



**Aerospace Medicine  
and Biology**  
A Continuing  
Bibliography  
with Indexes

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August 1989

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National Aeronautics and  
Space Administration

**Aerospace Medicine and Biology**  
A Continuing Bibliography with Indexes

Pages 151-170

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**Aerospace Medicine & Biology  
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## ACCESSION NUMBER RANGES

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# **AEROSPACE MEDICINE AND BIOLOGY**

**A CONTINUING BIBLIOGRAPHY  
WITH INDEXES**

**(Supplement 326)**

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in July 1989 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA)*.



National Aeronautics and Space Administration  
Office of Management  
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Washington, DC

1989

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# INTRODUCTION

This Supplement to *Aerospace Medicine and Biology* lists 108 reports, articles and other documents announced during July 1989 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*. The first issue of the bibliography was published in July 1964.

In its subject coverage, *Aerospace Medicine and Biology* concentrates on the biological, physiological, psychological, and environmental effects to which man is subjected during and following simulated or actual flight in the Earth's atmosphere or in interplanetary space. References describing similar effects on biological organisms of lower order are also included. Such related topics as sanitary problems, pharmacology, toxicology, safety and survival, life support systems, exobiology, and personnel factors receive appropriate attention. In general, emphasis is placed on applied research, but references to fundamental studies and theoretical principles related to experimental development also qualify for inclusion.

Each entry in the bibliography consists of a bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by *STAR* categories 51 through 55, the Life Sciences division. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR*, including the original accession numbers from the respective announcement journals. The *IAA* items will precede the *STAR* items within each category.

Seven indexes — subject, personal author, corporate source, foreign technology, contract, report number, and accession number — are included.

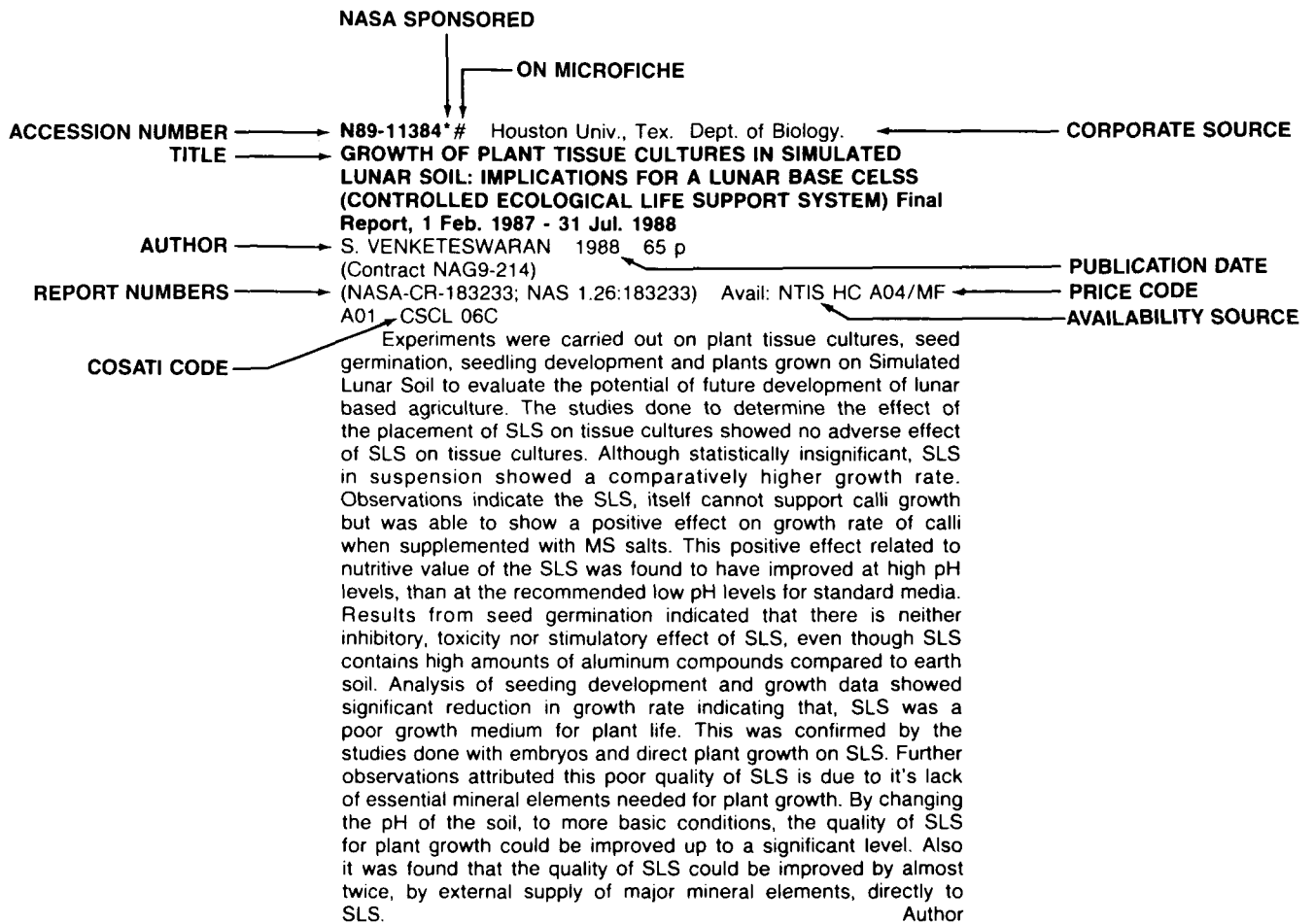
An annual index will be prepared at the end of the calendar year covering all documents listed in the 1989 Supplements.

Information on the availability of cited publications including addresses of organizations and NTIS price schedules is located at the back of this bibliography.

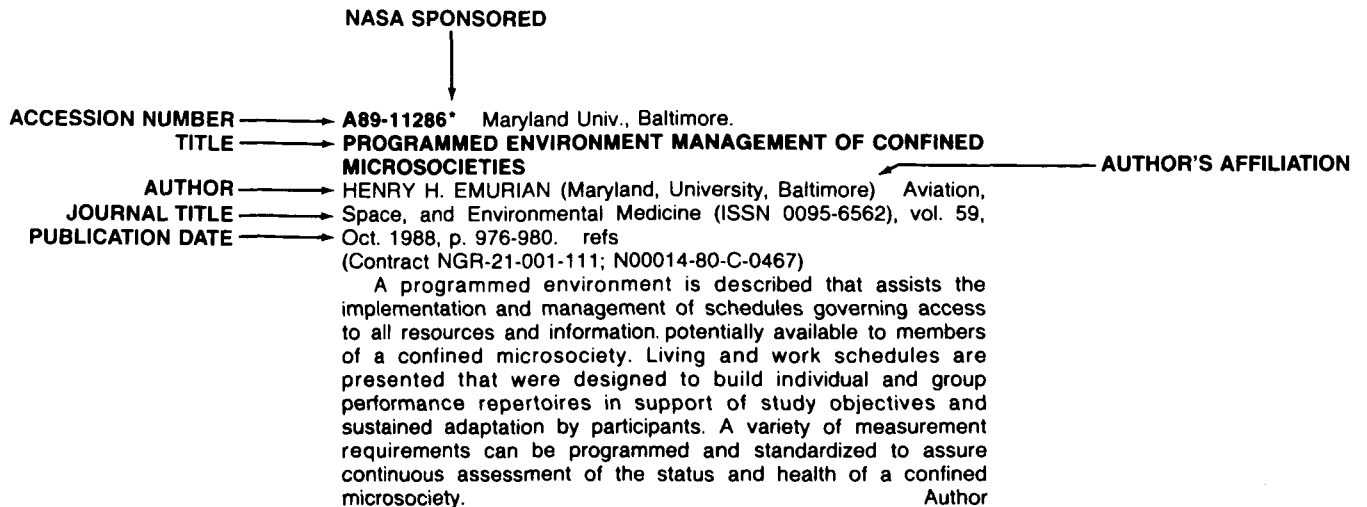
# TABLE OF CONTENTS

	<b>Page</b>
<b>Category 51 Life Sciences (General)</b>	<b>151</b>
<b>Category 52 Aerospace Medicine</b> Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.	<b>158</b>
<b>Category 53 Behavioral Sciences</b> Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.	<b>162</b>
<b>Category 54 Man/System Technology and Life Support</b> Includes human engineering; biotechnology; and space suits and protective clothing.	<b>164</b>
<b>Category 55 Space Biology</b> Includes exobiology; planetary biology; and extraterrestrial life.	<b>168</b>
<b>Subject Index .....</b>	<b>A-1</b>
<b>Personal Author Index .....</b>	<b>B-1</b>
<b>Corporate Source Index .....</b>	<b>C-1</b>
<b>Foreign Technology Index .....</b>	<b>D-1</b>
<b>Contract Number Index .....</b>	<b>E-1</b>
<b>Report Number Index .....</b>	<b>F-1</b>
<b>Accession Number Index .....</b>	<b>G-1</b>

## TYPICAL REPORT CITATION AND ABSTRACT



## TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT



# AEROSPACE MEDICINE AND BIOLOGY

*A Continuing Bibliography (Suppl. 326)*

AUGUST 1989

51

## LIFE SCIENCES (GENERAL)

**A89-32749**

### THE RELATIONSHIP OF A PROCHLOROPHYTE PROCHLOROTHRIX HOLLANDICA TO GREEN CHLOROPLASTS

SEAN TURNER, STEPHEN J. GIOVANNONI, NORMAN R. PACE (Indiana University, Bloomington), TINEKE BURGER-WIERSMA, and LUUC R. MUR (Amsterdam, Universiteit, Netherlands) *Nature* (ISSN 0028-0836), vol. 337, Jan. 26, 1989, p. 380-382. Research supported by the U.S. Navy and NIH. refs

The prochlorophytes *Prochloron didemni* and *Prochlorothrix hollandica* have been suggested to be modern counterparts of the ancestor of the green chloroplasts because they are prokaryotes that contain both chlorophylls a and b and lack phycobilins. A 16S rRNA-based phylogenetic analysis of *P. hollandica* is reported which reveals that the organism falls within the cyanobacterial line of descent, as do the green chloroplasts, but that it is not a specific relative of green chloroplasts. Similar pigment compositions thus do not necessarily reflect close evolutionary relationships. C.D.

**A89-32750**

### PSBA GENES INDICATE COMMON ANCESTRY OF PROCHLOROPHYTES AND CHLOROPLASTS

C. W. MORDEN and S. S. GOLDEN (Texas A & M University, College Station) *Nature* (ISSN 0028-0836), vol. 337, Jan. 26, 1989, p. 382-385. Research supported by Texas A & M University and NIH. refs

The *psbA* genes of the freshwater filamentous prochlorophyte *Prochlorothrix hollandica*, which encode the photosystem II thylakoid protein D1, were cloned and sequenced and the sequences were compared to those reported for cyanobacteria, a green alga, a liverwort, and several higher plants. The two *psbA* genes in *P. hollandica* encode an identical amino-acid sequence. As in all chloroplast *psbA* genes, there is a seven amino-acid gap near the C terminus of the derived protein relative to the protein predicted by cyanobacterial genes, suggesting that *P. hollandica* is part of the lineage that led to chloroplasts after a divergence from cyanobacteria. This hypothesis is also supported by phylogenetic analysis of derived D1 amino-acid sequences from *psbA* genes of 13 taxa on the basis of parsimony. C.D.

**A89-32757**

### A NOVEL EYE IN 'EYELESS' SHRIMP FROM HYDROTHERMAL VENTS OF THE MID-ATLANTIC RIDGE

CINDY LEE VAN DOVER (Woods Hole Oceanographic Institution, MA), ETE Z. SZUTS (Woods Hole Oceanographic Institution; Boston University, MA), STEVEN C. CHAMBERLAIN (Syracuse University, NY), and J. R. CANN (Newcastle upon Tyne, University, Newcastle upon Tyne, England) *Nature* (ISSN 0028-0836), vol. 337, Feb. 2, 1989, p. 458-460. Research supported by PHS. refs

*Rimicaris exoculata* is a shrimp that swarms over

high-temperature sulfide chimneys at Midatlantic Ridge hydrothermal fields. This shrimp lacks an externally differentiated eye, having instead a pair of large organs within the cephalothorax immediately behind the dorsal surface of the transparent carapace, connected by large nerve tracts to the supraesophageal ganglion. These organs contain a visual pigment with an absorption spectrum characteristic of rhodopsin. Ultrastructural evidence for degraded rhabdomeral material suggests the presence of photoreceptors. No image-forming optics are associated with the organs, which are interpreted here as being eyes adapted for detection of low-level illumination, and it is suggested that they evolved in response to a source of radiation associated with the environment of hydrothermal vents. C.D.

**A89-32758**

### THE VISIBILITY OF 350 DEG C BLACK-BODY RADIATION BY THE SHRIMP RIMICARIS EXOCULATA AND MAN

DENIS G. PELLI and STEVEN C. CHAMBERLAIN (Syracuse University, NY) *Nature* (ISSN 0028-0836), vol. 337, Feb. 2, 1989, p. 460, 461. refs

The eye of the 'eyeless' shrimp *Rimicaris exoculata* is unusual in having no image-forming optics and a high concentration of rhodopsin. The shrimps swarm around 350 C hydrothermal 'black smoker' vents in the Midatlantic Ridge. Physical calculations are presented here which indicate that the shrimp can see the blackbody radiation of the vents, even though these sources are practically invisible to the human eye. This should be useful to the shrimp, as it feeds on sulfide-loving bacteria very near the vents but avoids the vents themselves. C.D.

**A89-32759**

### AMINOACYLATION OF RNA MINIHELICES WITH ALANINE

CHRISTOPHER FRANCKLYN and PAUL SCHIMMEL (MIT, Cambridge, MA) *Nature* (ISSN 0028-0836), vol. 337, Feb. 2, 1989, p. 478-481. Research supported by NIH. refs

The possibility is investigated that an RNA minihelix, composed only of the amino-acid acceptor-T Psi C helix, could be a substrate for alanine tRNA synthetase. It is shown here that a synthetic hairpin minihelix can be enzymatically aminoacylated with alanine. Alanine incorporation requires a single G-U base pair and occurs in helices that otherwise differ significantly in sequence. Aminoacylation can be achieved with only seven base pairs in the helix. These results invite speculation that short RNA minihelices could have tagged primitive RNA genome molecules. After serving as primitive RNA telomeres, the minihelices may have been released to become pre-tRNAs upon which the first peptides were synthesized. C.D.

**A89-34037**

### EXTERNAL BREATHING, GAS EXCHANGE, AND BLOOD ACID-BASE BALANCE IN DOGS UNDER HYPERTHERMIA [VNESHNEE DYKHANIE, GAZOOBMEN I KISLOTNO-OSNOVNOE SOSTOIANIE KROVI PRI GIPERTERMII U SOBAK]

M. M. SEREDENKO, V. P. POZHAROV, T. D. MINIAILENKO, V. I. BOIKO, and L. A. GRABOVSKII (AN USSR, Institut Fiziologii, Kiev, Ukrainian SSR) *Fiziologicheskii Zhurnal* (Kiev) (ISSN 0201-8489), vol. 35, Jan.-Feb. 1989, p. 21-25. In Russian. refs

The effects of hyperthermia on the respiration rate, gas exchange, and acid-base balance were investigated in dogs



## 51 LIFE SCIENCES (GENERAL)

maintained in a chamber at varying conditions of temperature and humidity. It is shown that hyperthermia (as determined from increases of rectal temperature to 40-42 C) leads to increases in respiration rate and oxygen consumption, severe hypocapnia, decompensated respiratory alkalosis, and a pronounced discrepancy between alveolar ventilation and CO<sub>2</sub> elimination.

I.S.

### A89-34319

#### RNA EVOLUTION AND THE ORIGINS OF LIFE

GERALD F. JOYCE (Scripps Clinic, La Jolla, CA) *Nature* (ISSN 0028-0836), vol. 338, March 16, 1989, p. 217-224. refs

The idea that there was a time, before the origin of protein synthesis, when life was based entirely on RNA is addressed. The advantages of RNA as the basis for the early evolution of life are reviewed. The chemical obstacles to the initiation of an RNA world are discussed, and how in principle they may have been overcome is suggested.

C.D.

### A89-34398\* Massachusetts Inst. of Tech., Cambridge.

#### SUPERCRITICAL FLUID EXTRACTION AND CHARACTERIZATION OF LIPIDS FROM ALGAE SCENEDESMUS OBLIQUUS

K. J. CHOI, Z. NAKHOST, V. J. KRUKONIS, and M. KAREL (MIT, Cambridge, MA) *Food Biotechnology* (ISSN 0890-5436), vol. 1, 1987, p. 263-281. refs  
(Contract NCC2-231)

Lipids were extracted from a protein concentrate of green algae (*Scenedesmus obliquus*), using a one-step supercritical carbon dioxide extraction procedure in presence of ethanol as an entrainer, and were characterized. The compositions of neutral lipids, glycolipids, and phospholipids, separated into individual components by column, thin-layer, and gas-liquid chromatography procedures, are presented. Fatty acid composition patterns indicated that the major fatty acids were 16:0, 16:1, 16:2, 16:3, 16:4, 18:1, 18:2, and 18:3. The lipids of *S. obliquus* were found to contain relatively high concentrations of polyunsaturated fatty acids and essential fatty acids.

I.S.

### A89-34400\* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

#### SUPPRESSION OF MORPHOGENESIS IN EMBRYONIC MOUSE LIMBS EXPOSED IN VITRO TO EXCESS GRAVITY

JACKIE C. DUKE (NASA, Johnson Space Center, Texas, University, Houston) *Teratology* (ISSN 0040-3709), vol. 27, 1983, p. 427-436. refs

The effect of excess gravity on in vitro mammalian limb chondrogenesis is studied. Limb buds from mice of various gestational stages were exposed to excess gravity (2.6G) using a culture centrifuge. Both forelimbs and hind limbs were cultured, and the development of various limb elements was scored after four to six days. The 2.6G force significantly depressed the development of limb elements when applied during the teratogen-sensitive period of chondrogenesis.

Author

### A89-34535\* Wuerzburg Univ. (Germany, F.R.).

#### INCREASED EFFICIENCY OF MAMMALIAN SOMATIC CELL HYBRID PRODUCTION UNDER MICROGRAVITY CONDITIONS DURING BALLISTIC ROCKET FLIGHT

R. SCHNETTLER, P. GESSNER, U. ZIMMERMANN (Wuerzburg, Universitaet, Federal Republic of Germany), G. A. NEIL (Iowa, University, Iowa City), H. B. URNOVITZ (Calypte Biomedical Co., Berkeley, CA) et al. *Applied Microgravity Technology* (ISSN 0931-9530), vol. 2, Feb. 1989, p. 3-9. refs  
(Contract BMFT-01-QV-354; NAG8-716)

The electrofusion of hybridoma cell lines under short-duration microgravity during a flight of the TEXUS 18 Black Brand ballistic sounding rocket at Kiruna, Sweden is reported. The fusion partners, growth medium, cell fusion medium, cell fusion, cell viability in the fusion medium, and postfusion cell culture are described, and the rocket, cell fusion chamber, apparatus, and module are examined. The experimental timeline, the effects of fusion medium and

incubation time on cell viability and hybrid yields, and the effect of microgravity on hybrid yields are considered.

C.D.

### A89-34539

#### ALTERATION OF GRAVITATIONAL FIELD EFFECT ON SEDIMENTATION OF ERYTHROCYTES BY INHOMOGENEOUS MAGNETIC FIELD

MEGHA SINGH and H. J. RATH (Indian Institute of Technology, Madras, India) *Applied Microgravity Technology* (ISSN 0931-9530), vol. 2, Feb. 1989, p. 45-48. Research supported by the Alexander von Humboldt-Stiftung. refs

The effect of an inhomogeneous magnetic field on the mobility of erythrocytes at various points of a sample contained in a glass chamber by a He-Ne laser is investigated. In the presence of the field, the cell concentration is higher at various points in the sample, and the tendency to aggregate is enhanced compared to that in a control sample. The field thus has a positive influence on erythrocyte sedimentation.

C.D.

### A89-34998\* Louisville Univ., KY.

#### TRANSCRIPTIONAL REGULATION OF DECREASED PROTEIN SYNTHESIS DURING SKELETAL MUSCLE UNLOADING

G. HOWARD, J. M. STEFFEN, and T. E. GEOGHEGAN (Louisville, University, KY) *Journal of Applied Physiology* (ISSN 0161-7567), vol. 66, March 1989, p. 1093-1098. Research supported by the Kentucky EPSCoR Program. refs  
(Contract NSG-2325; NSF RII-86-10671)

The regulatory role of transcriptional alterations in unloaded skeletal muscles was investigated by determining levels of total muscle RNA and mRNA fractions in soleus, gastrocnemius, and extensor digitorum longus (EDL) of rats subjected to whole-body suspension for up to 7 days. After 7 days, total RNA and mRNA contents were lower in soleus and gastrocnemius, compared with controls, but the concentrations of both RNAs per g muscle were unaltered. Alpha-actin mRNA (assessed by dot hybridization) was significantly reduced in soleus after 1, 3, and 7 days of suspension and in gastrocnemius after 3 and 7 days, but was unchanged in EDL. Protein synthesis directed by RNA extracted from soleus and EDL indicated marked alteration in mRNAs coding for several small proteins. Results suggest that altered transcription and availability of specific mRNAs contribute significantly to the regulation of protein synthesis during skeletal muscle unloading.

I.S.

### A89-35500

#### COMPARATIVE EVALUATION OF THE EFFECT OF IMMOBILIZATION STRESS ON THE DYNAMICS OF RESISTANCE TO THE INDUCTION OF THE PEROXIDATION OF LIPIDS OF THE INTERNAL ORGANS AND BRAIN

[SRAVNITEL'NAIA OTSENKA VLIANIIA IMMOBILIZATSIONNOGO STRESSA NA DINAMIKU USTOICHIVOSTI K INDUKTSII PEREKISNOGO OKISLENIIA LIPIDOV VNUTRENNIKH ORGANOV I GOLOVNOGO MOZGA] I.U. V. ARKHIPENKO, V. V. DIDENKO, T. G. SAZONTOVA, and F. Z. MEERSON (AMN SSSR, Nauchno-Issledovatel'skii Institut Obshchei Patologii i Patologicheskoi Fiziologii, Moscow, USSR) *Akademiia Nauk SSSR, Doklady* (ISSN 0002-3264), vol. 304, no. 6, 1989, p. 1500-1503. In Russian. refs

### N89-20601# Pittsburgh Univ., PA. Graduate School of Public Health.

#### NEW MODELS TO ASSESS BEHAVIORAL AND PHYSIOLOGICAL PERFORMANCE OF ANIMALS DURING INHALATION EXPOSURES Ph.D. Thesis

DOLORES ELIZABETH MALEK Oct. 1988 164 p  
(Contract NIST-NANB-4001)  
(PB89-128946; NIST/GCR-88/551) Avail: NTIS HC A08/MF A01 CSCL 06C

Previously the toxicity of fire smoke has been examined primarily in sedentary animals and lethality was noted. The evaluation of escape potential from a toxic environment, however, requires the measurement of sublethal responses in active animals that are escape predictive. To address this need, the mouse track model

and the guinea pig ergometer model have been developed. The mouse track model was a ventilated S shaped exposure system. Performance was evaluated by two sublethal responses, distance traveled/time and incapacitation. A novel feature of the mouse track model was its ability to detect an early deterioration in performance before incapacitation and death. The guinea pig ergometer model was designed where a 4.9L exposure chamber enclosed a motor driven rubberized wheel. Extrapolation of exercising guinea pig data to human was similar to theoretical models that predict human response to CO. Humans were estimated to progress five times the distance of the guinea pig at a similar level of toxicity for CO. Author

**N89-20602\*#** Lockheed Engineering and Sciences Co., Washington, DC.

**USSR SPACE LIFE SCIENCES DIGEST, ISSUE 21**

LYDIA RAZRAN HOOKE, P. LYNN DONALDSON, VICTORIA GARSHNEK, and JOSEPH ROWE Washington NASA Mar. 1989 108 p  
(Contract NASW-4292)

(NASA-CR-3922(24); NAS 1.26:3922(24)) Avail: NTIS HC A06/MF A01 CSCL 06C

This is the twenty-first issue of NASA's USSR Space Life Sciences Digest. It contains abstracts of 37 papers published in Russian language periodicals or books or presented at conferences and of a Soviet monograph on animal ontogeny in weightlessness. Selected abstracts are illustrated with figures and tables from the original. A book review of a work on adaptation to stress is also included. The abstracts in this issue have been identified as relevant to 25 areas of space biology and medicine. These areas are: adaptation, biological rhythms, body fluids, botany, cardiovascular and respiratory systems, cytology, developmental biology, endocrinology, enzymology, equipment and instrumentation, exobiology, gravitational biology, habitability and environmental effects, hematology, human performance, life support systems, mathematical modeling, metabolism, microbiology, musculoskeletal system, neurophysiology, operational medicine, perception, psychology, and reproductive system. Author

**N89-20603#** California Univ., Berkeley. Lawrence Berkeley Lab. Engineering Div.

**THE DEVELOPMENT OF A COMPTON LUNG DENSITOMETER**

BILLY W. LOO, FRED S. GOULDING, NORM W. MADDEN, and DANIEL S. SIMON (California Univ., San Francisco.) Nov. 1988 18 p Presented at the IEEE Nuclear Science Symposium, Orlando, FL, 9 Nov. 1988

(Contract DE-AC03-76SF-00098)

(DE89-006654; LBL-25170; CONF-881103-36) Avail: NTIS HC A03/MF A01

A field instrument is being developed for the non-invasive determination of absolute lung density using unique Compton backscattering techniques. A system consisting of a mono-energetic gamma-ray beam and a shielded high resolution high-purity-germanium (HPGe) detector in a close-coupled geometry is designed to minimize errors due to multiple scattering and uncontrollable attenuation in the chestwall. Results of studies on system performance with phantoms, the optimization of detectors, and the fabrication of a practical gamma-ray source are presented. DOE

**N89-20604#** California Univ., Berkeley. Lawrence Berkeley Lab. Accelerator and Fusion Research Div.

**X-RAY MICROSCOPY FOR THE LIFE AND PHYSICAL SCIENCES**

D. ATTWOOD, Y. VLADIMIRSKY, D. KERN, W. MEYER-ILSE, J. KIRZ, S. ROTHMAN, H. RARBACK, N. ISKANDER, K. MCQUAID, H. ADE (State Univ. of New York, Stony Brook.) et al. Jun. 1988 6 p Presented at the Topical Meeting on Short Wavelength Coherent Radiation Generation and Applications, North Falmouth, MA, 26 Sep. 1988 Prepared in cooperation with International Business Machines Corp., Hopewell Junction, NY  
(Contract DE-AC03-76SF-00098; DE-AC02-76CH-00016)

(DE89-006707; LBL-26232; CONF-8809281-1) Avail: NTIS HC A02/MF A01

In this brief report we describe two recent X-ray microscopy experiments which demonstrate achievements of significant milestones in the development of high spatial resolution X-ray microscopy for the life and physical sciences. In one series of experiments it was clearly demonstrated that X-ray optical systems are capable of forming images of nanostructure patterns associated with future microelectronic devices, to a spatial resolution better than 0.1 microns. In the second set of experiments, unaltered biological material was imaged in its natural state without recourse to sectioning, staining, fixing or drying, at a spatial resolution well beyond that of the optical microscope, and with a delivered energy dose well below that of an electron microscope. DOE

**N89-21290\*#** California Univ., San Diego. Dept. of Biology.  
**LIMITATIONS ON K-T MASS EXTINCTION THEORIES BASED UPON THE VERTEBRATE RECORD**

J. DAVID ARCHIBALD and LAURIE J. BRYANT *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 4-5 1988 Prepared in cooperation with California Univ., Berkeley

Avail: NTIS HC A11/MF A01 CSCL 06B

Theories of extinction are only as good as the patterns of extinction that they purport to explain. Often such patterns are ignored. For the terminal Cretaceous events, different groups of organisms in different environments show different patterns of extinction that to date cannot be explained by a single causal mechanism. Several patterns of extinction (and/or preservational bias) can be observed for the various groups of vertebrates from the uppermost Cretaceous Hell Creek Formation and lower Paleocene Tullock Formation in eastern Montana. The taxonomic level at which the percentage of survivals (or extinctions) is calculated will have an effect upon the perception of faunal turnover. In addition to the better known mammals and better publicized dinosaurs, there are almost 60 additional species of reptiles, birds, amphibians, and fish in the HELL Creek Formation. Simple arithmetic suggests only 33 percent survival of these vertebrates from the Hell Creek Fm. into the Tullock Fm. A more critical examination of the data shows that almost all Hell Creek species not found in the Tullock are represented in one of the following categories; extremely rare forms, elasmobranch fish that underwent rapid speciation taxa that although not known or rare in the Tullock, are found elsewhere. Each of the categories is largely the result of the following biases: taphonomy, ecological differences, taxonomic artifact paleogeography. The two most important factors appear to be the possible taphonomic biases and the taxonomic artifacts. The extinction patterns among the vertebrates do not appear to be attributable to any single cause, catastrophic or otherwise. Author

**N89-21295\*#** California Univ., Berkeley. Marine Sciences Group.

**LATE WENLOCK (MIDDLE SILURIAN) BIO-EVENTS: CAUSED BY VOLATILE BOLOID IMPACT/S**

W. B. N. BERRY and P. WILDE *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 13-14 1988

Avail: NTIS HC A11/MF A01 CSCL 06B

Late Wenlockian (late mid-Silurian) life is characterized by three significant changes or bioevents: sudden development of massive carbonate reefs after a long interval of limited reef growth; sudden mass mortality among colonial zooplankton, graptolites; and origination of land plants with vascular tissue (Cooksonia). Both marine bioevents are short in duration and occur essentially simultaneously at the end of the Wenlock without any recorded major climatic change from the general global warm climate. These three disparate biologic events may be linked to sudden environmental change that could have resulted from sudden infusion of a massive amount of ammonia into the tropical ocean. Impact of a boloid or swarm of extraterrestrial bodies containing

## 51 LIFE SCIENCES (GENERAL)

substantial quantities of a volatile (ammonia) component could provide such an infusion. Major carbonate precipitation (formation), as seen in the reefs as well as, to a more limited extent, in certain brachiopods, would be favored by increased pH resulting from addition of a massive quantity of ammonia into the upper ocean. Because of the buffer capacity of the ocean and dilution effects, the pH would have returned soon to equilibrium. Major proliferation of massive reefs ceased at the same time. Addition of ammonia as fertilizer to terrestrial environments in the tropics would have created optimum environmental conditions for development of land plants with vascular, nutrient-conductive tissue. Fertilization of terrestrial environments thus seemingly preceded development of vascular tissue by a short time interval. Although no direct evidence of impact of a volatile boloid may be found, the bioevent evidence is suggestive that such an impact in the oceans could have taken place. Indeed, in the case of an ammonia boloid, evidence, such as that of the Late Wenlockian bioevents may be the only available data for impact of such a boloid. Author

**N89-21301\*#** Carpenter (Kenneth), Philadelphia, PA.

### **DINOSAUR BONE BEDS AND MASS MORTALITY: IMPLICATIONS FOR THE K-T EXTINCTION**

KENNETH CARPENTER *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 24-25 1988  
Avail: NTIS HC A11/MF A01 CSCL 06B

Mass accumulations of fossilized large terrestrial vertebrate skeletons (bone beds: BB) provide a test for K-T catastrophic extinction hypotheses. The two major factors contributing to BB formation are mode of death and sedimentation rate. Catastrophic mass mortality (CMM) is the sudden death of numerous individuals where species, age, health, gender, or social ranking offer no survivorship advantage. Noncatastrophic mass mortality (NCMM) occurs over time and is strongly influenced by species, age, or gender. In addition to cause of death, sedimentation rate is also important in BB formation. Models of BBs can be made. The CMM drops all individuals in their tracks, therefore, the BB should reflect the living population with respect to species, age, or gender. The NCMM results in monospecific BBs skewed in the direction of the less fit, usually the very young or very old, or towards a specific gender. The NCMM and AM BBs may become more similar the more spread out over time NCMM deaths occur because carcasses are widely scattered requiring hydraulic accumulation, and the greater time allows for more disarticulation and weathering. The CMM and NCMM BB appear to be dominated by social animals. Applying this and the characteristics of mortality patterns to the uppermost Cretaceous Hell Creek Formation indicates that only NCMM and AM BB occur. Furthermore, NCMM BB are rare in the upper third of the Hell Creek. Near the K-T boundary, only AM BB are known. The absence of CMM and NCMM BB appears to be real reflecting a decrease in population levels of some dinosaurs prior to the K-T event. The absence of CMM suggests that the K-T event did not lead to an instantaneous extinction of dinosaurs. Nor was there a protracted die-off due to an asteroid impact winter, because no NCMM BB are known at or near the K-T boundary. Author

**N89-21304\*#** Colorado Univ., Boulder. Dept. of Geology.

### **ORIGINATION, DIVERSITY, AND EXTINCTION METRICS ESSENTIAL FOR ANALYSIS OF MASS BIOTIC CRISIS EVENTS: AN EXAMPLE FROM CRETACEOUS AMMONOIDEA Abstract Only**

CHRISTOPHER J. COLLOM *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 30 1988  
Avail: NTIS HC A11/MF A01 CSCL 06B

Traditional mass extinction research has predominantly concentrated on statistically demonstrating that mass extinction intervals are significantly above background levels of familial and generic extinction in terms of extinction percentage, extinction rate, and per-taxon extinction rate; mass extinction intervals occur on a set periodicity throughout geologic time, which is estimated to be

some 30 MYR in duration. The published literature has given little emphasis to equally important considerations and metrics such as origination rate, standing diversity, and rate of generation of new taxa DURING mass extinction intervals. The extent to which a mass extinction affects the regional or global biota, must ultimately be gauged by taking into consideration both the number of taxa which become extinct at or near the event (stage) boundary, and the number of taxa which are either not affected at all by the extinction or actually evolved during or shortly before/after the extinction interval. These effects can be seen in Cretaceous Ammonoidea (at the genus level), and their combined usage allow better insight into paleobiological dynamics and responses to mass extinction and its affect on this dominant Molluscan organism. Author

**N89-21324\*#** Birmingham Univ. (England). Dept. of Geological Sciences.

### **THE END-TRIASSIC MASS EXTINCTION EVENT**

A. HALLAM *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 66-67 1988  
Avail: NTIS HC A11/MF A01 CSCL 06B

The end-Triassic is the least studied of the five major episodes of mass extinction recognized in the Phanerozoic, and the Triassic-Jurassic boundary is not precisely defined in most parts of the world, with a paucity of good marine sections and an insufficiency of biostratigraphically valuable fossils. Despite these limitations it is clear that there was a significant episode of mass extinction, affecting many groups, in the Late Norian and the existing facts are consistent with it having taken place at the very end of the period. The best record globally comes from marine strata. There was an almost complete turnover of ammonites across the T-J boundary, with perhaps no more than one genus surviving. About half the bivalve genera and most of the species went extinct, as did many archaeogastropods. Many Paleozoic-dominant brachiopods also disappeared, as did the last of the conodonts. There was a major collapse and disappearance of the Alpine calcareous sponge. Among terrestrial biota, a significant extinction event involving tetrapods was recognized. With regard to possible environmental events that may be postulated to account for the extinctions, there is no evidence of any significant global change of climate at this time. The existence of the large Manicouagan crater in Quebec, dated as about late or end-Triassic, has led to the suggestion that an impact event might be implicated, but so far despite intensive search no unequivocal iridium anomaly or shocked quartz was discovered. On the other hand there is strong evidence for significant marine regression in many parts of the world. It is proposed therefore that the likeliest cause of the marine extinctions is severe reduction in habitat area caused either by regression of epicontinental seas, subsequent widespread anoxia during the succeeding transgression, or a combination of the two. Author

**N89-21325\*#** Geological Inst., Oster Voldgade (Denmark).

### **DIACHRONISM BETWEEN EXTINCTION TIME OF TERRESTRIAL AND MARINE DINOSAURS**

H. J. HANSEN *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 2 1988  
Avail: NTIS HC A11/MF A01 CSCL 06B

The dinosaur eggs of southern France occur in continental, fine-grained red-beds, rich in carbonate. The last eggs in the region occur in the magnetic polarity interval 30 normal. Estimates of the accumulation rate of these sediments on the basis of the magneto-stratigraphy leads to placement of the time of disappearance of the dinosaurs in this region of 200,000 to 400,000 years earlier than the Cretaceous-Tertiary boundary. In the Red Deer Valley, Canada, estimates of average accumulation rate lead to a time of disappearance of the dinosaurs of 135,000 to 157,000 years earlier than the Cretaceous-Tertiary boundary. In the central part of Poland, in the Nasilow Quarry, the paleomagnetic pattern shows 7 m of chalk of reversed polarity containing in its upper part the marine Cretaceous-Tertiary biostratigraphic boundary. A

and the guinea pig ergometer model have been developed. The mouse track model was a ventilated S shaped exposure system. Performance was evaluated by two sublethal responses, distance traveled/time and incapacitation. A novel feature of the mouse track model was its ability to detect an early deterioration in performance before incapacitation and death. The guinea pig ergometer model was designed where a 4.9L exposure chamber enclosed a motor driven rubberized wheel. Extrapolation of exercising guinea pig data to human was similar to theoretical models that predict human response to CO. Humans were estimated to progress five times the distance of the guinea pig at a similar level of toxicity for CO. Author

**N89-20602\*#** Lockheed Engineering and Sciences Co., Washington, DC.

**USSR SPACE LIFE SCIENCES DIGEST, ISSUE 21**

LYDIA RAZRAN HOOKE, P. LYNN DONALDSON, VICTORIA GARSHNEK, and JOSEPH ROWE Washington NASA Mar. 1989 108 p

(Contract NASW-4292)

(NASA-CR-3922(24); NAS 1.26:3922(24)) Avail: NTIS HC A06/MF A01 CSCL 06C

This is the twenty-first issue of NASA's USSR Space Life Sciences Digest. It contains abstracts of 37 papers published in Russian language periodicals or books or presented at conferences and of a Soviet monograph on animal ontogeny in weightlessness. Selected abstracts are illustrated with figures and tables from the original. A book review of a work on adaptation to stress is also included. The abstracts in this issue have been identified as relevant to 25 areas of space biology and medicine. These areas are: adaptation, biological rhythms, body fluids, botany, cardiovascular and respiratory systems, cytology, developmental biology, endocrinology, enzymology, equipment and instrumentation, exobiology, gravitational biology, habitability and environmental effects, hematology, human performance, life support systems, mathematical modeling, metabolism, microbiology, musculoskeletal system, neurophysiology, operational medicine, perception, psychology, and reproductive system. Author

**N89-20603#** California Univ., Berkeley. Lawrence Berkeley Lab. Engineering Div.

**THE DEVELOPMENT OF A COMPTON LUNG DENSITOMETER**

BILLY W. LOO, FRED S. GOULDING, NORM W. MADDEN, and DANIEL S. SIMON (California Univ., San Francisco.) Nov. 1988 18 p Presented at the IEEE Nuclear Science Symposium, Orlando, FL, 9 Nov. 1988

(Contract DE-AC03-76SF-00098)

(DE89-006654; LBL-25170; CONF-881103-36) Avail: NTIS HC A03/MF A01

A field instrument is being developed for the non-invasive determination of absolute lung density using unique Compton backscattering techniques. A system consisting of a monoenergetic gamma-ray beam and a shielded high resolution high-purity-germanium (HPGe) detector in a close-coupled geometry is designed to minimize errors due to multiple scattering and uncontrollable attenuation in the chestwall. Results of studies on system performance with phantoms, the optimization of detectors, and the fabrication of a practical gamma-ray source are presented. DOE

**N89-20604#** California Univ., Berkeley. Lawrence Berkeley Lab. Accelerator and Fusion Research Div.

**X-RAY MICROSCOPY FOR THE LIFE AND PHYSICAL SCIENCES**

D. ATTWOOD, Y. VLADIMIRSKY, D. KERN, W. MEYER-ILSE, J. KIRZ, S. ROTHMAN, H. RARBACK, N. ISKANDER, K. MCQUAID, H. ADE (State Univ. of New York, Stony Brook.) et al. Jun. 1988 6 p Presented at the Topical Meeting on Short Wavelength Coherent Radiation Generation and Applications, North Falmouth, MA, 26 Sep. 1988 Prepared in cooperation with International Business Machines Corp., Hopewell Junction, NY (Contract DE-AC03-76SF-00098; DE-AC02-76CH-00016)

(DE89-006707; LBL-26232; CONF-8809281-1) Avail: NTIS HC A02/MF A01

In this brief report we describe two recent X-ray microscopy experiments which demonstrate achievements of significant milestones in the development of high spatial resolution X-ray microscopy for the life and physical sciences. In one series of experiments it was clearly demonstrated that X-ray optical systems are capable of forming images of nanostructure patterns associated with future microelectronic devices, to a spatial resolution better than 0.1 microns. In the second set of experiments, unaltered biological material was imaged in its natural state without recourse to sectioning, staining, fixing or drying, at a spatial resolution well beyond that of the optical microscope, and with a delivered energy dose well below that of an electron microscope. DOE

**N89-21290\*#** California Univ., San Diego. Dept. of Biology. **LIMITATIONS ON K-T MASS EXTINCTION THEORIES BASED UPON THE VERTEBRATE RECORD**

J. DAVID ARCHIBALD and LAURIE J. BRYANT *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 4-5 1988 Prepared in cooperation with California Univ., Berkeley

Avail: NTIS HC A11/MF A01 CSCL 06B

Theories of extinction are only as good as the patterns of extinction that they purport to explain. Often such patterns are ignored. For the terminal Cretaceous events, different groups of organisms in different environments show different patterns of extinction that to date cannot be explained by a single causal mechanism. Several patterns of extinction (and/or preservational bias) can be observed for the various groups of vertebrates from the uppermost Cretaceous Hell Creek Formation and lower Paleocene Tullock Formation in eastern Montana. The taxonomic level at which the percentage of survivals (or extinctions) is calculated will have an effect upon the perception of faunal turnover. In addition to the better known mammals and better publicized dinosaurs, there are almost 60 additional species of reptiles, birds, amphibians, and fish in the HELL Creek Formation. Simple arithmetic suggests only 33 percent survival of these vertebrates from the Hell Creek Fm. into the Tullock Fm. A more critical examination of the data shows that almost all Hell Creek species not found in the Tullock are represented in one of the following categories; extremely rare forms, elasmobranch fish that underwent rapid speciation taxa that although not known or rare in the Tullock, are found elsewhere. Each of the categories is largely the result of the following biases: taphonomy, ecological differences, taxonomic artifact paleogeography. The two most important factors appear to be the possible taphonomic biases and the taxonomic artifacts. The extinction patterns among the vertebrates do not appear to be attributable to any single cause, catastrophic or otherwise. Author

**N89-21295\*#** California Univ., Berkeley. Marine Sciences Group.

**LATE WENLOCK (MIDDLE SILURIAN) BIO-EVENTS: CAUSED BY VOLATILE BOLOID IMPACT/S**

W. B. N. BERRY and P. WILDE *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 13-14 1988

Avail: NTIS HC A11/MF A01 CSCL 06B

Late Wenlockian (late mid-Silurian) life is characterized by three significant changes or bioevents: sudden development of massive carbonate reefs after a long interval of limited reef growth; sudden mass mortality among colonial zooplankton, graptolites; and origination of land plants with vascular tissue (Cooksonia). Both marine bioevents are short in duration and occur essentially simultaneously at the end of the Wenlock without any recorded major climatic change from the general global warm climate. These three disparate biologic events may be linked to sudden environmental change that could have resulted from sudden infusion of a massive amount of ammonia into the tropical ocean. Impact of a boloid or swarm of extraterrestrial bodies containing

substantial quantities of a volatile (ammonia) component could provide such an infusion. Major carbonate precipitation (formation), as seen in the reefs as well as, to a more limited extent, in certain brachiopods, would be favored by increased pH resulting from addition of a massive quantity of ammonia into the upper ocean. Because of the buffer capacity of the ocean and dilution effects, the pH would have returned soon to equilibrium. Major proliferation of massive reefs ceased at the same time. Addition of ammonia as fertilizer to terrestrial environments in the tropics would have created optimum environmental conditions for development of land plants with vascular, nutrient-conductive tissue. Fertilization of terrestrial environments thus seemingly preceded development of vascular tissue by a short time interval. Although no direct evidence of impact of a volatile boloid may be found, the bioevent evidence is suggestive that such an impact in the oceans could have taken place. Indeed, in the case of an ammonia boloid, evidence, such as that of the Late Wenlockian bioevents may be the only available data for impact of such a boloid.

Author

**N89-21301\*#** Carpenter (Kenneth), Philadelphia, PA.

**DINOSAUR BONE BEDS AND MASS MORTALITY: IMPLICATIONS FOR THE K-T EXTINCTION**

KENNETH CARPENTER /in Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 24-25 1988  
 Avail: NTIS HC A11/MF A01 CSCL 06B

Mass accumulations of fossilized large terrestrial vertebrate skeletons (bone beds: BB) provide a test for K-T catastrophic extinction hypotheses. The two major factors contributing to BB formation are mode of death and sedimentation rate. Catastrophic mass mortality (CMM) is the sudden death of numerous individuals where species, age, health, gender, or social ranking offer no survivorship advantage. Noncatastrophic mass mortality (NCMM) occurs over time and is strongly influenced by species, age, or gender. In addition to cause of death, sedimentation rate is also important in BB formation. Models of BBs can be made. The CMM drops all individuals in their tracks, therefore, the BB should reflect the living population with respect to species, age, or gender. The NCMM results in monospecific BBs skewed in the direction of the less fit, usually the very young or very old, or towards a specific gender. The NCMM and AM BBs may become more similar the more spread out over time NCMM deaths occur because carcasses are widely scattered requiring hydraulic accumulation, and the greater time allows for more disarticulation and weathering. The CMM and NCMM BB appear to be dominated by social animals. Applying this and the characteristics of mortality patterns to the uppermost Cretaceous Hell Creek Formation indicates that only NCMM and AM BB occur. Furthermore, NCMM BB are rare in the upper third of the Hell Creek. Near the K-T boundary, only AM BB are known. The absence of CMM and NCMM BB appears to be real reflecting a decrease in population levels of some dinosaurs prior to the K-T event. The absence of CMM suggests that the K-T event did not lead to an instantaneous extinction of dinosaurs. Nor was there a protracted die-off due to an asteroid impact winter, because no NCMM BB are known at or near the K-T boundary.

Author

**N89-21304\*#** Colorado Univ., Boulder. Dept. of Geology.

**ORIGINATION, DIVERSITY, AND EXTINCTION METRICS ESSENTIAL FOR ANALYSIS OF MASS BIOTIC CRISIS EVENTS: AN EXAMPLE FROM CRETACEOUS AMMONOIDEA**  
**Abstract Only**

CHRISTOPHER J. COLLOM /in Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 30 1988  
 Avail: NTIS HC A11/MF A01 CSCL 06B

Traditional mass extinction research has predominantly concentrated on statistically demonstrating that mass extinction intervals are significantly above background levels of familial and generic extinction in terms of extinction percentage, extinction rate, and per-taxon extinction rate; mass extinction intervals occur on a set periodicity throughout geologic time, which is estimated to be

some 30 MYR in duration. The published literature has given little emphasis to equally important considerations and metrics such as origination rate, standing diversity, and rate of generation of new taxa DURING mass extinction intervals. The extent to which a mass extinction affects the regional or global biota, must ultimately be gauged by taking into consideration both the number of taxa which become extinct at or near the event (stage) boundary, and the number of taxa which are either not affected at all by the extinction or actually evolved during or shortly before/after the extinction interval. These effects can be seen in Cretaceous Ammonoidea (at the genus level), and their combined usage allow better insight into paleobiological dynamics and responses to mass extinction and its affect on this dominant Molluscan organism.

Author

**N89-21324\*#** Birmingham Univ. (England). Dept. of Geological Sciences.

**THE END-TRIASSIC MASS EXTINCTION EVENT**

A. HALLAM /in Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 66-67 1988  
 Avail: NTIS HC A11/MF A01 CSCL 06B

The end-Triassic is the least studied of the five major episodes of mass extinction recognized in the Phanerozoic, and the Triassic-Jurassic boundary is not precisely defined in most parts of the world, with a paucity of good marine sections and an insufficiency of biostratigraphically valuable fossils. Despite these limitations it is clear that there was a significant episode of mass extinction, affecting many groups, in the Late Norian and the existing facts are consistent with it having taken place at the very end of the period. The best record globally comes from marine strata. There was an almost complete turnover of ammonites across the T-J boundary, with perhaps no more than one genus surviving. About half the bivalve genera and most of the species went extinct, as did many archaeogastropods. Many Paleozoic-dominant brachiopods also disappeared, as did the last of the conodonts. There was a major collapse and disappearance of the Alpine calcareous sponge. Among terrestrial biota, a significant extinction event involving tetrapods was recognized. With regard to possible environmental events that may be postulated to account for the extinctions, there is no evidence of any significant global change of climate at this time. The existence of the large Manicouagan crater in Quebec, dated as about late or end-Triassic, has led to the suggestion that an impact event might be implicated, but so far despite intensive search no unequivocal iridium anomaly or shocked quartz was discovered. On the other hand there is strong evidence for significant marine regression in many parts of the world. It is proposed therefore that the likeliest cause of the marine extinctions is severe reduction in habitat area caused either by regression of epicontinental seas, subsequent widespread anoxia during the succeeding transgression, or a combination of the two.

Author

**N89-21325\*#** Geological Inst., Oster Voldgade (Denmark).

**DIACHRONISM BETWEEN EXTINCTION TIME OF TERRESTRIAL AND MARINE DINOSAURS**

H. J. HANSEN /in Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 2 1988  
 Avail: NTIS HC A11/MF A01 CSCL 06B

The dinosaur eggs of southern France occur in continental, fine-grained red-beds, rich in carbonate. The last eggs in the region occur in the magnetic polarity interval 30 normal. Estimates of the accumulation rate of these sediments on the basis of the magneto-stratigraphy leads to placement of the time of disappearance of the dinosaurs in this region of 200,000 to 400,000 years earlier than the Cretaceous-Tertiary boundary. In the Red Deer Valley, Canada, estimates of average accumulation rate lead to a time of disappearance of the dinosaurs of 135,000 to 157,000 years earlier than the Cretaceous-Tertiary boundary. In the central part of Poland, in the Nasilow Quarry, the paleomagnetic pattern shows 7 m of chalk of reversed polarity containing in its upper part the marine Cretaceous-Tertiary biostratigraphic boundary. A

greensand deposit contains numerous re-deposited Maastrichtian fossils. The fossils show no signs of wear and are of very different sizes including 1 mm thick juvenile belemnites. The deposit was described as a lag-sediment. Among the various fossils are teeth of mosasaurs. Thus there is coincidence in time between the extinction of mosasaurs and other Cretaceous organisms. This leads to the conclusion, that extinction of terrestrial dinosaurs took place earlier than extinction of marine dinosaurs at the Cretaceous-Tertiary boundary. Author

**N89-21329\*#** Washington State Univ., Pullman. Dept. of Geology.

**SELECTIVE EXTINCTION OF MARINE PLANKTON AT THE END OF THE MESOZOIC ERA: THE FOSSIL AND STABLE ISOTOPE RECORD Abstract Only**

Y. HERMAN and S. K. BHATTACHARYA *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 75 1988 Prepared in cooperation with Physical Research Lab., Ahmedabad (India)

Avail: NTIS HC A11/MF A01 CSCL 06B

Floral, faunal and stable isotope evidence in a continuous sequence of latest Cretaceous and earliest Tertiary shallow water marine deposits in the Mangyshlak Peninsula, USSR suggest severe environmental changes at the Cretaceous/Tertiary (K/T) boundary. Time frame is provided by nanno, micro and microfossils as well as by magnetic stratigraphy and an iridium spike. Oxygen isotopic analyses of the bulk sediments, composed of nanno and microplankton skeletal remains, show a sharp positive spike at the K/T boundary. This shift is primarily attributed to severe cooling possibly accompanied by increased salinities of the surface mixed layer. Floral and faunal extinctions were selective, affecting approximately 90 percent of the warm water calcareous phyto and zooplankton genera in the Tethyan-Paratethyan regions. These highly diverse taxa with many endemic representatives were at the peak of their evolutionary development. Geologic evidence indicates that the terminal Cretaceous temperature decline was coeval with widespread and intense volcanic activity which reached a peak at the close of the Mesozoic Era. Increased acidity temporarily prohibited calcite nucleation of the surface dwelling warm-water plankton. Superimposed upon decreased alkalinity, severe and rapid climatic changes caused the extinction of calcareous phyto and zooplankton. Author

**N89-21354\*#** Florida International Univ., Miami. Dept. of Geology.

**STEP-WISE EXTINCTIONS AT THE CRETACEOUS-TERTIARY BOUNDARY AND THEIR CLIMATIC IMPLICATIONS**

FLORENTIN J.-M. R. MAURRASSE *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 117 1988

Avail: NTIS HC A11/MF A01 CSCL 06B

A comparative study of planktonic foraminifera and radiolarian assemblages from the Cretaceous-Tertiary (K-T) boundary section of the Beloc Formation in the southern Peninsula of Haiti, and the lowermost Danian sequence of the Micara Formation in southern Cuba reveals a remarkable pattern of step-wise extinctions. This pattern is consistent in both places despite the widely different lithologies of the two formations. Because of a step-wise extinction and the delayed disappearance of taxa known to be more representative of cooler water realms, it is inferred that a cooling trend which characterized the close of the Maastrichtian and the onset of the Tertiary had the major adverse effect on the existing biota. Although repetitive lithologic and faunal fluctuations throughout the Maastrichtian sediments found at Deep Sea Drilling Project (DSDP) site 146/149 in the Caribbean Sea indicate variations reminiscent of known climatically induced cycles in the Cenozoic, rapid biotic succession appears to have taken place during a crisis period of a duration greater than 2 million years. Widespread and abundant volcanic activities recorded in the Caribbean area during the crisis period gives further credence

to earlier contention that intense volcanism may have played a major role in exacerbating pre-existing climatic conditions during that time. Author

**N89-21357\*#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Geological Sciences.

**EARTH ORBITAL VARIATIONS AND VERTEBRATE BIOEVOLUTION**

DEWEY M. MCLEAN *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 121 1988  
Avail: NTIS HC A11/MF A01 CSCL 06B

Cause of the Pleistocene-Holocene transition mammalian extinctions at the end of the last age is the subject of debate between those advocating human predation and climate change. Identification of an ambient air temperature (AAT)-uterine blood flow (UBF) coupling phenomenon supports climate change as a factor in the extinctions, and couples the extinctions to earth orbital variations that drive ice age climatology. The AAT-UBF phenomenon couples mammalian bioevolution directly to climate change via effects of environmental heat upon blood flow to the female uterus and damage to developing embryos. Extinctions were in progress during climatic warming before the Younger Dryas event, and after, at times when the AAT-UBF couple would have been operative; however, impact of a sudden short-term cooling on mammals in the process of adapting to smaller size and relatively larger S/V would have been severe. Variations in earth's orbit, and orbital forcing of atmospheric CO<sub>2</sub> concentrations, were causes of the succession of Pleistocene ice ages. Coincidence of mammalian extinctions with terminations of the more intense cold stages links mammalian bioevolution to variations in earth's orbit. Earth orbital variations are a driving source of vertebrate bioevolution. Author

**N89-21363\*#** Geological Survey, Denver, CO.

**PLANT MICROFOSSIL RECORD OF THE TERMINAL CRETACEOUS EVENT IN THE WESTERN UNITED STATES AND CANADA**

D. J. NICHOLS and R. F. FLEMING *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 130-131 1988

Avail: NTIS HC A11/MF A01 CSCL 06B

Plant microfossils, principally pollen grains and spores produced by land plants, provide an excellent record of the terminal Cretaceous event in nonmarine environments. The record indicates regional devastation of the latest Cretaceous vegetation with the extinction of many groups, followed by a recolonization of the earliest Tertiary land surface, and development of a permanently changed land flora. The regional variations in depositional environments, plant communities, and paleoclimates provide insight into the nature and effects of the event, which were short-lived but profound. The plant microfossil data support the hypothesis that an abruptly initiated, major ecological crisis occurred at the end of the Cretaceous. Disruption of the Late Cretaceous flora ultimately contributed to the rise of modern vegetation. The plant microfossils together with geochemical and mineralogical data are consistent with an extraterrestrial impact having been the cause of the terminal Cretaceous event. Author

**N89-21367\*#** California Univ., Los Angeles.

**PERMO-TRIASSIC VERTEBRATE EXTINCTIONS: A PROGRAM**

E. C. OLSON *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 137-138 1988

Avail: NTIS HC A11/MF A01 CSCL 06B

Since the time of the Authors' study on this subject, a great deal of new information has become available. Concepts of the nature of extinctions have changed materially. The Authors' conclusion that a catastrophic event was not responsible for the extinction of vertebrates has modified to the extent that hypotheses involving either the impact of a massive extra-terrestrial body or volcanism provide plausible but not currently fully testable



hypotheses. Stated changes resulted in a rapid decrease in organic diversity, as the ratio of origins of taxa to extinctions shifted from strongly positive to negative, with momentary equilibrium being reached at about the Permo-Triassic boundary. The proximate causes of the changes in the terrestrial biota appear to lie in two primary factors: (1) strong climatic changes (global mean temperatures, temperature ranges, humidity) and (2) susceptibility of the dominant vertebrates (large dicynodonts) and the glossopteris flora to disruption of the equilibrium of the world ecosystem. The following proximate causes have been proposed: (1) rhythmic fluctuations in solar radiation, (2) tectonic events as Pangea assembled, altering land-ocean relationships, patterns of wind and water circulation and continental physiography, (3) volcanism, and (4) changes subsequent to impacts of one or more massive extra terrestrial objects, bodies or comets. These hypotheses are discussed. Author

**N89-21380\*#** Geological Survey, Denver, CO.  
**LATE FRASNIAN MASS EXTINCTION: CONODONT EVENT STRATIGRAPHY, GLOBAL CHANGES, AND POSSIBLE CAUSES**

CHARLES A. SANDBERG, WILLI ZIEGLER, ROLAND DREESEN (INIEX, Liege, Belgium), and JAMIE L. BUTLER *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 160-161 1988  
 Avail: NTIS HC A11/MF A01 CSCL 06B

Several abrupt changes in conodont biofacies are documented to occur synchronously at six primary control sections across the Frasnian-Famennian boundary in Euramerica. These changes occurred within a time-span of only about 100,000 years near the end of the latest Frasnian linguiformis Zone, which is formally named to replace the Uppermost gigas Zone. The conodont-biofacies changes are interpreted to reflect a eustatic rise followed by an abrupt eustatic fall immediately preceding the late Frasnian mass extinction. Two new conodont species are named and described. *Ancyrognathus ubiquitous* n.sp. is recorded only just below and above the level of late Frasnian extinction and hence is a global marker for that event. *Palmatolepis praetriangularis* n.sp. is the long-sought Frasnian ancestor of the formerly cryptogenic species, *Pa. triangularis*, indicator of the earliest Famennian Lower triangularis Zone. The actual extinction event occurred entirely within the Frasnian and is interpreted to have been of brief duration—from as long as 20,000 years to as short as several days. The eustatic rise-and-fall couplet associated with the late Frasnian mass extinction is similar to eustatic couplets associated with the demise of most Frasnian (F2h) reefs worldwide about 1 m.y. earlier and with a latest Famennian mass extinction about 9.5 m.y. later. All these events may be directly or indirectly attributable to extraterrestrial triggering mechanisms. An impact of a small bolide or a near miss of a larger bolide may have caused the earlier demise of Frasnian reefs. An impact of possibly the same larger bolide in the Southern Hemisphere would explain the late Frasnian mass extinction. Global regression during the Famennian probably resulted from Southern-Hemisphere glaciation triggered by the latest Frasnian impact. Glaciation probably was the indirect cause of the latest Famennian mass extinction. Author

**N89-21385\*#** Chicago Univ., IL. Dept. of the Geophysical Sciences.

**PERIODICITY OF EXTINCTION: A 1988 UPDATE**

J. JOHN SEPKOWSKI, JR. *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 170-171 1988  
 Avail: NTIS HC A11/MF A01 CSCL 06B

The hypothesis that events of mass extinction recur periodically at approximately 26 my intervals is an empirical claim based on analysis of data from the fossil record. The hypothesis has become closely linked with catastrophism because several events in the periodic series are associated with evidence of extraterrestrial impacts, and terrestrial forcing mechanisms with long, periodic recurrences are not easily conceived. Astronomical mechanisms

that have been hypothesized include undetected solar companions and solar oscillation about the galactic plane, which induce comet showers and result in impacts on Earth at regular intervals. Because these mechanisms are speculative, they have been the subject of considerable controversy, as has the hypothesis of periodicity of extinction. In response to criticisms and uncertainties, a data base was developed on times of extinction of marine animal genera. A time series is given and analyzed with 49 sample points for the per-genus extinction rate from the Late Permian to the Recent. An unexpected pattern in the data is the uniformity of magnitude of many of the periodic extinction events. Observations suggest that the sequence of extinction events might be the result of two sets of mechanisms: a periodic forcing that normally induces only moderate amounts of extinction, and independent incidents or catastrophes that, when coincident with the periodic forcing, amplify its signal and produce major-mass extinctions. Author

**N89-21390\*#** Minnesota Univ., Minneapolis. Dept. of Geology and Geophysics.

**BIOSTRATIGRAPHIC CASE STUDIES OF SIX MAJOR EXTINCTIONS**

R. E. SLOAN *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 180-181 1988  
 Avail: NTIS HC A11/MF A01 CSCL 06B

Biostratigraphic case studies of six major extinctions show all are gradual save one, which is a catastrophic extinction of terrestrial origin. These extinctions show a continuum of environmental insults from major to minor. The major causes of these extinctions are positive and negative eustatic sea level changes, temperature, or ecological competition. Extraterrestrial causes should not be posited without positive association with a stratigraphically sharp extinction. The Cretaceous-Tertiary terrestrial extinction is considerably smaller in percentage of extinction than the marine extinction. The Cretaceous-Tertiary terrestrial extinction is considerably smaller in percentage of extinction than the marine Great Plains of the U.S. and Canada had become extinct in the 9 my before the late Maastrichtian sea level drop. The best data on the Permo-Triassic terrestrial extinction are from the Karoo basin of South Africa. This is a series of 6 extinctions in some 8 my, recorded in some 2800 meters of sediment. Precision of dating is enhanced by the high rate of accumulation of these sediments. Few data are readily available on the timing of the marine Permo-Triassic extinction, due to the very restricted number of sequences of Tatarian marine rocks. The terminal Ordovician extinction at 438 my is relatively rapid, taking place over about 0.5 my. The most significant aspect of this extinction is a eustatic sea level lowering associated with a major episode of glaciation. New data on this extinction is the reduction from 61 genera of trilobites in North America to 14, for a 77 percent extinction. Another Ordovician extinction present over 10 percent of the North American craton occurs at 454 my in the form of a catastrophic extinction due to a volcanic eruption which blanketed the U.S. east of the Transcontinental Arch. This is the only other sizeable extinction in the Ordovician. Author

**N89-21396\*#** Wesleyan Univ., Middletown, CT. Dept. of Earth and Environmental Sciences.

**MASS EXTINCTIONS IN THE DEEP SEA**

E. THOMAS *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 192-193 1988  
 Avail: NTIS HC A11/MF A01 CSCL 06B

The character of mass extinctions can be assessed by studying extinction patterns of organisms, the fabric of the extinction, and assessing the environmental niche and mode of life of survivors. Deep-sea benthic foraminifera have been listed as little affected by the Cretaceous-Tertiary (K-T) mass extinction, but very few quantitative data are available. New data on deep-sea Late Maastrichtian-Eocene benthic foraminifera from Maud Rise (Antarctica) indicate that about 10 percent of the species living at depths of 2000 to 2500 m had last appearances within 1 my of the Cretaceous-Tertiary (K-T) boundary, versus about 25 percent

of species at 1000 to 1500 m. Many survivors from the Cretaceous became extinct in a period of global deep-sea benthic foraminiferal extinction at the end of the Paleocene, a time otherwise marked by very few extinctions. Preliminary conclusions suggest that the deep oceanic environment is essentially decoupled from the shallow marine and terrestrial environment, and that even major disturbances of one of these will not greatly affect the other. This gives deep-sea benthic faunas a good opportunity to recolonize shallow environments from greater depths and vice versa after massive extinctions. The decoupling means that data on deep-sea benthic boundary was caused by the environmental effects of asteroid impact or excessive volcanism. The benthic foraminiferal data strongly suggest, however, that the environmental results were strongest at the Earth's surface, and that there was no major disturbance of the deep ocean; this pattern might result both from excessive volcanism and from an impact on land. Author

**N89-21404\*#** Washington Univ., Seattle. Dept. of Geological Sciences.

**MACROFOSSIL EXTINCTION PATTERNS AT BAY OF BISCAY CRETACEOUS-TERTIARY BOUNDARY SECTIONS**

PETER D. WARD and KENNETH MACLEOD *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 206-207 1988

Avail: NTIS HC A11/MF A01 CSCL 06B

Researchers examined several K-T boundary cores at Deep Sea Drilling Project (DSDP) core repositories to document biostratigraphic ranges of inoceramid shell fragments and prisms. As in land-based sections, prisms in the deep sea cores disappear well before the K-T boundary. Ammonites show a very different extinction pattern than do the inoceramids. A minimum of seven ammonite species have been collected from the last meter of Cretaceous strata in the Bay of Biscay basin. In three of the sections there is no marked drop in either species numbers or abundance prior to the K-T boundary Cretaceous strata; at the Zumaya section, however, both species richness and abundance drop in the last 20 m of the Cretaceous, with only a single ammonite specimen recovered to date from the uppermost 12 m of Cretaceous strata in this section. Researchers conclude that inoceramid bivalves and ammonites showed two different times and patterns of extinction, at least in the Bay of Biscay region. The inoceramids disappeared gradually during the Early Maestrichtian, and survived only into the earliest Late Maestrichtian. Ammonites, on the other hand, maintained relatively high species richness throughout the Maestrichtian, and then disappeared suddenly, either coincident with, or immediately before the microfossil extinction event marking the very end of the Cretaceous. Author

**N89-21406\*#** Alabama Univ., Birmingham. Dept. of Physics.

**HEAVY METAL TOXICITY AS A KILL MECHANISM IN IMPACT CAUSED MASS EXTINCTIONS**

T. J. WADOWIAK, S. A. DAVENPORT, D. D. JONES, and P. WADOWIAK (Wdowiak, P., Birmingham, AL) *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 209-210 1988

Avail: NTIS HC A11/MF A01 CSCL 06B

Heavy metals that are known to be toxic exist in carbonaceous chondrites at abundances considerably in excess to that of the terrestrial crust. An impactor of relatively undifferentiated cosmic matter would inject into the terrestrial environment large quantities of toxic elements. The abundances of toxic metals found in the Allende CV carbonaceous chondrite and the ratio of meteoritic abundance to crustal abundance are: Cr, 3630 PPM, 30X; Co, 662 PPM, 23X; ni, 13300 PPM, 134X; se, 8.2 PPM, 164X; Os, 0.828 PPM, 166X. The resulting areal density for global dispersal of impactor derived heavy metals and their dilution with terrestrial ejecta are important factors in the determination of the significance of impactor heavy metal toxicity as a kill mechanism in impact caused mass extinctions. A 10 km-diameter asteroid having a density of 3 gram per cu cm would yield a global areal density of

impact dispersed chondritic material of 3 kg per square meter. The present areal density of living matter on the terrestrial land surface is 1 kg per square meter. Dilution of impactor material with terrestrial ejecta is determined by energetics, with the mass of ejecta estimated to be in the range of 10 to 100 times that of the mass of the impactor. Because a pelagic impact would be the most likely case, the result would be a heavy metal rainout. Author

**N89-21412\*#** Rhode Island Univ., Narragansett. Graduate School of Oceanography.

**THE CRETACEOUS-TERTIARY BOUNDARY MARINE EXTINCTION AND GLOBAL PRIMARY PRODUCTIVITY COLLAPSE**

J. C. ZACHOS, M. A. ARTHUS, and W. E. DEAN *In* Lunar and Planetary Inst., Global Catastrophes in Earth History: An Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality p 221-222 1988 Prepared in cooperation with Geological Survey, Denver, CO

Avail: NTIS HC A11/MF A01 CSCL 06B

The extinction of marine phyto- and zoo-plankton across the K-T boundary has been well documented. Such an event may have resulted in decreased photosynthetic fixation of carbon in surface waters and a collapse of the food chain in the marine biosphere. Because the vertical and horizontal distribution of the carbon isotopic composition of total dissolved carbon (TDC) in the modern ocean is controlled by the transfer of organic carbon from the surface to deep reservoirs, it follows that a major disruption of the marine biosphere would have had a major effect on the distribution of carbon isotopes in the ocean. Negative carbon isotope excursions have been identified at many marine K-T boundary sequences worldwide and are interpreted as a signal of decreased oceanic primary productivity. However, the magnitude, duration and consequences of this productivity crisis have been poorly constrained. On the basis of planktonic and benthic calcareous microfossil carbon isotope and other geochemical data from DSDP Site 577 located on the Shatsky Rise in the north-central Pacific, as well as other sites, researchers have been able to provide a reasonable estimate of the duration and magnitude of this event. Author

**N89-21461#** Health Effects Research Lab., Research Triangle Park, NC.

**PULMONARY FUNCTION STUDIES IN THE RAT ADDRESSING CONCENTRATION VERSUS TIME RELATIONSHIPS OF OZONE (O3)**

D. L. COSTA, G. E. HATCH, J. HIGHFILL, M. A. STEVENS, and J. S. TEPPER Nov. 1988 13 p Prepared in cooperation with Northrop Services, Inc., Research Triangle Park, NC (PB89-129050; EPA/600/D-88/256) Avail: NTIS HC A03/MF A01 CSCL 06C

Recent data from human studies suggest that the current 1 hr National Ambient Air Quality Standard (NAAQS) for O3 may not be appropriate for exposures of several hours. Animal studies are being used to further investigate this issue. A polynomial model has been developed to depict lung injury from the interaction of O3 concentration (C) and exposure duration (T). The model was derived from lung fluid protein values in rats exposed in a matrix design to 0.1 to 0.8 ppm O3 for 2, 4, or 8 hrs. Airway dysfunction was correlated only at the highest CxT products. Rats, exposed to 0.5 or 0.8 ppm O3 for 2 or 7 hours with intermittent 8 percent CO2 to augment ventilation, were evaluated with static and dynamic lung function tests. Protein leakage into the airspace was also assessed. Although, the impact of T on O3 for 2 or 7 hours with intermittent 8 percent CO2 to augment ventilation, were evaluated with static and dynamic lung function tests. Protein leakage into the airspace was also assessed. Although, the impact of T on O3 toxicity appeared to be C-dependent, loss of function was not necessarily linear. Collectively, studies provide a preliminary basis for the evaluation of duration of exposure on the pulmonary response to O3. Author



## AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

A89-34019

**RESONANCE PHENOMENA IN EEG DURING PHOTOSTIMULATION WITH FLASHES OF VARYING FREQUENCY. I - ANALYSIS OF THE EFFECTS OF PHOTOSTIMULATION [REZONANSNYE IAVLENIIA V EEG PRI FOTOSTIMULIATSII C MENIAIUSHCHEISIA CHASTOTOI VSPYSHEK. I - ANALIZ EFJEKTOV FOTOSTIMULIATSII]**

A. T. BONDAR', A. I. FEDOTCHEV, and V. F. KONOVALOV (AN SSSR, Institut Biologicheskoi Fiziki, Pushchino, USSR) *Fiziologija Cheloveka* (ISSN 0131-1646), vol. 15, Jan.-Feb. 1989, p. 3-12. In Russian. refs

EEG patterns obtained on human subjects during photostimulation by flashes whose frequency was linearly increased from 1 to 15 Hz and then decreased to 1 Hz were analyzed, and the effects of photostimulation were correlated with individual features of the EEG patterns and with the sensations experienced by individual subjects during the flashing. It was found that light flashes induced the appearance in the EEG spectra of local density peaks which could be correlated with the frequency and the harmonics of the flashes. Correlations were also found between the background and the resonance EEG characteristics, as well as between the resonance effects and subjective estimations of time. I.S.

A89-34020

**CENTRAL HEMODYNAMICS OF HEALTHY HUMANS DURING A GRADUAL DECREASE OF CIRCULATING BLOOD VOLUME [TSENTRAL'NAIA GEMODINAMIKA ZDOROVOGO CHELOVEKA VO VREMIA DOZIROVANNOGO UMEN'SHENIIA OB'EMA TSIRKULIRUIUSHCHEI KROVI]**

V. E. KATKOV, V. V. CHESTUKHIN, V. V. RUMIANTSEV, E. M. NIKOLAENKO, and A. V. MASLENNIKOV *Fiziologija Cheloveka* (ISSN 0131-1646), vol. 15, Jan.-Feb. 1989, p. 75-80. In Russian. refs

The effects of gradual decreases of the circulating-blood volume (CBV) on the parameters of central blood circulation, acid-base balance, and blood oxygen were investigated in nine human subjects subjected to gradual (400 ml in 4-5 min) removals of arterial or venous blood. It was found that even small losses of blood induced a fall of venous pressure in the intrathorax region (the central venous pressure and pulmonary-artery pressure), which continued to decrease with increasing CBV loss. On the other hand, the parameters of acid-base balanced arterial oxygenation, the stroke volume, and the minute volume remained unchanged. A linear regression equation was derived for the relationship between the CBV on the one hand and the central venous pressure and the pulmonary-artery pressure on the other. I.S.

A89-34021

**ANALYSIS OF TEMPERATURE PATTERNS IN HUMANS [ANALIZ TEMPERATURNYKH PATTERNOV CHELOVEKA]**

F. F. SULTANOV, I. I. ERMAKOVA, A. G. GRIGOR'IAN, and I. M. MOMMADOV (AN TSSR, Institut Fiziologii i Eksperimental'noi Patologii Aridnoi Zony, Ashkhabad, Turkmen SSR; AN USSR, Institut Kibernetiki, Kiev, Ukrainian SSR) *Fiziologija Cheloveka* (ISSN 0131-1646), vol. 15, Jan.-Feb. 1989, p. 117-120. In Russian. refs

The method of Ermakov and Grigor'ian (1986) for plotting skin-temperature patterns (STPs) on a circular diagram was used to plot STPs of 47 subjects acclimated to temperatures of 21, 28, and 41 C at respective humidity values of 48, 49, and 30 percent, and the subjects' STPs were correlated with their thermoregulating reactions. Skin temperatures were measured at eight locations, including the forehead, trunk, shoulder, hand, and foot, as well as

two arm locations and two leg locations. The STP plots obtained at 28 C revealed individual differences among different subjects, making it possible to group the subjects into three types according to their STP pattern. Measurements at 41 C and under conditions of physical load resulted in characteristic STP changes, indicating that STP is a reliable index of temperature homeostasis and thermoregulatory ability. I.S.

A89-34441\* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**AIRCREW FATIGUE AND CIRCADIAN RHYTHMICITY**

R. CURTIS GRAEBER (NASA, Ames Research Center, Moffett Field, CA; U.S. Army, Medical Service Corps, Washington, DC) *IN: Human factors in aviation*. San Diego, CA, Academic Press, Inc., 1988, p. 305-344. refs

Recent statistical and experimental studies on the role of circadian rhythms in aircrew fatigue and aviation accidents are reviewed from a human-factors perspective, and typical data are presented in extensive graphs. Consideration is given to the biological clock and the limits of endurance, circadian desynchronization, sleep and sleepiness, short-haul and long-haul operational studies, and the potential advantages of cockpit automation. T.K.

A89-34999

**BLUNTED HYPOXIC VENTILATORY DRIVE IN SUBJECTS SUSCEPTIBLE TO HIGH-ALTITUDE PULMONARY EDEMA**

YUKINORI MATSUZAWA, KEISAKU FUJIMOTO, TOSHIO KOBAYASHI, NAMUSHI R. NAMUSHI, KAZURO HARADA (Shinshu University, Matsumoto, Japan) et al. *Journal of Applied Physiology* (ISSN 0161-7567), vol. 66, March 1989, p. 1152-1157. refs

The relationship between the susceptibility to high-altitude pulmonary edema (HAPE) and the blunted hypoxic ventilatory response (HVR) was investigated using the results of conventional pulmonary function test and HVR and hypercapnic ventilatory response (HCVR) tests performed on lowlanders with or without a previous history of HAPE. In the pulmonary function and HCVR tests, no significant differences were found between the two groups. On the other hand, in the HVR test, HAPE-susceptible subjects showed significantly lower HVR values than control subjects. I.S.

A89-35000\* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.

**CHANGES IN SIZE AND COMPLIANCE OF THE CALF AFTER 30 DAYS OF SIMULATED MICROGRAVITY**

VICTOR A. CONVERTINO, DONALD F. DOERR, and STEWART L. STEIN (NASA, Kennedy Space Center, Cocoa Beach, FL; Sunnyvale Medical Clinic, Radiology Dept., CA) *Journal of Applied Physiology* (ISSN 0161-7567), vol. 66, March 1989, p. 1509-1512. refs

The hypothesis that reducing muscle compartment by a long-term exposure to microgravity would cause increased leg venous compliance was tested in eight men who were assessed for vascular compliance and for serial circumferences of the calf before and after 30 days of continuous 6-deg head-down bed rest. It was found that head-down bed rest caused decreases in the calculated calf volume and the calf-muscle compartment, as well as increases in calf compliance. The percent increases in calf compliance correlated significantly with decreases in calf muscle compartment. I.S.

N89-20605# National Library of Medicine, Bethesda, MD.

**MEDICAL SUBJECT HEADINGS, TREE STRUCTURES, 1989**

Jul. 1988 521 p  
(PB89-100028; NLM/MED-89/02) Avail: NTIS HC A22/MF A01  
CSCL 06P

All Medical Subject Headings currently in use by the National Library of Medicine's indexers, catalogers, and searchers are arranged in a hierarchical manner showing relationships between broader and narrower terms. Included are minor and geographical descriptors. GRA

**N89-20606#** ICON Consultants, Birmingham, AL.  
**USING DEPTH RECOVERY IN HUMANS Final Report, Aug. 1987 - Jun. 1988**

THOMAS K. KUYK 7 Jul. 1988 61 p  
 (Contract F33615-87-C-0541)  
 (AD-A201278; AAMRL-TR-88-035) Avail: NTIS HC A04/MF A01  
 CSCL 23C

This program investigated the relevant information content contained in a physiologically based model of the human visual system with regard to the efficient extraction of depth through stereopsis. A computational system was developed using the Gabor representational scheme to model the spatial weighting functions of simple and complex cells known to exist in primate visual cortex. The algorithm was implemented in a foveated representation produced by a complex-logarithmic, conformal mapping of each image yielding the advantage of both high resolution and a wide field-of-view. The algorithm was tested by extracting depth arrays from random-dot stereograms. The results demonstrated that the depth mapping was accurate and in excellent agreement with the percept produced when human observers fused the same stereo images. The significance of this approach is that it models not a visual system but rather an experimentally verified model of the primate visual system. This is critical to the effective application of human information processing techniques to specialized or intelligent image processing systems. GRA

**N89-20607#** Iowa Univ., Iowa City. Dept. of Physical Therapy Education.

**INFLUENCES OF MUSCLE FIBER COMPOSITION AND STRENGTH ON EMG (ELECTROMYOGRAPHIC ACTIVITY), SPINAL MOTION AND LOAD ACCELERATION DURING A REPETITIVE LIFTING TASK**

THOMAS MICHAEL COOK and GARY L. SODERBERG May 1988 81 p  
 (Contract PHS-OH-01929)  
 (PB89-131221) Avail: NTIS HC A05/MF A01 CSCL 06P

The changes which occur over time in the erector spinae muscles of the lower back in the instantaneous fatigue state were studied in relation to the selected kinematic and kinetic features of lifting. The influences of muscle fiber composition and lifting strength on changes in electromyographic activity (EMG), spinal motion, and load acceleration during this time period were investigated. A total of 24 male volunteers participated in the study. A great deal of variability was noted in regard to EMG amplitude and EMG center frequency from the L3 erector spinae musculature in regard to the range of motion of the lumbar segment, and in regard to the maximum vertical acceleration applied to the load being lifted. A significant relationship was noted between the EMG amplitude and EMG center frequency trends during repetitive lifting but not among these EMG measures and trunk range of motion, maximum load acceleration, height, or weight. A significant relationship was noted between lifting strength of the subject and the amount of trunk range of motion at the beginning of the lifting session and to the height and weight of the subject. Finally, significant relations were noted between muscle fiber composition and the maximum vertical acceleration applied to the load at the beginning of the lifting session. Author

**N89-20608#** International Centre for Theoretical Physics, Trieste (Italy).

**PROPAGATION OF THE NERVE IMPULSE UNDER THE EFFECT OF A MAGNETIC FIELD**

J. CHELA-FLORES, E. M. EL-SAYED, and X. Y. WANG Sep. 1988 18 p Submitted for publication  
 (DE88-705371; IC-88/323) Avail: NTIS (US Sales Only) HC A03/MF A01

The recent significant advance in superconductivity at high temperatures has raised an important problem in biophysics, in view of the underlying interest that has arisen in experiments in which very high magnetic fields are needed (in the multi-tesla range). This is occurring against a theoretical background in which there is no reliable way of estimating the effect of magnetic fields on the central nervous system. This has led us to discuss the

problem of the coupling of magnetic fields with the coherent propagation of the polarization of the plasma membrane along the axon. Our work lies within the context of the phenomenological model of nerve impulse propagation due to Hodgkin and Huxley. Using the concept of gauge invariance we find that the magnetic field has a non negligible effect on the velocity of propagation of the action potential in the limit of the Fitzhugh-Nagumo equation without recovery, but more realistic cases do not change the main conclusions of this work. DOE

**N89-20609#** Defence Research Establishment Ottawa, (Ontario).

**WHY COLD-WET MAKES ONE FEEL CHILLED: A LITERATURE REVIEW**

RITA M. CROW Jun. 1988 16 p  
 (AD-A203452; DREO-TN-88-22) Avail: NTIS HC A03/MF A01  
 CSCL 06J

This paper reviews physiological experiments which have been carried out to determine if heat loss from the body is greater in cold-wet temperatures and humidities. It also reviews the effect of solar radiation the interaction of skin and humidity and skin and temperature and other postulations for the cold-wet sensation. It concludes that the best explanation for the chilling effect of cold-wet is the penetration of fine experiments would be needed to confirm this. GRA

**N89-21462#** Tulsa Univ., OK. Dept. of Psychology.  
**BEHAVIORAL EFFECTS OF MICROWAVES: RELATIONSHIP OF TOTAL DOSE AND DOSE RATE**

MARY ELLEN OCONNOR and ROBERT STRATTAN Oct. 1988 67 p  
 (Contract EPA-68-02-4120)  
 (PB89-118640; EPA/600/1-88/005) Avail: NTIS HC A04/MF A01 CSCL 06R

The goal of the research was to compare the relationship of whole body averaged specific absorption rate (SAR) and specific absorption (SA) to determine whether dose rate or dose was the better predictor of biological effects. Sperm positive Long-Evans female rats were exposed to 2450 MHz CW microwave radiation for 1 to 3 hours at approximately 10 W/kg. The maternal subjects were then observed for natural delivery of their litters. Sensitivity to thermally induced seizures and huddling were studied in the offspring. Analyses revealed that there were no statistically significant differences between exposed and control offspring on the behavioral indices. The behavior did not appear to be affected by prenatal exposure to microwave radiation at this level. The huddle sizes became smaller as the pups aged both in exposed and control offspring. GRA

**N89-21463\*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

**SACCADIC EYE MOVEMENT DURING SPACEFLIGHT**

JOHN J. URI, BARRY J. LINDER, THOMAS P. MOORE (Methodist Hospital, Indianapolis, IN.), SAM L. POOL, and WILLIAM E. THORNTON Apr. 1989 13 p  
 (NASA-TM-100475; S-592; NAS 1.15:100475) Avail: NTIS HC A03/MF A01 CSCL 06P

Saccadic eye movements were studied in six subjects during two Space Shuttle missions. Reaction time, peak velocity and accuracy of horizontal, visually-guided saccades were examined preflight, inflight and postflight. Conventional electro-oculography was used to record eye position, with the subjects responding to pseudo-randomly illuminated targets at 0 deg and + or - 10 deg and 20 deg visual angles. In all subjects, preflight measurements were within normal limits. Reaction time was significantly increased inflight, while peak velocity was significantly decreased. A tendency toward a greater proportion of hypometric saccades inflight was also noted. Possible explanations for these changes and possible correlations with space motion sickness are discussed. Author

**N89-21464#** Texas Univ., Galveston. Dept. of Physiology and Biophysics.

**GATING KINETICS AND ION TRANSFER IN CHANNELS OF NERVE MEMBRANE Annual Report, Nov. 1987 - Nov. 1988**

HARVEY M. FISHMAN 9 Nov. 1988 13 p

(Contract N00014-87-K-0055; RR04108)

(AD-A202509) Avail: NTIS HC A03/MF A01 CSCL 06D

Whether the kinetics and thermodynamics of electric-field initiated alteration of nerve membrane to the conduction of specific ions through ion channels (gating) can be validly described by linear, equilibrium models will be determined by examining the time reversal properties of ion channel current fluctuations. The kinetics of gated channels derived from analysis of stochastic current fluctuations and those derived from linear macroscopic determinations (membrane complex admittance determinations) will be compared to ascertain whether the assumed relationship exists. GRA

**N89-21465#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**LMS ADAPTIVE FILTERING APPLIED TO A MICROWAVE ARTERIAL PULSE MONITOR M.S. Thesis**

BRIAN J. SIMES Dec. 1988 118 p

(AD-A202732; AFIT/GE/ENG/88D-45) Avail: NTIS HC A06/MF A01 CSCL 06L

A prototype microwave arterial pulse monitor was evaluated and modified. Evaluation test data was collected from the temporal region of human volunteers using the microwave arterial pulse monitor. Three sets of test signals were developed using this test data. These test signals were used to evaluate the feasibility of using a LMS adaptive noise cancellation filter for reduction of noise artifacts observed in the output of the microwave arterial pulse monitor. A computer program using the LMS algorithm was written and the performance of the LMS filter was evaluated for its effectiveness in removing the unwanted noise. A system model describing the performance characteristics of the test subject-monitor-filter interface is presented. GRA

**N89-21466#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**A STUDY OF MOTION SICKNESS: MATHEMATICAL MODELING AND DATA ANALYSIS M.S. Thesis**

MARK F. SCOTT Dec. 1988 106 p

(AD-A202770; AFIT/GEO/ENG/88D-4) Avail: NTIS HC A06/MF A01 CSCL 06J

Male test subjects were given the drug phenytoin in a double blind, placebo controlled crossover experiment. They were then rotated in a motion chair while eleven of their physiological parameters were measured. The drug appeared to delay or even prevent the evolution of motion sickness, depending on the test subject. Barron Associates' Abductive Reasoning Mechanism software was used to develop new motion sickness models. The biophysiological data collected in 1988 were analyzed for trends; several were found. GRA

**N89-21467#** Texas Univ. Health Science Center, San Antonio. Dept. of Radiology.

**EFFECTS OF SIMULTANEOUS RADIOFREQUENCY RADIATION AND CHEMICAL EXPOSURE OF MAMMALIAN CELLS, VOLUME 2 Final Report, 2 Jan. 1984 - 31 Dec. 1986**

MARTIN L. MELTZ, VICTOR CIARAVINO, JAMES J. KERBACHER, and PHYLLIS EAGAN Jul. 1988 84 p

(Contract F33615-84-C-0604)

(AD-A202780; USAFSAM-TR-87-32-VOL-2) Avail: NTIS HC A05/MF A01 CSCL 06G

A circulating water-bath exposure system has been designed for in vitro radiofrequency radiation (RFR) exposure studies in the 915 to 2450 MHz range. A continuously rotating Styrofoam float, holding ten T-25 tissue culture flasks, averages out field heterogeneity and allows mixing in the medium in the flasks. The presence of cells in the exposure flask (as attached monolayer or cell suspension) did not result in an SAR different from that measured in the medium without cells present. We have posed

two hypotheses relative to the mutagenic activity of RFR: (1) that RFR by itself is genotoxic to mammalian cells in vitro; and (2) that a simultaneous exposure of mammalian cells to RFR during treatment with a genotoxic chemical will result in an alteration of the genotoxic activity of the chemical alone. RFR exposure alone (at moderate power levels which resulted in a temperature increase in the cell culture medium of no more than 3 C) is not mutagenic. During simultaneous treatment, the RFR does not affect either the inhibition of cell growth or the extent of mutagenesis resulting from the chemical treatment alone. The same two hypotheses were explored for induction of sister chromatid exchanges (SCEs) and chromosome aberrations in Chinese hamster ovary cells which were similarly exposed to RFR and chemicals. The chemicals studied for SCE induction were mitomycin C (MMC) and Adriamycin. GRA

**N89-21468#** Smith-Kettlewell Inst. of Visual Sciences, San Francisco, CA.

**PSYCHOPHYSICAL STUDIES OF VISUAL CORTICAL FUNCTIONS Final Technical Report, 1 Sep. 1985 - 31 Aug. 1988**

KEN NAKAYAMA 20 Oct. 1988 6 p

(Contract AF-AFOSR-0320-83; AF PROJ. 2313)

(AD-A202814; AFOSR-88-1226TR) Avail: NTIS HC A02/MF A01 CSCL 05H

Our research continues to study two primary areas. First is the area of visual attention where we have shown that there are both transient and sustained components. In contrast to the sustained component, we find that the transient component is much more powerful, is short lasting, is relatively independent of volition and finally, is also independent of the stimulus that elicits it. Thus, it is a genuine attentional effect not tied directly to the sensory stimulus but is probably operative relatively early in visual cortical processing, particularly in relation to the sustained component. We have also shown that the latency of this transient component is reduced by the prior removal of a stimulus fixation mark. Such a finding provides strong support for the view that express saccadic eye movements (seen under similar conditions) are mediated by rapid shifts of attention. Second, we have been studying issues related to partial visibility. In particular, we examine how the visual system deals with occlusion. Our results indicate that the occlusive relations of surfaces have widespread effects in vision, influencing color, motion, transparency and depth. GRA

**N89-21469#** Oregon Univ., Eugene. Dept. of Computer and Information Science.

**RECONSTRUCTION OF BINOCULAR DEPTH ACROSS CONTINUOUS SURFACES**

KENT A. STEVENS and ALLEN BROOKES 14 Dec. 1988 55 p

(Contract N00014-87-K-0321; RR042)

(AD-A202827) Avail: NTIS HC A04/MF A01 CSCL 06D

This technical report consists of two publications. The first will appear in the Journal of Experimental Psychology: Human Perception and Performance in 1989. This article examines the perception of depth in random dot surface versus volume stimuli, and shows that depth associated with a continuous surface is subject to reconstruction artifacts, where equivalent random-dot volume stimuli are used as a control. The second article has been submitted for publication. This article explores the analogy between the reconstruction of stereoscopic depth and the reconstruction of brightness. The analogy holds for a number of classical simultaneous contrast effects. Dissimilarities are found, however, in terms of the lateral inhibition effects traditionally attributed to underlying spatial-differentiation operators. GRA

**N89-21470#** Kings Coll., London (England). Dept. of Physics.

**ACCURATE DETERMINATION OF THE COMPLEX PERMITTIVITY OF BIOLOGICAL TISSUE AROUND 35 GHZ Final Report, 15 Mar. 1984 - 14 Mar. 1986**

RODNEY J. SHEPPARD Sep. 1988 53 p

(Contract AF-AFOSR-0097-84; AF PROJ. 2312)  
(AD-A202907; USAFSAM-TR-87-13) Avail: NTIS HC A04/MF  
A01 CSDL 06G

Apparatus is described which enables the complex permittivity of liquids and solid tissue to be measured at a frequency of 35 GHz. The results are presented on various rabbit tissues, including muscle, fat, skin, brain tissues, and eye lens; and some phantom tissue equivalent materials have been devised. Various liquids have been measured, including rabbit blood, water, and saline. The results have been examined for any evidence of an anomalous/resonant behavior, but none was found. GRA

**N89-21471#** Mayo Clinic, Rochester, MN.  
**G-INDUCED LOSS OF CONSCIOUSNESS AND ITS  
PREVENTION Final Report, Jan. 1942 - Jan. 1988**

EARL H. WOOD Sep. 1988 54 p  
(Contract N66001-87-C-0079; AF PROJ. 7930)  
(AD-A202960; USAFSAM-TR-87-41) Avail: NTIS HC A04/MF  
A01 CSDL 06J

The current capabilities of trained individuals to maintain clear vision during sustained exposures to 9 Gz, an increase in protected G tolerance of about 4 G over World War II fighter pilots, is a result of combined use of a G suit and very effective self-protective straining maneuvers such as the M-1, L-1 and pressure breathing, all of which are variants of the Valsalva maneuver developed in the 1940s. However, more than ten fatal crashes attributed to acceleration induced loss of consciousness (GLOC) have occurred in recent years. The most plausible causes are: (1) increased capability of jet-powered fighters to sustain, with minimal pilot effort, accelerations in the 7 to 10 Gz range for periods longer than the symptom-free 3 to 8 second cerebral ischemic anoxic period which precedes GLOC, (2) an improperly performed Valsalva-type straining maneuver, and (3) development of a hypotensive vasovagal type reaction. A foolproof GLOC warning system such as detection of zero arterial pulsations at ear level to activate an automatic plane control takeover system could avoid most GLOC crashes. However, an omni-directional surveillance fighter plane cockpit for a fully horizontal position, preferable prone, is the only certain way to eliminate GLOC and to achieve the probable tactical advantages of sustained combat maneuvering in the 9 to 15 Gz range. GRA

**N89-21472#** Rochester Univ., NY. Center for Visual Science.  
**PERIPHERAL LIMITATIONS ON SPATIAL VISION Final  
Report, 1 Dec. 1984 - 31 May 1988**

DAVID R. WILLIAMS 6 Oct. 1988 16 p  
(Contract AF-AFOSR-0019-85; AF PROJ. 2313)  
(AD-A203388; AFOSR-88-1335TR) Avail: NTIS HC A02/MF A01  
CSDL 06D

This project employed psychophysical techniques to examine the limitation on spatial vision imposed by the first stages in the visual pathway. All the experiments capitalized on the use of laser interferometry, which allows sinusoidal gratings to be formed on an observer's retina that are immune to optical blurring. Comparisons of contrast sensitivity to such gratings with contrast sensitivity to gratings viewed under normal conditions provides an estimate of the modulation transfer function of the eye's optics. In addition, the appearance of very high frequency gratings is distorted, or aliased, by the cone mosaic. Such moire patterns provide the basis for a number of psychophysical techniques to assess the topography of the cone mosaic in the living eye. These measurements, accompanied by measurements of visual acuity for interference fringes clarify the relationship between cone spacing and resolution. Resolution was also measured under conditions in which only the M or L cones could detect the interference fringe. Visual acuity was little different than it was when both cone types detected the grating, showing that resolution is immune to photoreceptor loss under these circumstances. GRA

**N89-21473#** Massachusetts Inst. of Tech., Cambridge. Artificial Intelligence Lab.  
**SEEING GHOST SOLUTIONS IN STEREO VISION**

DAPHNA WEINSHALL Sep. 1988 14 p Prepared in cooperation with Whitaker Coll., MA  
(Contract N00014-85-K-0124; DACA76-85-C-0010)  
(AD-A203581; AI-M-1073; CBIP-33) Avail: NTIS HC A03/MF  
A01 CSDL 06D

A unique matching is a stated objective of most computational theories of stereo vision. This report describes situations where humans perceive a small number of surfaces carried by non-unique matching of random dot patterns, although a unique solution exists and is observed unambiguously in the perception of isolated features. We find both cases where non-unique matchings compete and suppress each other and cases where they are all perceived as transparent surfaces. The circumstances under which each behavior occurs are discussed and a possible explanation is sketched. It appears that matching reduces many false targets to a few, but may still yield multiple solutions in some cases through a (possibly different) process of surface interpolation. GRA

**N89-21474#** Navy Personnel Research and Development Center, San Diego, CA.

**BRAIN ACTIVITY DURING TACTICAL DECISION-MAKING.  
PART 5: A CROSS-STUDY VALIDATION OF EVOKED  
POTENTIALS AS INDICES OF WORKLOAD**

LEONARD J. TREJO, GREGORY W. LEWIS, and MARK H. BLANKENSHIP Oct. 1988 17 p  
(AD-A203763; NPRDC-TN-89-7) Avail: NTIS HC A03/MF A01  
CSDL 05H

The results of such tests can predict academic performance reasonably well but are less effective in predicting on-job performance. In an attempt to better understand the human as an integrator and decision maker in operating systems, event-related potentials (ERPs) have been employed to assess individual brain processes and their relationship to differences in on-job performance and decision making. The purpose of this report is to demonstrate a cross-study validation of the use of ERPs as indices of cognitive workload. The first study found that certain ERP amplitude measures decreased by about 40 percent as workload increased from baseline to active participation in an anti-air warfare situation (AIRDEF). The study was conducted in the summer of 1985 with group of 30 U.S. Marines stationed at the Naval Air Station, North Island, San Diego. The basic design of the experiment consisted of a single-task condition in which subjects performed an anti-air warfare simulation (AIRDEF) task under three progressively higher levels of difficulty. ERPs were recorded to a visual stimulus that was presented on the same monitor as the higher levels of difficulty. ERPs were recorded to a visual stimulus that was presented on the same monitor as the simulation, but this stimulus had no task relevance. GRA

**N89-21475\*** National Aeronautics and Space Administration, Washington, DC.

**AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING  
BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 321)**

Mar. 1989 54 p  
(NASA-SP-7011(321); NAS 1.21:7011(321)) Avail: NTIS HC A04;  
NTIS standing order as PB89-912300, \$10.50 domestic, \$21.00  
foreign CSDL 06E

This bibliography lists 137 reports, articles, and other documents introduced into the NASA scientific and technical information system in February 1989. Author

**N89-21476\*** National Aeronautics and Space Administration, Washington, DC.

**AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING  
BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 322)**

Apr. 1989 62 p  
(NASA-SP-7011(322); NAS 1.21:7011(322)) Avail: NTIS HC A04;  
NTIS standing order as PB89-912300, \$10.50 domestic, \$21.00  
foreign CSDL 06E

This bibliography lists 163 reports, articles, and other documents introduced into the NASA scientific and technical information system in March 1989. Author

## BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

**A89-34435**

**THE HUMAN SENSES IN FLIGHT**

HERSCHEL W. LEIBOWITZ (Pennsylvania State University, University Park) IN: Human factors in aviation. San Diego, CA, Academic Press, Inc., 1988, p. 83-110. refs

Sensory-perception problems in aircraft operation are reviewed from a human-factors perspective. Topics examined include limitations on human vision under flight conditions, anatomical and functional approaches to vision, the rod and cone cells of the human retina, dual processing modes for visual information, nighttime landing accidents, spatial disorientation and motion sickness, and the perception of motion. It is argued that pilots need to be rigorously trained to ignore visual and vestibular sensations in situations where they are known to provide erroneous information. T.K.

**A89-34436\*** Illinois Univ., Champaign.

**INFORMATION PROCESSING**

CHRISTOPHER D. WICKENS and JOHN M. FLACH (Illinois, University, Champaign) IN: Human factors in aviation. San Diego, CA, Academic Press, Inc., 1988, p. 111-155. refs (Contract NAG2-308)

Theoretical models of sensory-information processing by the human brain are reviewed from a human-factors perspective, with a focus on their implications for aircraft and avionics design. The topics addressed include perception (signal detection and selection), linguistic factors in perception (context provision, logical reversals, absence of cues, and order reversals), mental models, and working and long-term memory. Particular attention is given to decision-making problems such as situation assessment, decision formulation, decision quality, selection of action, the speed-accuracy tradeoff, stimulus-response compatibility, stimulus sequencing, dual-task performance, task difficulty and structure, and factors affecting multiple task performance (processing modalities, codes, and stages). T.K.

**A89-34437\*** Battelle Memorial Inst., Seattle.

**HUMAN WORKLOAD IN AVIATION**

BARRY H. KANTOWITZ (Battelle Memorial Institute, Seattle, WA) and PATRICIA A. CASPER (Purdue University, West Lafayette, IN) IN: Human factors in aviation. San Diego, CA, Academic Press, Inc., 1988, p. 157-187. refs (Contract NCC2-228)

The application of human-factors analysis techniques to the evaluation of aircraft-crew workloads is discussed in an introductory overview. Consideration is given to the importance of workload for safety, crew size, automation, and certification; the definition and measurement of workload, physical vs mental workloads, subjective ratings, secondary tasks, biocybernetic measures, and attention and workload. Recent studies of pilot and ATC workloads are reviewed, and typical data are presented in graphs. Future trends are discussed, and it is predicted that increased cockpit automation will eventually require new methods to maintain operator attention rather than reduce workload. T.K.

**A89-34438\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**GROUP INTERACTION AND FLIGHT CREW PERFORMANCE**

H. CLAYTON FOUSHEE (NASA, Ames Research Center, Moffett Field, CA) and ROBERT L. HELMREICH (Texas, University, Austin) IN: Human factors in aviation. San Diego, CA, Academic Press, Inc., 1988, p. 189-227. refs

The application of human-factors analysis to the performance of aircraft-operation tasks by the crew as a group is discussed in an introductory review and illustrated with anecdotal material.

Topics addressed include the function of a group in the operational environment, the classification of group performance factors (input, process, and output parameters), input variables and the flight crew process, and the effect of process variables on performance. Consideration is given to aviation safety issues, techniques for altering group norms, ways of increasing crew effort and coordination, and the optimization of group composition. T.K.

**A89-34439**

**FLIGHT TRAINING AND SIMULATION**

PAUL W. CARO (Seville Training Systems, Inc., Irving, TX) IN: Human factors in aviation. San Diego, CA, Academic Press, Inc., 1988, p. 229-261. refs

Human-factors aspects of pilot flight and simulator training are discussed in an introductory review. The history of simulator design is traced; changes in the position of the FAA vis a vis simulator training are recalled; and factors influencing the learning process are considered, including cues, discriminations, generalizations, the degree of realism, and mediation. The stages and procedures involved in the development of a training program are described and illustrated with a flow chart, and consideration is given to problems in the selection and training of instructors, quality control of the training process, embedded training and testing, training in the management of cockpit resources, the individualization of training, and the application of artificial intelligence. T.K.

**A89-34440\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**HUMAN ERROR IN AVIATION OPERATIONS**

DAVID C. NAGEL (NASA, Ames Research Center, Moffett Field, CA) IN: Human factors in aviation. San Diego, CA, Academic Press, Inc., 1988, p. 263-303. refs

The role of human error in commercial and general aviation accidents and the techniques used to evaluate it are reviewed from a human-factors perspective. Topics addressed include the general decline in accidents per million departures since the 1960s, the increase in the proportion of accidents due to human error, methods for studying error, theoretical error models, and the design of error-resistant systems. Consideration is given to information acquisition and processing errors, visually guided flight, disorientation, instrument-assisted guidance, communication errors, decision errors, debiasing, and action errors. T.K.

**A89-34660**

**BINOCULAR UNMASKING - AN ANALOG TO BINAURAL UNMASKING?**

BRUCE SCHNEIDER, GIAMPAOLO MORAGLIA, and ALLAN JEPSON (Toronto, University, Mississauga, Canada) Science (ISSN 0036-8075), vol. 243, March 17, 1989, p. 1479-1481. Research supported by NSERC. refs

A visual analog to binaural unmasking was explored. The observer's task was to detect, under stereoscopic viewing conditions, an apertured sinusoidal grating added to a square patch of visual noise. In the experimental condition, the square patch of noise was presented within a frame such that the right-eye noise was a shifted version of the left-eye noise. Because of the disparity in the noise images, subjects perceived, under stereoscopic viewing conditions, that the noise patch was located behind the frame. When sinusoidal signals were added to this noise patch, the signals were clearly more detectable when the signal disparity was zero than when the signal disparity equaled that of the noise patch, demonstrating the existence of visual unmasking. Hence, under appropriate circumstances, binocular processing, in addition to providing information about depth, can also enhance the detectability of visual pattern. Author

**A89-34833**

**PROCESSING DEMANDS, EFFORT, AND INDIVIDUAL DIFFERENCES IN FOUR DIFFERENT VIGILANCE TASKS**

HARRY S. KOELEGA, JAN-ALBERT BRINKMAN, LOEK HENDRIKS, and MARINUS N. VERBATEN (Utrecht, Rijksuniversiteit, Netherlands) Human Factors (ISSN 0018-7208), vol. 31, Feb. 1989, p. 45-62. refs

In an attempt to specify the limiting conditions of the taxonomy of vigilance tasks, four tasks differing in memory load and in stimuli employed (sensory or cognitive) were compared. Electrodermal activity and subjective measures were used to determine the investment of effort. The data show that vigilance level and vigilance decrement dissociate. The level seems to relate to effort demand and investment. Tasks employing unfamiliar stimuli showed a decline in sensitivity; cognitive tasks employing alphanumeric stimuli did not. Principal components analyses suggest that measures of speed and accuracy may reflect relatively independent systems. Subjective data showed that good performers expend more effort in difficult and complex tasks. Effortful processing seems to prevent rather than induce a decline in efficiency.

Author

**A89-34834**

**VISUAL ACCOMMODATION AND TARGET DETECTION IN THE VICINITY OF A WINDOW POST**

JENNY CHONG and THOMAS J. TRIGGS (Monash University, Clayton, Australia) *Human Factors* (ISSN 0018-7208), vol. 31, Feb. 1989, p. 63-75. refs

The effects of an intervening post on the visual accommodation and detection of a driver or pilot are examined. When subjects focused toward a distance by looking through a large aperture in an intervening post, the detection of a target was significantly better than when no aperture was present. Target detection performance decreased with decreasing aperture size. Detection accuracy changed significantly only with marked changes in visual accommodation. Interference to target detection was observed for targets occurring at a laterally proximal position to the intervening object.

R.B.

**A89-34835**

**SIMULATOR DESIGN AND INSTRUCTIONAL FEATURES FOR AIR-TO-GROUND ATTACK - A TRANSFER STUDY**

GAVAN LINTERN (Illinois, University, Savoy), DANIEL J. SHEPPARD, DONNA L. PARKER, KAREN E. YATES, and MARGARET D. NOLAN (Essex Corp., Orlando, FL) *Human Factors* (ISSN 0018-7208), vol. 31, Feb. 1989, p. 87-99. Research supported by the U.S. Navy. refs

Results are presented from a transfer experiment to define simulator design requirements and instructional procedures for an air-to-ground attack trainer. Two levels of scene detail, three levels of field of view, and three levels of simulator training trials were manipulated. It is found that the most substantial transfer gains were produced by the first 24 training trials, with little additional benefit from further training. No evidence was found of differential transfer from different simulator conditions. The results suggest that physical fidelity is not a requirement for positive transfer and that a concept such as psychological fidelity or functional equivalence is needed.

R.B.

**N89-20610\* #** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**PRECISION IN THE PERCEPTION OF DIRECTION OF A MOVING PATTERN**

LELAND S. STONE Dec. 1988 21 p (NASA-TM-101080; A-89062; NAS 1.15:101080) Avail: NTIS HC A03/MF A01 CSCL 05I

The precision of the model of pattern motion analysis put forth by Adelson and Movshon (1982) who proposed that humans determine the direction of a moving plaid (the sum of two sinusoidal gratings of different orientations) in two steps is qualitatively examined. The velocities of the grating components are first estimated, then combined using the intersection of constraints to determine the velocity of the plaid as a whole. Under the additional assumption that the noise sources for the component velocities are independent, an approximate expression can be derived for the precision in plaid direction as a function of the precision in the speed and direction of the components. Monte Carlo simulations verify that the expression is valid to within 5 percent over the natural range of the parameters. The expression is then used to predict human performance based on available estimates

of human precision in the judgment of single component speed. Human performance is predicted to deteriorate by a factor of 3 as half the angle between the wavefronts (theta) decreases from 60 to 30 deg, but actual performance does not. The mean direction discrimination for three human observers was 4.3 plus or minus 0.9 deg (SD) for theta = 60 deg and 5.9 plus or minus 1.2 for theta = 30 deg. This discrepancy can be resolved in two ways. If the noises in the internal representations of the component speeds are smaller than the available estimates or if these noises are not independent, then the psychophysical results are consistent with the Adelson-Movshon hypothesis.

Author

**N89-20611#** Institute for Perception RVO-TNO, Soesterberg (Netherlands). Afdeling Cognitive Psychologie.

**COGNITIVE PSYCHOLOGY AT THE INSTITUTE FOR PERCEPTION**

A. F. SANDERS Dec. 1987 44 p In DUTCH; ENGLISH summary (IZF-1987-41; TDCK-88-0288; ETN-89-94065) Avail: NTIS HC A03/MF A01

Cognitive psychology research since the 1960's is reviewed. Research on generating random sequences and internal models is recalled. Imagery, associational knowledge networks, learning functional rules, and subjective probabilities involved in decision making are discussed. This last theme can be further classified as research on gambling, decision heuristics, risk taking in traffic, and decision making in complex command and control systems. Research on internal models in ship maneuvering is mentioned.

ESA

**N89-20612#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Interactive Systems.

**THE POWER OF PHYSICAL REPRESENTATIONS**

VAROL AKMAN and PAUL J. W. TENHAGEN May 1988 26 p Presented at the 2nd Eurographics Workshop on Intelligent CAD Systems: Implementational Issues, Veldhoven, Netherlands, 11-15 Apr. 1988 (CWI-CS-R8819; B8827443; ETN-89-94176) Avail: NTIS HC A03/MF A01

It is argued that common sense reasoning about the physical world as exemplified by, iron sinks in water, or if a ball is dropped it gains speed, will be indispensable in future programs. To make such predictions (envisioning), programs should use abstract entities (such as the gravitational field), principles (such as the principle of superposition), and laws (such as the conservation of energy) of physics for representation and reasoning.

ESA

**N89-20613#** Illinois Univ., Savoy. Aviation Research Lab.

**COMPONENTIAL ANALYSIS OF PILOT DECISION MAKING**

**Final Report, Jun. 1986 - Sep. 1987**

CHRISTOPHER D. WICKENS, ALAN STOKES, BARBARA BARNETT, and TOM DAVIS, JR. Aug. 1988 94 p (Contract F33615-85-D-0514) (AD-A203711; AAMRL-TR-88-017) Avail: NTIS HC A05/MF A01 CSCL 05H

This report describes the development of a computerized pilot decision-making simulator/trainer known as MIDIS, and its utilization as a research tool in the validation of an information-processing model of pilot decision making. Efforts in this project followed two parallel but interacting tracks: development of decision scenarios for the MIDIS program, following the sequence of a realistic IFR flight, and compilation of a cognitive test battery, based on an information processing model of decision making, and designed to assess individual differences in those cognitive attributes determined to be important in effective decision making. Subjects consisted of thirty eight instrument rated pilots subdivided into two groups on the basis of reported hours of flight experience. The experiment consisted of four parts: administration - of the cognitive test battery, pre-flight planning, a practice flight, and the actual MIDIS run. Subjects were scored as to the optimality and latency of their choices, and their rated confidence. The results indicated that low and high experienced pilots did not differ from each other in terms of their judgement



performance, but that high experience pilots expressed slightly greater confidence in their decisions. The two groups however did differ in terms of what problem variables degraded decision performance, and what individual abilities affected that performance. In particular, novice decision performance was partially predicted by information processing tests related to spatial abilities, working memory capacity, mathematical ability and by tests of declarative knowledge. GRA

**N89-21477\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**HELICOPTER FLIGHTS WITH NIGHT-VISION GOGGLES: HUMAN FACTORS ASPECTS**

MICHAEL S. BRICKNER Mar. 1989 38 p  
(NASA-TM-101039; A-88305; NAS 1.15:101039) Avail: NTIS HC A03/MF A01 CSCL 05I

Night-vision goggles (NVGs) and, in particular, the advanced, helmet-mounted Aviators Night-Vision-Imaging System (ANVIS) allows helicopter pilots to perform low-level flight at night. It consists of light intensifier tubes which amplify low-intensity ambient illumination (star and moon light) and an optical system which together produce a bright image of the scene. However, these NVGs do not turn night into day, and, while they may often provide significant advantages over unaided night flight, they may also result in visual fatigue, high workload, and safety hazards. These problems reflect both system limitations and human-factors issues. A brief description of the technical characteristics of NVGs and of human night-vision capabilities is followed by a description and analysis of specific perceptual problems which occur with the use of NVGs in flight. Some of the issues addressed include: limitations imposed by a restricted field of view; problems related to binocular rivalry; the consequences of inappropriate focusing of the eye; the effects of ambient illumination levels and of various types of terrain on image quality; difficulties in distance and slope estimation; effects of dazzling; and visual fatigue and superimposed symbology. These issues are described and analyzed in terms of their possible consequences on helicopter pilot performance. The additional influence of individual differences among pilots is emphasized. Thermal imaging systems (forward looking infrared (FLIR)) are described briefly and compared to light intensifier systems (NVGs). Many of the phenomena which are described are not readily understood. More research is required to better understand the human-factors problems created by the use of NVGs and other night-vision aids, to enhance system design, and to improve training methods and simulation techniques. Author

**N89-21478#** Yale Univ., New Haven, CT.  
**COPING WITH NOVELTY AND HUMAN INTELLIGENCE: THE ROLE OF COUNTERFACTUAL REASONING Final Report**  
ROBERT J. STERNBERG 1988 123 p  
(Contract N00014-85-K-0589)  
(AD-A203624) Avail: NTIS HC A06/MF A01 CSCL 05H

This Final Report is divided into four main sections. In the first section, a subset of the empirical research done with my collaborators under the contract is described in detail. Rather than attempt to describe every study, selected studies are described in detail. These studies show some of the range of work accomplished during the contract. In the second section, a list of the publications is presented that have ensued from 1985 to 1988, as well as publications that are in press. These are the years during which the contract was held. In the third section, presentations are listed which were given during the years of the contract. And in the fourth and final section, the final budgetary accounting for the contract is given. GRA

**MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT**

Includes human engineering; biotechnology; and space suits and protective clothing.

**A89-34388**  
**GETTING A GRIP ON SPACE**

RAY SPANGENBURG and DIANE MOSER Ad Astra (ISSN 1041-102X), vol. 1, March 1989, p. 31-34.

The development of gloves for EVA on the Space Station is discussed. The gloves used in the various space missions are described, noting the problems associated with their designs. The problems of flexibility, tactility, fabric selection, and the effects of pressure are considered. R.B.

**A89-34431\*** Miami Univ., Coral Gables, FL.

**HUMAN FACTORS IN AVIATION**

EARL L. WIENER, ED. (Miami University, Coral Gables, FL) and DAVID C. NAGEL, ED. (NASA, Ames Research Center, Moffett Field, CA) San Diego, CA, Academic Press, Inc., 1988, 704 p. For individual items see A89-34432 to A89-34450.

The fundamental principles of human-factors (HF) analysis for aviation applications are examined in a collection of reviews by leading experts, with an emphasis on recent developments. The aim is to provide information and guidance to the aviation community outside the HF field itself. Topics addressed include the systems approach to HF, system safety considerations, the human senses in flight, information processing, aviation workloads, group interaction and crew performance, flight training and simulation, human error in aviation operations, and aircrew fatigue and circadian rhythms. Also discussed are pilot control; aviation displays; cockpit automation; HF aspects of software interfaces; the design and integration of cockpit-crew systems; and HF issues for airline pilots, general aviation, helicopters, and ATC. T.K.

**A89-34432**  
**INTRODUCTORY OVERVIEW**

ELWYN EDWARDS IN: Human factors in aviation. San Diego, CA, Academic Press, Inc., 1988, p. 3-25. refs

The history, basic principles, and techniques of human-factors (HF) analysis or ergonomics for aviation applications are reviewed. Consideration is given to studies of aircraft safety and crew stress before and during World War II, the formal definition of HF, the SHEL (software, hardware, environment, and liveware) model of HF analysis, primary areas of HF concern, and operator skill and error. Also provided is a survey of the current status of HF research. T.K.

**A89-34433**  
**THE SYSTEM PERSPECTIVE**

THOMAS B. SHERIDAN (MIT, Cambridge, MA) IN: Human factors in aviation. San Diego, CA, Academic Press, Inc., 1988, p. 27-51. refs

The application of systems theory to aviation human-factors analyses is discussed in an introductory overview. Topics addressed include small- and large-scale problems (pilot control of an aircraft vs the U.S. National Airspace System), aircraft production as a system, system definition and representation, and the advantages of a systems approach. Consideration is given to the history of systems analysis; current practices; goals, decision, and control; and supervisory control of systems. Extensive diagrams and flow charts are provided. T.K.

**A89-34434**  
**SYSTEM SAFETY**

C. O. MILLER (System Safety, Inc., McLean, VA) IN: Human factors in aviation. San Diego, CA, Academic Press, Inc., 1988, p. 53-80. refs

The application of human-factors analysis to safety problems in aviation is discussed in an introductory overview. Topics addressed include the definition of system safety, the history of safety studies, the relationship of human factors to system safety, the roles of the FAA and DOD in establishing safety standards, the safety goals of MIL-STD-882B, hazard analysis, and the differences between hazard and reliability analyses. Goals for future research are identified, with an emphasis on the need to consider behavioral, medical, operational, task-specific, equipment-design, and environmental factors. T.K.

A89-34442

**PILOT CONTROL**

SHELDON BARON (BBN Laboratories, Inc., Cambridge, MA) IN: Human factors in aviation. San Diego, CA, Academic Press, Inc., 1988, p. 347-385. refs

The application of human-factors analysis methods to the aircraft-control problem is described in an introductory review and illustrated with diagrams and graphs. The emphasis is on the closed-loop control tasks imposing the highest workload on the pilot. Sections are devoted to the basic nature of the problem, analysis methods, factors affecting human control performance, the characteristics of the human controller, the measurement of human control performance, models of the pilot-vehicle system, the changes introduced by technological advances, and human-factors engineering considerations in advanced control. T.K.

A89-34445

**SOFTWARE INTERFACES FOR AVIATION SYSTEMS**

ROBERT C. WILLIGES, BEVERLY H. WILLIGES (Virginia Polytechnic Institute and State University, Blacksburg), and ROBERT G. FAINTER (Arizona State University, Tempe) IN: Human factors in aviation. San Diego, CA, Academic Press, Inc., 1988, p. 463-493. refs

The application of human-factors analysis to the design of aircraft-control and ATC software is discussed in an introductory overview and illustrated with tables and flow charts. The fundamental issues are listed and explained, including intersystem data compatibility, consistency, demands on user memory, structure, feedback, workload, and individualization. Software design guidelines are then given for data entry, display, and management; action control; feedback and user guidance; error management; data protection; language definition; and communication between users. Also discussed are the stages of the general software-development process, the complexities of flight-management software (real-time capability, concurrency, and fault tolerance), and the specific procedures involved in the development of human-computer software interfaces. T.K.

A89-34447

**AIRLINE PILOTS' PERSPECTIVE**

RICHARD B. STONE (Delta Air Lines, Inc., Atlanta, GA) and GARY L. BABCOCK (United Airlines, Inc., Chicago, IL) IN: Human factors in aviation. San Diego, CA, Academic Press, Inc., 1988, p. 529-560. refs

The current working conditions for commercial aircraft pilots are surveyed, with an emphasis on cockpit design and human-factors engineering issues. The history of cockpit instrumentation since World War I is recalled; the evolution of FAA work rules for pilots is traced; recent studies of pilot safety and health issues are summarized; and current airports, approach charts, navigation aids, ATC systems, and weather services are briefly characterized. Also considered are the selection and certification of pilots, pilot-airline relations, techniques for minimizing pilot errors, simulation and flight training methods, and planned or potential improvements (TCAS, MLS, advanced head-up displays, extension of twin-engine operations, increased automation, and side-stick controllers). T.K.

A89-34449\* National Aeronautics and Space Administration, Ames Research Center, Moffett Field, CA.

**HELICOPTER HUMAN FACTORS**

SANDRA G. HART (NASA, Ames Research Center, Moffett Field, CA) IN: Human factors in aviation. San Diego, CA, Academic Press, Inc., 1988, p. 591-638. refs

The state-of-the-art helicopter and its pilot are examined using the tools of human-factors analysis. The significant role of human error in helicopter accidents is discussed; the history of human-factors research on helicopters is briefly traced; the typical flight tasks are described; and the noise, vibration, and temperature conditions typical of modern military helicopters are characterized. Also considered are helicopter controls, cockpit instruments and displays, and the impact of cockpit design on pilot workload. Particular attention is given to possible advanced-technology improvements, such as control stabilization and augmentation, FBW and fly-by-light systems, multifunction displays, night-vision goggles, pilot night-vision systems, night-vision displays with superimposed symbols, target acquisition and designation systems, and aural displays. Diagrams, drawings, and photographs are provided. T.K.

A89-34832

**MODELING THE COGNITIVE CONTENT OF DISPLAYS**

RICHARD A. CHECHILE, REBECCA N. FLEISCHMAN, ANN MARIE SASSEVILLE (Tufts University, Medford, MA), and ROBERT G. EGGLESTON (USAF, Wright-Patterson AFB, OH) Human Factors (ISSN 0018-7208), vol. 31, Feb. 1989, p. 31-43. refs (Contract F33615-82-C-0513)

A method for measuring the cognitive complexity of visual displays is applied to a dynamic display of avionic information. Two interrelated knowledge systems, world and display knowledge, are modeled with a semantic network formalism. Orthogonal predictor measures of cognitive complexity are derived from the networks. Simulations are conducted, focusing on three dependent variables: the maximum probability of threat in the mission, the mission failure rate, and the time in a threat condition. The results suggest that a model of cognitive complexity based on a semantic network formalism may be used to quantitatively evaluate the quality of competing display format concepts. R.B.

A89-35844

**OBOGS FOR JAPANESE NEW INTERMEDIATE JET TRAINER T-4**

NORIO TODA (Japan Defense Agency, Air Development Dept., Tokyo), MORIO IDO (Kawasaki Heavy Industry, Ltd., Japan), and MICHIO ETOH (Tokyo Aircraft Instrument Co., Ltd., Komae, Japan) SAFE Journal, vol. 19, Spring 1989, p. 42-49.

The onboard oxygen generating system (OBOGS) developed for Japan's new intermediate jet trainer, the T-4, is described. The designs of the system's four units, namely, the concentrator; the regulator-oxygen, front; the regulator-oxygen, rear; and the backup oxygen system, are examined. The technical problems faced during the early stages of the development of the OBOGS's subsystems and the problems of successful integration of the new components and subsystems into one working OBOGS are discussed in detail. The OBOGS completed, trouble-free, 1250 hours of service flights aboard the T-4 aircraft, demonstrating the reliability of the system. A block diagram of the OBOGS and design diagrams of its four compositing units are included. I.S.

N89-20614# Army Aeromedical Research Lab., Fort Rucker, AL.

**SPH-4 HELMET RETENTION ASSEMBLY REINFORCEMENT Final Report**

RONALD W. PALMER and J. L. HALEY, JR. Jul. 1988 23 p (AD-A200432; USAARL-88-10) Avail: NTIS HC A02/MF A01 CSDL 05H

The purpose of a helmet's retention assembly is to keep the helmet firmly and securely in place on the wearer's head, thus preventing the exposure of the cranium to direct impact. The standard SPH-4 retention assembly is prone to excessive elongation under stress, and allows excessive helmet displacement and cranium exposure. A modified SPH-4 retention assembly, reinforced with 0.75-inch tubular nylon webbing; was manufactured in this laboratory and tested quasi-statically on a testing machine



## 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

which exerted a force at a constant speed. A standard SPH-4 retention assembly was also tested as a control. The reinforced retention assembly withstood a 450-lb load without failure. Elongation of the reinforced retention assembly, measured at 300-lb load, was almost 50 percent less than that of the standard retention assembly measured at the same load. GRA

**N89-20615\*#** George Washington Univ., Washington, DC. Science Communication Studies.

### **NUTRITIONAL MODELS FOR A CONTROLLED ECOLOGICAL LIFE SUPPORT SYSTEM (CELSS): LINEAR MATHEMATICAL MODELING**

ROSE C. WADE NASA Mar. 1989 135 p  
(Contract NASW-3165; NASW-4324)  
(NASA-CR-4229; NAS 1.26:4229) Avail: NTIS HC A07/MF A01  
CSCL 06K

The NASA Controlled Ecological Life Support System (CELSS) Program is involved in developing a biogenerative life support system that will supply food, air, and water to space crews on long-duration missions. An important part of this effort is in development of the knowledge and technological capability of producing and processing foods to provide optimal diets for space crews. This involves such interrelated factors as determination of the diet, based on knowledge of nutrient needs of humans and adjustments in those needs that may be required as a result of the conditions of long-duration space flight; determination of the optimal mixture of crops required to provide nutrients at levels that are sufficient but not excessive or toxic; and consideration of the critical issues of spacecraft space and power limitations, which impose a phytomass minimization requirement. The complex interactions among these factors are examined with the goal of supplying a diet that will satisfy human needs while minimizing the total phytomass requirement. The approach taken was to collect plant nutritional composition and phytomass production data, identify human nutritional needs and estimate the adjustments to the nutrient requirements likely to result from space flight, and then to generate mathematical models from these data. Author

**N89-20616#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.

### **DIRECT MANIPULATION AND OTHER STYLES OF MAN-MACHINE INTERACTION**

J. M. VERSENDAAL 1988 18 p  
(REPT-88-53; ISSN-0920-8577; ETN-89-94020) Avail: NTIS HC A03/MF A01

The direct manipulation (DM) approach to user-computer interaction, where the user directly manipulates the object presented on the screen is discussed. It is shown that DM is quite complex with respect to conventional dialog styles. Direct manipulation is actually a highly interwoven question/answer dialog style. Feedback in DM is often more complex than feedback in conventional dialog styles; syntactic feedback and semantic feedback in DM systems are often mixed. As a consequence it is more difficult to describe DM systems than to describe systems based on other dialog styles. Modeling a DM system by separating the syntactic and semantic aspects of the system is not possible. Modeling the design process of DM systems is possible using an object-oriented approach which can be used in information system modeling as well. Once an object-oriented conceptual model is specified for a certain DM system, this model can be part of the run time of the DM system. ESA

**N89-20617#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.

### **USER INTERFACES AND HIGHLY INTERACTIVE SYSTEMS: SURVEY OF CURRENT RESEARCH**

J. M. VERSENDAAL 1988 33 p  
(REPT-88-60; ISSN-0920-8577; ETN-89-94026) Avail: NTIS HC A03/MF A01

The state of the art in highly interactive system design, particularly in design of user-computer dialogs, is reviewed. Methodologies for interactive system design are described.

Management systems for user interfaces and interactive applications are discussed. The object oriented approach for user interface and interactive system design is outlined. ESA

**N89-20618#** Institute for Perception RVO-TNO, Soesterberg (Netherlands). Afdeling Thermofysiologie.

### **SAFE WORKING TIME LIMITS IN IMPERMEABLE PROTECTIVE CLOTHING: RECOMMENDATIONS BASED UPON EXPERIMENTAL MEASUREMENTS**

F. J. G. VANDELINDE Oct. 1987 35 p In DUTCH; ENGLISH summary  
(Contract A81/K/041)  
(IZF-1987-28; TDCK-87-4844; ETN-89-94064) Avail: NTIS HC A03/MF A01

Safe working time limits in water vapor impermeable protective clothing are calculated for young, well-trained men. The approach is largely empirical. The equations used are simple, and can easily be incorporated in a hand held computer. They offer the possibility for implementation of auxiliary cooling, and alterations of the thermal state of the body prior to work. Literature data is applied to extend the predictions to different ages, gender, and fitness. Decontamination work, previously determined to be moderately heavy, can generally be carried out for over 2 hr at ambient temperatures of 15 C and lower. At higher environmental or metabolic load, individual factors play an important role in the individual's capacity to work in impermeable clothing, and may limit the individual tolerance to less than 30 min. ESA

**N89-21479\*#** Pittsburgh Univ., PA. Dept. of Electrical Engineering.

### **COMPUTER SIMULATION OF A PILOT IN V/STOL AIRCRAFT CONTROL LOOPS Final Report**

WILLIAM G. VOGT, MARLIN H. MICKLE, MARK E. ZIPF, and SENOL KUCUK 31 Jan. 1989 447 p  
(Contract NAG3-729)  
(NASA-CR-184815; NAS 1.26:184815) Avail: NTIS HC A19/MF A01 CSCL 05H

The objective was to develop a computerized adaptive pilot model for the computer model of the research aircraft, the Harrier II AV-8B V/STOL with special emphasis on propulsion control. In fact, two versions of the adaptive pilot are given. The first, simply called the Adaptive Control Model (ACM) of a pilot includes a parameter estimation algorithm for the parameters of the aircraft and an adaption scheme based on the root locus of the poles of the pilot controlled aircraft. The second, called the Optimal Control Model of the pilot (OCM), includes an adaption algorithm and an optimal control algorithm. These computer simulations were developed as a part of the ongoing research program in pilot model simulation supported by NASA Lewis from April 1, 1985 to August 30, 1986 under NASA Grant NAG 3-606 and from September 1, 1986 through November 30, 1988 under NASA Grant NAG 3-729. Once installed, these pilot models permitted the computer simulation of the pilot model to close all of the control loops normally closed by a pilot actually manipulating the control variables. The current version of this has permitted a baseline comparison of various qualitative and quantitative performance indices for propulsion control, the control loops and the work load on the pilot. Actual data for an aircraft flown by a human pilot furnished by NASA was compared to the outputs furnished by the computerized pilot and found to be favorable. Author

**N89-21480#** Lawrence Livermore National Lab., CA.

### **REVIEW AND ANALYSIS OF THE LITERATURE IN THE AREA OF HUMAN PERFORMANCE MODELING**

HILARY D. BURTON, JANICE BUTLER, WILLIAM W. BANKS, and THOMAS E. BERGHAGE (RMC International, San Diego, CA.) Nov. 1988 141 p  
(Contract W-7405-ENG-48)  
(DE89-006800; UCID-21558) Avail: NTIS HC A07/MF A01

The following review of the literature in the area of human performance modeling was compiled in conjunction with work sponsored by the U.S. Naval Health Research Center, San Diego, California, on the application of human performance data in

wargaming models and simulation. The results were obtained by searching a number of on-line retrieval systems, downloading the data, and processing it using software developed by the Technology Information Systems Program. Databases which were searched included PsycINFO (American Psychological Association), Compendex (Engineering Index), Inspec (Institute of Electrical Engineers), NTIS (National Technical Information Service), DROLS (Department of Defense), NASA-Recon (National Aeronautics and Space Administration), Science Citation Index (Institute for Scientific Information), Conference Papers Index (Cambridge Scientific Abstracts), and a number of other databases which produced no retrieval results. Those citations identified as part of the PsycINFO databases are reprinted with permission of the American Psychological Association, publisher of Psychological abstracts and the PsycINFO database (Copyright c 1967 to 1988 by the American Psychological Association), and may not be reproduced without its prior permission. DOE

**N89-21481#** Aerospace Medical Research Labs., Wright-Patterson AFB, OH.  
**LCP-10 INTELLIGIBILITY OF OXYGEN MASKS AND MICROPHONES IN AIRCRAFT NOISE Summary Report, Oct. 1986 - Oct. 1988**  
 CHARLES W. NIXON and RICHARD L. MCKINLEY 24 Oct. 1988 37 p  
 (AD-A202474; AAMRL-TR-88-048) Avail: NTIS HC A03/MF A01 CSCL 25D

A series of studies was conducted to examine the effectiveness and limitations of the Joint Tactical Information Distribution System (JTIDS) voice channel in noisy environments. Initial efforts to improve performance focused on the input to JTIDS, specifically modifications to the oxygen mask and the use of prototype noise cancelling microphones. No improvements in voice communications were observed with the modified masks, prototype microphones or the various mask-microphone combinations. These and other measurement data demonstrated that the limit to voice communications performance with this system in noise was imposed at the listener instead of at the talker (oxygen mask input). The sound attenuation properties of the helmets and headsets were not adequate to provide the required speech-to-noise ratios at the ear in the highest noise levels. Among the conclusions were: (1) speech processed by the JTIDS voice channel may be more vulnerable to noise or easier to mask than regular speech, (2) efforts to improve voice communications effectiveness in noise in the near term should focus on improvements in the signal at the listener, and (3) active noise reduction technology in headsets has been proven, it offers a high potential for enhanced voice communications with the basic JTIDS voice channel and its utility should be pursued. GRA

**N89-21482#** Army Aeromedical Research Unit, Fort Rucker, AL.  
**SPH-4 US ARMY FLIGHT HELMET PERFORMANCE 1983-1987 Final Report**  
 PETER VYRNWY-JONES, BERNARD LANOUE, and DOUGLAS PRITTS Aug. 1988 64 p  
 (AD-A202589; USAARL-88-15) Avail: NTIS HC A04/MF A01 CSCL 05H

Injury data was obtained from the U.S. Safety Center for the occupants of U.S. Army aircraft who were wearing aviator helmets when involved in duty-related aircraft accidents from the period beginning in June 1982 and ending in October 1987. The injury data was correlated with the physical condition of the helmets involved which had been obtained by the U.S. Army Aeromedical Research Laboratory under the Aviation Life Support Equipment Retrieval Program. The helmet performance was evaluated with regard to current injury prevention capabilities and potential improvements for future helmet designs. All helmets involved were involved in aircraft accidents except one SPH-4 which had been damaged by small arms fire. GRA

**N89-21483#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.  
**CAPACITY OF HUMAN OPERATOR USING SMART STICK CONTROLLER M.S. Thesis**  
 ADOLPHO COZZONE Dec. 1988 138 p  
 (AD-A202712; AFIT/GE/ENG/88D-7) Avail: NTIS HC A07/MF A01 CSCL 23B

This thesis provides an analysis of transformation rate and capacity for six subjects using the smart stick controller. The subjects were tested in both a passive and active stick mode using three different forcing functions. The smart stick controller is an aircraft stick actively controlled by an algorithm developed by the Armstrong Aerospace Medical Research Laboratory (AAMRL) at Wright-Patterson AFB, OH to improve pilot tracking performance. In the passive mode, the stick behaves as any other stick used to control aircraft. However, in the active mode, the stick exerts a force in the direction opposite to the desired motion. This thesis reviews the literature, develops and analyzes a compensatory tracking task using classical control theory, and applies information theory results to the human quasilinear model to determine the transformation rate and capacity of the human operator. Finally, the results for both the active and passive mode are compared. Power spectral densities of the forcing functions, display error, and human response are used to calculate the human transfer function, noise remnant, transformation rate and capacity. GRA

**N89-21484#** Anthropology Research Project, Yellow Springs, OH.  
**MEASURER'S HANDBOOK: US ARMY ANTHROPOMETRIC SURVEY, 1987-1988 Final Technical Report, Oct. 1986 - May 1987**  
 CHARLES CLAUSER, ILSE TEBBETTS, BRUCE BRADTMILLER, JOHN MCCONVILLE, and CLAIRE GORDON 4 May 1988 330 p  
 (Contract DAAK60-86-C-0128)  
 (AD-A202721; NATICK-TR-88/043) Avail: NTIS HC A15/MF A01 CSCL 05I

The purpose of this manual is to describe and explain the tools and procedures required for the precise and accurate measurement of U.S. Army men and women. The handbook contains instructions for the measurement of 132 directly measured dimensions of the body, and for obtaining additional head and hand data collected with the use of two pieces of custom-designed equipment: an electronic headboard and a hand photometric system. Also included in this generously illustrated measurer's guide are instructions for locating and drawing the landmarks required to define and standardize the dimensions, suggestions for handling subjects, and a guide to the operations and care of the personal computers to be used to record and edit the data in the field. The measurements obtained in this anthropometric survey will form the basis for ensuring that Army clothing, equipment, and systems properly accommodate Army personnel who run the body-size gamut from small women to large men. GRA

**N89-21485#** Navy Clothing and Textile Research Facility, Natick, MA.  
**THERMAL PROTECTION AFFORDED BY TWO ANTI-EXPOSURE COVERALLS WHEN WORN IN COLD WATER Final Technical Report, Dec. 1987 - Jul. 1988**  
 NANCY A. PIMENTAL and BARBARA A. AVELLINI Oct. 1988 19 p  
 (AD-A202865; NCTRF-172) Avail: NTIS HC A03/MF A01 CSCL 05H

The Navy Clothing and Textile Research Facility (NCTRF) was contracted by U.S. Coast Guard Headquarters to evaluate the thermal protection afforded by two prototype aircrew anti exposure coveralls when worn in cold water. The coveralls were developed by two different manufacturers to meet U.S. Coast Guard specification G-OAV-3-1401/A of 15 July 1986. The coveralls were evaluated on seven male subjects immersed in 10 C (50 F) water for 2 hours (with air temperature 13 C, minimal wind). When either of the two anti-exposure coveralls was worn, all subjects were

able to complete the 2-hour water immersion. There were no differences in the thermal protection afforded by the two coveralls, as measured by rectal temperature, skin temperature, heart rate, and oxygen uptake responses ( $P$  greater than 0.05). The decrease in rectal temperature after 2 hours of cold water immersion averaged 1.0 C; mean weighted skin temperature averaged 2.3 C. Final heart rate averaged 77 b/min. Oxygen consumption, which was used as a measure of shivering, was the same when either coverall was worn. Both coveralls met the Coast Guard requirement of preventing rectal temperature from dropping more than 1 C per hour. GRA

**N89-21486#** Army Aeromedical Research Lab., Fort Rucker, AL.

**THE IMPACT OF THE US ARMY'S AH-64 HELMET MOUNTED DISPLAY ON FUTURE AVIATION HELMET DESIGN Final Report**

CLARENCE E. RASH and JOHN S. MARTIN Aug. 1988 21 p (AD-A202984; USAARL-88-13) Avail: NTIS HC A03/MF A01 CSCL 05H

Historically, the goal of aviation helmet design has been to primarily provide impact and noise protection to the user. In 1984, the U.S. Army fielded an advanced attack helicopter which required a new helmet concept in which the role of the helmet was expanded to provide a visually coupled interface between the aviator and the aircraft. This new helmet system, the Integrated Helmet and Display Sighting System (IHADSS), uses a helmet fitted with infrared (IR) emitters and a monocular display. The IR emitters allow a slewable IR imaging sensor, mounted on the nose of the aircraft, to be slaved to the aviators head movements. Imagery from this sensor is presented to the aviator through the helmet mounted display. This type system generates several concerns, recognized early on, but still unresolved. These areas include questions of monocular vs. binocular imagery, eye dominance, and binocular rivalry. Additionally, the task of interfacing the aviator's head to the aircraft has introduced previously unrecognized problems relating to head anthropometry and facial anatomy. The fitting process has become a crucial factor in the aviator's ability to interface with the aircraft systems. The development and fielding of the IHADSS helmet mounted display have expanded the role and importance of the helmet. GRA

**N89-21487#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**GRAPHICAL MAN-MACHINE INTERFACE FOR AN INTEGRATED EVALUATION ENVIRONMENT M.S. Thesis**

JERRY J. KANSKI Dec. 1988 160 p (AD-A203054; AFIT/GE/ENG/88D-17) Avail: NTIS HC A08/MF A01 CSCL 12E

The purpose of this thesis was to create an effective color graphical man-machine interface prototype for the various software resources used by AFIT researchers. The research was completed in four steps: (1) The general user requirements and specific interface requirements for the interface were determined; (2) An interface design which met all of the requirements determined in step 1 was created; (3) The design created in step 2 was implemented; and (4) The man-machine interface was evaluated by a group of representative users. The design effort resulted in a general purpose interface design that was highly adaptable and expandable. The design met all of the requirements determined in step 1, yet included the flexibility to meet future, as yet undetermined, requirements. The implementation of the interface design also featured adaptability and flexibility. The implementation combined a variety of graphical techniques to create a very powerful system. In addition, the resulting man-machine interface was evaluated by a group of AFIT engineering students and staff. The results of the evaluation indicated that the graphical man machine interface prototype was a success. GRA

**N89-21488#** Army Aeromedical Research Unit, Fort Rucker, AL. **POLYCARBONATE OPHTHALMIC LENSES FOR AMETROPIC ARMY AVIATORS USING NIGHT VISION GOGGLES Final Report**

JOHN K. CROSLY Aug. 1988 38 p (AD-A203100; USAARL-88-12) Avail: NTIS HC A03/MF A01 CSCL 05H

U.S. Army aviators use the AN/PVS-5 Night Vision Goggles (NVG) with a modified faceplate which enables wearing of corrective spectacles, when required. The next generation NVGs, the Aviator Night Vision Imaging System (ANVIS), permit spectacle wear by design. With only glass lenses available to the aviator requiring optical correction, there is a potential for eye injury from broken glass should the goggles accidentally be displaced. This report documents studies to: (1) compare the impact resistance of glass, CR-39 (plastic), and polycarbonate lenses to simulated NVG tubes, (2) establish the approximate forces necessary to cause glass lens breakage by displaced NVG tubes, and (3) determine the performance of polycarbonate lenses in the aviation environment. GRA

**N89-21489#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**F-16 SPEAKER-INDEPENDENT SPEECH RECOGNITION SYSTEM USING COCKPIT COMMANDS (70 WORDS) M.S. Thesis**

PETER Y. KIM Dec. 1988 138 p (AD-A203177; AFIT/GE/ENG/88D-18) Avail: NTIS HC A07/MF A01 CSCL 25D

A system is developed to achieve speaker independent isolated speech recognition. The system uses LPC Spectrum, Formants, and Frication Frequency as a feature set. Dynamic programming is applied for distance calculations. The fundamental design concept is to create a universal template for multiple speakers. A new algorithm, which combines the vocabularies of several speakers to produce one optimal template, is incorporated into the system. An advanced speech analysis tool called SPIRE provides the computational functions required to extract appropriate features. Seventy words, from the list of F-16 cockpit commands, are selected as a vocabulary of the system. The use of a merged template based on three of the feature sets achieves an accuracy of 99 percent. The system is implemented in list programming on Symbolics 3600 series computer. GRA

## 55

## SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

**A89-32809**

**HYDROGEN ISOTOPE COMPOSITION OF INSOLUBLE ORGANIC MATTER FROM CHERTS**

FRANCOIS ROBERT (California Institute of Technology, Pasadena) *Geochimica et Cosmochimica Acta* (ISSN 0016-7037), vol. 53, Feb. 1989, p. 453-460. refs (Contract NSF EAR-83-13086)

The extent of hydrogen isotope exchange between water and kerogen in cherts was investigated in experiments in which chemically extracted kerogen was treated with thermally and isotopically controlled water and the D/H ratio was determined. It was found that about 7 percent of organic hydrogen may exchange with water at 80 C. The D/H ratio of the acid residues extracted from cherts whose age lie between present and 3.5 Gyr shows no systematic variation, indicating that either the mean isotopic composition of the earth hydrosphere did not change significantly through geological time, or, more likely, that the kerogen was isotopically reequilibrated during thermal events after its formation. I.S.

**A89-33789**

**UV SPECTROSCOPY OF TITAN'S ATMOSPHERE, PLANETARY ORGANIC CHEMISTRY, AND PREBIOLOGICAL SYNTHESIS**

PAUL BRUSTON, HENRI PONCET (CNRS, Laboratoire de

Physique Stellaire et Planetaire, Verrieres-le-Buisson, France), FRANCOIS RAULIN (Paris XII, Universite, Creteil, France), CLAUDINA COSSART-MAGOS (CNRS, Laboratoire de Photophysique Moleculaire, Orsay, France), and REGIS COURTIN (Paris, Observatoire, Meudon, France) *Icarus* (ISSN 0019-1035), vol. 78, March 1989, p. 38-53. Research supported by CNRS. refs

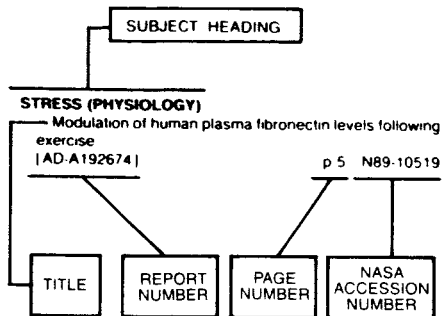
**A89-35705**

**PROBABLE PATHWAYS FOR THE FORMATION OF  
NON-PROTEIN AMINO ACIDS, CONTAINED IN METEORITES,  
FROM PROTEIN AMINO ACIDS BY DECARBOXYLATION AND  
DEAMINATION**

CH. P. IVANOV (B'lgarska Akademiia na Naukite, Institut po Organichna Khimiia s Tsent'r po Fitokhimiia, Sofia, Bulgaria) *Bolgarskaia Akademiia Nauk, Doklady* (ISSN 0366-8688), vol. 42, no. 2, 1989, p. 77-80. refs

A search has been conducted for possible pathways for the formation of nonprotein amino acids from protein acids under conditions probable on the parent body of a meteorite or in meteorites themselves. Consideration is given to possible decomposition reactions of the protein acids and possible synthetic chemical processes between protein acids and members of the other classes of organic compounds in meteorites. It is concluded that all nonprotein amino acids identified in meteorites may be obtained from protein acids through decarboxylation, deamination, and alpha-carbon alkylation by hydroxyalkylation with lower carbonyl compounds. R.B.

## Typical Subject Index Listing



The subject heading is a key to the subject content of the document. The title is used to provide a description of the subject matter. When the title is insufficiently descriptive of document content, a title extension is added, separated from the title by three hyphens. The (NASA or AIAA) accession number and the page number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document. Under any one subject heading, the accession numbers are arranged in sequence with the AIAA accession numbers appearing first.

## A

- ABSTRACTS**  
USSR Space Life Sciences Digest, Issue 21  
[NASA-CR-3922(24)] p 153 N89-20602
- ABUNDANCE**  
Hydrogen isotope composition of insoluble organic matter from cherts p 168 A89-32809
- ACCELERATION (PHYSICS)**  
G-induced loss of consciousness and its prevention [AD-A202960] p 161 N89-21471
- ACCELERATION TOLERANCE**  
G-induced loss of consciousness and its prevention [AD-A202960] p 161 N89-21471
- ADAPTIVE CONTROL**  
Computer simulation of a pilot in V/STOL aircraft control loops [NASA-CR-184815] p 166 N89-21479
- ADAPTIVE FILTERS**  
LMS adaptive filtering applied to a microwave arterial pulse monitor [AD-A202732] p 160 N89-21465
- AERONAUTICS**  
Human factors in aviation --- Book  
Introductory overview p 164 A89-34431  
p 164 A89-34432
- AEROSPACE MEDICINE**  
USSR Space Life Sciences Digest, Issue 21 [NASA-CR-3922(24)] p 153 N89-20602  
Aerospace medicine and biology: A continuing bibliography with indexes (supplement 321) [NASA-SP-7011(321)] p 161 N89-21475  
Aerospace medicine and biology: A continuing bibliography with indexes (supplement 322) [NASA-SP-7011(322)] p 161 N89-21476  
SPH-4 US Army flight helmet performance 1983-1987 [AD-A202589] p 167 N89-21482
- AIRCRAFT ACCIDENTS**  
Human error in aviation operations p 162 A89-34440

- SPH-4 US Army flight helmet performance 1983-1987 [AD-A202589] p 167 N89-21482
- AIRCRAFT CONTROL**  
The system perspective --- for pilot-aircraft control interaction p 164 A89-34433  
Pilot control p 165 A89-34442  
Capacity of human operator using smart stick controller [AD-A202712] p 167 N89-21483
- AIRCRAFT EQUIPMENT**  
OBOGS for Japanese new intermediate jet trainer T-4 p 165 A89-35844
- AIRCRAFT INSTRUMENTS**  
Human workload in aviation p 162 A89-34437  
Helicopter human factors p 165 A89-34449
- AIRCRAFT NOISE**  
LCP-10 intelligibility of oxygen masks and microphones in aircraft noise [AD-A202474] p 167 N89-21481
- AIRCRAFT PILOTS**  
Human factors in aviation --- Book  
Airline pilots' perspective --- on cockpit controls, selection and training, and work environment p 165 A89-34447  
p 165 A89-34449  
Helicopter human factors p 165 A89-34449  
Saccadic eye movement during spaceflight [NASA-TM-100475] p 159 N89-21463  
The impact of the US Army's AH-64 helmet mounted display on future aviation helmet design [AD-A202984] p 168 N89-21486  
Polycarbonate ophthalmic lenses for ametropic Army aviators using night vision goggles [AD-A203100] p 168 N89-21488
- AIRCRAFT SAFETY**  
System safety --- in aviation p 164 A89-34434  
Group interaction and flight crew performance p 162 A89-34438
- ALANINE**  
Aminoacylation of RNA minihelices with alanine p 151 A89-32759
- ALERTNESS**  
Processing demands, effort, and individual differences in four different vigilance tasks p 162 A89-34833
- ALGORITHMS**  
Using depth recovery in humans [AD-A201278] p 159 N89-20606
- AMINO ACIDS**  
Probable pathways for the formation of non-protein amino acids, contained in meteorites, from protein amino acids by decarboxylation and deamination p 169 A89-35705
- ANOXIA**  
The end-triassic mass extinction event p 154 N89-21324
- ANTHROPOMETRY**  
Measurer's handbook: US Army anthropometric survey, 1987-1988 [AD-A202721] p 167 N89-21484
- ARTHOPODS**  
The visibility of 350 deg C black-body radiation by the shrimp *Rimicaris exoculata* and man p 151 A89-32758
- ARTIFICIAL INTELLIGENCE**  
Using depth recovery in humans [AD-A201278] p 159 N89-20606
- ATLANTIC OCEAN**  
Macrofossil extinction patterns at Bay of Biscay Cretaceous-Tertiary boundary sections p 157 N89-21404
- ATROPHY**  
Transcriptional regulation of decreased protein synthesis during skeletal muscle unloading p 152 A89-34998
- ATTACK AIRCRAFT**  
Simulator design and instructional features for air-to-ground attack - A transfer study p 163 A89-34835
- ATTENTION**  
Processing demands, effort, and individual differences in four different vigilance tasks p 162 A89-34833

- AUTOMATIC PILOTS**  
G-induced loss of consciousness and its prevention [AD-A202960] p 161 N89-21471
- AVIONICS**  
Software interfaces for aviation systems p 165 A89-34445
- ## B
- BACKSCATTERING**  
The development of a Compton lung densitometer [DE89-006654] p 153 N89-20603
- BED REST**  
Changes in size and compliance of the calf after 30 days of simulated microgravity p 158 A89-35000
- BEHAVIOR**  
Behavioral effects of microwaves: Relationship of total dose and dose rate [PB89-118640] p 159 N89-21462
- BIBLIOGRAPHIES**  
Aerospace medicine and biology: A continuing bibliography with indexes (supplement 321) [NASA-SP-7011(321)] p 161 N89-21475  
Aerospace medicine and biology: A continuing bibliography with indexes (supplement 322) [NASA-SP-7011(322)] p 161 N89-21476  
Review and analysis of the literature in the area of human performance modeling [DE89-006800] p 166 N89-21480
- BINAURAL HEARING**  
Binocular unmasking - An analog to binocular unmasking? p 162 A89-34660
- BINOCULAR VISION**  
Binocular unmasking - An analog to binocular unmasking? p 162 A89-34660  
Reconstruction of binocular depth across continuous surfaces [AD-A202827] p 160 N89-21469
- BIOASTRONAUTICS**  
Saccadic eye movement during spaceflight [NASA-TM-100475] p 159 N89-21463  
Aerospace medicine and biology: A continuing bibliography with indexes (supplement 321) [NASA-SP-7011(321)] p 161 N89-21475  
Aerospace medicine and biology: A continuing bibliography with indexes (supplement 322) [NASA-SP-7011(322)] p 161 N89-21476
- BIOLOGICAL EFFECTS**  
A novel eye in 'eyeless' shrimp from hydrothermal vents of the Mid-Atlantic Ridge p 151 A89-32757  
Behavioral effects of microwaves: Relationship of total dose and dose rate [PB89-118640] p 159 N89-21462  
Saccadic eye movement during spaceflight [NASA-TM-100475] p 159 N89-21463  
Aerospace medicine and biology: A continuing bibliography with indexes (supplement 321) [NASA-SP-7011(321)] p 161 N89-21475  
Aerospace medicine and biology: A continuing bibliography with indexes (supplement 322) [NASA-SP-7011(322)] p 161 N89-21476
- BIOLOGICAL EVOLUTION**  
The relationship of a prochlorophyte *Prochlorothrix hollandica* to green chloroplasts p 151 A89-32749  
Aminoacylation of RNA minihelices with alanine p 151 A89-32759  
RNA evolution and the origins of life p 152 A89-34319  
Earth orbital variations and vertebrate bioevolution p 155 N89-21357
- BIONICS**  
Using depth recovery in humans [AD-A201278] p 159 N89-20606
- BIOSYNTHESIS**  
UV spectroscopy of Titan's atmosphere, planetary organic chemistry, and prebiological synthesis p 168 A89-33789
- BLACK BODY RADIATION**  
The visibility of 350 deg C black-body radiation by the shrimp *Rimicaris exoculata* and man p 151 A89-32758

## BLACKOUT (PHYSIOLOGY)

G-induced loss of consciousness and its prevention  
[AD-A202960] p 161 N89-21471

## BLOOD

External breathing, gas exchange, and blood acid-base balance in dogs under hyperthermia p 151 A89-34037

## BLOOD CIRCULATION

Central hemodynamics of healthy humans during a gradual decrease of circulating blood volume p 158 A89-34020

## BLOOD VOLUME

Central hemodynamics of healthy humans during a gradual decrease of circulating blood volume p 158 A89-34020

## BODY SIZE (BIOLOGY)

Measurer's handbook: US Army anthropometric survey, 1987-1988  
[AD-A202721] p 167 N89-21484

## BODY TEMPERATURE

Analysis of temperature patterns in humans p 158 A89-34021

Why cold-wet makes one feel chilled: A literature review  
[AD-A203452] p 159 N89-20609

Thermal protection afforded by two anti-exposure coveralls when worn in cold water  
[AD-A202865] p 167 N89-21485

## BOLIDES

Late Wenlock (middle Silurian) bio-events: Caused by volatile boloid impact/s p 153 N89-21295

## BONES

Dinosaur bone beds and mass mortality: Implications for the K-T extinction p 154 N89-21301

## BRAIN

Comparative evaluation of the effect of immobilization stress on the dynamics of resistance to the induction of the peroxidation of lipids of the internal organs and brain p 152 A89-35500

Brain activity during tactical decision-making. Part 5: A cross-study validation of evoked potentials as indices of workload  
[AD-A203763] p 161 N89-21474

## BRIGHTNESS

Reconstruction of binocular depth across continuous surfaces  
[AD-A202827] p 160 N89-21469

## C

## CARBON DIOXIDE

Supercritical fluid extraction and characterization of lipids from algae *Scenedesmus obliquus* p 152 A89-34398

## CARBON ISOTOPES

The Cretaceous-Tertiary boundary marine extinction and global primary productivity collapse p 157 N89-21412

## CARBONACEOUS CHONDRITES

Heavy metal toxicity as a kill mechanism in impact caused mass extinctions p 157 N89-21406

## CELLS (BIOLOGY)

Increased efficiency of mammalian somatic cell hybrid production under microgravity conditions during ballistic rocket flight p 152 A89-34535

Using depth recovery in humans  
[AD-A201278] p 159 N89-20606

Effects of simultaneous radiofrequency radiation and chemical exposure of mammalian cells, volume 2  
[AD-A202780] p 160 N89-21467

## CEREBRAL CORTEX

Psychophysical studies of visual cortical functions  
[AD-A202814] p 160 N89-21468

## CHANNEL NOISE

LCP-10 intelligibility of oxygen masks and microphones in aircraft noise  
[AD-A202474] p 167 N89-21481

## CHEMICAL EVOLUTION

RNA evolution and the origins of life p 152 A89-34319

## CHLOROPHYLLS

The relationship of a prochlorophyte *Prochlorothrix hollandica* to green chloroplasts p 151 A89-32749

## CHLOROPLASTS

The relationship of a prochlorophyte *Prochlorothrix hollandica* to green chloroplasts p 151 A89-32749  
psbA genes indicate common ancestry of prochlorophytes and chloroplasts p 151 A89-32750

## CIRCADIAN RHYTHMS

Aircrew fatigue and circadian rhythmicity p 158 A89-34441

## CIVIL AVIATION

Human error in aviation operations p 162 A89-34440

## CLIMATE CHANGE

Late Wenlock (middle Silurian) bio-events: Caused by volatile boloid impact/s p 153 N89-21295

The end-triassic mass extinction event p 154 N89-21324

Earth orbital variations and vertebrate bioevolution p 155 N89-21357

Permo-Triassic vertebrate extinctions: A program p 155 N89-21367

## CLIMATOLOGY

Late Wenlock (middle Silurian) bio-events: Caused by volatile boloid impact/s p 153 N89-21295

Step-wise extinctions at the Cretaceous-Tertiary boundary and their climatic implications p 155 N89-21354

## CLOSED ECOLOGICAL SYSTEMS

Nutritional models for a Controlled Ecological Life Support System (CELSS): Linear mathematical modeling [NASA-CR-4229] p 166 N89-20615

## COCKPITS

Human factors in aviation --- Book p 164 A89-34431

Airline pilots' perspective --- on cockpit controls, selection and training, and work environment p 165 A89-34447

F-16 speaker-independent speech recognition system using cockpit commands (70 words)  
[AD-A203177] p 168 N89-21489

## COGNITION

Modeling the cognitive content of displays p 165 A89-34832

The power of physical representations  
[CWI-CS-R8819] p 163 N89-20612

Coping with novelty and human intelligence: The role of counterfactual reasoning  
[AD-A203624] p 164 N89-21478

## COGNITIVE PSYCHOLOGY

Cognitive psychology at the Institute for Perception [IZF-1987-41] p 163 N89-20611

## COLD WATER

Thermal protection afforded by two anti-exposure coveralls when worn in cold water  
[AD-A202865] p 167 N89-21485

## COLD WEATHER TESTS

Why cold-wet makes one feel chilled: A literature review  
[AD-A203452] p 159 N89-20609

## COMFORT

Safe working time limits in impermeable protective clothing: Recommendations based upon experimental measurements [IZF-1987-28] p 166 N89-20618

## COMPTON EFFECT

The development of a Compton lung densitometer [DE89-006654] p 153 N89-20603

## COMPUTER AIDED DESIGN

Direct manipulation and other styles of man-machine interaction [REPT-88-53] p 166 N89-20616

## COMPUTER GRAPHICS

Graphical man-machine interface for an integrated evaluation environment  
[AD-A203054] p 168 N89-21487

## COMPUTER PROGRAMMING

Direct manipulation and other styles of man-machine interaction [REPT-88-53] p 166 N89-20616

## COMPUTER PROGRAMS

LMS adaptive filtering applied to a microwave arterial pulse monitor  
[AD-A202732] p 160 N89-21465

Accurate determination of the complex permittivity of biological tissue around 35 GHz  
[AD-A202907] p 160 N89-21470

Graphical man-machine interface for an integrated evaluation environment  
[AD-A203054] p 168 N89-21487

## COMPUTER SYSTEMS DESIGN

Graphical man-machine interface for an integrated evaluation environment  
[AD-A203054] p 168 N89-21487

Direct manipulation and other styles of man-machine interaction [REPT-88-53] p 166 N89-20616

## COMPUTERIZED SIMULATION

Componential analysis of pilot decision making  
[AD-A203711] p 163 N89-20613

Computer simulation of a pilot in V/STOL aircraft control loops [NASA-CR-184815] p 166 N89-21479

## CONTROL STICKS

Capacity of human operator using smart stick controller  
[AD-A202712] p 167 N89-21483

## CONTROL SYSTEMS DESIGN

Pilot control p 165 A89-34442

## COVERALLS

Thermal protection afforded by two anti-exposure coveralls when worn in cold water  
[AD-A202865] p 167 N89-21485

## CRASHES

G-induced loss of consciousness and its prevention  
[AD-A202960] p 161 N89-21471

## CROPS

Nutritional models for a Controlled Ecological Life Support System (CELSS): Linear mathematical modeling [NASA-CR-4229] p 166 N89-20615

## CYBERNETICS

Information processing --- in human performance p 162 A89-34436

## D

## DECARBOXYLATION

Probable pathways for the formation of non-protein amino acids, contained in meteorites, from protein amino acids by decarboxylation and deamination p 169 A89-35705

## DECISION MAKING

Componential analysis of pilot decision making  
[AD-A203711] p 163 N89-20613

Brain activity during tactical decision-making. Part 5: A cross-study validation of evoked potentials as indices of workload  
[AD-A203763] p 161 N89-21474

## DENSITOMETERS

The development of a Compton lung densitometer [DE89-006654] p 153 N89-20603

## DIELECTRIC PROPERTIES

Accurate determination of the complex permittivity of biological tissue around 35 GHz  
[AD-A202907] p 160 N89-21470

## DISPLAY DEVICES

Modeling the cognitive content of displays p 165 A89-34832

## DYNAMIC PROGRAMMING

F-16 speaker-independent speech recognition system using cockpit commands (70 words)  
[AD-A203177] p 168 N89-21489

## DYNAMIC RESPONSE

Origination, diversity, and extinction metrics essential for analysis of mass biotic crisis events: An example from cretaceous ammonidea p 154 N89-21304

## E

## EARTH ORBITS

Earth orbital variations and vertebrate bioevolution p 155 N89-21357

## EARTH SURFACE

Heavy metal toxicity as a kill mechanism in impact caused mass extinctions p 157 N89-21406

## ECOSYSTEMS

Permo-Triassic vertebrate extinctions: A program p 155 N89-21367

## EDEMA

Blunted hypoxic ventilatory drive in subjects susceptible to high-altitude pulmonary edema p 158 A89-34999

## EGGS

Diachronism between extinction time of terrestrial and marine dinosaurs p 154 N89-21325

## ELECTROENCEPHALOGRAPHY

Resonance phenomena in EEG during photostimulation with flashes of varying frequency. I - Analysis of the effects of photostimulation p 158 A89-34019

Brain activity during tactical decision-making. Part 5: A cross-study validation of evoked potentials as indices of workload  
[AD-A203763] p 161 N89-21474

## ELECTROMYOGRAPHY

Influences of muscle fiber composition and strength on EMG (electromyographic activity), spinal motion and load acceleration during a repetitive lifting task [PB89-131221] p 159 N89-20607

## ELECTROPHYSIOLOGY

Gating kinetics and ion transfer in channels of nerve membrane  
[AD-A202509] p 160 N89-21464

## EMBRYOS

Suppression of morphogenesis in embryonic mouse limbs exposed in vitro to excess gravity p 152 A89-34400

## ENERGY ABSORPTION

SPH-4 US Army flight helmet performance 1983-1987  
[AD-A202589] p 167 N89-21482

## ENVIRONMENT EFFECTS

Mass extinctions in the deep sea p 156 N89-21396

## EQUIPMENT SPECIFICATIONS

The development of a Compton lung densitometer [DE89-006654] p 153 N89-20603

**ERYTHROCYTES**

Alteration of gravitational field effect on sedimentation of erythrocytes by inhomogeneous magnetic field p 152 A89-34539

**EVOKED RESPONSE (PSYCHOPHYSIOLOGY)**

Brain activity during tactical decision-making. Part 5: A cross-study validation of evoked potentials as indices of workload [AD-A203763] p 161 N89-21474

**EXERCISE PHYSIOLOGY**

New models to assess behavioral and physiological performance of animals during inhalation exposures [PB89-128946] p 152 N89-20601

**EXOBIOLGY**

Aerospace medicine and biology: A continuing bibliography with indexes (supplement 321) [NASA-SP-7011(321)] p 161 N89-21475  
Aerospace medicine and biology: A continuing bibliography with indexes (supplement 322) [NASA-SP-7011(322)] p 161 N89-21476

**EXPERT SYSTEMS**

The power of physical representations [CWI-CS-R8819] p 163 N89-20612

**EXPOSURE**

New models to assess behavioral and physiological performance of animals during inhalation exposures [PB89-128946] p 152 N89-20601

**EXTINCTION**

Limitations on K-T mass extinction theories based upon the vertebrate record p 153 N89-21290  
Dinosaur bone beds and mass mortality: Implications for the K-T extinction p 154 N89-21301  
Origination, diversity, and extinction metrics essential for analysis of mass biotic crisis events: An example from cretaceous ammonioidea p 154 N89-21304  
The end-triassic mass extinction event p 154 N89-21324  
Diachronism between extinction time of terrestrial and marine dinosaurs p 154 N89-21325  
Selective extinction of marine plankton at the end of the Mesozoic era: The fossil and stable isotope record p 155 N89-21329

Step-wise extinctions at the Cretaceous-Tertiary boundary and their climatic implications p 155 N89-21354

Earth orbital variations and vertebrate bioevolution p 155 N89-21357

Plant microfossil record of the terminal Cretaceous event in the western United States and Canada p 155 N89-21363

Permo-Triassic vertebrate extinctions: A program p 155 N89-21367

Late Frasnian mass extinction: Conodont event stratigraphy, global changes, and possible causes p 156 N89-21380

Periodicity of extinction: A 1988 update p 156 N89-21385

Biostratigraphic case studies of six major extinctions p 156 N89-21390

Mass extinctions in the deep sea p 156 N89-21396

Macrofossil extinction patterns at Bay of Biscay Cretaceous-Tertiary boundary sections p 157 N89-21404

Heavy metal toxicity as a kill mechanism in impact caused mass extinctions p 157 N89-21406

The Cretaceous-Tertiary boundary marine extinction and global primary productivity collapse p 157 N89-21412

**EXTRAVEHICULAR ACTIVITY**

Getting a grip on space p 164 A89-34388

**EYE (ANATOMY)**

The visibility of 350 deg C black-body radiation by the shrimp *Rimicaris exoculata* and man p 151 A89-32758

Polycarbonate ophthalmic lenses for ametropic Army aviators using night vision goggles [AD-A203100] p 168 N89-21488

**F****F-16 AIRCRAFT**

F-16 speaker-independent speech recognition system using cockpit commands (70 words) [AD-A203177] p 168 N89-21489

**FATIGUE (BIOLOGY)**

Aircrew fatigue and circadian rhythmicity p 158 A89-34441

**FEEDBACK CONTROL**

Direct manipulation and other styles of man-machine interaction [REPT-88-53] p 166 N89-20616

**FIBERS**

Influences of muscle fiber composition and strength on EMG (electromyographic activity), spinal motion and load acceleration during a repetitive lifting task [PB89-131221] p 159 N89-20607

**FIRES**

New models to assess behavioral and physiological performance of animals during inhalation exposures [PB89-128946] p 152 N89-20601

**FLIGHT CLOTHING**

SPH-4 US Army flight helmet performance 1983-1987 [AD-A202589] p 167 N89-21482

**FLIGHT CONTROL**

The human senses in flight p 162 A89-34435  
Pilot control p 165 A89-34442  
Computer simulation of a pilot in V/STOL aircraft control loops [NASA-CR-184815] p 166 N89-21479  
Capacity of human operator using smart stick controller [AD-A202712] p 167 N89-21483

**FLIGHT CREWS**

Group interaction and flight crew performance p 162 A89-34438  
Aircrew fatigue and circadian rhythmicity p 158 A89-34441

**FLIGHT SAFETY**

Aircrew fatigue and circadian rhythmicity p 158 A89-34441

**FLIGHT SIMULATION**

Flight training and simulation p 162 A89-34439

**FLIGHT SIMULATORS**

Flight training and simulation p 162 A89-34439  
Simulator design and instructional features for air-to-ground attack - A transfer study p 163 A89-34835

**FLIGHT TESTS**

Capacity of human operator using smart stick controller [AD-A202712] p 167 N89-21483

**FLIGHT TRAINING**

Flight training and simulation p 162 A89-34439

**FOOD CHAIN**

The Cretaceous-Tertiary boundary marine extinction and global primary productivity collapse p 157 N89-21412

**FOSSILS**

The end-triassic mass extinction event p 154 N89-21324

Diachronism between extinction time of terrestrial and marine dinosaurs p 154 N89-21325

Late Frasnian mass extinction: Conodont event stratigraphy, global changes, and possible causes p 156 N89-21380

Periodicity of extinction: A 1988 update p 156 N89-21385

Macrofossil extinction patterns at Bay of Biscay Cretaceous-Tertiary boundary sections p 157 N89-21404

**FRACTIONATION**

Hydrogen isotope composition of insoluble organic matter from cherts p 168 A89-32609

**G****GAS EXCHANGE**

External breathing, gas exchange, and blood acid-base balance in dogs under hyperthermia p 151 A89-34037

**GENES**

psbA genes indicate common ancestry of prochlorophytes and chloroplasts p 151 A89-32750

**GENETIC CODE**

Aminoacylation of RNA minihelices with alanine p 151 A89-32759

**GEOCHEMISTRY**

Plant microfossil record of the terminal Cretaceous event in the western United States and Canada p 155 N89-21363

The Cretaceous-Tertiary boundary marine extinction and global primary productivity collapse p 157 N89-21412

**GEOCHRONOLOGY**

Limitations on K-T mass extinction theories based upon the vertebrate record p 153 N89-21290

Late Wenlock (middle Silurian) bio-events: Caused by volatile boloid impact/s p 153 N89-21295

Dinosaur bone beds and mass mortality: Implications for the K-T extinction p 154 N89-21301

Origination, diversity, and extinction metrics essential for analysis of mass biotic crisis events: An example from cretaceous ammonioidea p 154 N89-21304

The end-triassic mass extinction event p 154 N89-21324

Diachronism between extinction time of terrestrial and marine dinosaurs p 154 N89-21325

Selective extinction of marine plankton at the end of the Mesozoic era: The fossil and stable isotope record p 155 N89-21329

Step-wise extinctions at the Cretaceous-Tertiary boundary and their climatic implications p 155 N89-21354

Earth orbital variations and vertebrate bioevolution p 155 N89-21357

Plant microfossil record of the terminal Cretaceous event in the western United States and Canada p 155 N89-21363

Permo-Triassic vertebrate extinctions: A program p 155 N89-21367

Late Frasnian mass extinction: Conodont event stratigraphy, global changes, and possible causes p 156 N89-21380

Periodicity of extinction: A 1988 update p 156 N89-21385

Biostratigraphic case studies of six major extinctions p 156 N89-21390

Macrofossil extinction patterns at Bay of Biscay Cretaceous-Tertiary boundary sections p 157 N89-21404

The Cretaceous-Tertiary boundary marine extinction and global primary productivity collapse p 157 N89-21412

**GEOMORPHOLOGY**

Permo-Triassic vertebrate extinctions: A program p 155 N89-21367

**GLACIAL DRIFT**

Late Frasnian mass extinction: Conodont event stratigraphy, global changes, and possible causes p 156 N89-21380

**GLASS**

Polycarbonate ophthalmic lenses for ametropic Army aviators using night vision goggles [AD-A203100] p 168 N89-21488

**GLOVES**

Getting a grip on space p 164 A89-34388

**GOGGLES**

Helicopter flights with night-vision goggles: Human factors aspects [NASA-TM-101039] p 164 N89-21477

Polycarbonate ophthalmic lenses for ametropic Army aviators using night vision goggles [AD-A203100] p 168 N89-21488

**GRAVITATIONAL EFFECTS**

Alteration of gravitational field effect on sedimentation of erythrocytes by inhomogeneous magnetic field [NASA-CR-3922(24)] p 153 N89-20602

USSR Space Life Sciences Digest, Issue 21 [NASA-CR-3922(24)] p 153 N89-20602

**GRAVITATIONAL PHYSIOLOGY**

Suppression of morphogenesis in embryonic mouse limbs exposed in vitro to excess gravity p 152 A89-34400

**GROUP DYNAMICS**

Group interaction and flight crew performance p 162 A89-34438

**GUINEA PIGS**

New models to assess behavioral and physiological performance of animals during inhalation exposures [PB89-128946] p 152 N89-20601

**H****HANDBOOKS**

Measurer's handbook: US Army anthropometric survey, 1987-1988 [AD-A202721] p 167 N89-21484

**HARRIER AIRCRAFT**

Computer simulation of a pilot in V/STOL aircraft control loops [NASA-CR-184815] p 166 N89-21479

**HAZARDS**

Helicopter flights with night-vision goggles: Human factors aspects [NASA-TM-101039] p 164 N89-21477

**HEAD (ANATOMY)**

SPH-4 US Army flight helmet performance 1983-1987 [AD-A202589] p 167 N89-21482

**HEART FUNCTION**

Comparative evaluation of the effect of immobilization stress on the dynamics of resistance to the induction of the peroxidation of lipids of the internal organs and brain p 152 A89-35500

**HEART RATE**

LMS adaptive filtering applied to a microwave arterial pulse monitor [AD-A202732] p 160 N89-21465

**HELICOPTER DESIGN**

Helicopter human factors p 165 A89-34449

**HELMET MOUNTED DISPLAYS**

The impact of the US Army's AH-64 helmet mounted display on future aviation helmet design [AD-A202984] p 168 N89-21486

**HELMETS**

SPH-4 helmet retention assembly reinforcement [AD-A200432] p 165 N89-20614

SPH-4 US Army flight helmet performance 1983-1987 [AD-A202589] p 167 N89-21482

- The impact of the US Army's AH-64 helmet mounted display on future aviation helmet design [AD-A202984] p 168 N89-21486
- HEMODYNAMICS**  
Central hemodynamics of healthy humans during a gradual decrease of circulating blood volume p 158 A89-34020
- HIGH ALTITUDE ENVIRONMENTS**  
Blunted hypoxic ventilatory drive in subjects susceptible to high-altitude pulmonary edema p 158 A89-34999
- HIGH GRAVITY ENVIRONMENTS**  
Suppression of morphogenesis in embryonic mouse limbs exposed *in vitro* to excess gravity p 152 A89-34400
- HIGH RESOLUTION**  
Using depth recovery in humans [AD-A201278] p 159 N89-20606
- HUMAN BEINGS**  
The visibility of 350 deg C black-body radiation by the shrimp *Rimicaris exoculata* and man p 151 A89-32758  
Using depth recovery in humans [AD-A201278] p 159 N89-20606  
Seeing Ghost solutions in stereo vision [AD-A203581] p 161 N89-21473
- HUMAN BODY**  
Central hemodynamics of healthy humans during a gradual decrease of circulating blood volume p 158 A89-34020  
Analysis of temperature patterns in humans p 158 A89-34021
- HUMAN FACTORS ENGINEERING**  
Getting a grip on space p 164 A89-34388  
Human factors in aviation --- Book p 164 A89-34431  
Introductory overview p 164 A89-34432  
The system perspective --- for pilot-aircraft control interaction p 164 A89-34433  
System safety --- in aviation p 164 A89-34434  
The human senses in flight p 162 A89-34435  
Information processing --- in human performance p 162 A89-34436  
Human workload in aviation p 162 A89-34437  
Software interfaces for aviation systems p 165 A89-34445  
Airline pilots' perspective --- on cockpit controls, selection and training, and work environment p 165 A89-34447  
Helicopter human factors p 165 A89-34449  
Modeling the cognitive content of displays p 165 A89-34832  
Simulator design and instructional features for air-to-ground attack - A transfer study p 163 A89-34835  
User interfaces and highly interactive systems: Survey of current research [REPT-88-60] p 166 N89-20617  
Helicopter flights with night-vision goggles: Human factors aspects [NASA-TM-101039] p 164 N89-21477  
Capacity of human operator using smart stick controller [AD-A202712] p 167 N89-21483  
Measurer's handbook: US Army anthropometric survey, 1987-1988 [AD-A202721] p 167 N89-21484  
The impact of the US Army's AH-64 helmet mounted display on future aviation helmet design [AD-A202984] p 168 N89-21486
- HUMAN PERFORMANCE**  
Information processing --- in human performance p 162 A89-34436  
Human workload in aviation p 162 A89-34437  
Group interaction and flight crew performance p 162 A89-34438  
Processing demands, effort, and individual differences in four different vigilance tasks p 162 A89-34833  
USSR Space Life Sciences Digest, Issue 21 [NASA-CR-3922(24)] p 153 N89-20602  
Cognitive psychology at the Institute for Perception [IZF-1987-41] p 163 N89-20611  
Review and analysis of the literature in the area of human performance modeling [DE89-006800] p 166 N89-21480
- HYDROGEN ISOTOPES**  
Hydrogen isotope composition of insoluble organic matter from cherts p 168 A89-32809
- HYDROTHERMAL SYSTEMS**  
A novel eye in 'eyeless' shrimp from hydrothermal vents of the Mid-Atlantic Ridge p 151 A89-32757
- HYPERCAPNIA**  
Blunted hypoxic ventilatory drive in subjects susceptible to high-altitude pulmonary edema p 158 A89-34999

**HYPERTHERMIA**

- External breathing, gas exchange, and blood acid-base balance in dogs under hyperthermia p 151 A89-34037

**HYPODYNAMIA**

- Transcriptional regulation of decreased protein synthesis during skeletal muscle unloading p 152 A89-34998

**HYPOKINESIA**

- Changes in size and compliance of the calf after 30 days of simulated microgravity p 158 A89-35000

**HYPOXIA**

- Blunted hypoxic ventilatory drive in subjects susceptible to high-altitude pulmonary edema p 158 A89-34999

**I****IDENTIFYING**

- Seeing Ghost solutions in stereo vision [AD-A203581] p 161 N89-21473

**IMAGE PROCESSING**

- Using depth recovery in humans [AD-A201278] p 159 N89-20606

**IMAGES**

- Psychophysical studies of visual cortical functions [AD-A202814] p 160 N89-21468

**IMPACT TESTS**

- SPH-4 helmet retention assembly reinforcement [AD-A200432] p 165 N89-20614

**IMPULSES**

- Propagation of the nerve impulse under the effect of a magnetic field [DE88-705371] p 159 N89-20608

**INDEXES (DOCUMENTATION)**

- Medical subject headings, tree structures, 1989 [PB89-100028] p 158 N89-20605  
Aerospace medicine and biology: A continuing bibliography with indexes (supplement 321) [NASA-SP-7011(321)] p 161 N89-21475  
Aerospace medicine and biology: A continuing bibliography with indexes (supplement 322) [NASA-SP-7011(322)] p 161 N89-21476

**INFORMATION PROCESSING (BIOLOGY)**

- Precision in the perception of direction of a moving pattern [NASA-TM-101080] p 163 N89-20610  
Componential analysis of pilot decision making [AD-A203711] p 163 N89-20613

**INTELLECT**

- Coping with novelty and human intelligence: The role of counterfactual reasoning [AD-A203624] p 164 N89-21478

**INTELLIGENCE**

- Coping with novelty and human intelligence: The role of counterfactual reasoning [AD-A203624] p 164 N89-21478

**INTERFERENCE GRATING**

- Peripheral limitations on spatial vision [AD-A203388] p 161 N89-21472

**INTERPOLATION**

- Seeing Ghost solutions in stereo vision [AD-A203581] p 161 N89-21473

**ION CURRENTS**

- Gating kinetics and ion transfer in channels of nerve membrane [AD-A202509] p 160 N89-21464

**IRIDIUM ISOTOPES**

- Selective extinction of marine plankton at the end of the Mesozoic era: The fossil and stable isotope record p 155 N89-21329

**ISOTOPIC LABELING**

- Selective extinction of marine plankton at the end of the Mesozoic era: The fossil and stable isotope record p 155 N89-21329

**J****JET AIRCRAFT**

- OBOGS for Japanese new intermediate jet trainer T-4 p 165 A89-35844

**K****KINETICS**

- Gating kinetics and ion transfer in channels of nerve membrane [AD-A202509] p 160 N89-21464

**KNOWLEDGE REPRESENTATION**

- Modeling the cognitive content of displays p 165 A89-34832  
The power of physical representations [CWI-CS-R8819] p 163 N89-20612

**L****LEG (ANATOMY)**

- Changes in size and compliance of the calf after 30 days of simulated microgravity p 158 A89-35000

**LENSES**

- Polycarbonate ophthalmic lenses for ametropic Army aviators using night vision goggles [AD-A203100] p 168 N89-21488

**LIFE SCIENCES**

- X-ray microscopy for the life and physical sciences [DE89-006707] p 153 N89-20604

**LIGHT (VISIBLE RADIATION)**

- Resonance phenomena in EEG during photostimulation with flashes of varying frequency. I - Analysis of the effects of photostimulation p 158 A89-34019

**LIPIDS**

- Supercritical fluid extraction and characterization of lipids from algae *Scenedesmus obliquus* p 152 A89-34398  
Comparative evaluation of the effect of immobilization stress on the dynamics of resistance to the induction of the peroxidation of lipids of the internal organs and brain p 152 A89-35500

**LIVER**

- Comparative evaluation of the effect of immobilization stress on the dynamics of resistance to the induction of the peroxidation of lipids of the internal organs and brain p 152 A89-35500

**LONG DURATION SPACE FLIGHT**

- Nutritional models for a Controlled Ecological Life Support System (CELSS): Linear mathematical modeling [NASA-CR-4229] p 166 N89-20615

**LUNGS**

- The development of a Compton lung densitometer [DE89-006654] p 153 N89-20603

**M****MAGNETIC EFFECTS**

- Alteration of gravitational field effect on sedimentation of erythrocytes by inhomogeneous magnetic field p 152 A89-34539

**MAGNETIC FIELDS**

- Propagation of the nerve impulse under the effect of a magnetic field [DE88-705371] p 159 N89-20608

**MAMMALS**

- Effects of simultaneous radiofrequency radiation and chemical exposure of mammalian cells, volume 2 [AD-A202780] p 160 N89-21467

**MAN MACHINE SYSTEMS**

- The system perspective --- for pilot-aircraft control interaction p 164 A89-34433  
The human senses in flight p 162 A89-34435  
Information processing --- in human performance p 162 A89-34436  
Pilot control p 165 A89-34442  
Airline pilots' perspective --- on cockpit controls, selection and training, and work environment p 165 A89-34447  
Helicopter human factors p 165 A89-34449

**MAN-COMPUTER INTERFACE**

- Software interfaces for aviation systems p 165 A89-34445  
Modeling the cognitive content of displays p 165 A89-34832

- Direct manipulation and other styles of man-machine interaction [REPT-88-53] p 166 N89-20616

- User interfaces and highly interactive systems: Survey of current research [REPT-88-60] p 166 N89-20617

- Graphical man-machine interface for an integrated evaluation environment [AD-A203054] p 168 N89-21487

**MANNED SPACE FLIGHT**

- Saccadic eye movement during spaceflight [NASA-TM-100475] p 159 N89-21463

**MANUAL CONTROL**

- Capacity of human operator using smart stick controller [AD-A202712] p 167 N89-21483

**MARINE ENVIRONMENTS**

- The end-triassic mass extinction event p 154 N89-21324  
Diachronism between extinction time of terrestrial and marine dinosaurs p 154 N89-21325

- Selective extinction of marine plankton at the end of the Mesozoic era: The fossil and stable isotope record p 155 N89-21329

- Mass extinctions in the deep sea p 156 N89-21396

- Macrofossil extinction patterns at Bay of Biscay Cretaceous-Tertiary boundary sections p 157 N89-21404



**MATHEMATICAL MODELS**

- Precision in the perception of direction of a moving pattern  
[NASA-TM-101080] p 163 N89-20610
- Nutritional models for a Controlled Ecological Life Support System (CELSS): Linear mathematical modeling  
[NASA-CR-4229] p 166 N89-20615
- A study of motion sickness: Mathematical modeling and data analysis  
[AD-A202770] p 160 N89-21466

**MEDICAL SCIENCE**

- Medical subject headings, tree structures, 1989  
[PB89-100028] p 158 N89-20605

**MEMBRANES**

- Gating kinetics and ion transfer in channels of nerve membrane  
[AD-A202509] p 160 N89-21464

**MENTAL PERFORMANCE**

- Componential analysis of pilot decision making  
[AD-A203711] p 163 N89-20613
- Coping with novelty and human intelligence: The role of counterfactual reasoning  
[AD-A203624] p 164 N89-21478

**METALS**

- Heavy metal toxicity as a kill mechanism in impact caused mass extinctions p 157 N89-21406

**METEORIC COLLISIONS**

- Late Wenlock (middle Silurian) bio-events: Caused by volatile boloid impact/s p 153 N89-21295
- Dinosaur bone beds and mass mortality: Implications for the K-T extinction p 154 N89-21301
- Plant microfossil record of the terminal Cretaceous event in the western United States and Canada p 155 N89-21363
- Permo-Triassic vertebrate extinctions: A program p 155 N89-21367
- Periodicity of extinction: A 1988 update p 156 N89-21385
- Mass extinctions in the deep sea p 156 N89-21396
- Heavy metal toxicity as a kill mechanism in impact caused mass extinctions p 157 N89-21406

**MICROPHONES**

- LCP-10 intelligibility of oxygen masks and microphones in aircraft noise  
[AD-A202474] p 167 N89-21481

**MICROSCOPY**

- X-ray microscopy for the life and physical sciences  
[DE89-006707] p 153 N89-20604

**MICROWAVES**

- Behavioral effects of microwaves: Relationship of total dose and dose rate  
[PB89-118640] p 159 N89-21462
- LMS adaptive filtering applied to a microwave arterial pulse monitor  
[AD-A202732] p 160 N89-21465

**MILITARY HELICOPTERS**

- The impact of the US Army's AH-64 helmet mounted display on future aviation helmet design  
[AD-A202984] p 168 N89-21486

**MOISTURE**

- Why cold-wet makes one feel chilled: A literature review  
[AD-A203452] p 159 N89-20609

**MONITORS**

- LMS adaptive filtering applied to a microwave arterial pulse monitor  
[AD-A202732] p 160 N89-21465

**MORTALITY**

- Late Wenlock (middle Silurian) bio-events: Caused by volatile boloid impact/s p 153 N89-21295
- Dinosaur bone beds and mass mortality: Implications for the K-T extinction p 154 N89-21301

**MOTION PERCEPTION**

- The human senses in flight p 162 A89-34435
- Precision in the perception of direction of a moving pattern  
[NASA-TM-101080] p 163 N89-20610

**MOTION SICKNESS**

- A study of motion sickness: Mathematical modeling and data analysis  
[AD-A202770] p 160 N89-21466

**MOTION SICKNESS DRUGS**

- A study of motion sickness: Mathematical modeling and data analysis  
[AD-A202770] p 160 N89-21466

**MURCHISON METEORITE**

- Probable pathways for the formation of non-protein amino acids, contained in meteorites, from protein amino acids by decarboxylation and deamination p 169 A89-35705

**MUSCLES**

- Influences of muscle fiber composition and strength on EMG (electromyographic activity), spinal motion and load acceleration during a repetitive lifting task  
[PB89-131221] p 159 N89-20607

**MUSCULAR STRENGTH**

- Influences of muscle fiber composition and strength on EMG (electromyographic activity), spinal motion and load acceleration during a repetitive lifting task  
[PB89-131221] p 159 N89-20607

**MUSCULAR TONUS**

- Changes in size and compliance of the calf after 30 days of simulated microgravity p 158 A89-35000

**MUSCLOSKELETAL SYSTEM**

- Transcriptional regulation of decreased protein synthesis during skeletal muscle unloading p 152 A89-34998

**MUTATIONS**

- Effects of simultaneous radiofrequency radiation and chemical exposure of mammalian cells, volume 2  
[AD-A202780] p 160 N89-21467

**N****NERVES**

- Propagation of the nerve impulse under the effect of a magnetic field  
[DE88-705371] p 159 N89-20608

- Gating kinetics and ion transfer in channels of nerve membrane  
[AD-A202509] p 160 N89-21464

**NEUROMUSCULAR TRANSMISSION**

- Gating kinetics and ion transfer in channels of nerve membrane  
[AD-A202509] p 160 N89-21464

**NIGHT FLIGHTS (AIRCRAFT)**

- Helicopter flights with night-vision goggles: Human factors aspects  
[NASA-TM-101039] p 164 N89-21477

**NIGHT VISION**

- Helicopter flights with night-vision goggles: Human factors aspects  
[NASA-TM-101039] p 164 N89-21477

- Polycarbonate ophthalmic lenses for ametropic Army aviators using night vision goggles  
[AD-A203100] p 168 N89-21488

**NITRILES**

- UV spectroscopy of Titan's atmosphere, planetary organic chemistry, and prebiological synthesis p 168 A89-33789

**NOISE REDUCTION**

- LMS adaptive filtering applied to a microwave arterial pulse monitor  
[AD-A202732] p 160 N89-21465
- LCP-10 intelligibility of oxygen masks and microphones in aircraft noise  
[AD-A202474] p 167 N89-21481

**NUTRITIONAL REQUIREMENTS**

- Nutritional models for a Controlled Ecological Life Support System (CELSS): Linear mathematical modeling  
[NASA-CR-4229] p 166 N89-20615

**O****OCEAN BOTTOM**

- A novel eye in 'eyeless' shrimp from hydrothermal vents of the Mid-Atlantic Ridge p 151 A89-32757
- Mass extinctions in the deep sea p 156 N89-21396
- Macrofossil extinction patterns at Bay of Biscay Cretaceous-Tertiary boundary sections p 157 N89-21412

- The Cretaceous-Tertiary boundary marine extinction and global primary productivity collapse p 157 N89-21412

**ONBOARD EQUIPMENT**

- OBOGS for Japanese new intermediate jet trainer T-4 p 165 A89-35844

**OPERATOR PERFORMANCE**

- Visual accommodation and target detection in the vicinity of a window post p 163 A89-34834
- Safe working time limits in impermeable protective clothing: Recommendations based upon experimental measurements  
[IZF-1987-28] p 166 N89-20618

**OPHTHALMOLOGY**

- Polycarbonate ophthalmic lenses for ametropic Army aviators using night vision goggles  
[AD-A203100] p 168 N89-21488

**OPTIMAL CONTROL**

- Computer simulation of a pilot in V/STOL aircraft control loops  
[NASA-CR-184815] p 166 N89-21479

**OPTIMIZATION**

- The development of a Compton lung densitometer  
[DE89-006654] p 153 N89-20603

**ORBIT PERTURBATION**

- Earth orbital variations and vertebrate bioevolution p 155 N89-21357

**ORGANIC CHEMISTRY**

- UV spectroscopy of Titan's atmosphere, planetary organic chemistry, and prebiological synthesis p 168 A89-33789

- Probable pathways for the formation of non-protein amino acids, contained in meteorites, from protein amino acids by decarboxylation and deamination p 169 A89-35705

**ORGANIC MATERIALS**

- Hydrogen isotope composition of insoluble organic matter from cherts p 168 A89-32809

**ORGANISMS**

- Limitations on K-T mass extinction theories based upon the vertebrate record p 153 N89-21290
- Mass extinctions in the deep sea p 156 N89-21396

**OXIDATION**

- Comparative evaluation of the effect of immobilization stress on the dynamics of resistance to the induction of the peroxidation of lipids of the internal organs and brain p 152 A89-35500

**OXYGEN SUPPLY EQUIPMENT**

- OBOGS for Japanese new intermediate jet trainer T-4 p 165 A89-35844

**OZONE**

- Pulmonary function studies in the rat addressing concentration versus time relationships of ozone (O<sub>3</sub>)  
[PB89-129050] p 157 N89-21461

**P****PALEOBIOLOGY**

- Origination, diversity, and extinction metrics essential for analysis of mass biotic crisis events: An example from Cretaceous ammonoidea p 154 N89-21304

**PALEOCLIMATOLOGY**

- Plant microfossil record of the terminal Cretaceous event in the western United States and Canada p 155 N89-21363

**PALEOMAGNETISM**

- Diachronism between extinction time of terrestrial and marine dinosaurs p 154 N89-21325

**PATTERN RECOGNITION**

- Precision in the perception of direction of a moving pattern  
[NASA-TM-101080] p 163 N89-20610

**PENETRATION**

- Why cold-wet makes one feel chilled: A literature review  
[AD-A203452] p 159 N89-20609

**PERFORMANCE PREDICTION**

- Review and analysis of the literature in the area of human performance modeling  
[DE89-006800] p 166 N89-21480

**PERIODIC VARIATIONS**

- Periodicity of extinction: A 1988 update p 156 N89-21385

**PERIPHERAL VISION**

- Peripheral limitations on spatial vision  
[AD-A203388] p 161 N89-21472

**PERMITTIVITY**

- Accurate determination of the complex permittivity of biological tissue around 35 GHz  
[AD-A202907] p 160 N89-21470

**PERSONNEL**

- Measurer's handbook: US Army anthropometric survey, 1987-1988  
[AD-A202721] p 167 N89-21484

**PETROLOGY**

- Hydrogen isotope composition of insoluble organic matter from cherts p 168 A89-32809

**PHOTORECEPTORS**

- Peripheral limitations on spatial vision  
[AD-A203388] p 161 N89-21472

**PHYSICAL WORK**

- Safe working time limits in impermeable protective clothing: Recommendations based upon experimental measurements  
[IZF-1987-28] p 166 N89-20618

**PHYSIOLOGICAL EFFECTS**

- New models to assess behavioral and physiological performance of animals during inhalation exposures  
[PB89-128946] p 152 N89-20601

- Pulmonary function studies in the rat addressing concentration versus time relationships of ozone (O<sub>3</sub>)  
[PB89-129050] p 157 N89-21461

**PHYSIOLOGICAL TESTS**

- Resonance phenomena in EEG during photostimulation with flashes of varying frequency. I - Analysis of the effects of photostimulation p 158 A89-34019

**PHYSIOLOGY**

- Why cold-wet makes one feel chilled: A literature review  
[AD-A203452] p 159 N89-20609

**PHYTOPLANKTON**

Selective extinction of marine plankton at the end of the Mesozoic era: The fossil and stable isotope record p 155 N89-21329

**PILOT ERROR**

Group interaction and flight crew performance p 162 A89-34438  
Human error in aviation operations p 162 A89-34440

**PILOT PERFORMANCE**

The system perspective --- for pilot-aircraft control interaction p 164 A89-34433  
The human senses in flight p 162 A89-34435  
Pilot control p 165 A89-34442  
Airline pilots' perspective --- on cockpit controls, selection and training, and work environment p 165 A89-34447  
Simulator design and instructional features for air-to-ground attack - A transfer study p 163 A89-34835  
Componential analysis of pilot decision making [AD-A203711] p 163 N89-20613  
Helicopter flights with night-vision goggles: Human factors aspects [NASA-TM-101039] p 164 N89-21477  
Computer simulation of a pilot in V/STOL aircraft control loops [NASA-CR-184815] p 166 N89-21479  
Capacity of human operator using smart stick controller [AD-A202712] p 167 N89-21483

**PILOT TRAINING**

Componential analysis of pilot decision making [AD-A203711] p 163 N89-20613

**PLANKTON**

The Cretaceous-Tertiary boundary marine extinction and global primary productivity collapse p 157 N89-21412

**POLYCARBONATES**

Polycarbonate ophthalmic lenses for ametropic Army aviators using night vision goggles [AD-A203100] p 168 N89-21488

**PORTABLE EQUIPMENT**

The development of a Compton lung densitometer [DE89-006654] p 153 N89-20603

**PRESSURE BREATHING**

G-induced loss of consciousness and its prevention [AD-A202960] p 161 N89-21471

**PRODUCTIVITY**

The Cretaceous-Tertiary boundary marine extinction and global primary productivity collapse p 157 N89-21412

**PROTECTIVE CLOTHING**

SPH-4 helmet retention assembly reinforcement [AD-A200432] p 165 N89-20614  
Thermal protection afforded by two anti-exposure coveralls when worn in cold water [AD-A202865] p 167 N89-21485

**PROTEIN SYNTHESIS**

Transcriptional regulation of decreased protein synthesis during skeletal muscle unloading p 152 A89-34998

**PROTEINS**

Probable pathways for the formation of non-protein amino acids, contained in meteorites, from protein amino acids by decarboxylation and deamination p 169 A89-35705

**PROTOBIOLOGY**

UV spectroscopy of Titan's atmosphere, planetary organic chemistry, and prebiological synthesis p 168 A89-33789

**PSYCHOLOGY**

Why cold-wet makes one feel chilled: A literature review [AD-A203452] p 159 N89-20609  
Coping with novelty and human intelligence: The role of counterfactual reasoning [AD-A203624] p 164 N89-21478

**PSYCHOMOTOR PERFORMANCE**

Coping with novelty and human intelligence: The role of counterfactual reasoning [AD-A203624] p 164 N89-21478

**PSYCHOPHYSICS**

Precision in the perception of direction of a moving pattern [NASA-TM-101080] p 163 N89-20610  
Psychophysical studies of visual cortical functions [AD-A202814] p 160 N89-21468  
Peripheral limitations on spatial vision [AD-A203388] p 161 N89-21472

**PULMONARY FUNCTIONS**

Blunted hypoxic ventilatory drive in subjects susceptible to high-altitude pulmonary edema p 158 A89-34999  
Pulmonary function studies in the rat addressing concentration versus time relationships of ozone (O3) [PB89-129050] p 157 N89-21461

**PULSE RATE**

LMS adaptive filtering applied to a microwave arterial pulse monitor [AD-A202732] p 160 N89-21465

**R**

**RADIATION DOSAGE**

Behavioral effects of microwaves: Relationship of total dose and dose rate [PB89-118640] p 159 N89-21462  
Effects of simultaneous radiofrequency radiation and chemical exposure of mammalian cells, volume 2 [AD-A202780] p 160 N89-21467

**RADIATION EFFECTS**

Behavioral effects of microwaves: Relationship of total dose and dose rate [PB89-118640] p 159 N89-21462  
Effects of simultaneous radiofrequency radiation and chemical exposure of mammalian cells, volume 2 [AD-A202780] p 160 N89-21467

**RADIATION SOURCES**

A novel eye in 'eyeless' shrimp from hydrothermal vents of the Mid-Atlantic Ridge p 151 A89-32757

**RADIATION TOLERANCE**

Effects of simultaneous radiofrequency radiation and chemical exposure of mammalian cells, volume 2 [AD-A202780] p 160 N89-21467

**RADIO WAVES**

Effects of simultaneous radiofrequency radiation and chemical exposure of mammalian cells, volume 2 [AD-A202780] p 160 N89-21467

**REDUCED GRAVITY**

Increased efficiency of mammalian somatic cell hybrid production under microgravity conditions during ballistic rocket flight p 152 A89-34535  
Alteration of gravitational field effect on sedimentation of erythrocytes by inhomogeneous magnetic field p 152 A89-34539

**REINFORCING MATERIALS**

SPH-4 helmet retention assembly reinforcement [AD-A200432] p 165 N89-20614

**REPTILES**

Diachronism between extinction time of terrestrial and marine dinosaurs p 154 N89-21325

**RESEARCH**

Cognitive psychology at the Institute for Perception [IZF-1987-41] p 163 N89-20611

**RESONANCE**

Accurate determination of the complex permittivity of biological tissue around 35 GHz [AD-A200907] p 160 N89-21470

**RESPIRATION**

New models to assess behavioral and physiological performance of animals during inhalation exposures [PB89-128946] p 152 N89-20601

**RESPIRATORY PHYSIOLOGY**

External breathing, gas exchange, and blood acid-base balance in dogs under hyperthermia p 151 A89-34037

**RESPIRATORY SYSTEM**

Pulmonary function studies in the rat addressing concentration versus time relationships of ozone (O3) [PB89-129050] p 157 N89-21461

**RIBONUCLEIC ACIDS**

Aminoacylation of RNA minihelices with alanine p 151 A89-32759  
RNA evolution and the origins of life p 152 A89-34319

**ROTATING ENVIRONMENTS**

A study of motion sickness: Mathematical modeling and data analysis [AD-A202770] p 160 N89-21466

**S**

**SACCADIC EYE MOVEMENTS**

Saccadic eye movement during spaceflight [NASA-TM-100475] p 159 N89-21463  
Psychophysical studies of visual cortical functions [AD-A202814] p 160 N89-21468

**SAFETY FACTORS**

System safety --- in aviation p 164 A89-34434  
Human error in aviation operations p 162 A89-34440

**SATELLITE ATMOSPHERES**

UV spectroscopy of Titan's atmosphere, planetary organic chemistry, and prebiological synthesis p 168 A89-33789

**SEDIMENTS**

Alteration of gravitational field effect on sedimentation of erythrocytes by inhomogeneous magnetic field p 152 A89-34539

Step-wise extinctions at the Cretaceous-Tertiary boundary and their climatic implications p 155 N89-21354

Biostratigraphic case studies of six major extinctions p 156 N89-21390

The Cretaceous-Tertiary boundary marine extinction and global primary productivity collapse p 157 N89-21412

**SENSORY PERCEPTION**

Why cold-wet makes one feel chilled: A literature review [AD-A203452] p 159 N89-20609  
Psychophysical studies of visual cortical functions [AD-A202814] p 160 N89-21468

**SHELLFISH**

A novel eye in 'eyeless' shrimp from hydrothermal vents of the Mid-Atlantic Ridge p 151 A89-32757  
The visibility of 350 deg C black-body radiation by the shrimp *Rimicaris exoculata* and man p 151 A89-32758  
Macrofossil extinction patterns at Bay of Biscay Cretaceous-Tertiary boundary sections p 157 N89-21404

**SIGNAL PROCESSING**

LMS adaptive filtering applied to a microwave arterial pulse monitor [AD-A202732] p 160 N89-21465

**SIMULATION**

Brain activity during tactical decision-making. Part 5: A cross-study validation of evoked potentials as indices of workload [AD-A203763] p 161 N89-21474

**SKIN TEMPERATURE (BIOLOGY)**

Analysis of temperature patterns in humans p 158 A89-34021

**SMOKE**

New models to assess behavioral and physiological performance of animals during inhalation exposures [PB89-128946] p 152 N89-20601

**SOFTWARE ENGINEERING**

Software interfaces for aviation systems p 165 A89-34445

**SPACE ADAPTATION SYNDROME**

USSR Space Life Sciences Digest, Issue 21 [NASA-CR-3922(24)] p 153 N89-20602

**SPACE PERCEPTION**

Using depth recovery in humans [AD-A201278] p 159 N89-20606  
Reconstruction of binocular depth across continuous surfaces [AD-A202827] p 160 N89-21469  
Peripheral limitations on spatial vision [AD-A203388] p 161 N89-21472  
Seeing Ghost solutions in stereo vision [AD-A203581] p 161 N89-21473

**SPACE SHUTTLES**

Saccadic eye movement during spaceflight [NASA-TM-100475] p 159 N89-21463

**SPACE SUITS**

Getting a grip on space p 164 A89-34388

**SPACEBORNE EXPERIMENTS**

Increased efficiency of mammalian somatic cell hybrid production under microgravity conditions during ballistic rocket flight p 152 A89-34535

**SPATIAL DISTRIBUTION**

Using depth recovery in humans [AD-A201278] p 159 N89-20606

**SPATIAL RESOLUTION**

Peripheral limitations on spatial vision [AD-A203388] p 161 N89-21472

**SPECTRAL SENSITIVITY**

The visibility of 350 deg C black-body radiation by the shrimp *Rimicaris exoculata* and man p 151 A89-32758

**SPEECH**

F-16 speaker-independent speech recognition system using cockpit commands (70 words) [AD-A203177] p 168 N89-21489

**SPEECH RECOGNITION**

F-16 speaker-independent speech recognition system using cockpit commands (70 words) [AD-A203177] p 168 N89-21489

**SPINE**

Influences of muscle fiber composition and strength on EMG (electromyographic activity), spinal motion and load acceleration during a repetitive lifting task [PB89-131221] p 159 N89-20607

**STATISTICAL ANALYSIS**

Behavioral effects of microwaves: Relationship of total dose and dose rate [PB89-118640] p 159 N89-21462

**STATISTICAL DISTRIBUTIONS**

Origination, diversity, and extinction metrics essential for analysis of mass biotic crisis events: An example from cretaceous ammonioidea p 154 N89-21304

**STEREOSCOPIC VISION**  
 Seeing Ghost solutions in stereo vision  
 [AD-A203581] p 161 N89-21473

**STEREOSCOPY**  
 Reconstruction of binocular depth across continuous surfaces  
 [AD-A202827] p 160 N89-21469  
 Seeing Ghost solutions in stereo vision  
 [AD-A203581] p 161 N89-21473

**STRATIGRAPHY**  
 The end-Triassic mass extinction event  
 p 154 N89-21324  
 Late Frasnian mass extinction: Conodont event stratigraphy, global changes, and possible causes  
 p 156 N89-21380  
 Biostratigraphic case studies of six major extinctions  
 p 156 N89-21390

**STRESS (BIOLOGY)**  
 Comparative evaluation of the effect of immobilization stress on the dynamics of resistance to the induction of the peroxidation of lipids of the internal organs and brain  
 p 152 A89-35500

**SUBJECTS**  
 Medical subject headings, tree structures, 1989  
 [PB89-100028] p 158 N89-20605

**SUPERCRITICAL FLUIDS**  
 Supercritical fluid extraction and characterization of lipids from algae *Scenedesmus obliquus*  
 p 152 A89-34398

**SURVEYS**  
 Measurer's handbook: US Army anthropometric survey, 1987-1988  
 [AD-A202721] p 167 N89-21484

**SURVIVAL**  
 Limitations on K-T mass extinction theories based upon the vertebrate record  
 p 153 N89-21290

**SYSTEMS ANALYSIS**  
 Introductory overview  
 p 164 A89-34432  
 The system perspective --- for pilot-aircraft control interaction  
 p 164 A89-34433  
 System safety --- in aviation  
 p 164 A89-34434

**SYSTEMS ENGINEERING**  
 Human factors in aviation --- Book  
 p 164 A89-34431  
 Airline pilots' perspective --- on cockpit controls, selection and training, and work environment  
 p 165 A89-34447

**T**

**TARGET ACQUISITION**  
 Visual accommodation and target detection in the vicinity of a window post  
 p 163 A89-34834

**TARGET RECOGNITION**  
 Seeing Ghost solutions in stereo vision  
 [AD-A203581] p 161 N89-21473

**TAXONOMY**  
 Limitations on K-T mass extinction theories based upon the vertebrate record  
 p 153 N89-21290

**TEMPERATURE DISTRIBUTION**  
 Analysis of temperature patterns in humans  
 p 158 A89-34021

**THERMAL PROTECTION**  
 Thermal protection afforded by two anti-exposure coveralls when worn in cold water  
 [AD-A202865] p 167 N89-21485

**THERMOREGULATION**  
 External breathing, gas exchange, and blood acid-base balance in dogs under hyperthermia  
 p 151 A89-34037

**THESAURI**  
 Medical subject headings, tree structures, 1989  
 [PB89-100028] p 158 N89-20605

**TIME MEASUREMENT**  
 Biostratigraphic case studies of six major extinctions  
 p 156 N89-21390

**TIME SERIES ANALYSIS**  
 Periodicity of extinction: A 1988 update  
 p 156 N89-21385

**TISSUES (BIOLOGY)**  
 Gating kinetics and ion transfer in channels of nerve membrane  
 [AD-A202509] p 160 N89-21464  
 Accurate determination of the complex permittivity of biological tissue around 35 GHz  
 [AD-A202907] p 160 N89-21470

**TITAN**  
 UV spectroscopy of Titan's atmosphere, planetary organic chemistry, and prebiological synthesis  
 p 168 A89-33789

**TOLERANCES (PHYSIOLOGY)**  
 A study of motion sickness: Mathematical modeling and data analysis  
 [AD-A202770] p 160 N89-21466

**TOXICITY**  
 New models to assess behavioral and physiological performance of animals during inhalation exposures  
 [PB89-128946] p 152 N89-20601  
 Heavy metal toxicity as a kill mechanism in impact caused mass extinctions  
 p 157 N89-21406

**TRAINING AIRCRAFT**  
 OBOGS for Japanese new intermediate jet trainer T-4  
 p 165 A89-35844

**TRAINING EVALUATION**  
 Flight training and simulation  
 p 162 A89-34439

**TRANSMISSION LINES**  
 LCP-10 intelligibility of oxygen masks and microphones in aircraft noise  
 [AD-A202474] p 167 N89-21481

**TREND ANALYSIS**  
 Limitations on K-T mass extinction theories based upon the vertebrate record  
 p 153 N89-21290  
 A study of motion sickness: Mathematical modeling and data analysis  
 [AD-A202770] p 160 N89-21466

U

**U.S.S.R.**  
 USSR Space Life Sciences Digest, Issue 21  
 [NASA-CR-3922(24)] p 153 N89-20602

**ULTRAVIOLET SPECTROSCOPY**  
 UV spectroscopy of Titan's atmosphere, planetary organic chemistry, and prebiological synthesis  
 p 168 A89-33789

**USER REQUIREMENTS**  
 User interfaces and highly interactive systems: Survey of current research  
 [REPT-88-60] p 166 N89-20617

V

**VAPOR BARRIER CLOTHING**  
 Safe working time limits in impermeable protective clothing: Recommendations based upon experimental measurements  
 [IZF-1987-28] p 166 N89-20618

**VERTEBRATES**  
 Limitations on K-T mass extinction theories based upon the vertebrate record  
 p 153 N89-21290  
 Dinosaur bone beds and mass mortality: Implications for the K-T extinction  
 p 154 N89-21301  
 Permo-Triassic vertebrate extinctions: A program  
 p 155 N89-21367

**VISIBILITY**  
 The visibility of 350 deg C black-body radiation by the shrimp *Rimicaris exoculata* and man  
 p 151 A89-32758

**VISION**  
 Psychophysical studies of visual cortical functions  
 [AD-A202814] p 160 N89-21468

**VISUAL ACCOMMODATION**  
 Visual accommodation and target detection in the vicinity of a window post  
 p 163 A89-34834

**VISUAL ACUITY**  
 Peripheral limitations on spatial vision  
 [AD-A203388] p 161 N89-21472

**VISUAL PERCEPTION**  
 The human senses in flight  
 p 162 A89-34435  
 Binocular unmasking - An analog to binaural unmasking?  
 p 162 A89-34660  
 Precision in the perception of direction of a moving pattern  
 [NASA-TM-101080] p 163 N89-20610

**VISUAL PIGMENTS**  
 A novel eye in 'eyeless' shrimp from hydrothermal vents of the Mid-Atlantic Ridge  
 p 151 A89-32757

**VISUAL STIMULI**  
 Resonance phenomena in EEG during photostimulation with flashes of varying frequency. I - Analysis of the effects of photostimulation  
 p 158 A89-34019  
 Reconstruction of binocular depth across continuous surfaces  
 [AD-A202827] p 160 N89-21469

**VOICE COMMUNICATION**  
 LCP-10 intelligibility of oxygen masks and microphones in aircraft noise  
 [AD-A202474] p 167 N89-21481

**VOICE DATA PROCESSING**  
 F-16 speaker-independent speech recognition system using cockpit commands (70 words)  
 [AD-A203177] p 168 N89-21489

**VOLCANOLOGY**  
 Step-wise extinctions at the Cretaceous-Tertiary boundary and their climatic implications  
 p 155 N89-21354  
 Permo-Triassic vertebrate extinctions: A program  
 p 155 N89-21367

W

Biostratigraphic case studies of six major extinctions  
 p 156 N89-21390

**WARNING SYSTEMS**  
 G-induced loss of consciousness and its prevention  
 [AD-A202960] p 161 N89-21471

**WAVE PROPAGATION**  
 Propagation of the nerve impulse under the effect of a magnetic field  
 [DE88-705371] p 159 N89-20608

**WEATHERING**  
 Dinosaur bone beds and mass mortality: Implications for the K-T extinction  
 p 154 N89-21301

**WEIGHTLESSNESS SIMULATION**  
 Changes in size and compliance of the calf after 30 days of simulated microgravity  
 p 158 A89-35000

**WINDOWS (APERTURES)**  
 Visual accommodation and target detection in the vicinity of a window post  
 p 163 A89-34834

**WORDS (LANGUAGE)**  
 F-16 speaker-independent speech recognition system using cockpit commands (70 words)  
 [AD-A203177] p 168 N89-21489

**WORK CAPACITY**  
 Influences of muscle fiber composition and strength on EMG (electromyographic activity), spinal motion and load acceleration during a repetitive lifting task  
 [PB89-131221] p 159 N89-20607  
 Safe working time limits in impermeable protective clothing: Recommendations based upon experimental measurements  
 [IZF-1987-28] p 166 N89-20618

**WORKLOADS (PSYCHOPHYSIOLOGY)**  
 Human workload in aviation  
 p 162 A89-34437  
 Processing demands, effort, and individual differences in four different vigilance tasks  
 p 162 A89-34833  
 Brain activity during tactical decision-making. Part 5: A cross-study validation of evoked potentials as indices of workload  
 [AD-A203763] p 161 N89-21474

X

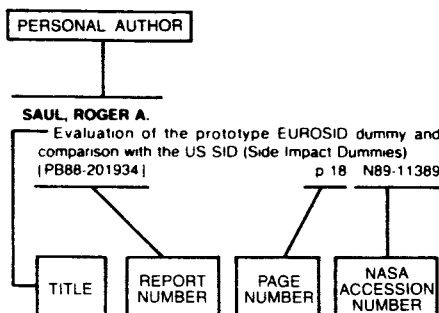
**X RAYS**  
 X-ray microscopy for the life and physical sciences  
 [DE89-006707] p 153 N89-20604

Z

**ZOOPLANKTON**  
 Selective extinction of marine plankton at the end of the Mesozoic era: The fossil and stable isotope record  
 p 155 N89-21329

# PERSONAL AUTHOR INDEX

## Typical Personal Author Index Listing



Listings in this index are arranged alphabetically by personal author. The title of the document provides the user with a brief description of the subject matter. The report number helps to indicate the type of document listed (e.g., NASA report, translation, NASA contractor report). The page and accession numbers are located beneath and to the right of the title. Under any one author's name the accession numbers are arranged in sequence with the AIAA accession numbers appearing first.

### A

- ADE, H.**  
X-ray microscopy for the life and physical sciences [DE89-006707] p 153 N89-20604
- AKMAN, VAROL**  
The power of physical representations [CWI-CS-R8819] p 163 N89-20612
- ARCHIBALD, J. DAVID**  
Limitations on K-T mass extinction theories based upon the vertebrate record p 153 N89-21290
- ARKHIPENKO, I. V.**  
Comparative evaluation of the effect of immobilization stress on the dynamics of resistance to the induction of the peroxidation of lipids of the internal organs and brain p 152 A89-35500
- ARTHUS, M. A.**  
The Cretaceous-Tertiary boundary marine extinction and global primary productivity collapse p 157 N89-21412
- ATTWOOD, D.**  
X-ray microscopy for the life and physical sciences [DE89-006707] p 153 N89-20604
- AVELLINI, BARBARA A.**  
Thermal protection afforded by two anti-exposure coveralls when worn in cold water [AD-A202865] p 167 N89-21485

### B

- BABCOCK, GARY L.**  
Airline pilots' perspective p 165 A89-34447
- BANKS, WILLIAM W.**  
Review and analysis of the literature in the area of human performance modeling [DE89-006800] p 166 N89-21480
- BARNETT, BARBARA**  
Componential analysis of pilot decision making [AD-A203711] p 163 N89-20613
- BARON, SHELDON**  
Pilot control p 165 A89-34442
- BERGHAGE, THOMAS E.**  
Review and analysis of the literature in the area of human performance modeling [DE89-006800] p 166 N89-21480

- BERRY, W. B. N.**  
Late Wenlock (middle Silurian) bio-events: Caused by volatile boloid impact/s p 153 N89-21295
- BHATTACHARYA, S. K.**  
Selective extinction of marine plankton at the end of the Mesozoic era: The fossil and stable isotope record p 155 N89-21329
- BLANKENSHIP, MARK H.**  
Brain activity during tactical decision-making. Part 5: A cross-study validation of evoked potentials as indices of workload [AD-A203763] p 161 N89-21474
- BOIKO, V. I.**  
External breathing, gas exchange, and blood acid-base balance in dogs under hyperthermia p 151 A89-34037
- BONDAR', A. T.**  
Resonance phenomena in EEG during photostimulation with flashes of varying frequency. I - Analysis of the effects of photostimulation p 158 A89-34019
- BRADTMILLER, BRUCE**  
Measuror's handbook: US Army anthropometric survey, 1987-1988 [AD-A202721] p 167 N89-21484
- BRICKNER, MICHAEL S.**  
Helicopter flights with night-vision goggles: Human factors aspects [NASA-TM-101039] p 164 N89-21477
- BRINKMAN, JAN-ALBERT**  
Processing demands, effort, and individual differences in four different vigilance tasks p 162 A89-34833
- BROOKES, ALLEN**  
Reconstruction of binocular depth across continuous surfaces [AD-A202827] p 160 N89-21469
- BRUSTON, PAUL**  
UV spectroscopy of Titan's atmosphere, planetary organic chemistry, and prebiological synthesis p 168 A89-33789
- BRYANT, LAURIE J.**  
Limitations on K-T mass extinction theories based upon the vertebrate record p 153 N89-21290
- BURGER-WIERSMA, TINEKE**  
The relationship of a prochlorophyte *Prochlorothrix hollandica* to green chloroplasts p 151 A89-32749
- BURTON, HILARY D.**  
Review and analysis of the literature in the area of human performance modeling [DE89-006800] p 166 N89-21480
- BUTLER, JAMIE L.**  
Late Frasnian mass extinction: Conodont event stratigraphy, global changes, and possible causes p 156 N89-21380
- BUTLER, JANICE**  
Review and analysis of the literature in the area of human performance modeling [DE89-006800] p 166 N89-21480

### C

- CANN, J. R.**  
A novel eye in 'eyeless' shrimp from hydrothermal vents of the Mid-Atlantic Ridge p 151 A89-32757
- CARO, PAUL W.**  
Flight training and simulation p 162 A89-34439
- CARPENTER, KENNETH**  
Dinosaur bone beds and mass mortality: Implications for the K-T extinction p 154 N89-21301
- CASPER, PATRICIA A.**  
Human workload in aviation p 162 A89-34437
- CHAMBERLAIN, STEVEN C.**  
A novel eye in 'eyeless' shrimp from hydrothermal vents of the Mid-Atlantic Ridge p 151 A89-32757  
The visibility of 350 deg C black-body radiation by the shrimp *Rimicaris exoculata* and man p 151 A89-32758
- CHECHILE, RICHARD A.**  
Modeling the cognitive content of displays p 165 A89-34832

- CHELA-FLORES, J.**  
Propagation of the nerve impulse under the effect of a magnetic field [DE88-705371] p 159 N89-20608
- CHESTUKHIN, V. V.**  
Central hemodynamics of healthy humans during a gradual decrease of circulating blood volume p 158 A89-34020
- CHOI, K. J.**  
Supercritical fluid extraction and characterization of lipids from algae *Scenedesmus obliquus* p 152 A89-34398
- CHONG, JENNY**  
Visual accommodation and target detection in the vicinity of a window post p 163 A89-34834
- CIARAVINO, VICTOR**  
Effects of simultaneous radiofrequency radiation and chemical exposure of mammalian cells, volume 2 [AD-A202780] p 160 N89-21467
- CLAUSER, CHARLES**  
Measuror's handbook: US Army anthropometric survey, 1987-1988 [AD-A202721] p 167 N89-21484
- COLLOM, CHRISTOPHER J.**  
Origination, diversity, and extinction metrics essential for analysis of mass biotic crisis events: An example from cretaceous ammonioidea p 154 N89-21304
- CONVERTINO, VICTOR A.**  
Changes in size and compliance of the calf after 30 days of simulated microgravity p 158 A89-35000
- COOK, THOMAS MICHAEL**  
Influences of muscle fiber composition and strength on EMG (electromyographic activity), spinal motion and load acceleration during a repetitive lifting task [PB89-131221] p 159 N89-20607
- COSSART-MAGOS, CLAUDINA**  
UV spectroscopy of Titan's atmosphere, planetary organic chemistry, and prebiological synthesis p 168 A89-33789
- COSTA, D. L.**  
Pulmonary function studies in the rat addressing concentration versus time relationships of ozone (O3) [PB89-129050] p 157 N89-21461
- COURTIN, REGIS**  
UV spectroscopy of Titan's atmosphere, planetary organic chemistry, and prebiological synthesis p 168 A89-33789
- COZZONE, ADOLPHO**  
Capacity of human operator using smart stick controller [AD-A202712] p 167 N89-21483
- CROSLY, JOHN K.**  
Polycarbonate ophthalmic lenses for ametropic Army aviators using night vision goggles [AD-A203100] p 168 N89-21488
- CROW, RITA M.**  
Why cold-wet makes one feel chilled: A literature review [AD-A203452] p 159 N89-20609

### D

- DAVENPORT, S. A.**  
Heavy metal toxicity as a kill mechanism in impact caused mass extinctions p 157 N89-21406
- DAVIS, TOM, JR.**  
Componential analysis of pilot decision making [AD-A203711] p 163 N89-20613
- DEAN, W. E.**  
The Cretaceous-Tertiary boundary marine extinction and global primary productivity collapse p 157 N89-21412
- DIDENKO, V. V.**  
Comparative evaluation of the effect of immobilization stress on the dynamics of resistance to the induction of the peroxidation of lipids of the internal organs and brain p 152 A89-35500
- DOERR, DONALD F.**  
Changes in size and compliance of the calf after 30 days of simulated microgravity p 158 A89-35000
- DONALDSON, P. LYNN**  
USSR Space Life Sciences Digest, Issue 21 [NASA-CR-3922(24)] p 153 N89-20602

## DREESEN, ROLAND

Late Frasnian mass extinction: Conodont event stratigraphy, global changes, and possible causes p 156 N89-21380

## DUKE, JACKIE C.

Suppression of morphogenesis in embryonic mouse limbs exposed in vitro to excess gravity p 152 A89-34400

## E

## EAGAN, PHYLLIS

Effects of simultaneous radiofrequency radiation and chemical exposure of mammalian cells, volume 2 [AD-A202780] p 160 N89-21467

## EDWARDS, ELWYN

Introductory overview p 164 A89-34432

## EGGLESTON, ROBERT G.

Modeling the cognitive content of displays p 165 A89-34832

## EL-SAYED, E. M.

Propagation of the nerve impulse under the effect of a magnetic field [DE88-705371] p 159 N89-20608

## ERMAKOVA, I. I.

Analysis of temperature patterns in humans p 158 A89-34021

## ETOH, MICHIO

OBOGS for Japanese new intermediate jet trainer T-4 p 165 A89-35844

## F

## FAINTER, ROBERT G.

Software interfaces for aviation systems p 165 A89-34445

## FEDOTCHEV, A. I.

Resonance phenomena in EEG during photostimulation with flashes of varying frequency. I - Analysis of the effects of photostimulation p 158 A89-34019

## FISHMAN, HARVEY M.

Gating kinetics and ion transfer in channels of nerve membrane [AD-A202509] p 160 N89-21464

## FLACH, JOHN M.

Information processing p 162 A89-34436

## FLEISCHMAN, REBECCA N.

Modeling the cognitive content of displays p 165 A89-34832

## FLEMING, R. F.

Plant microfossil record of the terminal Cretaceous event in the western United States and Canada p 155 N89-21363

## FOUSHEE, H. CLAYTON

Group interaction and flight crew performance p 162 A89-34438

## FRANCKLYN, CHRISTOPHER

Aminoacylation of RNA minihelices with alanine p 151 A89-32759

## FUJIMOTO, KEISAKU

Blunted hypoxic ventilatory drive in subjects susceptible to high-altitude pulmonary edema p 158 A89-34999

## G

## GARSHNEK, VICTORIA

USSR Space Life Sciences Digest, Issue 21 [NASA-CR-3922(24)] p 153 N89-20602

## GEOGHEGAN, T. E.

Transcriptional regulation of decreased protein synthesis during skeletal muscle unloading p 152 A89-34998

## GESSNER, P.

Increased efficiency of mammalian somatic cell hybrid production under microgravity conditions during ballistic rocket flight p 152 A89-34535

## GIOVANNONI, STEPHEN J.

The relationship of a prochlorophyte Prochlorothrix hollandica to green chloroplasts p 151 A89-32749

## GOLDEN, S. S.

psbA genes indicate common ancestry of prochlorophytes and chloroplasts p 151 A89-32750

## GORDON, CLAIRE

Measurer's handbook: US Army anthropometric survey, 1987-1988 [AD-A202721] p 167 N89-21484

## GOULDING, FRED S.

The development of a Compton lung densitometer [DE89-006654] p 153 N89-20603

## GRABOVSKII, L. A.

External breathing, gas exchange, and blood acid-base balance in dogs under hyperthermia p 151 A89-34037

## GRAEBER, R. CURTIS

Aircrew fatigue and circadian rhythmicity p 158 A89-34441

## GRIGOR'IAN, A. G.

Analysis of temperature patterns in humans p 158 A89-34021

## H

## HALEY, J. L., JR.

SPH-4 helmet retention assembly reinforcement [AD-A200432] p 165 N89-20614

## HALLAM, A.

The end-triassic mass extinction event p 154 N89-21324

## HANSEN, H. J.

Diachronism between extinction time of terrestrial and marine dinosaurs p 154 N89-21325

## HARADA, KAZURO

Blunted hypoxic ventilatory drive in subjects susceptible to high-altitude pulmonary edema p 158 A89-34999

## HART, SANDRA G.

Helicopter human factors p 165 A89-34449

## HATCH, G. E.

Pulmonary function studies in the rat addressing concentration versus time relationships of ozone (O3) [PB89-129050] p 157 N89-21461

## HELMREICH, ROBERT L.

Group interaction and flight crew performance p 162 A89-34438

## HENDRIKS, LOEK

Processing demands, effort, and individual differences in four different vigilance tasks p 162 A89-34833

## HERMAN, Y.

Selective extinction of marine plankton at the end of the Mesozoic era: The fossil and stable isotope record p 155 N89-21329

## HIGHFILL, J.

Pulmonary function studies in the rat addressing concentration versus time relationships of ozone (O3) [PB89-129050] p 157 N89-21461

## HOOKE, LYDIA RAZRAN

USSR Space Life Sciences Digest, Issue 21 [NASA-CR-3922(24)] p 153 N89-20602

## HOWARD, G.

Transcriptional regulation of decreased protein synthesis during skeletal muscle unloading p 152 A89-34998

## I

## IDO, MORIO

OBOGS for Japanese new intermediate jet trainer T-4 p 165 A89-35844

## ISKANDER, N.

X-ray microscopy for the life and physical sciences [DE89-006707] p 153 N89-20604

## IVANOV, CH. P.

Probable pathways for the formation of non-protein amino acids, contained in meteorites, from protein amino acids by decarboxylation and deamination p 169 A89-35705

## J

## JEPSON, ALLAN

Binocular unmasking - An analog to binaural unmasking? p 162 A89-34660

## JONES, D. D.

Heavy metal toxicity as a kill mechanism in impact caused mass extinctions p 157 N89-21406

## JOYCE, GERALD F.

RNA evolution and the origins of life p 152 A89-34319

## K

## KANSKI, JERRY J.

Graphical man-machine interface for an integrated evaluation environment [AD-A203054] p 168 N89-21487

## KANTOWITZ, BARRY H.

Human workload in aviation p 162 A89-34437

## KAREL, M.

Supercritical fluid extraction and characterization of lipids from algae *Scenedesmus obliquus* p 152 A89-34398

## KATKOV, V. E.

Central hemodynamics of healthy humans during a gradual decrease of circulating blood volume p 158 A89-34020

## KERBACHER, JAMES J.

Effects of simultaneous radiofrequency radiation and chemical exposure of mammalian cells, volume 2 [AD-A202780] p 160 N89-21467

## KERN, D.

X-ray microscopy for the life and physical sciences [DE89-006707] p 153 N89-20604

## KIM, PETER Y.

F-16 speaker-independent speech recognition system using cockpit commands (70 words) [AD-A203177] p 168 N89-21489

## KIRZ, J.

X-ray microscopy for the life and physical sciences [DE89-006707] p 153 N89-20604

## KOBAYASHI, TOSHIO

Blunted hypoxic ventilatory drive in subjects susceptible to high-altitude pulmonary edema p 158 A89-34999

## KOELEGA, HARRY S.

Processing demands, effort, and individual differences in four different vigilance tasks p 162 A89-34833

## KONOVALOV, V. F.

Resonance phenomena in EEG during photostimulation with flashes of varying frequency. I - Analysis of the effects of photostimulation p 158 A89-34019

## KRUKONIS, V. J.

Supercritical fluid extraction and characterization of lipids from algae *Scenedesmus obliquus* p 152 A89-34398

## KUCUK, SENOL

Computer simulation of a pilot in V/STOL aircraft control loops [NASA-CR-184815] p 166 N89-21479

## KUYK, THOMAS K.

Using depth recovery in humans [AD-A201278] p 159 N89-20606

## L

## LANOUE, BERNARD

SPH-4 US Army flight helmet performance 1983-1987 [AD-A202589] p 167 N89-21482

## LEIBOWITZ, HERSHEL W.

The human senses in flight p 162 A89-34435

## LEWIS, GREGORY W.

Brain activity during tactical decision-making. Part 5: A cross-study validation of evoked potentials as indices of workload [AD-A203763] p 161 N89-21474

## LINDER, BARRY J.

Saccadic eye movement during spaceflight [NASA-TM-100475] p 159 N89-21463

## LINTERN, GAVAN

Simulator design and instructional features for air-to-ground attack - A transfer study p 163 A89-34835

## LOO, BILLY W.

The development of a Compton lung densitometer [DE89-006654] p 153 N89-20603

## M

## MACLEOD, KENNETH

Macrofossil extinction patterns at Bay of Biscay Cretaceous-Tertiary boundary sections p 157 N89-21404

## MADDEN, NORM W.

The development of a Compton lung densitometer [DE89-006654] p 153 N89-20603

## MALEK, DOLORES ELIZABETH

New models to assess behavioral and physiological performance of animals during inhalation exposures [PB89-128946] p 152 N89-20601

## MARTIN, JOHN S.

The impact of the US Army's AH-64 helmet mounted display on future aviation helmet design [AD-A202984] p 168 N89-21486

## MASLENNIKOV, A. V.

Central hemodynamics of healthy humans during a gradual decrease of circulating blood volume p 158 A89-34020

## MATSUZAWA, YUKINORI

Blunted hypoxic ventilatory drive in subjects susceptible to high-altitude pulmonary edema p 158 A89-34999

## MAURRASSE, FLORENTIN J.-M. R.

Step-wise extinctions at the Cretaceous-Tertiary boundary and their climatic implications p 155 N89-21354

## MCCONVILLE, JOHN

Measurer's handbook: US Army anthropometric survey, 1987-1988 [AD-A202721] p 167 N89-21484

## MCKINLEY, RICHARD L.

LCP-10 intelligibility of oxygen masks and microphones in aircraft noise [AD-A202474] p 167 N89-21481

## MCLEAN, DEWEY M.

Earth orbital variations and vertebrate bioevolution p 155 N89-21357

- MCQUAID, K.**  
X-ray microscopy for the life and physical sciences  
[DE89-006707] p 153 N89-20604
- MEERSON, F. Z.**  
Comparative evaluation of the effect of immobilization stress on the dynamics of resistance to the induction of the peroxidation of lipids of the internal organs and brain p 152 A89-35500
- MELTZ, MARTIN L.**  
Effects of simultaneous radiofrequency radiation and chemical exposure of mammalian cells, volume 2  
[AD-A202780] p 160 N89-21467
- MEYER-ILSE, W.**  
X-ray microscopy for the life and physical sciences  
[DE89-006707] p 153 N89-20604
- MICKLE, MARLIN H.**  
Computer simulation of a pilot in V/STOL aircraft control loops  
[NASA-CR-184815] p 166 N89-21479
- MILLER, C. O.**  
System safety p 164 A89-34434
- MINIAILENKO, T. D.**  
External breathing, gas exchange, and blood acid-base balance in dogs under hyperthermia p 151 A89-34037
- MOMMADOV, I. M.**  
Analysis of temperature patterns in humans p 158 A89-34021
- MOORE, THOMAS P.**  
Saccadic eye movement during spaceflight  
[NASA-TM-100475] p 159 N89-21463
- MORAGLIA, GIAMPAOLO**  
Binocular unmasking - An analog to binaural unmasking? p 162 A89-34660
- MORDEN, C. W.**  
psbA genes indicate common ancestry of prochlorophytes and chloroplasts p 151 A89-32750
- MOSER, DIANE**  
Getting a grip on space p 164 A89-34388
- MUR, LUUC R.**  
The relationship of a prochlorophyte *Prochlorothrix hollandica* to green chloroplasts p 151 A89-32749
- N**
- NAGEL, DAVID C.**  
Human factors in aviation p 164 A89-34431  
Human error in aviation operations p 162 A89-34440
- NAKAYAMA, KEN**  
Psychophysical studies of visual cortical functions  
[AD-A202814] p 160 N89-21468
- NAKHOST, Z.**  
Supercritical fluid extraction and characterization of lipids from algae *Scenedesmus obliquus* p 152 A89-34398
- NAMUSHI, NAMUSHI R.**  
Blunted hypoxic ventilatory drive in subjects susceptible to high-altitude pulmonary edema p 158 A89-34999
- NEIL, G. A.**  
Increased efficiency of mammalian somatic cell hybrid production under microgravity conditions during ballistic rocket flight p 152 A89-34535
- NICHOLS, D. J.**  
Plant microfossil record of the terminal Cretaceous event in the western United States and Canada p 155 N89-21363
- NIKOLAENKO, E. M.**  
Central hemodynamics of healthy humans during a gradual decrease of circulating blood volume p 158 A89-34020
- NIXON, CHARLES W.**  
LCP-10 intelligibility of oxygen masks and microphones in aircraft noise  
[AD-A202474] p 167 N89-21481
- NOLAN, MARGARET D.**  
Simulator design and instructional features for air-to-ground attack - A transfer study p 163 A89-34835
- O**
- O'CONNOR, MARY ELLEN**  
Behavioral effects of microwaves: Relationship of total dose and dose rate  
[PB89-118640] p 159 N89-21462
- OLSON, E. C.**  
Permo-Triassic vertebrate extinctions: A program p 155 N89-21367
- P**
- PACE, NORMAN R.**  
The relationship of a prochlorophyte *Prochlorothrix hollandica* to green chloroplasts p 151 A89-32749
- PALMER, RONALD W.**  
SPH-4 helmet retention assembly reinforcement  
[AD-A200432] p 165 N89-20614
- PARKER, DONNA L.**  
Simulator design and instructional features for air-to-ground attack - A transfer study p 163 A89-34835
- PELLI, DENIS G.**  
The visibility of 350 deg C black-body radiation by the shrimp *Fimricaris exoculata* and man p 151 A89-32758
- PIMENTAL, NANCY A.**  
Thermal protection afforded by two anti-exposure coveralls when worn in cold water p 167 N89-21485
- PONCET, HENRI**  
UV spectroscopy of Titan's atmosphere, planetary organic chemistry, and prebiological synthesis p 168 A89-33789
- POOL, SAM L.**  
Saccadic eye movement during spaceflight  
[NASA-TM-100475] p 159 N89-21463
- POZHAROV, V. P.**  
External breathing, gas exchange, and blood acid-base balance in dogs under hyperthermia p 151 A89-34037
- PRITTS, DOUGLAS**  
SPH-4 US Army flight helmet performance 1983-1987  
[AD-A202589] p 167 N89-21482
- R**
- RARBACK, H.**  
X-ray microscopy for the life and physical sciences  
[DE89-006707] p 153 N89-20604
- RASH, CLARENCE E.**  
The impact of the US Army's AH-64 helmet mounted display on future aviation helmet design  
[AD-A202984] p 168 N89-21486
- RATH, H. J.**  
Alteration of gravitational field effect on sedimentation of erythrocytes by inhomogeneous magnetic field p 152 A89-34539
- RAULIN, FRANCOIS**  
UV spectroscopy of Titan's atmosphere, planetary organic chemistry, and prebiological synthesis p 168 A89-33789
- ROBERT, FRANCOIS**  
Hydrogen isotope composition of insoluble organic matter from cherts p 168 A89-32809
- ROTHMAN, S.**  
X-ray microscopy for the life and physical sciences  
[DE89-006707] p 153 N89-20604
- ROWE, JOSEPH**  
USSR Space Life Sciences Digest, Issue 21  
[NASA-CR-3922(24)] p 153 N89-20602
- RUMIANTSEV, V. V.**  
Central hemodynamics of healthy humans during a gradual decrease of circulating blood volume p 158 A89-34020
- S**
- SANDBERG, CHARLES A.**  
Late Frasnian mass extinction: Conodont event stratigraphy, global changes, and possible causes p 156 N89-21380
- SANDERS, A. F.**  
Cognitive psychology at the Institute for Perception  
[IZF-1987-41] p 163 N89-20611
- SASSEVILLE, ANN MARIE**  
Modeling the cognitive content of displays p 165 A89-34832
- SAZONTOVA, T. G.**  
Comparative evaluation of the effect of immobilization stress on the dynamics of resistance to the induction of the peroxidation of lipids of the internal organs and brain p 152 A89-35500
- SCHIMMEL, PAUL**  
Aminoacylation of RNA minihelices with alanine p 151 A89-32759
- SCHNEIDER, BRUCE**  
Binocular unmasking - An analog to binaural unmasking? p 162 A89-34660
- SCHNETTLER, R.**  
Increased efficiency of mammalian somatic cell hybrid production under microgravity conditions during ballistic rocket flight p 152 A89-34535
- SCOTT, MARK F.**  
A study of motion sickness: Mathematical modeling and data analysis  
[AD-A202770] p 160 N89-21466
- SEPKOWSKI, J. JOHN, JR.**  
Periodicity of extinction: A 1988 update p 156 N89-21385
- SEREDENKO, M. M.**  
External breathing, gas exchange, and blood acid-base balance in dogs under hyperthermia p 151 A89-34037
- SHEPPARD, DANIEL J.**  
Simulator design and instructional features for air-to-ground attack - A transfer study p 163 A89-34835
- SHEPPARD, RODNEY J.**  
Accurate determination of the complex permittivity of biological tissue around 35 GHz  
[AD-A202907] p 160 N89-21470
- SHERIDAN, THOMAS B.**  
The system perspective p 164 A89-34433
- SIMES, BRIAN J.**  
LMS adaptive filtering applied to a microwave arterial pulse monitor  
[AD-A202732] p 160 N89-21465
- SIMON, DANIEL S.**  
The development of a Compton lung densitometer  
[DE89-006654] p 153 N89-20603
- SINGH, MEGHA**  
Alteration of gravitational field effect on sedimentation of erythrocytes by inhomogeneous magnetic field p 152 A89-34539
- SLOAN, R. E.**  
Biostratigraphic case studies of six major extinctions p 156 N89-21390
- SODERBERG, GARY L.**  
Influences of muscle fiber composition and strength on EMG (electromyographic activity), spinal motion and load acceleration during a repetitive lifting task  
[PB89-131221] p 159 N89-20607
- SPANGENBURG, RAY**  
Getting a grip on space p 164 A89-34388
- STEFFEN, J. M.**  
Transcriptional regulation of decreased protein synthesis during skeletal muscle unloading p 152 A89-34998
- STEIN, STEWART L.**  
Changes in size and compliance of the calf after 30 days of simulated microgravity p 158 A89-35000
- STERNBERG, ROBERT J.**  
Coping with novelty and human intelligence: The role of counterfactual reasoning p 164 N89-21478
- STEVENS, KENT A.**  
Reconstruction of binocular depth across continuous surfaces  
[AD-A202827] p 160 N89-21469
- STEVENS, M. A.**  
Pulmonary function studies in the rat addressing concentration versus time relationships of ozone (O3)  
[PB89-129050] p 157 N89-21461
- STOKES, ALAN**  
Componential analysis of pilot decision making  
[AD-A203711] p 163 N89-20613
- STONE, LELAND S.**  
Precision in the perception of direction of a moving pattern  
[NASA-TM-101080] p 163 N89-20610
- STONE, RICHARD B.**  
Airline pilots' perspective p 165 A89-34447
- STRATTAN, ROBERT**  
Behavioral effects of microwaves: Relationship of total dose and dose rate  
[PB89-118640] p 159 N89-21462
- SULTANOV, F. F.**  
Analysis of temperature patterns in humans p 158 A89-34021
- SZUTS, ETE Z.**  
A novel eye in 'eyeless' shrimp from hydrothermal vents of the Mid-Atlantic Ridge p 151 A89-32757
- T**
- TEBBETTS, ILSE**  
Measurer's handbook: US Army anthropometric survey, 1987-1988  
[AD-A202721] p 167 N89-21484
- TENHAGEN, PAUL J. W.**  
The power of physical representations  
[CWI-CS-R8819] p 163 N89-20612
- TEPPER, J. S.**  
Pulmonary function studies in the rat addressing concentration versus time relationships of ozone (O3)  
[PB89-129050] p 157 N89-21461
- THOMAS, E.**  
Mass extinctions in the deep sea p 156 N89-21396
- THORNTON, WILLIAM E.**  
Saccadic eye movement during spaceflight  
[NASA-TM-100475] p 159 N89-21463

**TODA, NORIO**

OBOGS for Japanese new intermediate jet trainer T-4  
p 165 A89-35844

**TREJO, LEONARD J.**

Brain activity during tactical decision-making. Part 5: A cross-study validation of evoked potentials as indices of workload

[AD-A203763] p 161 N89-21474

**TRIGGS, THOMAS J.**

Visual accommodation and target detection in the vicinity of a window post

p 163 A89-34834

**TURNER, SEAN**

The relationship of a prochlorophyte *Prochlorothrix hollandica* to green chloroplasts

p 151 A89-32749

**U****URI, JOHN J.**

Saccadic eye movement during spaceflight

[NASA-TM-100475] p 159 N89-21463

**URNOVITZ, H. B.**

Increased efficiency of mammalian somatic cell hybrid production under microgravity conditions during ballistic rocket flight

p 152 A89-34535

**V****VAN DOVER, CINDY LEE**

A novel eye in 'eyeless' shrimp from hydrothermal vents of the Mid-Atlantic Ridge

p 151 A89-32757

**VANDELINDE, F. J. G.**

Safe working time limits in impermeable protective clothing: Recommendations based upon experimental measurements

[IZF-1987-28] p 166 N89-20618

**VERBATEN, MARINUS N.**

Processing demands, effort, and individual differences in four different vigilance tasks

p 162 A89-34833

**VERSENDAAL, J. M.**

Direct manipulation and other styles of man-machine interaction

[REPT-88-53] p 166 N89-20616

User interfaces and highly interactive systems: Survey of current research

[REPT-88-60] p 166 N89-20617

**VLADIMIRSKY, Y.**

X-ray microscopy for the life and physical sciences

[DE89-006707] p 153 N89-20604

**VOGT, WILLIAM G.**

Computer simulation of a pilot in V/STOL aircraft control loops

[NASA-CR-184815] p 166 N89-21479

**VYRNWY-JONES, PETER**

SPH-4 US Army flight helmet performance 1983-1987

[AD-A202589] p 167 N89-21482

**W****WADE, ROSE C.**

Nutritional models for a Controlled Ecological Life Support System (CELSS): Linear mathematical modeling

[NASA-CR-4229] p 166 N89-20615

**WANG, X. Y.**

Propagation of the nerve impulse under the effect of a magnetic field

[DE88-705371] p 159 N89-20608

**WARD, PETER D.**

Macrofossil extinction patterns at Bay of Biscay Cretaceous-Tertiary boundary sections

p 157 N89-21404

**WDOWIAK, P.**

Heavy metal toxicity as a kill mechanism in impact caused mass extinctions

p 157 N89-21406

**WDOWIAK, T. J.**

Heavy metal toxicity as a kill mechanism in impact caused mass extinctions

p 157 N89-21406

**WEINSHALL, DAPHNA**

Seeing Ghost solutions in stereo vision

[AD-A203581] p 161 N89-21473

**WICKENS, CHRISTOPHER D.**

Information processing

p 162 A89-34436

Componential analysis of pilot decision making

[AD-A203711] p 163 N89-20613

**WIENER, EARL L.**

Human factors in aviation

p 164 A89-34431

**WILDE, P.**

Late Wenlock (middle Silurian) bio-events: Caused by volatile boloid impact/s

p 153 N89-21295

**WILLIAMS, DAVID R.**

Peripheral limitations on spatial vision

[AD-A203388] p 161 N89-21472

**WILLIGES, BEVERLY H.**

Software interfaces for aviation systems

p 165 A89-34445

**WILLIGES, ROBERT C.**

Software interfaces for aviation systems

p 165 A89-34445

**WOOD, EARL H.**

G-induced loss of consciousness and its prevention

[AD-A202960] p 161 N89-21471

**Y****YATES, KAREN E.**

Simulator design and instructional features for air-to-ground attack - A transfer study

p 163 A89-34835

**Z****ZACHOS, J. C.**

The Cretaceous-Tertiary boundary marine extinction and global primary productivity collapse

p 157 N89-21412

**ZIEGLER, WILLI**

Late Frasnian mass extinction: Conodont event stratigraphy, global changes, and possible causes

p 156 N89-21380

**ZIMMERMANN, U.**

Increased efficiency of mammalian somatic cell hybrid production under microgravity conditions during ballistic rocket flight

p 152 A89-34535

**ZIPF, MARK E.**

Computer simulation of a pilot in V/STOL aircraft control loops

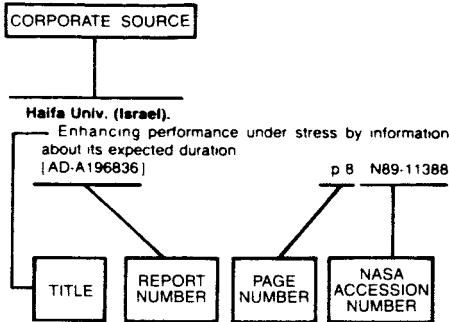
[NASA-CR-184815] p 166 N89-21479

# CORPORATE SOURCE INDEX

AEROSPACE MEDICINE AND BIOLOGY / A Continuing Bibliography (Supplement 326)

August 1989

## Typical Corporate Source Index Listing



Listings in this index are arranged alphabetically by corporate source. The title of the document is used to provide a brief description of the subject matter. The page number and the accession number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document.

## A

- Aerospace Medical Research Labs., Wright-Patterson AFB, OH.**  
LCP-10 intelligibility of oxygen masks and microphones in aircraft noise [AD-A202474] p 167 N89-21481
- Air Force Inst. of Tech., Wright-Patterson AFB, OH.**  
LMS adaptive filtering applied to a microwave arterial pulse monitor [AD-A202732] p 160 N89-21465  
A study of motion sickness: Mathematical modeling and data analysis [AD-A202770] p 160 N89-21466  
Capacity of human operator using smart stick controller [AD-A202712] p 167 N89-21483  
Graphical man-machine interface for an integrated evaluation environment [AD-A203054] p 168 N89-21487  
F-16 speaker-independent speech recognition system using cockpit commands (70 words) [AD-A203177] p 168 N89-21489
- Alabama Univ., Birmingham.**  
Heavy metal toxicity as a kill mechanism in impact caused mass extinctions p 157 N89-21406
- Anthropology Research Project, Yellow Springs, OH.**  
Measurer's handbook: US Army anthropometric survey, 1987-1988 [AD-A202721] p 167 N89-21484
- Army Aeromedical Research Lab., Fort Rucker, AL.**  
SPH-4 helmet retention assembly reinforcement [AD-A200432] p 165 N89-20614  
The impact of the US Army's AH-64 helmet mounted display on future aviation helmet design [AD-A202984] p 168 N89-21486
- Army Aeromedical Research Unit, Fort Rucker, AL.**  
SPH-4 US Army flight helmet performance 1983-1987 [AD-A202589] p 167 N89-21482

- Polycarbonate ophthalmic lenses for ametropic Army aviators using night vision goggles [AD-A203100] p 168 N89-21488
- Army Medical Service, Washington, DC.**  
Aircrew fatigue and circadian rhythmicity p 158 A89-34441

## B

- Battelle Memorial Inst., Seattle.**  
Human workload in aviation p 162 A89-34437
- Birmingham Univ. (England).**  
The end-triassic mass extinction event p 154 N89-21324

## C

- California Univ., Berkeley.**  
Limitations on K-T mass extinction theories based upon the vertebrate record p 153 N89-21290  
Late Wenlock (middle Silurian) bio-events: Caused by volatile boloid impact/s p 153 N89-21295
- California Univ., Berkeley. Lawrence Berkeley Lab.**  
The development of a Compton lung densitometer [DE89-006654] p 153 N89-20603  
X-ray microscopy for the life and physical sciences [DE89-006707] p 153 N89-20604
- California Univ., Los Angeles.**  
Permo-Triassic vertebrate extinctions: A program p 155 N89-21367
- California Univ., San Diego.**  
Limitations on K-T mass extinction theories based upon the vertebrate record p 153 N89-21290
- Carpenter (Kenneth), Philadelphia, PA.**  
Dinosaur bone beds and mass mortality: Implications for the K-T extinction p 154 N89-21301
- Center for Mathematics and Computer Science, Amsterdam (Netherlands).**  
The power of physical representations [CWI-CS-R8819] p 163 N89-20612
- Chicago Univ., IL.**  
Periodicity of extinction: A 1988 update p 156 N89-21385
- Colorado Univ., Boulder.**  
Origination, diversity, and extinction metrics essential for analysis of mass biotic crisis events: An example from cretaceous ammonioidea p 154 N89-21304

## D

- Defence Research Establishment Ottawa, (Ontario).**  
Why cold-wet makes one feel chilled: A literature review [AD-A203452] p 159 N89-20609

## F

- Florida International Univ., Miami.**  
Step-wise extinctions at the Cretaceous-Tertiary boundary and their climatic implications p 155 N89-21354

## G

- Geological Inst., Oster Voldgade (Denmark).**  
Diachronism between extinction time of terrestrial and marine dinosaurs p 154 N89-21325
- Geological Survey, Denver, CO.**  
Plant microfossil record of the terminal Cretaceous event in the western United States and Canada p 155 N89-21363  
Late Frasnian mass extinction: Conodont event stratigraphy, global changes, and possible causes p 156 N89-21380  
The Cretaceous-Tertiary boundary marine extinction and global primary productivity collapse p 157 N89-21412

- George Washington Univ., Washington, DC.**  
Nutritional models for a Controlled Ecological Life Support System (CELSS): Linear mathematical modeling [NASA-CR-4229] p 166 N89-20615

## H

- Health Effects Research Lab., Research Triangle Park, NC.**  
Pulmonary function studies in the rat addressing concentration versus time relationships of ozone (O3) [PB89-129050] p 157 N89-21461

## I

- ICON Consultants, Birmingham, AL.**  
Using depth recovery in humans [AD-A201278] p 159 N89-20606
- Illinois Univ., Champaign.**  
Information processing p 162 A89-34436
- Illinois Univ., Savoy.**  
Componential analysis of pilot decision making [AD-A203711] p 163 N89-20613
- Institute for Perception RVO-TNO, Soesterberg (Netherlands).**  
Cognitive psychology at the Institute for Perception [IZF-1987-41] p 163 N89-20611  
Safe working time limits in impermeable protective clothing: Recommendations based upon experimental measurements [IZF-1987-28] p 166 N89-20618
- International Business Machines Corp., Hopewell Junction, NY.**  
X-ray microscopy for the life and physical sciences [DE89-006707] p 153 N89-20604
- International Centre for Theoretical Physics, Trieste (Italy).**  
Propagation of the nerve impulse under the effect of a magnetic field [DE88-705371] p 159 N89-20608
- Iowa Univ., Iowa City.**  
Increased efficiency of mammalian somatic cell hybrid production under microgravity conditions during ballistic rocket flight p 152 A89-34535  
Influences of muscle fiber composition and strength on EMG (electromyographic activity), spinal motion and load acceleration during a repetitive lifting task [PB89-131221] p 159 N89-20607

## K

- Kings Coll., London (England).**  
Accurate determination of the complex permittivity of biological tissue around 35 GHz [AD-A202907] p 160 N89-21470

## L

- Lawrence Livermore National Lab., CA.**  
Review and analysis of the literature in the area of human performance modeling [DE89-006800] p 166 N89-21480
- Lockheed Engineering and Sciences Co., Washington, DC.**  
USSR Space Life Sciences Digest, Issue 21 [NASA-CR-3922(24)] p 153 N89-20602
- Louisville Univ., KY.**  
Transcriptional regulation of decreased protein synthesis during skeletal muscle unloading p 152 A89-34998

## M

- Massachusetts Inst. of Tech., Cambridge.**  
Supercritical fluid extraction and characterization of lipids from algae *Scenedesmus obliquus* p 152 A89-34398  
Seeing Ghost solutions in stereo vision [AD-A203581] p 161 N89-21473

SOURCE



**Mayo Clinic, Rochester, MN.**  
 G-induced loss of consciousness and its prevention  
 [AD-A202960] p 161 N89-21471

**Miami Univ., Coral Gables, FL.**  
 Human factors in aviation p 164 A89-34431

**Minnesota Univ., Minneapolis.**  
 Biostratigraphic case studies of six major extinctions  
 p 156 N89-21390

**N**

**National Aeronautics and Space Administration, Washington, DC.**  
 Aerospace medicine and biology: A continuing bibliography with indexes (supplement 321)  
 [NASA-SP-7011(321)] p 161 N89-21475

Aerospace medicine and biology: A continuing bibliography with indexes (supplement 322)  
 [NASA-SP-7011(322)] p 161 N89-21476

**National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.**  
 Human factors in aviation p 164 A89-34431  
 Group interaction and flight crew performance p 162 A89-34438  
 Human error in aviation operations p 162 A89-34440  
 Aircrew fatigue and circadian rhythmicity p 158 A89-34441  
 Helicopter human factors p 165 A89-34449  
 Precision in the perception of direction of a moving pattern  
 [NASA-TM-101080] p 163 N89-20610  
 Helicopter flights with night-vision goggles: Human factors aspects  
 [NASA-TM-101039] p 164 N89-21477

**National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.**  
 Changes in size and compliance of the calf after 30 days of simulated microgravity p 158 A89-35000

**National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.**  
 Suppression of morphogenesis in embryonic mouse limbs exposed in vitro to excess gravity p 152 A89-34400  
 Saccadic eye movement during spaceflight  
 [NASA-TM-100475] p 159 N89-21463

**National Library of Medicine, Bethesda, MD.**  
 Medical subject headings, tree structures, 1989  
 [PB89-100028] p 158 N89-20605

**Navy Clothing and Textile Research Facility, Natick, MA.**  
 Thermal protection afforded by two anti-exposure coveralls when worn in cold water  
 [AD-A202865] p 167 N89-21485

**Navy Personnel Research and Development Center, San Diego, CA.**  
 Brain activity during tactical decision-making. Part 5: A cross-study validation of evoked potentials as indices of workload  
 [AD-A203763] p 161 N89-21474

**Northrop Services, Inc., Research Triangle Park, NC.**  
 Pulmonary function studies in the rat addressing concentration versus time relationships of ozone (O3)  
 [PB89-129050] p 157 N89-21461

**O**

**Oregon Univ., Eugene.**  
 Reconstruction of binocular depth across continuous surfaces  
 [AD-A202827] p 160 N89-21469

**P**

**Physical Research Lab., Ahmedabad (India).**  
 Selective extinction of marine plankton at the end of the Mesozoic era: The fossil and stable isotope record  
 p 155 N89-21329

**Pittsburgh Univ., PA.**  
 New models to assess behavioral and physiological performance of animals during inhalation exposures  
 [PB89-128946] p 152 N89-20601  
 Computer simulation of a pilot in V/STOL aircraft control loops  
 [NASA-CR-184815] p 166 N89-21479

**Purdue Univ., West Lafayette, IN.**  
 Human workload in aviation p 162 A89-34437

**R**

**Rhode Island Univ., Narragansett.**  
 The Cretaceous-Tertiary boundary marine extinction and global primary productivity collapse p 157 N89-21412

**Rochester Univ., NY.**  
 Peripheral limitations on spatial vision  
 [AD-A203388] p 161 N89-21472

**S**

**Smith-Kettlewell Inst. of Visual Sciences, San Francisco, CA.**  
 Psychophysical studies of visual cortical functions  
 [AD-A202814] p 160 N89-21468

**T**

**Technische Univ., Delft (Netherlands).**  
 Direct manipulation and other styles of man-machine interaction  
 [REPT-88-53] p 166 N89-20616  
 User interfaces and highly interactive systems: Survey of current research  
 [REPT-88-60] p 166 N89-20617

**Texas Univ., Austin.**  
 Group interaction and flight crew performance p 162 A89-34438

**Texas Univ., Galveston.**  
 Gating kinetics and ion transfer in channels of nerve membrane  
 [AD-A202509] p 160 N89-21464

**Texas Univ., Houston.**  
 Suppression of morphogenesis in embryonic mouse limbs exposed in vitro to excess gravity p 152 A89-34400

**Texas Univ. Health Science Center, San Antonio.**  
 Effects of simultaneous radiofrequency radiation and chemical exposure of mammalian cells, volume 2  
 [AD-A202780] p 160 N89-21467

**Tulsa Univ., OK.**  
 Behavioral effects of microwaves: Relationship of total dose and dose rate  
 [PB89-118640] p 159 N89-21462

**V**

**Virginia Polytechnic Inst. and State Univ., Blacksburg.**  
 Earth orbital variations and vertebrate bioevolution p 155 N89-21357

**W**

**Washington State Univ., Pullman.**  
 Selective extinction of marine plankton at the end of the Mesozoic era: The fossil and stable isotope record  
 p 155 N89-21329

**Washington Univ., Seattle.**  
 Macrofossil extinction patterns at Bay of Biscay Cretaceous-Tertiary boundary sections p 157 N89-21404

**Wesleyan Univ., Middletown, CT.**  
 Mass extinctions in the deep sea p 156 N89-21396

**Whitaker Coll., MA.**  
 Seeing Ghost solutions in stereo vision  
 [AD-A203581] p 161 N89-21473

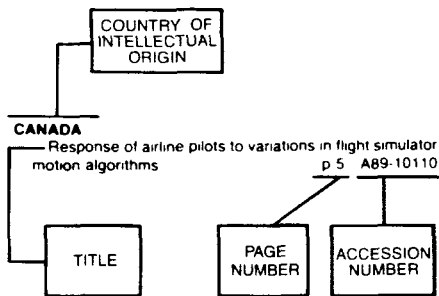
**Wuerzburg Univ. (Germany, F.R.).**  
 Increased efficiency of mammalian somatic cell hybrid production under microgravity conditions during ballistic rocket flight p 152 A89-34535

**Y**

**Yale Univ., New Haven, CT.**  
 Coping with novelty and human intelligence: The role of counterfactual reasoning  
 [AD-A203624] p 164 N89-21478

# FOREIGN TECHNOLOGY INDEX

## Typical Foreign Technology Index Listing



Listings in this index are arranged alphabetically by country of intellectual origin. The title of the document is used to provide a brief description of the subject matter. The page number and the accession number are included in each entry to assist the user in locating the citation in the abstract section. If applicable, a report number is also included as an aid in identifying the document.

## A

### AUSTRALIA

Visual accommodation and target detection in the vicinity of a window post p 163 A89-34834

## B

### BULGARIA

Probable pathways for the formation of non-protein amino acids, contained in meteorites, from protein amino acids by decarboxylation and deamination p 169 A89-35705

## C

### CANADA

Binocular unmasking - An analog to binaural unmasking? p 162 A89-34660

## D

### DENMARK

Diachronism between extinction time of terrestrial and marine dinosaurs p 154 N89-21325

## F

### FRANCE

UV spectroscopy of Titan's atmosphere, planetary organic chemistry, and prebiological synthesis p 168 A89-33789

## G

### GERMANY, FEDERAL REPUBLIC OF

Increased efficiency of mammalian somatic cell hybrid production under microgravity conditions during ballistic rocket flight p 152 A89-34535

## I

### INDIA

Alteration of gravitational field effect on sedimentation of erythrocytes by inhomogeneous magnetic field p 152 A89-34539

### ITALY

Propagation of the nerve impulse under the effect of a magnetic field [DE88-705371] p 159 N89-20608

## J

### JAPAN

Blunted hypoxic ventilatory drive in subjects susceptible to high-altitude pulmonary edema p 158 A89-34999  
OBOGS for Japanese new intermediate jet trainer T-4 p 165 A89-35844

## N

### NETHERLANDS

Processing demands, effort, and individual differences in four different vigilance tasks p 162 A89-34833  
Cognitive psychology at the Institute for Perception [IZF-1987-41] p 163 N89-20611  
The power of physical representations [CWI-CS-R8819] p 163 N89-20612  
Direct manipulation and other styles of man-machine interaction [REPT-88-53] p 166 N89-20616  
User interfaces and highly interactive systems: Survey of current research [REPT-88-60] p 166 N89-20617  
Safe working time limits in impermeable protective clothing: Recommendations based upon experimental measurements [IZF-1987-28] p 166 N89-20618

## U

### U.S.S.R.

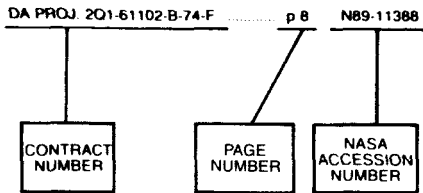
Resonance phenomena in EEG during photostimulation with flashes of varying frequency. I - Analysis of the effects of photostimulation p 158 A89-34019  
Central hemodynamics of healthy humans during a gradual decrease of circulating blood volume p 158 A89-34020  
Analysis of temperature patterns in humans p 158 A89-34021  
External breathing, gas exchange, and blood acid-base balance in dogs under hyperthermia p 151 A89-34037  
Comparative evaluation of the effect of immobilization stress on the dynamics of resistance to the induction of the peroxidation of lipids of the internal organs and brain p 152 A89-35500

### UNITED KINGDOM

Introductory overview p 164 A89-34432  
The end-triassic mass extinction event p 154 N89-21324  
Accurate determination of the complex permittivity of biological tissue around 35 GHz [AD-A202907] p 160 N89-21470

# CONTRACT NUMBER INDEX

## Typical Contract Number Index Listing

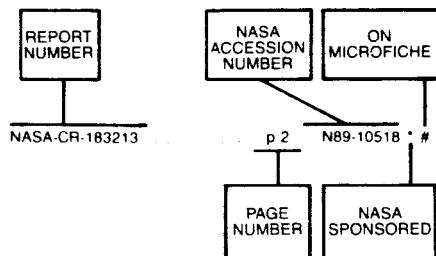


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AF PROJ. 2312 .....	p 160	N89-21470
AF PROJ. 2313 .....	p 160	N89-21468
	p 161	N89-21472
AF PROJ. 7930 .....	p 161	N89-21471
AF-AFOSR-0019-85 .....	p 161	N89-21472
AF-AFOSR-0097-84 .....	p 160	N89-21470
AF-AFOSR-0320-83 .....	p 160	N89-21468
A81/K/041 .....	p 166	N89-20618
BMFT-01-QV-354 .....	p 152	A89-34535
DAAK60-86-C-0128 .....	p 167	N89-21484
DACA76-85-C-0010 .....	p 161	N89-21473
DE-AC02-76CH-00016 .....	p 153	N89-20604
DE-AC03-76SF-00088 .....	p 153	N89-20603
	p 153	N89-20604
EPA-68-02-4120 .....	p 159	N89-21462
F33615-82-C-0513 .....	p 165	A89-34832
F33615-84-C-0604 .....	p 160	N89-21467
F33615-85-D-0514 .....	p 163	N89-20613
F33615-87-C-0541 .....	p 159	N89-20606
NAG2-308 .....	p 162	A89-34436
NAG3-729 .....	p 166	N89-21479
NAG8-716 .....	p 152	A89-34535
NASW-3165 .....	p 166	N89-20615
NASW-4292 .....	p 153	N89-20602
NASW-4324 .....	p 166	N89-20615
NCC2-228 .....	p 162	A89-34437
NCC2-231 .....	p 152	A89-34398
NIST-NANB-4001 .....	p 152	N89-20601
NSF EAR-83-13086 .....	p 168	A89-32809
NSF RII-86-10671 .....	p 152	A89-34998
NSG-2325 .....	p 152	A89-34998
N00014-85-K-0124 .....	p 161	N89-21473
N00014-85-K-0589 .....	p 164	N89-21478
N00014-87-K-0055 .....	p 160	N89-21464
N00014-87-K-0321 .....	p 160	N89-21469
N66001-87-C-0079 .....	p 161	N89-21471
PHS-OH-01929 .....	p 159	N89-20607
RR04108 .....	p 160	N89-21464
RR042 .....	p 160	N89-21469
W-7405-ENG-48 .....	p 166	N89-21480
505-67-11 .....	p 164	N89-21477

# REPORT NUMBER INDEX

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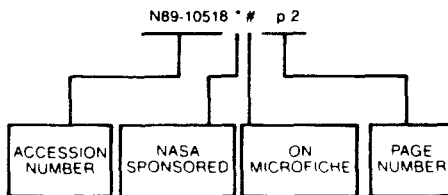
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A-88305 ..... p 164 N89-21477 \* #  
 A-89062 ..... p 163 N89-20610 \* #  
 AAMRL-TR-88-017 ..... p 163 N89-20613 #  
 AAMRL-TR-88-035 ..... p 159 N89-20606 #  
 AAMRL-TR-88-048 ..... p 167 N89-21481 #  
 AD-A200432 ..... p 165 N89-20614 #  
 AD-A201278 ..... p 159 N89-20606 #  
 AD-A202474 ..... p 167 N89-21481 #  
 AD-A202509 ..... p 160 N89-21464 #  
 AD-A202589 ..... p 167 N89-21482 #  
 AD-A202712 ..... p 167 N89-21483 #  
 AD-A202721 ..... p 167 N89-21484 #  
 AD-A202732 ..... p 160 N89-21465 #  
 AD-A202770 ..... p 160 N89-21466 #  
 AD-A202780 ..... p 160 N89-21467 #  
 AD-A202814 ..... p 160 N89-21468 #  
 AD-A202827 ..... p 160 N89-21469 #  
 AD-A202865 ..... p 167 N89-21485 #  
 AD-A202907 ..... p 160 N89-21470 #  
 AD-A202960 ..... p 161 N89-21471 #  
 AD-A202984 ..... p 168 N89-21486 #  
 AD-A203054 ..... p 168 N89-21487 #  
 AD-A203100 ..... p 168 N89-21488 #  
 AD-A203177 ..... p 168 N89-21489 #  
 AD-A203388 ..... p 161 N89-21472 #  
 AD-A203452 ..... p 159 N89-20609 #  
 AD-A203581 ..... p 161 N89-21473 #  
 AD-A203624 ..... p 164 N89-21478 #  
 AD-A203711 ..... p 163 N89-20613 #  
 AD-A203763 ..... p 161 N89-21474 #  
 AFIT/GE/ENG/88D-17 ..... p 168 N89-21487 #  
 AFIT/GE/ENG/88D-18 ..... p 168 N89-21489 #  
 AFIT/GE/ENG/88D-45 ..... p 160 N89-21465 #  
 AFIT/GE/ENG/88D-7 ..... p 167 N89-21483 #  
 AFIT/GEO/ENG/88D-4 ..... p 160 N89-21466 #  
 AFOSR-88-1226TR ..... p 160 N89-21468 #  
 AFOSR-88-1335TR ..... p 161 N89-21472 #  
 AI-M-1073 ..... p 161 N89-21473 #  
 B8827443 ..... p 163 N89-20612 #  
 CBIP-33 ..... p 161 N89-21473 #  
 CONF-8809281-1 ..... p 153 N89-20604 #  
 CONF-881103-36 ..... p 153 N89-20603 #  
 CWI-CS-R8819 ..... p 163 N89-20612 #  
 DE88-705371 ..... p 159 N89-20608 #

DE89-006654 ..... p 153 N89-20603 #  
 DE89-006707 ..... p 153 N89-20604 #  
 DE89-006800 ..... p 166 N89-21480 #  
 DREO-TN-88-22 ..... p 159 N89-20609 #  
 EPA/600/D-88/256 ..... p 157 N89-21461 #  
 EPA/600/1-88/005 ..... p 159 N89-21462 #  
 ETN-89-94020 ..... p 166 N89-20616 #  
 ETN-89-94026 ..... p 166 N89-20617 #  
 ETN-89-94064 ..... p 166 N89-20618 #  
 ETN-89-94065 ..... p 163 N89-20611 #  
 ETN-89-94176 ..... p 163 N89-20612 #  
 IC-88/323 ..... p 159 N89-20608 #  
 ISSN-0920-8577 ..... p 166 N89-20616 #  
 ISSN-0920-8577 ..... p 166 N89-20617 #  
 IZF-1987-28 ..... p 166 N89-20618 #  
 IZF-1987-41 ..... p 163 N89-20611 #  
 LBL-25170 ..... p 153 N89-20603 #  
 LBL-26232 ..... p 153 N89-20604 #  
 NAS 1.15:100475 ..... p 159 N89-21463 \* #  
 NAS 1.15:101039 ..... p 164 N89-21477 \* #  
 NAS 1.15:101080 ..... p 163 N89-20610 \* #  
 NAS 1.21:7011(321) ..... p 161 N89-21475 \* #  
 NAS 1.21:7011(322) ..... p 161 N89-21476 \* #  
 NAS 1.26:184815 ..... p 166 N89-21479 \* #  
 NAS 1.26:3922(24) ..... p 153 N89-20602 \* #  
 NAS 1.26:4229 ..... p 166 N89-20615 \* #  
 NASA-CR-184815 ..... p 166 N89-21479 \* #  
 NASA-CR-3922(24) ..... p 153 N89-20602 \* #  
 NASA-CR-4229 ..... p 166 N89-20615 \* #  
 NASA-SP-7011(321) ..... p 161 N89-21475 \* #  
 NASA-SP-7011(322) ..... p 161 N89-21476 \* #  
 NASA-TM-100475 ..... p 159 N89-21463 \* #  
 NASA-TM-101039 ..... p 164 N89-21477 \* #  
 NASA-TM-101080 ..... p 163 N89-20610 \* #  
 NATICK-TR-88/043 ..... p 167 N89-21484 #  
 NCTRF-172 ..... p 167 N89-21485 #  
 NIST/GCR-88/551 ..... p 152 N89-20601 #  
 NLM/MED-89/02 ..... p 158 N89-20605 #  
 NPRDC-TN-89-7 ..... p 161 N89-21474 #  
 PB89-100028 ..... p 158 N89-20605 #  
 PB89-118640 ..... p 159 N89-21462 #  
 PB89-128946 ..... p 152 N89-20601 #  
 PB89-129050 ..... p 157 N89-21461 #  
 PB89-131221 ..... p 159 N89-20607 #  
 REPT-88-53 ..... p 166 N89-20616 #  
 REPT-88-60 ..... p 166 N89-20617 #  
 S-592 ..... p 159 N89-21463 \* #  
 TDCK-87-4844 ..... p 166 N89-20618 #  
 TDCK-88-0288 ..... p 163 N89-20611 #  
 UCID-21558 ..... p 166 N89-21480 #  
 USAARL-88-10 ..... p 165 N89-20614 #  
 USAARL-88-12 ..... p 168 N89-21488 #  
 USAARL-88-13 ..... p 168 N89-21486 #  
 USAARL-88-15 ..... p 167 N89-21482 #  
 USAFSAM-TR-87-13 ..... p 160 N89-21470 #  
 USAFSAM-TR-87-32-VOL-2 ..... p 160 N89-21467 #  
 USAFSAM-TR-87-41 ..... p 161 N89-21471 #

# ACCESSION NUMBER INDEX

## Typical Accession Number Index Listing



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A89-32749	p 151	N89-20612	#	p 163
A89-32750	p 151	N89-20613	#	p 163
A89-32757	p 151	N89-20614	#	p 165
A89-32758	p 151	N89-20615	* #	p 166
A89-32759	p 151	N89-20616	#	p 166
A89-32809	p 168	N89-20617	#	p 166
A89-33789	p 168	N89-20618	#	p 166
A89-34019	p 158	N89-21290	* #	p 153
A89-34020	p 158	N89-21295	* #	p 153
A89-34021	p 158	N89-21301	* #	p 154
A89-34037	p 151	N89-21304	* #	p 154
A89-34319	p 152	N89-21324	* #	p 154
A89-34388	p 164	N89-21325	* #	p 154
A89-34398	* p 152	N89-21329	* #	p 155
A89-34400	* p 152	N89-21354	* #	p 155
A89-34431	* p 164	N89-21357	* #	p 155
A89-34432	p 164	N89-21363	* #	p 155
A89-34433	p 164	N89-21367	* #	p 155
A89-34434	p 164	N89-21380	* #	p 156
A89-34435	p 162	N89-21385	* #	p 156
A89-34436	* p 162	N89-21390	* #	p 156
A89-34437	* p 162	N89-21396	* #	p 156
A89-34438	* p 162	N89-21404	* #	p 157
A89-34439	p 162	N89-21406	* #	p 157
A89-34440	* p 162	N89-21412	* #	p 157
A89-34441	* p 158	N89-21461	#	p 157
A89-34442	p 165	N89-21462	#	p 159
A89-34445	p 165	N89-21463	* #	p 159
A89-34447	p 165	N89-21464	#	p 160
A89-34449	* p 165	N89-21465	#	p 160
A89-34535	* p 152	N89-21466	#	p 160
A89-34539	p 152	N89-21467	#	p 160
A89-34660	p 162	N89-21468	#	p 160
A89-34832	p 165	N89-21469	#	p 160
A89-34833	p 162	N89-21470	#	p 160
A89-34834	p 163	N89-21471	#	p 161
A89-34835	p 163	N89-21472	#	p 161
A89-34998	* p 152	N89-21473	#	p 161
A89-34999	p 158	N89-21474	#	p 161
A89-35000	* p 158	N89-21475	* #	p 161
A89-35500	p 152	N89-21476	* #	p 161
A89-35705	p 169	N89-21477	* #	p 164
A89-35844	p 165	N89-21478	#	p 164
		N89-21479	* #	p 166
		N89-21480	#	p 166
N89-20601	# p 152	N89-21481	#	p 167
N89-20602	* # p 153	N89-21482	#	p 167
N89-20603	# p 153	N89-21483	#	p 167
N89-20604	# p 153	N89-21484	#	p 167
N89-20605	# p 158	N89-21485	#	p 167
N89-20606	# p 159	N89-21486	#	p 168
N89-20607	# p 159	N89-21487	#	p 168
N89-20608	# p 159	N89-21488	#	p 168
N89-20609	# p 159	N89-21489	#	p 168
N89-20610	* # p 163			
N89-20611	# p 163			

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## ARIZONA

**DEPT. OF LIBRARY, ARCHIVES AND PUBLIC RECORDS**  
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1700 West Washington  
Phoenix, AZ 85007  
(602) 255-4121

**UNIVERSITY OF ARIZONA LIB.**  
Government Documents Dept.  
Tucson, AZ 85721  
(602) 621-6433

## ARKANSAS

**ARKANSAS STATE LIBRARY**  
One Capitol Mall  
Little Rock, AR 72201  
(501) 371-2326

## CALIFORNIA

**CALIFORNIA STATE LIBRARY**  
Govt. Publications Section  
P.O. Box 2037  
Sacramento, CA 95809  
(916) 324-4863

## COLORADO

**UNIV. OF COLORADO LIB.**  
Government Pub. Division  
Campus Box 184  
Boulder, CO 80309  
(303) 492-8834

## DENVER PUBLIC LIBRARY

Govt. Pub. Department  
1357 Broadway  
Denver, CO 80203  
(303) 571-2131

## CONNECTICUT

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Government Documents Unit  
231 Capitol Avenue  
Hartford, CT 06106  
(203) 566-7029

## FLORIDA

**UNIV. OF FLORIDA LIBRARIES**  
Library West  
Documents Department  
Gainesville, FL 32511  
(904) 392-0367

## GEORGIA

**UNIV. OF GEORGIA LIBRARIES**  
Government Reference Dept.  
Athens, GA 30602  
(404) 542-8949

## HAWAII

**UNIV. OF HAWAII LIBRARY**  
Govt. Documents Collection  
2550 The Mall  
Honolulu, HI 96822  
(808) 948-8230

## IDAHO

**UNIV. OF IDAHO LIBRARY**  
Documents Section  
Moscow, ID 83843  
(208) 885-6344

## ILLINOIS

**ILLINOIS STATE LIBRARY**  
Information Services Branch  
Centennial Building  
Springfield, IL 62756  
(217) 782-5185

## INDIANA

**INDIANA STATE LIBRARY**  
Senais Documents Section  
140 North Senate Avenue  
Indianapolis, IN 46204  
(317) 232-3686

## IOWA

**UNIV. OF IOWA LIBRARIES**  
Govt. Documents Department  
Iowa City, IA 52242  
(319) 353-3318

## KANSAS

**UNIVERSITY OF KANSAS**  
Doc. Collect.—Spencer Lib.  
Lawrence, KS 66045-2800  
(913) 864-4662

## KENTUCKY

**UNIV. OF KENTUCKY LIBRARIES**  
Govt. Pub. Department  
Lexington, KY 40506-0039  
(606) 257-3139

## LOUISIANA

**LOUISIANA STATE UNIVERSITY**  
Middleton Library  
Govt. Docs. Dept.  
Baton Rouge, LA 70803  
(504) 388-2570

## LOUISIANA TECHNICAL UNIV. LIBRARY

Documents Department  
Ruston, LA 71272-0046  
(318) 257-4962

## MAINE

**UNIVERSITY OF MAINE**  
Raymond H. Fogler Library  
Tri-State Regional Documents  
Depository  
Orono, ME 04469  
(207) 581-1680

## MARYLAND

**UNIVERSITY OF MARYLAND**  
McKeldin Lib.—Doc. Div.  
College Park, MD 20742  
(301) 454-3034

## MASSACHUSETTS

**BOSTON PUBLIC LIBRARY**  
Government Docs. Dept.  
Boston, MA 02117  
(617) 536-5400 ext.226

## MICHIGAN

**DETROIT PUBLIC LIBRARY**  
Sociology Department  
5201 Woodward Avenue  
Detroit, MI 48202-4093  
(313) 833-1409

## MICHIGAN STATE LIBRARY

P.O. Box 30007  
Lansing, MI 48909  
(517) 373-1593

## MINNESOTA

**UNIVERSITY OF MINNESOTA**  
Government Pubs. Division  
409 Wilson Library  
309 19th Avenue South  
Minneapolis, MN 55455  
(612) 373-7670

## MISSISSIPPI

**UNIV. OF MISSISSIPPI LIB.**  
Documents Department  
University, MS 38677  
(601) 232-5857

## MONTANA

**UNIV. OF MONTANA**  
Mansfield Library  
Documents Division  
Missoula, MT 59812  
(406) 243-6700

## NEBRASKA

**UNIVERSITY OF NEBRASKA - LINCOLN**  
Love Library  
Documents Department  
Lincoln, NE 68588-0410  
(402) 472-2562

## NEVADA

**UNIVERSITY OF NEVADA LIB.**  
Govt. Pub. Department  
Reno, NV 89557-0044  
(702) 764-6579

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**NEWARK PUBLIC LIBRARY**  
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Newark, NJ 07101-0630  
(201) 733-7812

## NEW MEXICO

**UNIVERSITY OF NEW MEXICO**  
Zimmerman Library  
Government Pub. Dept.  
Albuquerque, NM 87131  
(505) 277-5441

## NEW MEXICO STATE LIBRARY

Reference Department  
325 Don Gaspar Avenue  
Santa Fe, NM 87503  
(505) 827-3826

## NEW YORK

**NEW YORK STATE LIBRARY**  
Empire State Plaza  
Albany, NY 12230  
(518) 474-5563

## NORTH CAROLINA

**UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL**  
Davis Library  
BA/SS Documents Division  
Chapel Hill, NC 27515  
(919) 962-1151

## NORTH DAKOTA

**UNIVERSITY OF NORTH DAKOTA**  
Chester Fritz Library  
Documents Department  
Grand Forks, ND 58202  
(701) 777-4529  
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Dakota State Univ. Library

## OHIO

**STATE LIBRARY OF OHIO**  
Documents Department  
65 South Front Street  
Columbus, OH 43266-0334  
(614) 462-7051

## OKLAHOMA

**OKLAHOMA DEPT. OF LIB.**  
Government Documents  
200 NE 16th Street  
Oklahoma City, OK 73105  
(405) 521-2502, ext. 252

**OKLAHOMA STATE UNIV. LIB.**  
Documents Department  
Stillwater, OK 74078  
(405) 624-6546

## OREGON

**PORTLAND STATE UNIV. LIB.**  
Documents Department  
P.O. Box 1151  
Portland, OR 97207  
(503) 229-3673

## PENNSYLVANIA

**STATE LIBRARY OF PENN.**  
Government Pub. Section  
P.O. Box 1601  
Harrisburg, PA 17105  
(717) 787-3752

## TEXAS

**TEXAS STATE LIBRARY**  
Public Services Department  
P.O. Box 12927—Cap. Sta.  
Austin, TX 78711  
(512) 475-2996

## TEXAS TECH. UNIV. LIBRARY

Govt. Documents Department  
Lubbock, TX 79409  
(806) 742-2268

## UTAH

**UTAH STATE UNIVERSITY**  
Merrill Library, U.M.C. 30  
Logan, UT 84322  
(801) 750-2682

## VIRGINIA

**UNIVERSITY OF VIRGINIA**  
Alderman Lib.—Public Doc.  
Charlottesville, VA 22903-2498  
(804) 924-3133

## WASHINGTON

**WASHINGTON STATE LIBRARY**  
Documents Section  
Olympia, WA 98504  
(206) 753-4027

## WEST VIRGINIA

**WEST VIRGINIA UNIV. LIB.**  
Documents Department  
Morgantown, WV 26506-6059  
(304) 293-3640

## WISCONSIN

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Milwaukee, WI 53233  
(414) 278-3065

## ST. HIST. LIB. OF WISCONSIN

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Madison, WI 53706  
(608) 262-4347

## WYOMING

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