OF THE HUMAN BODY ...URFACE. J. Appl. Physiol. 3:580-590
(See also USAF, Wright-Patterson AFB, Aero Medical Lab. Technical Rept. 6469)

ABSTRACT: By means of methods previously developed for the investigation of acoustical and mechanical vibrations, the impedance of the body surface was measured. It is shown that it is possible to calculate the stiffness constant of the muscle from the results obtained. A non-linear relation between stiffness and applied pressure was established experimentally. From the impedances measured, contact time and rebound of a hammer striking the body were calculated. In this way, the results of the impedance method could be checked against those obtained with a ballistic method published recently. The agreement was satisfactory.

...ke, E.K., 1952 IMPEDANCE OF THE HUMAN MASTOID.
Journal of the Acoustical Society of America, 24: 410-411

...TRACT: The impedance of the human mastoid was determined by means of ...brating piston, one end of which was placed in firm contact with the body ...rface. The impedances of several subjects were measured. The compliance ... and the resistance r were calculated from the results; the average values ...re $c = 1.5 \times 10^{-8}$ cm/dyne and $r = 1.0 \times 10^{4}$ dyne/cm/sec, for an area of ...e piston base of 1 cm^2 and an application force of 250 g. It is shown how ...e impendance depends on the area and the application force of the piston. ... critical review of the literature on the subject is given.

282

Franke, E.K., H.E. von Gierke, F.M. Grossman and W.E. von Wittern 1952 THE JAW MOTIONS RELATIVE TO THE SKULL AND THEIR INFLUENCE ON HEARING BY BONE CONDUCTION. Journal of the Acoustical Society of America, 24(2):142-146, March 1952

ABSTRACT: Opening and closing the mouth increases the sound pressure produced by bone conduction in the closed auditory canal by as much as six to ten decibels in the frequency range between 40 cps and 700 cps. This difference is explained by vibrations of the lower jaw relative to the skull. The resonance curve of this motion was measured and used to calculate the influence of the lower jaw motion on the sound level in the closed auditory canal. The results show that the measured frequency response of the difference in sound pressure open mouth vs closed mouth, may be explained entirely by vibrations of the lower jaw.

283

Franke, E. K., H. E. von Gierke, H. L. Oestreicher, H. O. Parrack, & W. W. von Wittern 1952 PHYSICS OF VIBRATION IN LIVING TISSUES. J. Appl. Physiol. 4:886-900, 1952.
See also USAF, Wright-Patterson AFB, Ohio, Aero Med. Lab. AF TR 6367, 1951.

284

Franke, E. K. 1954 THE RESPONSE OF THE HUMAN SKULL TO MECHANICAL VIBRATIONS. (Wright Air Development Center, Wright-Patterson AFB, Ohio) Tech. Rept. No. 54-24. ASTIA AD 61 817.
See also J. Accoustical Soc. Am. 28:1277-1285. 1956.

ABSTRACT: This report describes measurements of the mechanical impedance and of the resonance frequencies of the human skull. The measurements were made in the frequency range from 200 to 1,600 cps, the skull being excited to vibration by means of an electrodynamically driven piston with a small contact area. Data were obtained from living subjects, a dry skull preparation and a human cadaver. The modulus of elasticity of skull bone, calculated from the resonance frequency of the skull, is consistent with the value obtained by static measuring methods. The propagation velocity of bending waves in the skull bones, also calculated from the resonance frequency, agrees satisfactorily with the experimentally determined propagation velocity. It is shown, finally, that a vibrating spherical shell is a suitable model for the skull and describes its vibration patterns with good approximation.

285

Franke, E. K. 1955 THE MECHANICS OF VIBRATION IN THE HUMAN BODY. Supplement to Shock and Vibration Bulletin, No. 22, 7-15.

ABSTRACT: This paper discusses the principles of the application of mechanics to the human body. To illustrate the proceedure for constructing a simplified model, a few examples of work at Wright Air Development Center are presented. The mechanical behavior of the human tissue is treated as a semi-infinite visco-elastic medium and that of the whole body as a simple harmonic oscillator.

287

Franke, E. K. 1956 THE RESPONSE OF THE HUMAN SKULL TO MECHANICAL VIBRATIONS J. Acoustical Society Am. 28:1277-1285, 1956.

ABSTRACT: This report describes measurements of the mechanical impedance and of the resonance frequencies of the human skull. The measurements were made in the frequency range from 200 to 1,600 cps, the skull being excited to vibration by means of an electrodynamically driven piston with a small contact area. Data were obtained from living subjects, a dry skull preparation and a human cadaver. The modulus of elasticity of skull bone, calculated from the resonance frequency of the skull, is consistent with

he value obtained by static measuring methods. The propagation velocity f bending waves in the skull bones, also calculated from the resonance requency, agrees satisfactorily with the experimentally determined ropagation velocity. It is shown, finally, that a vibrating spherical hell is a suitable model for the skull and describes its vibration patterns ith good approximation.

88

Franke, E. K., & K. M. Hildreth 1956 LOCAL VASCULAR RESPONSE TO VIBRATIONS. (Wright Air Development Ctr., Wright-Patterson AFB, Ohio) WADC TN 56-297; ASTIA AD-97 106; July 1956

ABSTRACT: Measurements were made of the heat flow through the human body surface after stimulation by mechanical vibrations from hand tools. Studies were restricted to the frequency range between 2000 and 20,000 cycles/min; vibrations in this range are produced by light hand tools, such as hand grinders and polishers. The heat flow of 13 male subjects, whose average age was 20 yr, was determined; heat flow was used as an indication of vascular response, since vascular response accompanies any change in peripheral blood circulation. A flow calorimeter was used to measure heat flow, and a vibrating piston was used as the vibrating source. Results indicated that after vibration exposure, heat flow increased to an amount which corresponded to a dilation of peripheral capillaries. The time required for heat flow to return to a normal, previbrational level was variable from subject to subject. (ASTIA)

289

Franken, P.A. 1960 METHODS OF SPACE VEHICLE NOISE PREDICTION. (Wright Air Development Center, Wright-Patterson AFB, Ohio) WADC-TR-58-343

ABSTRACT: Possible sources of noise in space vehicle are reviewed. Information is summarized describing the various fluctuating pressure fields that may exist at the vehicle exterior. The response of the vehicle structure to these pressure fields and the resulting radiation of noise to the internal spaces are studied analytically. The need for new theoretical and experimental knowledge in specific areas is emphasized. The effects of rocket engine noise on communication and hearings are considered in detail. General comments are made concerning vehicle and equipment design for noise control.

290

Fraser, F.T. 1963 ASPECTS OF THE HUMAN RESPONSE TO HIGH SPEED LOW LEVEL FLIGHT. (Royal Canadian Air Force, Institute of Aviation Medicine, Toronto, Ontario, Canada)

ABSTRACT: As a preliminary investigation of the human response to high speed

low level flight, a T-33 aircraft was flown at not more than 100-feet AGL and approximately 400K on a selected course for a duration of about 40 minutes per run. Three pilots of differing anthropomorphic form each made several flights in varying conditions of turbulence. Continuous acceleration tracings were registered on an airborne recorder, from the seat, the "hard hat", and the pilot's hip, along with ECGs and pneumograms. A photographic record of head movement was obtained. Analysis of the tracings showed the dimensions of vertical accelerations and jolts, the predominant frequency response, etc. ECG showed no abberations, but varied in rate in association with buffeting and flying stress. Pneumograms showed the effects of buffeting on respiratory rate and pattern. A technique was devised for analysing the tracing in terms of jolt function, believed to give a closer representation of the intensity and duration of the buffeting. Subjective reports, borne out by the photographic record, indicated that on some runs the pilot was approaching the limit of his ability to control the aircraft. Pilots varied in their subjective and physiological response. (Aerospace Medicine 34(3):255, March 1963.)

291

Fraser, N. M. 1960 HUMAN PERFORMANCE UNDER VIBRATION. (National Institute of Health RF Project, Ohio State University, Columbus, Ohio) Sept. 1960; Appendix IV

292

Fraser, T. M., G. Hoover, & W. F. Ashe 1960 HUMAN PERFORMANCE UNDER VIBRATION: PHYSIOLOGICAL AND PSYCHOMOTOR RESPONSE OF A VIBRATING SUBJECT MONITORING A VIBRATING DISPLAY. (Paper, 31st Annual Meeting of the Aerospace Medical Association, Americana Hotel, Bal Harbour, Miami Beach, Fla., May 9-11, 1960)

ABSTRACT: Human subjects were serially exposed on a shake table to a spectrum of vibration that combined each of the selected frequencies and amplitudes with each of the three planes of space. Frequencies ranged from 2 to 12 cps, and amplitudes from 0.06 to 0.25 inches. While under vibration, the subjects monitored, by a control stick, a two-dimensional, visual display presented on a bank of lights mounted on the table. Error was electronically computed. Statistical analysis demonstrated differences in performance relating to frequency, amplitude, and plane. By exposing subjects under similar conditions of vibration to a nonvibrating display, differences were also observed between performance, during which both subject and display were vibrating, and performance, in which the subject only was vibrating. Physiological responses concurrently investigated included electrocardiography, electromyography, respiration, body damping, and postvibration blood pressure. Specific physiological changes were observed.

ser, T.M., G.N. Hoover, & W.F. Ashe 1960 ASPECTS OF THE PHYSIOLOGICAL RESPONSE TO WHOLE-BODY VIBRATION
er, American Physiological Society Fall Meeting. Stanford, California. August 23, 1960

4

ser, T.M., G.N. Hoover, and W.F. Ashe. 1961 TRACKING PERFORMANCE DURING LOW FREQUENCY VIBRATION. Aerospace Med. 32(9):829-835, Sept. 1961.

STRACT: Healthy subjects were exposed to harmonic sinusoidal vibration in randomly selected combinations of 3 planes, 4 frequencies, and 4 plitudes, namely 2, 4, 7, and 12, cps, and 1/16, 1/8, 3/16, and 1/4 inch. ter training to proficiency in the nil vibration state, the subjects' rformance of a similarly vibrating tracking task was measured. Measurements re also made of the ability of vibrating subjects to track a non-vibrating sk.

crement in performance was observed related to plane, and to function of plitude modified by a fractional exponent of frequency.

significant difference was observed between the performance of a vibrating sk and non-vibrating task.

95

Fraser, T.M. 1961 THE PATHOLOGY OF LOW FREQUENCY VIBRATION. (Presented at the 4th Joint Committee on Aviation Pathology, Toronto, Oct., 1961.)

ABSTRACT: This paper reviews the literature selecting evidences for traumatic injury as a result of vibration. Certain aspects of the physiological responses to vibration are reviewed in their relationship to secondary pathology. Several approaches to a study of vibration pathology are discussed.

296

Freberg, C. R., & E. N. Kemler 1943 ELEMENTS OF MECHANICAL VIBRATIONS (New York: Wiley, 1943)

298

Freeman, D.E. 1961 VIBRATIONAL SPECTROSCOPY IN OPTICS AND SPECTROSCOPY (Tufts U., Medford, Mass.) Scientific rept. no. 2, ASTIA AD-266 394, November 1961

ABSTRACT: Since 1959, when the Optical Society of America commenced cover-to-cover translation of the Russian journal, Optika i Spektroskopiya, the translated version, Optics and Spectroscopy, has contained about 150 articles in the field of vibrational spectroscopy. The quality of the translations in high and merits the close attention of spectroscopists. This review, dealing with the period from January, 1959 until March, 1961, is not intended to be exhaustively comprehensive but is focussed on selected topics, so that some articles, especially those of a more empirical nature, are omitted. (Author)

299

Frenzel, H., K. Hinsberg, and H. Schultes 1933 [METHOD OF EXPERIMENTAL STUDY OF BIOLOGICAL ACTION OF ULTRASONIC WAVES] Z. ges. exptl. Med. 89: 246-251

300

Freundlich, H., K. Sollner and F. Rogowski 1932 BIOLOGICAL ACTION OF ULTRASONIC WAVES Klin. Wochschr. 11: 1512-1513

301

Frings, H., C. H. Allen and I. Rudnick 1948 THE PHYSICAL EFFECTS OF HIGH INTENSITY AIR-BORNE ULTRASONIC WAVES ON ANIMALS. J. of Cellular and Comparative Physiology. 31:339-358.

302

Frings, H., M.Frings & A. Kivert 1950 BEHAVIOR PATTERNS OF THE LABORATORY MOUSE UNDER AUDITORY STRESS - AND APPENDIX (Pennsylvania State College, State College, Pa.; AMC, Wright-Patterson AFB, Dayton, O.) AF-TR-6028; September 1950, ATI 85939

ABSTRACT: Mice of three strains (albino, C-57, and dba) were tested for susceptibility to audiogenic seizure over the age range 15 to 50 days. The sound stimulus was a 10 kc per sec note at an average intensity of 99db. The seizure pattern and pre-seizure behavior of the mice as well as the seizure susceptibility as affected by age, sex, and strain of mice are discussed. The apparatus used in the experiment, which allows control of the sound stimulus in the study of audiogenic seizure in rodents, is described. It was found that there were few inter-strain or sex differences in behavior or in incidence of seizures. In general, C-57 mice seem least susceptible and dba mice most susceptible, but great individual variation in susceptibility and pattern was observed even within the same litter. The analysis of commercial mouse diet and dog-biscuit distributed by two companies is appended.

, H. and I. Senkovits 1950 DESTRUCTION OF THE PINNAE OF WHITE MICE BY HIGH INTENSITY AIR-BORNE SOUND. (U. S. A. F., Air Materiel Command, Wright-Patterson AFB, Ohio) USAF TR No. 6029, July 1950 (Unclassified, English).

, W.J. and V.J. Wulff 1950 EFFECT OF ULTRASOUND ON NERVOUS TISSUES. Fed. Proc. 9:45

RACT: Ultrasound was applied to peripheral nerve, crayfish ventral nerve and spinal cord of the frog. Ultrasound was without effect on excitability form of the spike potential or propagation velocity of peripheral nerve, after prolonged exposures. The excised crayfish ventral nerve cord exposed ultrasound exhibited a reduction of spontaneous activity after several onds exposure and recovered its original activity about one minute after the rasound was turned off. Frogs positioned so that ultrasound was incident on dorsal surface over the lumbar enlargement evidenced paralysis of the hind s after 4.3 seconds exposure (at room temperature) and produced paralysis er 7.3 seconds exposure (at 1°-2°C.) Histological examination of the sciatic ves showed extensive degeneration of nerves and examination of the spinal d exhibited a maximal rise of 1° - 2° C. The spinal cord of intact frogs ibited temperatures rises as great as 40° C. By using frogs cooled to 1° C. reducing the ultrasound exposure to two 4.3-second pulses interrupted by minute cooling off period, it was demonstrated that temperature rises did not ceed 15°C. and that paralysis of the hind legs occurred during the second 4.3 cond exposure. Similar experiments on frogs (room temperature) indicated aralysis upon exposure to ultrasound pulses of 0.80 second, delivered at a rate f 2.0/sec. and no paralysis upon exposure to sound pulses of 0.010 second delivered at a rate of 20/sec., yet the latter procedure produced a higher cord temperature than the former.

05

Fry, W.J. and R.B. Fry 1953 TEMPERATURE CHANGES PRODUCED IN TISSUE DURING ULTRASONIC IRRADIATION.
Journal of the Acoustical Society of America 25:6-11, Jan. 1953.

ABSTRACT: This paper is concerned with the technique of temperature measurement in living tissue during irradiation by high intensity ultrasound. The intrepretation of data obtained by the use of thermocouples is presented. The specific biological object used in this study is the spinal cord of rats exposed by laminectomy. This particular preparation serves to illustrate the relative importance of the heat conduction process in contributing to the temperature change as a function of the proximity of the imbedded thermocouple to bone and the time elapsed after initiation of the exposure.

The ultrasonic frequency used in these studies was 980 kc. The sound intensities incident on the cord were between 60 and 80 watts/cm^2. The experimental results presented in the paper are used to obtain values for the acoustic absorption coefficient of the tissue of the spinal cord. The range of values obtained for the intensity absorption coefficient per centimeter from measurements made on six adult rats at various positions in the spinal cord is 0.19 to 0.23 if the heat capacity of the tissue at constant pressure is 1.00 calorie/cm^3.

306

Fry, W.J. and R.B. Fry 1954 DETERMINATION OF ABSOLUTE SOUND LEVELS AND ACOUSTIC ABSORPTION COEFFICIENTS BY THERMOCOUPLE PROBES - EXPERIMENT. Journal of the Acoustical Society of America 26:311-317, May 1954.

ABSTRACT: A stable, readily constructable thermocouple probe has been developed to determine absolute sound levels in ultrasonic fields in liquid media. This paper includes criteria for design of such probes and a discussion of experimental measurements made with such a device.

It is a consequence of the method that if the sound intensity at an appropriate size thermocouple junction imbedded in an absorbing medium is known the acoustic absorption coefficient of the material can be determined. The method thus makes possible the determination of absorption coefficients of minute quantities of material.

The probe consists of a thermocouple imbedded in a sound absorbing medium which closely matches in density and sound velocity the medium in which the sound level is to be determined. In use the transducer which generates the acoustic field is excited to generate sound pulses with a rectangular envelope. The initial time rate of change of the temperature at the thermocouple junction is determined. In addition to the measurement of the temperature change, the calculation of the absolute sound intensity requires only a knowledge of the absorption coefficient of the imbedding material and its heat capacity per unit volume at the temperature at which the measurements are made.

The experimental results include a comparison of the sound level determined by a thermocouple probe and a determination by radiation pressure methods. The values obtained by the two methods agree within the uncertainty of the experimental measurements.

307

Fry, W.J., Fry, F.J., Fry, R.B., Tucker, D. and Welkowitz, W. 1954 PHYSICAL ACTION OF INTENSE HIGH FREQUENCY SOUND ON VERTEBRATE TISSUE. (Wright Air Develop. Center, Air Research and Develop. Command, Wright-Patterson AFB, Ohio) WADC Techn. Report 54-152, September 1954. ASTIA AD 56 536.

ABSTRACT: This report reviews the work accomplished on contract AF33(038)20922 from its inception to January 1, 1954. The work has included an extensive investigation of the physical mechanism of the action of sound on tissue. Tissue of both the central nervous system and of muscle has been used in the work. A new type of acoustic probe has been developed as a primary result of this work. Another result evolving from the temperature study has been a method of measuring acoustic absorption coefficients of tissue. Additional studies of the physical mechanism of acoustic action on the tissue have been concerned with cavitation. Histological studies of irradiated tissue have been made and a more extensive histological investigation is planned. Studies in which tissue of the central nervous system is irradiated show that both reversible and irreversible effects can be produced by the sound. (Part B of this report is catalogued by ASTIA as AD 151 086)

308

Fry, W. J., J. F. Brennan & J. W. Barnard 1957 HISTOLOGICAL STUDY OF CHANGES PRODUCED BY ULTRASOUND IN THE GREY AND WHITE MATTER OF THE CENTRAL NERVOUS SYSTEM.
In Elizabeth Kelly, ed., Ultrasound in Biology and Medicine. (Washington: American Institute of Biological Sciences, 1957) Chap. VII, pp. 110-130.

309

Fry, W. J., L. D. Dreyer, & F. Dunn 1958 PHYSICAL ACTION OF INTENSE HIGH FREQUENCY SOUND ON VERTEBRATE TISSUE. (Wright Air Development Division, Wright-Patterson AFB, Ohio) WADD TR 54-152, Part II; ASTIA AD-151 086, Mar.

ABSTRACT: The work described and the results presented in Part A of this report relate to the initiation of an elaborate series of experiments designed to yield information regarding the fundamental physical mechanisms involved in the irradiation of biological materials with ultrasound. The work was undertaken to demonstrate that it is possible to realize accurately reproducible results on a suitably prepared and precisely irradiated biological specimen. In Part B some aspects of the muscle contraction problem are discussed and an elaborate precision muscle irradiation laboratory, including a new type of myograph are discussed. Results with this instrument are not included. Part A of this report is catalogued by ASTIA as AD 56 536.

310

Fryer, D. I. 1960 PHYSIOLOGICAL EFFECTS OF DYNAMIC EXPOSURE TO RAM PRESSURES (Paper, 31st Annual Meeting of the Aerospace Medical Association , Americana Hotel, Bal Harbour, Miami Beach, Fla., May 9-11, 1960)

311

Fusco, M. P. Piccoli, O. Elmino & A Rossi 1962 [THE MODIFICATIONS OF BLOOD COAGULATION IN EXPERIMENTAL ANIMALS (RABBITS) SUBJECTED TO VIBRATIONS.] Boll. Soc. Ital. Biol. Sper. 38:1007-1008, 31 Oct. 1962 (It)

312

Fusco, M., P. Piccoli, O. Elmino & A. Rossi 1962 [BEHAVIOR OF THE PERIPHERAL CIRCULATION IN ANIMALS SUBJECTED TO VIBRATIONS]
Boll. Soc. Ital. Biol. Sper. 38:1009, 31 Oct. 1962 (It)

313

Fusco, M., O. Elmino, A. Rossi, & A. Silvestroni 1962 COMPORTAMENTO DEL CIRCOLO PERIFERICO IN ANIMALI SOTTOPOSTI A VIBRAZIONI. (Behavior of Peripheral Circulation in Animals Subjected to Vibrations) Folia medica (Napoli), 45(11):1051-1058. Nov. 1962. In Italian.

A study was made of the behavior of the peripheral rheogram and the cutaneous temperature in two groups of rabbits subjected to vibrations. In the first group an increase in cutaneous temperature by about 3° C., and increase of the presystolic wave of the rheogram was seen after an hour of vibration. These changes were reversed within 24 hours. In the second series, the animals were subjected to vibration for 15 days, for one hour daily, and readings were taken at 24-hour intervals after the last vibration. No changes were observed in relation to the initial readings. Blood stasis, with vibratory microtrauma, appears to affect the blood vessel wall by conditioning it to a dyskinetic state first, and then to a spasmic state, thereby inducing the complex disease syndrome caused by vibrating instruments.

VIBRATION

G

14

aeuman, J. V., G. N. Hoover & W. F. Ashe 1961 OXYGEN CONSUMPTION DURING HUMAN VIBRATION EXPOSURE.
(Paper, 32nd Annual Meeting of the Aerospace Medical Association, Palmer House, Chicago, Ill., April 24-27, 1961)

ABSTRACT: Human subjects were exposed to whole body vibration at varying amplitudes and frequencies. They were seated unrestrained on a shake-table and free to assume the most tolerable posture which would also permit them to periodically carry out a fairly difficult tracking task. Oxygen consumption, carbon-dioxide elimination, and respiratory volume were measured and compared to resting controls in an attempt to estimate the amount of voluntary and involuntary protective muscular activity involved during vibration. (Aerospace Med. 32(3): 231, March 1961)

15

euman, J.V., G.N. Hoover, and W.F. Ashe. 1962 OXYGEN CONSUMPTION DURING HUMAN VIBRATION. Aerospace Med. 33: 469-474

STRACT: The data support the hypothesis that human subjects can tolerate severe degrees of whole body vibration if they are unrestrained and allowed to protect themselves. This protection is apparently a function of positioning the body and by voluntary and involuntary muscular garding to dampen the vibration and reduce the transmission of stress to the vulnerable body areas. These efforts result in an increase in metabolic activity which is strikingly reflected in oxygen uptake. At levels of 6-15 cps, near the primary and secondary body resonance points, the increase in oxygen consumption is nearly linear with increasing frequency of vibration. The magnitude of increased metabolic load resulting from this effort is not extreme, but significant; and since it must be a constant effort, it is sufficient to be a subustantial contributor to fatigue in subjects exposed to vibration over extended periods of time. On the other hand, there is objective evidence of a sedative and sommolent effect of vibration at 2 cps, which is well below body resonance. It may be these vibrations are responsible for the subjective dorwsiness occuring in persons exposed to vibrations of machinery and vehicles.
Finally, there appears to be an induced hyperventilation at 6 cps, possibly as a result of the resonance of the abdominal organ mass producing diaphragmatic pressure, or alterations in respiratory mechanics induced by physical discomfort. One may speculate on the possibility of respiratory alkalosis sufficient to contribute to impaired function.

316

Gagge, A.P. 1945 HUMAN FACTORS IN AIRCRAFT DESIGN.
(U.S. AAF-ATSC, Engineering Division, Aero Medical Laboratory)
TSEAL-3-3-695-53, 29 May 1945.
See also Air Surgeon's Bulletin, 2(9):298-301, 1945.

ABSTRACT: This paper deals with all the problems of human factors except the question of design arising in connection with instruments and controls. Such items as g tolerances; visual acuity, depth perception, night vision, sound tolerance; temperature, altitude tolerance, and space requirements.

317

Galef, A.E. 1960 A QUASI-SINUSOIDAL VIBRATION TEST AS A SUBSTITUTE FOR RANDOM VIBRATION TESTING
(Paper, 28th Symposium on Shock, Vibration and Associated Environments, The Departmental and Commerce Auditoriums, Washington, D.C., February 9-11, 1960)
Published in ASTIA AD 244 857

ABSTRACT: A vibration test, using a modulated sinusoid, is shown to be a reasonable compromise between the random vibration often measured in the field and the sinusoidal vibration of many test specs. It may be performed with existing electrodynamic shakers with only minor modifications, the input required is relatively insensitive to damping in the test specimen, and a good approximation to a Rayleigh distribution of stress amplitudes can be attained.

318

Galkin, A.M., A.R. Kotova, A.V. Petrov, et al. 1958 ISSLEDOVANIIA ZHIZNEDEIATEL'NOSTI ZHIVOTNYKH PRI POLETAKH V GERMETICHESKIKH KABINAKH RAKET DO VYSOTY 212 KM. (STUDIES ON VITAL FUNCTIONS OF ANIMALS DURING FLIGHTS IN HERMETIC CABINS OF ROCKETS UP TO 212 KM)
In: Preliminary Results of Scientific Researches on the First Soviet Artificial Earth Satellites and Rockets, Articles XIth, Section of I G Y Program (Rockets and Satellites) No. 1 (Moscow, Academy of Sciences, 1958)
Pp. 112-129. JPRS/DC-288: 5-28.

ABSTRACT: Medico-biological investigations during rocket flights into the atmosphere have been conducted systematically in the Soviet Union since 1949, for the purpose of studying shifts in certain physiological functions, behavior of the animals during flights, and any bodily changes as a result of the flights. In 1957, 14 dogs (only 5 dogs are listed, although some were flown 2 or 3 times) were flown in pairs (1 anaethetized, the other normal) in hermetically sealed biopacks on 7 distinct flights to altitudes of 62 to 130 miles. Pre- and post-flight examinations included blood, chest X-ray, EKG, blood pressure, respiration and pulse, urinalysis, temperature, and body weight. Blood pressure, pulse, and respiration were registered during 3-hr. training periods in the cabin and during centrifuge training. A telemetric control system registered the compartment shell temperature, thermoinsulating lining, and barometric pressure inside the cabin. Physio-

logical functions were measured by means of pickoffs, amplifying units, automatic pressure devices, electric clocks, and automatic optical recording devices. Motion pictures were taken at intervals during flight. The state of the physiological functions was not successfully registered during all parts of the flight projectory, inasmuch as abrupt changes in the direction of action G-stresses interfered with instrument operation and caused sharp animal movements which were reflected in the quality of the recordings. Some data are illustrated, although data are cited for determining the extent of experimental successes. Conclusions were as follows: (1) The vitally necessary conditions were guaranteed by the hermetically sealed cabin. (2) Acute disorder in the physiological functions did not occur, and no postflight changes in behavior were observed. (3) The pulse and respiration rates and the blood pressure of the conscious animals increased during the active part of the flights. During the period of dynamic weightlessness the registered physiological parameters were maintained at a high level for the first two to three minutes, with a tendency to decrease. The physiological indices returned to their original level within 4 to 5 mins. after dynamic weightlessness had begun. In the anaesthetized animals, the pulse rate, respiration, and blood pressure did not differ from their original values during the period of weightlessness. (4) The recovery system guarantees safe landing, although additional work is necessary to insure stabilization and more favorable deceleration conditions during the nose sections' fall from altitudes of 200 km and higher.

319

Sanshina, A. N. 1961 [SOME DATA ON THE COMBINED EFFECT OF RADIATION AND VIBRATION ON AN ANIMAL BODY. (MORPHOLOGICAL STUDY)] Med. Radiol (Moskva) 6:71-75, May 1961 (Russian)

320

Gantmakher, F.P., and M.G. Krein 1950 OSCILLATION MATRICES AND KERNELS AND SMALL VIBRATIONS OF MECHANICAL SYSTEMS. (Translation, Atomic Energy Commission) AEC-TR-4431

ABSTRACT: The purpose of this book is to introduce the reader to a new circle of algebraic ideas, which, in our opinion, represents a natural mathematical base for the investigation of the so-called oscillation properties of small harmonic oscillations of linear elastic continua.

321

Garcia-Austt E., and Migliaro, E.G. 1959 EFFECT OF MECHANICAL VIBRATION ON THE ELECTROCORTICOGRAM. An Fac Med Montevideo 44:285-92

322

Garrill, R.A. & F.W. Snyder 1957 PRELIMINARY STUDY OF AIRCREW TOLERANCE TO LOW-FREQUENCY VERTICAL VIBRATION. (Boeing Airplane Company, Wichita, Kansas) Document No. D3-1189, Issue No. 36, Contract No. AF 34(601)-2975

ABSTRACT: Five aircrewmen were subjected to vertical harmonic motions of frequencies ranging from 3 to 30 cps with input accelerations ranging to a maximum of over 2.5 g. The subjective judgments of the effect of the vibrations on the aircrewmen were reported by them in terms of a 5-point scale. The results of the subjective judgment tests indicate that aircrewmen are able to tolerate unexpectedly high levels of vibratory acceleration for relatively short periods at the frequencies explored. Transmissability of vibration from supporting structure adjoining the seat to just under the body of the seated airman varied with frequency. Generally, the higher frequencies were transmitted with a greater loss in amplitude of vibration (or g's) than were the lower frequencies.

The same aircrewmen performed a tracking task while being subjected to vibration of various amplitudes and frequencies. The magnitude and duration of error in tracking was electrically integrated to produce a comparable score for each vibration condition. It was tentatively found that there were statistically significant decrements in performance under vibration conditions which were judged to be nearly "intolerable." In addition, there were some notable individual differences in response to the various vibration conditions.

323

Garrote, V.M. 1946 VIBRATIONS, NOISES AND TOXIC SUBSTANCES IN AERO MEDICINE Gac. med. espan. 20:284-288

324

Garrote Vega, M. 1946 VIBRACIONES RUIDOS Y SUSTANCIAS TOXICAS EN MEDICINA AEREA. (Vibration, noise and toxic substances in aviation medicine.) Gac. Med. espan. 20:284-288

325

Gaspa, P. 1953 PROBLEMES PHYSIOLOGIQUES POSES PAR L'ASTRONAUTIQUE (PHYSIOLOGICAL PROBLEMS POSED BY SPACE FLIGHT) Rev. path. gen. comp. 53: 1485-1503

326

Gauer, O., H. Savely, & R. Edelberg 1952 DISCUSSION AT THE PANEL SESSION DURING THE 19TH SYMPOSIUM ON SHOCK AND VIBRATION. (Wright Air Development Center, Wright-Patterson AFB, 10-11 Sept. 1952)

327

Gauer, O., & J.P. Henry 1953 PHYSIOLOGY OF FLIGHT. Air Force Manual 160-30 (Washington, D.C.: U.S. Government Printing Office, July 1953) p. 133-134.

328

Gazenko, O.G. & V.B. Malkin 1960 BIOLOGY OF COSMIC FLIGHTS (BIOLOGIYA KOSMICHESKIKH POLETOV)
(Aerospace Technical Intelligence Center, Wright-Patterson AFB, Ohio) Trans. No. F-TS-9899, Oct. 1960 ASTIA AD 257 712
Original Source: Nauka i zhian' 11: 17-22 (and p. 2 of centerfolds), 1958

ABSTRACT: Tests with animals carried in rockets up to 110 km showed normal reactions, insofar as they withstood acceleration and retardation satisfactorily, and blood pressure, pulse, and breathing increased only slightly. At heights up to 212 km, especially unfavorable effects were noticed at re-entry of the rockets into the atmosphere. However, the problem of re-entry of 450 km has been solved. Soviet researchers are especially concerned with the problem of re-entry of passengers from space ships. Great difficulties have yet to be overcome in solving re-entry at supersonic velocities. The effects of acceleration are being thoroughly studied, whereby it was found that acceleration of 10 G may be endured for several minutes. However, acceleration should be considerably lower than this to maintain operating ability. The authors describe the different operation of re-entry from a cosmic flight; catapulting of pressure cabin from the space ship, slowing down of descent by means of reactive drives and parachute, and finally landing of the cabin with a parachute.

329

Gazenko, O.G. & V.I. Yazdovskiy 1961 SOME RESULTS OF PHYSIOLOGICAL REACTIONS TO SPACE FLIGHT CONDITIONS
Paper: XII th International Astronautical Congress in Washington, D.C., Oct. 4, 1961

ABSTRACT: In this discussion of the problems of overload and weightlessness, it is noted that a direct dependence of blood oxygenation on the rate of the blood stream testifies to the active participation of hemodynamics of pulmonary circulation in the oxygenation of the blood in the lungs. Thus, active rearrangement of pulmonary circulation can within certain limits insure the preservation of the necessary blood oxygenation level. However, in view of the apparent inequality of the volumes of blood ejected by the right and left ventricles, and taking into account the progressive storage of blood in the lungs, it is difficult to imagine the possibility of enduring increased gravitation for a lengthy period of time. In the study of the mechanisms of the action of overloads on the central nervous system, tests with aminazine as a means of blocking the impulsation at the level of the reticular formation of the middle brain offer promise. The differences in the frequency of pulse and breathing registered by Gagarin and Titov in centrifugal tests and during actual flight are attributed to emotional stress. With regard to weightlessness, the definite instability which has been indicated in the central apparatus which controls vegatative functions probably results from a change in the afferent impulses. Titov noted unpleasant sensations of vestibular character during the entire period of weightlessness. These require a careful analysis. (CARI)

330

Gazenko, O.G. 1962 SOME PROBLEMS OF SPACE BIOLOGY
Akademiya nauk SSSR. Vestnik (Moskva) 32(1): 30-34, Jan. 1962

ABSTRACT: The General Assembly of the Otdeleniye biologicheskikh nauk Akademii nauk SSSR (Department of Biological Sciences of the Academy of Sciences USSR) met in Moscow in 1961 to discuss problems of space biology. Over 30 reports were made and three films shown. N.M. Sisakyan, V.V. Parin, V.N. Chernigovskiy, and V.I. Yazdovskiy reported on "Problems of Space Biology and Physiology." In the report "Some General Results of Medical and Biological Experiments on Cosmic Earth Satellites", O.G. Gazenko, A.M. Genin, and V.I. Yazdovskiy discussed the main results of the biological experiments. The following three main problems exist at present in space biology: (1) clarification of effect of extreme factors of space on living terrestrial organisms; (2) elaboration of the biological fundamentals of safeguarding space flight; and life on other planets; (3) investigation of the conditions and forms of life beyond the earth. The factors of space flight affecting living organism may be divided into three groups: (1) overstrain, vibrations, engine noise, weightlessness; (2) ultraviolet, infrared, and visible ranges of radiation, ionizing radiation, concentration of gas and solid matter, temperature conditions, etc.; (3) insulation, restricted space, peculiarities of the microclimate, rhythm of life, nutrition, etc. The cosmonauts Yu. A. Gagarin and G.S. Titov are mentioned. Under the effect of weightlessness, the two Soviet cosmonauts felt a change of heart beat, diziness, and sickness. The effect of overstrain and protective measures are serious problems. Perfection of biotelemetry is of great importance for the development of space biology. Lately, methods have been elaborated, permitting to study the coordination of arbitrary movements of man and the blood supply to the brain. (CARI)

331

Gazenko, O. 1962 SPACE BIOLOGY
(Joint Publications Research Service, Washington, D.C.) JPRS-16677
Transl. from Nedelya (Moscow), Aug. 5-11, 1962, Pp. 6-7

ABSTRACT: This article discusses the role of biology in the space sciences in terms of the effects of the space environment on living organisms, and of the methods for selecting and training the astronaut. The space environment problems covered are weightlessness, overloading, radiation, and psychological stresses. The importance of considering these psychological factors when selecting astronauts is considered, and methods of training under isolated conditions are described.

332

Geldard, F.A. and B. Gilmer 1934 A METHOD FOR INVESTIGATING THE SENSITIVITY OF THE SKIN TO MECHANICAL VIBRATION. J. Gen. Psychol 11: 301-310

See Also: Psychol. Abstr. 9: 2589 (1935)

333

Geldard, F.A. and B.vH. Gilmer 1935 A METHOD FOR INVESTIGATING THE SENSITIVITY OF THE SKIN TO MECHANICAL VIBRATION Psychol. Abstr. 9:2589
See Also: J. Gen. Psychol 11:301-310

ABSTRACT: The authors describe an adequate method and an efficient apparatus for the investigation of skin sensitivity to mechanical vibration.

334

Geldard, F. A. 1940 THE PERCEPTION OF MECHANICAL VIBRATION: I. HISTORY OF A CONTROVERSY.
J. gen. Psychol. 22:243-269, 1940.

335

Geldard, F. A. 1940 THE PERCEPTION OF MECHANICAL VIBRATION: II. THE RESPONSE OF PRESSURE RECEPTORS.
J. gen. Psychol. 22:271-280, 1940.

336

Geldard, F. A. 1940 THE PERCEPTION OF MECHANICAL VIBRATION: III. THE FREQUENCY FUNCTION.
J. gen. Psychol. 22:281-289, 1940.

337

Geldard, F. A. 1940 THE PERCEPTION OF MECHANICAL VIBRATION: IV. IS THERE A SEPARATE "VIBRATORY SENSE"?
J. gen. Psychol. 22:291-308, 1940.

338

Geldard, F. A. 1953 THE HUMAN SENSES (New York: John Wiley & Sons, Inc., 1953).

339

Generales, C.D. J., Jr. 1960 SPACE MEDICINE AND THE PHYSICIAN.
New York State J. of Medicine 60(11):1741-1761, June 1, 1960.

ABSTRACT: Reviews the background of man's desire to travel through interplanetary space from year 1500 A.D. Discusses various aspects of space medicine,

including psychological problems of weightlessness, isolation, day-night cycle. Lists human factors in space travel which need further research. The task of space medicine is to adjust man to space environmental conditions which affect him physically and psychologically.

340

Gerathewohl, S.J. & G.R. Steinkamp 1958 HUMAN FACTORS REQUIREMENTS FOR PUTTING A MAN INTO ORBIT
In: Hecht, F., ed., IXth International Astronautical Congress, Proceedings, 1958. (Vienna: Springes - Verlag, 1959)

341

Gerhardt, H.J. & H. Wagner 1962 DIE WIRKUNG DOSIERTER GERAUSCHBELASTUNG AUF DIE MIKROFONPOTENTIALE DER MEERSCHWEINCHENSCHNECKE (THE EFFECT OF MEASURED NOISE STRESS ON THE COCHLEAR MICROPHONICS IN THE GUINEA PIG)
Archiv fur Ohren-Nasen-und Kehlkopfheilkunde (Berlin), 179(5): 458-472.

ABSTRACT: Guinea pigs were exposed to white noise at intensities of 105 decibels, 120 db., and 130 db. The effects were investigated by registering the frequency spectrum of the cochlear microphonic (Mp). The decrease of the Mp under noise stress extended over the entire frequency spectrum. Statistical analysis showed an increasing decline of the Mp in the direction of the low end of the spectrum. There were no dips dimilar to the "c^5 dip" in man. Diagrams of the degree of noise damage in relation to noise intensity and duration of exposure reveal that under a critical threshold for noise stress, noise of any duration of exposure does not have an adverse effect on hearing, but above this threshold noise damage increases sharply linear to stress intensity. The decline of the Mp is largest in the beginning of exposure. The stress effects are already marked after 30 minutes.

342

Gertel, M. 1961 DYNAMICS OF HORIZONTAL VIBRATION TESTING
In 1961 Proceedings of the Institute of Environmental Sciences National Meeting, April 5, 6, 7, 1961, Washington, D. C. (Mt. Prospect, Ill.: Institute of Environmental Sciences, P. O. Box 191) pp. 577-584

SUMMARY: In summation, a dynamic analysis of the rotation-translation coupling problems inherent in horizontal (and vertical) vibration testing has been presented with the objective of pointing out how these problems can be minimized. It has been shown that a slip plate or oil table device embodies a high effective rotation stiffness which is ideally suited to minimizing crosstalk due to rotation coupling. Further, the limitations of slip tables with respect to allowable driving force eccentricity and useful frequency range has been presented in order to promote more effective utilization of these devices by vibration test engineers. (AUTHOR)

43

Retline, G. L. 1955 VIBRATION TOLERANCE LEVELS IN MILITARY AIRCRAFT. Supplement to 22nd Shock and Vibration Bulletin. (Office of Secretary of Defense, Washington, D. C.) pp. 24-27.

ABSTRACT: In light of Air Force experience with operation of military aircraft, the author seeks to correlate presently available data on the levels of vibration discomfort and tolerance.

44

Riedt, R.R. 1958 VIBRATION MEASUREMENTS AND THEIR MEANING. (Paper, presented at the American Rocket Society Semi-Annual Meeting, Statler Hotel, Los Angeles, Calif., June 9-12, 1958) ARS 619-58

45

Rillings, W.H. 1950 THE EFFECTS OF INTERPLANETARY FLIGHT Brit. Interplan. Soc. J. 9: 105-107, May 1950

46

Rilmer, B. von H. 1935 THE MEASUREMENT OF THE SENSITIVITY OF THE SKIN TO MECHANICAL VIBRATION. J. Gen. Psychol. 13:42-61. See also Biol. Abstr. 10:10930 (1936)

47

Rilmer, B.v.H. 1936 A STUDY OF THE REGENERATION OF VIBRATORY SENSITIVITY J. Gen. Psychol. 14:461-462

48

Glanvill, A. D., et al. 1937 THE MAXIMUM AMPLITUDE AND VELOCITY OF JOINT MOVEMENTS IN NORMAL MALE HUMAN ADULTS. (Wright Air Development Ctr., Wright-Patterson AFB, Ohio) WADC TN 55-159 See also Human Biology 9:197-211

349

Goldberg, M.N., R.A. Mills & W.V. Blockley 1960 INSTRUMENTATION PACKAGE FOR INFLIGHT PHYSIOLOGICAL STUDIES. (North American Aviation, Inc., Los Angeles, Calif.) WADD TR 60-83, Feb. 1960. ASTIA AD 236 039.

ABSTRACT: An instrumentation package was developed for the monitoring of pilot physiological status during flights in the X-15. Data recorded include electrocardiograph signals, respiratory flow rates, skin and deep body temperatures, and helmet-suit and suit-cockpit pressure differentials. Environmental and flight tests were performed to determine the characteristics of the package and to survey subject response during stress. The package is capable of driving a pulse duration modulation (PDM) system for telemetering pressure data. Descriptions of the components and methods of use are included.

350

Goldman, D. E. 1946 MECHANICAL FORCES - TABLE I. ESTIMATED TOLERANCES OF UNPROTECTED HUMAN BODY TO VARIOUS MECHANICAL FORCES. J. Aviation Med. 17(5):426-430, Oct. 1946.

ABSTRACT: Aviation personnel, especially those in military service, are subjected to a wide variety of mechanical forces including changes in ambient pressure, acceleration, wind blast and vibration as well as the forces associated with parachute escape, crashes, explosions and missile casualties. Little is known of the actions of these forces or of means of protection against them.

Eventually it should be possible to accumulate a background of information sufficient to permit generalizations and to allow specific predictions to be made as to tolerances and requirements for protection.

A listing of complexities must be made to enable an intelligent choice to be made of methods for handling problems which must be solved.

A first step, the performance of a structural analysis of the human body, involves a study of the geometrical and physical layout and the determination of the elastic properties of the various parts and connections.

Secondly, a vibration analysis should yield considerable information of value. Resonance measurements can be used to find natural frequencies, damping coefficients, effective masses and spring constants.

From such orderly investigations, it should be possible to learn a great deal about basic physiology and some of its practical consequences. A table of human tolerance limits of various grades and for various forces is essential for engineers concerned with the design of aircraft and of other machinery involving close human association.

351

Goldman, D.E. 1947 VIBRATION STUDIES ON THE HUMAN BODY. In SHOCK AND VIBRATION BULLETIN NO. 2 - MARCH 1947 (Office of Naval Research, Naval Research Lab., Washington, D.C.) ATI 75123

ABSTRACT: The ultimate practical purpose of shock and vibration studies is to set up safety limits at various levels, and to find out the requirements for protective devices. A joint project has been set up, in which the Naval Research Laboratory is responsible for the engineering and physical aspects, and the Naval Medical Research Institute for the biological and medical aspects. A brief discussion of the various projects is given. One of the projects includes a vibration table on which human subjects can be subjected to vibrations in the frequency range from 2 to 30 or 40 cycles per second, at accelerations up to 10 g. Further, accelerometers are being obtained which are small enough and light enough to be attached to various parts of the body without interfering seriously with the mechanical properties of the body.

352

Goldman, D. E., 1948 EFFECT OF MECHANICAL VIBRATION ON THE PATELLAR REFLEX OF THE CAT. Am. J. Physiol., 155: 78

ABSTRACT: Experiments on the effects of mechanical vibration on the patellar reflexes of the cat confirm observations that such vibration produces an inhibition. It is shown that the inhibitory phenomenon is readily explained on the basis of vibratory excitation of the reflex itself. The autonomic nervous system plays no direct part in the phenomenon. The inhibition appears between 10 to 30 cps and fades out gradually above 300 cps with the apparatus used. It is suggested that the inhibitory phenomenon may underline certain effects of the exposure of man to mechanical vibration or intense sound.

353

Goldman, D. E. 1948 THE EFFECT OF MECHANICAL VIBRATION ON THE PATELLAR REFLEX OF THE CAT. (Nav. Med. Res. Instit., Nat. Naval Med. Ctr, Bethesda, Md) Proj. NM 004 001, Rept. No. 2. Pp. 1 - 4, 17 Mar. 1948.

354

Goldman, D. E. 1948 A REVIEW OF SUBJECTIVE RESPONSES TO VIBRATORY MOTION OF THE HUMAN BODY IN THE FREQUENCY RANGE 1 TO 70 CYCLES PER SECOND. (Naval Research Institute, Naval Medical Center, Bethesda, Md.) Proj. No. NM 004-001, Rept. No. 1. ASTIA ATI 47 359

ABSTRACT: Analysis has been given of measurements made by several investigators on subjective responses to mechanical vibration. It has been found possible to refer them to three levels; 1. the threshold of perception, 2, the threshold of discomfort, and 3. the threshold of tolerance.

A set of reference curves of amplitude vs frequency has been obtained subject to an estimated uncertainity of about 1/2 a log unit. The shape of these curves appears referable to the combined effects of mechanical resonance of body structures and to the frequency characteristics of the sensory mechanism involved.

Under certain conditions a cautious application of these reference curves to practical field situations may be made.

355

Goldman, D. E. 1952 MECHANICAL VIBRATION AND ITS EFFECTS ON MAN. (Naval Medical Research Institute, Besthesda, Md.) Lecture and Review Series No. 52-1; ASTIA AD-6179; 6 Feb. 1952

ABSTRACT: Reprint of a lecture delivered as part of the Training Course for Public Health Officials on "The Acoustic Spectrum" given by the School of Public Health, University of Michigan, February 5-8, 1952. A general discussion is given of low-frequency mechanical vibration in the range from one to a few hundred cycles per second with special reference to its effects on man. Matters taken up include the relevant physical properties of tissue, vibration(perception) thresholds of persons seated or standing on vibrating supports, subjective responses, physiological and pathological effects. Applications to industry and transportation are suggested and the need for further experimental work is emphasized. (Author)

356

Goldman, D.E. 1952 MECHANICAL VIBRATION AND ITS EFFECTS ON MAN in Noise - Causes, effects, measurement, costs, control (Ann Arbor, Mich.: Univ. of Mich. Press, 1952), pp 54-58

357

Goldman, D.E. and J.R. Richards 1954 THE MEASUREMENT OF HIGH FREQUENCY SOUND VELOCITY IN MAMMALIAN SOFT TISSUES. (Naval Medical Research Institute National Naval Medical Center, Bethesda, Maryland) Proj. no. NM 004 005.03.07

ABSTRACT: A two crystal interferometer for rapid measurement of sound velocity in liquids and soft animal tissues is described. Velocities can be determined to within three parts per thousand with a path length of a few millimeters. The frequencies used are 1,2,4,12, and 36 mc. Temperature is controlled to 0.1°C. A phase comparison method is used for wave length incorporating a dual heterodyne reduction to audio-frequency with presentation as a Lissajous figure on an oscilloscope. Results are given for a few mammalian tissues showing the precision and reproducibility of measurements.

dman, D. E. 1957 EFFECTS OF VIBRATION ON MAN.
In C. M. Harris, ed., Handbook on Noise Control, (New York: McGraw-
Hill, 1957). Pp. 11-20.

TRACT: The mechanical effect of vibration on the body is to produce motion
relative displacement. Large organs may pull on supporting ligaments and
se crushing injuries to soft tissues. Thermal effects are a direct consequence
absorption of vibrational energy. None have been observed at low frequencies
many at ultrasonic frequencies where animals may be heated to a point beyond
ir capacity to dissipate the heat, with consequent thermal death. Biological
sponses to vibration represent essentially a failure of the body to remain a
ssive system. Mechanical stimulation is detected by the auditory and vestibular
tems, mechanical skin receptors, and internally located proprioceptors.
bration can affect people's attitudes, feelings and work performance. Major
juries resulting from vibrations are those of hearing loss from high-level
ise and hand injury from the continued use of vibrating hand tools. A survey
presented of the human body as a dynamic mechanical system and of the effects
vibration on man and his various parts. Included are tables of the physical
roperties of the human body, acoustical properties of soft tissues, mechanical
pedance of surface of thigh, stomach, upper arm, and mastoid.

59

Goldman, D. E. and H. E. von Gierke 1960 THE EFFECTS OF SHOCK AND
VIBRATION ON MAN
(Naval Medical Research Inst., Bethesda, Md.)
8 Jan. 1960 ASTIA AD 241 621

CONTENTS:

Tolerance criteria for various types of exposure and actual environments experienced by man
Vibration exposure
Deceleration exposure, crash, and impact

SUMMARY: (1) The determination of the structure and properties of the human body considered as a mechanical as well as a biological system.
(2) The effects of shock and vibration forces on this system.
(3) The protection required by the system under various exposure conditions and the means by which this protection is to be achieved.

360

Goldman, D.E. April 1960 THE REACTION OF THE HUMAN BODY TO EXTREME VIBRATION
(1960 Proceedings of the Institute of Environmental Sciences, C-17--)

ABSTRACT: This is a commentary on a paper presented by E.B. Magid and R.R. Coermann to the Institute of Environmental Sciences in April of 1960. The title of the paper was "The Reaction of the Human Body to Extreme Vibration."

361

Goldman, D. E. 1961 THE BIOLOGICAL EFFECTS OF VIBRATION.
(US Armed Forces, National Research Council, Committee on Hearing and Bio-Acoustics, Washington, D. C.) Contract Nonr-230005; ASTIA AD-256 926; April 1961

This report includes:
Goldman, D. E., & H. E. von Gierke 1960 THE EFFECTS OF SHOCK AND VIBRATION ON MAN. (Naval Medical Research Inst., Bethesda, Md.) Lecture and Review Series No. 60-3; 8 Jan. 1960

ABSTRACT: This report discusses the effects of vibration on man. It summarizes briefly:
(a) the measurement of vibration,
(b) the production of controlled vibratory stimulation for research purposes,
(c) the injurious effects of vibration,
(d) discomfort due to vibration,
(e) effects of vibration on task performance, and
(f) beneficial uses of vibration.
(AUTHOR)

362

Goodfellow, L.D. 1934 THE SENSITIVITY OF VARIOUS AREAS OF THE BODY TO VIBRATORY STIMULI J. Gen. Psychol 11:435-440
See Also: Psychol. Abstr. 9:2593(1935)

Dfellow, L.D. 1935 THE SENSITIVITY OF VARIOUS AREAS OF THE BODY TO VIBRATORY STIMULI Psychol. Abstr. 9: 2593
See also: J. Gen. Psychol 11:435-440

Dfellow, L.D. 1945 ARTIFACTS IN THE INVESTIGATION OF SENSITIVITY TO VIBRATION J. Exptl. Psychol. 35: 425-431
See also: Psychol. Abstr. 20:382 (1946)

Dfellow, L.D. 1946 ARTIFACTS IN THE INVESTIGATION OF SENSITIVITY TO VIBRATION. Psychol. Abstr. 20:382
See also: J. Exptl. Psychol. 35:425-431

TRACT: Six unselected female dogs were used in an experiment to determine sensitivity of a dog's foot to mechanical vibrations of various frequencies. frequency-intensity function was found to be essentially the same as that orted for human observers. Much more stable thresholds were obtained when large vibrator (area of 250 mm.^{2}) was used. None of the dogs showed a loss sensitivity to vibration after cochlear destruction. It is suggested that serious discrepancies in results which appear in the literature on the rception of mechanical vibration are the result of the failure of experiment- to realize that the amount of energy from the contactor which actually aches the end organ depends upon the proper matching of mechanical impendances.

6

oodman, B. D. 1961 THE PSYCHOLOGICAL AND SOCIAL PROBLEMS OF MAN IN SPACE: A LITERATURE SURVEY
(System Development Corp., Santa Monica, Calif.) FN-5220, 2 Mar. 1961.
ASTIA AD 252 434

ABSTRACT: This bibliography brings together the reports, books, and periodical articles published through January 1961 in the specific area of behavioral science related to space flight, or as it is sometimes call space psychology. This area includes social and sensory isolation, psychological assessment and training, fatigue, confinement, performance under stress, work schedules, motivation, weightlessness, disorientation, emotional stability and the day-night cycle.

367

Goodman, B.D. 1961 PSYCHOLOGICAL AND SOCIAL PROBLEMS OF MAN IN SPACE - A LITERATURE SURVEY
American Rocket Society Journal 31(7): 863-872, July 1961

ABSTRACT: What type of man will be able to endure for months or even years the vast silence and loneliness of space, far removed from the sounds and sights of his natural environments? What type of man can remain alert and maintain his performance, deprived of ordinary sensory stimuli, enclosed in the cramped quarters of a space capsule as it leaves Earth and all that is familiar? It is the purpose of this bibliography to bring together the reports, books, and periodical articles published thru the early part of 1961 dealing with the specific area of behavioral science related to space flight, or as it is sometimes called "space psychology." This area includes problems of confinement, isolation, sensory deprivation, weightlessness, psychological assessment and training, motivation and morale, emotional stability, boredom and fatigue, performance under stress, and work load. (Author)

368

Gord, Biermann 1931 WELTRAUMSCHIFFAHRT? EINE KURZE STUDIE DES PROBLEMS (SPACE TRAVEL? A BRIEF STUDY OF THE PROBLEMS)
(Bremen: F. Leuwer, 1931)

ABSTRACT: Early history of the physical and technical problems of rocketry with a discussion of space travel.

369

Gorrill, R. B., & F. W. Snyder 1957 PRELIMINARY STUDY OF AIRCREW TOLERANCE TO LOW-FREQUENCY VERTICAL VIBRATION. (Boeing Airplane Company, Wichita, Kansas) Document No. D3-1189, July 1957

ABSTRACT: Tests were conducted with aircrewmen to 1) determine their opinion of vibration levels of short duration for each 5 points on a subjective scale under simulated operating conditions, 2) to determine quantitatively the effects of vibration upon the capability of performing a visualmotor task, and 3) to determine the differences in vibratory g's recorded adjacent to the base of the airman's spine (under the upper fabric cover of the seat cushion) and those recorded at the table of the vibration exciter (corresponding to supporting airframe structure in the operational case).

Five aircrewmen were subjected to vertical harmonic motion of frequencies re ranging from 3 to 30 cps with input accelerations ranging to a maximum of over 2.5 g. The sujective judgments of the effect of the vibrations on the aircrewmen were reported by them in terms of a 5 point scale. The results of th subjective judgement tests indicate that aircrewmen were able to tolerate unexpectedly high levels ov vibratory acceleration for relatively short periods at the frequencies explored. Transmissibility of vibration from supporting

tructure adjoining the seat to just under the body of the seated airman varied ith frequency. Generally the higher frequencies were transmitted with greater loss in amplitude of vibration than were the lower frequencies. The me aircrewmen performed a tracking task while being subjected to vibration f various smplitudes and frequencies. The magnitude and duration of error' n tracking was electrically integrated to produce a comparable source for ch vibration condition. It was tentatively found that there were tatistically significant decrements in performance under vibration conditions hich were judged to be nearly intolerable. In addition, there were some notable ndividual differences in response to the various vibration conditions.

70

ougerot, L. 1940 EFFETS PHYSIOLOGIQUES DES FORCES D'INERTIE. ETUDE DES EFFETS CIRCULATOIRES, RESPIRATOIRES ET VESTIBULAIRES CHEZ L'AVIATEUR. (The Psychological Effects of Inertia Forces. Study of the Circulatory, Respiratory and Vestibular Effects in the Aviator) (Paris: Maloine, 1940)

71

raham, E.W. & A.M. Rodriguez 1952 RESPONSE OF SOME LINEAR SYSTEMS TO RANDOM FORCES WITH REFERENCE TO AIRCRAFT BUFFETING. (Douglas Aircraft Co., Inc., Santa Monica, Calif.) Rept. No. SM-14517, Sept. 1952. ASTIA AD 240 250.

ABSTRACT: In connection with aircraft buffeting, some studies are made of mechanical systems subjected to random forces. No attempt is made to consider an actual aircraft structure. Instead, highly simplified systems are chosen in order to clarify some of the fundamentals of the problem. Some results are reviewed for free particles and simple oscillators subjected to random forces, considering the transient response in addition to the steady state. An oscillator plus a lever is studied, the fulcrum of the lever corresponding to a nodal point for one mode of an oscillating beam. Two oscillators which are coupled through damping is present. Finally, the equations for response of a uniform slender beam are given. The forcing functions considered are concentrated at a point in space and include a single forcing frequency, a white spectrum and truncated white spectrum. (The response to the white spectrum is the Brownian motion of the system). The damping is external and applied at a point. (Author)

372

Grandpierre, R. and P. Grognot. 1955 EFFETS PHYSIOPATHOLOGIQUES DES VIBRATIONS TRANSMISES PAR L'AIR EN AVIATION: LES MOYENS DE PROTECTION. The physiopathological effects of vibrations transmitted by air in aviation; means of protection.) Med. Aeronaut. 10:309-344.

373

Granick, N. 1959 STATUS REPORT ON RANDOM VIBRATION SIMULATION. (Wright Air Development Center, Wright-Patterson AFB, Dayton, Ohio) WADC Technical Note 58-274, ASTIA AD-203125, March 1959

ABSTRACT: The status of random vibration research as it pertains to problems in simulation is reviewed critically. Areas of experimental research are suggested which eventually may determine the extent to which random vibration should be used in the laboratory. The continued use of sinusoidal vibration techniques for the simulation of noise-induced vibration appears justified on the basis of existing knowledge and economic considerations.

374

Granick, N. 1961 CHOOSING A SUITABLE SWEEP-RATE FOR SINUSOIDAL VIBRATION TESTING. In 1961 Proceedings of the Institute of Environmental Sciences National Meeting, April 5, 6, 7, 1961, Washington, D. C. (Mt. Prospect, Ill.: Institute of Environmental Sciences, P. O. Box 191) pp. 533-554

SUMMARY: Sweep-frequency vibration tests generally are conducted using a sweep-rate that varies directly with test frequency. The idea is to pass through every resonance in the frequency range such that an equal number of seconds is spent in each resonant bandwidth. The underlying assumption is that "average Q" (transmissibility) of resonances may be considered to be the same through the entire frequency range of interest. An argument will be drawn here that "average Q" actually must INCREASE with an increase in resonant frequency, for tests which employ a constant level of acceleration control. Therefore, a suitable sweep-frequency rate must be one which changes with a fractional power of the test frequency, rather than with the first power. (AUTHOR)

375

Granit, R. 1955 RECEPTORS AND SENSORY PERCEPTION (New Haven: Yale Univ. Press. 1955)

376

Grant, W. J. 1961 A STUDY TO CORRELATE FLIGHT MEASURED HELICOPTER VIBRATION DATA AND PILOT COMMENTS. (Wright Air Development Division, Wright-Patterson AFB, Ohio) WADD TR 61-66; ASTIA AD-269 001; Aug. 1961

ABSTRACT: The results of a study aimed at improving the correlation between recorded helicopter vibration data and pilot comments are presented. Lissajous' patterns of resultant displacement, velocity, and acceleration are constructed and evaluated to define those characteristics which best correlate with the pertinent pilot comments. A new measure of comfort level, Equivalent Vibration Level (Veq) is defined. These quantities are calculated for all Lissajous' figures, and resultant acceleration is seen to be the most meaningful parameter. An improvement in the degree of correlation between measured vibration and pilot comment is shown through the use of Veq for the patterns of resultant acceleration, in lieu of the standard vibration criteria. (AUTHOR)

y, K.F. 1957 MECHANICAL SYSTEMS SUGGESTED FOR G PROTECTION
ation Medical Acceleration Laboratory, Johnsville, Pa.) NADC-MA-5708, July 15, 1957

n, G.S. & J.B. Scott 1956 THE ESTIMATION OF THE OSCILLATORY MOTION OF A DECELERATING MISSILE DESCENDING THROUGH THE ATMOSPHERE (Royal Aircraft Establishment (Gt. Brit.) Dec 1956, Technical note no. GW 440; JSRP Control no. 570353, ASTIA AD-127 646.

gor'yeva, V. M. 1961 BIOLOGICAL EFFECT OF ULTRASONIC WAVES PROPAGATED IN THE AIR.
(Trans. of Gigiyena Trudy i Professional'nyye Zabolevaniya (USSR) 4(10): 35-40, 1960)
(Office of Technical Services, Washington, D. C.) 61-21335

ewold, H.E., D.M. Cunningham, and G.P. Wilson. 1955 MECHANICAL AMPLITUDE - FREQUENCY RESPONSE OF THE HUMAN BODY. Fed. Proc. 14:64

TRACT: A known horizontal harmonic force was applied to the feet of 9 and 6 women and the amplitude of body motion at the pelvis recorded. frequency of the harmonic force was varied from 1 to 24 cps. which ers the range of predominant heart components. Identical tests were made h subjects lying on a very flexible table. Amplitude of table motion also recorded. All results show that the body does not move as a single t. A predominant resonant peak occurs at from 3.5 to 5 cps. (with the ral structures acting as the spring) on the stiff table and at 1.3 cps. e loaded table natural frequency) on the low resonance table. Amplitude body motion diminishes above resonance to a fairly constant value at ut 10 cps. On the high frequency table, and at about 6 cps. on the low quency table, with secondary or tertiary resonances appearing from 6-14 ., depending on the build of the subject. Since the most important heart cited frequencies are in the range of 4 cps. and higher, the low frequency pension is more desirable in this region as it yields a flatter response d moves with the body.

381

Grognot, P. A. 1952 REACTIONS SANGUINES ET CIRCULATOIRES PROVOQUEES PAR LES VIBRATIONS ULTRASONORES TRANSMISES DANS L'AIR (Blood and Circulatory Responses to Ultrasonic Vibrations Transmitted in Air.) Journal de Physiologie (Paris) 44(2):255-259

ABSTRACT: Normally dressed healthy test subjects with their faces uncovered were exposed to ultrasonic vibrations of 25 kilohertz (25,000 cycles per second) at a constant intensity of 115 decibels. The earducts were protected by ear stoppers against side noises produced by the apparatus. After one hour of exposure, an increase in eosinophils ranging from 30 to 50%, accompanied by a decrease of arterial tension (1.5 mm. Hg), was observed in 86% of the subjects. Experiments were repeated on persons with pharyngeal and parasitic infections, with similar results. In subsequent experiments it was found that a minimum intensity of 95 decibels was required to effect an increase in eosinophils. In certain cases a lessening of the rate of eosinophil increase was observed when other parts besides the face were subjected to repeated exposures. Supersonic vibrations aimed at the epigastric region did not cause eosinophil increase. The paper concludes with an attempt of presenting a physiological interpretation of the phenomenon.

382

Grognot, P.A. 1952 EFFETS PHYSIO-PATHOLOGIQUES PROVOQUES PAR LES VIBRATIONS ULTRASONORES DE 25,000 HZ TRANSMISES PAR L'AIR (PHYSIOPATHOLOGICAL EFFECTS INDUCED BY ULTRASONIC VIBRATIONS OF 25,000 HERTZ TRANSMITTED THROUGH AIR) Medecine aeronautique (Paris), 7(4):364-370

ABSTRACT: The effects of exposure of human subjects to ultrasonic vibration of 25,000 Hertz (25,000 cycles per second) were studied. Exposure of the entire body, without shielding, resulted in a marked increase of eosinophil cells in the blood and a decrease of arterial pressure. A minimum intensity of 95 decibels was needed to produce a noticeable change in eosinophil number. When only the lower arm or the epigastric region were exposed to the vibration, increase in eosinophil cells occurred in only 50% of the subjects. - It is interesting to note that deaf-mutes or people having hearing disorders did not have any eosinophil increase, no matter what part of the body was exposed to ultrasonic vibration. - Guinea pigs and rats exposed to the same vibration developed celular lesions in the nervous system which resulted in psychomotor disturbances.

383

Gubkin, A.N., V.G. Sergiyenko and N.M. Trofimenko 1961 CONCERNING THE THEORY OF VIBRATION ELEMENTS IN ELECTRETS (Pribory i Tekhniki Experimenta, Issue Nr. 2, 1961, pp. 166-169) Technical Documents Liaison Office, Wright-Patterson Air Force Base, Ohio, Oct. 17, 1961, MCL-1405/1+2 ASTIA AD 265 741

ABSTRACT: Proposed is the theory of vibration elements, which work with the use of electrets. The results of the theory were verified experimentally on a model of the electret vibration element.

nard, J. C. 1958 THE PHYSIOLOGICAL EFFECTS OF TRANSIENT MECHANICAL FORCES. (Paper; B.I.S. Space Medicine Symposium, London, 1958.)

gnard, J. C. 1959 THE PHYSIOLOGICAL EFFECTS OF MECHANICAL VIBRATION: A SELECTED BIBLIOGRAPHY. PT. I: BODY RESONANCE PHENOMENA. (Royal Air Force, Inst. of Aviation Med., Farnborough) I.A.M. Rept. No. 124.
See also Proc. R. Soc. Med., 1959.

ignard, J.C. 1959 THE PHYSICAL RESPONSE OF SEATED MEN TO LOW-FREQUENCY VERTICAL VIBRATION: SOME PRELIMINARY STUDIES. (RAF, Institute of Aviation Medicine, Farnborough) FPRC 1062 April 1959. ASTIA AD 229 171

RACT: Vertical sinusoidal vibration was applied to 10 male subjects in tandardized sitting position, at frequencies from 7 to 60 c/s and elerations up to 1 g. Transmissibility, which is defined in these eriments as the ratio of the peak vibration acceleration recorded at part of the body concerned to that recorded from the reference accelero-ter, was measured at the hip and at the shoulder. Subjective reactions e also noted.

was found that a peak in transmissibility (with values exceeding 100 cent) indicative of resonance, occurred below 10 c/s and that at higher quencies transmissibility fell off in a characteristic way. Less than per cent of the applied acceleration was transmitted to the shoulder at quencies above 20 c/s and less than 20 per cent above 40 c/s. Trans-sibility to the hip (iliac crest) was less than 60 per cent above 20 and less than 30 per cent above 40 c/s. There was no evidence of a jor body resonance above 12 c/s.

sing appeared to increase transmissibility at all frequencies. bjectively, discomfort was greatest at the lower frequencies. Below out 12 c/s, major parts of the body appear to be excited to resonate ile at higher frequencies progressively smaller parts are affected.

x out of 10 subjects experienced some feeling of instability while being ibrated, with difficulty in holding a given posture, but there was no rsistence of these sensations after vibration ceased.

rther studies will be necessary, extending over a lower frequency range d including a larger group of subjects, in order to define the response the seated body to vertical vibration below 10 c/s and to determine ether more than one discrete peak in transmissibility occurs in this gion. It will be of practical value to determine the range of individ-l variation in response to vibration, as well as the factors (such as dy size and weight, attitude, posture and muscular tension) which may oduce variations in individual resonant frequencies.

387

Guignard, J.C. 1959 SOME EFFECTS OF LOW-FREQUENCY MECHANICAL VIBRATION ON MAN (Paper, 59th Meeting of the Engineering Physics Sub-Committee, Aeronautical Research Council, September 25, 1959, Royal Aeronautical Society, 4 Hamilton Place, London, W.1) I.A.M. Memorandum S. 19 (Scientific) ARC #21

ABSTRACT: This paper presents a brief history of vibration investigation. The physical, physiology, pathology, and physiological psychology reactions of previous research on human reaction to vibration are discussed. The approach, method, and results of current research are another phase of the paper.

388

Guignard, J.C. & P.R. Travers 1959 EFFECT OF VIBRATION OF THE HEAD AND OF THE WHOLE BODY ON THE ELECTROMYOGRAPHIC ACTIVITY OF POSTURAL MUSCLES IN MAN. (RAF, Institute of Aviation Medicine, Farnborough) FPRC Memo 120, April 1959. ASTIA AD 237 769

ABSTRACT: The influence of whole-body, head and limb vibration upon the electromyographic activity of resting and active postural muscles was observed in man. Using the RAF type 3 clinical electromyograph and concentric needle electrodes, a satisfactory trace could be obtained during trunk and limb vibration at frequencies from 2 to 10 c/s and vibrational accelerations exceeding 1.0g.

Vibration of the whole body or of a single limb at frequencies below 10 c/s elicits a periodic synchronous stretch reflex from resting postural muscles in that limb. The amount of activity observed appeared to be related to the intensity of vibration and could be reduced by restraining passive movement of the limb. Inhibition of tendon reflexes was not observed. No change attributable to local mechanical stimulation occurred in the character of maximum volitional response or in the excitability of postural muscles.
Intense vibration of the upper body, including the head, appeared to have a facilitatory effect upon statokinetic, reflex activity, the effect persisting after vibration had ceased. It is tentatively concluded that this effect might be associated with vestibular stimulation by low- frequency vibration but more precise experiments will be required to show whether this is true and whether simple vibratory labyrinthine stimulation has a direct tonic effect upon postural activity.

389

Guignard, J. C. & A. Irving 1959 EFFECT OF WHOLE BODY VIBRATION ON VISION. (RAF, Institute of Aviation Medicine, Farnborough) I.A.M. Scientific Memo. No. 21.

gnard, J. C. & A. Irving 1959 A NOTE ON THE USE OF HIGH SPEED CINEPHOTOGRAPHY IN THE ANALYSIS OF HUMAN RESPONSE TO VIBRATION. (RAF, Inst. Av. Med., Farnborough) I.A.M. Scientific Memo 13.

nard, J.C., and A. Irwing 1960 EFFECTS OF LOW FREQUENCY VIBRATION ON MAN British Assoc. at Cardiff, September 1960

ignard, J. C., P. Travers & A. Irving 1960 EFFECTS OF LOW FREQUENCY VIBRATION ON MAN. Engineering 190(4925):364-367.

uignard, J. C. & A. Irving 1960 EFFECT OF NOISE AND VIBRATION ON MAN. Nature 188:533-534.

Guignard, J. C. & D. H. Drazin 1960 SOME EFFECTS OF LOW FREQUENCY VIBRATION ON VISION. Proc. 5th European Cong. of Aviation Med., London, 1960.

Guignard, J. C. & P. Travers 1960 PHYSIOLOGICAL EFFECTS OF MECHANICAL VIBRATION . Proc. Roy. Soc. Med. 53:92-96, Feb. 1960.

396

Guignard, J. C. 1961 HUMAN FREQUENCY-RESPONSE TO VIBRATION
In SPACE MEDICAL SYMPOSIUM. Astronautik (Stockholm) 2(4):227

ABSTRACT: In exposure to infrasonic frequencies of mechanical vibration, a number of physical resonances occur in man, in particular resonance of the shoulder girdle at about 5 c.p.s. Data on the effects of vibration on task performance, visual performance, and on frequency response of eye movements will be given in the full paper.

397

Guignard, J.C. 1961 PHYSIOLOGICAL EFFECTS OF LOW-FREQUENCY VIBRATION (Paper, Symposium on Vibrations, 20 January 1961, at Imperial College, London)

ABSTRACT: This paper described some measurements of the response of the seated human body to vertical vibrations which indicated that at frequencies near 5 cy/ there was an amplification of vibrations transmitted through the trunk to the he

398

Guignard, J. C. and A. Irving 1961 MEASUREMENTS OF EYE MOVEMENTS DURING LOW-FREQUENCY VIBRATION.
Aerospace Medicine 32(3):233, March 1961

ABSTRACT: Measurements have been made of the frequency-response of compensatory and pursuit eye movements during vertical sinusoidal vibration of: (a) the man, with the target at rest; and (b) the target, with the man at rest. In such measurements it is essential to use a method which in no way impedes movements of the eye. Such a method, in which, by corneal reflection, the image of a wedge-shaped object is viewed through a slit by a photomultiplier tube, is described in this paper. The vibration frequencies investigated ranged from 0.5 to 5 cycles per second. Angular displacement-amplitudes of the target with respect to the eye of up to 2^{o} were used. The importance of normal vestibular function in determining the servo characteristics of the oculomotor system is discussed.

399

Guignard, J. C. & A. Irving 1962 MEASUREMENTS OF EYE MOVEMENTS DURING LOW FREQUENCY VIBRATION.
Aerospace Med. 33(10):1230-1238, Oct. 1962.

ABSTRACT: (1) Measurements have been made of the frequency-response of compensatory and pursuit eye movements during vertical sinusoidal vibration of (a) the man, with the target at rest; and (b) the target, with the man at rest. The angular double amplitude of relative movement between target and eye was 0.8 degree of arc in each case. (2) The eye movement recording system, in which, by corneal reflexion, the image of a triangular object is viewed through a slit by a photo-multiplief tube, is described in this paper. The resolution of the system was 2 minutes of arc. (3) Results suggest that the frequency response of compensatory eye movements fixating a static target during vibration of the man is higher than the frequency response of pursuit movements made by the still subject fixating an oxcillating target. It is tentatively concluded that otolithic stimulation during vibration of the man is mainly responsible for this difference. (4) Consumption of alcohol (1.5 cc. of whisky/kg. of body weight) lowered a subject's frequency response of eye movement in both experimental situations, but the effect was considerable greater during vibration of the man.

, E. 1954 NOISE AND VIBRATION IN RC-121D AIRCRAFT. WADC Technical Memorandum Report WCRD 54-118, SECTION VI, pp. 38-48, December 1954

llemin, J.V., & P. Wechsberg 1953 PHYSIOLOGICAL EFFECTS OF MECHANICAL VIBRATION. Amer. J. Physiol. 171:730-731

TRACT: Albino rats were kept in pens having vibrating floors made of alumi rods, thus affecting primarily the paws of the animals. The frequency the vibration was 3600 and 7200 cycles per minute, with accelerations of 8- , for 12 hours daily with a total exposure time of about 1000 hours. ults of the experiment indicated deficient vascular function (engorgement paw capillaries) measured by the delay in the rewarming of the hind paws er chilling. Forty-five minutes were needed to rewarm the paws of the reated rats; after 700 hours exposure to vibration, 90 minutes more was ded in 50% of the rats vibrated at 3600 cycles and in 75% of those vibrated 7200 c.p.s. showed complete recovery after 30 days of rest; when the posure was renewed, all pathological symptoms promptly reappeared.

illemin, V., & P. Wechsberg 1953 PHYSIOLOGICAL EFFECTS OF MECHANICAL VIBRATION. (School of Aviation Medicine, Randolph Field, Texas) ASTIA AD-5953, JAN. 1963. See also Amer. J. Physiol. 171:730-731

STRACT: Small groups of rats subjected to mechanical vibration under ontrolled conditions of duration, intensity, and frequency showed alterations f vascular tonus as expressed in terms of delayed rewarming of vibrated extremities after standard chilling. Frequencies of 3,600 and 7,200 cycles per minute and an acceleration amplitude of 8 to 9 g-units were used. Rewarming times, increased progressively with exposure time of as much as 1,000 hours, returned to normal values after a 30-day rest period, and increased again during a second period of exposure. Alterations of vascular tonus appeared earlier in rats exposed to the higher frequency. Abnormal paw capillaries were observed after prolonged vibration. Preliminary experiments showed that low oxygen tension aggravates vibration-induced vasomotor disturbances.

403

Guillemin, V. and P. Wechsberg. 1953 PHYSIOLOGICAL EFFECTS OF LONG TERM REPETITIVE EXPOSURE TO MECHANICAL VIBRATION. J. Aviation Med. 24(3):208-221.

ABSTRACT: Young albino rats were subjected to long term repetitive exposures

to vibration. One group of 8 rats was kept in a vibrating floor cage operating at 3600 cpm for a schedule of vibration totaling 1000 hours followed by a rest period of 30 days and then subjected to a second exposure of 300 hours. A second group of 10 animals was exposed to vibration at 7200 cpm for 700 hours. The physiological effect of vibration was evaluated in terms of the vascular response of the hind extremities to a standard technique of chilling. The test consisted of chilling the hind paws and legs in still, cold air until skin temperature of 57 F was reached and then rewarmed at room temperature. The normal (control) rewarming times were all under 90 minutes and mostly under 60 minutes after 1000 hours of exposure to vibration at 3600 cpm. In the second group 75% had rewarming times over 90 minutes after 7000 hours of exposure to 7200 cpm. Microscopic examination of rat paw capillaries in vivo indicated that capillaries of vibrated animals showed more tortous forms and greater engorgement than those of the controls.

404

Gullett, C. C. 1961 AEROMEDICAL ASPECTS OF TURBO-JET COMMERCIAL AIRCRAFT. Aerospace Med. 32(9):818-824.

405

Gurevich, M. I. and M. G. Sirotina 1960 ON THE EFFECT OF ULTRASONIC VIBRATIONS ON THE BLOOD
(Trans. of Fiziologichnyy Zhurnal (USSR) 6(1):73-77, 1960)
(Office of Technical Services, Washington, D.C.) 60-11942

406

Gurovskii, N. N. 1959 HYGIENIC ASSESSMENT OFTHE VIBRATION FACTOR ON THE MI-4 HELICOPTER. Gegiena i Sanitariia (Moskova) 24(3):27-33. Translation No. 59-11727.

ABSTRACT: The physiologic effects on animal and human subjects of vibrations (45 cps at an amplitude of 0.3, mm for one hour) approaching the highest frequency limits for helicopter vibrations were investigated. Initial exposure to such vibrations produced considerable changes in conditioned motor reflexes of white rats and in conditioned defense reflexes of dogs. Alterations in conditioned reflexes and lengthening of reaction times were observed in airmen exposed to vibrations on laboratory stand and during flight in the MI-4 helicopter. It was concluded that initial vibratory stimuli evoke a spread of inhibitory processes through the central nervous system of both man and animals. However, adaptation took place quite rapidly upon repeated exposure to such stimuli in all subjects studied. It appears that vibration disturbes the excitatory-inhibitory equilibrium in the cerebral cortex thus enhancing the inhibitory process of the orientating reaction-external inhibition type. The rapid and stable appearance of adaptation to vibration in the human organism indicates that vibrations of the order found in the MI-4 helicopter are permissible.

VIBRATION

H

7

ck, M. 1955 HUMAN TOLERANCE TO VIBRATION OCCURRING IN TRACTORS AND AGRICULTURAL MACHINERY.
(Translated by Engineering Research Division, John Deere Waterloo Tractor Works, Waterloo, Iowa) ASAE Winter Meeting,

s, D. L., J. R. Parks and J. F. Eichelberger 1949 VIBRATIONLESS GALVONOMETER SUPPORT. (Mound Laboratory) LC No. AECU-348.

ber, H. 1952 THE CONCEPT OF WEIGHT IN AVIATION
rnal of Aviation Medicine 23(6): 594-596, 1952

STRACT: For purposes of aviation engineering and medicine, the concept of ight is redefined. The principle of d'Alembert states that the sum of the rce of gravity, the force of inertia, and the external forces acting upon a dy is zero. The weight of the body is then the resultant external force erted upon the body by a restraining agent in response to forces of gravity d inertia. Six dynamic situations are illustrated, in which the three forces re represented as vectors.

10

aber, H. ed. 1953 PROCEEDINGS OF A SYMPOSIUM ON FRONTIERS OF MAN-CONTROLLED FLIGHT, INSTITUTE OF TRANSPORTATION AND TRAFFIC ENGINEERING, UNIVERSITY OF CALIFORNIA, LOS ANGELES, 3 APRIL 1953

STRACT: Contents include:
ippert, S., "Limitations to Noise and Vibration Control"
aber, H., "The Mechanical Environment in the Future Aircraft"
oth, H.P., "Impact and Dynamic Response of the Body"
lockley, W.V., "Combined Physiological Stresses"
ll Speakers, Panel Discussion on Frontiers of Man-Controlled Flight.

411

Haber, H. 1959 THE PHYSICAL FACTORS IN THE SPACE ENVIRONMENT. In Seifert, H. S., ed. Space Technology (New York: T. Wiley and Sons, 1959) Chapter 27

412

Hale, E.P. 1953 BEHAVIORAL AND STRESS OF SOUND ON ANIMALS (Wright-Patterson A.F.B., Ohio) WADC Technical Rept. No. 53-283, June 1953 . ASTIA AD 25577

413

Hale, H. B., R. B. Mefferd, Jr., G. Vawter, G. E. Foerster, & D. Criscuolo 1959 INFLUENCE OF LONG-TERM EXPOSURE TO ADVERSE ENVIRONMENTS ON ORGAN WEIGHTS AND HISTOLOGY. (School of Avia. Med., USAF Aerospace Medical Center, (ATC) Brooks AFB Texas) Research Rept. No. 59-13, Jan. 1959

414

Ham, N. D., H. H. Moser, & J. Zvara 1958 INVESTIGATION OF ROTOR RESPONSE TO VIBRATORY AERODYNAMIC INPUTS. PART I. EXPERIMENTAL RESULTS AND CORRELATION WITH THEORY. (Wright Air Development Ctr., Wright-Patterson AFB, Ohio) WADC TR 58-87, Pt. I; ASTIA AD-203 389; Oct. 1958

ABSTRACT: The experimentally determined flapping response (1) to harmonic variation in pitch and (2) to vertical shaking of the hub, are compared with theoretical responses calculated for three different two-dimensional, aerodynamic theories. The test data indicates that for low blade pitch angles, the returning wake shed by the rotating blade has a marked effect on the blade response at even integers of the frequency ratio $v=\omega/\Omega$, while for high pitch angles the effect of the helical wake is negligible. This agrees with theoretical calculated responses obtained with the aerodynamic theory using a modified lift deficiency function developed by Loewy. The test results indicate that wake interference effects persist for low pitch settings at advance ratios between 0 and 2. Test data obtained with a rotor-rotor type of excitation is a tandem rotor configuration are included. Results indicate that vertical hub shears of the aft rotor are increased. (AUTHOR)

415

Hamme, R. N. 1957 VIBRATION DAMPING. In C. M. Harris, ed. Handbook of Noise Control (New York: McGraw-Hill, 1957), pp14-1 to 14-30.

416

Hansen, A.T. 1949 PRESSURE MEASUREMENT IN THE HUMAN ORGANISM (Copenhagen: Teknish Farlag, 1949)

7

rdy, H.C. 1947 NOISE AND VIBRATION REDUCTION New Frontier 10:3-6

18

rdy, V.S. and K.G. Jahnel 1957 INDEX TO SHOCK AND VIBRATION BULLETINS NOS. 1 THROUGH 24. A SUBJECT INDEX AND AUTHOR INDEX (Assistant Secretary of Defense (Research and Engineering), Washington, D.C.) Oct. 1957, ASTIA AD-320 436

19

arris, C. M., ed. 1957 HANDBOOK OF NOISE CONTROL (New York: McGraw-Hill, 1957)

20

rris, J. D. 1953 RECOVERY CURVES AND EQUINOXIOUS EXPOSURES IN REVERSIBLE AUDITORY FATIGUE FOLLOWING STIMULATION UP TO 140 db PLUS. Laryngoscope 63:660-673

421

arris, W., R.R. Mackie, and C.L. Wilson 1956 PERFORMANCE UNDER STRESS: A REVIEW CRITIQUE OF RECENT STUDIES. (Human Factors Res., Inc., Los Angeles, Calif.) TR VI, July 1956. ASTIA AD 103 779.

422

arvey, E.N. and A.L. Loomis 1928 HIGH FREQUENCY SOUND WAVES OF SMALL INTENSITY AND THEIR BIOLOGICAL EFFECTS Biol. Abstr. 2:9687
See also: Nature 121:622-624 (1928)

423

Harvey, E.N. and A.L. Loomis 1928 HIGH FREQUENCY SOUND WAVES OF SMALL INTENSITY AND THEIR BIOLOGICAL EFFECTS Nature 121:622-624
See also Biol. Abstr. 2: 9687 (1928)

424

Harvey, E.N. 1929 THE EFFECT OF HIGH FREQUENCY SOUND WAVES ON HEART MUSCLE AND OTHER IRRITABLE TISSUES Am J. Physiol. 91:284-290

425

Harvey, E.N. 1929 THE EFFECT OF HIGH FREQUENCY SOUND WAVES ON CELLS AND TISSUES Am J. Physiol 90:379
See also: Biol. Abstr. 4:23928 (1930)

426

Harvey, E.N. 1930 THE EFFECT OF HIGH FREQUENCY SOUND WAVES ON CELLS AND TISSUES
Biol. Abstr. 4:23928
See Also: Am J. Physiol 90:379

427

Harvey, E.N. 1930 BIOLOGICAL ASPECTS OF ULTRASONIC WAVES, A GENERAL SURVEY
Biol. Bull. 59:306-325

428

Harvey, E.N. and A.L. Loomis 1931 HIGH SPEED PHOTOMICROGRAPHY OF LIVING CELLS SUBJECTED TO SUPERSONIC VIBRATIONS J. Gen. Physiol. 15:147-153
See also: Biol. Abstr. 6:24728 (1932)

429

Harvey, E.N. and A.L. Loomis 1932 HIGH SPEED PHOTOMICROGRAPHY OF LIVING CELLS SUBJECTED TO SUPERSONIC VIBRATIONS. Biol. Abstr. 6:24728
See also: J. Gen. Physiol. 15:147-153

430

Hasslacher, G.J., III 1959 DEVELOPMENT OF METHOD, EQUIPMENT, INSTRUMENTATION AND TECHNIQUE FOR DETERMINING THE INHERENT FRAGILITY RATINGS OF MILITARY MATERIEL. (Pennsylvania State U., University Park) Progress rept. no. 22, ASTIA AD-235 220

ABSTRACT: The evaluation of the mechanically loaded piezoelectric accelerometer is continuing. An HY 3422 HYGE accelerator and HY 3005 rail system have been installed. Several modifications to the drop tower have been made to facilitate end item testing. Initial results have been obtained on the impact testing of type 1625 electron tubes. Planning for testing of cans under impact conditions is underway. (Author)

31

Hawkes, R. 1956 AEROMEDICINE REINFORCES FRAIL MAN Aviation Week 65(6): 360-361, 363-365, 6 Aug. 1956

ABSTRACT: An overall view is presented of the basic and applied research carried out by branches of the Aero Medical Laboratory. The current ideas in research and design of oxygen systems, pressure breathing devices, and pressure suits are noted. Studies of the effects of acceleration and deceleration have culminated in the requirement of an escape capsule in all designs capable of supersonic speeds or high-altitude flight. Further, studies in aviation psychology, bioacoustics, vision in an empty visual field, and flight feeding are mentioned.

432

Hayes, W. H., D. A. Hilton et al. 1962 IN-FLIGHT NOISE MEASUREMENTS FOR THE PROJECT MERCURY VEHICLE. Langley Res. Cen., Va.) NASA TN D-994, Jan. 1962.

ABSTRACT: The main sources of noise are the rocket engines during the launch phase and the noise of aerodynamic origin during the exit phase of the flight. The rocket noise was a maximum at lift-off and decreased rapidly as the vehicle gained altitude and speed. The noise of aerodynamic origin increased generally as the dynamic pressure increased and was also affected significantly by the Mach number and the external contouring of the vehicle. (Author)

433

Heckl, M. A., R. H. Lyon, G. Maidanik, & E. E. Ungar 1962 NEW METHODS FOR UNDERSTANDING AND CONTROLLING VIBRATIONS OF COMPLEX STRUCTURES. (Aeronautical Systems Division, Wright-Patterson AFB, Ohio) ASD-TN-61-122; ASTIA AD-281 798; June 1962

ABSTRACT: New methods are outlined for dealing with the vibration responses of complex flight vehicle structures to local and to diffuse acoustic excitation. Energy absorption at structural joints and acoustic radiation resistance are shown to be important in establishing levels of these responses. Some experimental results pertaining to energy absorption coefficients and radiation resistance are given, and procedures for estimating the latter are discussed. Feasibility studies of vibration absorbers utilizing viscoelastic spring elements and distributed mass systems and of vibration isolators composed of viscoelastic leaf springs are summarized. Only the latter are found to possess some practical advantages over conventional systems. An analytical investigation is summarized, which shows that generally damping of only the plates of beam-plate systems may be more desirable than damping of only the beams. (AUTHOR)

434

Hedenius, P. 1962 [MEDICOBIOLOGICAL EFFECTS OF MECHANICAL VIBRATIONS AND RADIATION. 8. VIEWS ON THE PRACTICAL CONSEQUENCES OF THE MEDICOBIOLOGICAL EFFECTS OF MECHANICAL VIBRATIONS AND RADIATION.] Svensk Lakartidn 59:949-951, March 22, 1962 (Sw)

435

Heim, J.W. 1937 A LABORATORY FOR RESEARCH IN AVIATION. J. Aviation Med. 8(2):75-80

ABSTRACT: Discusses the physiological research laboratory of the Air Corps Materiel Division, Wright Field, Dayton Ohio. Enumerates equipment and apparatus available for research in aviation medicine. Lists projects completed and projects active (in June, 1937). (CARI)

436

Helvey, T.C. 1957 THE DISSIPATION OF VIBRATIONAL ENERGY IN THE HUMAN BODY. J. Aviation Med. 28: 202

ABSTRACT: The major limitation for a human operator in a man-machine system is caused by multiple stresses which are non-additive parameters. In a broad program on stress physiology, studies were carried out with low frequency vibration with a range of 3 to 30 cps which is frequent in high performance airplanes. Longitudinal and transverse measurements were made on the extremeties chest and torso. Significant resonant frequencies were noted for various organs and parts of the body. Some of the transverse resonance energies must be considered as deleterious for pilot performance. The longitudinal dissipation of vibrational energy in the limbs in very favorable (except at frequencies below 5 cps with peak G above 2.5), if only a vertical component with one degree of freedom is applied to the flexed limb. The measurements were made with one degree of fredom is applied to the flexed limb. The measurements were made with small accelerometers placed on biokinetically significant points and their outputs recorded with a multichannel galvanometer.

437

Helvey, T.C. 1960 STUDY IN BIOSEISMOLOGY: DISSIPATION OF VIBRATIONAL ENERGY IN THE HUMAN BODY. Astronautik (Stockholm), 2(2): 89-102

ABSTRACT: Experiments have been performed to study the dissipation of transverse and longitudinal vibrational energy in various parts of the human body. The results show that in the susonic, low-frequency range, body parts exhibit distinct resonance frequencies which in many cases can be detrimental to human performance. It has been found that there is no direct proportionality between performance decrement and discomfort caused by the vibration. A new type of human oscillator is described briefly. The equipment provides low-frequency,

amplitude random motion with three degrees of freedom. Although the ment can be used for the study of the propagation of vibrational energy in uman body, its prime purpose is the study of the mechanism of the onset isorientation and motion sickness.

er, E. & L. J. Santa Maria Feb. 1961 RESPONSE OF SUBJECTS TO SOME CONDITIONS OF A SIMULATED ORBITAL FLIGHT PATTERN. Aerospace Medicine 32(2):126-133.

RY: Some of the physiological responses of subjects wearing ventilated pressure suits and exposed to pressure and thermal profiles character- of extreme conditions of orbital flight patterns were presented. No ificant physiological stress was evidenced in subjects exposed to a fied thermal profile, except for the sweating response of one subject. ure of experienced subjects to long duration thermal loads simulating tively severe post-landing and full thermal profiles resulted in pre- e test termination when ventilating air temperature was more than a egrees above initial mean skin temperature. (Author)

ik, F., M. Hrdlicka, and J. Sprindrich 1942 [BIOLOGICAL EFFECTS OF ULTRA-ONICS] Shorn. lék 44:15

ules, W.L. 1962 SHOCK AND VIBRATION ENVIRONMENT . AN ASTIA REPORT BIBLIO-GRAPHY (Armed Services Technical Information Agency, Arlington, Va.) 15 Aug. 1962, ASTIA AD-329 865

TRACT: This bibliography was prepared by ASTIA in response to requests for ormation concerning shock and vibration environment. Citations are included classified reports cataloged by ASTIA from 1953 through 1 July 1962. Entrie arranged alphabetically by subject area. In general, the references fall hin the following broad topic areas: mechanical shock and vibration; applica s to particular fields such as space technology, naval engineering, military ipment, test facilities; and associated environments. An unclassified volume the bibliography is issued separately as AD-277 392. (U)

rrick, J.F. 1949 SOME BIOLOGIC ASPECTS OF ULTRASONICS Arch. Phys. Med. 30: 145-149

442

Hersey, I. 1959 SOVIET BIOLOGICAL EXPERIMENTS
Astronautics, 4(2): 31, 80-81 Feb., 1959
See also: J. Aviation Med., 29: 781-84, 1958

ABSTRACT: A discussion is presented of Russian biological experimentation in space flight, as reviewed by A.G. Kousnetzov, chief of the physiology depart ment of the Soviet Air Force Scientific Research Experimental Institute of Aviation Medicine in Moscow, in a paper delivered at the Third European Congre of Aviation Medicine, Louvain, Belgium, in September 1958. Soviety investigat of the effects of space flight on the human organism have been in progress sin 1949. In the initial phase, animals encapsulated in hermetically sealed cabin were rocket-flown to heights of 100-210 km. and then ejected for return to eart by parachute. In the second phase, the capsule was eliminated, and the animal (in a special high-altitude suit) was separated by catapult from the descending rocket (at heights of 75-85 km. and of 39-46 km.) and parachuted to earth. The third phase of the experiments culminated in animal-rocket launchings to a heig of 473 km. No major physiologic changes that could be regarded as resulting fr acceleration, catapult launchings, or parachute descent from any of the altitud studied were observed in the animals. A biological experiment which met all th conditions of space flight was realized with the launching of Sputnik II carryi the dog, Laika. During the crucial period between launching and the time the satellite was placed in orbit, the animal was in such a position as to sustain transverse acceleration. Data about the condition and behavior of the animal were successfully transmitted and received. Included was information on the effects of acceleration upon the frequency of heart contractions; the effects of zero-G conditions and weightlessness; the position of the dog's body in space; changes in the functional state of the nervous system; and changes in blood circulation and breathing. No physiologic manifestations of the effects of cosmic radiation on the animal were discovered.

443

Hettinger, T. 1956 DER EINFLUSS SINUSFÖRMIGER SCHWINGUNGEN AUF DIE SKELETMUSKULATUR. (Influence of sinusoidal vibrations on skeletal musculature.) Internat. Ztschr. angew. Physiol. 16:192-197.

444

Hettinger, T. 1957 THE EFFECT OF VIBRATIONS ON MUSCULAR EFFICIENCY
(Die Beeinflussung der muskularen Leistungsfahigkeit durch Erschutterungen). Internationale Zeitschrift fur angewandte Physiologie (Berlin) 16(6): 500-511

ABSTRACT: It was shown in experiments with a vibratory device and hand ergometer that: (1) work on the vibratory apparatus results in a vascular reaction which affects subsequent performance on the ergometer; (2) the duration of vibratory work does not affect the intensity of the vascular reactions; (3) adaptation occurs; (4) this adaptation is seen as resulting from increased vascularization during work on the apparatus; (5) there are considerable individual differences in performance after vibration; (6) it is possible to estimate ergometric performance on basis of skin temperature on

back of the hand after vibration; (7) people with less reactive vascular tems are predisposed to development of pathological symptoms during work jecting them to vibration; also their performance is lowered.

ter, T. F. 1958 VISCO-ELASTIC LOSSES IN TISSUES IN THE ULTRASONIC RANGE (Wright Air Development Division, Wright-Patterson AFB, Ohio) WADD TR 57-706; ASTIA AD-142 171; Aug. 1958

TRACT: The propagation of ultrasonic waves is accompanied by a loss of vibra- nal energy whose frequency dependence is characteristic of the structural pro- rties of the medium. A review of the various loss mechanisms that may occur in imal tissues or in other live colloids reveals that the different organizational vels of these structures---from the protein molecule to the gross-tissue matrix, y contribute to the losses in many different ways. A transition of low-to high- equency absorption indicative of visco-elastic relaxation processes is observed. the basis of new data, the hypothesis is advanced that low-frequency absorption due mainly to gross-tissue properties, whereas the seat of high-frequency absorp n is mainly in the molecular constituents of the tissues, i.e., in the protein lecules.

es, M. 1958 EFFECTS OF INTENSE VIBRATION, II. PHYSIOLOGY AND PATHOLOGY. (U.S. Army Medical Research Lab., Fort Knox, Ky.) Rept. No. 358.

TRACT: A detailed histo-pathological study of monkeys exposed to 10 cps at 25 and 0.150 inches peak to peak displacements for 8 hours.

eft, L. O and F. J. Leech 1958 NOISE AND VIBRATION ENVIRONMENTS CONNECTED WITH MISSILES AND SPACE VEHICLE OPERATIONS
Proceedings of the ARDC Science and Engineering Symposium, September 1958
See also (Wright Air Development Center, Wright-Patterson AFB, Ohio) July 1958. Rept. No. 3487.

STRACT: The following conclusions are made: (1) Noise from space vehicle eration may be predicted with sufficient accuracy for human factor analysis ith the exception of the re-entry phase. More measurements are needed for is phase. (2) Larger rocket motors will produce more energy at the very w frequencies because of their larger nozzle diameters. (3) Noise environ- nt should not create a barrier to manned space travel. (4) Air damping ill not exist at high altitudes, therefore, resonsance should be damped by her means. (5) For vibration the frequency range of interest is from 1/2 o 20 cps. (6) There is no preduction scheme for vibration such as we have or noise. (7) As with noise, we know practically nothing about vibration uring re-entry. This phase of space flight is expected to present a major ibration problem.

448

Hoffmann, H. & H. Kottenhoff 1962 DER EINFLUSS VON VIBRATIONEN AUF LEISTUNGSFUNK TIONEN UND EMOTIONALES VERHALTEN (THE EFFECT OF VIBRATIONS ON PERFORMANCE AND EMOTIONAL BEHAVIOR)
Internationale Zeitschrift fur angewandte Physiologie (Berlin), 19 (3): 149-167. 1962. In German.

ABSTRACT: Twenty students in the age range of 21-37 years were subjected to 30 minutes of vibration at 32 c.p.s. with an amplitude of ± 1 mm. The effects of vibration on performance were investigated before, during, and after the exposure with the following tests: (1) skill tests (Mirror drawing, figure completion, and the spiral after-effect); (2) tests of personality or emotionality (subjective emotional rating scale, continuous registration of pulse rate, Brengelmann's questionnaire, and a tachistoscopic reading test); and (3) measurement of psychomotor tone variables (writing pressure). The skill tests showed an inhibition of the retino-cortical excitability (spiral after-effect) by vibration as contrasted to a compensatory or reactive increase in efficiency on the figure-completion and mirror-drawing tests. The pulse rate rose at the beginning of vibration exposure and fell slightly at the end of the exposure period. Negative emotional states expressed on the emotional scale during vibration were reversed only 1½ hours after the end of the exposure in contrast to the quickly reversible changes of the spiral after-effect. Psychomotor tone measurements showed a state of excitation and disinhibition at the beginning of vibration, followed by cortical inhibition after vibration. These data correlated with the findings on the spiral after-effect test.

449

Honig, C. R., & S. M. Tenney 1956 GENESIS OF LATE SYSTOLIC AND DIASTOLIC BALLISTIC VIBRATIONS. (Rochester University of School of Medicine and Dentistry, New York) Contract AF 33(616)2485; ASTIA AD-140 484; 20 July 1956
See also Reprint American Heart Journal (St. Louis). Pp. 655-664, May 1957

ABSTRACT: The end-systolic ballistic deflection is dependent upon deceleration of the arterial column during reduced ejection and represents a balance between headward and footward force vectors. Aortic obstruction attenuates footward force by disturbing this balance. Pulse wave reflection may modulate end-systolic force but is not essential to its genesis. The initial diastolic vibrations are related to the magnitude and rate of change of force with aortic valve closure. The pulmonary valve contributes only under conditions of hypertension or increased flow in the lesser circuit. Vibrations subsequent to value closure vary with aortic pressure, volume, elasticity, length, and coupling and disappear when arterial resonance is abolished. The aortic standing wave therefore seems responsible for their production. Study of limbless subjects indicates that the arch vessels, iliacs, and femorals are part of the resonator in which the standing wave oscillates. Venous blood flow and ventricular relaxation do not contribute to the diastolic complex, and cardiac filling generates small vibrations unless venous return is augmented or ventricular expansion is abnormally limited. (AUTHOR)

ver, G.N., W.F. Ashe, & L.B. Roberts 1960 GROWTH AND METABOLIC RESPONSES OF RATS EXPOSED TO WHOLE-BODY VIBRATION
r, American Physiological Society Fall Meeting, Stanford, Calif. August 23, 1960.

ver, G.N. & F.R. Johanson 1960 PROBLEMS IN INSTRUMENTATION FOR DYNAMIC SUBJECTS. Proc. National Electronics Conf. 16: 659-671

ver, G. N., W. F. Ashe, J. H. Dines, & T. M. Fraser 1961 VIBRATION STUDIES, III. BLOOD PRESSURE RESPONSES TO WHOLE BODY VIBRATION IN ANESTHETIZED DOGS. Arch. Environmental Health, 3: 426-432, Oct. 1961.

TRACT: A system for the direct measurement of blood pressure in dogs osed to whole body vibration is described. Vibration forces seem to be ebraically added to the blood pressure pulse in such a manner that t frequencies are established. In addition, integration of the pulse ssure curves indicate that regulatory mechanisms bring about a small crease in blood pressure during vibration exposure.

ver, G.N. 1962 THE BIOLOGY OF THE WHOLE BODY MECHANICAL VIBRATION: AN ANNOTATED BIBLIOGRAPHY (Ohio State Univ. Research Foundation, Columbus) NIH grant RG-5348 and OH-6, June 1962

STRACT: The papers are, in general, limited to those dealing with whole body posures. Many papers have been omitted because of their inavailability at is time. Also, some contributions probably, and most likely, have been over- oked. The papers have been arranged in alphabetical order according to the ior author. In most cases the author's summary or abstract is used. To aid selecting papers, an author and subject index is appended. The literature rch for this work was closed in May 1962. (Author)

ver, G. N., & W. F. Ashe 1962 RESPIRATORY RESPONSE TO WHOLE BODY VERTICAL VIBRATION. Aerospace Medicine 33(8):980-984, Aug. 1962

MARY: Data are presented which indicate that respiratory minute volume changes served in subjects exposed to extended vertical vibration are a function of both spiratory rate and tidal volume. At a vibration amplitude of .062 inches,

the response is predominantly through rate, while at .125 inch it is mainly thr
tidal volume. The former situation seems to be correcting ventilation for a
tendency to decrease tidal volume at the lower amplitude.
Post vibration data show a trend toward lower respiratory rates and tidal volu
Pneumotachographs indicate that air flow oscillates during vibration exposures.
A limited number of estimations of this volume show it to be less than the
physiological dead space. (AUTHOR)

455

Hoover,, George N. & W.F. Ashe 1962 RESPIRATORY RESPONSE TO WHOLE-BODY VERTICAL
VIBRATION
Paper: 33rd Annual Meeting of the Aerospace Medical Association, Chalfonte-
Haddon Hall, Atlantic City, N.J., April 9-12, 1962
Reprinted: Aerospace Medicine, 33 (8): 980-984

ABSTRACT: Human subjects were exposed to whole-body vertical vibration in the seated position. The vibration frequencies were 2, 4, 6, 8, 11 and 15 cps at amplitudes of .0625 and .125 inch. The peak accelerations of vibration were from ±0.03 to ±2.88 G. Respiratory frequency was not altered significantly by these levels of vibration. Tidal volumes were increased in all but the three lowest vibration intensities. At the lower amplitude respiratory minute volume was not drastically altered. At 8, 11 and 15 cps in the higher amplitude vibrations considerable increase in was noted. The greatest increase in was seen at 11 cps, the postulated resonant frequency of the lung-thorax system. Oscillations of pneumotachograph tracings were found to coincide with the vibration frequency and in the higher frequencies appear to be greater than the amplitude of the respiratory flow itself. It is suggested that much of the increase in ventilation is a result of a forced hyperventilation and is most significant at the resonant frequencies of the chest-lung system.

456

Hoover, G. W. 1957 INSTRUMENTATION FOR SPACE FLIGHT.
In Campbell, P. A., K. Dannenberg, W. O. Roberts, H. Haber, A. S. Crossfield, G. W. Hoover, A. M. Mayo, J. P. Hagen, & H. Strughold, SPACE TRAVEL: A SYMPOSIUM. J. Avia. Med. 28:495-498

457

Hoover, G. W., 1957 PREDICTIONS FOR THE FUTURE. (PROBLEMS OF ESCAPE FROM HIGH PERFORMANCE AIRCRAFT: A SYMPOSIUM). J. Aviat. Med. 28(1):95-100.

ABSTRACT: With due consideration for all other parameters, man's psychophysiologic limitation is the constant around which any man-machine system must be designed. In the area of geophysical problems, we must protect

man against solar radiation and its effects and materials and against
ic radiation and its effects. The problems of escape, although far from
a monor consideration must be solved if man is to continue his climb
he speed and altitude curve.

aircraft of the future must meet the following requirements:
1. It must be efficient in operation.
2. It must have wide mission capability.
3. It must provide means for adeqate escape and survival.
4. It must be reliable.
5. It must be economical.

er, George W. 1958 A PROGRAM FOR SPACE BIOLOGICAL EXPERIMENTS
(American Rocket Society, 500 Fifth Avenue, N.Y. 36, N.Y.)

ick, R.J. 1961 THE RELATIVE EFFECTS OF NOISE AND VIBRATION UPON SIMPLE REACTION TIME. (Bostrom Res. Labs. Rept. No. 132, Milwaukee, Wis., January 1961)

TRACT: Eight subjects served in noise and vibration conditions to determine
relative effects of these variables upon simple reaction time (RT). No
nificant differences were found between (a) no stimulation, (b) noise,
) vibration, and (d) noise plus vibration conditions. Noise level was
sured at 87 db and the vertical vibration was 3.5 cps with g acceleration
ensity of 0.30. It was also determined that there were no trends in RT
ring any of the conditions.

0

rnick, R. J. 1961 RESEARCH INTO THE EFFECTS OF VIBRATION ON MAN
(Paper Symposium of the Midwest Human Factors Society, May 19, 1961)
(Bostrom Research Laboratories, Milwaukee, Wisc.)
BRL Rep. 136, May 1961.

STRACT: This article describes the environmental problem of whole-body
ibration and its importance in understanding the human component in a
ynamic system. A research program concerned with this problem is described;
quipment, methodology, and findings to date are summarized. Future
nvestigations are noted. (Tufts)

461

Hornick, R.J., C.A. Boetcher, and A.K. Simons 1961 THE EFFECT OF LOW FREQUENCY HIGH AMPLITUDE, WHOLE BODY VIBRATION UPON HUMAN PERFORMANCE (Bostrom Resear Labs, Milwaukee, Wisconsin) BRL Report No. E-123, July 1961

462

Hornick, R. J., C. A. Boettcher & A. K. Simons 1961 THE EFFECT OF LOW FREQUENCY, HIGH AMPLITUDE, WHOLE BODY, LONGITUDINAL AND TRANSVERSE VIBRATION UPON HUMAN PERFORMANCE. FINAL REPORT. (Bostrom Research Laboratories, Bostrom Corporation, Milwaukee, Wisc.) Contract DA 11 022 509 ORD 3300, Proj. TE1 1000, July 1961

ABSTRACT: Two experiments were conducted to determine the effects of horizontal (transverse and longitudinal) vibration upon the seated human being. Such vibration is typically found in ground vehicles. For transverse vibration frequencies from 1.5 to 5.5 cps with intensities of 0.15, 0.25, and 0.35 g were used; for longitudinal vibration the same frequencies with intensities of 0.15, 0.25, and 0.30 g were used. Measures of compensatory

463

Hornick, R.J. 1961 EFFECTS OF TRACTOR VIBRATION ON OPERATORS, A CONSIDERATION OF HUMAN FACTORS. Agricultural Engineering 42: 674-675; 696-697

ABSTRACT: The experiments revealed that man½s ability to steer or track can be significantly affected by the direction and frequency of vibration. Man's reaction time is significantly slowed following exposure to vertical and transverse vibration. Visual acuity was found not to be affected. It is believed t that vibration must be of a higher frequency for visual acuity to be impaired. Transverse vibration below 2.5 cps causes a significant loss in the effective visual field (peripheral vision) during the initial 15 min. exposure. The ability to maintain a constant foot pressure was seen to be affected adversely by vertical and transverse vibration. Impairment in foot pressure constancy seems to be a mechanical function of the frequency (error increases as frequency in vertical vibration; greatest error for below 2.5 cps in transverse vibration) and the intensity of vibration. Recovery of this ability was immediate following exposure to either vertical or transverse vibration.

464

Hornick, R.J. 1961 THE EFFECTS OF TRACTOR VIBRATION ON WORK PERFORMANCE (Bostrom Research Lab., Milwaukee, Wisconsin) BRL Report No. 131, June 1961

k, R.J. 1961 HUMAN EXPOSURE TO HELICOPTER VIBRATION: A LITERATURE VIEW. (Bostrom Research Laboratories, Milwaukee, Wis.) BRL Rept. o. 133, February 1961

CT: This review consists of four logically related sections. The first s the type of vibration found in helicopters during flight. The second n explores the subjective effects of the helicopter flight environment ned from pilot observations and complaints. The third contains analyses e objective research studies regarding the effects of vibration on man r to helicopter vibrations. The fourth section is a brief mention of ted efforts desirable in helicopter vibration research.

ick, R. J. 1962 PROBLEMS IN VIBRATION RESEARCH.
Hum. Factors 4:325-330, Oct. 1962

ick, R.J. 1962 EFFECTS OF WHOLE-BODY VIBRATION IN THREE DIRECTIONS UPON HUMAN PERFORMANCE
nal of Engineering Psychol. 1(3): 93-101, July 1962

RACT: The possible influence exerted by whole-body vibration on human ormance was investigated experimentally using three planes of vibration at frequencies and three intensity levels. Body dquilibrium was measured re and after each vibration condition. Low-frequency vibration similar to that untered in vehicles significantly impaired human performance related to control he vehicle, i.e., compensatory tracking ability, choice reaction time, foot ssure constancy, and peripheral vision may be significantly impaired during /or following vibration exposure. A certain relationship is indicated between y resonance frequencies for vertical motion (4.5 to 5.5 c.p.s.) and transverse ion (1.5 c.p.s.) and the occurrence of performance decrements as a result of ration at the same frequencies.

rnick, R. J. & R. W. Costin 1962 EFFECTS OF SPACE VEHICLE VIBRATION UPON HUMAN OCCUPANTS
Paper: 33rd Annual Meeting of the Aerospace Medical Association, Chalfonte Haddon Hall, Atlantic City, N. J., April 9-12, 1962.

STRACT: It is known that various space vehicles vibrate, especially ring periods of launch and re-entry. The characteristics of such bration are mentioned. Possible effects of this vibration on man's rformance and physiological functions are discussed based upon research nducted on humans. Effects on performance include those of compensatory racking ability, vision, reaction time, and body equilibrium. Physiological asures include oxygen consumption, breathing rate, and total ventilation.

Attention is also given to combinations of motion, body support positions, and the relationships of performance, physiological responses, and mechanical response of the human body.

469

Hornick, R. J. 1962 VIBRATION ISOLATION IN THE HUMAN LEG. Hum. Factors 4:301-303, Oct. 1962

470

Howell, W. C., & G. E. Briggs 1959 AN INITIAL EVALUATION OF A VIBROTACTILE DISPLAY IN COMPLEX CONTROL TASKS. (Ohio State Univ. Research Foundation, Columbus, Ohio) Contr. AF 33(616)-5524, Proj. RF-813, Rept. No. 813-5, ASTIA AD-230 472, 31 Oct. 1959

471

Hueter, T. F. 1958 VISCO-ELASTIC LOSSES IN TISSUES IN THE ULTRASONIC RANGE. (Wright Air Development Center, Wright-Patterson AFB, Ohio) WADC Technical Report 57-706, August 1958. ASTIA AD 142 171.

472

Hugony, A. 1935 ÜBER DIE EMPFINDUNG VON SCHWINGUNGEN MITTELS DES TASTSINNES (The Sensation of Vibration by Means of the Touch-Sense) Zeitschrift für Biologie (Munich) 96: 548-553

473

Hunsaker, J. C. and E. E. Wilson 1915 THE BEHAVIOR OF AEROPLANES IN GUSTS. (National Advisory Commitee for Aeronautics, Washington, D. C.) NACA Rept. No. 1.

474

Hunter, H.N. & M. Weiss 1953 PILOT'S ABILITY TO SIMULATE AN EMERGENCY ESCAPE WITH VARIOUS TYPES OF EJECTION SEATS WHILE SUBJECTED TO A FLUCTUATING ACCELERATION (U.S. Naval Air Development Center, Johnsville, Pa.) NADC-MA-LR1, Nov. 3, 1953 Proj. No. TED ADC AE 6303. ASTIA AD 54 281

ABSTRACT: To determine some of the difficulties a pilot experiences in operating

ejection seat under emergency conditions, three types of ejection seats, i.e., ir Force "arm rest" upward, Air Force "D-Ring" downward, and Navy "face curtain" ward were installed, respectively, in the AMAL centrifuge and tests were nducted wherein pilots were requested to execute ejection procedures under luctuating G conditions. To simulate an aircraft in an uncontrolled condition, sitive G was varied from 1.5 to 6.5 G at a rate of 8 G per second while the bject pitched and/or rolled through a maximum angle of 36°. One of the major lts found in all seats was the difficulty subjects had in retracting their t into the stirrups. Other problems encountered were the failure to properly rate the face curtain, fouling of the arm rest, and the straining to reach "D-Ring". Factors affecting the efficient use of the equipment were the thing worn and training and practice effects

5

ter, H.N. & H.S. Weiss 1954 PILOT'S ABILITY TO ACTUATE F9F-6 EJECTION SEAT CONTROLS UNDER FLUCTUATING G CONDITIONS
S. Naval Air Development Center, Johnsville, Pa.) NADC-MA-LR3 Sept. 16, 1954 ASTIA AD 70 757

TRACT: The pilots were requested to execute the maneuvers required in an -6 ejection sequence upon receipt of a signal during an acceleration stress tern. All parts of the seat that were involved with the ejection sequence the pre-ejection lever were fitted with microswitches and wired to recoders that the time required to complete all maneuvers could be determined. The eleration pattern fluctuated the positive G from 1.5 to 7.0 at 5 G/sec while subject pitched or rolled to a maximum of 70°. The maximum acceleration rate change of roll was 5.8 rad/sec^2 and the maximum acceleration rate of change pitch was 4.5 rad/sec^2. The average time for each maneuver under conditions ich included all test conditions of an emergency escape were: 3.22 sec-feet raction: 1.77 sec pre-ejection movement, and 1.71 sec face curtain actuation.

ter, H. 1955 PILOT'S ABILITY TO ACTUATE F9F-6 EJECTION SEAT CONTROLS UNDER FLUCTUATING G CONDITIONS
al Air Development Center, Johnsville, Pa.) Project TED ADC AE-6303.1, 31 Dec. 1955

TRACT: All available ejection systems (Navy, face curtain, upward; Air Force, rest, upward; and Air Force, "D" ring, downward) were evaluated by exposing and Navy pilots in full flihgt gear to fluctuating G. For upward ejections h the arm rests and face curtains were accessible to the pilot and the time uired to actuate each under simulated uncontrolled flight conditions was roximately the same. In each system the most time-consuming maneuver was cing the feet on the stirrups. For downward ejections the "D" ring was ily accessible. However, the supports to hold the feet down during ejection er operated properly.

477

Hunter, P.A. & M.W. Fetner 1963 MANEUVER ACCELERATIONS EXPERIENCED DURING ROUTINE OPERATIONS OF A COMMERCIAL TURBOJET TRANSPORT AIRPLANE. (National Aeronautics and Space Administration, Washington, D.C.) NASA TN D-1801, May 1963.

ABSTRACT: The incremental maneuver normal accelerations collected during routine commercial operations of a four-engine turbojet transport have been evaluated. Frequency distributions of positive and negative accelerations by flight condition are presented.

478

Hurt, G.J., Jr. 1963 ROUGH-AIR EFFECT ON CREW PERFORMANCE DURING A SIMULATED LOW-ALTITUDE HIGH-SPEED SURVEILLANCE MISSION. (National Aeronautics and Space Administration, Washington, D.C.) NASA TN D-1924, August 1963.

ABSTRACT: Test subjects were exposed to several levels of simulated gust intensity. The root mean square of the normal acceleration ranged from 0.16g for the lowest level to 0.95g for the highest level of response simulated. The simulated gust intensities and vehicle response levels were in excess of the accepted human comfort level. It was found that the observer would be disrupted but not stopped in the performance of the assigned tasks.

479

Huter, T. 1948 MEASUREMENT OF ULTRASOUND ABSORPTION IN ANIMAL TISSUES AND RELATION TO FREQUENCY. Naturwissenschaften 35:285-287
See Also: Chem. Abstr. 44:3052C (1950)
Phys. Abstr. 52:6045 (1949)

480

Huter, T. 1949 MEASUREMENT OF ULTRASOUND ABSORPTION IN ANIMAL TISSUES AND RELATION TO FREQUENCY Phys. Abstr. 52:6045
Naturwissenschaften 35:285-287 (1948)
Chem. Abstr. 44:3052c (1950)

481

Huter, T. 1950 MEASUREMENT OF ULTRASOUND ABSORPTION IN ANIMAL TISSUES AND RELATION TO FREQUENCY Chem. Abstr. 44:3052c
See Also Naturwissenschaften 35:285-287(1948)
Phys. Abstr. 52:6045 (1949)

VIBRATION

I

in, N. 1960 THE SHIP-SATELLITE SPEAKS
enaya zvezda P. 3; 18 May 1960

trial Lab., 1958 SHIPBOARD VIBRATION PROBLEMS DURING 1957.
(Industrial Lab., Mare Island Naval Shipyard, Vallejo, Calif.)
ASTIA AD- 217 665,

trial Lab., 1959 SHIPBOARD VIBRATION PROBLEMS DURING 1958.
(Industrial Lab., Mare Island Naval Shipyard, Vallejo, Calif.)
ASTIA AD-217 666

, I. B., & J. S. Milne, Jr. 1961 A VIBRATION AMPLITUDE RECORDING SYSTEM FOR AEROSPACE DESIGN EVALUATION STUDIES. In 1961 Proceedings of the Institute of Environmental Sciences National Meeting, April 5, 6, 7, 1961, Washington, D. C. (Mt. Prospect, Ill.: Institute of Environmental Sciences, P. O. Box 191) pp. 555-563

RY: In making vibration studies of missile and satellite components and com- t parts, it is very helpful to the design engineer to know resonant frequen- and mechanical gains on various parts of the components. Where the "quick design technique is employed, it is desirable to have this information avail- immediately without the use of complex and time consuming data reduction ms. The system described is a four-channel recorder system where vibration ltudes from four selected positions can be compared to each other at any tion frequency between 10 and 2000 cycles per second. The data is presented ur continuous records of amplitude against a frequency mark on the edge of record which is coded against a printed tape record of frequency. The system mposed of commercially available equipment and has an overall calibrated racy of ± 10%. (AUTHOR)

ov, P. 1960 ASSAULT ON SPACE
P. 4; 21 May 1960

VIBRATION

J

487

Jacklin, H.M. 1936 HUMAN REACTIONS TO VIBRATION.
Soc. Automotive Eng. Jour. 39: 401-407, Oct. 1936

ABSTRACT: This paper deals with the range of 0 to 215 inches amplitude and 1 to 17 cps. The subjective reactions were rated as I, perceptible; one feels motion or that distant objects are moving slightly. II, Disturbing; one notes that certain organs or parts of the body have greater vibration than the total body and attempts are made to prevent the motion. III, Uncomfortable; one wants very little of this treatment. The resulting curves show great similarity of slope, and on semi-log coordinates fits the equation $K = Ae^{0.61}$ where; K is a constant, A is max. acceleration in ft/sec^2, f is frequency in cps. Values for K are derived for several hundred subjects on a hard seat.

488

Jacklin, H. M. 1948 HUMAN REACTIONS TO VIBRATION.
S.A.E. Journal 56:49.

489

Jackson, M. M. 1939 THE FREQUENCY FUNCTION OF VIBRATORY SENSITIVITY.
(Unpublished master's thesis, University of Virginia)

490

Jacobs, H.I. 1960 A REVIEW OF AVAILABLE INFORMATION ON THE ACOUSTICAL AND VIBRATIONAL ASPECTS OF MANNED SPACE FLIGHT
Aerospace Medicine 31 (6): 468-477, June 1960

ABSTRACT: This paper is a review of the problem of noise and vibration with respect to manned space flight. Acoustic environment can be predicted for future space vehicles with sufficient accuracy for human factor analyses. The noise environment should not create a barrier to manned space travel. Vibration, as limited by the structural requirements of current space vehicle design, is within human tolerance limits.

cobsen, L. S., & R. S. Ayre 1958 ENGINEERING VIBRATIONS.
(New York: McGraw-Hill, 1958)

cobson, R.H. 1959 ANALOG STUDY OF RESPONSE TO JET AIRCRAFT VIBRATIONS
ight Air Development Center, Wright-Patterson Air Force Base, Ohio)
WADC TN 50-179, February 1959, ASTIA AD 216711, Contract No. AF33(616)-5033,
Task No. 61966

TRACT: An analog investigation was performed to determine differences in
ration responses between actual aircraft random vibration inputs and
uivalent" sinusoidal vibrations. The random vibration inputs consisted
36 magnetic tape recordings made at four measurement locations on B-52
rcraft. Analog responses were determined for linear single-degree-of-
edom systems at 17 values of natural frequency between 13 and 500 cps, and
th damping characterized by resonant transmissibilities (Q) of 5, 10, and 25.
It was found that, for one of the measurement locations, the response to
aircraft random vibrations was smaller than the response to an "equivalent"
usoidal vibration. For the remaining three locations, no significant difference
observed between responses to the two types of input. It is concluded that,
values of Q considered, specification vibration levels should not be modified
account for differences between responses to random vibrations occurring in
rcraft and responses to sinusoidal vibrations employed in laboratory evaluations.

cobson, R.H. 1959 STUDY OF VIBRATION AND SHOCK IN AIRCRAFT AND DEVELOPMENT
OF INSTRUMENT MOUNTINGS
light Control Laboratory, Wright Air Development Center, Wright-Patterson
Air Force Base, Ohio) WADC TR 58-148, March 1959, Contract No. AF
33(616)-5033, Task No. 61966, ASTIA AD 228510

BSTRACT: A study of instrument requirements revealed that the ability of
yroscopically stabilized flight control instruments to withstand shock and
ibration varied widely, and for many such instruemnts protective mounting
ases were not required. However, to define the mounting base objectives clearly,
t was decided to design the mounting base for the Lear Two-Gyro Master Reference.
Of a large number of requirements to be met by the mounting base, the most
portant were those of freedom of translational motion in the three principal
irections coupled with severe constraint against any form of rotational motion.
rther, a resonant frequency of 15 to 20 cps and a maximum resonant magnification
ctor (Q) of 4 were established for the mounting base.
The developed mounting base incorporated three sets of thin leaf springs
lexures) which allow the required three-degree-of-freedom translational
tion. To control the resonant transmissibility, damper elements were in-
rporated into the mounting base with a pair of these elements in parallel with
ch set of flexures. The damper elements consisted of 3/4 in. cubes of
lastic 6508 silicone rubber in which small pieces of 0.085 in. diameter
flon tubing were randomly embedded. The report discusses the design and
valuation of the mounting base and the development of the damper elements.

494

Janeway, R. N. 1945 VEHICLE VIBRATION LIMITS TO FIT THE PASSENGER. (Report presented at the S.A.E., Nat. Car and Production Meeting, Mar. 1945) S.A.E. Preprint 160.

ABSTRACT: This paper is a report on an analytical study of all available experimental data relating to human tolerance of vertical sinusoidal vibration. The practical objective was to derive the safe limits of vibration intensity for passenger comfort over the complete range of frequencies encountered in vehicles.

495

Janeway, R. N. 1949 PASSENGER VIBRATION LIMITS. S.A.E. Journal 56(4):48-49.

496

Janeway, R. N. 1950 RIDE AND VIBRATION DATA, SAE Publication, 1950.

497

Jeffcoate, G. O. 1951 THE EFFECTS OF NOISE AND VIBRATION ON PEOPLE. (D.S.I.R., Road Research Lab., Harmondsworth) Note No. RN/1643/GOJ

498

Johnson, E. E. 1952 A SURVEY OF TANK CREW PROBLEMS. (Army Medical Research Lab., Fort Knox, Ky.) Proj. 6 95 20 001, MEDEA, Rept. 93, Aug. 1952

ABSTRACT: To point up problems of the tank crew which may be alleviated by human engineering research, 894 tank crewmen attending the Armored School, Fort Knox, Kentucky, were oriented as to kinds of problems the human engineer is interested in and then asked to relate some relevant incident that they had either observed or participated in. A total of 623 incidents were found to concern general problems of human engineering and 521 of these concerned the tank crew. These incidents were categorized as they applied to the commander, gunner, loader, driver and crew in general. Recommendations are made for improved survey techniques.

ublications Research Service 1963 VIBRATION DISEASE AND ERMAL DEHYDRATION (SELECTED) TRANSLATIONS. (Joint Publication esearch Service, Washington, D.C.) 5 Apr. 1963. ASTIA AD 405 210 rans. of Gigiena Truda i Professional'nye Zabolevaniya (USSR) 7(1):4-13, 36-41, 1963.

TS:

Materials on the pathogenesis of vibration disease, by Ye Ts. yava-Galanina and N.I. Karpova
Application of vibration stimulator for detecting certain functional s in workers experiencing vibration effects under industrial conditions, M. Butkovskaya and Yu. S. Koryukaev
Water and salt exchange in thermal dehydration, by L. Gets.

s, C.D., J.H. Shaw, et al 1961 PRELIMINARY INVESTIGATION OF INTERPLANETARY LUNAR AND NEAR PLANET ENVIRONMENTS AND METHODS OF SIMULATION nautical Systems Division, Wright-Patterson AFB, Ohio) ASD TR 61-267 July 1961 ASTIA AD 268 791

TRACT: Summaries of the natural environments of Mars, Venus, the Moon and terplanetary space are presented. The primary induced environmental stresses sociated with thermal radiation, cosmic atomic and subatomic radiation, meteo- id particles, vibration, shock, acceleration, and low pressure are described r operation near the above bodies including range of anticipated values and thods of simulation. Additional simulation techniques associated with tempera- re, heat flux and atmospheric composition are discussed. An environmental test hilosophy and a summary of heat transfer characteristics of high speed vehicles re included. Important areas not covered in this report are combined, induced nvironments associated with atmospheric entry and biological effects and nuclear reaction radiations. (Author)

01

Juin, G. 1961 CONSIDERATIONS SUR L'AGGRAVATION DES FACTEURS DE FATIGUE CHEZ LES EQUIPAGES DE L'AVIATION COMMERCIALE FRANCAISE VOLANT SUR APPAREILS A REACTION. (Considerations on the Aggravation of Fatigue Factors in French Commercial Airlines Crewmen.
Rivista di Medicina Aeronautica e Spaziale (Roma) 24(1):29-43 Jan. - Mar. 1961. (In French, with English summary)

502

Jurczak, M. 1962 EFFECT OF VIBRATION ON THE ORGANISM
Lek. Woj. 38:1080-1089, 1962 (Pol)

VIBRATION

K

503

Kahn, A. 1960 THE RESPONSE CHARACTERISTICS OF THE HUMAN BODY TO LOW FREQUENCY VERTICAL VIBRATION
(Westinghouse Electric Corporation, Baltimore, Md.)
Human Factors Data Bull. 47, Feb. 1960

ABSTRACT: To determine the transmitting characteristics of the living human body for low frequency vertical vibration, data were obtained from ten seated Ss. The chair was attached to a vibration generator and traveling gantry which could provide a continuous variable frequency from 6 to 150 cps. In this experiment a peak vibrational acceleration of one g (measured at seat) was not exceeded. Accelerometers were mounted at the hip, shoulder, and seat (reference). Transmissibility (ratio of peak vibrational acceleration at a particular part of the body to the peak recorded at the seat) for hip and shoulder were given. (Tufts)

504

Kampik, A. 1930 EXPERIMENTELLE UNTERSUCHUNGEN ÜBER DIE PRAKTISCHE LEISTUNGSFÄHIGKEIT DER VIBRATIONSEMPFINDUNGEN (Experimental Examinations Concerning the Practical Conductivity of the Vibration Sensation)
Archiv für die gesamte Psychologie (Leipzig) 76: 3-70

505

Keidel, W. D. 1956 VIBRATIONS RECEPTION: DER ERSCHUTTERUNGSSINN DES MENSCHEN.
(Vibration Perception: The Vibration Sense of Man)
Erlanger Forschungen, Reihe B. (Erlangen: Universitatsbund Erlangen, 1956) Vol. 2.

ABSTRACT: Research in the field of vibration sensations is reviewed. The following aspects are considered: physical characteristics of body as conveyor of stimuli, anatomy of receptors, regulation of receptor-neural fiber unity, thresholds as indices of sensitivity, and central transformation and evaluation. Of interest to aviation medicine is a chapter dealing with research and clinical data on vibration damage to the human organism (p. 116-117). The author concludes that there is no specific vibration receptor, rather, information about vibration is transmitted through three different sensory organ systems: mechanoreceptors (skin and tendon and organs), the ear, and the periosteal pain receptors. Approximately 288 references.

06

lleher, J.F. 1960 A PROPOSED QUALIFICATION TEST PROCEDURE FOR SYSTEM COMPATIBILITY DURING VIBRATION. (1960 Proceedings of the Institute of Environmental Sciences, 91-96);

07

ndricks, E.J. 1952 AEROMEDICINE: THE DOMINANT SCIENCE
ro Digest 64(1): 72-80, 82, 90. Jan. 1952

TRACT: The physiological problems resulting from the advances of modern
ation in high-altitude and high-speed flying are briefly discussed. New
hods and techniques in meeting problems such as temperature and pressure
ges, anoxia, bio-acoustic effects, bailing out from high altitudes, and
trument control (human engineering) are summarized. In conclusion, the
irements for and the functions and duties of the flight surgeon are outlined.

, J.B. & G. R. Wendt 1947 STUDIES OF MOTION SICKNESS. XVI. THE EFFECTS UPON SICKNESS RATES OF WAVES OF VARIOUS FREQUENCIES BUT IDENTICAL ACCELERATION. J. Exper. Psychol. 37:440-448

ov, A. 1960 ASTRONAUTS, ON THE STARTING LINE. THE DAY IS NEAR
omol'skaya pravda P. 2; 2 December 1960.

ets, I. I. 1958 O VLIIANII OBSHCHEI VIBRATSII NA DETORODNUIU FUNKTSIIU. (Effect of general vibration on genital function.) Tr. Leningradsk. sanit. gig. med. inst. 44:196-207

bengof, V.G., L.M. Dantsig & G.I. Simonyan 1943 INTERRELATIONSHIP BETWEEN HEMODYNAMICS AND RENAL FUNCTION DURING ACCELERATION
inicheskaia Meditsina (Moscow) 21(3): 47-50

512

Koelsch, F. 1935 LÄRM--ERSCHÜTTERUNGEN. (Noise-vibrations.)
Jahreskurze Arztliche Fortbildung, 26:1-13.

513

Konecci, E.B. 1957 PHYSICAL AND PHYSIOLOGICAL FACTORS IN MAJOR AIRCRAFT ACCIDENTS
Directorate of Flight Safety Research, USAF, Norton AFB, California
AFCFS-G-2, M-4-57, 13 February 1957.

514

Konecci, E.B. 1957 PHYSIOLOGICAL FACTORS IN USAF AIRCRAFT ACCIDENTS
Paper: Aero Medical Association, 28th Annual Meeting, Denver, Colo. May 1957
See also: Journal of Aviation Medicine 28(6): 553-558

515

Konecci, E.B. 1957 PHYSIOLOGIC FACTORS IN AIRCRAFT ACCIDENTS IN THE U.S. AIR FORCE
Journal of Aviation Medicine 28(6): 553-558

ABSTRACT: In conclusion, we can say that factors affecting the normal physiologic state of the pilot (or crew) are contributing causes rather than primary causes of major aircraft accidents. A few physiologic conditions like hypoxia and vertigo/disorientation were primary causes. Fatigue appeared as a contributing factor in a number of accidents but the incidence appears to be decreasing i.e., thirty-four cases in 1955 to thirteen in 1956. G forces and vibrations appeared as contributing factors in a large number of accidents; however, their significance could not be fully evaluated from the available data. The adversities of decompression, physical disturbances, hyperventilation, hypoglycemia, carbon monoxide poisoning, and air sickness do not seem to be primary problem areas.

516

Konstantinov, A. 1960 MAN GOES OUT INTO SPACE
Trud P. 2; 17 May 1960.

I. 1961 EXPERIENCE WITH THE APPLICATION OF OXYHEMOMETRY IN THE OF THE EFFECT OF GENERAL VIBRATIONS ON THE HUMAN ORGANISM. Tr. Leningrad Sanitarnogig Med. Inst. 71:16-22, 1961 (Russian)

, B. 1960 DREAM BECOMES FACT 4; 20 May 1960

S.B. & R.A. Byers 1960 A MODULAR CONCEPT FOR A MULTI-MANNED SPACE TION

ceedings of the Manned Space Stations Symposium, Inst. Aeronautical nces, New York, 1960, pp. 36-73)

: Contains a section on the Micro-Encology which is broken down into owing subsections: Biochemical (Respiratory, Nutritional, Waste); ical (Termal, Vibratory and Aurol, Gravitational); External Phenomena n, Meteors); and Hardware (Micro-Atmosphere System, Equipment Weights r).

eyn, A. Ye. 1960 ELECTROCARDIOGRAPHIC CHANGES IN FLIGHT PERSONNEL ER THE INFLUENCE OF FLIGHT STRAIN -meditsinskiy Zhurnal 5: 224-227 e also: JPRS Trans. No. 5592

, K.D. 1950 THE EFFECTS OF NOISE ON MAN J. of Speech and Hearing isorders, Monograph Supplement 1, 1950

ova, P.S. 1960 ON THE PROBLEM OF THE EFFECT OF VIBRATION ON THE TATE OF HEARING AND ON THE VESTIBULAR APPARATUS. Vestn Otorinolaring 22:15-21, May-June 1960

523

Kuligowski, Z. K. 1961 MOTOR CONDITIONED REFLEXES IN RATS EXPOSED TO THE COMBINED EFFECT OF VIBRATIONS AND NOISE.
In Acta Physiol. Pol. 12:821-832, Nov.-Dec. 1961, (Polland)

524

Kumai, T. 1957 SOME MEASUREMENTS OF ACCELERATION OF HULL VIBRATION AND HUMA SENSITIVITY TO VIBRATION. (Kyushu University, Japan) Reports of Researc Institute for Applied Mechanics 5(17):21-26

525

Kuznetsov et al. 1959 THE EFFECT OF VIBRATION ON THE METABOLISM OF CERTAIN VITAMINS IN THE HUMAN BODY.
Voprosy Pitaniya (USSR) 18(3):14-17 LC Trans. no. 59-13775

ABSTRACT:
The effect of the stress of vibration in an industrial situation upon the metabolism of various vitamins is examined. The results of tests involving 9 individuals indicate that the diet of persons exposed to intense vibration should include additional vitamins, especially vitamin B_6.

526

Kylstra, J. 1956 REGISTRATION OF ACCELERATION BY MEANS OF U-EFFECT
Nederl. tijdschr. geneesk. 100: 911-914, March 31, 1956

VIBRATION

L

e, K. O. & R. R. Coermann 1962 VISUAL ACUITY UNDER VIBRATION. Hum. Factors 4:291-300, Oct. 1962.

er, E. and W. Vethacke. 1957 GEFÄSSVERÄNDERUNGEN NACH RHYTHMISCHEN ERSCHUTTERUNGEN. (Vascular changes caused by rhythmic vibrations.) Monatsschr. Unfallh. 60:129-137

, K. 1961 EQUIPMENT AND TECHNIQUES USED IN CALIBRATING VIBRATION MEASURING TRANSDUCERS TO 10,000 CYCLES PER SECOND In 1961 Proceedings of the Institute of Environmental Sciences National Meeting, April 5, 6, 7, 1961, Washington, D. C. (Mt. Prospect, Ill.: Institute of Environmental Sciences, P. O. Box 191) pp. 109-114

TRACT: In recent years, there has been a widespread increase in research, velopment and testing programs in which vibration measuring transducers play important role. Calibrating these transducers to the standards set by the tional Bureau of Standards is a problem which concerns both the calibration boratories and the user of transducers. This paper discusses a method of cali- rating vibration measuring transducers which provides traceability to NBS. The alibration factor obtained is considered correct within ± 1% to 100 cps and ± 2% 2000 cps. Calibrations from 2000 to 10,000 cps, traceable to NBS certified andards, are expected to be accurate within 5 per cent. The calibration method d its accuracy are discussed in detail. (AUTHOR)

530

awton, Alfred H. 1952 HUMAN FACTORS IN THE OPERATIONS AND DESIGN OF AIRCRAFT ournal of Aviation Medicine 23: 254-258 & 306

BSTRACT: Human factors in aviation embrace three broad divisions: (1) aviation edicine, which familizrizes pilots with their equipment, safety measures, and preventive medical aspects; (2) human engineering, which analyses limitations of human response to the aircraft and its equipment; and (3) human resources which relate to selection, classification, aptitude measurement, training, and

human relations, taking into account the diversified nature of human beings. Psychophysiological aspects of noise, vibration, use of pressurized cabins, use of ejection seats and all kinds of protective equipment, and the impact of speed are discussed. Animal experiments have a great value in furthering research but ultimately each device, method, and principle has to be tested by "human guinea pigs."

531

Lazzaroni, A. 1962 EFFECTS OF VIBRATIONS AND LOW FREQUENCY WAVES ON PERSONS LIVING IN THE VICINITY OF AIRPORTS.
Riv. Pat. Clin. 17:1099-1109, Dec. 1962 (Italy)

532

Lebedeva, A. F. and C. H. Ch'u 1960 EFFECT OF GENERAL VERTICAL VIBRATIONS ON ARTERIAL BLOOD PRESSURE AND PULSE.
In Tr. Leningrad Sanitarnogig Med. Inst. 61:85-90, 1960 (Russian)

533

Lederer, L.G. 1956 THE AEROMEDICAL ASPECTS OF TURBO-PROP COMMERCIAL AIRCRAFT. A STUDY OF VISCOUNT PASSENGER OPERATIONS IN THE UNITED STATES.
J. Aviation Med. 27(4):287-300

SUMMARY: The aeromedical characteristics of the VISCOUNT turbo-prop airliner have been discussed as related to operation in commercial avaition in the United States. The differences between turbo-prop and conventional piston powered aircraft have been demonstrated particularly in the field of noise and vibration. The level of cabin pressurization has been discussed and shown to be more physiologically acceptable than other commercial aircraft operating in the United States.

Pilot transition training has been discussed and a new type of flying in commercial operation, have been cited, such as "hull life," and metal fatigue." It is hoped that as new better commercial aircraft are developed, the aero-medical aspects such as have been covered in the presentation will also be reported.

534

Lederer, P.S. 1955 A TORSIONAL VIBRATION CALIBRATOR (National Bureau of Standards, U.S.A.)

ABSTRACT: Describes a small torsional vibration calibrator which generates steady state vibrations to be used for the dynamic calibration of angular motion

ducers over a frequency range from 0.57 cps to 30 cps. The maximum angular erations obtained between 3 cps and 30 cps range from 20 to 40 peak radians econd per second (for table loads between 0 to 20 lb in^2). A condition onance at 2 cps raises the output to 79 radians per second per second. At cps., a maximum acceleration of 2.5 peak radians per second per second can tained.

nn, G., & D Dieckmann 1956 DIE WIRKUNG MECHANISCHER SCHWINGUNGEN (0.5 BIS 100 HERTZ) AUF DEN MENSCHEN. (THE EFFECT OF MECHANICAL OSCILLATIONS (0.5 TO 100 C.P.S.) ON MAN) Forschungsberichte des Wirtschafts- und Verkehrsministeriums Nordrhein-Westfalen (Köln und Opladen) 362:92

TRACT: Subjects were stimulated with vertical, horizontal, and transverse usoidal vibrations, in the frequency range of 1-70 c.p.s. in sitting and standpositions. Physical measurements of acceleration and direction of vertical ration showed differential resonance of various body parts. The trunk resonates frequencies around 5 c.p.s., the head at 20 to 30 c.p.s. Transverse vibration perceived by subjects as the most unpleasant. Amplitudes of head movements the above vibrations were large and ellyptical. Nausea and gastric complaints ch accompanied transversal vibrations suggest a relation between ellyptical d movements and kinetoses by the way of endolymph movement in labyrinths. sidering vibration stresses on man, from the standpoint of vibration-mechanics should be regarded as a damped-mass-spring system rather than pure mass. His stic properties are to be considered also.

7

or, M., & W. F. Rector 1961 ACOUSTICS IN MANNED SPACE VEHICLES (Proceedings of the Institute of Environmental Sciences National Meeting, April 5, 6, 7, 1961, Washington, D. C.; Paper not available at publication)

8

tavet, A. A. and Z. V. Gordon, eds. 1962 BIOLOGICAL ACTION OF ULTRAHIGH FREQUENCIES
(Trans. of mono. O Biologicheskom Vozdeistvii Sverkhvysokikh Chastot, Moscow, 1960)
(Office of Technical Services, Washington, D.C.) 62-19175

539

Lewis, D. 1943 THE EFFECTS OF NOISE AND VIBRATION ON CERTAIN PSYCHOMOTOR RESPONSES (C.A.A. Div. of Research, U.S. Dept. Commerce Report No. 8, Washington, D.C.) ATI 75937

ABSTRACT: The noise and vibration of airplanes are widely thought to reduce the efficiency of aviators. Service personnel often report annoyance and feel that their work suffers. The present experiments were undertaken to learn if there is actually a decrement in work under noise and vibration conditions similar to those characterizing military aircraft. The experiments were performed at the University of Iowa with 80 male college students, C.P.T. applicants, and trained as subjects. The subjects performed on a Mashburn apparatus. The Mashburn involves a control stick and rudder bar which are manipulated by the subject in response to changes in three banks of stimulus lights. As soon as the subject has responded to one set of lights, a new combination appears. For the present study the Mashburn apparatus was modified so that the platform could be made to vibrate. Effects of noise and vibration, respectively, on heart rate, breathing, tilt perception, brain waves, and hearing acuity were also studied. On the whole the results were negative in the sense that they revealed no consistently significant differences between reactions when noise, vibration, or both were present and when these supposedly disturbing factors were absent.

540

Lewis, H.O. 1961 SHOCK TESTING WITH ELECTRODYNAMIC SHAKERS
In 1961 Proceedings of the Institute of Environmental Sciences National Meeting, April 5,6,7, 1961, Washington, D.C. (Mt. Prospect, Ill. : Institute of Environmental Sciences) Pp. 267-276

SUMMARY: This report should be considered solely as a preliminary description of shock tests conducted with electrodynamic shakers. Because of the marked limitations in time, this technique has been developed only to the point of making testing possible.

In the Polaris Missile System Test Services Laboratory, shakers are employed extensively to shock-test articles weighing from 200 to 1000 pounds within the pulse durations described above. Plans are currently underway to extend the use of this technique to all items requiring pulse durations up to 14 milliseconds. There are several areas which need further development before the technique can be considered " of age". First, an effective and repeatable method of producing the desired pulses must be developed. Then, if this technique receives sufficient acceptance, the shaker manufacturers should market the exciters with longer stroke capabilities. This would permit the particular method of conducting a shock test to be extended over a wider range of pulse

541

Liddell, G. & Jacklin, II. M., 1933 RIDING COMFORT ANALYSIS
Engineering Bulletin, No. 3, Purdue University, May 1933

2

der, G.S., 1961 EFFECTS OF MECHANICAL VIBRATION ON HUMANS. (North American Aviation, Los Angeles, Calif.) Rept. No. NA-59-1420, March 1961

3

der, G. S. 1962 MECHANICAL VIBRATION EFFECTS ON HUMAN BEINGS. Aerospace Medicine 33(8):939-949, Aug. 1962

ABSTRACT: This paper is a review of the literature regarding the effects of mechanical vibration on humans. It is intended to provide a readily accessible compilation of vibration information for those persons concerned with aerospace vehicle design and operation.

544

ippert, S. and E.P. Wheaton 1945 HUMAN RESPONSE TO VERTICAL VIBRATION (Douglas Aircraft Co., Inc., Santa Monica, Calif.) Rept. No. SM-20021; STIA AD-61 619; (Oct. 18, 1945, rev. April 26, 1955) ASTIA AD-61 619

ABSTRACT: Simplified graphs showing human responses to vertical vibration were prepared from an analysis of the literature on the subject. The graphs extend over a range of double amplitudes from .000029 inches to 100 inches, and over a range of frequencies from .1 to 256 cycles per second. These ranges include the regions of interest in aircraft--namely, the low frequency vibrations due to gusts and buffeting, the transient vibrations encountered in the seats after an initial displacement, and the steady state vibrations due to engines and propellers.

545

Lippert, S. 1947 HUMAN RESPONSE TO VERTICAL VIBRATION J. Soc. Automotive Engrs 55:32-34

546

Lippert, S. 1948 COMPREHENSIVE GRAPH FOR THE COLLECTION OF NOISE AND VIBRATION DATA.
J. Aviation Med. 19:279-286

ABSTRACT: It has been common practice in the aircraft industry in the past to consider the effects of noise and vibration on the passenger as separate disturbances. With the advent of jet and rocket engines, higher intensities and

higher frequencies are encountered than ever before. New techniques and new instruments are required to measure the noise and vibration and to assess the effects on the human body.

The graph described in this paper makes it possible to spot in data in one set of units, and permits its immediate interpretation in other units. The grid work can be readily extended to include any magnitudes of noise or vibration disturbance.

547

Lippert, Stanley 1953 LIMITATIONS TO NOISE AND VIBRATION CONTROL. In Proceedings of Symposium on Frontiers of Man-Controlled Flight, Institute of Transportation and Traffic Engineers, Univ. of Calif., Los Angeles, April 1953.

548

Lockheed Electronics Co. 1961 LOW-LEVEL VIBRATION-MEASUREMENT FEASIBILITY STUDY. (Lockheed Electronics Co., Plainsfield, N.J.) Final Rept. ASTIA AD-257 180, 31 December 1960

ABSTRACT: Research was conducted to determine the feasibility of using piezoelectric type accelerometers, coupled to electronic integrating networks, for Measurement of vibration velocities corresponding to minimum accelerations of 0.0002 g over a frequency range of 10 c to 10 kc. Tests were conducted with a commercial accelerometer operating in conjunction with a new design of amplifier having the lowest noise level presently achievable in the state-of-the-art. The spectrum of the noise was measured, and the sensitivity of the accelerometer-amplifier combination was determined. It was found that accelerations of 0.0002 g could be measured with good S/N ratio over the entire frequency range of interest. However, integration of the output to obtain velocities yielded useable S/N's only at the lower end of the spectrum. This resulted from the low-frequency peak in the noise spectrum combined with the -6 db per octave slope of the integrating network. It is concluded that peizoelectric accelerometers are not feasible for measurement of vibration velocities down to the minimum levels of interest. (Author)

549

Loeb, M. 1954 A PRELIMINARY INVESTIGATION OF THE EFFECTS OF WHOLE-BODY VIBRATION AND NOISE.
(U.S. Army, Med. Res. Lab., Ft. Knox, Ky.) Proj. 6-95-20-001, Rept. No. 145, Nov. 12, 1954. ASTIA AD 47142.

ABSTRACT: An investigation was conducted to test several measures as indices of possible nonauditory impairment arising from moderately intense noise and

ation. Psychomotor, sensory, and simple physiological tests were presented 16 subjects before, during, and after control periods and periods of exposure ight vibration, heavy vibration, and noise. Among these tests were measures irror tracing performance, speed of trapping, different types of reaction , manual steadiness, strength of grip, visual acuity, systolic and diastolic d pressure, pulse rate, urine albumin, and urinary potassium excretion. lysis of the data revealed temporal (practice or adaptation) effects of mirror ing, pulse rate, and systolic blood pressure. No variation under control, e, and vibration conditions occurred except in the cases of the visual acuity manual steadiness measures. Tremor was relatively unchanged under light ation and showed a significant increase under heavy vibration and more under vy vibration, but was not affected by noise.

b, M. Oct. 1954 A FURTHER INVESTIGATION OF THE INFLUENCE OF WHOLE BODY VIBRATION AND NOISE ON TREMOR AND VISUAL ACUITY. (Army Medical Research Lab.) Project No. 6-95-20-001, Rept. No. 165, 22 Oct. 1954. (24 Jan. 1955)

TRACT: Differential effects on visual acuity, tremor in a supported hand, and ing tremor were obtained during exposure to different intensities and frequencies vibration. Measurements were obtained before, during, and after exposure to 2 plitudes of bibration at 3 different frequencies and a 115-db broadband noise. n annoyance and tolerability thres olds were also determined under vibration. erally during vibration, visual acuity was impaired and manual and aiming tremor re increased while noise had no effect. Effects were more pronounced at 15 c n at higher frequencies, while distinct differential effects between light and avy vibration were present only at lower frequencies. (See also AD-47 142)

. Loeckle 1940 THE EFFECT OF VIBRATION ON THE AUTONOMIC NERVOUS SYSTEM AND TENDON REFLEXES
orschungsbericht D.V.L. (ZWB) No. 1283, Sept. 1940)
A.E. Translation No. 183

eckle, W.E. 1941 EFFECT OF VIBRATION ON VEGETATIVE NERVOUS SYSTEM AND TENDON REFLEXES. (Ueber die Wirkung von Schwingungen auf das vegetative Nervensystem und die Sehnenreflexe) ASTIA ATI-8773

STRACT: Organic processes which cause weakening or disappearance of reflexes ere investigated on human beings and animals. A jolting machine, producing ertical vibrations of nearly sinusoidal form, was used in experiments. Factors ontributing to change in muscle tone and reflexes, such as frequency, amplitude nd duration of vibrational stimuli are discussed. Absence of patellar reflexes is traced to changes in blood vessels and muscle fibers connected with the ympathetic nervous system. Physiological and technical significance of results is stressed.

553

Loeckle, W.E. 1941 CONCERNING THE EFFECT OF VIBRATION ON THE AUTONOMIC NERVOUS SYSTEM AND THE VISUAL REFLEXES. Jahrbuch 1941 der deutschen Luftahrtforschung. 103-108
See also Luftfahrtmedizin 5:305-316,1941.

ABSTRACT: Mechanical vibration of a shake-table affected the entire organism or individual points of the flesh of men and animals. In this connection the failure of the patellar reflex observed by Coermann was found as a result of an autonomic response to vibration, and certainly the vibration of the blood vessels and other organs with smooth musculature caused a regional disorder of normal sympathetic tone which manifested itself particularly in the visual reflex center. The investigation was related to the patellar, Achilles-, and forearm reflex. Degrees and rate of reflex reduction depend upon frequency, amplitude and duration of vibration as well as on the subject a and his condition at the time. The significance of the results is seen in the following connotation: 1) New viewpoints for use in teaching about the visual reflex and autonomic nervous system. 2) Clear explanation of the physiological effect of mechanical vibration. 3) Consideration of more possible detrimental effects of vibration. And 4) importance of the investigation of technically decisive factors of an injurious vibration.

554

Loeckle, W. E. 1950 THE PHYSIOLOGICAL EFFECTS OF MECHANICAL VIBRATION. In: German Aviation Medicine in World War II, Chapt. VII-C, 2:716-722 (Washington, D.C.: Government Printing Office)

ABSTRACT: This chapter describes the data collected in Germany before and during World War II. Methods for subjectively measuring vibration effects are described. The "shake-table" of the Deutsche Reichsban is also described, which has a capability of 20 cps at 1.6 cm amplitude. A detailed list of subjective sensations is given.

Resonant frequencies of the body were found to lie between 4 and 10 cps. Above the resonant range, the transmission of vibration seems inversely proportional to frequency, and above 140 cps body damping is complete with little or no vibration reaching the head. Tolerance is not related to resonant frequency, but to the damping factor.

A whistled note is modulated, and exhaled smoke is emitted in pressure waves. The vibrations are superimposed on respiratory movements. X-ray studies show that the liver controls diaphragmatic movement with resonance occurring between 6 and 10 cps. An increase in pulmonary ventilation has been observed, but after subjects become accustomed to the vibration, the values return to normal.

Vision impairment is related to the transmission of vibration to the head. Above 16 cps transmission is fairly constant and diplopia is present.

The tendon reflex is inhibited and it seems to require involvement of some smooth muscle tissue. The inhibition is greater when the vascular area in the femoral region is vibrated than when skeletal muscle (Gastrocnemius) is vibrated alone.

There were no constant changes seen in pulse and blood pressure.

5

bard, C. F., E. L. Beckman, R. F. Rushmer, D. R. Drury, J. Goodman, Hugh Edmonson, J. P. Henry, & Aaron Klein Nov. 1948 THE EFFECT OF NEGATIVE RADIAL ACCELERATION ON LARGE EXPERIMENTAL ANIMALS (GOATS). I. PATHOLOGY. (Dept. of Avia. Med., University of Southern Calif., Los Angeles, Calif.) Office of Naval Research Contract N6ori77, Task 1, Project NR 161-014, 30 Nov. 1948.

TRACT:

The effects of negative radial acceleration (centrifugal force from tail to head) upon 11 goats were studied on the human centrifuge at the University of Southern California, at levels of -5G and -8G.

Autopsies were conducted on all animals, and specimens taken for histopathologic study.

Routing gross pathological examinations were made. In selected cases, opthalmological examinations were made, electrocardiograms recorded, chest x-rays taken and blood samples collected and analyzed for plasma protein, hematocrit, oxygen and carbon dioxide saturation and hemoglobin content.

These experiments indicate that repeated exposures to negative G produce considerable edema and numberous hemorrages, both petechial.

Negative G seems to offer greater danger of strangulation by edema of the glottis and surrounding tissues and cardio vascular damage than by cerebral hemorrhage.

A motion picture was prepared which records both gross and microscopic pathologic findings as well as typical experimental procedures.

aco, G. 1935 BIOLOGICAL ACTION OF ULTRASONICS
Riforma med. 51:1608.

org, J. O. 1963 A SLINGSHOT SHOCK TESTER
(Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena, Calif.)
April 1963.

RACT: This paper describes the design, development and operation shock tester capable of subjecting small specimens to accelerations o approximately 40,000 g, with impact velocities to 200 fps. The specimen is mounted on a rail-guided carriage. Elastic shock-rber cord (bungee) is used to impart the desired impact velocity

558

Loring, J.C.G. 1954 SELECTED BIBLIOGRAPHY ON THE EFFECTS OF HIGH INTENSITY NOISE ON MAN (Psycho-Acoustic Lab., Harvard U. Cambridge, Mass.) Rept. No PNR-140, Jan. 1954

559

Lotis, V. M., I. P. Solov'eva & LIa. Tartakovskaia 1962 THE EFFECT OF GENERAL VIBRATIONS ON THE SEXUAL APPARATUS IN WOMEN. Vop. Okhr. Materin. Dets. 7:62-66, Oct. 1962 (Rus)

560

Lotze, H.R. 1958 POWER SPECTRAL ANALYSIS OF SLED VIBRATION DATA (Air Force Missile Development Center, Holloman Air Force Base, N. Mex.) AFMDC TN-58-12, Sept. 1958; ASTIA AD-154 106

ABSTRACT: A description is given of the analysis and processing of vibration data which originated from a sled run on the AFMDC Track. Different procedures of analysis are explained and compared with respect to applicability. Practical results were validated by the fact that the spectral densities obtained from analog and digital analysis show a very similar frequency characteristic. (Author)

561

Lovelace, W.R. 1939 ON GERMAN VIBRATING MACHINE, GERMAN FATIGUE TESTS AND US FATIGUE TESTS. (RAF, Institute of Aviation Medicine, Farnborough) FPRC 57, Sept. 1939.

562

Lowry, R.D. and Wolff, W.M. 1961 DESCRIPTION AND PERFORMANCE EVALUATION OF THE AEROSPACE MEDICAL RESEARCH LABORATORIES' VERTICAL ACCELERATOR (United States Air Force, Wright-Patterson Air Force Base, Ohio) USAF ASD Technical Report 61-743 Dec. 1961

ABSTRACT: The Aerospace Medical Research Laboratories' Vertical Accelerator was developed for bioastronautics research to simulate vibration and buffeting encountered in aerospace operations. The design, motion capabilities, control and safety features are described. This Vertical Accelerator can be programmed with periodic or random acceleration patterns obtained from actual environmental measurements. It is a complex electromechanical device employing a unique type of friction drive to move a test platform with a 200-lb. load capacity. The accelerator, for continuous operation, can produce peak to peak amplitudes of $\pm$ 5 ft. over the frequency range from 0.5 cps to 10 cps. The maximum acceleration output is from 2.5 to 3 G depending on load and permissible distortion.

en, L. R. 1954 HELICOPTER GROUND RESONANCE, IN THEORY AND EXPERIMENT. (National Aeronautical Research Institute, Amsterdam) Report V.1748; ASTIA AD-108 973; Oct. 1954

RY: The principle of ground resonance is discussed by investigation of the ency graph and its physical background. Therefore, it is indicated what may ground resonance, in spite of extensive calculation made in the design . Attention is called to the influence on ground resonance of combined blade on and flapping and the influence of slipping of the friction damper in the ol system. Conclusions are given relating to factors which should be taken consideration during design, as well as to the program of tie-down tests. OR)

sik, S. J., A. W. Nolle, eds. 1955 HANDBOOK OF ACOUSTIC NOISE CONTROL VOLUME I. PHYSICAL ACOUSTICS SUPPLEMENT 1. (Air Research and Dev. Command, Wright-Patterson AFB, Ohio) WADC TR-52-204, April 1955. ASTIA AD 66250.

TRACT: The Handbook of Acoustic Noise Control is intended to provide an over- view of the problem of the control of acoustic noise. Since the publication the first two volumes, the need for their revision has become apparent. In e cases, material has been added to enlarge the coverage of original sections. others sections have been completely re-written to present the latest experi- tal or theoretical information available. With ever-increasing interest and tivity in acoustic noise control, published procedures must, of necessity, lag ind the newest thinking in the field. There are few areas of the noise control oblem where the present answers are the "best". As the operational require- nts for noise control devices change and as new or more powerful sound sources pear in our advancing technology, better answers will have to be found. In resenting these revised sections, an attempt is being made to keep up with our xpanding knowledge.

his supplement contains additions and revisions to Volume I which treated the eneration and control of various types of noise sources. Similarly, Volume II, hich analyzed the interaction between noise and man, is being supplemented. hese supplements, together with the unchanged sections of Volumes I and II, rovide a unified view of noise control problems.

565

Lyubomudrov 1959 VIBRATION AND ITS SIGNIFICANCE IN INDUSTRIAL HYGIENE, YE. TS. ANDREYEVAGALANINA, MEDGIZ, 1986 (BOOK REVIEW) Sovetskaya Medisina (USSR) 23(1):152-153 LC Trans. no. 59- 11715

VIBRATION

Mc

566

McClemments, A., 1951 OPERATIONAL ASPECTS OF HELICOPTER VIBRATION (Paper, Royal Academy of Science Symposium, London, England, January 1951)

567

McClements, A., F.S. Shapiro, G.E. Bennett, and R.H. Warde 1951 VIBRATIONS IN HELICOPTERS. (A symposium at the Royal Aeronautical Society.) Flight, 1: 138-141

568

McCloskey, K., & C. C. Clark 1963 A CHRONOLOGICAL BIBLIOGRAPHY OF THE BIOLOGICAL EFFECTS OF VIBRATION. (Martin Company, Baltimore, Maryland) Engineering Report 12576, Feb. 1963

569

McCollom, I.N. 1956 FINAL REPT.
(San Diego State College, San Diego, Calif.) Contract Nonr-126801 1 Dec. 1956
ASTIA AD 118 905

ABSTRACT: Work involved in compiling a human-engineering guide for equipment design is outlined. Bibliographies, abstracts, translations, experimental studies and special reports were prepared in the following areas: (1) comparison and interaction among sensory input channels (AD 95 131); (2) disorientation; (3) effect on human performance of acceleration, motion, and vibration; (4) effect on human performance of ventilation, temperature, and humidity; (5) man-machine integration (AD 106 677); (6) motion sickness (AD 95 139) and therapeutic drugs; (7) simulators and proficiency measuring devices; (8) speech communication; (9) systems considerations; and (10) work and fatigue (AD 95 133, AD 95 137). A special human-engineering bibliography of 5600 entries was assembled and published. (ASTIA)

rland, R.A. 1941 FATIGUE IN AIRCRAFT PILOTS.
New Engl. J. Med., 225:845-855

RACT: Fatigue is discussed generally as being due to emotional stress,
of exercise, reduced oxygen tension, etc.

oise and vibration in an airplane are contributing factors to pilot
ue. To ameliorate these conditions, the pilot's seats should be vibra-
free and located conveniently near controls and instruments, the navigat-
ables should be cushioned to prevent vibration, the cockpit should be
illuminated, static in earphones, and glare from metal surfaces should
liminated. Ventilation and temperature should be controlled.

of these adverse conditions in the cockpit can be corrected by engineer-

ldrick, R.T. 1960 SHIP VIBRATION. (David Taylor Model Basin, Wash. D.C.)
Report no. 1451; ASTIA AD- 259 466

TRACT: Details are given on the general subject of ship vibration, including
the structural and hydrodynamic phases of the subject. Brief mention is
made of vibration in the propulsion system. Procedures for dealing with
problem of ship vibration in the design stage are suggested. An introduction
hydroelasticity is included. (Author)

Kenzie, A.A. and F. Rockett 1947 APPLICATIONS OF SONIC AND ULTRASONIC
VIBRATION: TABULATION. Electronics 20:140-141, June 1947

3

cKinnon, M., & J. M. Taylor 1961 AN ANALYTIC STUDY OF VIBRATION TRANSMISSION
IN TYPICAL SHIPBOARD INSTALLATIONS. (Master's Thesis: Massachusetts Insti-
tute of Technology, 1961) (U. S. Naval Postgraduate School, Monterey, Calif.,
Rept. No. M2295

74

acduff, J. N., & J. R. Carreri 1958 VIBRATION CONTROL.
(New York: McGraw-Hill Book Co., 1958)

VIBRATION

M

575

Mach, E. 1875 GRUNDLINIEN DER LEHRE VON DEN BEWEGUNGSEMPFINDUNGEN. (Outl
of the Theory of Motor Sensations)
(Leipzig: Verlag von Wilhelm Engelmann, 1875)

576

Mach, E. 1959 THE ANALYSIS OF SENSATIONS (English Translation)
(Dover Publications Inc., New York, 1959)

577

Mackworth, N.H. 1950 RESEARCHES ON THE MEASUREMENT OF HUMAN PERFORMANCE
(His Majesty's Stationery Office, London) Med. Res. Council, Special Report
Serial No. 268

578

Magid, E. B. & R. R. Coermann April 1960 THE REACTION OF THE HUMAN
BODY TO EXTREME VIBRATION (1960 Proceedings of the Institute of
Environmental Sciences, 135-154)

ABSTRACT: These studies show that the combination of mechanical measurements and analysis of subjective responses can lead to a greater understanding of the effects of extrinsically applied dynamic forces to the body. Harmful effects of vibrations to body organs with high mobility must be expected at the low frequencies. The body organs that are more restrained and therefore have little mobility are affected at higher frequencies. Protective devices applied to the human body must suppress the resonance peaks of these organs. Damping structures on the seats of passenger vehicles should have a natural frequency below 3 cps with suitable damping characteristics. The exposure time is a very important factor for the tolerance limit to steady state vibrations. To investigate tolerance to random vibration the relative influence of power spectrum, peak factor, and time integral must be investigated. Since body size, position and attitude will affect mechanical and therefore physiological responses, future studies by various groups should include complete descriptions of experimental test procedure with particular emphasis on the time periods.

9

gid, E.B., R.R. Coermann, and G.H. Ziegenruecker 1960 HUMAN TOLERANCE TO WHOLE BODY SINUSOIDAL VIBRATION, SHORT TIME, ONE MINUTE AND THREE MINUTES STUDIES. Aerospace Med. 31: 915-924

STRACT: Short time, one-minute and three minute tolerance studies were formed. Then subjects were included in the short time studies and a erance curve based on subjective responses were compiled. Because of the ger of incurring actual body damage, the tolerance range was attained the actual tolerance level estimated for the long time studies, in which subjects were included.

xteen sensations or symptoms were recorded and a table describing regional ptomatology was compiled unique to low frequency, high amplitude sinusoidal le body vibrations within the reange of subjective tolerance. The possible iology of the symptoms experienced during vibration are discussed.

G was taken before, during, and after each run. No abnormal tracings were served except in one case. After a one-minute run at 8 cps, the subject perienced momentary syncope associated with inversion of the P wave reverted fter 2 minutes with no sequelae. It is suggested that subjective response y be utilized to aid in defining machanical and physiological reactions to e body to vibrations.

rther study is necessary to ascertain the dynamics of the cardiovascular, lmonary, nervous skeletal, and endocrine systems during low frequency, high plitude whole body vibration.

0

id, E. B. and R. R. Coermann 1960 THE REACTION OF THE HUMAN BODY TO EXTREME VIBRATIONS
In Proceedings of the Institute of Environmental Science, National Meeting, pp.135-154.

1

gid, E.B., R.R. Coermann, R.D. Lowry & W.J. Bosley 1962 PHYSIOLOGICAL AND MECHANICAL RESPONSE OF THE HUMAN TO LONGITUDINAL WHOLE-BODY VIBRATION AS DETERMINED BY SUBJECTIVE RESPONSE. (Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio) Final Report. MRL-TDR-62-66. June 1962. ASTIA AD 288877

BSTRACT: The production of symptoms in specific body regions to whole-body ibrations is dependent upon physiological alterations resulting from the hanical stimulation of various organ-tissue complexes of the body.

We investigated subjective response to gain an insight into the mechanical properties of the body. Fifteen subjects experienced with whole-body vibrations were included in a two-phase study in an attempt to measure qualitatively subjective response to longitudinal vibrations from 1 to 20 cps in a sitting position. In the first phase the complexity of body response to whole-body vibration was demonstrated since the subjects usually experienced several symptoms for each frequency tested. The second phase suggested that the sensations were resonance-dependent. Mechanical and physiological responses were correlated. (Author)

582

Mahaffey, P.T. and K.W. Smith 1960 A METHOD FOR PREDICTING ENVIRONMENTAL VIBRATION LEVELS IN JET-POWERED VEHICLES
(Paper, 28th Symposium on Shock, Vibration and Associated Environments, The Departmental and Commerce Auditoriums, Washington, D.C., February 9-11, 1960) Published in ASTIA AD 244 857

ABSTRACT: A method for predicting environmental vibration levels for jet-powered vehicles is described. A quantitative relationship is determined between structural vibration and acoustic noise level on the external super of a structure by statistical analysis of measured data. Comparisons of measured and predicted levels are shown.

583

Mahone, Richard M. & Arthur E. Hirsch 1962 BIBLIOGRAPHY ON THE EFFECTS OF SHOCK AND VIBRATION ON MEN
(David Taylor Model Basin, Department of the Navy, Washington 7, D.C.) Structural Mechanics Laboratory Technical Note No. SML-740-8 Jan. 196?

584

Mains, R.M. 1960 INTRODUCTION TO SHOCK AND VIBRATION SIMULATION
(Paper, 28th Symposium on Shock, Vibration and Associated Environments, The Departmental and Commerce Auditoriums, Washington, D.C., February 9-11, 1960) Published in ASTIA AD 244 857

ABSTRACT: Shock and vibration testing or simulation are essential for demonstrating what improvements can be or have been made in the design, for determining the adequacy and acceptability of the design, and for controlling the quality of the product. These various functions of testing or simulation are discussed in this paper.

s, R. M. 1961 SIMULATION OF SHOCK AND VIBRATION ENVIRONMENTS. In 1961 Proceedings of the Institute of Environmental Sciences National Meeting, April 5, 6, 7, 1961, Washington, D. C. (Mt. Prospect, Ill.: Institute of Environmental Sciences, P. O. Box 191) pp. 39-52

cik, V. 1961 OTAZKY KOSMICKEHO LEKARSTVI (Problems of Space Medicine) rba (Prague) 26(17): 387-388, April 27, 1961 (In Czech.)
See also: U.S. Joint Publ. Research Service, Washington, D.C., Trans. No. 4717 (1842-S), June 22, 1961

TRACT: This is a review of the physiological problems encountered in space ght. A rotating anti-g capsule may be installed in the space ship in order keep the astronaut transverse to the direction of acceleration. Although ghtlessness does not affect vital functions, it does affect coordination orientation in space. Vibration is another problem encountered in space ghts. Vibrations of high amplitude cause general fatigue and disturb the vous system, vision, and hearing. The cabin atmosphere may be composed of oxygen, 20% helium, and 20% nitrogen. If so, the high oxygen content helium will avert some of the consequences of explosive decompression reduction of cabin pressure.

del, M.J. 1962 EFFECT OF SINUSOIDAL VERTICAL VIBRATION ON THE URINARY SEDIMENT IN MAN. (Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio) Final Report. MRL-TDR-62-63, June 1962. ASTIA AD 283 844

TRACT: Experiments were conducted to determine whether sinusoidal, low equency vertical vibration for 1 minute at subjective tolerance levels uld produce renal damage. Two groups of vibrated sitting subjects (frequency to 9 cps) were compared to a control group which had never been exposed vibration experiments. One group had long experience, varying from 6 nths to 2 years, with experimental sinusoidal vibration at subjective lerance levels. The other group was experiencing its first shake at high vels (near subjective tolerance). No difference could be detected in the inary sediment between the two experimental groups or between the vibrated oups and the control subjects. Although the data does not indicate renal mage, it might have occurred if the vibrations had been continued for a nger time period.

588

Mandel, M. J. & R. D. Lowry 1962 ONE-MINUTE TOLERANCE IN MAN TO VERTICAL SINUSOIDAL VIBRATION IN THE SITTING POSITION.
(6570th Aerospace Medical Research Lab., Aerospace Medical Division, Wrig Patterson AFB, Ohio) AMRL-TDR-62-121, Oct. 1962. ASTIA AD 292 704.

ABSTRACT: One-minute subjective tolerance in man to sinusoidal vertical vibration was determined in the sitting position. In comparing the data to previou published information, we noted that, although the new levels were higher, the contour of the curve remained unchanged. The reasons for this difference, as well as specific subjective complaints leading to tolerance, are presented and discussed. (ASTIA)

589

Mandel, M. J. 1962 EFFECT OF ANGIOTENSIN INFUSION ON REGIONAL BLOOD FLOW AND REGIONAL VASCULAR RESISTANCE IN THE RAT
(Doctoral Dissertation, Ohio State University) December 1962

590

Mandel, M. J. and L. A Sapirstein 1962 EFFECT OF ANGIOTENSIN INFUSION ON REGIONAL BLOOD FLOW AND REGIONAL VASCULAR RESISTANCE IN THE RAT
Circulation Research 10:806, 1962

591

Mandel, M. J. 1963 SHORT-TIME TOLERANCE AND PULSE RESPONSE IN MAN TO SINUSOIDA VIBRATION IN THE SEMI-SUPINE POSITION IN X, Y, AND Z AXES. (Paper, 34th Annual Meeting of the Aerospace Medical Association, Statler-Hilton Hotel, Los Angeles, Calif., April 28 - May 2, 1963)

ABSTRACT: Short time subjective tolerance in man in the semi-supine position was determined to ascertain whether this position, best for sustained linear acceleration, was also best for vibration. Thirty male volunteer subjects were exposed to subjective tolerance vibration levels in the 3-20 cps range, utilizing a Western Gear mechanical shake table capable of either vertical or horizontal oscillation. The subjects were positioned so that the vertical direction represented the X axis (front to back). Short time tolerance levels for both the head and body were investigated in the X, Y and Z axes, and the results compared to one-minute body tolerance to vertical sinusoidal vibration in the sitting position. Although the Y and Z axes closely parallel each other with regard to both g tolerance and subjective complaints, the X axis was uniquely different. The g tolerance in the X axis had a very slow rise with increasing frequency unlike the hyperbolic contour seen in the Y and Z axes. Moreover, the X axis, chest pain and inspiratory dyspnea were the most singular tolerance limiting factors in all but one subject regardless of frequency. The pulse rate response monitored by ECG was quite uniform regardless of body position or shake-axis, exhibiting the usual response seen with exercise. Comparison of the results with those seen in the sitting position indicate that the semi-supine position is probably not the best one for vibration.

el, M. J. 1963 SHORT-TIME TOLERANCE AND PULSE RESPONSE IN MAN TO SINUSOIDAL VIBRATION IN THE SEMI-SUPINE POSITION IN X, Y, AND Z AXES. (Wright-Patterson AFB, Ohio). Rept. No. AMRL-TDR-62-122, Oct. 1962.

RACT: Short time subjective tolerance in man in the semi-supine position was rmined to ascertain whether this position, best for sustained linear accelera-, was also best for vibration. Thirty male volunteer subjects were exposed bjective tolerance vibration levels in the 3-20 cps range, utilizing a rn Gear mechanical shake table capable of either vertical or horizontal lation. The subjects were positioned so that the vertical direction repre-d the X axis (front to back). Short time tolerance levels for both the head body were investigated in the X, Y and Z axes, and the results compared to minute body tolerance to vertical sinusoidal vibration in the sitting position. ugh the Y and Z axes closely parallel each other with regard to both g rances and subjective complaints, the X axis was uniquely different. The g rance in the X axis had a very slow rise with increasing frequency unlike yperbolic contour seen in the Y and Z axes. Moreover, the X axis, chest pain spiratory dyspnea were the most singular tolerance limiting factors in all ne subject regardless of frequency. The pulse rate response monitored by ECG ite uniform regardless of body position or shake-axis, exhibiting the usual nse seen with exercise. Comparison of the results with those seen in the ng position indicate that the semi-supine position is probably not the best or vibration. (Aerospace Medicine 34(3):260-261, March 1963)

lsdorf, J.E. 1959 LOGISTIC SUPPORT TO MAN'S ECOLOGY IN SPACE nical Engineering 81:79, July 1959

CT: This paper discusses the ecological elements with which the system provide the satellite crew. Provision for potable water and nutriment ans of ingestion; gases for breathing; disposal of body wastes; protection thermal, noise, radiation, psychological and G-stresses are treated in some l. It is shown that the solution of the problem of man's ecology in space es talent from a number of technical areas. The author briefly examines ckheed ecological model, first as a means of illustrating man's metabolic ge, and second, as a tool for solving some of the problems of designing ng-endurance, manned satellites.

, R. G. 1943 PENDULUM-TYPE VIBRATION ABSORBERS. . aeronaut. Sci. 10:38, 1943.

595

Marcus, Henri; James E. Walsh; L.P. Clark et al 1948 SHOCK AND VIBRATION BUL
NO. 7
(Office of Naval Research, Naval Research Lab., Washington, D.C.) NRL Rept. No.
S-3229 ASTIA ATI 75 153

ABSTRACT: The eighth symposium on shock and vibration was held at Naval Resear
Laboratory. Papers presented were concerned with the effect of shock and vibra
on structures, vibration problems of aircraft, theoretical and experimental
research on flutter in aircraft, photoviscous flow channel, static stress in
aircraft structures, the measurement of mechanical transients following landin
impact of a model airplane, ejection of pilots from aircraft, and the measurem
of forces acting on the pilot during crash landing.

596

Markarian, S.S. 1959 O VLIIANII VIBRATSII NA LORORGANY.
(The Effect of Vibrations on the Ear-Nose- and Throat Organs.)
Voennomeditsinskii Zhurnal (Moscow)(4): 70-74, April 1959

ABSTRACT: Five series of experiments were conducted with 14 male subjects,
22-35 years of age using the following parameters of vibration, characteristic
of certain types of aircraft: (1) Frequency 10 cps, amplitude 1.8 mm;
(2) Frequency 40 cps, amplitude 0.8mm; (3) 40 cps, amplitude 1.6 mm; (4) 10
cps, 2.4 mm; and (5) 70 cps, 0.4 mm. The exposure in the first three series
lasted 4-hours; in the last two series 8-hours. A predominantly high-
frequency noise in the intensity range of 105-110 db was added in the first
and second series for 6 subjects. The function of the sound analysor was
examined by audiometry before the start of vibrations, five or ten minutes
after vibrations, and an hour after the vibration was discontinued. The
function of the vestibular analysor was investigation by means of electric
rotary chair before, during, and after vibrations. Vibration in the para-
meters studied unassociated with noise does not produce any changes in the
function of the vestibular or cardiovascular system. Vibrations of a frequency
of 70 cps, amplitude 0.4 mm and above produce hearing changes in presence
of noise of 105-110 db. It is concluded that vibration in combination with
noise within the limits indicated is not physiologically permissible.

597

Marko, A.R. 1959 OPTIC-MICROSCOPIC REGISTRATION OF MICROVIBRATION OF THE
HUMAN BODY. Mikroskopie, 14:102-5, July 1959

598

Marko, A.R., M.A. McLennan, E.G. Correll 1962 A SOLID STATE MEASURING DEVICE FOR GALVANIC SKIN RESPONSE
(6570th Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio) TDR No. AMRL-TDR-62-117 ASTIA AD 292 690

ABSTRACT: The problem of monitoring galvanic skin resistance, especially when used in combination with electrocardiographic or electroencephalographic recordings is discussed. A new approach is outlined that eliminates interference from other measurements. A small, lightweight laboratory model has been built that has low power consumption and is insensitive to vibration and acceleration forces. The performance, stability, and accuracy of the model is equivalent to larger, more conventional instruments used for the same purpose.

599

Marshall, G. S. 1933 THE PHYSIOLOGICAL LIMITATIONS OF FLYING.
J. Royal Aero. Soc. 37:389-410
See also Flight 25:99-100

600

Martin Co., Denver, Colo. 1961 MTSS. GENERAL HUMAN FACTORS CONSIDERATIONS. VOLUME III.
(Aeronautical Systems Division, Wright-Patterson AFB, Ohio) ASD-CR-61-14, ASD-TR-61-211, July 1961 ASTIA AD 273 005L

ABSTRACT: Contents include material in the following subjects:
Acceleration
Weightlessness
Artificial Gravity
Labyrinthine Sensitivity in Space Flight
Vibration
Summary of Vibration Test Results
Summary of Literature Surveyed

601

Matthews, R.H.C. 1945 HUMAN LIMITS IN FLIGHT
(Smithsonian Institute, Washington, D.C.) Publication 3785

ABSTRACT: A modern aircraft will climb in a few minutes to heights at which the air is so thin that will no longer support life. It can turn and maneuver so fast that pilot may easily be rendered unconscious from the mechanical

forces which it imposes on his body, and in an aircraft which is moving rapidly in three planes of space the pilot can be subjected to stresses beyond the limits which the human body can stand. Besides the stresses from wind pressure, cold, vibration, and noise, the pilots body must also be protected from other less obvious stresses. The two greatest stresses which an aircraft puts upon the pilot and those reviewed in this publication are those stresses due to acceleration and those due to high flying in the rarefied air of the upper atmosphere.

602

Mayo, A.M. 1951 BASIC ENVIRONMENTAL PROBLEMS RELATING TO MAN IN THE "AEROPAUSE" AS SEEN BY A AERONAUTICAL ENGINEER
(Douglas Aircraft Co., Inc., El Segundo, Calif.) Nov. 6, 1951 ASTIA AD 87 435

ABSTRACT: While many new factors and principles must be considered in design for flight in the AEROPAUSE, emphasis on the cardinal principles of working toward the optimum pilot-airplane combination, will probably pay the greatest total dividend in operational efficiency. This principle can best be approached by making use of the best available aeromedical and engineering data, in order to arrive at workable compromises in each. Some of the new problems will radically affect some of the equipment associated with the airplane.

New problems include those of fit and arrangement of the aircraft cabin, time-distance factor, temperature of the aircraft, pressure environment in the cabin, acceleration, noise and vibration and the escape problem.

603

Mayo, A. M. 1952 BASIC ENVIRONMENTAL PROBLEMS RELATING MAN AND THE AEROPAUSE AS VISUALIZED BY THE AERONAUTICAL ENGINEER. In White, C. S., & O. O. Benson, Jr., eds., Physics and Medicine of the Upper Atmosphere, A Study of the Aeropause (Albuquerque, N. Mex.: University of New Mexico Press, 1952) pp. 6-22

ABSTRACT: Flight in the aeropause will impose great physiological and psychological demands on pilot and crew. The rapid advances in aircraft construction call for a corresponding step-up in education and training. The human factor should, on the other hand, be considered in the design of equipment and instrumentation. The latter should be reduced to the absolute essentials. Further clarification of the visual effects of reduced light dispersion is required. The reduction of the time-distance factor in high-speed flight will put more reliance on automatic control mechanisms, confining the human element to slow-rate monitoring operations. Temperature regulation systems will have to be adapted to the increasing speeds (a chart indicating various cooling systems practicable at the various speed ranges is presented). Problems concerning pressurization, physiological effects of acceleration, of noise, and vibration are discussed. Brief sections are dedicated to radiation and meteor hazards. General principles of escape mechanisms are analyzed. In conclusion it is recognized that a compromising formula is to be worked out to balance all factors involved and keep the resulting costs at a minimum.

.M. 1959 SOME SURVIVAL ASPECTS OF SPACE TRAVEL
ic Ind. Feb. 1959 Pp. 60-63

CT: Discussion of the need for highly reliable and accurate high-speed
ic control systems. Various environmental problems, such as exposure
ic radiation meteorites and temperature, and high acceleration rates
cussed.

, H & F.M. Keating 1961 EFFECT OF ELEVATED AMBIENT TEMPERATURE
AND VIBRATION UPON THE RECTAL TEMPERATURE OF THE RESTRAINED RAT.
(Paper, 32nd Annual Meeting, Aerospace Medical Association, Chicago,
Ill. 24-27 April 1961)

ACT: Restrained male rats (140-160 grams) of a Sprague-Dawley strain
exposed to non-lethal elevated ambient temperatures and to vibration.
nt temperature, vibrational frequency, and duration of exposure were
constant. The vibrational amplitudes were varied. Rectal temperature
e animals was measured using a thermistor probe. Restrained animals
subjected to varying vibrational displacements (0.0", 0.100", 0.210",
.320" double amplitude) keeping frequency (30 cps) and temperature 110°
(43.4°C.) constant. The rectal temperatures of the animals following
minutes exposure were +3.1° F., +4.7°F., +6.1° F., and +7.8° F.,
ectively. The incidence of lethality for these animals up to 24 hours
ving exposure was 0, 10, 25, and 75 per cent, respectively. The experi-
was repeated at a different frequency. Varying the vibration displace-
was repeated at a different frequency. Varying the vibration displace-
s (0.0", 0.050", 0.075", and 0.100" double amplitude) and maintaining
frequency (60cps) and temperature 110° F. (43.4° C.) constant resulted
n increase in rectal temperature of +3.1° F., +6.4° F., +14.9° F.,
pectively. The incidences of lethality up to 24 hours following
osure were 0, 24, 42, and 100 per cent, respectively. At both
quencies, the rise in rectal temperature was correlated with the
rease in acceleratory force. In order to determine the mechanism
erlying the nature of rectal temperature response to increasing
eleratory forces, animals were sacrificed by exposure to ether anes-
sia and immediately vibrated at varying displacements (0.0", 0.050 ",
075", and 0.100" double amplitude) keeping frequency (60 cps) and
bient temperature 110° F. (43.4° C.) constant. This particular set
conditions was chosen because the differential in rectal temperature
the live animals was greater with increasing vibratory amplitudes.
llowing the 20 minute period of exposure, the rectal temperature of
e dead animals were +2.0° F., +7.9° F., +9.8° F., and +13.7° F.,
spectively. The rectal temperatures of the dead animals were not
gnificantly different from those of the live animals exposed to the
entical stress conditions. Mechanisms by which elevated rectal
mperatures result from exposure to increasing acceleratory forces may
ssibly be that vibratory energy is translated into heat energy an/or
ibration facilitates transfer of heat from the environment into the
imal. Although the rectal temperatures of the animals were not signi-
icantly different from those of the live animals exposed to the same
nvironmental conditions, metabolism and heat transfer mechanisms avail-
le to the live animals cannot be disregarded.

606

Megel, H., F.M. Keating, and J.A. Stern. 1961 EFFECT OF ELEVATED AMBIENT TEMPERATURE AND VIBRATION UPON THE RECTAL TEMPERATURE OF THE RESTRAINED RAT. Aerospace Med. 32 (12): 1135-1139

ABSTRACT: Restrained male rats (140-160 gm) were exposed to non-lethal ambient temperature and to vibration (110F°, 30 and 60 cps, 10, 15, and 20 g). Ambient temperature, vibrational frequency, and duration of exposure were kept constant. It was noted that the rectal temperatures of the animals rose in proportion to increased acceleration. Possible mechanisms in the production and retention of heat by the animals are discussed.

607

Megel, H, H. Wozniak, E.L. Frazier & H.C. Mason 1962 EFFECT OF ALTITUDE UPON TOLERANCE TO VIBRATION STRESS
Paper: 33rd Annual Meeting of the Aerospace Medical Association, Chalfonte-Haddon Hall, Atlantic City, N.J., April 9-12, 1962

ABSTRACT: Restrained adult male rats of a Sprague-Dawley strain were exposed to a constant vibration stress (60 cps-15 g) at varying altitudes. Using lethal as an index of tolerance, exposure of animals to vibration and altitudes less than 10,000 feet resulted in an incidence of lethality which did not differ from that observed for vibration alone. Above 10,000 feet, the per cent mortality increased as a function of altitude even though exposure to these altitudes per were sub-lethal. It was demonstrated also that the increased lethality resulting from simultaneous exposure to the combined environments was caused by the reduced partial pressure of oxygen rather than the reduction in barometric pressure. Massive lung hemorrhage and severe intestinal damage were found in those animals succumbing to the combined environments. The possible causes for the enhanced mortality will be discussed.

608

Megel, H., H. Wozniak, E. Frazier and H.C. Mason 1963 EFFECT OF ALTITUDE UPON TOLERANCE OF RATS TO VIBRATION STRESS. Aerospace Medicine, 34(4): 319-321, April 1963

ABSTRACT: Restrained adult male rats of a Sprague-Dawley strain were exposed to sinusoidal or random vibration at varying simulated altitudes. Using mortality as the index of tolerance, exposure of animals to sinusoidal vibration and altitudes less than 10,000 feet resulted in incidences of mortality which did not differ from that observed for vibration at sea level. Above 10,000 feet, per cent mortality increased as a function of altitude. The increased mortality resulting from simultaneous exposure to the combined environments may be attributed to the effects of reduced partial pressure of oxygen. Exposure of restrained rats to the combined environments of random vibration and an altitude of 18,000 feet resulted in interaction with regard to mortality. Pulmonary hemorrage was found in those animals succumbing to the combined environments.

r, F.I. 1937 A PHYSIOLOGICAL EVALUATION OF VIBRATION MEASUREMENTS st. Z. 2:1-10

r, F. J. 1935 SENSITIVITY OF THE HUMAN BODY TO VIBRATIONS. (Made public by the Institute for Research on Noise and Warmth at tuttgart Institute of Technology).
ee also Forschung (V. D. I. Berlin) 6:116-121, May-June, 1935.

, F. J. 1935 SENSITIVITY OF HUMAN BEINGS TO VIBRATION. Forschung (V.D.I. Berlin), 6:116-121, May-June, 1935.

ing, W. H. 1955 A SHOCK AVOIDANCE APPARATUS EMPLOYING AN INSTRUMENTAL MANIPULATORY RESPONSE. (USAF School of Aviation Medicine, Brooks AFB, Texas) Rept. 55-25, August 1955.

r, S.J. 1900 EFFECT OF SHAKING UPON RED BLOOD CELLS. The Johns Hopkins sp. Reports 9:133-151

lle-Jones, G. 1960 A NOTE ON SOME HUMAN FACTORS IN HELICOPTER FLYING. (RAF, Institute of Aviation Medicine, Farnborough) FPRC Memo No. 142.

ill-Jones, G., & D.H. Drazin 1961 OSCILLATORY MOTION IN FLIGHT. (RAF, Institute of Aviation Medicine, Farnborough) FPRC report 1168 July 1961.

616

Mendelson, E. E., H. Conway, and J. R. Poppen 1947 CLINICAL SURVEY OF VIBRATORY INFLUENCE OF I-16 JET ENGINE ON MAN (Navy Dept. Bureau of Aero. Rept.) TED NAM AE-5090, December 11, 1947.

617

Mendes, M.F. 1952 FATORES QUE AFETAM AOS AVIADORES, DURANTE, O DESEMPHENHO DE SEUS DEVERES (Factors Which Affect Aviators During The Performance of Their Duties)
Revista Medica da aeronautica (Rio de Janeiro) 4(3): 5-18

ABSTRACT: The last decade witnessed the expansion of the literature of aviation medicine. The majority of pertinent studies centered around three physical phenomena: the density of air, the ambient temperature, and acceleration. The factors most likely to affect the pilot during flight, such as altitude, temperature, noise, light, position of the body in flight, diet, and fatigue are analyzed in some detail.

618

Mercier, A. 1948 L'INFLUENCE DES VIBRATIONS SUR LA VISION (The Influence of Vibration on Vision)
La Médecine Aéronautique 3(-6): 154-162; May-June 1948

619

Mercier, A., G. Perdriel, and P. Ganas 1959 LA VISION DANS LE VOL A BASSE ALTITUDE ET A GRANDE VITESSE. (Vision In Low Altitude and High Speed Flying.) Medecine Aeronautique (Paris), 14: 15-24

ABSTRACT: From the 271 answers to a questionnaire sent to test, fighter, and reconnaissance pilots and to all-weather fighter navigators, the authors conclude that low-altitude, high speed flying does not precipitate a noticeable visual fatigue, but generates a nervous tension which, added to the effects of turbulence could impair the visual function. Vision is impaired by the increasing speed of scanning while sensory perception remains relatively slow. Reading the instrument panel or the map is almost impossible and the fatigue of accommodation is manifested, especially among radar navigators. Low-level obstacle jumping (impossible in jets) has no influence on vision. Detection and identification of an aircraft from a distance of 4.5 km is often difficult Goggles are easily fogged because of the elevated cabin temperature, and especially if the oxygen mask is improperly adjusted. Vibrations, although usually rare, affect vision and often cause flyers to return to higher altitudes. During night flying, watching the instruments impairs retinal adaptation and increases visual fatigue.

ier, A. & G. Perdriel 1962 LES PROBLEMES VISUELS DANS LE VOL A BASSE ALTITUDE (VISUAL PROBLEMS IN FLIGHT AT LOW ALTITUDE) in VISUAL PROBLEMS IN AVIATION MEDICINE (Advisory Group for Aeronautical Research and Development Paris (France), Oxford, N.Y.: Pergamon Press)

ACT: The importance, for combatants in general, and more particularly aviators, to acquire and maintain a good night vision, has for a long stimulated research towards improving it. Studies on the value of the oscopic night vision threshold, that is to say on the perception of s under reduced conditions of illumination, which seems to constitute best standard for testing the practical value of an aviator's night vision revealed that this threshold improves with the number of night flight s. It was therefore logical to try to simulate the conditions of night ht in order to obtain such an improvement of night vision as a great er of night flight hours achieves, similarly to pilot training accomplished the ground with a Link-trainer. The Rose and Flack device, modified and im ed by Perdriel, has been used systematically for this purpose, according technique making it possible to achieve the successive stages of mesopic scotopic vision and to demonstrate the possibilities as well as limitations night visiion, and the means to avoid them. An improvement by 18 percent the value of the morphoscopic vision threshold after 8 training sessions established the efficiency of this technique which permits checking, ntaining, and recovering a satisfactory night vision without resorting to expensive and sometimes dangerous method of frequent night flights. THOR)

hven, T. J., G. R. Allen & B. C. Short 1961 THE TRANSMISSION OF AIRCRAFT VIBRATION TO MAN-MOUNTED EQUIPMENT. (Royal Aircraft Establishment, Great Britain) Technical Note No. Mech. Eng. 334, June 1961. ASTIA Doc. No. AD-266 123.

TRACT: The transmission of aircraft vibration to man-mounted functional uipment was investigated by laboratory tests on subjects in aircrew equipnt assemblies and an ejection seat. Transmissibility/frequency curves were rived in the three cardinal directions for items in the head and trunk gions, and show that man-mounted equipment will be subjected to significant roportions, and in some cases amplifications, of aircraft vibration. In the rtical and fore and aft directions the curves approximate to those of a lassical spring-type anti-vibration mounting system with viseous damping, a ow natural frequency and negligible transmissibility above 30 cps. The esults show a fair degree of correlation with limited measurements made of ody vibration. (Author)

622

Meyer-Delius, J. 1959 EFFECT OF SOUND ON MAN
(Trans. of ATZ (Automobiltechnische Zeitschrift) (Germany) 59(10):29
297, 1957)
(SLA Translations Center, Chicago, Ill.) 59-17398

623

Michon, P. 1939 ON THE TIME OF VIBRATORY REACTIONS: TECHNIQUE, PHYSIOLOG
INFORMATION Compt. rend. soc. biol. 130:358-359

624

Mikulinskii, A. M. & A. V. Krakovskii 1962 A METHOD FOR THE MEASUREMENT
HIGH-FREQUENCY VIBRATIONS.
Gig Sanit. 27:55-57, Oct. 1962 (Russian)

625

Milin, R. and O. Kosak. 1951 UTICAJ BUKE I POTRESA NA NADBUBREZNE ZLEZD
(Effect of noise and vibration on the adrenal glands)
Med. pregled, Novi Sad. (9-10):120-130

626

Miller, C. 1956 CONVAIR REPORT ON HUMAN CENTRIFUGE TEST. (Convair, San Diego, Calif.) Report 2C-8-033, 29 Oct 1956

627

Miller, E. M. 1956 WINDOW INTO SPACE Air Force 39:43-46

ABSTRACT: Research in the field of space medicine conducted at the School of Aviation Medicine (SAM), Randolph AFB, Texas. Article also names some of the physicians and scientists working in SAM and its Dept. of Space Medicine, defines the school's mission and briefly traces SAM's history from its creation in 1918. For a report on man's probable reactions to space travel and equipment necessary to keep him alive in a space ship, see the author's recorded interview with J. G. Guame, M. D., and Capt. E. M. Roth, USAF(MC), titled "To Mars and Back - How Soon" ibid, pp 47-52.

.A., W.A. Rosenblith, R. Galambos, I.J. Hirsh and S.K. Hirsh 1950 IOGRAPHY IN AUDITION (Psycho-Acoustic Lab., Cambridge 38, Mass.: Harvard sity Press)

H., M.B. Riley, S. Bondurant, & E.P. Hiatt 1958 THE DURATION TOLERANCE TO POSITIVE ACCELERATION. (Wright Air Development Center, r Research and Development Command, Wright-Patterson AFB, Ohio) DC TR 58-635, Nov. 1958. ASTIA AD 208 151.

CT: Human tolerance to prolonged positive (headward) accelerations -blackout magnitude was investigated in this study. The data indicate an is able to withstand the forces of positive g for durations much than previously supposed. Exposures as long as an hour at 3.0 g well tolerated by most subjects. Except for moderate tachycardia thologic abnormalities were observed in the electrocardiographic ngs recorded continuously on all subjects. Explored were the durations lerance at g levels varying from 3.0 to 6.0 g. The effects of anti-g upon tolerance are also reported.

r, H., M. B. Riley, S. Bondurant, & E. P. Hiatt 1959 THE DURATION OF TOLERANCE TO POSITIVE ACCELERATION. Aerospace Med. 30(5):360-366, May 1959. See also (Wright Air Development Ctr., Wright-Patterson AFB, Ohio) WADC TR 58-635; ASTIA AD-208 151.

TRACT: Human tolerance to prolonged positive (headward) accelerations ub-blackout magnitude was investigated in this study. The data dicate that man is able to withstand the forces of positive g for ations much longer than previously supposed. Exposures as long an hour at 3.0 g appear well tolerated by most subjects. Except moderate tachycardia no pathologic abnormalities were observed in electrocardiographic tracings recorded continuously on all subjects. plored were the durations of tolerance at g levels varying from 3.0 6.0 g. The effects of anti-g suits upon tolerance are also reported. THOR)

1

ller, J. et al. 1953 A BIBLIOGRAPHY FOR THE DEVELOPMENT OF STRESS-SENSITIVE TESTS. (Psychological Research Associates, Washington, D.C.) PRB Technical Research Note 22, October 1953. ASTIA AD-41773.

STRACT: The items in this bibliography have been selected and assembled

with view to providing a survey of the background material useful in the preparation of stress-sensitive tests. It contains a list of references cite by title only and abstracts of those references which were deemed most import and having the most direct bearing on the present research.

632

Miller, J.W., ed. 1962 VISUAL PROBLEMS OF SPACE TRAVEL
(National Academy of Sciences, National Research Council, Washington, D.C.)
June 18, 1962 ASTIA AD 276 513

ABSTRACT: The problems of space flight as they relate to the visual mechanis are discussed. Substantial portions of the Brown report are quoted in the present report. This report, in addition to updating the Brown report presen a considerable amount of additional information regarding specific critical visual problems, as well as a recently compiled, extensive bibliography of research in this field. (Author)

633

Miller, S. U., N. S. Namerow & P. G. Strauss 1960 A PRAGMATIC APPROACH TO BIO-INSTRUMENTATION
In Vistas in Astronautics--1960, Proceedings of Third AFOSR Astronautics Symposium, Los Angeles, Calif., October 12-14, 1960. (Society of Automotive Engineers, Inc., New York, New York) III, 95-102, Oct. 1960.

ABSTRACT: This paper discusses a number of problem areas associated with the abstraction of meaningful physiologic data from man and experimental animals under the actual or simulated conditions of space. The bioinstrumentation profiles essential to both current and future generations of space flight are considered. It is demonstrated that single measurements can at times be quite misleading, and tha, optimally, several carefully chosen nonredundant physiologic and environmental parameters should be monitored. The practicality of bioelectric devices is briefly discussed. (Tufts)

634

Miller, W. H. 1938 ANALYSIS OF THE AVIATION MEDICINE SITUATION AND RECOMMEN TIONS FOR A BUREAU PROGRAM. (Civil Aeronautics Authority, Washington, D. C Technical Development Rept. No. 9; Apr. 1938

SUMMARY: The purposes of the work reported herein are to conduct a survey of various research facilities adaptable to or engaged in a study of pilot fatigue

outline a program of investigation. It was necessary to obtain relative to existing or projected efforts of this nature as well as of attainment and desirability. Attention was given to the administrsonnel, and physical properties of many institutes and agencies. have been reached and recommendations made for Bureau sponsorship of ion in this field.

ffort is toward the determination of effects of pressure changes and of human and animal physiology. Simulated and actual flying conditions o produce symptoms. Study is being made regarding centrifugal, centri- gravitational forces and the resultant physiological alterations. has, in the past, been made regarding the effects of acceleration, ion, and gravitational forces. (CAA)

, J.R. 1960 SPACE ENVIRONMENTAL EFFECTS
ght Air Development Ctr., Wright-Patterson AFB, Ohio, Proceedings of C Space Technology Lecture Series, Volume I Technical Areas. C TR 59-732, Pp. 61-74. ASTIA AD 235 424.

: The environments described may occur individually or in combination, tain combinations cause more significant effects than others. The effects unction of many variables including the components, the characteristics component materials, and the environmental conditions. To achieve reliable nce the designers of systems will need to acquire an understanding of the ted environments and their combined effects. Test conditions should relate ly to the actual conditions encountered in space. (Author)

ki, L. 1962 BIOLOGICAL EFFECTS OF VIBRATIONS.
Med. Pracy. 13:355-369, 1962 (Pol)

istry of Aviation 1962 A BIBLIOGRAPHY ON AIRCRAFT NOISE. SUPPLEMENT NO. 7. (Ministry of Aviation, Gt. Brit.) Rpt. no. TIL/BIB/11, ASTIA AD-286 437, July 1962

istry of Supply 1955 PERSONNEL RESEARCH: A BIBLIOGRAPHY OF UNPUBLISHED REFERENCES. PART I. HUMAN ENGINEERING. PART II. HEALTH AND SAFETY. (Ministry of Supply, Gt. Brit.) Report No. TIB/BIB(U)3, pt 1 and 2, April 1955 ASTIA AD 84 989.

39

Hinoguchi, G. 1940 EFFECTS OF ULTRASONIC WAVES ON RABBIT Acta Schol. Med. Univ. Imp. Kioto 23:250-284

640

Misrahy, G. A., W. J. Gannon, & K. M. Hildreth 1958 EFFECTS OF LOUD SOUR
THE EEG AND EVOKED POTENTIALS IN RABBITS (Wright Air Development Divis
Wright-Patterson AFB, Ohio) WADD TR 57-453; ASTIA AD-130 935; May 1958.

ABSTRACT: Young rabbits were subjected to 1000 cps tones ranging in intensi
from 100 to 130 db. Normal patterns of EEG and evoked potentials are present
and discussed as well as changes produced during sound stimulation. The latt
consists of a flattening of the EEG with increased fast activity and a dimin
of the amplitude of the various components of the evoked potential. Chlorpro
hastened the return to normal of the EEG and evoked potential.

641

Misrahy, G. A., E. W. Shinabarger, & J. E. Arnold 1958 CHANGES IN COCHLEA
ENDOLYMPHATIC OXYGEN AVAILABILITY, ACTION POTENTIAL, AND MICROPHONICS DU
AND FOLLOWING ASPHYXIA, HYPOXIA, AND EXPOSURE TO LOUD SOUNDS. J. Acoust
Society of America 30(8):701-704, Aug. 1958

642

Mitchell, B. R., & A. T. Bernardini 1959 ANIMAL AND HUMAN STUDIES
OF THE EFFECTS OF LOW-FREQUENCY OSCILLATION COMBINED WITH TRANSVERSE
ACCELERATION. (Wright Air Development Ctr., Wright-Patterson AFB,
Ohio) WADC TR 59-92.

643

Modignani, L., L. Renato, B. D. Blivaiss, and E.G. Magid 1962 EFFECT
OF ALL BODY VIBRATION ON PLASMATIC AND URINARY CORTICOSTEROID LEVELS
In Proceedings of International Congress on Hormonal Steroids, Milano,
Italy, May 1962.

644

Moffitt, O. P., J. Tonndorf, and E. Guild 1948 THE VESTIBULAR
APPARATUS. PHYSIOLOGY AND APPLICATION TO AVIATION MEDICINE
(USAF School of Aviation Medicine, Randolph AFB, Texas) Dec. 1948.

C. T. 1958 SOLUTIONS TO VIBRATION PROBLEMS ARE EASY TO FIND USING OLE PARAMETERS.
.E. Journal 66(11):62-65, Pt. 2

: "Four-Pole Parameters" is an analytical technique which simplifies ution of complicated mechanical vibration problems. Complex problems ken up into a series of small ones; then the small problems are solved results combined to produce the desired answers. Not only does this e simplify a problem but in addition the solutions to the "small prob- n be used over and over again in other complex problems. This paper s an outline of the four-pole theory. This is the first time a concerted has been made to apply them to mechanical problems. The range of mechan- oblems that yield to four-pole analysis includes all linear systems and future it may be possible to extend the theory to some non-linear cases.

, J. 1961 A PROBLEM OF SINUSOIDAL VS. RANDOM VIBRATION
1961 Proceedings of the Institute of Environmental Sciences National eeting, April 5, 6, 7, 1961, Washington, D. C. (Mt. Prospect, Ill.: stitute of Environmental Sciences, P. O. Box 191) pp. 571-576

SIONS: Of interest to those perplexed by the question of sinusoidal vs. testing is the fact that this program pointed out an area in which random g succeeded whereas sinusoidal techniques failed. A procedure has been d for obtaining a random test - which need not be white noise - calculated oduce the same performance characteristics as did the service environment. equivalence is obtained in spite of the fact that the service environment was only in sinusoidal parameters. The equivalent test was verified by obtaining atory results comparing very well with service results.
andom vibration test is currently in use for assuring the quality of production are and has proven to be a useful tool in improving the service reliability e equipment. (AUTHOR)

tgomery, Jr., A.V. 1962 EFFECT OF SPACE ON MAN
National Symposium on Effects of Space Environment on Materials, St. Louis, May 7, 8, and 9, 1962 (St. Louis McDonnel Aircraft Corporation)

TRACT: A few principles involved in the definition of a spacecraft environment outlined and exemplified. These principles involve individual variations, ation of stimulus, discrete range of acceptability, and interactive effects ween simultaneously applied environmental factors. (Author)

648

Moore, F. L. 1952 NEW DITCHING SURVIVAL PLAN URGED. Aviation Week 56: 84-86, 12 May 1952.

ABSTRACT: New equipment for passenger survival after water landings may result from evidence CAB collected from survivors of a DC-4, "ditching" off Sand Spit Airport B. C. Basic assumptions as to what passengers and crew could do within the minute or two the plane floated after landing on water, are given, but only two of six water landings since 1949 have been successful. Recommendations are given for survival and a description of the accident at Sand Spit is given, when an engine quit on a DC-4, whereby the crew and 33 passengers died, after the pilot tried to make a landing on the airfield and turned off the runway into the water.

649

Moralevich, A. 1960 ANIMAL ASTRONAUTS
Komsomol'skaya pravda P. 4; 6 July 1960.

650

Morgan, R. L., & G. A. Eckstrand 1953 EFFECTS OF A CHANGED ENVIRONMENTAL CONTENT UPON PERFORMANCE OF A TRACKING TASK. (Wright Air Development Ctr., Wright-Patterson AFB, Ohio) WADC TR 53-235; Oct. 1953

ABSTRACT: To study the effect of environmental content on transfer of training, two groups of 20 male subjects kept movable cross hairs centered on a spot with a control stick in a simulated cockpit. One group practised in a complex situation, (enclosed cockpit, red panel lights, helmet, engine noise, vibration, etc.) the other in a simplex situation (open cockpit, ambient illumination, no helmet, no noise, no vibration). A week later, both groups practised in the complex situation. Tracking accuracy under final conditions is interpreted regarding degree of realism required in training simulators. (NTDC)

651

Morin, L. 1961 LA PHYSIOLOGIE DE L'ESPACE (THE PHYSIOLOGY OF SPACE) Laval medical (Montreal) 32(2): 161-177, Sept. 1961, in French

ABSTRACT: This is a review of the physiological effects and ecological problems of space flight. The astronaut will be subjected to acceleration, deceleration, weightlessness, vibration, noise, monotony, extreme temperatures, and the danger of meteorites and radiations.

652

Morozov, V.P. 1960 THE ROLE OF VIBRATION SENSATION IN REGULATION OF VOCAL FUNCTION OF MAN (O roli vibratsionnogo chuvstva v regulirovani golosovoi funktsii cheloveka). Vestnik leningradskogo universiteta (Leningrad), 15(3) : 174- 178

ABSTRACT: The accuracy of vocal reproduction of the duration of a given tone was studied by a special voice-recording apparatus under normal conditions, in noise, and in noise with artificial vibratory feed-back applied to the hand surface. The accuracy of vocal response is considerably reduced by noise as it interferes with the acoustic feedback. It is, however, restored to a great extent by the vibratory feedback of the subject's own vocal activity to the skin. Since vocalization under normal conditions is accompanied by strong vibratory stimulation of natural origin (vibration of vocal cords, resonance, et cetera), the sensation of vibrations by ear and muscle receptors is important in the regulation of the vocal function in speech and singing.

653

Morris, G.J., & J.W. Stickle 1960 RESPONSE OF A LIGHT AIRPLANE TO ROUGHNESS OF UNPAVED RUNWAYS. (National Aeronautics and Space Administration, Washington, D.C.) NASA Technical Note D-510, Sept. 1960. ASTIA AD 241 933

ABSTRACT: The response of a light liaison-type airplane to roughness of unpaved runways was studied by measuring center-of-gravity acceleration as the airplane was taxied at constant speeds over two grass runways and a concrete taxiway. The results are presented in the form of acceleration distributions, acceleration power spectra, transfer functions, and average peak accelerations as functions of taxiing speed. Measurements from elevation profile surveys of the runways and taxiway are presented in the form of elevation profiles and power spectra. (Author)

654

Moskal, B. 1961 PROBLEMS IN ACOUSTICAL ENVIRONMENTAL SIMULATION (Proceedings of the Institute of Environmental Sciences National Meeting, April 5, 6, 7, 1961, Washington, D. C.; Paper not available for publication)

655

Mozell, M. M. and D, C. White 1958 BEHAVIORAL EFFECTS OF WHOLE BODY VIBRATION
(U.S. Naval Air Development Center, Johnsville, Pennsylvania)
NADC-MA-5802 January 28, 1958 ASTIA AD 156 470

ABSTRACT: A study was made of the effect of whole body vibration on the ability of humans to read the digits of an aircraft mileage indicator and their ability to do a tracking task which simulated the control of an

aircraft. Vertical sinusoidal vibration of frequencies ranging between 0 and 50 cycles per second (cps) with amplitudes of 0.05, 0.1, and 0.16-inch double amplitude were used. It is concluded that increasing the frequency of vibration above 8 cps has an increasingly detrimental effect on visual performance. This effect reaches a maximum between 40 and 50 cps. The increase of amplitude ot vibration from 0.05 to 0.1-inch double amplitude has no effect upon visual performance. Therefore, a case was made for using frequency and amplitude rather than G as vibration coordinates. It is further concluded that vibration, within the limits of the experiment, has little effect upon tracking ability.

656

Mozell, M. M. and D. C. White 1958 BEHAVIORAL EFFECTS OF WHOLE BODY VIBRATION
J. of Aviation Medicine 29(10):716-724, October 1958

ABSTRACT: A study was made of the effect of whole body vibration on the ability of humans to read the digits of an aircraft mileage indicator and their ability to do a tracking task which simulated the control of an aircraft. Vertical sinusoidal vibration of frequencies ranging between 0 and 50 cps with amplitudes of 0.05, 0.1, and 0.16-inch double amplitude were used. It is concluded that increasing the frequency of vibration above 8 cps has an increasingly detrimental effect on visual performance. This effect reaches a miximum between 40 and 50 cps. The increase of amplitude of vibration from 0.05 to 0.1-inch double amplitude has no effect upon visual performance. A case was made for using frequency and amplitude rather than G as vibration co-ordinates. It is concluded that vibration, within the limits of the experiment, has little effect upon tracking ability.

657

Müller, B. 1956 FLUGMEDIZINE: KOMPENDIUM DER LUFTFAHRTMEDIZIN (Aviation Medicine: Compendium of Aviation Medicine)
(Dusseldorf: Droste, 1956) Nordrhein-Westfalen. Ministerium fur Wirtschaft und Verkehr. Verkehrswissenschaftliche Veroffentlichungen. Heft 34.

ABSTRACT: This monograph surveys the field of aviation medicine and is intended for use by medical students, students of aerotechnology, physicians, engineers, and fliers interested in aeromedical problems. The chapters deal with the historical development of aviation and aviation medicine, high-altitude flight and the effects of altitude, acceleration and centrifugal forces, motion sickness, sensory organs and sensory illusions in flight, orientation as to the position in space and movement, psychophysiology of fliers, flight hygiene, flight accidents, physical and psychological examinations of fliers, flying fatigue -- symptoms and therapy, and some problems of space medicine.

58

Muller, E. A. 1938 DIE WIRKUNG SINUSFÖRMIGER VERTIKALSCHWINGUNGEN AUF DEN SITZENDEN UND STEHENDEN MENSCHEN. (The Effect of Sinusoidal Vertical Vibration on the Seated and Standing Man.)
Arbeitsphysiologie 9(10):459-476

59

Mullinger, D.E. 1961 THE DEVELOPMENT OF A RANDOM MOTION VIBRATION SYSTEM. (Royal Aircraft Establishment, Gt. Brit.) Technical note no. GW 571; ASTIA AD- 259 789 ; April 1961

ABSTRACT: Development is described of an equipment intended for studies in random motion within the frequency range 30 c/s to 5 Kc/s. The statistical properties of random noise are summarised, as are the reasons for the choice of the equipment. A moving-coil vibrator of 500 lb rms thrust was used, and the main task was to obtain a flat frequency response from the system, using electrical correcting networks. Originally multiple band-pass filters were provided for equalising and spectrum shaping, but these were found to be unacceptable as the mixing of coherent signals could produce de-randomisation. The equalising method adopted uses notch and step filters and gives satisfactory results. A further problem was to obtain a stable mechanical response, and this involved a structural modification to the vibrator. A simple method of shaping noise spectra was evolved which is particularly suitable for vibration testing. It is concluded that the adaptation of a vibration system for random motion can be a simple process if the vibrator characteristics are satisfactory. (Author)

660

Mulwert, E., T. Schultes and H. Schultes 1942 A DEVICE FOR TREATING MATERIALS AND ANIMALS WITH ULTRASONIC WAVES FOR THE PURPOSE OF INDUCING CHEMICAL, BIOLOGICAL OR PHYSICAL EFFECTS Chem. Abstr. 36:939
See also: German Patent 703,884, 13 Feb. 1941

661

Myklestad, N. O. 1956 FUNDAMENTALS OF VIBRATION ANALYSIS (New York: McGraw-Hill, 1956)

VIBRATION

N

662

Nadel, A.B. 1958 HUMAN FACTORS REQUIREMENTS OF A MANNED SPACE VEHICLE (General Electric Co., Santa Barbara, Calif.) Rept. RM 58TMP 10 April 1958

ABSTRACT: This report presents an analysis of human factors requirements of a manned space vehicle in light of present knowledge. One section deals with the physical environment of the operator, covering the effects of physical stimuli from space external to the craft, their possible effects on the operator and protective measures needed. Another section is concerned primarily with inputs from space received via the sensory system of the operator. Phenomena apprehended through the perceptual system are described together with their possible effects and practices recommended to avoid undesirable effects. The information processing function (information items needed, displays, and display-control relations) is discussed at length.

663

Nadel, A.B. 1959 SUPPORTING MAN IN SPACE: 1970-1975 (General Electric Co., Santa Barbara, Calif.) RM 59 TMP-85 Nov. 30, 1959

ABSTRACT: Reviews progress in space technology expected during the periods 1970-1975. Discusses requirements and capabilities in these areas: (1) the physical environment-atmosphere, gravitational forces, temperature and radiation; and (2) acoustic noise and vibration

664

Nadel, A. B. 1959 AUDITORY NOISE AND VIBRATION PROBLEMS FOR MANNED SPACE VEHICLES. (Technical Military Planning Operation, General Electric Co. Santa Barbara, Calif.) Research Memo RM 59TMP-50, 20 Oct. 1959

665

Maimark, G. M. 1951 BIBLIOGRAPHY ON SONIC AND ULTRA-SONIC VIBRATION: BIOLOGICAL, BIOCHEMICAL AND BIOPHYSICAL APPLICATIONS. Franklin Inst. J. 251:279-299, 402-408.

ABSTRACT: Includes 580 titles from 1900 to 1950.

666

Nefedov, P. 1960 THE PRIDE OF THE 20TH CENTURY Izvestiya P. 1; 24 August 1961

667

Neiswander, R.S. & H.T. Armstrong 1947 MOTION ASPECTS OF FLIGHT STIMULATION (Link Aviation Devices, Inc., Binghamton, New York) Eng. Rept. No. 164.233

668

Newcomer, E.H. and R.H. Wallace 1949 CHROMOSOMAL AND NUCLEAR ABERRATIONS INDUCED BY ULTRASONIC VIBRATIONS Am. J. Botany 36:230-236

669

Newman, E.B. 1955 PSYCHO-PHYSICAL EFFECTS OF NOISE (Psycho-Acoustic Lab., Harvard U., Cambridge, Mass.) Rept. No. PNR-176, 1955

670

Newman, R.P 1962 MULTI-RESONANCE RESPONSE TO SINE AND RANDOM VIBRATION (Institute of Environmental Sciences, Mt Prospect, Ill.) Reprint 62-561

ABSTRACT: The intent of this study is to consider the output response of a system of resonant components excited by three different types of vibration: (1) sine vibration (2) random vibration and,(3) controlled sine-spectrum (periodic vibration

The approach to this study was to construct a simple test system containing seven resonant components each component having its resonant frequency separated from all others such that harmonics from one component would not excite another. The test system was then subjected to sine vibration, random vibration, and controlled sine-spectrum(periodic)) vibration. Comparisons of the time variant excitations of the seven resonant components subjected to the three different types of vibrations are presented and discussed.

671

Nickerson, J.L., G. Nemhauser, C. Gannon, J. Greenman, and R. Satzman. 1961 RESONANT FREQUENCIES ON INTERNAL BODY STRUCTURES. Fed. Proc. 20: 215

ABSTRACT: An X-ray kymograph has been devised which enables us to determine with high accuracy, the resonant frequencies and the amount of movement of internal organs under externally applied sinusoidal forces. Values for structures in the abdomen and the thorax are reported.

672

Nickerson, J. L., & R. R. Coermann 1962 INTERNAL BODY MOVEMENTS RESULTING FROM EXTERNALLY APPLIED SINUSOIDAL FORCES. (6570th Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio) AMRL-TDR-62-81; July 1962 Same as ASTIA AD-290 500

ABSTRACT: This report contains a description of an x-ray device designed to permit the observation of the movement of internal structures in the animal body subjected to sinusoidal oscillations. From the x-rays taken by this device, it has been possible to determine the resonance frequency and phase shift of regions within the abdomen and thorax set in motion by external oscillatory forces. The results of observations made on anesthetized dogs show that the visceral content of the abdomen and thorax appears to oscillate as a mass having a resonant frequency of 3 to 5 cycles per second and with damping of one-fifth to one-quarter of the critical value. (AUTHOR)

673

Niven, J. I. & W. C. Hixson 1961 FREQUENCY RESPONSE OF THE HUMAN SEMICIRCULAR CANALS: I. STEADY-STATE OCULAR NYSTAGMUS RESPONSE TO HIGH-LEVEL SINUSOIDAL ANGULAR ROTATIONS
(USN School of Aviation Medicine, Pensacola Air Station, Fla. & National Aeronautics and Space Administration, Washington, D. C.)
Proj. MR005.13 6001, Subtask 1, Rep. 58, March 1961.

ABSTRACT: The use of a transition technique for quantifying nystagmic response to semicircular canal stimulation by high level, sinusoidal angular accelerations is presented. The frequency response characteristics are evaluated from cornea-retinal potential recordings obtained at rotation frequencies from 0.02 to 0.20 cps with a constant peak acceleration of 40 degrees/sec.^{2}. Interpretation of the data is directed toward an analysis of the performance of the cupula-endolymph system, rather than a description of its physical characteristics. (Tufts)

n, C. W. 1962 INFLUENCE OF SELECTED VIBRATION UPON SPEECH, I RANGE OF 10 CPS TO 50 CPS
In Journal of Auditory Research 2:247-266, 1962

, C.W. & H.C. Sommer 1963 INFLUENCE OF SELECTED VIBRATIONS UPON SPEECH (RANGE OF 2 CPS - 20 CPS AND RANDOM)
physics Lab., 6750th Aerospace Medical Division, Dayton, Ohio)
Tech. Doc. Rept. No. AMRL-TDR-63-49; Project No. 7231; Task 723103

RACT: Certain characteristics of speech are altered during low-frequency ation of a talker. Therefore, adequate speech communication cannot be red during vibration and buffeting associated with powered flight and reentry pace vehicles. In experiment I, seated talkers read standard speech material e being subjected to vertical, low-frequency sinusoidal vibrations. This ch was evaluated both objectively and subjectively in terms of intelligibility tion, and quality of speech. Vibration frequencies of 6 cps, 8 cps, and ps were most detrimental to speech production. In experiment II, sitting ers read material during random vibration (0.5 - 8 cps). No significant ch production differences were found. Speech may be adequate during the itions represented in this study, however, when these conditions are exceeded ntinuous speech communication capability may not exist.

on, C. W., & H. C. Sommer 1963 SPEECH IN VIBRATION ENVIRONS
(Paper, 34th Annual Meeting of the Aerospace Medical Association, Statler-Hilton Hotel, Los Angeles, Calif., April 29-May 2, 1963)

TRACT: A capability ofr continuous speech communication from the space vehicle a vital requirement in rocket-propelled, manned space flight. The influence vibration and buffeting to be experienced during powered flight and re-entry n the speech of space travelers is problematical for vehicles with the increased ust of future propulsive systems. This communication problem is intensified the high noise levels which accompany the transient low-frequency vibrations. rtain regions of the body structure most susceptible to low-frequency vibrations e regions also fundamental to normal speech production. This discussion des- ibes research on man's ability to produce adequate speech during exposure to tense low-frequency vibrations. Talkers positioned on a Mercury space couch re exposed to three different modes of sinusoidal vibration along the x, y, d z axes at frequencies from 6 cps to 20 cps. Efficiency of the vibrated eech in quiet and in the presence of noise was evaluated by trained observers. sults indicate changes in intelligibility and other basic parameters of speech e to the vibration stimulus. These data are useful to assist in predicting n's ability to produce satisfactory speech communication during phases of space light accompanied by low-frequency vibration

677

North American Aviation 1958 PROPOSAL FOR A STUDY OF HUMAN PERFORMANCE CAPABILITY UNDER SIMULATED AIRCRAFT FLIGHT BUFFETING CONDITIONS. (Columbus Division, North American Aviation Co.) NAA Rept. No. NA58H-427, Aug. 1958

678

Novikov, K. & B. Shchandronov 1960 ALTITUDE IS 450 km
Sovetskaya Rossiya P. 4; 20 May 1960

679

Novotny, S. and J. Uher 1959 OCCUPATIONAL TRAUMA BY PNEUMATIC TOOLS AS A CAUSE OF SPINAL LESIONS. Pracov Lek. 11:511-5, December 1959

VIBRATION

0

9

streicher, H. L. 1950 A THEORY OF THE PROPAGATION OF MECHANICAL VIBRATIONS IN HUMAN AND ANIMAL TISSUE
(Air Development Center, Wright-Patterson AFB, Ohio)
AF Technical Rep. No. 6244, November 1950

streicher, H. L. 1950 A THEORY OF THE PROPAGATION OF MECHANICAL VIBRATIONS IN HUMAN AND ANIMAL TISSUE. J. acoust. Soc. Amer. 22:682
See also WADC TR 6244

2

streicher, H. L. 1951 FIELD AND IMPEDANCE OF AN OSCILLATING SPHERE IN A VISCO-ELASTIC MEDIUM WITH APPLICATIONS TO BIOPHYSICS
Journal of the Acoustical Society of America 23:707-714, 1951

3

ffice of Naval Research 1955 SYMPOSIUM ON PHYSIOLOGICAL PSYCHOLOGY, SCHOOL OF AVIATION MEDICINE, U.S. NAVAL AIR STATION, PENSACOLA, FLORIDA, MARCH 10, 11, 1955, UNDER THE SPONSORSHIP OF PHYSIOLOGICAL PSYCHOLOGY BRANCH, PSYCHOLOGICAL SCIENCES DIVISION, OFFICE OF NAVAL RESEARCH.
(Office of Naval Research, Washington, D.C.) ONR Symposium rept. no. ACR-1; ASTIA AD 80 100.

684

Ogle, D.C. 1957 MAN IN SPACE VEHICLE
U.S. Armed Forces Med. J. 8(11): 1561-1570, Nov. 1957

ABSTRACT: This is a discussion of the physiological forces in man during a spaceflight. The author also comments on the hazards of the upper atmosphere

685

O'Hearne, C. S. 1961 STUDIES APPLICABLE TO THE EVALUATION OF THE EFFECT OF FASTENING LOOSENESS ON EQUIPMENT RESPONSE TO FOUNDATION OSCILLATIONS. In 1961 Proceedings of the Institute of Environmental Sciences National Meeting April 5, 6, 7, 1961, Washington, D. C. (Mt. Prospect, Ill.: Institute of Environmental Sciences, P. O. Box 191) pp. 585-594

CONCLUSIONS: For the range of parameters investigated, play retarded by minimum coulomb friction tends to alleviate the rms oscillatory load response to stationary random input. This may be attributed to a peak biting or clipping effect. Play with almost no friction tends to aggravate the rms oscillatory load response only slightly. Sinusoidal inputs at frequencies near resonance apparently produce responses following a similar trend. The limited results suggest that the range of the effect is more extreme in the sinusoidal case. (AUTHOR)

686

Okos, G., L. Magos, and G. Kovac. 1954 DURCH VIBRATIONSSCHADEN VERURSACHTE GEFASSVERANDERUNGEN. (Vascular changes caused by vibration injury.) Acta med. hung. 6:75-79

687

Oleson, M.W. 1960 APPLICATION OF A SPECIAL TEST FIXTURE TO VIBRATION MEASUREMENT DURING STATIC FIRING OF ROCKET MOTORS
(Paper, 28th Symposium on Shock, Vibration and Associated Environments, The Departmental and Commerce Auditoriums, Washington, D.C., February 9-11, 1960) Published in ASTIA AD 244 857

ABSTRACT: Measurement of vibration induced during rocket motor static firings is one technique for obtaining environmental data applicable to rocket vehicle components. However, the usefulness of such data may be compromised by conditions peculiar to the static test itself. The accuracy of data obtained may be improved by the use of special test fixtures during the static firings, as shown by measurements on two different types of rocket motor.

88

lmer, D. & I. Jacques 1928 TRANSIENT INCREASE IN BLOOD PRESSURE AND DECREASE IN PULSE RATE PRODUCED BY LEANING FORWARD
ompt. Rend. Soc. de Biol. 99: 169-170

89

dway, F.I., J.P. Gardner & M.R. Sharpe 1962 SPACE MEDICINE: THE BASIC FACTORS
n: Basic Astronautics: An Introduction to Space Science, Engineering, and Medicine (Englewood Cliffs, N.J.: Prentice-Hall Space Technology Series) Pp. 468-471

Sections on Vibration, Sound, Temperature (Chapter 12)

BSTRACT: The effects of vibration on the human being are primarily mechanical d to a much lesser degree thermal. Vibration in space carrier vehicles has ny sources such as rotating engine components, engine pulses, and gimbaling, coustic pressures, buffeting, and fuel slashing. Vibration produces movement d displacement of the internal organs of the body, all of which have different tural frequencies. The range is still largely unknown but the thorax and dominal organs appear most sensitive to vibration, having a natural frequency some 3 cps. Elastic corsets and pressure suits instead of damping this requency merely shift it to higher values, but a rigid restraint like a cast educes it to 1.5 cps. With regard to space flight it seems that the vibrational requency range most detrimental to man lies between 2 and 100 cps. (CARI)

690

Oshima, Masamitsu 1961 VIBRATION AND HUMAN BODY.
Tekko Rodo Eisei 2:39, 1953 (Aerospace Technical Intelligence Ctr., Wright-Patterson AFB, Ohio Trans. No. MCL-803; 25 April 1961) ASTIA AD-259 593

ABSTRACT: The author gives a detailed report on the sense of vibration and the effects of generalized vibration on the human body. He also discusses the theory of disturbances of vibration, permissible doses of vibration, and damage to human beings by vibration. Medications and other methods to increase the tolerance against vibrations is still another subject discussed. Many charts are included fo: illustration of facts and figures.

691

Oslake, J. J., N. L. Haight, & L. J. Oberste 1960 ACOUSTICAL HAZARDS OF ROCKET BOOSTERS. VOLUME II. EFFECTS ON MAN. (Aeronutronic, Newport Beach Calif.) Technical Rept. No. U-108:97; Contract N123(61756)23304A; ASTIA AD-253 316; 30 Nov. 1960

CONTENTS:
Effects of rocket noise on hearing:
- Mechanism of hearing;
- Temporary hearing loss;
- Permanent hearing loss;
- Exposure to rocket noise;
- Attenuation by ear defenders

Psychological and biological effects:
- Central nervous system effects;
- Influence on visual thresholds;
- Aural pain;
- Effects of mechanical vibrations

Effects of noise on speech;
- Statistics of speech;
- Speech intelligibility;
- Effects on warning devices

Community reaction to rocket noise:
- Community characteristics;
- Prediction of community reaction

Acoustical criteria for rocket noise:
- Hearing damage risk criteria;
- Criteria for speech communication;
- Criteria for residential areas

(ASTIA)

VIBRATION

P

692

Paic, M., P. Haber, J. Voet and A. Eliasz 1935 BIOLOGICAL ACTION OF ULTRASONICS Compt. rend. soc. biol. 119:1061-1063

693

Pak, C. H. 1961 FORCED VIBRATIONS OF A MASS ON A NONLINEAR SPRING. (Masters Thesis: U. S. Naval Postgraduate School, 1961) Rept. P12

694

Palmisano, C. 1951 STUDIO DEL TONO LABIRINTICO E DEI RIFLESSI VEGETATI-VOLABIRINTICI IN SOGGETTI IMBARACTI SU NAVI DI SUPERFICIE E STUDIO DELLE VARIAZIONI DELL'ECCITABILITA VESTIBOLARE PER LO STI'MOLO FIXICO DI MOVIMENTI NAVE NELLA NAUPATIA (Labyrinth Tone and Autonomic Labyrinth Reflexes in Sailors and Variations of Vestibular Excitability Due to the Physical Stimulus of Ship Movements in Seasickness) Annali di medicina navale e coloniale (Rome) 56(4): 424-426. July-Aug. 1951.

695

Paparopoli, G. and S. Terranova. 1955 RILIEVI FOTOPLETISMOGRAFICI IN LAVORATORI ADDETTI A STRUMENTI VIBRANTI. (Photoplethysmographic data in workers using vibrating instruments.) Folia med. 38:1260-1271

696

Pape, R.W. and D.E. Goldman. 1960 OBSERVATIONS ON DAMAGE TO EXPERIMENTAL ANIMALS EXPOSED TO MECHANICAL VIBRATION. Aerospace Med. 31 (4) : 317

ABSTRACT: Anesthetized male cats have been exposed to mechanical vibration in the range from 5 to 20 cps. Pulmonary hemmorhage and evidence of traumatic myocardial damage may occur if the acceleration exceeds about 5 G for a sufficient time. Both the frequency and severity of the injuries increase as the acceleration increases. When the acceleration exceeds about 10 G death may result from the exposure. Minimal injury indicated by delayed changes in cardiac potentials, which may, however, be reversible. Confirmatory evidence is obtained from post mortem and histological examination of tissues. Other observations have revealed a definite effect of the method of supporting the animals during exposure.

697

Parey, W. 1932 SENSITIVENESS OF THE HUMAN BODY TO VIBRATIONS Power Plant Eng 36:705

698

Parks, D.L. 1960 A PRELIMINARY STUDY OF THE EFFECTS OF VERTICAL AIRCRAFT VIBRATION ON TRACKING PERFORMANCE AND REACTION TIME (Boeing Airplane Co., Wichita, Kansas) D-3-3476, November 1960

ABSTRACT: Applicable human vibeation data is limited in quantity and restricted in utility for application to design problems since most of the information is based upon sinusoidal vibration which is seldom found in an operational environment

699

Parks, D. L., 1961
A COMPARISON OF SINUSOIDAL AND RANDOM VIBRATION EFFECTS ON HUMAN PERFORMANCE
(The Boeing Company, Wichita Division, Kansas)
Tech. Rep. No. D3-3512-2 July ASTIA AD 261 331

ABSTRACT: Ten male subjects performed a complex task during vertical vibration in a preliminary study to compare performance with sinusoidal, constant period random amplitude, and random (aircraft-turbulence)

tion. Performance on the three subtasks varied: performance on a t
ng task with delayed control-display feedback was differently affected
ding to type of vibration; no affect was found for a tracking task
t feed-back delay; and response time did not change.
Results were analyzed for consistent trends in vibration effects
could be correlated with mechanical and psychological definitions
ibration for evidence of a human performance transfer function for
ation. Psychological and amplitude bases for this function could
be found, vibration acceleration (g) effects were not clear, and RMS
itude power was correlated with constancies in performance. It was
ested that testing combinations of RMS and frequency (and related
ors) could lead to a performance transfer function permitting transforma-
of human performance data from sinusoidal to operational vibrating
ironments.

0

rks, D. L., & F. W. Snyder 1961 HUMAN REACTION TO LOW FREQUENCY VIBRATION. (Boeing Co., Wichita, Kansas) Technical Rept. No. 1; Document No. D3-3512-1; Contract Nonr-299400; 24 July 1961; ASTIA AD-261 330

STRACT: Systematically derived judgments of levels of vertical sinusoidal vibra-
on severity from 1 to 27 cps were obtained under laboratory controlled conditions
r each of 16 selected male subjects. These vibration levels were established
terms of four levels defined as Definitely Perceptible, Mildly Annoying,
tremely Annoying and Alarming as acceleration increased for each fixed frequency
a constant rate. The results established four profiles of acceleration from
to 27 cps to be used as the vibration frequency and amplitude points in the
ibration environment for a series of tests of human performance in the remaining
ogram. Correlation of judgment with velocity, acceleration, and double ampli-
ude according to frequency were noted. A definite correlation between reported
ody area selectively affected and frequency was also found. As reported in
evious studies sensitive to vibration at selected frequencies, suggesting
ody organ and appendage resonance. (AUTHOR)

1

arks, Donald L. 1961 A COMPARISON OF SINUSOIDAL AND RANDOM VIBRATION EFFECTS ON HUMAN PERFORMANCE
(The Boeing Company, Wichita Division) Naval Research Contract Nonr 2994(00) Technical Report D3-3512-2 July 28, 1961 ASTIA AD 261331

ABSTRACT: Ten male subjects performed a complex task during vertical vibration in a preliminary study to compare performance with sinusoidal, constant period random amplitude, and random (aircraft turbulence) vibration. Performance on the three subtasks varied: performance on a tracking task with delayed control-

display feedback was differently affected according to type of vibration; no effect was found for a tracking task without feedback delay; and response time did not change.

Results were analyzed for consistent trends in vibration effects which could be correlated with mechanical and psychological definitions of vibration for evidence of a human performance transfer function for vibration. Psychologi and amplitude bases for this function could not be found, vibration acceleration (g) effects were not clear, and RMS amplitude power was correlated with constanc in performance. It was suggested that testing combinations of RMS and frequenc (and related factors) could lead to a performance transfer function permitting transformation of human performance data from sinusoidal to operational vibrating environments.

702

Parks, D. L. 1962 DEFINING HUMAN REACTION TO WHOLE-BODY VIBRATION
Hum. Factors 4:305-314, Oct. 1962.

703

Parin, V. 1960 GREAT EVE
Izvestiya P. 3; 17 May 1960

704

Parin, V.V. 1960 ON THE EVE OF THE SOLUTION OF THE PROBLEM
Trud P. 2; 17 May 1960.

705

Parin, V. 1960 GET TO KNOW: SPACE BIOLOGY
Trud P. 3; 15 October 1960

706

Parin, V. 1961 THANKS TO THIS DAY LIFE IS WORTH LIVING
Vestnik vozdushnogo flota 4: 53-55

rrack, Horace O., Donald H. Eldredge & Henry F. Koster 1948 PHYSIOLOGICAL EFFECTS OF INTENSE SOUND
gineering Division, Air Materiel Command, United States Air Force)
Eng. Div. Memo. Report No. MCREXD-695-71B May 24, 1948 ASTIA ATI 28968

STRACT: This report presents results obtained in preliminary experiments
signed to determine the physiological effects of intense sound on man and
imals

3

rrack, H.O. and D.H. Eldredge 1947 CERTAIN PHYSIOLOGICAL REACTIONS TO INTENSE SOUND FIELDS Federation Proc. 7:90

9

rack, H. O., H. von Gierke, H. Oestericher & W. W. von Wittern 1950 ABSORPTION OF VIBRATORY ENERGY BY HUMAN BODY SURFACE.
Fed. Proc. 9:99-100. ASTIA AD 261 330.

RACT: Measurements were made of the response of the body surface to mechan-
vibrations. Three methods were used in overlapping frequency ranges so as
pan a total frequency range of 20-20,000 cps. The results are consistent
describe the mechanical impedance of the body surface and the elastic pro-
ties of the tissue. The impedance consists of a frictional resistance and a
ctance. The resistance is proportional to the square root of the frequency.
reactance is an elastance varying inversely with frequency up to about 50
where it becomes zero. Above this frequency the reactance is an inertance
t is proportional to frequency throughout the measured range. The vibratory
rgy absorbed at the body surface and converted to heat in the tissues may be
culated from the impedance. From these results was developed a theory on the
hanical behavior of the vibrating body tissue that considered the tissue as
elastic medium with viscosity. For such a model, and for the frequency range
-20,000 cps, equivoluminal shear waves with velocities less than sound are
dominant. It is only at still higher frequencies that compression waves play
important roll. The theory also explains the surface waves observed experi-
ntally

710

Parrack, H. O. 1956 NOISE, VIBRATION AND PEOPLE
Noise Control 2(6):10-24, Nov. 1956

ABSTRACT: The physiological effects of acoustic energy are considered in relati to mechanical damage to the body and functional impairment of sense organs. An attempt is made to evaluate the percentage of population who will develop hearin loss due to aging alone, those who will develop hearing loss due to exposure to noise, and those who will develop it for other reasons. Persons who are suscep- tible to permanent hearing damage from exposure to noise may be detected by an unusually large temporary threshold shift for a given noise exposure. Less dire effects of noise include interference with communication and arousal of antagoni tic emotions. Problems created by noise fields found in practical situations are considered for the air crew, passengers, aircraft maintenance crew, other ground support personnel, and people outside an air base.

711

Parsons, J.A., 1956 SPECTROPHOTOMETRIC ANALYSIS OF SOCIUM, CALCIUM AND POTASSIUM IN BLOOD SERUM OF NORMAL AND NOISE EXPOSED ANIMALS
(Masters Thesis, Pennsylvania State University, June 1956)

712

Paton, C.R., E.C. Pickard & V.H. Hoehn 1940 SEAT CUSHIONS AND THE RIDE PROBLEM
S.A.E. Journal 47: 273-283, July 1940

713

Paulson, E. C. 1949 TRACTOR DRIVERS' COMPLAINTS.
Minnesota Medicine 32(4):386-387, April 1949.

ABSTRACT: An enumeration of symptoms suffered by a small group (23) of farmers directly attributable to tractor driving is made. The mechanism of production is discussed as is their prevention and treatment. The most important point is recognition of the more unusual manifestations of this condition so that correct advise and treatment is instituted.

COMPLAINT	NUMBER
Backache	10
Indigestion	7
Abdominal soreness	5
Sore stiff neck	3
Pain in extremities	2
Others	3

rl Harbor Naval Shipyard, T.H. 1960 VIBRATION AND NOISE SURVEY REPORTS ISSUED FOR 1959. ASTIA AD-231 263, 8 January 1960

TRACT: An investigation to determine the cause of excessively vibrating fore t was conducted aboard the USS Forster (DER 334) on 26 January, 1959. Vibra- n data were obtained on the fantail (after towing pad) and at the base of the remast. Spot checks were made in other spaces of the ship. The natural period vibration of the foremast platform was experimentally determined after the a-trial. The hull vibration levels observed were considered acceptable. The st vibrations occurred at normal hull vibration criticals. The foremast plat- rm has a natural period of vibration close to the 180 rpm hull critical which xplains any high vibration levels. No corrective action should be undertaken t the present time with respect to the shafting or propellers. The mast vibra- ion should be corrected by stiffening the mast to shift the natural period way from the hull criticals; preferably 220 cpm to 260 cpm.

715

Pearlstein, J. 1960 MEASUREMENT OF DISPLACEMENT, VELOCITY, AND ACCELERATION: BIBLIOGRAPHY WITH ABSTRACTS AND INDEX. (Diamond Ordnance Fuze Laboratories, Ordnance Corps, Washington 25, D. C.) TR-836; ASTIA AD-243 420; 22 Aug.1960

ABSTRACT: A bibliography is presented with abstracts and index covering technical literature on the measurement of displacement, velocity, and acceleration. The references were obtained from the peek-a-boo files of the Office of Basic Instrumentation of the National Bureau of Standards and represent a sample of the literature published from about 1950 to 1958. (AUTHOR)

716

Pennsylvania State U. 1957 BIBLIOGRAPHY ON SHOCK AND SHOCK EXCITED VIBRATIONS VOLUME I (INTRODUCTION AND ABSTRACTS OF TECHNICAL PAPERS)(Pennsylvania State U. Coll. of Engineering and Architecture, University Park) Sept 1957, ASTIA AD-200 830

717

Perilhou, P. & H. Pieron 1942 QUELQUES CARACTERISTIQUES DES SENSATIONS VIBRATOIRES (Some Characteristics of the Vibratory Sensations) C.R. Soc. Biol. (Paris) 136: 448-449

718

Perry, C. D. & H. R. Lissner 1961 SHOCK AND VIBRATION HANDBOOK, Vol. I BASIC THEORY AND MEASUREMENTATION, Chapter 17 Strain Gage Instrumentation McGraw Hill Book Co

719

Piccoli, P., A. Rossi & O. Elmino 1962 BEHAVIOR OF COAGULATION FACTORS IN ANIMALS SUBJECTED TO VIBRATIONS.
Folia Med (Napoli) 45:1236-1247, Dec. 1962 (Italy)

720

Piersol, A. G. 1957 THE EFFECT OF PROPELLER PHASE SYNCHRONIZATION ON DC-7 CABI SOUND & VIBRATION LEVELS. (Douglas Aircraft Co.) DACo Testing Division, Rept. No. DEV. 2427, 23 July 1957

721

Piolett, L. 1960 LE VOYAGE TERRE LUNE-SERA-T-IL UN JOUR UN VOYAGE D'AGREMENT? (THE EARTH-MOON TRIP - WILL IT ONE DAY BE A PLEASURE TRIP?)
L'air, May 1960, Pp. 16-18, in French

ABSTRACT: The author presents the following hazards which must be solved before man has a 90% chance of survival of a space flight: (1) the accelerations of launching and landing, (2) extreme temperature variations, (3) the noise and vibration of the rocket, (4) the state of weightlessness, (5) ionizing and nonionizing radiation, and (6) meteoritic impact.

722

Pisarenko, G. S. 1960 OSCILLATIONS OF ELASTIC SYSTEMS WITH CONSIDERATION OF ENERGY SCATTERING IN THE MATERIAL. Kolebaniya Uprugikh Sistem S Uchetom Rasseyaniya Energii V Materiale, pp. 236 (Aerospace Technical Intelligence Ctr., Wright-Patterson AFB, Ohio, Trans. No. MCL-128/1 + 2, 15 Dec. 1960) ASTIA AD-254 195

ABSTRACT: Theoretical analyses of oscillations of elastic systems with allowance for dissipation of energy in material are presented. The method of calculation

ives direct integration of the differential equation of oscillation of a
m with the non-linear law of internal dissipation of energy. Chapters are
ded on:
ibration of a system with one degree of freedom,
ransverse vibraticns of the shaft with a constant cross-section,
ransversal vibrations of the rod of changing cross-section,
ransversal vibrations of turbine vanes of constant cross-section in the field
f centrifugal forces,
ransversal vibrations of a turbine vane in the case of slow changing frequency
f excitation,
ransversal vibrations of short bars applied to design of turbine vanes;
ransverse vibration of turbine vanes of variable cross-section
in the field of centrifugal forces,
torsional vibrations of shafts,
experimental methods of determining the dissipation of energy in the material
during forced vibrations, and
experimental methods of investigating the dissipation of energy in the
material during free vibrations.
IA)

ett, R. 1962 ANALYTICAL DETERMINATION OF MECHANICAL IMPEDANCE.
In: Shock, Vibration and Associated Environment Bulletin No. 30
(Office of the Secretary of Defense, Washington, D.C., January 1962)
ASTIA AD-273 514, pp. 8-18

ACT: This paper discusses the impedance, dynamic stiffness, effective
, mobility, and receptance of simple lumped elements and shows how they
e combined to find the impedance of systems of moderate complexity. It
indicates methods for finding the impedance of systems of moderate
lexity. It also indicates methods for finding the impedance of simple
orm, continuous systems and lists references dealing with more complex
ctures.

und, R.S. 1962 PHYSIOLOGICAL ASPECTS OF THE SPACEMAN
Brown, K., and L.D. Ely, eds., Space Logistics Engineering
(New York: John Wiley and Sons, 1962) pp. 55-135

TRACT: The complexity of space logistics engineering for the comfort of
astronaut in a space vehicle is described as a function of mission duration

and of the operational requirements and performance capabilities expected. The following physiological parameters are reviewed: (1) vehicle-induced stresses (propulsion, noise, vibration, accelerations, zero gravity, re-entry, emergency escape); (2) internal environment of the space capsule (sources of oxygen supply, handling food, biological photosynthesis systems, methods of carbon dioxide elimination, water and waste control, toxicological considerations, temperature and humidity regulation); (3) radiation hazard shielding requirements, low-level chronic exposure hazard; and (4) psychological stress (isolation, confinement, and sensory deprivation).

725

Pohlman, R. 1939 ABSORPTION OF ULTRASONIC WAVES IN HUMAN TISSUES AND ITS DEPENDENCE UPON FREQUENCY.
Physik. Z. 40:159-161.
See also Biol. Abstr. 14:8131 (1940)
Phys. Abstr. 42:2169 (1939)

726

Pohlman, R. 1939 ABSORPTION OF ULTRASONIC WAVES IN HUMAN TISSUES AND ITS DEPENDENCE UPON FREQUENCY Phys. Abstr. 42:2169 (1939)
See Also: Biol. Abstr. 14:8131 (1940)
Physik. Z. 40:159-161 (1939)

727

Pohlman R., R. Richter and E. Parrow 1939 DISTRIBUTION AND ABSORBTION OF ULTRASONICS IN HUMAN TISSUE AND THEIR THERAPEUTIC EFFECTS ON ISCHIAS AND PLEXUS NEURALGIA
(Deutsche Medizinische Wochenschrift 65 (1939) pp. 251-254)

R.A.E. Translation No. 193 ASTIA AD 266614

28

krovskiy, G. 1961 MAN GOES OUT INTO SPACE
Kryl'ya rodiny 1961(6):17-18

STRACT: The article deals with the first cosmic flight of Major Yu. A. Gagarin the spaceship "Vostok", which proved that man can exist and function normally space. K. E. Tsiolkovskiy was amongst the first scientists to point out that n in a cosmic flight would experience two distinctly different states, i.e. erloads which would be felt during the acceleration and deceleration in the osphere before landing, and a state of weightlessness while the spaceship is orbit. Insignificant "g" loads would be possible during change-over from one bit into another or before landing. "g" loads have been known to high-speed lots, and momentary weightlessness to aerobatic pilots. Checking of a prolonged ate of weightlessness had to be carried out under conditions of a real cosmic ight. Three aspects of the phenomena were observed: 1) weightlessness reduces e load on blood vessels and facilitates the heart functions. It lowers the rain of the human body, and could be used as a treatment for heart diseases; it affects the intake of food, which becomes weightless; further investigation to the food's progress in the digestive system was required; 3) the force of avity must play an important part in man's orientation in space as it acts on e body as a whole, and on the vestibular apparatus, which governs the sensation "Top" and "Bottom". After Major Yu. A. Gagarin's flight in space it was und that the human body withstands all unexpected and unusual conditions ite well. (CARI)

9

lotskii, I.G. and S.S. Urazovskii 1946 PHYSICOCHEMICAL AND BIOLOGICAL EFFECTS OF ULTRASONICS Vrachebnoc Delo 26:85-90

0

rtsmouth Naval Shipyard 1959 LIST OF TECHNICAL REPORTS ON VIBRATION MEASUREMENTS, 1957 - 1958. (Portsmouth Naval Shipyard, N.H.)
ASTIA AD- 225 969

731

Postlethwaite, F. 1944 HUMAN SUSCEPTIBILITY TO VIBRATION.
Engineering, No. 157

732

Powell, A. and T.J.B. Smith 1962 A BIBLIOGRAPHY ON AEROSONICS (California U., Los Angeles, Calif.) Rept. no. 62-4, Contract Norn-23362, Proj. NR 062-299-1-28-60

ABSTRACT: This bibliography consists mainly of references to open literature relating to those sections of acoustics which are particularly associated with fluid motion and thermal action. (Author)

VIBRATION

Q

VIBRATION

R

733

Radio Corporation of America 1960 STUDY OF INSTRUMENTATION AND TECHNIQUES FOR MONITORING VEHICLE AND EQUIPMENT ENVIRONMENTS AT HIGH ALTITUDE. INSTRUMENTATION AND MONITORING TECHNIQUES. (Wright Air Development Center, Wright-Patterson AFB, Ohio) WADC TN 59-307 June 1960 ASTIA AD 268 090

ABSTRACT: Instrumentation techniques are presented which are available within the state-of-the-art; an instrumentation system is proposed for the monitoring of high-altitude environments encountered by typical vehicles. The high altitude environmental effects on typical vehicles and equipment are summarized. The present airborne-instrumentation state-of-the-art is presented for measuring temperature, pressure, strain, vibration, acceleration, radiation, meteorite detection, and acoustic noise. A feasible instrumentation system is discussed for monitoring these deleterious environments. (Author)

734

Radke, A. O. Dec. 1957 VEHICLE VIBRATION, MAN'S NEW ENVIRONMENT. ASME Paper No. 57-A-54, Dec. 1957

ABSTRACT: Man, in his evolution, has adapted himself to, or has found compatible the low-amplitude, low-frequency motion experienced in walking. Where he has exposed himself to other sources of vibration-- that is, until the present automotive air age descended upon him-- he has been able to minimize their effect by limiting the speed at which he traveled (limiting the vibration intensity) or using his legs as a vibration isolator.

The charioteer stood, the horseman stood in his stirrups or posted.) In any case, the number of people exposed was not significant and the duration of their exposure was brief. In our modern environment however, man, almost universally, is exposed to vibration for which he is not physically prepared and, because of the requirements of the vehicles, is not permitted the use of his legs to minimize the effect, nor allowed to control the intensity of the vibration. In addition, his exposure is no longer brief, but in many cases, day long, day in, day out. A study of such effects is described.

735

Radke, A.O., 1957 VEHICLE VIBRATION---MAN'S NEW ENVIRONMENT.
(Bostrom Research Laboratories, Milwaukee, Wisconsin)
BRL Report No. 124, December 1957

6

adke, A. O. 1958 VEHICLE VIBRATION.
Mech. Engng. 80(7):38-41, July 1958

BSTRACT: This article reviews the present data available on man's tolerance to ibration. Available threshold data is presented in graphical form. General vidence of the physiologic damage and cost of vibration as reported by medical urveys is also included. Discussion revolves around the problem of insulation rom vibration with specific and general recommendations made concerning the esign of equipment (primarily suspension seating) to reduce vibration.

737

adulov, S. 1959 OTRASY A CHVENIE AKO HYGIENICKY PROBLEM (SHAKING AND VIBRATION AS A HYGIENIC PROBLEM)
Lekarsky Obzor, Vol. 8, No. 10, 1959, in Czech.

738

andle, R. J., Jr. 1959 VIBRATIONS IN HELICOPTERS: TRAINING CONSIDERATIONS.
(Wright Air Development Ctr., Wright-Patterson AFB, Ohio) WADC TN 59-61;
ASTIA AD-212 314; March 1959
NOTE: CARI P&S 30.1

ABSTRACT: Helicopter instructor pilots were interviewed individually to analyze in detail the role that vibrations play in piloting helicopters. Information was gathered which indicated that vibrations are utilized as cues in both normal control and the detection and diagnosis of system malfunctions. Training considerations are discussed and recommendations made for a relatively gross simulation of each of the several classes of vibrations in a proposed helicopter instrument trainer.

739

Reich, H. Kent 1962 FLIGHT VIBRATION SURVEY OF F-106A AIRCRAFT (Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio) ASD-TDR-62-504 Project No. 1309, Task No. 130906 May 1962 . ASTIA AD 282 207

ABSTRACT: An F-106A aircraft, SN 53-466, was surveyed at Wright-Patterson Air Force Base, Ohio to determine the vibration environment existing throughout the vheicle under all flight conditions expected in service. Approximately 18,890 data points were obtained from 25 separate locations on the vehicle during 23 test flights. The data obtained in this survey were evaluated to determine the adequacy of vibration test requirements for aircraft equipment as contained in Specification No. Mil-E-5272C. The data indicated that the vibration testing requirements of the specification are more than adequate, a finding substantiated by all previous (vibration) surveys performed on Century Series aircraft.

740

Reich, W. J. April 1960 FIXTURE RESONANCE EFFECTS ON SHOCK RESPONSE (1960 Proceedings of the Institute of Environmental Sciences, 69-80)

741

Reiher, H. & F.J. Meister 1931 THE SENSITIVENESS OF THE HUMAN BODY TO VIBRATIONS. (Die Empfindlichkeit Des Menschen Gegen Erschutterung) Forschung, Verein Deutschen Ingenieure (Berlin) 2(11):381-386, Nov. 1931. Translation: C.W. Kearns (Air Materiel Command, Wright-Patterson AFB, Ohio) No. F-TS-616-RE, Sept. 1946. ASTIA ATI 36 971. Also as (Office of Technical Services, Washington, D.C.) PB 42296, Aug. 1946

ABSTRACT: Investigations were conducted to determine the effect of horizontal and vertical vibrations on the human body. Ten persons of different occupations and temperaments ranging from 20 to 37 years of age were tested on a platform which was set into sinusoidal and horizontal vibrations. The persons to be observed lay or stood so that the vibrations were either along or across their body axis. These tests were conducted to determine the sensitivity and danger to vibratory sensation, and to further the establishment of boundaries of intermediate sensations. Results are given diagramatically.

harex, D. 1961 THE CIRCULATORY DISORDERS CAUSED BY NOISE. VASCULAR COMPLICATIONS OF THE TRAUMATO-VIBRATORY SYNDROMEL. In Bull. Soc. Sci. Med. Luxemb. 98:281-286, June 1961 (France)

, Inc. 1959 A PROPOSAL FOR RESEARCH AND DEVELOPMENT IN THE COMBINED ACCELERATION-VIBRATION PROBLEM, PARTICULARLY FOR CREWMAN PROTECTION IN SPACE VEHICLE SEATING SYSTEMS (REM, Inc., Portland, Oregon) Letter #311. 23 July 1959.

earch & Development Board, Washington, D. C. 1953 SHOCK AND VIBRATION BULLETIN NO. 19 (Research and Development Board, Washington, D. C.) ASTIA AD-9 513; 19 Feb. 1953

tarski, J.S. 1945 EFFECT OF VIBRATION UPON THE DENTAL PULP AND PERIOSTEUM OF WHITE RATS. J. Dental Research 24: 57-60

TRACT: Exposure of white rats to vibrations of 0.05 inch at 2600 cpm, 8 rs daily for 28 days did not affect the rate of growth of the incisor teeth the calcification of the dentin as shown by the constant average width and ber of measurable dark and light incremental rings of dentin. Histologic mination of dentin pulp, alveolar periosteum and alveolar bone and structures the temporomandibular articulation failed to disclose any greater variation cellular changes than occur normally.

h, H. L., & R. E. Baker 1961 SHIPBOARD SHOCK ENVIRONMENT In 1961 Proceedings of the Institute of Environmental Sciences National Meeting, April 5, 6, 7, 1961, Washington, D. C. (Mt. Prospect, Ill.: Institute of Environmental Sciences, P. O. Box 191) pp. 197-201

CLUSION: Through the study of shock environment and the associated response of hanical systems information is available on which to base the design of shock istant equipment. Application of these data will produce equipment and hulls lanced in terms of this ability to withstand attack. (AUTHOR)

747

Richards, J.E. 1949 SUMMARY OF EXISTING INFORMATION IN THE HUMAN REACTION TO VIBRATION. (British Shipbuilding Research Association) Report No. 28, Jan. 1949. (BB 319)

748

Riddell, F.R. & R.W. Detra 1959 RETURNING ALIVE FROM SPACE (Avco Mfg. Corp., Avco Research Lab., Everett, Mass.)

ABSTRACT: The paper discusses three problems of re-entry: deceleration, heat, and terminal landing conditions. (CARI) Hypersonic gliders and pure drag re-entry vehicles are compared. The drag vehicle has inherent advantages over the hypersonic glider which are usually not generally observed.

749

Riley, M. B. and A. T. Bernardini 1959 ANIMAL AND HUMAN STUDIES OF THE EFFECTS OF LOW FREQUENCY OSCILLATION COMBINED WITH TRANSVERSE ACCELERATION. (USAF Aero Med Lab) WADC TN 59-92. Mar. 1959. ASTIA Doc. No. AD 227 503.

Summary: Animal and human endurance is reported to low frequency oscillation during backward acceleration. No significant suggestion of trauma was found in animals subjected to a maximum oscillation-g pattern of 2.8 cycles per second through a 36 degree arc in a 12 g field. In humans, there were no identifiable end-point when they were subjected to a maximum oscillation-g pattern of 0.7 cycle per second through a 36 degree arc in an 8 g field.

750

Riser, G.T., 1961 EXPLORATORY INVESTIGATION OF THE EFFECTS OF LOW FREQUENCY RANDOM AMPLITUDE VIBRATION ON HUMAN PERFORMANCE. (The Boeing Company, Wichita, Kans.) Document #D3-3328, March 1, 1961

751

Riopelle, A. J., M. Hines, & M. Lawrence 1958 THE EFFECTS OF INTENSE VIBRATION. (Army Medical Research Lab., Ft. Knox, Ky.) Rept. No. 358; ASTIA AD 203 637, 10 Oct. 1958.

ABSTRACT: The behavioral, physiological, and pathological consequences of

ntense vibration (10 cps at 0.25 and 0.50 in. peak-to-peak displacement) were tudied. One animal died after 1 hr. and 2 survived 8 hrs. (0.25 in). Of the roup vibrated at a displacement of 0.50 in, one monkey died after 7 hrs., one ied the following day, and 2 recovered. Few behavioral changes were noted. etailed physiological and pathological changes were noted in all animals.

752

Rivers, T.M., J.E. Smadel and L.A. Chambers 1937 EFFECT OF INTENSE SONIC VIBRATIONS ON ELEMENTARY BODIES OF VACCINIA J. Exptl. Med. 65:677-685

3

Roberts, W. H. 1931 A TWO-DIMENSIONAL ANALYSIS OF DISCRIMINATION OF DIFFERENCES IN THE FREQUENCY OF VIBRATIONS BY MEANS OF THE SENSE OF TOUCH. J. Franklin Inst. 213:286-312.

754

Roggeveen, L. J., & H. A. E. van Dishoeck 1956 VESTIBULAR REACTIONS AS A RESULT OF ACOUSTIC STIMULATION. Practica oto-rhino-laryngologica (Basel) 18(4):205-213, July 1956

ABSTRACT: Literature on vestibular reactions caused by sound stimuli is reviewed. The description of a similar case is added, in which the lesion responsible for vestibular symptoms was demonstrated in the roentgenogram. The lesion consisted of a hiatus in the bony wall of the left superior semicircular canal, a localization not described before. (AUTHOR)

755

Roman, J. A., R. Coermann, & G. Ziegenruecker 1958 EFFECTS OF SEVERE WHOLE BODY VIBRATION ON MICE AND METHODS OF PROTECTION FROM VIBRATION INJURY. (Wright Air Development Ctr., Wright-Patterson AFB, Ohio) WADC TR 58-107; ASTIA AD 151 070
See also J. Avia. Med. 30:118-125, 1959.

ABSTRACT: A pilot study was carried out to investigate the mechanism and cause of death as well as other effects of severe vibration. Two hundred mice were exposed to severe vibration in planes parallel to and perpendicular to the

longitudinal body axis. Sinusoidal vibration of varying frequency and amplitude was used and death was selected as the physiological end point. When injuries were sustained, they consisted of G. I. tract bleeding, lung damage and various sites of minor hemorrhage. Data showing the relationship between frequency and duration of exposure required to kill are given for a constant acceleration and they point to a "maximum effect frequency" of 25 cps for transverse vibration and 18 cps for longitudinal vibration. Stroboscopic analysis at these frequencies suggests the existence of a resonant system made up of abdominal contents, abdominal wall, lungs and diaphragm. Tissue damage appears to have been caused by distortion and relative displacement of tissues or organs. Pure pressure effects were not observed. Means of protection against injuries resulting from whole body vibration were investigated and preliminary protection studies were done on humans. The principles of protection against severe whole body vibration are discussed as well as the relationship between vibration protection and protection from impact. (AUTHOR)

756

Roman, J., I.R. Coermann, & G. Ziengenruecker 1958 VIBRATION, BUFFETING AND IMPACT RESEARCH. (Paper, First Post-satellite Meeting of the Aero-Medical Association, Statler Hotel, Washington, D.C. March 24-26, 1958)

ABSTRACT: A "vertical accelerator" which simulates the dynamic loads expected of future aircraft was developed in order to study the effectiveness of devices for protection against vibration, buffeting, and impact. Experimentation revealed several mechanisms productive of injury in severe vibration of buffeting, and indicated that vibration and impact protection are intimately related and possible by simple means. It was shown that by simplification of mathematical models of organ systems, present knowledge of vibration physics may be directly applied to the development of protective equipment.
(J. Aviation Med., 29(3):248, March 1958)

757

Romani, J. D., & P. Bugard 1956 A FURTHER STUDY OF THE INFLUENCE OF SOUNDS ON THE ENDOCRINE SYSTEM. J. Acoust. Soc. Amer. 28(4):773- , July 1956

ABSTRACT: Two-thirds of guinea pigs subjected to sounds of 100 to 125 db. died after 12 to 18 hours of exposure. Examination showed congestion of the pituitary glands, with degranulation of the acidophil cells; inhibition of the thyroid and inability to react to overstimulation; and a decrease of lipoids in the adrenals. From these data and from previous observation the following is demonstrated: (1) Ultrasonics of 22.5 kc. at 160 to 165 db. for 1 to 4 minutes induce a destruction

of the medullar adrenal area, with the cortical area intact; death occurs in several minutes, with an increase in body temperature. (2) sounds of 100 to 125 db. for 15 to 25 minutes induce an alarm reaction at the stage of exhaustion; death occurs in 12 to 48 hours. (3) Sounds of 1 to 4 kc. at 130 to 140 db. for 1 to 4 hours induce a well-compensated alarm reaction in the dog and rabbit; after 200 hours adaptation occurs, with recuperation of the normal functions of the endocrine system.

758

Romba, J. J. & P. Martin 1961 THE PROPAGATION OF AIR SHOCK WAVES ON A BIOPHYSICAL MODEL.
(USA Ordnance Human Engineering Labs., Aberdeen Proving Ground, Md.) DA Proj. 5B9520001, Tech. Memo. 17 61, Sept. 1961.

ABSTRACT: Shock wave characteristics were studied in the field about and within the rhesus monkey body form. Measurements were obtained in free air, top of animal's head, the mid-brain and the lower thorax with distance and position of the explosive varied in relation to the animal's body. The study of shcok wave transmission from one body level to another was accomplished and the problem of shock wave energy distribution in the field of the organism was emphasized. The effects of medium through which shock wave transmission occurred and of body tissue on the shock wave characteristics were observed. (Tufts)

759

Rosenbaum, R. 1951 PRINCIPLES OF VIBRATION MEASURING EQUIPMENT (WITH EMPHASIS ON THE USE OF EQUIPMENT NOW AVAILABLE IN THE CAA WASHINGTON OFFICE-W-301) (CAA, Airframe & Equipment Engr. Br.; Prepared for CAA In-service Vibration Measurement Course, 14-18 May,1951)

ABSTRACT: The purpose of this report is to acquaint those persons who may have occasion to use vibration measuring equipment with the basic principles and limitations of the vibration equipment in general use in the aircraft industry. This report is also intended to be used to present background material for a course in instrumentation to be conducted for the benefit of the dynamics specialists in the CAA Regional Offices. The course will cover the basic principles associated with the proper selection, installation and calibration of vibration measuring equipment, with special emphasis on the application of the principles to the use of the specific equipment available at the present time in the Washington Office of the CAA.

760

Rosenblith, W. A., & K. N. Stevens 1953 HANDBOOK OF ACOUSTIC NOISE CONTROL, VOL. II, NOISE AND MAN. (Wright Air Development Ctr., Wright-Patterson AFB, Ohio) WADC TR 52-204, June 1953

761

Rosenfeldova, A. 1959 PRISPEVEK K PATOFYSIOLOGII VIBRACNI NEMOCI (CONTRIBUTION TO THE PATHOPHYSIOLOGY OF VIBRATION DISEASE) (Ceskoslovenska Fysiologie, Vol. 8, No. 6, 1959, in Czech.) Trans.: Czechoslovak Physiology, Praha, CSAV

762

Rosenfeldova, A. 1962 CONTRIBUTION TO PATHOPHYSIOLOGY OF VIBRATIONAL DISEASES (OCUPATIONAL DISEASES)(Foreign Technology Command, Wright-Patterson AFB, Ohio) FTD-TT 62-538, 20 April 1962, ASTIA AD280939

ABSTRACT: Applying the plethysmorgraphic method for hand and distal half of fore-arm we studied the primary and tertiary variations on 16 plate straighteners suffering from vibrational disease and 14 normal healthy persons. The plate straightener is more exposed to vibration and that is why his left hand becomes afflicted first of all. Plethysmogram changes in the left and right hands of afflicted persons are given in dependence upon the working anamnestic data and upon subjective complaints and then compared with the plethysmograms of healthy persons.

763

Rosmanith, J. 1960 FUNCTIONAL MECHANICAL CHANGES IN THE MOTOR AND STATIC APPARATUS IN RELATION TO WORK AND OCCUPATIONS. Pracov Lek 12:93-8, March 1960

764

Roth, E. M. 1955 MEDICAL ASPECTS OF TRAVEL IN OUTER SPACE. Harvard Med. Alumni Bull. 20(4):10-13, July 1955

enblyum, D. Ye. 1955 OB OSNOVNYKH VOPROSAKH V FIZIOLOGII USKORENIY (Fundamental Problems in Physiology of Accelerations)
enno-meditsinskiy zhurnal (Moscow) 7: 89-95
See also: AF Technical Intelligence Trans., AFOIN Rept. AF 747345.

f, S. 1935 DIE BEGRENZUNG DER FLIEGERISCHEN LEISTUNG DURCH DEN MENSCHLICHEN ORGANISMUS (The Limitation of the Flying Performance Because of the Human Organism)
ftwehr. (Berlin) 2: 297-300

ff, S. 1937 DIE LUFTKRANKHEIT (Airsickness)
uftfahrtmedizinische Abhandlungen (Leipzig) 1: 277-285

68

ust, H.H. and U. Pommerening. 1954 EIGENFREQUENZANREGUGNLUFTGEFULLTER KORPERHOHLEN. (Excitation of inherent frequency resonance in air-filled body cavities.) Arch. Phys. Therap. 6:442-448

769

Ryumin, V.P. 1959 THE EFFECT OF VIBRATION ON SECRETORY ACTIVITY OF THE DOGS STOMACH. (Viliyanii vabratsii na sekretsiyu zheludka sobaki.) Trudy Perm. Med. Inst.

ABSTRACT: The investigations were carried out by means of Morodovtsev's method on 2 dogs, and on a third with a pavolo pouch. It was found that application of vibrations (electromagnetic vibrator producing 100 cps, 0.15 mm amplitude) locally to the gastric area stimulate gastric secretion and results in an increased acidity of the juice produced. The effect is less marked when the stomach is empty and stronger when digestion is actually taking place.

VIBRATION

S

770

Sadoff, M., N.M. McFadden, & D.R. Heinle 1961 A STUDY OF LONGITUDINAL CONTROL PROBLEMS AT LOW AND NEGATIVE DAMPING AND STABILITY WITH EMPHASIS ON EFFECTS OF MOTION CUES (Ames Research Center, Moffett Field, Calif.) NASA Technical Note D-348, Jan. 1961. NASA N62-70922.

ABSTRACT: An investigation was conducted in several types of simulators, including the Johnsville centrifuge, and in flight to assess the effects of incomplete or spurious motion cues on pilot opinion and task performance over a wide range of longitudinal short-period dynamics. Most of the tests were conducted with a conventional center stick; however, a brief evaluation in the centrifuge of a pencil type side-arm controller was also made.

771

SAE Riding Comfort Research Committee 1950 RIDE AND VIBRATION DATA - A SET OF REFERENCE CHARTS (Special Publications Dept. (SP-6), SAE, Inc., 29 W. 39th St., New York 18, N.Y.

772

S. A. E. 1959 RIDE AND VIBRATION TERMINOLOGY
1959 S.A.E. Handbook (New York: S. A. E., 1959) 718:722

773

Salathe, A. 1877 DE L'ANEMIE ET DE LA CONGESTION CEREBRALE PROVOQUEE MECANIQUEMENT CHEZ LES ANIMAUX PAR L'ATTITUDE VERTICALE OU PAR UN MOUVEMENT GIRATOIRE (Concerning Anemia and the Cerebral Congestion Mechanically Caused in Animals by Vertical Position or by a Gyratory Motion)
Physiol. Exper. 3: 251-272

774

Salb, O.G. and R.E. Strum 1942 INSTRUMENT USEFUL IN THE ANALYSIS OF VIBRATION IN ORGANIZED LIVING TISSUE, U.S. Patent 2,294,015

775

Salter, L.C. 1951 GENERAL SYSTEMIC ACUTE AND CHRONIC DISORDERS RESULTING FROM TRACTOR RIDING.
(A survey among 1800 general practitioners in Iowa. July, 1951)

776

Sasagawa, K. 1938 INFLUENCE OF ULTRA-ACOUSTIC WAVES ON LIVING ORGANISMS Isikawa Mem. Vol. 182-199

777

Sasagawa, K. 1940 EFFECT OF ULTRASONIC WAVES ON LIVING ORGANISMS Japan. J. Med. Sci. III. Biophysics 6:131-132

778

Sato, M. 1961 RESPONSE OF PACINIAN CORPUSCLES TO SINUSOIDAL VIBRATION. In. J. Physiol. (London) 159:391-409, December 1961.

779

Schaefer, H.H. 1960 VIBRATION AS REINFORCER FOR INFANT CHILDREN. J. Exp. Anal Behavior 3:160, April 1960

780

Schaefer, V. H., & R. G. Ulmer 1959 A REPRESENTATIVE BIBLIOGRAPHY OF RESEARCH IN LOW-FREQUENCY MECHANICAL VIBRATION. (Army Medical Research Lab., Fort Knox, Ky.) AMRL Proj. No. 6-95-20-001-05; Rept. No. 405; ASTIA AD-228 941; 12 Nov. 1959

ABSTRACT: Object - It was desired to provide a collection of basic and representative publications in the field of low-frequency mechanical vibration.
Results- Following a survey of research in the area, and extensive bibliography has been assembled.

VIBRATION

S

770

Sadoff, M., N.M. McFadden, & D.R. Heinle 1961 A STUDY OF LONGITUDINAL CONTROL PROBLEMS AT LOW AND NEGATIVE DAMPING AND STABILITY WITH EMPHASIS ON EFFECTS OF MOTION CUES (Ames Research Center, Moffett Field, Calif.) NASA Technical Note D-348, Jan. 1961. NASA N62-70922.

ABSTRACT: An investigation was conducted in several types of simulators, including the Johnsville centrifuge, and in flight to assess the effects of incomplete or spurious motion cues on pilot opinion and task performance over a wide range of longitudinal short-period dynamics. Most of the tests were conducted with a conventional center stick; however, a brief evaluation in the centrifuge of a pencil type side-arm controller was also made.

771

SAE Riding Comfort Research Committee 1950 RIDE AND VIBRATION DATA - A SET OF REFERENCE CHARTS (Special Publications Dept. (SP-6), SAE, Inc., 29 W. 39th St., New York 18, N.Y.

772

S. A. E. 1959 RIDE AND VIBRATION TERMINOLOGY
1959 S.A.E. Handbook (New York: S. A. E., 1959) 718:722

773

Salathe, A. 1877 DE L'ANEMIE ET DE LA CONGESTION CEREBRALE PROVOQUEE MECANIQUEMENT CHEZ LES ANIMAUX PAR L'ATTITUDE VERTICALE OU PAR UN MOUVEMENT GIRATOIRE (Concerning Anemia and the Cerebral Congestion Mechanically Caused in Animals by Vertical Position or by a Gyratory Motion)
Physiol. Exper. 3: 251-272

774

Salb, O.G. and R.E. Strum 1942 INSTRUMENT USEFUL IN THE ANALYSIS OF VIBRATION IN ORGANIZED LIVING TISSUE, U.S. Patent 2,294,015

775

Salter, L.C. 1951 GENERAL SYSTEMIC ACUTE AND CHRONIC DISORDERS RESULTING FROM TRACTOR RIDING.
(A survey among 1800 general practitioners in Iowa. July, 1951)

776

Sasagawa, K. 1938 INFLUENCE OF ULTRA-ACOUSTIC WAVES ON LIVING ORGANISMS Isikawa Mem. Vol. 182-199

777

Sasagawa, K. 1940 EFFECT OF ULTRASONIC WAVES ON LIVING ORGANISMS Japan. J. Med. Sci. III. Biophysics 6:131-132

778

Sato, M. 1961 RESPONSE OF PACINIAN CORPUSCLES TO SINUSOIDAL VIBRATION. In. J. Physiol. (London) 159:391-409, December 1961.

779

Schaefer, H.H. 1960 VIBRATION AS REINFORCER FOR INFANT CHILDREN. J. Exp. Anal Behavior 3:160, April 1960

780

Schaefer, V. H., & R. G. Ulmer 1959 A REPRESENTATIVE BIBLIOGRAPHY OF RESEARCH IN LOW-FREQUENCY MECHANICAL VIBRATION. (Army Medical Research Lab., Fort Knox, Ky.) AMRL Proj. No. 6-95-20-001-05; Rept. No. 405; ASTIA AD-228 941; 12 Nov. 1959

ABSTRACT: Object - It was desired to provide a collection of basic and representative publications in the field of low-frequency mechanical vibration.
Results- Following a survey of research in the area, and extensive bibliography has been assembled.

781

Schaefer, V.H., H.J. Link, J. U. Farrar, and D Wiens; and D.H. Yost 1959 LETHALITY IN RATS AS A FUNCTION OF FREQUENCY IN CONSTANT-DISPLACEMENT VIBRATION. USAMRL Report No. 390

ABSTRACT: Restrained rats died significantly more quickly as frequency increased. Variability in lethal time decreased as frequency increased. Heart and lung hemorrhages were frequently observed; pulmonary atelectasis, emphysema and edema and gastrointestinal hemorrhages were found occasionally. There was some evidence of age and sex differences in susceptibility to vibration. Castration increased the survival time in male rats. Range 10-45 cps at 0.25 in. Females tend to be more resistant than males.

782

Schaefer, V. H., R. G. Ulmer, & H. J. Link 1959 SOME BEHAVIORAL AND PHYSIOLOGICAL STUDIES IN VIBRATION. (Army Medical Research Laboratory, Fort Knox, Ky.) Proj. No. 6-95-20-001; Rept. No. 389; ASTIA AD-218 075; June 12, 1959

ABSTRACT: Data were obtained on behavioral and physiological effects of whole-body vibration. Vibrated rats ate less, weighed less, required more food to maintain a given weight level, were less active, and ran more slowly in several situations to food rewards than non-vibrated controls. Testicular atrophy and myocardial hemorrhages were observed in some of the vibrated animals. The majority of the results support an interpretation of vibration as producing a marked but transitory general organismic debility. Other highly important effects, however, seem permanent and irreversible. (AUTHOR)

783

Schaefer, V.H., H.J. Link, J.U. Farrar, D. Wiens and J.M. Dinsmore 1959 LETHALITY IN RATS AS A FUNCTION OF FREQUENCY IN CONSTANT - DISPLACEMENT VIBRATION (U.S. Army Medical Research Labs., Ft. Knox, Kentucky) Report No. 390, 20 June, 1959

ABSTRACT: It was the purpose of this research to study the relationship between frequency of constant-displacement whole-body vibration and lethal exposure time. It was also desired to investigate pathological effects of vibration.

4

hafer, H. C. 1963 VIBRATION STUDIES FOR JET FIGHTER AND ATTACK BOMBER AIRCRAFT INSTRUMENTATION
(U. S. Naval Ordnance Test Station, China Lake, Calif.)
NOTS TP 3026 February 1963 ASTIA AD297 924

STRACT: Data on the total vibration environment of the instrumentation of ur Air Force century-series fighters and two Navy carrier-type jet fighter light attack bomber aircraft are reviewed. These data are combined to present a composite aircraft for the study of the vibration environment instrument sensors and indicators for aircraft in these categories. The cation zones of the instrument modules in the aircraft are taken into count, and vibration levels with respect to particular zones are discussed. e study indicates the need for additional data to be used in establishing pical vibration levels for aircraft instrumentation.

5

chmidt, I. 1938 BIBLIOGRAPHIE DER LUFTFAHRTMEDIZIN. (Bibliography of Aviation Medicine)
(Berlin: J. Springer, 1938)

BSTRACT: The first volume of an important bibliography, covering the literature n aviation medicine and high-altitude research up to the end of the year 1936. onstitutes a survey of world literature on the subjects of psychophysiology of he flier, altitude research, acceleration research (including centrifugal forces, arachute jumping, and air sickness), accidents, effects of sound, fatigue, lying sickness, flying fitness and aviation hygiene.

6

chmidt, I. 1943 BIBLIOGRAPHIE DER LUFTFAHRTMEDIZIN. ZWEITE FOLGE. EINE ZUSAMMENSTELLUNG VON ARBEITEN UBER LUFTFAHRTMEDIZIN UND GRENZGEBIETE, 1937 BIS ENDE 1940. (Bibliography of Aviation Medicine, Part Two).
Luftfahrtmedizin Vol. 8, No. 1, March 1943.

ABSTRACT: The second volume of an important bibliography, covering the literature in aviation medicine and high-altitude research through the years 1937 to the end of 1940. Constitutes a survey of world literature on the subjects of psychophysiology of the flier, altitude research, acceleration research (including centrifugal forces, parachute jumping, and air sickness), accidents, effects of sound, fatigue, flying sickness, flying fitness and aviation hygiene.

787

Schmidt, I. 1948 BIBLIOGRAPHY OF AVIATION MEDICINE. VOLUME III. (Incomplete) (School of Aviation Medicine, Randolph Air Force Base, Texas)

ABSTRACT: A compilation of reports pertaining to Aviation Medicine and its borderline fields, covering the years 1941 through 1945, and including supplementary references for the year 1940.

After the present material had been supplemented above all by Anglo-American literature, it was supposed to be published as the third volume of the "Bibliographie der Luftfahrtmedizin". But the war prevented its completion. As we believe that these references will be of interest to many an aeromedical scientist, they will be disseminated for public use. The references concern first of all German publications, but include also those foreign papers which have been accessible. Anglo-American references have been omitted, since they are all listed in the "Bibliography of Aviation Medicine" by E. C. Hoff and J. F. Fulton.

788

Schmitt, F.O., Olson, A.R. and C.H. Johnson 1928 EFFECTS OF HIGH FREQUENCY SOUND WAVES ON PROTOPLASM Proc. Soc. Exptl. Biol. Med. 25:718-720
See Also: Biol. Abstr. 6:24732 (1932)

789

Schmitt, F. O., & B. Uhlemeyer 1930 THE MECHANISM OF THE LETHAL EFFECTS OF ULTRASONIC RADIATION. Proc. Soc. Expl. Biol. & Med. 27:626-628

790

Schmitt, F.O., A.R. Olson, and C.H. Johnson 1932 EFFECTS OF HIGH FREQUENCY SOUND WAVES ON PROTOPLASM Biol. Abstr. 6:24732
See Also: Proc. Soc. Exptl. Biol. Med. 25:718-720

791

Schmitz, M.A. 1957 THE PSYCHOLOGICAL ASPECTS OF FARM WORK EFFICIENCY
Boxtrom Research Laboratories Report No. 125
Also: Paper, American Society of Agricultural Engineers, Chicago, Illinois, December 16, 1957. ASAE paper no. 57-621

ABSTRACT: The author briefly summarizes much of what is known to date that could be applied to the farm tractor-farmer system and then covers rather thoroughly one of these variables that is now being studied in his laboratory.

he variable concentrated on in this paper is that of vibration. Past research ver a wide range of frequencies and intensities of vibration have shown that an's physiological and psychomotor performance is generally affected by vibra- ion. The present research is concentrated in the range of frequencies from ne to seven cycles per second with amplitudes ranging from 3/16 inch to -1/8 inch. This range has been chosen on the basis of distributions reported y Simons and Radke as being typical of vibrations measured on rubber tired ractors and trucks. When man sits on a vibrating source he automatically eprives himself of a natural vibration isolator - his legs and feet, which olate him very well from shock and from vibration frequencies over 1-½ cps. sts on the vibration in farm equipment seats show the following trends:) visual acuity may be impaired up to 20%; (2) ability to perceive depth may affected; (3) the ability to balance oneself may be impaired; (4) ability track and keep constant foot pressure on a foot pedal shows greater error;) reaction time may be increased.

2

chmitz, M.A. 1958-1959 EFFECT OF LOW FREQUENCY HIGH AMPLITUDE WHOLE BODY VIBRATION ON HUMAN PERFORMANCE. (Bostrom Research Laboratories, Milwaukee, Wisconsin) Progress Report No. 2, Contract no. DA-49-007-MD-797

STRACT: The problems under investigation were: Do relatively low frequency d high amplitude vertical vibration (of the type found in work vehicles) ffect human psychomotor performance?; What types of performance are affected?; w are these responses affected by exposure time?

Eighteen human subjects were exposed to vibrations(while seated on a ooden chair on a mechanical shake table) of 2.5 and 3.5 cps frequency at 2 isplacements (4 conditions total) for 90 minute periods. Their performance s compared to a no-vibration condition on the following tests: Hand Tremor; Visual Acuity; Compensatory Tracking; Foot Pressure Constancy; Foot Reaction Time; and Body Equilibrium. Results show a significant decrement in performance for visual acuity, compensatory tracking, and foot pressure constancy. No significant changes were observed for hand tremor, foot reaction time or body equilibrium test measures.

The performance decrements appear to be a direct function of the vibration stimulus. No reliable change in performance for any of the measures was observed.

793

Schmitz, M.A., and A.K. Simons 1959 MAN'S RESPONSE TO LOW FREQUENCY VIBRATION (Amer. Soc. of Mech. Engineers (ASME), Bostrom Research Labs, Milwaukee, Wisconsin) November 1959, Report No. 59-A-200.

794

Schmitz, M.A. 1959 THE EFFECT OF LOW FREQUENCY, HIGH AMPLITUDE VIBRATION ON HUMAN PERFORMANCE (Bostrom Research Laboratories, Dept. of Army, Washington 25, D.C., Office of the Surgeon Gen.) Progress Report No. 21, January 1960, AD 218 201.

795

Schmitz, M.A. and A.K. Simons 1959 MAN'S RESPONSE TO LOW-FREQUENCY VIBRATION (Bostrom Res. Lab. Milwaukee, Wisc.) ASME Publication, Paper No. 59-A-200, Nov. 1959.

796

Schmitz, M.A., A.K. Simons, & C.A. Boettcher 1960 THE EFFECT OF LOW FREQUENCY, HIGH AMPLITUDE WHOLE BODY VERTICAL VIBRATION ON HUMAN PERFORMANCE. (Bostrom Research Labs., Milwaukee, Wis.) Rept. No. 130; Contract DA 49-007-md-797; Jan 31, 1961. ASTIA AD 241 792.

ABSTRACT: The problem investigated was essentially one of determining whether certain performances of humans would be affected by low frequency, high amplitude, vertical vibration; and if so, to what degree: and whether exposure time plays a significant role. This type of vibration is found in most ground vehicles. General conclusions based upon three studies are that whole body, low frequency, large amplitude, vertical vibration appears to: (1) increase error for compensatory tracking tasks during vibration as compared to control trials; (2) increase error for a constant foot pressure task as a function of frequency and intensity of vibration; (3) increase reaction time only after vibration ceases and is negatively correlated with input intensity; and (4) impair visual acuity as compared to control trials. Exploratory physiological studies with three dogs and one human are described. (Author)

797

Schmitz, M.A. 1959 THE EFFECT OF LOW FREQUENCY, HIGH AMPLITUDE WHOLE BODY VERTICAL VIBRATION ON HUMAN PERFORMANCE (Bostrom Research Laboratories, Milwaukee, Wisc.) Rept. no. 128, Sept. 24, 1959. ASTIA AD 218 201

NOTE: CARI P&S 30.1

ABSTRACT: Eighteen human subjects were exposed to vibrations of 2.5 and 3.5 cps. frequency at 2 displacements for 90 minute periods. Pre and post control measures were also taken before and after each test session. Their performance was compared to a no-vibration condition on the following tests: (1) Hand

or; (2) Visual Acuity; (3) Compensatory Tracking; (4) Foot Pressure Constance Foot Reaction Time and (6) Body Equilibrium. Results show a significant ement in performance for visual acuity, compensatory tracking, and foot ssure constancy. No significant changes were observed for hand tremor, foot ction time or body equilibrium test measures. The performance decrements ar to be a direct function of the vibration stimulus. No reliable change erformance for any of the measures was observed for length of time exposed.

mitz, M.A. and C.A. Boettcher. 1960 SOME PHYSIOLOGICAL EFFECTS OF LOW FREQUENCY, HIGH AMPLITUDE VIBRATION. ASME Paper No. 60-Prod. 17 (Bostrom Research Labs, Milwaukee, Wis.) May 1960.

STRACT: Man's need to move from place to place has led him to make use various modes of transportation which have one factor in common, viz., whole dy vibration in the range of 1-8 cps. This environmental variable has oduced a need for research to determine its physiological effects on man. e present investigation was conducted in compliance with this need.

e human subject and 3 dogs were exposed to frequencies in the 1-8 cps range d the following physiological measures taken on the three dogs: a) blood ressure in the right atrium of the heart; b) blood pressure in the right entricle of the heart; c) blood pressure in the left ventricle of the heart;) blood pressure in the aorta at heart level; e) heart rate, and f) cardiac utput.

lood pressure and heart rate were measures taken on the human subject. The esults of the exploratory physiological studies in general showed evidence f the following changes; 1) an increase in systolic and a decrease in diastolic pressure in the aorta, and right atrium in anesthetized dogs. 2) an increase in systolic pressure in man, but no appreciable change in diastolic pressure. 3) an increase in cardiac output. 4) large variations in pulse pressure. And 5) no appreciable change in heart rate. All changes appeared to be a function of frequency of vibration as well as intensity of vibration.

799

Schmitz, M. A., A. K. Simons, & C. A. Boettcher 1960 THE EFFECT OF LOW FREQUENCY, HIGH AMPLITUDE WHOLE BODY VERTICAL VIBRATION ON HUMAN PERFORMANCE. (Bostrom Research Labs., Milwaukee, Wisc.) Final Rept. 1 Apr. 1957 - 31 Jan. 1960; Rept. No. 130; Contract DA 49-007-md-797; ASTIA AD-241 792

ABSTRACT: The problem investigated was essentially one of determining whether certain performances of humans would be affected by low frequency, high amplitude, vertical vibration; and if so, to what degree; and whether exposure time plays a significant role. This type of vibration is found in most ground vehicles. General conclusions based upon three studies are that whole body, low frequency,

large amplitude, vertical vibration appears to: (1) increase error for compensatory tracking tasks during vibration as compared to control trials; (2) increase error for a constant foot pressure task as a function of frequency and intensity of vibration; (3) increase reaction time only after vibration ceases and is negatively correlated with input intensity; and (4) impair visual acuity as compared to control trials. Exploratory physiological studies with three dogs and one human are described. (AUTHOR)

800

Schneider, O. 1955 THE FOURTH CONGRESS OF THE FRENCH LANGUAGE SECTION OF THE INTERNATIONAL AERO-MEDICAL ASSOCIATION
Office of Naval Research, London. Technical Rept. No. ONRL-111-55, Oct. 27, 1955
ASTIA AD 82 711

ABSTRACT: The Fourth Congress of the French Language Section of the Association met in Paris 27-30 September 1955. The morning programs were devoted to discussions of special topics, including noise and vibration effects, aeronautica aspects of gastro-duodenal ulcer and pulmonary tuberculosis, and tropical diseases of importance in aviation. Afternoon sessions were devoted to a wide variety of aero-medical subjects. At the close of the Congress, the French Language Section voted to reconstitute itself as the European Section, with the aim of increasing the scope of its activities. The 1956 Congress will meet in the Netherlands at a place as yet undecided, and the 1957 Congress is scheduled for one of the Scandinavian countries.

801

Schmitz, M.A., A.K. Simons, and C.A. Boettcher 1961 THE EFFECT OF LOW FREQUENCY, HIGH AMPLITUDE WHOLE BODY VERTICAL VIBRATION ON HUMAN PERFORMANCE. (Bostrom Research Laboratories , Milwaukee, Wisconsin) Final report, Contract #DA-49-007-MD-797, January 31, 1961

802

Scholtz, G. 1935 AKTUELLE FRAGEN DER PHYSIOLOGIE DES FLIEGENS (Actual Questions About the Physiology of Flying)
Deutsche Medizinische Wochenschrift (Stuttgart) 61: 780

803

Schreiber, V. 1950 PUSOBENI MECHANICKYCH OTRESU NA ENDOKRINNI SYSTEM. (The effect of mechanical vibration on the endocrine system.) Pracovni lek. 2:153-165

804

Schreiber, V. 1950 THE EFFECT OF MECHANICAL SHAKING ON THE ENDOCRINE SYSTEM, PART I. Pracovni Lekarstvi (Czech.) 4:153

805

Schreuer, E. 1947 THE PHYSICAL BASIS OF BIOLOGICAL AND THERAPEUTIC EFFECTS OF ULTRASONICS Aerzil. Forsch 1:118-121

806

Schroeder, H.A. 1953 PERTINENT STUDIES OF HUMAN TO ACCELERATION Shock and Vibration Bulletin No. 19

807

Schwichtenberg, A.H. 1960 SPACE MEDICINE AND ASTRONAUT SELECTION Minnesota Med. 43(12): 797-812 Dec. 1960

ABSTRACT: In a manned space flight project, there is an interdependence in the fields of medicine, design engineering, and human engineering. The author describes the physical tests given during the selection of astronauts. He suggests that the knowledge and experience gained from research in aviation medicine be applied to the general medical practice.

808

Sebek, Jan, Valja Styblova 1959 VEGETATIVNI ZMENY U ONEMOCNENI Z VIBRACI (VEGETATIVE CHANGES IN THE EFFECTS OF VIBRATION) (Casopis Lekaru Ceskych, Vol. 98/1959, No. 25, 1959, in Czech.) Summary in: Russian, English, French

ABSTRACT: This is a preliminary report of the vegetative disturbances in 150 various types of workers, with particular attention to the types of work in the various sub-groups. There was a vegetative sympotomatology in 63 %, in particular vasomotor, thermal and sudomotor with vascular pain, various generalized changes, to which attention is given in the present article, while trophic changes will be concentrated on later.

809

Selye, H. 1950 THE PHYSIOLOGY AND PATHOLOGY OF EXPOSURE TO STRESS. (ACTA, Inc., Montreal, Canada)

810

Serbin, Hyman 1953 EFFECT OF FREE BODY MOTION ON FLUTTER. (Hyman Serbin) AF Technical Rept. No. 5988; Contract AF 33(038)11067; ASTIA AD-14 070; Jan. 1953

ABSTRACT: The problem considered is that of the longitudinal, short-period oscillations of aircraft and missiles in which an additional, elastic bending participates to overcome the rigid body damping. Both dynamic flutter stability and classical dynamic stability analyses are made of an elastic missile. The analyses indicated that the longitudinal dynamic instability of a body stabilized by a lifting surface which is flexible in bending can be predicted either by flutter theory or the classical dynamic stability theory which includes aeroelastic bending. For aircraft or missiles with only one lifting surface, the most critical configurations from the standpoint of low-frequency instability were those with high wing loadings, the body mass concentrated near the center of gravity, and the lifting surface located between 1 to 2 chord lengths behind the center of gravity. Increasing the sweepback angle of the lifting surfaces, while keeping the static stability constant, raises the instability speed. The instability is almost eliminated by adding a rigid tail behind the lifting surface. An equation is presented which approximately predicts the critical instability speed for a body with one unswept lifting surface. (ASTIA)

811

Semotan, J. 1961 VYZAM DUSEVNI HYGIENY V ASTRONAUTICE (THE IMPORTANCE OF MENTAL HYGIENE IN ASTRONAUTICS)
Cekoslov. Psychiat. (Prague) 57(1): 61-69, Jan. 1961. In Czech. with English summary.

ABSTRACT: Possible damage to the mental facilities of astronauts during space flight is discussed in this article. The dangerous influences include weightlessness, acceleration and deceleration, noise, vibration and isolation. The author suggests a psychogenic approach to the selection of spacemen. He also describes the present and future research for the preservation and development of mental health in the space crew.

812

Shablin, V.A. 1961 THE INFLUENCE OF ANGULAR DISPLACEMENT OF A JOLTING NATURE ON THE HUMAN BODY. (O Viliyanii Na Organizm Cheloveka uglovykh Peremeschenii Tolchkoobraznogo Khuraktera) Gigena i sanitariya (USSR) 26: 46-51

ABSTRACT: Some observations on 10 healthy persons 20 to 22 years indicated that the nature of functional changes in the body depends on the frequency of

ular displacements, the number and magnitude of the jolts. Angular displacements with a frequency of 23 per minute (0.38 cps) and an amplitude of 6° re the jolts were 13 per minute and an acceleration of 1.5 g acting on the n body for 2 hours originally changes the functional condition of the tibular apparatus and its excitability. Bradycardia is noted in the cardiocular system after the effect of these vibrations. With the increase in rate of angular displacement from 23 to 48 per minute (0.8 cps) keeping r physical factors constant there is an increase in volume of pulmonary ilation (to 174%) oxygen consumption (162% energy expenditure of the body %). Under these conditions which are otherwise the same the increase in number of jolts per minute with simultaneous although slight increase in r magnitude from 1.0 to 2.0 g. Along with the changes mentioned leads to inct phenomena of cardio-vascular and nervous system excitation.

alin, V. A. 1962 O KHARAKTERE IZMENENIIA USLOVNOREFLEKTORNYKH REAKTSII LIUDEI PRI VOZDEISTVII OKISI UGLERODA I VIBRATSII (ON THE CHARACTERISTICS OF CHANGES IN THE CONDITIONED REFLEX REACTIONS IN PEOPLE DURING THE ACTION OF CARBON MONOXIDE AND VIBRATION) Biulleten' eksperimental' noi biologii i meditsiny (Moskva) 53(1):45-47, Jan. 1962

RACT: Conditioned reflexes (CR) were elaborated in four groups of 9 subjects as follows: (a) Group I--blinking to sound as the conditioned stimulus (CS) ir blast as the unconditioned stimulus (UCS); (b) Group II--motor CR's rding to A. G. Ivanov Smolenskii) with speech reinforcement to yellow and lights as the positive stimulus and red light as the negative stimulus; roup III--latencies of reactions to sound and color signals during electritimulation of the skin on the forearm; and (d) Group IV--simple reaction registered to the appearance of colored stimuli without UCS reinforcement. imental conditions involved a 15-20 min. exposure to carbon monoxide in conations up to 2.5 mg./liter, and vibrations of 15-18 jolts per minute at an t level of 1.5-2 g. Under both conditions variability of CR latencies was derably reduced, suggesting lowered functional mobility of the cortical sses.

rick, C. E., Jr. May 1953 VARIABLES AFFECTING SENSITIVITY OF THE HUMAN SKIN TO MECHANICAL VIBRATION. Reprint from J. Experimental Psychology 45(5)273-282;
NOTE: CARI P&S 30.1

ACT: An examination was made of the role of the skin as a mechanical in producing the usual U-shaped sensitivity curve to vibration as a function

of frequency. It was assumed that the receptors sensitive to mechanical vibration do not respond selectively to frequency and that either skin or bony tissue possesses mechanical characteristics such that it has a natural period of vibration accompanied by maximum spread of disturbance, in the frequency region of 100 to 300 cy./sec. Hypotheses based on the above assumption were tested experimentally and it was concluded that: (a) Both skin and bony tissue may have resonant points within the usual ffequency range of vibrotactile investigation. (b) The conductivity of skin is maximal at the frequency of greatest vibratory sensitivity, and bony tissue is more efficient in the propagation of disturbances. (c) Mechanic impedance is minimal at the frequency of greatest sensitivity, and bony tissue shows a more sharply tuned resonance curve than relatively bone-free areas. The results of other investigators were discussed in the light of the present research, and it was concluded that more extensive research on sensitivitv of pressure "spots" and on the physical characteristics of the skin may reveal the cause of the lack of agreement of results at present in the literature.

815

Shpil'berg, P.I. 1962 ELEKTROENTSEFALOGRAFICHESKIE ISSLEDOVANIIA PRI VIBRATSIONNOI BOLEZNI, OBUSLOVLENNOI VOZDEISTVIEM OBSHCHEI VIBRATSII (ELECTROENCEPHALOGRAPHIC STUDIES OF VIBRATION SICKNESS CAUSED BY THE ACTION OF GENERAL VIBRATION

Gigiena truda i professional'nye zabolevaniia (Moskva), 6 (4): 14-22. April 1962. In Russian, with English summary (p. 22)

ABSTRACT: Electroencephalographic investigation of 105 cases of vibration sickness showed diffuse or bilateral encephalographic changes in the majority of the cases and localized changes in a few cases. The EEG were characterized by synchronized alpha and theta waves, rarely delta waves. Synchronized waves in form of spindles appeared at rest or upon provocation, e.g., hyperventilation. Sometimes the waves were continuous. External stimuli resulted in prolonged latency of the response. Alpha waves were obtained chiefly from occipital area, while theta waves were derived from the sincipito-temporal areas or occurred diffusely. In some patients the EEG shifts were reversible while in others they persisted even after removal of the vibration hazard.

816

Shchelkunov, I. P. 1962 ROENTGENOLOGICAL DATA ON CHANGES IN THE OSTEOARTICULAR SYSTEM DURING VIBRATION IN DYNAMICS.
In Ortop. Travm. Protez. 23:42-48, July 1962 (Russian)

817

Simons, A.K. 1951 TRACTOR RIDE RESEARCH
Paper: Society of Auto. Engineers National Tractor Meeting, 10-13, Sept. 1951
S.A.E. Preprint 653
See also: Society of Automobile Engineers Transactions, April 1952, Pp. 357-364
Note: CARI P&S 30.1

ABSTRACT: It cannot be over emphasized that the job the tractor must do, the position of the seat on the tractor, and the posture of the body in the seat will all affect tractor seat suspension design. One scientific approach to the problem is to (1) record the absolute tractor motion in all 3 directions simultaneously while the field operation is in progress, (2) subsequently analyze those records in the light of human tolerances and (3) design the seat suspension to isolate against the objectionable part of this motion. The use of such electronic equipment opens up new fields of investigation to the suspension engineer and the medical profession to determine physical and human responses to all conditions of motion. The challenge is to the seating engineer to try to devise a seat suspension that will do as good a job in isolating vibration and supporting his body as do his own legs without that unfortunate adjunct of becoming fatigued.

818

Simons, A.K. 1952 TRACTOR RIDE RESEARCH.
SAE Transactions, 6: 357-364

ABSTRACT: The results of these studies revealed: a) the test course ride typified plowing and discing operations, b) the predominance of all motion was near the natural frequency of the tractor in the vertical and transverse directions, c) the accelerations were consistantly beyond Jacklin's disturbing comfort level in the vertical and transverse directions and occasionally in the longitudinal direction, d) the need for reducing transverse and vertical vibrations appeared to be mutually desirable.

819

Simons, A.K. 1955 HEALTH HAZARDS OF ROUGH RIDING VEHICLES
(Bostrom Research Laboratories, Milwaukee, Wisconsin) Rept # 113, July 1955.

See also Report to Commission on Accidental Trauma, Dept. of Defense.

ABSTRACT: In spite of mounting evidence that truck and tractor riding conditions are undesirable, investigations studying human reactions in the vibration range

820

Simons, A.K., A.O. Radke & W.C. Oswald 1956 A STUDY OF "TRUCK RIDE" CHARACTERISTICS OF STANDARD CUSHION VS. SUSPENSION TYPE SEATS IN MILITARY VEHICLES
Detroit Arsenal and Aberdeen Proving Ground Contract No. DA-11-022-ORD-1999; ORD Project TT1-696; DA Project 5T7201001; Sub-Directive 60405330-11-80802. Rept. No. 118, 16 March 1956.

ABSTRACT: The purpose of this study was to electronically record and compare the "truck ride" (1-8 cps) felt by the truck driver in a standard seat cushion assembly and suspension seats installed in a rubber-tired military truck and driver over permanent test courses at the Aberdeen Proving Ground. Truck acceleration levels in the vertical, transverse and longitudinal directions were found to exceed the "intolerable" and "uncomfortable" limits suggested by vibration table studies in Europe and the U.S.A. The standard driver's cushion seat amplified vertical basic truck motions (1½-6 cps), transmitting an average of 124% of the vehicle vibration intensity to the driver's belt on the Belgian block and staggered bump courses. The assistant driver's seat averaged 139% transmission. The suspension seats attenuated the basic truck motions (1½-6 cps) to the extent of transmitting an average of 80% of the truck vibration intensity

821

Simons, A.K. 1956 MECHANICAL RESPONSE OF THE HUMAN BODY TO WHEELED VEHICLE VIBRATION, 1-6 CPS. (Paper presented at the 4th Annual Conf. of Human Engineers, New York University, Sept. 17, 18, 1956) Bostrom Res. Labs. Rept. no. 121

ABSTRACT: Laboratory vibration table studies on man in a rigid seat reveal man's gross natural frequency of about 4 cps and the different responses of man's head, neck and belt and the effect of muscle tone.

The truck driver exerts physical effort to control his "ride" when vibration isolation is not provided. This human effort is minimized and vibration isolation achieved only when the predominant vehicle frequencies are avoided in truck seat design.

Research should be accelerated on the effects of truck "ride and vibration" (1-8 cps) on the health, safety and efficiency of the soldier-driver and passengers

to the driver's belt for suspension A (69% for suspension B), over the same test courses. These field test results correlate with performances determined in laboratory vibration table studies of man on the standard and suspension type seats. This correlation is important because laboratory vibration table studies are easier to make and are subject to greater experimental controls. Laboratory vibration studies on man in a rigid seat were made (0-6cps) which show the different responses of man's head, neck and belt and the gross effects of variation in muscle tension.
Some theories are presented on man's expenditure of energy in holding onto steering wheel and pushing into back cushion to reduce the amplifying effect of conventional cushions. The serious lack of data throughout the world on man's short and long term reaction to vibrations in the 1-8 cps range is emphasized.

822

Simons, A.K. & M.A. Schmitz 1957-58 THE EFFECT OF LOW FREQUENCY, HIGH AMPLITUDE WHOLE BODY VIBRATION ON HUMAN PERFORMANCE.
(Research & DevelopmentDivision, Office of the Surgeon General Dept. of the Army, Washington, D.C.) Progress Report No. 1 April 1, 1957 - Jan. 31, 1958. ASTIA AD 157 778

ABSTRACT: Two sets of five subjects each were used for the exploratory phase of this research. Variables explored included: 1) Tapping rate; 2) Hand reaction time; 3) Hand tremor; 4) Body sway; 5) Mental addition; 6)Depth perception; 7) Visual acuity; 8) Tracking; 9) Foot pressure constancy; and 10) Foot reaction time.

Each subject, during this pilot phase of the project, was exposed to two vibration conditions and a control condition in a random order. The vibration conditions were 1) 2.5 cycles per second with a full amplitude of 1/2 inch giving an intensity level of .17 g acceleration; and 2) 3.5 cycles per second with a full amplitude of 1/2 inch giving an intensity of .31 g acceleration. Measures were taken before, at intervals during, and after the two vibration conditions and the control condition. All subjects were tested on a shake

823

Simons, A.K. 1956 MECHANICAL RESPONSE OF THE HUMAN BODY TO WHEELED VEHICLE VIBRATION, 1-6 CPS
(This is a summary of Report #118, Sept, 1956)

824

Simons, A. K., & M. A. Schmitz 1958 THE EFFECT OF LOW FREQUENCY, HIGH AMPLITUDE WHOLE BODY VIBRATION ON HUMAN PERFORMANCE. (Bostrom Research Labs., Milwaukee, Wisc.) Progress Rept. No. 1, 1 Apr. 1957 - 31 Jan. 1958; Contrac DA 49-007-md-797; ASTIA AD-157 778

ABSTRACT: The problem under investigation is: 1) Does low frequency, relatively high amplitude vertical vibration affect human performance?; 2) What kinds of pe formance does it affect?; and 3) What are the effects as a function of time exposed? Two sets of five subjects each were used for the exploratory phase of the research. Variables explored included: 1) Tapping rate; 2) Hand reaction time; 3) Hand tremor; 4) Body sway; 5) Mental addition; 6) Depth perception; 7) Visual acuity; 8) Tracking; 9) Foot pressure constancy; and 10) Foot reactio time. Each subject, during this pilot phase of the project, was exposed to two vibration conditions and a control condition in a random order. The vibration conditions were 1) 2.5 cycles per second with a full amplitude of 1/2 inch giving an intensity level of .17 g acceleration; and 2) 3.5 cycles per second with a full amplitude of 1/2 inch giving an intensity level of .31 g acceleration. Measures were taken before, at intervals during, and after the two vibration conditions and the control condition. All subjects were tested on a shake table while seated on a wooden contoured chair. Results appear to show trends toward table while seated on a wooden contoured chair.

Results appear to show trends toward decrement in performance in: 1) Hand reaction time; 2) Body sway: 3) Depth perception; 4) Visual acuity; 5) Tracking: and 6) Foot pressure constancy.

These variables have been chosen for further study using a sample of 20 male university students as subjects. This study is now underway and whether these trends hold and become conclusions depends upon data now being collected

decrement in performance in: 1) Hand reaction time; 2) Body sway; 3) Depth perception; 4) Visual acuity; 5) Tracking; and 6) Foot pressure constancy. These variables have been chosen for further study using a sample of 20 male university students as subjects. (AUTHOR)

825

Sisakyan, N. 1961 MANNED SPACE FLIGHT PROBLEMS DESCRIBED
FBIS, USSR & East Europe, Nr. 145, July 28, 1961

ABSTRACT: Successful completion of a series of experiments with satellite ships made it possible to start preparing for man's flight into space. Results of research have shown that the limits of endurance could be considerably expanded, provided one makes intelligent use of the organism itself, and even more-so of the proper technical means. The state of weightlessness is considered one of the characteristic factors of space flight. Experiments carried out on animals which were returned to earth proved that their 24-hour period in a state of weightlessness had no negative effect on their main functions. When a very careful analysis was carried out, some slight changes in the activity of the blood circulation apparatus had been discovered. (CARI)

Sisakyan, N.M. 1961 BIOLOGY AND COSMIC FLIGHTS
Dept. of Commerce, Washington, D.C. JPRS Trans. No. 9469, June 19, 1961
Original Source: Priroda (Nature) (Moscow) (1): 7-16, Jan. 1961

ABSTRACT: Soviet accomplishments in space biology in terms of space flights to date are summarized, and the problems to be resolved for successful manned cosmic flights are discussed. Vertical rocket flights carrying animals to 450 km altitude solved certain problems of assuring safety and special recovery under special flight conditions. The effects of acceleration and deceleration were manifested in the elevation of blood pressure, an increase in pulse frequency and certain changes in the electrocardiogram; during weightlessness these changes gradually decreased and approached the original level. After 5 to 6 minutes or at the end of the weightless period, the indices of the main physiological functions returned to the original level. The physiological information obtained by telemetry is still not completely processed; preliminary data testifies that changes in the physiological indices did not exceed changes observed during training.

827

Sisakyan, N.M. & V. Parin 1961 (COMMENTS)
Vestnik vozdushnogo flota 4: 34-39; April

828

Sisakyan, N.M. & V.I. Yazdovskiy 1962 METHODS AND TECHNIQUES OF BIOMEDICAL CONTROL IN SPACE FLIGHT
Aerospace Information Division, Washington, D.C. AID Report No. 62-201, Dec. 19, 1962. ASTIA AD 294 573
Original Source: Pervyye Kosmicheskiye Polety Cheloveka (First Space Flights of Man) Moskva, Izd-vo AN SSSR, pp. 167-174

ABSTRACT: Physiological measurements performed on Vostoks I and II included electrocardiography (with two sets of leads), pneomography, and registration of pulse rate. In addition, kinetocardiography was performed on Vostok II. The pulse rate was monitored continuously by means of a cardiophone which transformed the R peaks of electrocardiographs into rectilinear pulses of 0.1 to 0.2 sec duration. These were modulated by an auditory frequency of 3 kc and were transmitted continuously by a signal transmitter on a frequency of 19.95 mc. Other measurements were transmitted periodically. During reentry all physiological parameters were registered by means of a self-contained onboard system. After ejection of the cosmonaut, registration was carried on by means of a self-contained device located on his person. Transmitted data on pulse frequency was recorded on undulating and on magnetic tapes. (Author)

829

Sisakyan, N.M. & V.I. Yazdovskiy 1962 PHYSIOLOGICAL RESPONSES OF COSMONAUTS DURING SPACE FLIGHT
Aerospace Information Division, Washington, D.C. AID Rept. No. 62-202 Dec. 19, 1962 ASTIA AD 294 572
Original source: Pervyye Kosmicheskiye Polety Cheloveka (First Space Flights of Man) Moskva, Ozd-vo AN SSSR, pp. 176-198

ABSTRACT: This publication presents a detailed report of the physiological responses of Yu. A. Gagarin and G.S. Titov to space flight. The record of changes in pulse rate and respiration rate during acceleration and weightlessness are presented.

830

Sisakyan, N.M. 1963 PROBLEMS OF SPACE BIOLOGY. (Problemy Kosmicheskoy Biologii) (Foreign Tech., Div., Air Force Systems Command, Wright-Patterson AFB, Ohio) Trans. no. FTD-MT-62-78 from Izdatel'stvo Akademii Nauk SSSR. pp. 1-462, 1962 ASTIA AD-299 677

ABSTRACT: Experimental and theoretical works carried out chiefly within the last years, are presented. The first part includes theoretical and survey articles, encompassing the main problems of cosmic biology and giving general presentation concerning results and perspective of researches. The second part is devoted to an account of the results of experimental researches conducted under the conditions of real space flights on ships-satellites in 1960-1961. The third part summarizes the results of the biilogical experiment on the second artificial satellite of the Earth with the dog Layka-- the experiment which searches in the cosmos. In the fourth part are entered experimental laboratory and methodic works. (author)

831

Sisakyan, N.M. & V.I. Yazdovskiy 1962 RESULTS OF POSTFLIGHT MEDICAL EXAMINATIONS OF G.S. TITOV
Aerospace Information Division, Washington, D.C. AID Report No. 62-204 Dec. 19, 1962 ASTIA AD 294 571
Original Source: Pervyye Kosmicheskiye Polety Cheloveka (First Space Flights of Man) Moskva, Izd-vo AN SSSR pp. 125-153

832

Sisakyan, N.M., V.V. Parin et al. 1962 PROBLEMS OF SPACE BIOLOGY AND PHYSIOLOGY
Joint Publications Research Service, New York JPRS-16083, Nov. 7, 1962
ASTIA AD 299 909

833

Skolnick, A. 1938 UPPER LIMIT OF CUTANEOUS SENSITIVITY TO FREQUENCY OF VIBRATION IN THE WHITE RAT J. Exptl. Psychol 22:273-276

834

Skilling, D. C. 1961 ACOUSTIC HYPER-ENVIRONMENT AND ITS SIMULATION
In 1961 Proceedings of the Institute of Environmental Sciences National Meeting, April 5, 6, 7, 1961, Washington, D. C. (Mt. Prospect, Ill.: Institute of Environmental Sciences, P. O. Box 191) pp. 611-621

835

Sjoberg, A.A. 1931 EXPERIMENTELLE STUDIEN UBER DEN AUSLÖSUNGSMECHANISMUS DER SEEKRANKHEIT (Experimental Studies Concerning the Release Mechanism of Seasickness)
Acta Oto-Laryngologica (Stockholm) Supp. 14:1

836

Skudrzyk, E. 1949 THE MECHANICAL AND BIOLOGICAL EFFECTS OF ULTRASONICS BASED ON THE ANALOGY BETWEEN SOUND AND HEAT Acta physiol. Austriaca 3(1):56-65
See Also Phys. Abstr. 53:640 (1950)

837

Skudrzyk, E. 1950 THE MECHANICAL AND BIOLOGICAL EFFECTS OF ULTRASONICS BASED ON THE ANALOGY BETWEEN SOUND AND HEAT Phys. Abstr. 53:640
See Also: Acta physiol. Austriaca 53:640

838

Slager, U.T. 1962 SPACE MEDICINE
Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1962
Library of Congress Catalog Card No. 62-12491

ABSTRACT: Contents include papers on the following subjects: "The Concept of Space Flight"; "Development of the Space Vehicle"; "The Concept of Space Medicine" "Pressure and Oxygen in the Upper Atmosphere and Space"; "Meteoritic Material in the Upper Atmosphere and Space"; "Experimental Space Simulation"; "The Biological Effects of Low Pressure"; "The Temperature During Flight in the Atmosphere"; "The Temperature During Orbital Flight"; "Experimental Space Simulation"; "The Biological Effects of Temperature Variations"; "Radiation in Space"; "Experimental Space Simulation"; "Interaction of Electromagnetic Radiations With Matter"; "The Biological Effects of Non-Ionizing Radiation"; "Ionizing Radiations in Space"; "Experimental Space Simulation"; "Mode of Action of Ionizing Radiations"; "The Biological Effects of Ionizing Radiation"; "Dynamics of Space Flight"; "Experimental Simulation of Space Flight Accelerations"; "The Biological Effects of Acceleration"; "The Dynamics of Weightlessness"; "The Experimental Simulation of Weightlessness"; "The Biological Effects of Weightlessness"; "Noise and Vibration in Space Flight"; "Experimental Space Simulation"; "The Biological Effects of Sound and Vibration"; "Metabolic

839

Smith, A.M.O. and C.F. Lombard 1951 THE EFFECT OF ELASTICITY UPON THE PRESSURES WITHIN A LIQUID FILLED TUBE WHEN SUBJECTED TO FLUCTUATING FORCES (Department of Aviation Medicine, Univ. of Southern Calif., School of Med., Los Angeles, Calif.) Contract NSori77, Task 1, 31 March 1951

ABSTRACT: In order to better understand the recorded blood pressures of animals exposed to the fluctuating accelerations of the Epicyclic contrifuge, a theoretical analysis is presented so that the nature of the dynamic responses can be envisioned. This is a highly mathematical and theoretical treatise.

Requirements in Space"; "Experimental Space Simulation"; "The Biological Effects of Life Support Systems Imbalance"; "Life-Support Systems"; "Ionizing Radiation"; "Particulate Matter"; "Toxic Chemical Compounds"; "Psychological Stress in Space" "Experimental Space Simulation"; "Psychological Effects of Space Flight"; "The Space Environment"; and "Biology of Far Space".

840

ith, G.B., Jr., S.J. Gerathewohl et al. 1962 BIOASTRONAUTICS
tional Aeronautics and Space Administration, Washington, D.C. NASA-SP-18,
NASA N63-11508

STRACT: This publication contains papers presented at Session L of the NASA-
iversity Conference on the Science and Technology of Space Exploration, at
icago, Illinois on November 1-3, 1962. The following papers are presented:
nvironmental Biology" by G.B. Smith, Jr. (NASA, Manned Spacecraft Center);
hysiological and Behavioral Sciences" by S.J. Gerathewohl and B.E. Gernandt
ASA. Ames Research Center); "Bioengineering" by Richard S. Johnston (NASA.
nned Spacecraft Center); "Exobiology" by R.S. Young (NASA. Ames Research
nter).

841

ith, G.B. 1962 ENVIRONMENTAL BIOLOGY
n: Proceedings of the NASA-University Conference on the Sciences and Technology of Space Exploration, 1: 395-398. (Washington, D.C.: National Aeronautics and Space Administration) December 1962 NASA SP-18

BSTRACT: Environmental factors in space flight and their effects on man are
iscussed as they relate to promoting and maintaining are included: (1) bio-
ynamics, involving noise and vibrations, sustained accelerations and impacts,
nd the effects of weightlessness; (2) radiations from the sun, the stars, the
an Allen belt, and nuclear-reactor propulsion or power systems; (3) life support,
consisting of providing food, water, oxygen, etc.; and (4) medical selection and
aintenance. The National Aeronautics and Space Administration has used the
kills of various federal agencies, the academic world, and industry, as well
as its own centers in these endeavors.

842

Snow, M.L. H.A., 1928 SOME PHYSIOLOGICAL EFFECTS OF MECHANICAL VIBRATION Physical Therap. 46:113-123

843

Snow, Mary L.H.A. 1930 MECHANICAL *VIBRATION-ITS STATUS* IN MEDICINE. Phys. Therapeutics, 48:433-442

844

Snyder, F. W. 1957 PRELIMINARY STUDY OF AIRCREW TOLERANCE TO LOW-FREQUENCY VERTICAL VIBRATION. (Boeing Airplane Co., Wichita, Kansas) Document No. D3-1189; Contract AF 34(601)2975; ASTIA AD-155 462; 3 July 1957

ABSTRACT: Five aircrewmen were subjected to vertical harmonic motions of frequencies ranging from 3 to 30 cps with input accelerations ranging to a maximum of over 2.5 g. The subjective judgments of the effect of the vibrations on the aircrewmen were reported by them in terms of a 5-point scale. The results of the subjective judgment tests indicate that aircrewmen are able to tolerate unexpectedly high levels of vibratory acceleration for relatively short periods at the frequencies explored. Transmissability of vibration from supporting structure adjoining the seat to just under the body of the seated airman varied with frequency. Generally, the higher frequencies were transmitted with a greater loss in amplitude of vibration (or g's) than were the lower frequencies. The same aircrewmen performed a tracking task while being subjected to vibration of various amplitudes and frequencies. The magnitude and duration of error in tracking was electrically integrated to produce a comparable score for each vibration condition. It was tentatively found that there were statistically significant decrements in performance under vibration conditions which were judged to be nearly "intolerable." In addition, there were some notable individual differences in response to the

845

Snyder, F.W. 1962 EFFECTS OF LOW FREQUENCY VERTICAL VIBRATION ON HUMAN PERFORMANCE

Paper: 33rd Annual Meeting of the Aerospace Medical Association, Chalfonte-Haddon Hall, Atlantic City, N.J., April 9-12, 1962

ABSTRACT: This program was initiated in 1959 under contract with Office of Naval Research. A laboratory facility designed for human experimentation is used. Seventeen subjects participated in the first experiment establishing judged vibration severity levels identified as definitely perceptible, mildly annoying, extremely annoying, and alarming. Sinusoidal vibration frequencies ranged from 1-27 cps. Acceleration ranged from 0.01 G at 1 cps to 1.5 G at 20 cps. Performance of six to nine subjects was measured for continuous tracking and discrete tasks during vibration. Highlight results are: performance is degraded on some tasks but not on others; subjects are not always aware of performance degradation; some correlation exists between affected body region and vibration frequency; distracting irritation in nose region occurs above 12-14 cps; visual degradation is greatest in the range 12-23 cps.

846

Sokolov, V.A. 1961 STAGES ON A GREAT ROAD

Air Information Division, Wright-Patterson AFB, Ohio AID Rept. No. 61-156 ASTIA AD 269 794

Original Source: Nauka i zizhn' April 1961. Pp. 5, 8ff.

852

Spiegel, E.A. & T.D. Demetriades 1922 BEITRAGE ZUM STUDIUM VEGETATIVEN NERVENSYSTEMS. III. MITTEILUNG. DER EINFLUSS DES VESTIBULARAPPARATES AUF DAS GEFASZSYSTEM (Contribution to the Study of the Vegetative Nervous System. III. Report. The Influence of the Vestibular Apparatus Upon the Vessel System)
Archiv für die Gesamte Psychologie (Leipzig) 196: 185-199

853

Spieth, W and W.J. Trittipoe 1961 TEMPORARY THRESHOLD ELEVATION PRODUCED BY CONTINUOUS AND "IMPULSIVE"NOISES. (Cambridge Research Center) TN 61-7

854

Stadelman, W.J., & I.L. Kosin 1957 THE EFFECTS OF SOUNDS OF VARYING INTENSITIES ON CHICKENS AND HATCHING EGGS. (Wright Air Development Division, Wright-Patterson AFB, Ohio) WADD TR 57-87, Feb. 1957. ASTIA AD 118 038.

ABSTRACT: Young chickens were grown in pens subjected to sound levels varying from 80 to 115 decibels pressure at 20 minute intervals. The sound field was obtained with sound reproduction equipment using a tape with jet and propeller driven plane flyovers and airfield noises. Chickens grown under noise conditions from day old developed just as rapidly as chickens grown in control pens with a noise level of 65 decibels. There were no differences in growth rate, body weight, feed efficiency, feathering, mortality and abnormalities. When the noise level was maintained near 65 decibels for the first 30 days and then noise levels up to 120 decibels were applied, there was evidence of fright resulting in stampeding, crowding and smothering of chicks. Sound levels in excess of 120 decibels had no effect on hatchability when applied during incubation and hatching. The moving of setting hens from normal hen house environment to a pen with noise levels of about 115 decibels was effective in "breaking up" the setting hens. Eleven of 12 hens so treated did not remain broody. Other setting hens moved to similar pens except for the sound field remained broody and

855

Stapp, J. P. 1959 BIODYNAMICS OF SPACE FLIGHT.
In Man In Space (New York: Duell, Sloan, & Pearce, 1959)

856

Statni Lékařská Knihova (National Medical Library) 1959 THE ANNUAL OF CZECHOSLOVAK MEDICAL LITERATURE 1957
Praha, Czechoslovakia: Statni Zdravotnicke Nakladatelstvi (Prague 1, Czechoslovakia: State Health Publishing House)