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AGARD

ADVISORY GROUP FOR AEROSPACE RESEARCH & DEVELOPMENT
7 RUE ANCELLE 92200 NEUILLY SUR SEINE FRANCE

AGARD REPORT 805

Aircraft Flight Safety: A Bibliography

(La Sécurité en Vol: Une Bibliographie)

This Bibliography has been prepared as part of the programme of the Technical Information Panel of AGARD.

NORTH ATLANTIC TREATY ORGANIZATION

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North Atlantic Treaty Organization
Organisation du Traité de l'Atlantique Nord

The Mission of AGARD

According to its Charter, the mission of AGARD is to bring together the leading personalities of the NATO nations in the fields of science and technology relating to aerospace for the following purposes:

- Recommending effective ways for the member nations to use their research and development capabilities for the common benefit of the NATO community;
- Providing scientific and technical advice and assistance to the Military Committee in the field of aerospace research and development (with particular regard to its military application);
- Continuously stimulating advances in the aerospace sciences relevant to strengthening the common defence posture;
- Improving the co-operation among member nations in aerospace research and development;
- Exchange of scientific and technical information;
- Providing assistance to member nations for the purpose of increasing their scientific and technical potential;
- Rendering scientific and technical assistance, as requested, to other NATO bodies and to member nations in connection with research and development problems in the aerospace field.

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Preface

AGARD and the International Integration Association (IIA) of Russia jointly sponsored a conference on Aircraft Flight Safety which was held in Zhukovsky, near Moscow from 31st August to 5th September 1993. As part of the western contribution to this conference AGARD asked NASA's Center for AeroSpace Information (CASI) to prepare a bibliography on the topic. 'Aircraft Flight Safety' is a very broad theme, and as such is not a topic by which documents relating to aspects of it (such as the effects of adverse weather or human errors causing accidents) are likely to be indexed in a database. This made it difficult to prepare a comprehensive bibliography, and so it was decided to search for the aspects discussed in the 16 papers prepared as a result of AGARD's call for papers. Despite these limitations, it was felt that others would be interested in this bibliography and AGARD decided to give it a full distribution as an AGARD Report.

The entire conference proceedings, which will comprise about 130 papers, all but about 20 in Russian, will be printed in Russia. AGARD will give it a limited distribution, but the date of publication and the bibliographic details are not yet known.

Préface

Un symposium sur la sécurité en vol a été organisé conjointement par l'AGARD et L'Association Internationale d'Intégration (IIA) de la Russie, à Zhukovsky, près de Moscou, du 31 août au 5 septembre 1993. Dans le cadre de la contribution occidentale à cette conférence, l'AGARD a demandé à l'infocentre de la NASA (CASI) de préparer une bibliographie sur ce sujet.

"La sécurité en vol" est un thème très large, et par consequent, il est peu probable que des documents relatifs aux differents aspects de la question (tels que les effets du mauvais temps où l'erreur humaine dans les accidents) soient répertoriés sous cette seule rubrique dans une quelconque base de données. Pour cette raison, il s'est avéré difficile d'en établir une bibliographie complète et il a donc été décidé de procéder à la recherche des aspects traités par les 16 communications reçues suite à l'appel de communications lancé par l'AGARD. Malgré ces limitations, il a été considéré que la bibliographie était susceptible d'intéresser d'autres personnes et, par conséquent, elle a été diffusée sans restriction, sous forme de rapport AGARD.

Le compte rendu complet de la conférence, qui comprendra quelques 130 communications, dont 110 en russe, sera publié en Russie. Il sera diffusé de façon limitée par l'AGARD. Ni la date de publication ni le détail bibliographique ne sont connus à ce jour.

Contents

This Bibliography has been prepared by the NASA Center for AeroSpace Information (CASI)[1], to support the joint AGARD/ IAA Symposium on Aircraft Flight Safety. It includes selected reports, papers, books and other items entered into the NASA STI Database in the last two years.

The Bibliography has been sub-divided into the topics listed below. These topics have been assigned to items purely on the basis of the abstracts. Items that relate to two or more topics will be found in section X, 'General'.

[1] Identification numbers 91A(or N)26796, are NASA accession numbers and may be used to order copies of the cited documents from NASA CASI, via address, phone, or Internet as follows: 800 Elkridge Landing Road, Linthicum Heights, MD 21090-2934 USA, (301) 621-0390, or help@sti.nasa.gov.

* Most of the items in 'A' also include recommendations applicable to 'B'; and many items in 'B' discuss the human factors causing errors, and are thus applicable to 'A'. Items have been assigned to one or other of these topics according to the balance of the material as described in the abstract.

A.
Human Errors Causing Accidents or Safety-related Incidents

Human performance aspects of aircraft accidents
91A26796
DIEHL, ALAN E. IN: Aviation psychology (A91-26782 10-53). Aldershot, England and Brookfield, VT, Gower Technical, 1989, p. 378-403.
An overview is presented of the theory and practice of investigating the human performance aspects of aircraft accidents. The complex issues involved in the investigation procedures are discussed along with case studies which show the potential benefits of conducting detailed human performance analyses. Psychologists are becoming an integral part of the modern interdisciplinary teams that investigate civil and military aviation accidents. The basic role of these psychologists is to assist in systematically recording and explaining the effects of factors connected with human performance degradation. Details are provided on the accident causation, investigation, and prevention processes including the role played by the flight surgeon, research psychologist, and human factor advocates.

The influence of errors committed by air flight crews on flight safety
91A47525
GOLEGO, V. N. (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukrainian SSR) Kibernetika i Vychislitel'naia Tekhnika (ISSN 0454-9910), no. 88, 1990, p. 68-73. In Russian.
Statistical data on the contribution of flight-crew errors to aviation incidents and accidents are examined. It is found that there exists a group of errors whose influence on flight safety tends to remain constant or even to increase despite numerous measures undertaken to enhance safety. This phenomenon is explained from the standpoint of man-machine system theory.

Human performance and systems safety considerations in aviation mishaps
91A48785
DIEHL, ALAN E. (USAF, Inspection and Safety Center, Norton AFB, CA) International Journal of Aviation Psychology (ISSN 1050-8414), vol. 1, no. 2, 1991, p. 97-106.
This article provides an overview of (1) accident generation, (2) the ensuing investigation process, and (3) the types of prevention measures that will be employed to ultimately decrease the probability of similar mishaps. The stages of the accident-generation process include ubiquitous hazards which lead to occasional incidents that in turn result in less frequent accidents. Steps in the investigation process included fact finding, information analysis, and authority review. The use of comparison data sources and mishap data bases are important collateral-investigation activities. The basic classes of accident-prevention measures included environmental-hazard exposure limitations, equipment safety features and/or warning devices, and establishing procedural safeguards. Human factors problems are associated with 50 to 90 percent of all accidents, whereas system safety principles provide the logical framework for deciding which type of countermeasures to apply in ameliorating such problems. This article describes the interface between human factors and system-safety concepts and provides examples of successful accident-prevention programs.

Requirements for an aircraft mishap analysis system
92A11170
COURTRIGHT, JOHN F. (BDM International, Inc., Albuquerque, NM) IN: Human Factors Society, Annual Meeting, 34th, Orlando, FL, Oct. 8-12, 1990, Proceedings. Vol. 2 (A92-11126 01-54). Santa Monica, CA, Human Factors Society, 1990, p. 1047-1051.
The Aircraft Mishap Prevention (AMP) program is described which is designed to facilitate understanding of the extent and nature of human contribution to aircraft accidents. The program focuses on gathering data on factors such as equipment design, training, and operational practices, as well as analyzing corresponding deficiencies. Particular attention is given to the analysis of human factors in the AMP investigations; special software and staff are incorporated to study human factors in individual mishaps and in all mishaps. The analysis tools and the staff dedicated to interpreting the role of human factors can provide the AMP with the ability to employ statistics and modeling to quantify human contribution to aircraft mishaps. The results can provide the basis for developing countermeasures for mishaps including those for design, training, and operation.

Analysis of general aviation accidents during operations under instrument flight rules
92A11172
BENNETT, C. T.; SCHWIRZKE, MARTIN; HARM, C. (NASA, Ames Research Center; U.S. Army, Moffett Field, CA); (San Jose State University, CA) IN: Human Factors Society, Annual Meeting, 34th, Orlando, FL, Oct. 8-12, 1990, Proceedings. Vol. 2 (A92-11126 01-54). Santa Monica, CA, Human Factors Society, 1990, p. 1057-1061. National Aeronautics and Space Administration. Ames Research Center, Moffett

Field, CA.; Army Aviation Research and Development Command, Moffett Field, CA.; San Jose State Univ., CA.
A report is presented to describe some of the errors that pilots make during flight under IFR. The data indicate that there is less risk during the approach and landing phase of IFR flights, as compared to VFR operations. Single-pilot IFR accident rates continue to be higher than two-pilot IFR incident rates, reflecting the high work load of IFR operations.

The importance of the Type II error in aviation safety research
92A13027
HARRIS, DON (Cranfield Institute of Technology, England) IN: Stress and error in aviation (A92-13015 02-53). Aldershot, England and Brookfield, VT, Avebury Technical, 1991, p. 151-157.
It is argued that in certain cases the Type II decision error is the error to avoid in research related to aviation safety. This is illustrated with reference to the relative accident rates of two-crew versus three-crew commercial jet aircraft. Further examples in which the Type II error may be of importance are briefly outlined, as are some of the drawbacks associated with the use of the Type II error.

Management decisions have an impact on flight safety
92A15175
MAURINO, DANIEL (ICAO, Air Navigation Bureau, Montreal, Canada) ICAO Journal (ISSN 0018-8778), vol. 46, Oct. 1991, p. 6-9.
Decision-makers concerned with aviation at the system-level are ideally placed to improve flight safety through improvements in system cohesiveness and training. A direct relationship is established between management deficiencies and accident/incident precursors. Deficiencies in training may lead to such precursors as high workloads which may coexist with failures in maintenance and scheduling; these may in turn exacerbate workloads and pressures. Failures in system control may allow the pairing of inexperienced crew members or operations under unacceptably adverse conditions.

Taxonomy of crew resource management - Information processing domain
92A44957
FREEMAN, CHARLOTTE; SIMMON, DAVID A. (Samford University, Birmingham, AL); (United Airlines, Chicago, IL) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1 (A92-44901 19-53). Columbus, OH, Ohio State University, 1991, p. 391-397.
A taxonomy has been developed for crew resource management in an effort to identify specific types of errors and the corresponding training skills and strategies to reduce human error. Information processing was chosen for domain development following an analysis of over 500 incidents and accidents showed that in most cases information was available that could have been employed to prevent the incident. The taxonomy also reinforces the primary role of the pilot as an information processor.

Use of a human factors checklist in aircraft mishap investigations
92A44992
CIAVARELLI, ANTHONY P. (U.S. Naval Postgraduate School, Monterey, CA) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2 (A92-44901 19-53). Columbus, OH, Ohio State University, 1991, p. 613-618.
An account is given of the development and potential applications of a human-factors checklist devised for the clarification of chains of causality relating to pilot/crew involvement in accidents and incidents. The checklist which has been devised for U.S. Navy/Marine use is meant to function both as a 'user-friendly' investigation tool, and as the basis for a safety program that addresses key preventive factors in aircrew-related mishaps. The classification-structure of the checklist encompasses sensory-perceptual, knowledge-skill, medical-physiological, communications-coordination, decision-judgment, and attitude-personality, as well as supervisory and design-systemic factors.

The development of an intelligent human factors data base as an aid for the investigation of aircraft accidents
92A44994
FEGGETTER, AMANDA J. W. (Ministry of Defence, London, England) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2 (A92-44901 19-53). Columbus, OH, Ohio State University, 1991, p. 624-629.
A human factors data aid encompassing psychological, physiological, sociological, and ergonomic considerations has been developed for use in the investigation of aircraft accidents. This data base incorporates intelligence in the form of stored rules and prior knowledge, collectively constituting a comprehensive list of contributory factors; after covering a given incident in detail, the aid allows all relevant data to be organized in the form of a draft standardized report. The system also facilitates the reexamination of suspected causative factors.

Some factors associated with pilot age in general aviation crashes
92A45016
MORTIMER, RUDOLF G. (Illinois, University, Champaign) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2 (A92-44901 19-53). Columbus, OH, Ohio State University, 1991, p. 770-775.
A sample of 1034 NTSB Accident Brief reports for 1985/86 were analyzed to discern age differences of pilots in the characteristics of general aviation airplane accidents. Pilots aged 60 or more were more involved in taxiing accidents and those under 30 more in the maneuvering phase. In combination with pilot exposure data from another study and FAA accident data for 1986, the accident rates of pilots aged 60 or more and younger pilots were estimated. Those aged 60 or more had an accident rate about twice that of the younger pilots.

The utilization of the aviation safety reporting system - A case study in pilot fatigue
92A45020
LOGAN, AILEEN L.; BRAUNE, ROLF J. (Boeing Commercial Airplane Group, Seattle, WA) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2 (A92-44901 19-53). Columbus, OH, Ohio State University, 1991, p. 793-798.
The extent to which the optimal safety and efficiency of airline operations are affected by whether their aircrews are well rested and alert is presently evaluated in light of data from the Aviation Safety Reporting System's questionnaires. Attention is drawn to the apparently counter-intuitive finding that the majority of reported incidents occurred within the first two hours of the pilots' scheduled flying time. More specialized and intensive research on this factor is called for.

Midair collision - The links in a chain
92A52645
POPE, JOHN A. (John A. Pope & Associates, Arlington, VA) SAFE Journal, vol. 22, no. 4, July-Aug. 1992, p. 19-24.
The chain of events leading to a collision between a fixed-wing aircraft and a helicopter is described and analyzed to set forth recommendations for avoiding similar situations. Specific attention is given to the events which occurred after the helicopter pilot offered to fly beneath the chartered aircraft to inspect the landing gear. The conclusions of the National Transportation Safety Board are that: (1) deficiencies exist in operator training; (2) there lacked coordination for close-range maneuvering; and (3) the helicopter was responsible for maintaining safe separation. The critical factors proposed in the paper include human error and inexperience, the training of air taxi operators to meet the Federal Aviation Regulations, and lack of coordination between the pilots. The accident is shown to raise important questions regarding the market for on-demand air taxi operators in terms of ownership, management, financial condition, and knowledge of and adherence to air-traffic safety protocols.

Review of human error accidents in civil aviation
93A12367
KHOLA, H. S. (Civil Aviation and Technical Centre, New Delhi, India) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 44, no. 2, May 1992, p. 123-127.
A critical examination of civil aviation accidents during 1980-89 in India and worldwide is presented with attention given to the overall contribution of human error to the statistics. A total of 162 accidents are investigated showing that 76 percent of the accidents are due in some respect to human error. The errors are subdivided into deliberate errors (17 percent), skill errors (35 percent), and inadvertent errors (24 percent), and some strategies for reducing each category are advanced.

Human factors in crashes of commuter airplanes
93A24048
BAKER, SUSAN P.; LAMB, MARGARET W.; LI, GUOHUA; DODD, ROBERT S. (Johns Hopkins Univ., Baltimore, MD); (Sunshine Aviation Safety Studies, Questa, NM); (Johns Hopkins Univ., Baltimore, MD) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 64, no. 1, Jan. 1993, p. 63-68.
Pilots and frequent travelers on commuter aircraft are exposed to higher risks of death or injury than those on major air carriers. To provide a better understanding of the circumstances of crashes of scheduled commuter airplanes, National Transportation Safety Board data were analyzed for all cases of death, serious injury, or major damage involving commuter airplanes during 1983-88, when 172 people were killed and 207 injured in 118 events. Three-fourths of cases involved inadequate pilot performance, notably poor handling of emergencies and improper instrument flying procedures. Pilot errors occurred disproportionately in bad weather, wh[illegible]layed a role in 30 percent of crashes. Air-c[illegible] functions were involved in 42 percent of cra[illegible]ertain airplanes were overinvolved in gear [illegible]andings or in crashes due to fuel mismanagement. Greater priority should be given to applying known preventive measures to the problem of commuter crashes.

An analytical study of the effects of age and experience on flight safety
93A27158
GUIDE, PATRICK C.; GIBSON, RICHARD S. (Embry-Riddle Aeronautical Univ., Daytona Beach, FL) In: Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 (A93-27126 09-54). Santa Monica, CA, Human Factors Society, 1991, p. 180-184.
The purpose of this study was to determine whether there are any significant decreases in the safety and effectiveness of pilots by age 60. The data for this study comes from records of general aviation accidents (i.e., for private pilots, commercial pilots, and air transport pilots). This accident data has been acquired from many specialized aviation data banks, these include: NTSB, AOPA, FAA, and the COMSIS Research Corporation. The data were organized into groups according to age of the pilot-in-command (PIC) responsible for the accident. The grouping progresses in five-year increments starting at 20-24, and ending with 55-59. The data were analyzed in terms of different accident statistics (i.e., based upon the number of pilots and the number of hours flown). The results indicate that age and experience both affect safety. The magnitude of these effects and their implications for aviation safety are discussed.

Aircraft accident report: MarkAir, Inc., Boeing 737-2X6C, N670MA, controlled flight into terrain, Unalakleet, Alaska, 2 June 1990
92N13039
Avail: CASI HC A05/MF A01 National Transportation Safety Board, Washington, DC.
On 2 Jun. 1990, at 0937 Alaskan Daylight Time, MarkAir, Inc. flight 3087, a Boeing 737-2X6C, registered in the U.S. as N670MA, crashed about 7.5 miles short of runway 14, Unalakleet, Alaska, while executing a localizer approach to that runway. The flight originated at 0828 at Anchorage International Airport. Instrument meteorological conditions existed at the time, and a flight attendant sustained minor injuries. Another flight attendant sustained serious injuries. There were no passengers on board, and the airplane was destroyed. The flight was operated under FAR Part 121. The National Transportation Safety Board determines that the probable cause of this accident was deficiencies in flightcrew coordination, their failure to adequately prepare for and properly execute the UNK LOC Rwy 14 nonprecision approach and their subsequent premature descent. The safety issues that are discussed include cockpit resource management and approach chart symbology. This safety board issued a safety recommendation on approach chart standardization to the FAA. Safety recommendations were also issued to MarkAir, Inc., on the subjects of cockpit resource management and checklist usage.

Aircraft accident/incident summary report: Midair collision involving Lycoming Air Services Piper Aerostar PA-60 and Sun Company Aviation Department Bell 412, Merion, Pennsylvania, April 4, 1991
92N15055
Avail: CASI HC A03/MF A01 National Transportation Safety Board, Washington, DC.
An explanation is presented for the midair collision involving a Lycoming Air Services Piper Aerostar PA-60 and a Sun Company Aviation Dept. Bell 412. The safety issues discussed include pilot judgement, the training and checking of flight crews, the adequacy of the PA-60 flight manual, and FAA surveillance of the carrier.

UK airmisses involving commercial air transport, May-August 1991
93N11357
UK airmisses involving commercial air transport, January-April 1991
93N11358
Avail: Civil Aviation Authority, Greville House, 37 Gratton Road, Cheltenham, England Civil Aviation Authority, London (England).
In the introduction the following are briefly discussed: origination of an airmiss; purpose of airmiss reports; investigation of airmiss reports; categorization of airmisses; involvement of commercial air transport aircraft; airmisses related to flying hours. Tabulated statistics of the following are presented: the number of incidents of commercial air transport airmisses; commercial air transport aircraft involved in airmisses; commercial air transport airmisses related to flying hours. Reports in the commercial air transport airmisses from May-Aug. 1991, and Jan.-April 1991, respectively, are presented. These contain summaries of: pilot reports, transcripts of relevant RT frequencies, radar video recordings, and reports from appropriate air traffic control and operating authorities. The working groups discussion is summarized, and the risk and cause assessed.

Trans-cockpit authority gradient in Navy/Marine aircraft mishaps
93N15016
ALKOV, ROBERT A.; BOROWSKY, MICHAEL S.; WILLIAMSON, DANA W.; YACAVONE, DAVID W. In Advanced Aviation Concepts, Workshop on Aeronautical Decision Making (ADM). Volume 2: Plenary Session With Presentations and Proposed Action Plan p 56-66 (SEE N93-15013 04-03) Avail: CASI HC A03/MF A03 Naval Safety Center, Norfolk, VA.
Navy and Marine Corps aircraft mishaps which

have an aircrew causal factor assigned were analyzed to determine if the relative military rank of the pilot and copilot or Naval Flight Officer was associated with the rate of occurrence per 100,000 flight hours. All class A and B helicopter flight mishaps for the eleventh calendar year period 1980-1990 were examined. Although statistically significant differences were not found, pairing helicopter pilots who were of equal rank yielded the lowest rate (2.81), seemingly refuting Elwyn Edward's notion that a flat 'trans-cockpit authority gradient' may lead to greater problems in the cockpit than his hypothetical 'optimum gradient'. When there was one rank difference in the cockpit the rate was 2.340. When copilots flew with pilots who differed by two or more ranks, the largest pilot error rate (3.45) was revealed. These findings seem to support Edward's hypothesis that a steeper 'trans-cockpit authority gradient' may be detrimental to helicopter flight safety. Data from fighter and attack jet aircraft, where there is only one pilot flying with a radar intercept officer or a bombardier/ navigator, were also studied for the calendar years 1986-91. It was discovered that the lowest aircrew error rate (1.80) occurred when the pilot and the other aircrew member differed by more than one rank. When the aircrew were of the same rank the rate was 3.51. For those crews in which there was a one rank difference the rate was 3.85. Reasons for these findings are discussed.

How do we investigate the human factor in aircraft accidents?
93N19655
POLLACK, KRISTINA In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 3 p (SEE N93-19653 06-03) Avail: CASI HC A01/MF A04 Swedish Air Force, Stockholm.
Today, the reality is that two-thirds of accidents and incidents are related to Human Factors. The concept of Human Factors is hard to define, identify or verify and definitions of the concept are as many as its advocates. In order to be aware of the complexity of the Human Factor in defining the root cause of an accident, to sub-categorize the concept, to be able to analyze and to see the trends over a period of time, trained experts are required. The findings, including the Human Factor findings, must influence the total report, which will form the basis of future flight safety work.

A method for investigating human factor aspects of military aircraft accidents
93N19656
LEVY, RICHARD A. In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 19 p (SEE N93-19653 06-03) Avail: CASI HC A03/MF A04 Norton AFB Ballistic Missile Office, CA.
The term 'human factor' denotes the relationship between the aviator, the aircraft and the environment. This covers a very large and complex interrelated panorama of factors, to include as an example, personal stress, training, physiology, aircraft flight characteristics, judgement and decision making, experience, nutrition, fatigue, and motivation. A major concern in assessing the significance of any particular human factor, or combination of factors, is the method employed in the collection of the raw data and subsequent analysis. The method of investigation and analysis employed by the U.S. Air Force, the problems inherent in this approach, and a joint, NATO human factors aircraft accident investigation methodology and program are discussed.

The human factor problem in the Canadian Forces aviation
93N19657
DAVID, J. F. In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 9 p (SEE N93-19653 06-03) Avail: CASI HC A02/MF A04 Canadian Forces Headquarters, Ottawa (Ontario).
A 10-year analysis of human factor errors in the Canadian Air Force and where efforts should be concentrated to reduce human error are discussed. A 10-year analysis of our ground accidents and interestingly, close to 84 percent of the causes were related to personnel errors. Although the overall supervisory error was approximately 10 percent, it represented only 6 percent of the personnel error in air occurrences and close to 19 percent in ground occurrences. It was concluded that aviation psychology needs more investment. Furthermore, we cannot progress effectively in this area unless an extensive human factor data base is developed over coming decades. A human factor data base will allow for meaningful and more objective assessment by the decision makers and leaders.

Underlying causes of accidents: Causal networks
93N19658
RAMECKERS, FERDINAND H. J. I. In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 4 p (SEE N93-19653 06-03) Avail: CASI HC A01/MF A04 Royal Netherlands Air Force, The Hague.
This paper describes recent thinking about Accident Causation Theory, accident investigation and accident prevention. The central notion is that human error as the primary cause of accident causation, prevails at all levels in any complex organization and that accidents are caused by a unique network of factors, generated not only by unsafe acts of front-line operators, but also by fallible management decisions and all kinds of (psychological)

preconditions that exist in the operations environment. New approaches aiming at possibilities of proactive prevention are briefly touched.

Disorientation and flight safety: A survey of UK Army aircrew
93N19680
DURNFORD, S. J. In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 14 p (SEE N93-19653 06-03) Avail: CASI HC A03/MF A04 Army Air Corps, Stockbridge (England).
This paper reports the finding of a questionnaire survey intended to gather disorientation. 440 UK Army aircrew were targeted and the response rate was 79 percent. The survey confirmed the high incidence of disorientation (24 percent of aircrew had suffered at least one episode severe enough to have put flight safety at risk at some point during their flying career and 6 percent had suffered such an episode in the previous 4 months). Only 10 percent had never suffered any disorientation.

Significance of histological postmortem findings in pilots killed in military and civil aircraft accidents in Germany (West): A 25-year-review
93N19697
KRAEMER, M.; STOCKER, U. In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 5 p (SEE N93-19653 06-03) Avail: CASI HC A01/MF A04 German Air Force, Fuerstenfeldbruk (Germany).
The Division of Aerospace Pathology and Toxicology ('Flugunfallmedizin') at the German Air Force Aerospace Medical Institute was founded in 1964 by Col. Prof. Krefft and is since then located at Furstenfeldbruck AFB near Munich. The Division is engaged in the medical and medico-legal part of all fatal accident - most non fatal accident - and incident investigations concerning German military aircraft (Airforce, Navy and Army). The Division performs also some civilian medical accident investigations for the Federal Aviation Administration ('FUS, Flugunfall Untersuchungsstelle beim Luftfahrt Bundesamt'). The autopsy files of the period 1 January 1965 up to 31 December 1990 were reviewed. In 231 civilian and military crashes a total of 455 autopsies was performed, resulting in 385 valid autopsy reports of killed pilots including a histopathological examination. Histopathological findings were coded and stored in a data base of an IBM compatible computer. In those cases with positive histopathological findings in the files the tissue was reexamined. 36 cases showed severe histopathological alterations. 21 of these might be considered to have reduced physical and/or mental performance and thus have affected the capability of flight safety. A selection of ten cases is used to discuss problems of accident causality in case of positive histopathological findings. The value and validity of findings especially in those cases of a high degree of tissue destruction is demonstrated. In aircraft accident investigations autopsy and histopathological examination must - on the basis of nearly 5 percent positive histopathological findings - be regarded as mandatory.

Gremlins: A dozen hazardous thought and behavior patterns as risk factors
93N19709
CETINGUC, MUZAFFER In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 4 p (SEE N93-19653 06-03) Avail: CASI HC A01/MF A04
Gulhane Skeri Tip Akademisi, Eskisehir (Turkey).
The term 'Gremlins' is known as fictitious ill-tempered spirits loved by children as comic strips and movie characters. During World War 2, it was an easy and unscientific way to throw blame on Gremlins which were considered responsible for unexplainable mechanical difficulties, as if a gin caused malfunctions in the aircraft. It was the gremlin, that diagnosis of pilots and engineers for mechanical malfunctions, that caused aircraft accidents during World War 2. Today they are nothing but puppets and movie characters. Reasons of accidents are explained by more scientific methods. Although modern technology presents materials providing safety in almost all conditions, accidents continue on faults rising from human beings. In this concept, it fits more to use gremlins as 'ill-temperness belonging human psychology that may cause risk'. Some certain personality variances effect the decision and judgement functions. These disorders reflected to thinking and behavior, sometimes may be leading reasons of accidents.

Safety study: Alcohol and other drug involvement in fatal general aviation accidents, 1983 through 1988
93N23187 169 PAGES Avail: CASI HC A08/MF A02
National Transportation Safety Board, Washington, DC.
The Safety Board conducted this study to examine alcohol and other drug involvement in fatal general aviation accidents that occurred from 1983 through 1988 and to compare the level of alcohol-involved accidents with the level documented in its 1984 statistical review of alcohol-involved aviation accidents that occurred from 1975 through 1981. For general aviation accidents that were fatal to the pilot-in-command, comparisons are made for two accident groups in terms of accident characteristics, flight conditions, pilot-in-command characteristics, and causes and factors. The alcohol-involved group consists of accidents in which alcohol was cited by

the Safety Board as a cause or factor; the second group consists of accidents in which alcohol or other drugs were not cited as a cause or factor. Although the study briefly reviews accidents that were fatal to the pilot-in-command and in which drugs other than alcohol were cited as a cause or factor, the data are too limited for a comparative analysis to the alcohol-involved accidents or to accidents in which alcohol or other drugs were not cited.

Aircraft accident report: Tomy International, Inc., d/b/a Scenic Air Tours flight 22, Beech Model E18S, N342E in-flight collision with terrain, Mount Haleakala, Maui, Hawaii, 22 April 1992
93N25827
Avail: CASI HC A04/MF A01 National Transportation Safety Board, Washington, DC.
This report explains Scenic Air Tours flight 22's collision with mountainous terrain on the Island of Maui, Hawaii, while the Beech E18S airplane was on an air tour flight from Hilo, Hawaii, to Honolulu, Hawaii, on 22 Apr. 1992. The safety issues discussed in the report include visual flight in instrument meteorological conditions, navigational errors, pilot pre-employment qualifications and background checks, and the overall safety of the air tour industry. Recommendations concerning these issues were addressed to the Federal Aviation Administration and to Tomy International, Inc., d/b/a Scenic Air Tours.

B. Reducing the Incidence of Human Errors or Their Effects

TCAS finally moves into the cockpit
91A25838
PRYOR, DAVID (Allied Signal Aerospace Co., Bendix/King Air Transport Avionics Div., Fort Lauderdale, FL) Aerospace America (ISSN 0740-722X), vol. 29, Feb. 1991, p. 36-38.
Three versions of the Traffic Alert and Collision Avoidance System, TCAS, are described. TCAS works by providing a constant flow of data to aircraft on the status of nearby traffic. TCAS I is a low-power, short-range (3-5 n.mi.) system and display unit which can locate aircraft in an immediate vicinity and display their location in a given quadrant. TCAS II has an omni antenna on the bottom and a directional antenna on top of the aircraft; both antennas work with the transponder to interrogate every transponder-equipped aircraft in its surveillance range of 14 n.mi. The system gives visual and voice commands of vertical maneuvers needed to avoid other aircraft. TCAS III is currently under study and will be able to issue horizontal as well as vertical advisories, telling aircraft to maneuver out of the way of other aircraft flying in the vicinity. TCAS has been tested and certified on 20 different types of commercial aircraft, including the B 727, 737-300, 737-400, 747-100, 757, and 767, and the DC-10.

The automatic human
91A30769
BILLINGS, CHARLES (NASA, Ames Research Center, Moffett Field, CA) Aerospace (UK) (ISSN 0305-0831), vol. 18, March 1991, p. 14-19.
National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
An overview is presented of the growth and role of automation in civil aircraft operations for both cockpit management and ground control. NASA has initiated a research program centered on furthering automation and developing a consistent and rational philosophy of human centered aircraft and air traffic control automation. Introduction of the NASA Aviation Safety Reporting System (ASRS) has proved successful in bringing together pilots and ground controllers to report incidents of operational anomalies that can then be analyzed, leading to corrective action to prevent similar reoccurrences. Attention is given to the growing trend of extensive automation in the cockpit that appears to be leading to a diminution of management control of the aircraft by the decreasing number of flight crew members. A majority of reports indicate that there is a serious mismatch between new aircraft capabilities and ATC procedures, which were designed for older aircraft. ASRS has also kept research oriented toward real problems and community needs.

The ergonomic integrated flight deck
91A34916
STONE, GERALD (Douglas Aircraft Co., Long Beach, CA) IN: Human error avoidance techniques; Proceedings of the 2nd Conference, Herndon, VA, Sept. 18, 19, 1989 (A91-34906 14-53). Warrendale, PA, Society of Automotive Engineers, Inc., 1989, p. 73-85.
A coordinated flight deck design concept is presented, which takes into account human capabilities and limitations such as fit and function, seating, internal and external vision, reach, and safety. In addition to incorporating operational requirements, the concept covers amenities such as coffee cup holders, footrests, provisions for food service, storage of personal items such as suitcases and clothing, and maps, flight manuals, and charts. The design is brought together with computer-aided drafting procedures as well as sophisticated human

modeling techniques, enabling a step-by-step assessment of the resulting configuration.

Take-Off Performance Monitoring system algorithms and display development
91A47166
VERSPAY, SJACK (National Aerospace Laboratory, Amsterdam, Netherlands) IN: AIAA Atmospheric Flight Mechanics Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers (A91-47151 20-08). Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 150-157. Research supported by Netherlands Agency for Aerospace Programs.
As part of a study into the potential safety benefit of a Take-Off Performance Monitoring (TOPM) system the development of the algorithms and displays needed for such a system are presented. The predictive algorithms make use of a first order correction polynome which is shown to be capable of predicting performance better than a zero-order correction. Three displays are presented for three different Types of TOPM, which represent different levels of sophistication.

Opportunities to improve helicopter cockpit displays - A pilot's perspective
91A48659
STRINGER, PAUL G. (Essex Corp., Columbia, MA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 12 p.
Human error remains as the major cause/factor identified in both civil and military helicopter accident reports. This paper identifies some opportunities for improving helicopter operational performance and reduce human error accidents based on critical event analysis of accident reports and associated operational requirements. Analysis identified areas where the pilot was overloaded and information available to the pilot was inadequate for the particular situation. These results suggest several areas where the task demands could be made more compatible with the pilot capabilities for improved performance, fewer errors, and timely decisions in critical situations. Two areas addressed are power/flight performance management and obstacle avoidance. This information can be useful in developing helicopter automation and electronic display systems that improve safety and mission reliability.

Active noise reduction
92A32980
GEYER, CAROLYN R. (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: Annual SAFE Symposium, 28th, San Antonio, TX, Dec. 11-13, 1990, Proceedings (A92-32976 13-54). Newhall, CA, SAFE Association, 1991, p. 43-46.
Active noise reduction (ANR) techniques are described with reference to their application to crew members during aircraft operation to enhance productivity and safety. ANR concepts and theory are explained, and the development of protective ANR systems for direct implementation are described. Sound attenuation testing was conducted to study the feasibility of aircraft-powered ANR systems, and the positive results spurred their development for compatibility with flight helmets. The Helmets Limited ANR system uses a bypass mode at times of limited available power and complements the use of passive sound attenuation. Subjective testing results show that the device is effective, and a planned program of intensive evaluation is discussed. The aircraft that require an ANR system are listed, and key areas of implementation include battery power and the combination of ANR circuitry and helmet oxygen masks. It is suggested that ANR techniques can positively impact the efficiency and performance of crew members in high-noise-level aircraft.

Cockpit task management - Preliminary definitions, normative theory, error taxonomy, and design recommendations
92A33802
FUNK, KEN (Oregon State University, Corvallis) International Journal of Aviation Psychology (ISSN 1050-8414), vol. 1, no. 4, 1991, p. 271-285.
A preliminary formalization of the process that flight crews use to initiate, monitor, prioritize, execute, and terminate multiple, concurrent tasks is presented. Key terminology is defined and a preliminary, normative theory of cockpit task management (CTM) is presented. An error taxonomy that is applied to three National Transportation Safety Board aircraft accident reports is introduced. Recommendations for pilot-vehicle interfaces (PVIs) intended to facilitate CTM and an example, prototype PVI that was effective in improving CTM performance are provided. In conclusion, the complementary relationship between CTM and cockpit resource management (CRM) is described.

Flight safety - Human factors, the key to progress
92A39306
HAWKINS, FRANK H. IN: Safety at sea and in the air - Taking stock together; Proceedings of the Conference, London, England, Nov. 13-15, 1990 (A92-39301 16-03). London, Royal Aeronautical Society, 1990, p. 13.1-13.8.
It is noted that although aviation is basically a technological activity, present safety levels can be enhanced most effectively through improved attention to the human component in the system. This attention must be applied by increasing an understanding of the characteristics of this human element, its capabilities and limitations at all levels

in the industry, including management. Attention is given to the working interrelationship in the cockpit between hardware, software and 'liveware'(the human component).

Training for Advanced Technology Aircraft - A pilot's perspective
92A39979
ORLADY, HARRY W. SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Sept. 23-26, 1991. 10 p.
Changing needs in pilot training for Advanced Technology (ADVTECH) aircraft are examined. The importance of line-oriented flight training and crew resource management in that training is addressed. The role of training centers, provided for under the FAA's Advanced Qualification Program, are discussed.

A workshop on understanding and preventing aircrew error
92A44902
DIEHL, ALAN E. (USAF, Inspection and Safety Center, Norton AFB, CA) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1 (A92-44901 19-53). Columbus, OH, Ohio State University, 1991, p. 28-37.
A review is presented of a workshop concerning: an understanding of the factors which contribute to aircrew error accidents and incidents, the methodology being employed to investigate such events, and prevention measures currently available to decrease the probability of mishaps. It is shown how these activities are closely interrelated in today's aviation. This workshop examined training procedures used in accident prevention as well as case studies of major aircraft accidents.

EICAS in an integrated cockpit
92A44922
KOSOWSKI, JANALEE M. (Rockwell International Corp., Cedar Rapids, IA) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1 (A92-44901 19-53). Columbus, OH, Ohio State University, 1991, p. 166-171.
The primary objective of all the information that is available in the modern commercial cockpit is to fly the aircraft safety by providing the pilot with the pertinent information needed, when it is needed. The secondary objective is to operate the aircraft efficiently. Because of these objectives, the goal of EICAS (Engine Indication Crew Alerting System) is to assist the pilot in assimilating, interpreting, prioritizing, and acting upon the large amount information that is available. In the design phase of an EICAS development program, careful attention must be paid to the various methods used to present information to the pilot. Since the largest portion of all air traffic accidents are attributed to 'pilot error', careful attention to human factors during the design phase of these cockpit information systems will help reduce the potential for these types of errors.

Electronic checklists - Evaluation of two levels of automation
92A44924
PALMER, EVERETT; DEGANI, ASAF (NASA, Ames Research Center, Moffett Field, CA); (San Jose State University Foundation, CA) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1 (A92-44901 19-53). Columbus, OH, Ohio State University, 1991, p. 178-183., National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
Two versions of an electronic checklist have been implemented in the Advanced Concepts Flight Simulator (ACFS) at NASA Research Center. The two designs differ in the degree of pilot involvement in conducting the checklists. One version (manual-sensed), requires the crew to manually acknowledge the completion of each checklist item. The other version (automatic-sensed), automatically indicates completed items without requiring pilot acknowledgement. These two designs and a paper checklist (as a control condition) were evaluated in line oriented simulation. Twelve aircrews from one major air-carrier flew a routine, four leg, short-haul trip. This paper presents and discusses the portion of the experiment that was concerned with measuring the effect of the degree of automation on the crews' performance. It discusses and presents evidence for a potential down-side of implementing an electronic checklist that is designed to provide fully redundant monitoring of human procedure execution and monitoring.

Philosophy, policies, and procedures - The three P's of flight-deck operations
92A44925
DEGANI, ASAF; WIENER, EARL L. (San Jose State University Foundation, CA); (Miami, University, Coral Gables, FL) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1 (A92-44901 19-53). Columbus, OH, Ohio State University, 1991, p. 184-191. Research supported by NASA, America West Airlines, Inc., and Delta Air Lines, Inc., National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.; National Aeronautics and Space Administration, Washington, DC.
Standard operating procedures are drafted and provided to flight crews to dictate the manner in

which tasks are carried out. Failure to conform to Standard Operating Procedures (SOP) is frequently listed as the cause of violations, incidents, and accidents. However, procedures are often designed piecemeal, rather than being based on a sound philosophy of operations and policies that follow from such a philosophy. A framework of philosophy, policies, and procedures is proposed.

Stop, look and learn from accident investigation
92A44996
COOK, HENRY L. (Jungle Aviation and Radio Service, Waxhaw, NC) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2 (A92-44901 19-53). Columbus, OH, Ohio State University, 1991, p. 636-639.
An account is given to a method for helping pilots and aircraft mechanics learn from the mistakes of others through role-playing. In this training process, the reading of an accident report is followed by the participants' efforts to recreate the sequence of events which led to the mishap. The illustrative case from which lessons concerning the power of imaginative recreations of an accident scenario are drawn involved a helicopter landing.

Vigilance of aircrews during long-haul flights
92A45021
CABON, PH.; MOLLARD, R.; COBLENTZ, A.; FOUILLOT, J. P.; STOUFF, C.; MOLINIER, G. (Paris V, Universite, France); (Direction Generale de l'Aviation Civile, Paris, France)
IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2 (A92-44901 19-53). Columbus, OH, Ohio State University, 1991, p. 799-804. Research supported by Direction Generale de l'Aviation Civile and Airbus Industrie.
An effort is made to identify the factors that can modify pilot vigilance and performance during long-haul flights, in order to either institute measures for the reinvigoration of pilots or propose rest and nap periods. A data base encompassing such quantitative physiological data as pilot EEGs, EOGs, and EKGs were used to compile a data base for further evaluation. Vigilance, as indicated by the increase in the slow bands of EEG and in blink frequency, shows important variations during the low workload/monotonous activity cruising phase of a long-range flight.

Eliminating pilot-caused altitude deviations - A human factors approach
92A45041
SUMWALT, ROBERT L., III (Air Line Pilots Association, Columbia, SC) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2 (A92-44901 19-53). Columbus, OH, Ohio State University, 1991, p. 929-934.
The consequences of commercial aircraft altitude deviations range from rapid maneuvers to correct the oversight to near-collision incidents and actual accidents. An account is presently given of an airline's design and implementation of an altitude-awareness program involving: (1) mandatory education, (2) alerter-setting procedures, (3) altitude callouts, and (4) several recommended techniques. In the course of 8 months after program initiation, the airline has witnessed a 60-65 percent reduction in altitude deviations with loss of flight-path separation. Additional improvements are expected due to learning-curve considerations.

Teaching an old dog new tricks - Concepts, schemata and metacognition in pilot training and education
92A45046
STRAGISHER, GEORGE W. (Kent State University, OH) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2 (A92-44901 19-53). Columbus, OH, Ohio State University, 1991, p. 958-963.
Experienced pilots attempting to master new aircraft must learn how to recognize cues that signal problems with either the acquisition of critical new information or interference in effective interaction among crew members. An 'assertiveness training program' may be required for effective interaction in the cockpit environment. Attention is given to the 'concept mapping' method for decomposing an individual's ideas into relational components, in order to identify anomalies which may be acting as barriers to learning.

ICAO Flight Safety and Human Factors Programme
92A45055
MAURINO, DANIEL E. (International Civil Aviation Organization, Montreal, Canada) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2 (A92-44901 19-53). Columbus, OH, Ohio State University, 1991, p. 1014-1019.
The ICAO established its Flight Safety and Human Factors Program and Study Group. The first step toward achieving the Program's educational objectives is the organization of regional five-day seminars; two of these will be conducted each year in three-year cycles. At the end of each such cycle, a world-wide symposium will be held so that recent progress in human factors can be examined by leading authorities of the aviation community; the plan of investigative efforts for the following three-year period can then be reformulated in light of these discussions. The first of these symposia

was held in Leningrad (now St. Petersburg) in April, 1990.

Takeoff Performance Monitoring System display options
92A52433
MIDDLETON, DAVID B.; SRIVATSAN, RAGHAVACHARI; PERSON, LEE H., JR. (NASA, Langley Research Center, Hampton, VA); (Vigyan, Inc., Hampton, VA); (NASA, Langley Research Center, Hampton, VA) IN: AIAAHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers (A92-52426 22-09). Washington, American Institute of Aeronautics and Astronautics, 1992, p. 57-67.
The development of displays for the Takeoff Performance Monitoring System (TPMS) is described with attention given to the three concepts prepared for commercial applications. The TPMS algorithm is described and related to the display requirements for pilots of two-engine airplanes. Head-up and -down displays are considered for displaying the simple advisory data which indicate whether the takeoff is a 'Go' or 'No-go' based on engine failure, acceleration error, and runway length. Six pilots are shown the three display options which include: (1) basic information; (2) basic data with 'Go/No-go' advisory flags; and (3) basic data, advisory flags, and an abort-warning symbol. The pilots tended to select the option with the most advisory data available, but the inconclusive preference study led to the concept of presenting all three configurations as possible display options for the TPMS.

C.R.M. training for the advanced flight deck
93A13410
RACCA, EDDY L. (Airbus Industrie, Blagnac, France) In: Human factors on advanced flight decks; Proceedings of the Conference, London, United Kingdom, Mar. 14, 1991 (A93-13408 02-54). London, Royal Aeronautical Society, 1991, p. 4.1-4.3.
A development history is presented for the involvement of human factors considerations in the progression of Airbus airliner cockpits, from the rather conventional (but pilot/copilot side-panel-equipped) A 300, which first flew in 1972, to the advanced-technology A 320, intensively employing video displays. Attention is given to the significance of cockpit resource management, and to the Computerized System of Notation, Underscoring, and Statistics that has been used to deepen understanding of the experience of trainees.

The development of an efficient take-off performance monitor (TOPM)
93A14186
KHATWA, R. (National Aerospace Lab., Amsterdam, Netherlands) In: ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 (A93-14151 03-01). Washington, American Institute of Aeronautics and Astronautics, Inc., 1992, p. 219-241. Research supported by SERC, British Aerospace, PLC, and Netherlands Agency for Aerospace Programs.
A take-off performance monitor (TOPM) could assist the pilot in keeping the progress of the take-off constantly in view, so as to make it easier to decide if a take-off can safely be continued, or to support the decision to abandon it. This paper considers the development of a TOPM with a predictive capacity. A pre-take-off module calculates and displays the critical take-off lengths using nominally correct data. These lengths are evaluated on the basis of measured data and 'forward computations' during ground roll. Techniques to deal with anomalies such as sensor failures, incorrect data inputs, improper aircraft configuration and changes in take-off conditions during ground roll are proposed. The possibility of enhancing situation awareness by monitoring of the engine health and acceleration performance is investigated. Consideration is also given to the nature and cockpit position of the display.

Aircrew integrated management
93A14376
RACCA, EDDY L. (Aeroformation, Blagnac, France) In: ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 (A93-14151 03-01). Washington, American Institute of Aeronautics and Astronautics, Inc., 1992, p. 1819-1825.
A review of the human factors module recently introduced for application in flight crew transition courses is presented. Attention is given to an aircrew integrated management course focusing on the integration of the human factors elements of in-flight management by flight crews. Consideration is given to such specific areas of coordination as safety factors, efficiency, schedule, passenger comfort, regulations, and operating specifications.

National plan to enhance aviation safety through human factors improvements
91N10940
FOUSHEE, CLAY In NASA, Langley Research Center, Aviation Safety/Automation Program Conference p 55-65 (SEE N91-10936 02-03) Avail: CASI HC A02/MF A03 Federal Aviation Administration, Washington, DC.
The purpose of this section of the plan is to establish a development and implementation strategy plan for improving safety and efficiency in the Air Traffic Control (ATC) system. These improvements will be achieved through the proper applications of human factors considerations to the

present and future systems. The program will have four basic goals: (1) prepare for the future system through proper hiring and training; (2) develop a controller work station team concept (managing human errors); (3) understand and address the human factors implications of negative system results; and (4) define the proper division of responsibilities and interactions between the human and the machine in ATC systems. This plan addresses six program elements which together address the overall purpose. The six program elements are: (1) determine principles of human-centered automation that will enhance aviation safety and the efficiency of the air traffic controller; (2) provide new and/or enhanced methods and techniques to measure, assess, and improve human performance in the ATC environment; (3) determine system needs and methods for information transfer between and within controller teams and between controller teams and the cockpit; (4) determine how new controller work station technology can optimally be applied and integrated to enhance safety and efficiency; (5) assess training needs and develop improved techniques and strategies for selection, training, and evaluation of controllers; and (6) develop standards, methods, and procedures for the certification and validation of human engineering in the design, testing, and implementation of any hardware or software system element which affects information flow to or from the human.

Aviation safety and automation technology for subsonic transports
91N17009
ALBERS, JAMES A. Presented at the 1991 AIAA International Aerospace Conference and Engineering Show, 13 Feb. 1991, Los Angeles, CA Avail: CASI HC A04/MF A01 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
Discussed here are aviation safety human factors and air traffic control (ATC) automation research conducted at the NASA Ames Research Center. Research results are given in the areas of flight deck and ATC automations, displays and warning systems, crew coordination, and crew fatigue and jet lag. Accident investigation and an incident reporting system that is used to guide the human factors research is discussed. A design philosophy for human-centered automation is given, along with an evaluation of automation on advanced technology transports. Intelligent error tolerant systems such as electronic checklists are discussed along with design guidelines for reducing procedure errors. The data on evaluation of Crew Resource Management (CRM) training indicates highly significant positive changes in appropriate flight deck behavior and more effective use of available resources for crew members receiving the training.

Aircrew fatigue countermeasures
91N18077
MCCAULEY, STEPHENS F. In AGARD, Progress in Military Airlift 6 p (SEE N91-18067 10-03) Avail: CASI HC A02/MF A03 Military Airlift Command, Scott AFB, IL.
Since the earliest days of aviation, there have been aircraft accidents (now referred to as flight mishaps). In earlier times, mechanical malfunctions were blamed for the greater number of mishaps. Engineering and technological advances, however, have since lowered the likelihood of machine-induced mishaps. Now, the man part of the equation (in a chain of events leading to a mishap) is far more likely to be the primary cause. Thus, as aircraft are made more durable, reliable, and better able to sustain increased workloads, the humans who operate them must find ways to adapt or cope with the greater demands which result from improved machine capability. The bottom line question for today surfaces as: What causes crew members to commit errors in judgment, performance, or perception, and how might the influences of such causes be reduced. Progress in the field of human factors (HF) analysis has revealed some solutions while advancing the fundamental goal of flight safety - mishap prevention. The impact of HF studies on mishap prevention is clarified and summarized and how aircrew fatigue is a common denominator among HF elements is shown. Accepted techniques for combating and coping with fatigue are listed. Finally, recommendations on how to maintain operational awareness of aircrew fatigue considerations are proposed.

Automatic speech recognition in air traffic control: A human factors perspective
91N19025
KARLSSON, JOAKIM In NASA, Langley Research Center, Joint University Program for Air Transportation Research, 1989-1990 p 9-13 (SEE N91-19024 11-01) Avail: CASI HC A01/MF A02 Massachusetts Inst. of Tech., Cambridge.
The introduction of Automatic Speech Recognition (ASR) technology into the Air Traffic Control (ATC) system has the potential to improve overall safety and efficiency. However, because ASR technology is inherently a part of the man-machine interface between the user and the system, the human factors issues involved must be addressed. Here, some of the human factors problems are identified and related methods of investigation are presented. Research at M.I.T.'s Flight Transportation Laboratory is being conducted from a human factors perspective, focusing on intelligent parser design, presentation of feedback, error correction strategy design, and optimal choice of input modalities.

Enhancing the usability of CRT displays in test flight monitoring
91N20709
GRANAAS, MICHAEL M.; SREDINSKI, VICTORIA E. In NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) p 529-534 (SEE N91-20702 12-59) SAP: Avail: CASI HC A02/MF A03 South Dakota Univ., Vermillion.
Enhancing the usability of Mission Control Center (MCC) CRT displays stands to improve the quality, productivity, and safety of flight-test research at the NASA Ames-Dryden Flight Research Facility. The results of this research suggests that much can be done to assist the user and improve the quality of flight research through the enhancement of current displays. This research has applications to a variety of flight data monitoring displays.

Human factors of flight-deck checklists: The normal checklist
91N27144
DEGANI, ASAF; WIENER, EARL L. (San Jose State Univ., CA.) Avail: CASI HC A04/MF A01 Miami Univ., Coral Gables, FL.
Although the aircraft checklist has long been regarded as the foundation of pilot standardization and cockpit safety, it has escaped the scrutiny of the human factors profession. The improper use, or the non-use, of the normal checklist by flight crews is often cited as the probable cause or at least a contributing factor to aircraft accidents. An attempt is made to analyze the normal checklist, its functions, format, design, length, usage, and the limitations of the humans who must interact with it. The development of the checklist from the certification of a new model to its delivery and use by the customer are discussed. The influence of the government, particularly the FAA Principle Operations Inspector, the manufacturer's philosophy, the airline's culture, and the end user, the pilot, influence the ultimate design and usage of this device. The effects of airline mergers and acquisitions on checklist usage and design are noted. In addition, the interaction between production pressures and checklist usage and checklist management are addressed. Finally, a list of design guidelines for normal checklists is provided.

Soviet electronic display systems under research and manufactured for the civil aviation aircraft of the 1990s
92N13066
ZHIQIN, L. In Aviation Production Engineering (China), no. 5, May 1989, p. 28-29 Avail: CASI HC A03/MF A01 Air Force Systems Command, Wright-Patterson AFB, OH.
For many years, scientific research and production of on-board electronic equipment on Soviet civil aviation aircraft primarily directed its efforts to the resolution of the problems of guaranteeing a high degree of flight safety, and lowering operating expenses. Lightening aircrew operating responsibilities of the aircrews is an effective method of raising the safety of flying. The operating responsibilities of aircrew personnel are primarily determined by the information capacity and orderliness of the whole set of on-board equipment. The question of lightening aircrew operating responsibilities, in the last ten years, has had special practical significance. The reason for this is that, in this time period, civil aviation aircraft have been equipped with various types of new model guidance and communications gear, automatic flight control equipment, and electric supply equipment. In conjunction with this, there has been a choice to make use of new piloting principles, such as those based on opting for the use of overall energy amount information.

Background issues for on-line aircraft documentation
92N13858
RUSSELL, C. RAY In Old Dominion Univ., NASAmerican Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1991 p 198-201 (SEE N92-13832 04-80) Avail: CASI HC A01/MF A03 Appalachian State Univ., Boone, NC.
Currently, almost all aircraft documentation in commercial aircraft cockpits is presented via hardcopy manuals. Several recent projects are aimed at eliminating all paper documentation in cockpits using electronic libraries. Electronic libraries encompass diverse information bases including aircraft system documentation, operations and procedures, checklists, maintenance logs, minimum equipment lists, maps and charts, and flight management information. These electronic libraries are envisioned to be embedded in the avionics so as to provide real time monitoring and display of information. Background issues are examined (motivation, information retrieval models, and preliminary designs) for the on-line presentation of aircraft systems documentation including operations, procedures, and checklists.

The design and evaluation of fast-jet helmet mounted displays
92N19010
KARAVIS, A.; CLARKSON, G. J. N. In AGARD, Helmet Mounted Displays and Night Vision Goggles 8 p (SEE N92-19008 09-54) Avail: CASI HC A02/MF A02 Royal Aircraft Establishment, Farnborough (England).
The design philosophy adopted by the Flight Systems Department of the Royal Aerospace

Establishment (RAE), Farnborough for its fast-jet helmet display program is discussed. Details are given on the development of two devices and the tests and methods used to meet flight safety measurements. The devices, a Helmet Mounted Sight (HMS) and an Oxygen Mask Mounted Sight (OMMS), each posed different problems due to their inherently dissimilar concepts. Modifications to these devices as a result of ground and air testing to meet flight safety and operational requirements are covered. The ergonomic considerations applicable to the use of these and other head mounted devices when employed as integral components of the weapon system are also discussed. A brief account is given of display design considerations. Two helmet devices were successfully produced for evaluation in a combat environment.

Human factors in the CF-18 pilot environment
92N33660 293 Pages
DAVIDSON, R. A.; BEEVIS, D.; BUICK, F.; DONATI, A. L. M.; KANTOR, L.; BANNISTER, S. H. R.; BROOK, E. A.; ROCHEFORT, J. A. P.; TURNER, J. R. Avail: CASI HC A13/MF A03 Defence and Civil Inst. of Environmental Medicine, Downsview (Ontario).
A review of human factors in the CF-18 pilot environment was undertaken via a survey of 161 active CF-18 pilots. Over 300 human factors issues were initially identified, of which the 88 most relevant to CF-18 operations were selected and evaluated. The pilots were asked to assess, from a squadron perspective, the current effect of each issue on flight safety and operational effectiveness. Each issue was rated on a sliding scale and ratings were analyzed using a non-parametric procedure. Aircraft and aircraft operations issues were rated almost equally divided between beneficial and neutral. Most of the training related issues were rated as beneficial. Among issues related to squadron personnel, comparable numbers received beneficial, neutral, and detrimental ratings. A fourth of the organizational issues were rated as detrimental, with most of the rest rated as neutral. In general, issues beneficial to flight safety were also beneficial to operational effectiveness. Cause and effect models were developed to explain the ratings, supporting the opinion that the greatest threats to flight safety and operational effectiveness are the decreasing level of flying experience and inadequate manning levels. Specific conclusions and recommendations are presented for improving flight safety and operational effectiveness.

Does cockpit management training reduce aircrew error?
93N15014
DIEHL, ALAN E. In Advanced Aviation Concepts, Workshop on Aeronautical Decision Making (ADM). Volume 2: Plenary Session With Presentations and Proposed Action Plan p 3-24 (SEE N93-15013 04-03) Avail: CASI HC A03/MF A03 Air Force Inspection and Safety Center, Norton AFB, CA.
Human factors problems continue to be involved in majority of mishaps. Thus, the causes and cures for aircrew 'error' are widely discussed topics. Several experts have noted that labels like pilot 'error' are often misapplied in describing ergonomic, management, regulatory or systems design shortcomings. This paper uses the generic term 'cockpit management' when referring to the wide variety of programs which are designed to reduce aircrew errors. In fact, recent evidence suggests Cockpit Resource Management (CRM) and Aeronautical Decision making (ADM) training may help reduce aircrew error accident rates by as much as 81 percent. These programs have only emerged in the last decade largely because of the fundamental problems associated with detecting and controlling human error. Many of us have lamented the greater difficulties of accurately documenting human vis-a-via mechanical failures, (e.g., mental fatigue is usually tougher to prove than metal fatigue). It is also often harder for us as air safety investigators to specify effective countermeasures in the human factors domain. Thus, some organizations unfortunately have assumed such errors are 'the price of doing business'. This paper addresses these issues by: (1) examining the prevalence of major types of contemporary errors and reviewing the traditional methods which have been used to improve human reliability; (2) discussing how innovative cockpit management training programs were developed and implemented; and (3) describing the current evidence on the effectiveness of such programs.

Cockpit decision making
93N15015
DIEHL, ALAN E. In Advanced Aviation Concepts, Workshop on Aeronautical Decision Making (ADM). Volume 2: Plenary Session With Presentations and Proposed Action Plan p 25-29 (SEE N93-15013 04-03) Avail: CASI HC A01/MF A03 Air Force Inspection and Safety Center, Norton AFB, CA.
The categorical distinctions between Cockpit Resource Management (CRM) and Aeronautical Decision Making (ADM) training are becoming blurred. Most current versions of these programs have five common elements which deal with attention, crew, stress, attitude, and risk management issues. The results of six empirical and six operational evaluations provide strong evidence that these training programs can help reduce aircrew errors and thereby prevent accidents. While

additional research and development continues, there is a growing realization that these programs ideally need to be introduced rarely in flight training, reinforced during upgrade training, and reviewed during recurrent training and accident prevention sessions.

Embedded ADM reduces helicopter human error accidents
93N15024
FOX, ROY G. In Advanced Aviation Concepts, Workshop on Aeronautical Decision Making (ADM). Volume 2: Plenary Session With Presentations and Proposed Action Plan p 182-229 (SEE N93-15013 04-03) Avail: CASI HC A03/MF A03 Textron Bell Helicopter, Fort Worth, TX.
The basic outlines are: (1) Who is responsible for safety?; (2) measuring risk; (3) means of reducing risk; and (4) crash survival; (5) accident causes (2/3 are Human); (6) judgement training; and heliprops effects on 206 human error accident rates. The conclusion made is that, Judgement Training has more safety improvement potential than the total elimination of all airworthiness failure causes (a primary goal since the start of aviation).

Airbus Industrie TCAS experience
93N15186
GANZ, H. In DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 647-674 (SEE N93-15152 04-06) Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC Airbus Industrie, Toulouse (France).
TCAS 2 equipment (Traffic Alert and Collisional Avoidance System) is viewed as a supplement to the pilot who, with the aid of air traffic control system, has the primary responsibility for avoiding mid air collisions. A description of the system is given. Installation principles and experience gained on several aircraft types before obtaining approval of TCAS 2 installation are provided. The integration of this system raised a lot of problems, ranging from European airworthiness/operational approval requirements, missing top level specification, a not mature system and integration/ compatibility problems.

Workshop on Aeronautical Decision Making (ADM). Volume 1: Executive summary
93N16189
LOFARO, RONALD J. Workshop held in Denver, CO, 6-7 May 1992 Avail: CASI HC A05/MF A01 Advanced Aviation Concepts, Jupiter, FL.
This report presents Aeronautical Decision Making (ADM) training accomplishments, limitations, and future needs from the perspectives of commercial operators, general aviation, military aviation, and research development. A select group of experts on ADM was convened to share ideas, identify and explore future directions for advanced training. Cognitive training requirements based upon decision making task demands of both airplane and helicopter pilots and crews are analyzed. A major question which requires definitional research is the following: What is a real aircrew/pilot decision? That is, when does an event generate a true decisional opportunity for a pilot or crew versus a one-path only reaction, where the actual emphasis is not on cognitive decision making, but the application of procedures and basic airmanship. Going one step further, the group analyzed the decision making differences between expert and novice pilots when a real decision was required.

Towards an integrated approach to proactive monitoring and accident prevention
93N19700
REJMAN, MICHAEL H.; SYMONDS, COLIN J.; SHEPHERD, ERIC W. (City of London Polytechnic, England); (City of London Polytechnic, England) In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 5 p (SEE N93-19653 06-03) Avail: CASI HC A01/MF A04 Army Personnel Research Establishment, Farnborough (England).
Most traditional accident prevention programmes are based on information learned from accident research. While acknowledging the contribution from this approach, two difficulties can be identified. First, many accidents may be the product of a unique combination of circumstances. Second, the whole process is 'reactive'. In contrast, the research initiative reported here begins with the premise that the components of any organization may already hold much information which could be relevant to safety research and which could be used 'proactively'. A novel feature of the methodology outlines in this programme is that each of the areas can be considered as stand-alone models, capable of providing useful management information in their own right. Taken together, they represent a powerful and integrated approach to an organization's flight safety and accident prevention programme.

On the typography of flight-deck documentation
93N19970
DEGANI, ASAF Avail: CASI HC A03/MF A01 San Jose State Univ., CA.
Many types of paper documentation are employed on the flight-deck. They range from a simple checklist card to a bulky Aircraft Flight Manual (AFM). Some of these documentations have typographical and graphical deficiencies; yet, many cockpit tasks such as conducting checklists, way-point entry, limitations and performance

calculations, and many more, require the use of these documents. Moreover, during emergency and abnormal situations, the flight crews' effectiveness in combating the situation is highly dependent on such documentation; accessing and reading procedures has a significant impact on flight safety. Although flight-deck documentation are an important (and sometimes critical) form of display in the modern cockpit, there is a dearth of information on how to effectively design these displays. The object of this report is to provide a summary of the available literature regarding the design and typographical aspects of printed matter. The report attempts 'to bridge' the gap between basic research about typography, and the kind of information needed by designers of flight-deck documentation. The report focuses on typographical factors such as type-faces, character height, use of lower- and upper-case characters, line length, and spacing. Some graphical aspects such as layout, color coding, fonts, and character contrast are also discussed. In addition, several aspects of cockpit reading conditions such as glare, angular alignment, and paper quality are addressed. Finally, a list of recommendations for the graphical design of flight-deck documentation is provided.

Off-shore platform identification signs
93N24124
SMITH, A. J. London, England Civil Aviation Authority Avail: Civil Aviation Authority, Graville House, 37 Gratton Road, Cheltenham, United Kingdom, HC Royal Aerospace Establishment, Bedford (England).
A study to define the operational requirements for rig identification signs and to propose a specification for the physical characteristics of a sign that will meet the operational requirements is presented. Design considerations of conspicuity, legibility, atmospheric attenuation, and other factors are described and discussed. The following are concluded: the pilot needs to see the rig identification aid at a range of 1250 m, by day and by night in visibilities down to 1250 m; the visual aid must be usable from a range of at least 900 m in the conditions given above; the signs currently displayed in rigs do not have sufficient luminance contrast; the contrast of the signs is very variable and dependent on environmental factors, as a result of which the useful range of the signs is also very variable and is often insufficient; and a sign board of the type currently in use will generally have a range less than the meteorological visibility, whereas a lit sign or beacon can have ranges in excess of the meteorological visibility. It is recommended that a new visual aid be specified. There are two options: either provide an identification beacon or develop a sign that has high contrast levels and adequate intensity to be legible at ranges in excess of 1000 m. Both options are technically feasible with current technology. The choice will primarily be a flight operations decision. In either case a prototype unit could be made available for trials during the first half of 1992.

C.
Injury Reduction or Analysis

Seeking crashworthy seats
91A44345
DEMEIS, RICHARD Aerospace America (ISSN 0740-722X), vol. 29, July 1991, p. 44, 45.
A review is presented of current thinking, research and design in the construction and installation of energy-absorbing, crash resistant seats for crew/passengers in both military and commercial transports. The FAA now requires all newly certificated rotorcraft, light aircraft, and airliners to have seats able to withstand dynamic loads even with distorted floor attachment geometry. Energy dissipating linkages are now utilized to accommodate crash loads, with seats translating downward and absorbing the impact energy while keeping spine loads within tolerances. It is noted that airliner crash energy absorption can be an efficient combination of elastic and plastic deformation of the seat structure.

Survival Technology Restraint Improvement Program status
92A35429
WHITMAN, GARY R. (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: Annual SAFE Symposium, 29th, Las Vegas, NV, Nov. 11-13, 1991, Proceedings (A92-35426 14-54). Yoncalla, OR, SAFE Association, 1992, p. 14-19.
The Survival Technology Restraint Improvement Program (STRIP) which is a part of the Navy Aircrew Common Ejection Seat (NACES) program is reviewed. The STRIP program is aimed at developing a system for eliminating MA-2 restraint deficiencies and meeting the requirements of future tactical aircraft. The NACES has been incorporated into the T-45A, F-14D, F/A-18C, and F/A-18D, and was designed to interface with the MA-2 Torso Harness. Particular attention is given to the STRIP subsystems and evaluation process established to assess the system.

Energy attenuation for crashworthy seating systems - Past, present, and possible future development
92A35452
GLATZ, J. D. (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: Annual

SAFE Symposium, 29th, Las Vegas, NV, Nov. 11-13, 1991, Proceedings (A92-35426 14-54). Yoncalla, OR, SAFE Association, 1992, p. 174-181.
Consideration is given to past efforts that have led to successful operational use of energy attenuators for seating systems, recent research, and possible concepts for future development. Energy-attenuating seating systems are considered to be the most effective location for providing occupant energy protection in operational aircraft. They have been developed with new aircraft, including CH-46E Sea Knight, UH-60A Black Hawk, SH-60B Seahawk, and AH-64A Apache. The performance of energy-attenuating seating systems is less vulnerable to impact attitude and surface than energy attenuating landing gear or subfloor structure.

A new generation of U.S. Army flight helmets
92A45825
CARTER, RICHARD M. (U.S. Army, School of Aviation Medicine, Fort Rucker, AL) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 63, no. 7, July 1992, p. 629-633.
Head injuries are the most common cause of fatal injury in helicopter crashes. For over 80 years, the U.S. Army has used crash investigation studies to redesign flight helmets. This paper describes the evolution of the newly fielded U.S. Army helmet, the Sound Protection Helmet No. 4B (SPH-4B), and compares its protective features to its predecessors, especially the SPH-4. A major contribution to the helmet design process was made by the Aviation Life Support Equipment Retrieval Program (ALSERP), a functional program at the U.S. Army Aeromedical Research Laboratory. ALSERP has analyzed more than 500 helmets involved in crash events since 1972. Based on these studies of critical safety factors, the Army has developed and deployed the SPH-4B, a new helmet with improved energy absorption, retention, and stability.

Human factors of aircraft cabin safety
93A14218
MUIR, HELEN C.; THORNING, ARTHUR G. (Cranfield Inst. of Technology, Bedford, United Kingdom); (Department of Transport, London, United Kingdom) In: ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 (A93-14151 03-01). Washington, American Institute of Aeronautics and Astronautics, Inc., 1992, p. 519-524.
Attention is given to a British program of research into the human factors involved in aircraft cabin safety in the U.K. Results are presented of an extensive experimental program in which the influence of passenger evacuation on rates of changes to the cabin configurations adjacent to the exits, the presence of smoke in the cabin, the range of weights of the type II hatch, and the presence of an injured and immobile passenger seated adjacent to an exit are investigated. Other studies include the influence of changing the format and content of the information included in the preflight briefing and the influence of practice on the ability of volunteers from the public to operate a type III hatch.

Army cockpit delethalization program
93A15419
SHOPE, W. B.; GRETH, RICKY L.; PFAFF, MARK S. (LME, Inc., Warminster, PA) SAFE Journal, vol. 22, no. 5, Sept.-Oct. 1992, p. 53-61.
Biodynamic simulations, design studies, and experimental data are undertaken to determine strategies for reducing secondary cockpit injuries among helicopter pilots. The Army Cockpit Delethalization program is based on studies of the LHX attack helicopter and the V-22 tilt-wing VSTOL, and specific attention is given to reducing crew member forward movement, lateral displacement, and rebound impacts. A baseline computer simulation is developed for combined models of cockpit, seat occupant, and vehicle motion. Two delethalization concepts are designed: an automatic G-sensing shoulder-strap retractor/tensioner and an advanced restraint harness. An active inflatable bladder for head restraint is also developed by means of the numerical simulations. The restraint device offer complementary protection for helicopter pilots including reduced torso and head displacement, reduced arm flail, and reduced inertial movement upon impact. The simulations are supported by experimental data and suggest that the combined delethalization concepts can reduce the levels of secondary cockpit injuries.

The effects of structural failure on injuries sustained in the M1 Boeing 737 disaster, January 1989
93A25201
WHITE, BARRIE D.; FIRTH, JOHN L.; ROWLES, JOHN M. (Univ. Hospital, Nottingham, United Kingdom) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 64, no. 2, Feb. 1993, p. 95-102.
Only 10 occupants escaped uninjured from the wreckage of the East Midlands Boeing 737/400 aircraft accident. The remaining 116 suffered injuries similar in pattern, but ranging in severity from simple bruising to fatal crushing trauma. Overall, the individual's degree of injury and likelihood of death was proportional to the local structural damage of the aircraft. Limb injuries were particularly severe in the forward section of the wreckage where the floor failed. In areas where structural damage appeared to be survivable, a number of passengers suffered disproportionately

severe head injuries. Many of these had trauma to the posterior aspect of their head, some of whom died as a result. It is likely that these injuries were caused by falling overhead lockers or unrestrained cabin furniture. The significance of these injuries and their future prevention is discussed.

The effects of brace position on injuries sustained in the M1 Boeing 737/400 disaster, January 1989
93A25202
WHITE, BARRIE D.; FIRTH, JOHN L.; ROWLES, JOHN M. (Univ. Hospital, Nottingham, United Kingdom) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 64, no. 2, Feb. 1993, p. 103-109.
Of the initial 87 survivors of the East Midlands Boeing 737/400 aircraft, 77 sustained head and facial trauma during the crash, 45 of whom were rendered unconscious. There were 21 who received injuries to the back of their head, including 5 of the 6 severely head-injured adults. Those passengers who adopted the fully flexed 'brace' position for crash-landing achieved significant protection against head injury, concussion, and injuries from behind irrespective of local aircraft structural damage. A computer graphics simulation developed by a commercial firm (H.W. Structures, Ltd.) using the predicted crash pulse of the accident has validated these clinical findings and allows theoretical biomechanical modeling for the design of occupant protection systems in the future. Although the major role of structural failure should not be forgotten, bracing maximizes the chance of uninjured survival in the current generation of aircraft and should be demonstrated and practiced as a pre-flight routine.

The human factors relating to escape and survival from helicopters ditching in water
91N22099 125 PAGES
BROOKS, C. J. (Defence and Civil Inst. of Environmental Medicine, Downsview, Ontario) English language document was announced as N90-13358 Avail: CASI HC A06/MF A02 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
The worldwide incidence of military and civilian over-water helicopter accidents and the problems related to survival are described. Typical accident scenarios are reviewed from the moment the occupant steps onboard a helicopter to the pre-flight briefing through to the accident itself, to the difficulties with escape (commonly from underwater and in darkness), to the rescue and return safely to dry land. Improvements to crashworthiness and life support equipment in current in-service and future helicopters are proposed. A syllabus for underwater escape training is also discussed.

The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 2
91N24187 162 PAGES
ALEM, NABIH M.; SHANAHAN, DENNIS F.; BARSON, JOHN V. Avail: CASI HC A08/MF A02 Army Aeromedical Research Lab., Fort Rucker, AL.
Accident investigation records of U.S. Army helicopter crashes show injuries of pilots due to striking a structure inside the cockpit outnumber those due to excessive accelerations by a five-to-one ratio. This two-volume report presents the results of a study of the effectiveness of airbags in reducing the severity of contact injury to the gunner when striking the gunsight. Airbag systems were installed on the gunsights in simulated Cobra and Apache cockpits, then sled tested at 7 and 25 g. The tests indicated airbags reduced head accelerations by 65 percent, head injury criteria by 77 percent, and head angular acceleration by 76 percent in the Cobra tests. In the Apache tests, the airbags reduced those same indicators by 68, 52, and 83 percent. An airbag system, the report concludes, is likely to prevent severe or fatal head and chest injuries in an Apache or Cobra crash. Volume 1 of the report describes the tests and discusses the results. Volume 2 consists of Appendixes A, B, and C of the report and contains processed signal graphs of all sled tests.

An evaluation of in-cabin safety features in passenger aircraft
92N20794 209 PAGES
NICOL, D. J. Avail: CASI HC A10/MF A03 Cranfield Inst. of Tech., Bedford (England).
Aircraft passenger safety considerations are evaluated. The advantages of providing smokehoods for passengers and an onboard tender-fed water mist spray system are considered. Cabin configuration, with special reference to seat pitch and aisle width in and around emergency exits, is considered. Safety features which might improve the egress capability of passengers after a survival accident are evaluated within an economic framework. A mathematical model, to be used to determine the effect of cost and weight of various proposed safety features, is developed.

Ingress, emergency egress, and emergency evacuation testing of army aircraft
92N27750
Avail: CASI HC A03/MF A01 Army Aviation Test Board, Fort Rucker, AL.
This test operation procedure (TOP) specifies procedures for testing ingress, emergency egress, and emergency evacuation of Army aircraft. Components installed on the interior and exterior of

the aircraft as well as personnel equipment may adversely affect ingress and egress from an aircraft. The inherent design of a particular aircraft may also contribute to the time required to egress safely depending on the number of crew doors and exits designated as emergency evacuation routes. The criteria in appendix B provide guidelines for maximum times allowed for emergency egress and emergency evacuation.

Effects of seating configuration and number of type 3 exits on emergency aircraft evacuation
93N14277
MCLEAN, GARNET A.; CHITTUM, CHARLES B.; FUNKHOUSER, GORDON E.; FAIRLIE, GREGORY W.; FOLK, EARL W. Avail: CASI HC A03/MF A01 Federal Aviation Administration, Washington, DC.
An increase in the required pathway width from aircraft center aisles to Type 3 overwing exits is being weighed by the FAA. To augment the analysis, an examination of seat/exit configuration effects on simulated emergency egress was conducted in the CAMI Evacuation Research Facility. Four subject groups traversed four different seat/exit configurations in a counter-balanced, repeated-measures design. Pathway width was modified by altering seat pitch. In single-exit trials the fastest times and highest flow-rates occurred with a 20 pathway between triple seats or a 10 inch pathway between double seats. Double exits produced 36 percent shorter egress times (p less than .007), although flow-rates declined 11 percent and exit plug removal times increased 32 percent, compared to single exits. Efficient egress requires optimization of the space around the exit. Generally, wider pathways and fewer obstructions enhance this process; however; when available space exceeds individual passenger needs, conflicts may be produced which inhibit egress.

737-400 at Kegworth, 8 January 1989: The AAIB investigation
93N19661
CARTER, R. D. G. In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 15 p (SEE N93-19653 06-03) Avail: CASI HC A03/MF A04 Department of Transport (England).
A Boeing 737-400, jet transport aircraft, G-OBME, carrying 8 crew and 118 passengers, crashed near Kegworth, Leicestershire, on 8th January 1989. Of the 126 occupants, 47 died as a result of the accident and a further 74 suffered serious injury. This paper describes the structures and survivability investigations conducted into this accident by the Air Accidents Investigation Branch (AAIB) of the UK Department of Transport and reproduces the 11 AAIB Safety Recommendations (out of a total of 31 in the final report) concerning crashworthiness and survivability. This paper also describes the study performed for this investigation by the Cranfield Impact Centre, using the KRASH computer code to quantify impact pulses. The results of the KRASH work supported the AAIB recommendations in the G-OBME report and form the background to a program at the Cranfield Impact Centre to facilitate the use of impact computer codes in aircraft accident investigations.

Can injury scoring techniques provide additional information for crash investigators?
93N19663
ROWLES, J. M.; WALLACE, W. A.; ANTON, D. J. In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 10 p (SEE N93-19653 06-03) Avail: CASI HC A02/MF A04 Queens Medical Centre, Nottingham (England).
The Abbreviated Injury Score (AIS) and Injury Severity Score were calculated for all passengers and crew of the M1 Kegworth aircraft crash. Regional scores were significantly higher in nonsurvivors than survivors of the impact. Mortality and ISSs were found to correlate with the structural damage sustained by the aircraft. The use of injury scoring has highlighted variations in the severity of injuries sustained by occupants involved in an impact aircrash. This information has demonstrated that other factors in addition to the force of the impact were involved in the causation of injury, such as structural integrity, attempts by occupants to protect adjoining passengers, being struck by loose objects and rear facing seats.

Occupant simulation as an aspect of flight safety research
93N19665
NIEBOER, J. J.; WISMANS, J.; VERSCHUT, R. In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 9 p (SEE N93-19653 06-03) Avail: CASI HC A02/MF A04 Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Delft (Netherlands).
In the field of flight safety research there is a growing interest for mathematical simulation of human response and injuries associated with survivable aircraft accidents. A mathematical tool can be very helpful to evaluate and improve on-board restraint systems or to assess the effectiveness of different seat designs. The passenger brace position, being a human factor, can be evaluated efficiently as well. MADYMO is a well accepted integrated multibody/finite element program for Crash Victim Simulation. Recently the two-dimensional version of MADYMO was successfully applied for reconstruction of seat and

passenger behavior during the M1 Kegworth air accident. In this paper a brief description of MADYMO as well as three flight safety applications are presented. Special attention is given to the application concerning a dynamic seat test involving a 50th percentile Hybrid 2 dummy and a greater than P3/4 dummy, representing a nine-month-old child, seated in a child seat. The MADYMO model used for this application was validated on the basis of sled test results. It can be learned that MADYMO is capable of predicting passenger and seat response in an aircraft crash environment. A discussion on future developments in this field concludes this paper.

The effectiveness of airbags in reducing the severity of head injury from gunsight strikes in attack helicopters
93N19691
ALEM, NABIH M.; SHANAHAN, DENNIS F.; BARSON, JOHN V.; MUZZY, WILLIAM H., III (Naval Biodynamics Lab., New Orleans, LA.) In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 9 p (SEE N93-19653 06-03) Avail: CASI HC A02/MF A04
Army Aeromed. Research Lab., Fort Rucker, AL.
Accident investigation records at the U.S. Army Safety Center were examined to determine the frequency of gunner injuries incurred from striking the optical sighting systems in the Cobra and Apache attack helicopters during survivable mishaps. Among 105 survivable Cobra crashes during 1972-1990, the sighting system was implicated in 9 minor and 5 major injury cases, and 6 fatalities. The Apache had eight survivable mishaps since 1985, with only one gunner fatality which was attributed to the optical relay tube (ORT). In this Apache mishap and in the 11 Cobra cases where major or fatal injuries occurred, we theorized an airbag would have prevented serious injuries. To explore the role of airbags in reducing the severity of head strikes, we conducted 32 sled tests with and without airbags. In all tests without airbags, head strikes of the test manikin were sufficiently severe to cause facial fractures, but not necessarily irreversible brain damage. Airbags proved effective in reducing the severity of head strikes against sighting systems. Using mean values of several indicators of injury severity, airbags reduced head accelerations by 65 percent, head injury criteria by 77 percent, and head angular acceleration peal-to-peak swings by 76 percent in the Cobra tests. In the Apache tests, the airbags reduced those same indicators by 68, 52, and 83 percent, respectively. The study concludes that an airbag system, specifically designed for the Apache or Cobra, likely would prevent severe or fatal head and chest injuries.

Aircraft accident injuries in the Hellenic Air Force in the last 20 years
93N19698
PAXINOS, ODYSSEAS In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 4 p (SEE N93-19653 06-03) Avail: CASI HC A01/MF A04 Hellenic Air Force General Hospital, Athens (Greece).
Military flying is a dangerous activity and safety is a major concern. Post accident pathology is an essential tool of determining the cause of death of the pilot, types of injuries, possible physiological problems that contributed to the accident and finally, possible solutions to improve safety. The aircrew injuries of 151 Class-A accidents, of the Hellenic Air Force, in the last 20 years is presented. Accidents were divideo, according the aircraft type, in three groups: Jet Aircraft Accidents, Fixed Wing Props Accidents and Helicopter Accidents. In the Jet Aircraft group, a subdivision was made in three more subgroups: Non ejection attempted, successful ejection and unsuccessful ejection. In all groups the type and location of injuries was recorded, and the results were discussed. An attempt was made to give possible solutions. Injury data bank of aircraft accidents can be very useful in improving accident investigation techniques and safety and more data must be recorded.

An epidemiological study in SAF's pilots ejections
93N19699
ALCON, J. L. GARCIA; TEJEDA, M. R. DURAN; VAZQUEZ, J. M. MORENO (Extremadura Univ., Badajoz, Spain); In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 8 p (SEE N93-19653 06-03) Avail: CASI HC A02/MF A04
Spanish Air Force, Talavera AFB.
Aircraft escape systems - the ejection seat - have saved a lot of lives, however they often have several secondary problems. First, the physical injuries directly produced by the ejection itself; and secondly, the psychological alterations caused by the fact of suffering from an aircraft accident. This study has been made to get more data on ejections raised in some Spanish Air Force pilots in order to correct the possible mistakes in further ejections. The most remarkable results are: First, the importance of performing the ejection within the safety limits of the seat, and with a very good sitting posture, to minimize possible injuries. Secondly, the necessity for both ejection seat simulator and parachute training of pilots since most injuries are generated when the pilot has a wrong sitting posture and when he lands on the ground. And finally, the quick incorporation to flying duties as soon as the ejected pilot accomplished his total recovery.

D.
Other Aspects of Human Factors

Human factors training for aviation personnel
91A14334
MAURINO, D. E.; JOHNSTON, A. N. (International Civil Aviation Organization, Air Navigation Bureau, Montreal, Canada) ICAO Journal (ISSN 0018-8778), vol. 45, May 1990, p. 16-19.
The background to the new human factors training requirement introduced by ICAO in November 1989 is reviewed and general issues relevant to curriculum design and implementation of human factors training courses are discussed. Disciplines frequently involved in human factors are listed as psychology, engineering, human physiology, medicine, sociology, and anthropometry. A brief review of the Human Factors Digest is presented. The digest discusses the philosophical approach, the conceptual approach, and the software/hardware/environment/liveware (SHEL) model, which provides a conceptual framework and helps to illustrate the various "interfaces" or points of interaction between different subsystems in operational process. A 35 h pilot training course in human factors which explicitly addresses issues relating to crew communication, coordination, and management is discussed, with particular attention to curriculum development and trainee performance appraisal.

The role of professional standards in cockpit resource management (CRM)
91A34910
MCINTYRE, JAMES A. (Air Line Pilots Association, Washington, DC) IN: Human error avoidance techniques; Proceedings of the 2nd Conference, Herndon, VA, Sept. 18, 19, 1989 (A91-34906 14-53). Warrendale, PA, Society of Automotive Engineers, Inc., 1989, p. 39-41.
The paper examines the role of professional standards peer-group committees in dealing with the 'boomerang' effect when the pilot reacts contradictory to CRM training and emerges with a negative change in attitudes. It is pointed out that there is a general agreement that pilot peer pressure exerted through their own professional standards committees (PSC) may provide an effective interim method of dealing with the problem of such an aberrant behavior in the cockpit. The success of such committees is determined by the pilot group's voluntary dedication to overcoming personality conflicts and other stress factors that affect flight safety. The involvement of the Air Line Pilots Association PSC in a dispute between the union leadership and management is discussed.

Aircraft control in the 21st century - Examination of the role of the flight crew
91A49184
BULEY, ROBERT G. (Northwest Airlines, Inc., Minneapolis, MN) (Symposium International sur l'Aviation au XXIe Siecle, Paris, France, Nov. 14-16, 1990) Navigation (Paris) (ISSN 0028-1530), vol. 39, July 1991, p. 412-420. In French.
Future prospects concerning the role of the flight crew in aircraft control from the preflight verification phase, through takeoff and flight, and finally in the landing phase are discussed. It is pointed out that successful design of the air transportation system depends to a large extent on the proper definition of the role of the human operator. It is explained that a philosophy of automation that supports the role of the human operator should optimize the unique qualities of both the human and the machine in order to assure the optimal level of system safety. The operator should be allowed to exercise a greater degree of 'inner loop' control of the system as a means of assuring an adequate degree of situational awareness.

Stress and error in aviation
92A13015
FARMER, ERIC (RAF, Institute of Aviation Medicine, Farnborough, England) Aldershot, England and Brookfield, VT, Avebury Technical, 1991, 170 p. For individual items see A92-13016 to A92-13027.
The present conference on stress and error in aviation encompasses issues relating stress with workload, sleep management, aviation safety, testing systems, the effects of trauma, transmeridian travel, and human factors. Specific issues addressed include personality and task characteristics in helicopter pilot stress, a psychophysiological assessment test system, the assessment of pilot and weapon-system operator workloads, the development of a working model of flight-crew underload, the long-term psychological consequences of a major aircraft accident, and trauma-induced cyclothymia. Also addressed are the implications of irregular work and rest in civil air operations, a comparison of fatigue-related accidents across modes of transport, human factors in cabin safety, and the importance of type-II error in aviation safety research.

A conceptualization of aviation psychology on the civil flight deck
92A13849
LONG, JOHN B. (University College, London, England) IN: Human resource management in aviation (A92-13837 03-53). Aldershot, England and Brookfield, VT, Avebury Technical, 1991, p. 177-189.

Conceptions for human-factors engineering and human-computer interaction form the basis for a conceptual interpretation of aviation psychology for the commercial transport flight deck. The flight deck and the air crew are considered as an interactive worksystem for aircraft that supports transportation services. The requirements for a conceptualization of the interactive worksystem are set forth with attention given to supporting data and hypotheses from aviation psychology studies. The conceptualization is applied to aviation concerns including the relationship between efficiency and well-being, functionality, and usability. The conceptualization is of a general nature and can be applied to other areas of work and to other worksystems.

Rates and risk factors for accidents and incidents versus violations for U.S. airmen
92A14048
LUBNER, MAXINE E.; MARKOWITZ, JEFFREY S.; ISHERWOOD, DAVID A. (Columbia University, New York) International Journal of Aviation Psychology (ISSN 1050-8414), vol. 1, no. 3, 1991, p. 231-243. Research sponsored by FAA.
Rates and risks of general aviation accidents/incidents and violations were calculated employing case-control methodology. Cases, selected from Federal Aviation Administration (FAA) records of currently active airmen who had one or more accidents, incidents, or violations during 1982-1987, totaled 11,548. A comparison of cases and controls was made by using five predictors: gender, age, medical certificate, airmen's certificate, and FAA region. All variables showed significant results as risks for, or as protective factors against, having an accident/incident or violation. Some variables showed a greater risk for violations than for accidents/incidents. The period prevalence, or the number of existing cases divided by the average population, was 12.7 per 1000 for accidents/incidents and 7 per 1000 for violations. It was recommended that accidents/incidents and violations should not be routinely aggregated because their epidemiology differs.

Flight experience and the likelihood of U.S. Navy aircraft mishaps
92A20721
YACAVONE, D. W.; BOROWSKY, M. S.; BASON, R.; ALKOV, R. A. (U.S. Navy, Naval Safety Center, Norfolk, VA) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 63, Jan. 1992, p. 72-74.
Although the flight experience level of U.S. Navy pilots has not declined in recent years, current budget constraints will eventually lead to reductions in flight hours per pilot. This implies an eventual shifting of the distribution of flight hours. Analyses show that the rate of aircrew factor and pilot error mishaps tends to decrease as pilots' flight experience in model increases. Aviation loss rates are higher during a pilot's first 500 hours in model. This seems to be true no matter if the pilot is simply inexperienced overall or a highly experienced aviator transitioning to a different aircraft. These data suggest, therefore, that if the in-model experience levels of naval aviators decline sufficiently, the mishap rate will increase.

Analysis of changes in the pilot population and general aviation accidents
92A20722
BRUCKART, JAMES E. (U.S. Army, Aeromedical Research Laboratory, Fort Rucker, AL) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 63, Jan. 1992, p. 75-79.
The decreasing number of accidents and the evolving pilot population are investigated in terms of cross-correlation including such parameters as age distribution, certification, and flying habits. FAA surveys and accident data are employed to study trends in pilot-age distribution, certification, aircraft use, flight planning, and weather conditions relevant to general aviation accidents. The mean pilot age increased from 35 to 40 in the span of time studied (1968-1987), and the numbers of pilots with certifications increased for both Air Transport Pilot and instrumentation. The accident experience expected for the period studied based on the 1968-1973 data predicts 40 percent more accidents than actually occurred, and adjusted accident rates show significant reductions in accidents in all age groups as compared to actual accident experience over the last 20 years. The results are positive confirmation of actual aviation-safety advances related to improved pilot performance.

Peacetime U.S. Army aircrew rescue and factors delaying rescue
92A23311
BRUCKART, JAMES E. (USAF, School of Aerospace Medicine, Brooks AFB, TX) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 63, Feb. 1992, p. 132-134.
Recent mishaps are compared to 37 mishaps for which it took at least 2 h to reach the site in order to assess the factors which cause delays in rescue operations. Mishaps with delayed rescues are found to occur under adverse operational and environmental factors and are often associated with sudden aircraft failure. The delays studied are in no cases found to be the direct cause of death or loss of crew members in spite of the positive correlation between fatalities and prolonged rescues.

The application of human factors engineering at General Electric Aircraft Engines
93A14659
SCANLON, TIMOTHY J. (GE Aircraft Engines, Cincinnati, OH) SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992. 14 p.
Human factors engineering (HFE) techniques used by General Electric Aircraft Engines to analyze the engine-maintainer relationship and its impact on engine maintainability are described. This analysis performed during preliminary engine design makes it possible to specify HFE design criteria for incorporation into the system design. HFE analysis encompasses a broad spectrum of methodologies ranging from CAD systems with advanced HFE software to controlled dynamic simulations conducted with mockups, tooling, and subjects in ergonomic laboratories. It is concluded that incorporating HFE and maintainability in design is necessary to offset rising maintenance costs, and to ensure maintainer compatibility with the advanced propulsion and aircraft systems.

Human factors research in aircrew performance and training: 1986-1991
93N12609 170 PAGES
MCANULTY, D. M. Avail: CASI HC A08/MF A02 Anacapa Sciences, Inc., Fort Rucker, AL.
This report presents summary descriptions of the research performed by Anacapa Sciences, Inc., for the U.S. Army Research Institute for the Behavioral and Social Sciences Fort Rucker Field Unit. This effort was entitled Human Factors Research in Aircrew Performance and Training. From 9 Oct. 1986 - 31 Dec. 1991, Anacapa personnel worked on 42 research projects and 20 technical advisory services in emerging aviation systems design, manpower and personnel programs, aviator training, and aviation safety research. The report also describes research and development projects that were conducted under 17 subcontracts to Anacapa Sciences. These descriptions contain the following: (1) a background section that describes the rationale for the project and specifies the research objectives; (2) a research approach section that describes the tasks and activities required to meet the project objectives; and (3) a work completed section that may include research findings or, in the case of developmental activities, a description of the research products.

Special investigation report: Flight attendant training and performance during emergency situations
93N16834
Avail: CASI HC A04/MF A01 National Transportation Safety Board, Washington, DC.
This report reviews recent aviation accidents and incidents, Federal Aviation Regulations related to flight attendant training, and flight attendant training programs from 12 air carriers. Evidence from recent accident and incident investigations revealed that some flight attendants did not perform emergency duties in accordance with their air carrier training programs. The Safety Board believes that the ability of flight attendants to perform their duties successfully during emergency situations is directly related to the quality of their emergency training. As a result of this special investigation, the Safety Board issued 13 recommendations to the FAA about flight attendant training.

Prediction of success from training
93N19702
SYMONDS, COLIN J.; REJMAN, MICHAEL H.; SHEPHERD, ERIC W. (Army Personnel Research Establishment, Farnborough, England) In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 8 p (SEE N93-19653 06-03) Avail: CASI HC A02/MF A04 City of London Polytechnic (England).
Any training system contains information on the past and current performance of its students. However, such systems may also hold predictors capable of estimating the potential of a student. Failures that occur late during a course result in wasted costs, time and places, and also student career discontent. Therefore identifying the earliest indicators of failure is of primary importance to the operation of an efficient system. Research directed at uncovering these involves the identification of relevant behaviors; classification of the students' behaviors in real life situations; coding the classifications to form data points; and the application of analytic techniques to produce predictive models of behavior. The major emphasis of this paper is to describe attempts to define statistically derived criteria for success and failure in an existing flying training system. It is argued that the introduction of more objective techniques such as those described here may not only make the training system more efficient but may also reduce flight safety risks.

E.
Engines

Oceanic twinjet power
91A30768
VINALL, PETER (Civil Aviation Authority, London, England) Aerospace (UK) (ISSN 0305-0831), vol. 18, March 1991, p. 10-13.
A review is presented of the commercial airline propulsion reliability record with particular attention given to extended range twinjet operations

(ETOPS). Improvements in engine reliability are continually developing due to the constant effort and care in design, material selection, special manufacturing quality control, conservative time extension policies, diagnostic procedures, trend monitoring, and overhaul and maintenance quality control. Combinations of new design approaches and materials are being developed for high energy rotating parts that will overcome the adverse scale effect for large engines so that significantly greater containment of high energy debris can be attained without unacceptable sacrifices in cost, weight, payload and fuel consumption. The introduction of ETOPS has concentrated attention on inflight shutdown rates to ensure that the risk of total loss of thrust from independent causes is maintained at an acceptably low level. Consideration is given to bird ingestion problems, foreign object damage, and other possible causes of potential multiple power loss.

Engine reliability
92A39309
VINALL, PETER D. (Civil Aviation Authority, Gatwick, England) IN: Safety at sea and in the air--Taking stock together; Proceedings of the Conference, London, England, Nov. 13-15, 1990 (A92-39301 16-03). London, Royal Aeronautical Society, 1990, p. 18.1-18.14.
This report analyzes the reliability of aircraft engines against safety targets set in the context of airworthiness safety goals of the aircraft as a whole. Some examples illustrate experience that has led to changes in certification requirements aimed at attaining higher standards, but which also indicate the inherent difficulties of assuring that available data are correctly interpreted so that such changes do not inadvertently give rise to a reduction in safety. Particular examples are given to illustrate both the degree of past successes and the potential for introducing unintentional traps in the effort to improve the standards in light of experience and advances in design.

Fiber optic controls for aircraft engines - Issues and implications
92A46244
DASGUPTA, SAMHITA; POPPEL, GARY L.; ANDERSON, WILLIAM P. (GE Aircraft Engines, Cincinnati, OH) IN: Integrated optics and optoelectronics II; Proceedings of the Meeting, San Jose, CA, Sept. 17-19. 1990 (A92-46232 19-74). Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1991, p. 211-222., National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
Some of the issues involved with the application of fiber-optic controls for aircraft engines in the harsh operating environment are addressed, with emphasis on fiber-optic temperature, pressure, position, and speed sensors. Criteria are established to evaluate the optical modulation technique, the sensor/control unit interconnection, and the electro-optic architecture. Single mode and polarization dependent sensor types, sensors which depend on the reflection and/or transmission of light through the engine environment, and intensity-based analog sensors are eliminated as a possible candidate for engine implementation. Fiber-optic harnesses tested for their optical integrity, temperature stability, and mechanical strength, exhibit a capacity to meet mechanical strength requirements and still gain a significant reduction in cable weight.

Engine Health Monitoring
93A18787
COLLINS, M. (SD-Scicon UK, Ltd., Hook, United Kingdom) In: Aero engine reliability, integrity and safety; Proceedings of the Conference, Bristol, United Kingdom, Oct. 17, 18, 1991 (A93-18778 05-07). London, Royal Aeronautical Society, 1991, p. 9.1-9.5.
Engine Health Monitoring (EHM) of aircraft powerplants can yield highly flexible, computer-based reliability evaluations over the course of operational life. The EHM reliability-evaluation process is rendered more accessible to the end-user with the arrival of programs which allow the interactive investigation of problems, while enlisting the display capabilities of personal computers and workstations. Onboard Automatic Condition Monitoring Systems can be used to automate EHM data-entry.

Program plans: Aviation safety research
92N17587
WENTZ, WILLIAM H.; HUTCHINSON, JOHN J.
Avail: CASI HC A03/MF A01 Wichita State Univ., KS.
In the event of an engine failure, provision for containment of moving parts is desired to prevent secondary damage of structural members and aircraft mechanical systems including possible damage to adjacent engines. This problem was addressed by large engine manufacturers to various degrees and with various analysis procedures. Currently, the wide variety of approaches in use, combined with the absence of a data base of experimental results, make the problem of developing certification standards difficult. The research collected, analyzed, and organized information on design procedures for rotor containment and the effectiveness of designs. The objective was to enable development of the most appropriate and workable standards possible. The specific elements of this study included: (1) reviewing current FAA regulations or standards addressing rotor containment; (2) reviewing existing literature on design for

containment, reports of accident investigations, and test stand engine failure data; (3) contacting engine manufacturers and determining what design methods are currently employed and propulsion departments of airframe manufacturers to determine containment problems; (4) assessing effectiveness of computational codes for realistically predicting containment capabilities; and (5) presenting results of this study in a format designed to guide the development of certification standards.

Statistics on aircraft gas turbine engine rotor failures that occurred in US commercial aviation during 1989
92N30303
CHAPDELAINE, E. R.; FENTON, B. C.; DELUCIA, R. A.; MULLER, M. (Federal Aviation Administration, Atlantic City, NJ.); (Federal Aviation Administration, Atlantic City, NJ.); (Naval Air Propulsion Test Center, Trenton, NJ.) Avail: CASI HC A03/MF A01 Galaxy Scientific Corp., Mays Landing, NJ.
Presented here is statistical information relating to gas turbine engine rotor failures which occurred during 1989 in U.S. commercial aviation service use. Four hundred and thirty-five failures occurred in 1989. Rotor fragments were generated in 156 of the failures, and of these 24 were uncontained. The predominant failure involved blade fragments, 87 percent of which were contained. Eight disk failures occurred and six were uncontained. Thirty-six percent of the 435 failures occurred during the takeoff and climb stages of flight. This service data analysis is prepared on a calendar-year basis and published yearly. The data are useful in support of flight safety analyses, proposed regulatory actions, certification standards, and cost benefit analyses.

Statistics on aircraft gas turbine engine rotor failures that occurred in US commercial aviation during 1988
92N33105
DELUCIA, R. A.; CHAPDELAINE, E. R.; FENTON, B. C. (Federal Aviation Administration, Atlantic City, NJ.); (Federal Aviation Admin., Atlantic City, NJ.) Avail: CASI HC A03/MF A01 Naval Air Propulsion Test Center, Trenton, NJ.
Statistical information relating to gas turbine engine rotor failures, which occurred during 1988 in U.S. commercial aviation service, is presented. Four hundred and thirteen failures occurred in 1988. Rotor fragments were generated in 175 of the failures, and of these 14 were uncontained. The predominant failure involved blade fragments, 95 percent of which were contained. Five disk failures occurred and all were uncontained. Forty-two percent of the 413 failures occurred during the takeoff and climb stages of flight. This service data analysis is prepared on a calendar year basis and published yearly. The data are useful in support of flight safety analyses, proposed regulatory actions, certification standards, and cost benefit analyses.

Integrated engine control and monitoring with experiences derived from OLMOS
93N15168
SCHULZ, UWE; BOTT, JULIAN In DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 287-310 (SEE N93-15152 04-06) Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC Dornier System G.m.b.H., Friedrichshafen (Germany).
A description of the Onboard Life Monitoring System (OLMOS) for a fighter aircraft is given. The experiences with the system in service and the modifications derived from this are presented. Based on these experiences and the technical requirements for engine control and monitoring, the advantages and disadvantages of an integrated concept are presented. Different requirements with respect to reliability and flight safety are considered.

F.
Structures and Materials

Analysis of the dynamic behavior of aircraft structures during crash impacts
91A24426
WITTLIN, GIL; NERI, LARRY (Lockheed Aeronautical Systems Co., Burbank, CA); (FAA, Technical Center, Atlantic City, NJ) IN: ICAS, Congress, 17th, Stockholm, Sweden, Sept. 9-14, 1990, Proceedings. Vol. 2 (A91-24301 09-01). Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1990, p. 1209-1224.
A digital computer program developed for the purpose of performing aircraft crash dynamics analysis is described. The program, called KRASH, computes the time histories of N interconnected masses, each allowed six degrees of freedom. The program describes the interaction between a series of massless interconnecting structural elements and concentrated rigid body masses to which the structural elements are attached at their ends with the appropriate end fixity. The manner in which the structure moves and the forces act is directly related to the manner in which the aircraft being analyzed is modeled and the direction and magnitude of the external forces, as in the situation whenever the real structure is idealized mathematically. A description of KRASH validation tests and models, a range of application both for metals and composites, pertinent response time histories, and deformations are also discussed.

ASNT and aerospace - What about the next 50 years?
92A17293
COOPER, THOMAS D. (USAF, Wright Laboratory, Wright-Patterson AFB, OH)
(American Society of Nondestructive Testing, Fall Conference, Boston, MA, Sept. 15-18, 1991) Materials Evaluation (ISSN 0025-5327), vol. 49, Dec. 1991, p. 1526-1529, 1531-1535.
The 50-year history (since its inception in 1941) of the development of NDT inspection methods and of devices and systems for inspecting aircraft surfaces is described with special attention given to the technologies involved in these methods and devices and to the role of NDE in the damage-tolerance approach to designing new structures. Consideration is also given to recent improvements in the NDT methods developed for use in aerospace and to the projections of NDT developments for the next 50 years.

Wing leading edge design with composites to meet bird strike requirements
92A47404
JOHN, L. K. (DeHavilland Aircraft of Canada, Ltd., Canada) IN: Composites in manufacturing - Case studies (A92-47403 20-01). Dearborn, MI, Society of Manufacturing Engineers, 1991, p. 3-18.
Details of the design and testing of a wing leading edge for the DASH 8 aircraft, sufficiently rugged to withstand bird strikes and other incidental impacts, are discussed. The fiber-reinforced composite leading edge designed for bird-impact resistance is shown to be comparable in weight with a conventional metal design that does not meet the bird-impact requirements and significantly lighter than metal designs that would meet these requirements. In addition to meeting the design criteria, the DASH 8 leading edge made with aramid fiber and honeycomb core provides cost and weight benefits together with aerodynamic cleanliness, resulting in greater fuel efficiency.

On the use of protective aircraft thermohelmets for achieving high supersonic speeds
93A30461
CHEREPANOV, GENADY P. (Florida International Univ., Miami) Composites Engineering (ISSN 0961-9526), vol. 3, no. 4, 1993, p. 321-327.
Aircraft require protection from high stagnation temperatures during supersonic flight in dense atmospheres. This paper reviews several projects of disposable composite thermohelmets with smart-controlled and individually moving rods and analyzes unit-sintered ceramic thermohelmet structures. A computation of failure wave velocity in the steady-state brittle regime using eight physical parameters is presented. Results indicate that unit-sintered disposable thermohelmets made of alumina will provide safe protection for aircraft at high supersonic velocities.

Aircraft accident report: Explosive decompression - loss of cargo door in flight, United Airlines Flight 811, Boeing 747-122, N4713U, Honolulu, Hawaii, February 24, 1989
92N31159 119 PAGES
Supersedes NTSAAR-90/01; N90-21748 Avail: CASI HC A06/MF A02
National Transportation Safety Board, Wash., DC.
This report explains the explosive decompression resulting from the loss of a cargo door in flight on United Airlines flight 811, a Boeing 747-122, near Honolulu, Hawaii, on Feb. 24, 1989. The safety issues discussed in this report are the design and certification of the B-747 cargo doors, the operation and maintenance to assure the continuing airworthiness of the doors, and emergency response. Recommendations concerning these issues were made to the Federal Aviation Administration, the State of Hawaii, and the U.S. Department of Defense.

T-38 forward windshield development and performance demonstration report
93N20579 298 PAGES
MYERS, JAMES W. Avail: CASI HC A13/MF A03 PPG Industries, Inc., Huntsville, AL.
According to Air Force information, approximately 500 bird strikes occur each year in Air Training Command (ATC), with over half of these on the T-38. The current windscreen provides some protection at the slower speeds flown during the final phases of the T-38 landing pattern. However, during climbs, cruise, and descents below 10,000-feet the T-38 is normally flown at speeds of 240-to-300 knots which presents a bird strike hazard by larger birds to the pilots. The T-38 low level missions are of particular concern because they are flown at speeds of up to 420-knots. Based on training requirements, the altitude for T-38 low-level missions has decreased to 500-feet above ground level, along with increasing the number of sorties required. Although the Air Force plans student load reductions, the relative number of high-speed, low-level navigation sorties will increase.

Design development and durability validation of postbuckled composite and metal panels. Volume 4: Design guide update
93N70052
DEO, R. B.; KAN, H. P.; HANGEN, J. A.
Avail: CASI HC A04/MF A01 Northrop Corp., Hawthorne, CA.
The objective of this program was to develop design procedures and durability validation methods for curved metal and composite panels designed to

operate in the postbuckling range under the action of combined compression and shear loads. This research and technology effort was motivated by the need to develop design and life prediction methodologies for such structures. The program has been organized in four tasks. In Task 1, Technology Assessment, a complete review of the available test data was conducted to establish the strength, durability, and damage tolerance characteristics of postbuckled metal and composite panels and to identify data gaps that need to be filled. Task 2, Data Base Development, was comprised of static and fatigue tests required to fill in the data gaps identified in Task 1. New rigorous static analysis methods aimed at improving the accuracy of the existing analyses and life prediction techniques were developed in Task 3.

G. Ageing of Aircraft

Co-operation is crucial to success of aging aircraft review programmes
91A29054
TORKINGTON, COLIN (Australia's Civil Aviation Authority, Canberra) ICAO Journal (ISSN 0018-8778), vol. 45, Nov. 1990, p. 15-20.
An outline is presented of structural design concepts involved in the continuing programs associated with aging commercial aircraft inspections. The safe life concept requires that those parts of the structure whose failure could result in loss of the aircraft must be able to remain safely in use up to a predetermined retirement life. Although safe life components are now rarely utilized in the primary flight structure of commercial aircraft, many older safe life designs are still operating. Other design concepts described include the fail-safe concept, damage tolerance evaluation, the supplemental inspection document (SID) that was introduced to bring the aircraft up to a safety level equivalent to the new damage tolerance rules, and the Boeing approach to the SID audit approach. Additional concepts and recommendations are discussed, including research work, tear-down inspections of old aircraft, fatigue testing, nondestructive testing techniques, communication, human factors, and maintenance.

Safety of aging aircraft - Boeing programs for the 1990's
91A40563
HARRADINE, P. J.; MILLER, M. (Boeing Commercial Airplanes, Seattle, WA) AIAA, ASME, ASCE, AHS, and ASC, Structures, Structural Dynamics and Materials Conference, 32nd, Baltimore, MD, Apr. 8-10, 1991. 11 p.
An overview is presented of historical and current aging aircraft activities, efforts anticipated for aircraft models in production, and how the knowledge gained and lessons learned will be incorporated into future designs. It is shown how industry and airworthiness authorities have collaborated to develop and implement major new programs involving structural modifications, corrosion prevention and control, and the damage tolerance of structural repairs. Consideration is also given to awareness and training programs, including a course to acquaint key airline maintenance and FAA personnel with the requirements and the procedures of the newly mandated Corrosion Prevention and Control Program.

Aging fleet - Maintaining airworthiness
91A43077
COSGROVE, B. A. (Boeing Commercial Airplanes, Seattle, WA) IN: Israel Annual Conference on Aviation and Astronautics, 31st, Tel Aviv, Israel, Feb. 21, 22, 1990, Collection of Papers (A91-43076 18-99). Haifa, Israel, Technion - Israel Institute of Technology, 1990, p. 1-4.
The authors propose that, with proper maintenance and inspection, airplanes can be flown indefinitely. A system that keeps aircraft structures safe is described as well as measures that have been taken in response to aging aircraft. Particular attention is given to the concerns that arose following the explosive decompression experienced by an Aloha Airlines 737 on April 28, 1988.

Some consideration for evaluation of structural integrity of aging aircraft
92A43107
TERADA, HIROYUKI; ASADA, HIROO (National Aerospace Laboratory, Tokyo, Japan) IN: Aircraft Symposium, 28th, Tokyo, Japan, Nov. 7-9, 1990, Proceedings (A92-43095 18-01). Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 76-79.
The objective of this paper is to examine the achievement and the limitation of state-of-the-art of the methodology of damage tolerant design and the subjects to be solved for further improvement. The topics discussed are: the basic concept of full-scale fatigue testing, fracture mechanics applications, repair of detected damages, inspection technology, and determination of inspection intervals, reliability assessment for practical application, and the importance of various kinds of data acquisition.

The role of fatigue testing in the design, development and certification of the ATR 42/72
93A13637
MINUTO, A.; SCAFARO, S.; LANCIOTTI, A.; LAZZERI, L. (Alenia GAT, Naples, Italy); (Pisa

Univ., Italy) In: Aeronautical fatigue: Key to safety and structural integrity; Proceedings of the 16th ICAF Symposium, Tokyo, Japan, May 22-24, 1991 (A93-13626 02-39). Tokyo/Warley, United Kingdom, Ryoin Co., Ltd./Engineering Materials Advisory Services, Ltd., 1991, p. 217-236.
The paper describes the main lines of the test programs followed for the certification, for what concerns the fatigue design, of a commuter aircraft. A large number of experiments have been performed and the results are discussed here. The paper includes the description of the approach followed by ALENIA in defining the load spectra, the criteria for loading sequence construction and the necessary approximation (truncation and omission) required to carry out the tests in the most convenient way. The paper also discusses some of the main problems encountered in the full-scale test.

Human factors evaluation of the work environment of operators engaged in the inspection and repair of aging aircraft
92N27914
THACKRAY, RICHARD I. Avail: CASI HC A03/MF A01 Federal Aviation Administration, Washington, DC.
Site evaluations of air carriers and repair stations conducting inspections and heavy maintenance on PART 121 aging aircraft were conducted during 1989-90 under the Federal Aviation Administration's (FAA's) Office of Flight Standards Aging Fleet Evaluation Program. This report presents the findings of the human factors portion of this program in which aspects of the work environment of selected operators were evaluated with respect to illumination levels, noise, temperature/ventilation, work support equipment/workspace adequacy, occupational safety, and extent of worker overtime. Data are reported for 19 site evaluations. While 89 percent of the operators were given global ratings of acceptable or better in the area of human factors, the deficiencies noted were quite consistent across carriers and repair stations. Illumination levels, in particular, were found to be considerably below levels recommended by the Illuminating Engineering Society. There were also deficiencies in work support equipment and in compliance with the operator's stated safety program. Recommendations are given for improvements in each of these areas.

H. Fire

Minimizing aircraft fire/explosion hazards
91A49208
Aerospace Engineering (ISSN 0736-2536), vol. 11, Aug. 1991, p. 9-11., A review is presented of the particular problems faced by designers of military combat aircraft in that they must integrate fire/explosion protection (for peacetime operations) with measures that are intended to defeat the combustion-related kill mechanisms of counterair threats. The combat aircraft protection problem is multiplied by its considerable design sensitivity to the parasitic weight that is added to counter the explosion and fire hazards and threats. Generally, explosion/fire protection has a significant impact on hardening/vulnerability activities, 'kill given a hit' probabilities, and resulting vulnerable areas.

Burn injuries from small airplane crashes
91A55340
MOYE, STANLEY J.; CRUSE, C. W.; WATKINS, GEORGE M. (Tampa General Hospital; South Florida, University, FL) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 62, Nov. 1991, p. 1081-1083.
Because a large amount of general aviation activity occurs in Central Florida, admissions for victims of small airplane crashes were reviewed. Thirteen burn victims of small aircraft accidents over a 7-year period were identified. Of the 13, 12 survived their burn injuries, an overall survival rate of 92 percent. The extent of burn injury, Abbreviated Burn Severity Index, complications, other injuries, and rehabilitation potential are reviewed. Burn injury resulting from small airplane crashes is usually survivable if the patient arrives at the Burn Center alive. These burn victims generally are highly motivated individuals, are easily rehabilitated, and continue productive lives. Small airports and local hospitals should be aware of burn center availability because of the usual major extent of the burn injury.

Damping down the fires
92A25075
ELLIOTT, SIMON Flight International (ISSN 0015-3710), vol. 141, Feb. 5, 1992, p. 46-49.
A review is presented of the possible introduction of fire-retarding cabin water-spray systems into civil transport aircraft that may save lives, but with consequent penalties of increased weight, cost, and maintenance. Attention is given to various water-spray development schemes including droplet size, smoke control, flow rate, spray pattern, spray angle, and the viscosity/surface tension, temperature, and specific gravity of the liquid.

Live fire testing requirements - Assessing the impact
92A52016
O'BRYON, JAMES F. (DOD, Office of the Secretary of Defense, Washington) Aerospace America (ISSN 0740-722X), vol. 30, no. 8, Aug. 1992, p. 34-36.

Full-up live-fire testing (LFT) of aircraft configured for combat is evaluated in terms of the practical implications of the technique. LFT legislation requires the testing of tactical fighters, helicopters, and other aircraft when they are loaded with the flammables and explosives associated with combat. LFT permits the study of damage mechanisms and battle-damage repair techniques during the design phase, and probability-of-kill estimates and novel systems designs can be developed based on LFT data.

Development and growth of inaccessible aircraft fires under inflight airflow conditions
91N20064
BLAKE, DAVID Avail: CASI HC A03/MF A01 Federal Aviation Administration, Atlantic City, NJ.
An attempt was made to determine the likelihood of fire development and growth in accessible areas of an aircraft and the resulting hazards to cabin occupants from these fires. Numerous inflight fires or smoke events occur in accessible areas but are controlled by the crew or self-extinguish. Fatal inflight fires are rare events but start in inaccessible areas. Some 57 tests of hidden inflight fires in a section of a DC-10 aircraft were performed. The fires were started behind sidewall panels, below the cabin floor, above the cabin ceiling, in overhead stowage bins, in lavatory trash receptacles, and adjacent to lavatory flush motors. The conclusions are that although uncontaminated insulation blankets did not readily support combustion, contaminated insulation blankets were found to support combustion and the built in Halon 1301 trash receptacle extinguishers did not always completely extinguish trash fires.

Effectiveness of water spray within the cabin overhead area
91N30113
MARKER, TIMOTHY Avail: CASI HC A03/MF A01 Federal Aviation Administration, Atlantic City, NJ.
Four full-scale postcrash fire tests were conducted in a modified DC-10 fuselage to investigate the benefits, if any, of spraying water in the area above the cabin ceiling, known as the overhead. The tests were part of a 28-test series using a wide body fuselage to study the performance of an onboard cabin water spray system. The spray system uses low flow rate nozzles which produce a fine mist consisting of a range of water droplet diameters. The system being tested was a breadboard design for the purpose of demonstrating concept feasibility only. In order to better quantify the overhead spray performance, two areas of the cabin ceiling were removed: the area directly adjacent to the fire door, and an area in the forward section of the fuselage near the gas sampling stations. Temperature, smoke, heat, and gas concentrations were monitored at various locations throughout the fuselage. Test results showed little or no improvement in cabin conditions due to the overhead spray.

Onboard cabin water spray system under various discharge configurations
92N13043
MARKER, TIMOTHY Avail: CASI HC A03/MF A01 Federal Aviation Administration, Atlantic City, NJ.
Six full-scale fire tests were conducted in a modified DC-10 fuselage to investigate the effects of spraying water at different cabin locations or pre-wetting the cabin, while keeping the fire conditions constant. The tests were part of a 28 test series using a wide body fuselage to study the performance of an onboard cabin water spray system. The spray system utilizes low flow rate nozzles which produce a fine mist consisting of a range of water droplet diameters. The system being tested was a breadboard design for the purpose of demonstrating concept feasibility only. Two tests involved spraying water in different sections of the cabin and overhead. Two other tests investigated the effects of spraying varying quantities of water before the fire was ignited to pre-wet the interior. For comparison, one test used spray throughout the cabin, while the last test performed was without water in order to establish a baseline. Temperature, smoke, heat flux, and gas concentrations were monitored at various locations throughout the fuselage.

Inhalation toxicology. 12: Comparison of toxicity rankings of six polymers by lethality and by incapacitation in rats
92N21328
SANDERS, DONALD C.; ENDECOTT, BOYD R.; CHATURVEDI, ARVIND K. Avail: CASI HC A02/MF A01 Federal Aviation Administration, Washington, DC.
Polymeric aircraft cabin materials have the potential to produce toxic gases in fires. Lethality (LC50) in animal models is a standard index to rank polymers on the basis of their combustion product toxicity. However, the use of times-to-incapacitation (t sub i s) may be more realistic for predicting relative escape times from a fire environment. Therefore, LC50's and t sub i s for six pure polymers of different chemical classes were determined and compared. The polymers were polyamide, polystyrene, Nylon 6/6, polysulfone, polyethylene, and chlorinated polyethylene. In the study, male Sprague-Dawley rats (150-250 g), 12 animals per fuel loading, were exposed to the pyrolysis products from selected weights of each polymer for 30 min in a 265-L combustion exposure system, and LC50s were determined following a 14-day observation period.

Correlations between engineering, medical and behavioural aspects in fire-related aircraft accidents
93N19693
WINTERFELD, G. In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 6 p (SEE N93-19653 06-03) Avail: CASI HC A02/MF A04
Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Berlin (Germany).
An overview is given over the present situation in aircraft fire safety as it can be derived from the 73rd AGARD-PEP-Meeting devoted to this subject in 1989. It is characterized by increasing interaction between engineering and medical/behavioral aspects. A scenario for aircraft cabin fires is first developed showing that survival times both from the technical and medical point of view are of the same order of magnitude. Although fire-hardening has contributed much to increased survival times the prospects for further progress from this side diminish. Improvements are expected from improved conditions for emergency evacuations and from occupant protection systems. Modeling studies both on engineering and medical problems are increasingly applied to fire-related problems. The use of water spray systems and smoke hoods are discussed in the paper as well as studies on passenger behavior during evacuations. The combination of medical, behavioral and engineering expertise can be used to promote and optimize passenger protection in fire-related aircraft accidents.

A model study of the aircraft cabin environment resulting from in-flight fires
93N21557 126 PAGES
MCCAFFREY, B. J.; TU, KING-MON; RINKINEN, W. J.; EKLUND, T. I. (Maryland Univ., Baltimore.); (National Bureau of Standards, Washington, DC.); Avail: CASI HC A07/MF A02
Federal Aviation Administration, Atlantic City, NJ.
A series of tests were conducted to examine the effect of the ventilation on the environment in an aircraft passenger cabin during an in-flight fire. These tests were run in a reduced scale mockup of an aircraft passenger cabin. A propane burner operating at 10 or 30 kilowatts served as the fire source. The simulated seats and the cabin lining material were both noncombustible. The vertical temperature and gas concentration profiles in the cabin were measured as a function of time. Reversing the normal ventilation flow direction by introducing the forced air at the floor level and exhausting it at the ceiling significantly reduced the measured temperatures and gas concentrations. Opening two 152- by 305-millimeter hatches in the end walls at the ceiling level to the outside air resulted in a significant reduction in the measured gas concentrations.

I.
Adverse Weather

Aircraft low altitude wind shear detection and warning system
91A27005
SINCLAIR, PETER C.; KUHN, PETER M. (Colorado State University, Fort Collins); (ARIS, Inc., Fort Collins, CO) Journal of Applied Meteorology (ISSN 0894-8763), vol. 30, Jan. 1991, p. 3-16. Research supported by ARIS, Inc.
The feasibility of using FLIR radiometer as an airborne system for detecting hazardous low-altitude wind shear with at least one-minute of warning to the pilot is considered. Preliminary flight measurements showed that a FLIR system could successfully detect cool downdrafts of downbursts (microbursts/macrobursts, MB) and thunderstorm gust front outflows that are responsible for most LAWS events. A prototype FLIR system (nonscanning, fixed range) was tested near and within Colorado MBs, showing that a minimum warning time of one to four minutes, depending on aircraft speed, can be made available to the pilot prior to an MB encounter.

Windshear detection and recovery guidance on the BAE 146
91A29480
SLACK, N. P. (British Aerospace /Commercial Aircraft/, Ltd., Hatfield, England) IN: Windshear; Proceedings of the Conference, London, England, Nov. 1, 1990 (*A91-29476 11-03*). London, Royal Aeronautical Society, 1990, p. 7.1-7.7.
The installation of a windshear detection and recovery guidance system (WDGS) in the BAe 146 aircraft is described and the methods employed to develop and test the system are discussed. The WDGS has two basic functions: to detect and annunciate the presence of low-level airborne wind shear; and to provide guidance, by the flight director system, to permit the pilot to control the aircraft's performance. Simulation experience has shown that an anticipation of a severe wind shear by a few seconds appreciably increases the probability of recovery. Wind shear recovery guidance, based on angle of attack and modified by radio altitude and pitch attitude, is designed to permit quick transition out of the wind shear while preventing the aircraft from dropping, and utilizing the maximum lift capability to prevent ground impact. It is concluded that forward looking wind shear systems, currently being developed, will provide an additional safety benefit.

Methods for obtaining and reducing experimental droplet impingement data on arbitrary bodies

91A43310
PAPADAKIS, MICHAEL; ELANGOVAN, R.; FREUND, GEORGE A., JR.; BREER, MARLIN D. (Wichita State University, KS); (Boeing Co., Wichita, KS) Journal of Aircraft (ISSN 0021-8669), vol. 28, May 1991, p. 328-336. FAA-supported research., Wichita State Univ., KS.; Boeing Co., Wichita, KS.
Experimental water droplet impingement data are used to validate particle trajectory computer codes used in the analysis and certification of aircraft de-icing/anti-icing systems. Water droplet impingement characteristics of aerodynamic surfaces are usually obtained from wind-tunnel dye tracer experiments. This paper presents a dye tracer method for measuring water droplet impingement characteristics on arbitrary geometries and a new data reduction method, based on laser reflectance measurements, for extracting impingement data. Extraction of impingement data has been a very time-consuming process in the past. The new data reduction method developed is at least an order of magnitude more efficient than the method previously used. The accuracy of the method is discussed and results obtained are presented.

Current wave-form observed during lightning strikes on aircraft
91A45610
BOULAY, J.-L. (ONERA, Chatillon, France) (International Conference on Lightning and Static Electricity, Cocoa Beach, FL, Apr. 16-19, 1991) ONERA, TP no. 1991-28, 1991, 13 p.
In-flight data regarding electric and magnetic fields observed during lightning strikes is reviewed, and it is pointed out that the lightning-strike process begins with an attachment phase. Relight phases are also discussed, and a physical model explaining the physical mechanisms involved in the lightning preparation, attachment, connection, and relight phases is presented. Validation tests of these mechanisms, including long-arc tests in a laboratory environment, triggered lightning tests at an altitude, and observation of natural lightning strikes using an electromagnetic interferometer are considered. It is concluded that the pulse phases of lightning strikes should be simulated for correctly qualification tests of the aircraft equipment.

Artificial and natural icing conditions flight tests on the Piaggio P.180 Avanti aircraft
91A52938
CINQUETTI, PAOLO; MARTINI, SERGIO (Industrie Aeronautiche e Meccaniche Rinaldo Piaggio S.p.A., Genoa, Italy) SAE, General, Corporate, and Regional Aviation Meeting and Exposition, Wichita, KS, Apr. 9-11, 1991. 12 p.
An extensive development and certification test program carried out to meet the requirements for safe operations in ice conditions is described. The program encompasses preliminary evaluation in wind-tunnel tests, real flight in artificial icing conditions realized behind U.S. air tanker NKC-135, and natural ice tests performed in a wide range of atmospheric environments with a variety of average liquid water contents, cloud droplets median volume diameter and static temperature. The remarkable amount of data made it possible to accomplish power plant certification and assess all the ice protection systems with a high safety level. Some discrepancies found between data in artificial and natural tests are discussed.

Ice, rain, fog, and frost protection
91A53237
SAE Aerospace Information Report, SAE AIR 1168/4, July 30, 1990, 68 p.
The fundamental considerations and equations related to the calculation of ice, water, and fog protection requirements are set forth with methods for protection for aerospace application. Protecting nontransparent surfaces from ice is discussed with specific attention given to thermal ice protection and external factors which affect heat requirements. Other methods of ice protection for nontransparent surfaces include airfoil evaporative anti-icing, running-wet anti-icing, and electrothermal cyclic deicing. Design considerations are listed to determine the need for ice protection, and examples are given to illustrate typical applications. Windshield fog, frost, and ice protection are then described, and rain removal is mentioned. Hot-air jet blast, windshield wipers, and rain repellents are described and other protective devices are described and presented graphically.

Sensors and systems to enhance aviation safety against weather hazards
92A14265
MAHAPATRA, PRAVAS R.; ZRNIC, DUSAN S. (Indian Institute of Science, Bangalore, India); (NOAA, National Severe Storms Laboratory, Norman, OK) IEEE, Proceedings (ISSN 0018-9219), vol. 79, Sept. 1991, p. 1234-1267. Research sponsored by FAA.
The authors describe the physics of adverse weather, the basics of Doppler engineering, and a host of advanced sensing systems-some with the ability to autonomously identify and track storm conditions-for all stages of airplane travel. Three major new Doppler radar systems are discussed: the next generation weather radar, the terminal Doppler weather radar, and the airport surveillance radar with a dedicated weather channel. Other relatively simple new instruments for aviation weather support include the low level wind shear alert system, the Doppler wind profilers, the automated weather observation system, and the automated

surface observation system. These systems are designed to perform higher level functions such as detection, characterization, and hazard potential estimation of aviation-significant weather phenomena, as well as their communication and display automatically.

Lightning standards for aircraft protection
92A14688
PODGORSKI, ANDREW S. (National Research Council of Canada, Div. of Electrical Engineering, Ottawa) IN: IEEE 1990 International Symposium on Electromagnetic Compatibility, Washington, DC, Aug. 21-23, 1990, Record (A92-14679 03-33). New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 218-223.
The lightning peak current amplitudes and peak current derivatives recorded on short and tall towers and aircraft and obtained through EM field measurement in the high probability of occurrence region are successfully verified with the use of a unified lightning threat concept. The lightning peak current amplitudes and peak current derivatives are then extended to the low probability of occurrence region to determine the anticipated values of both variables. A comparison of the existing standards for protection of an aircraft with the anticipated peak current amplitudes and peak current derivatives is presented along with conclusions concerning the adequacy of existing standards.

Analysis technique for lightning attachment zoning of aircraft
92A20126
KING, C. H.; OGDEN, T. P. (Boeing Co., Seattle, WA) International Conference on Lightning and Static Electricity, University of Bath, England, Sept. 26-28, 1989. 5 p.
The design of aircraft lightning-protection systems is often based on aircraft zoning considerations which identify the most likely points of lightning attachment. Attention is presently given to a computer analysis technique which determines the probability of initial lightning attachment to aircraft surfaces on the basis of the 'rolling sphere' method. The method proceeds by envisioning a 25-m radius sphere which represents the severe case step-leader for lightning attachment as it rolls over the surface of the aircraft. The probability of attachment for each point is determined from geometrical considerations.

The detection and warning of low-level wind shear based on terminal single Doppler radar
93A22195
TSENG, H. Y.; WEIH, Y. P. (Taipei Meteorological Center, Taiwan) In: International Conference on Aviation Weather Systems, 4th, Paris, France, June 24-28, 1991, Preprints (A93-22101 07-47). Boston, MA, American Meteorological Society, 1991, p. J55-J58.
The study analyzes and states the weather pattern, Doppler radar observation, warning issuance, and the operational condition of the ATC personnel aircraft when significant low-level wind shear arose over C.K.S. Airport on April 22, 1980. The significant low-level wind shear and turbulence were caused by a cold front and the accompanying mesoscale convective thunderstorm system. Significant surface wind velocity change was also found to be one of the major causes of the low-level strong turbulence.

The obstacle avoidance radar - A safety mean for low altitude flights in adverse weather conditions
92A35743
QUEROL, HENRI (Thomson-CSF, Division Radars et Contre-Mesures, Montrouge, France) European Rotorcraft Forum, 16th, Glasgow, Scotland, Sept. 18-21, 1990, Paper. 10 p.
ROMEO is a low-altitude night/adverse-weather flight collision-avoidance system for helicopters which employs mm-wave technology. The applications for ROMEO are envisioned to be primarily in emergency medical services operations and in nap-of-the-earth military operations. Attention has been given to the detection capability of the system in the case of power lines, and the devising of a suitable cockpit display/pilot-interface configuration that maximizes collision-warning effectiveness.

Flying on thin ice
92A38375
ELLIOT, SIMON; WARWICK, GRAHAM Flight International (ISSN 0015-3710), vol. 141, no. 4316, April 29, 1992, p. 38-40.
A review is presented of several recent aircraft accidents showing that present airliner anti-icing measures are inadequate. Attention is given to these inadequacies and what is being done to correct them.

Aircraft ground deicing
92A40021
MASTER, CHARLES O. (FAA, Technical Center, Atlantic City, NJ) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Sept. 23-26, 1991. 9 p.
An overview is presented describing current advances in the materials and procedures for the anti-icing and deicing of aircraft prior to flight. Fluids for preventing icing are examined comparing the traditional North American freezing-point depressants (FPDs) with their European and military counterparts. The effectiveness of FPDs in general is related to holdover-time parameters which can be assessed according to performance

during high-humidity and water-spray endurance tests as well as in situ holdover-time testing. Aerodynamic performance tests are also important and include flat-plate and icing-tunnel tests developed by NASA, the FAA, and aircraft manufacturers. The FAA strategy is based on the Clean Aircraft Concept which addresses operational procedures, ice detection, and holdover-time predictions. It is noted that the pilot should always be considered the ultimate authority on the condition of the aircraft.

On the possibility of freezing and sticking phenomena in a transport during the ground taxiing and takeoff run and on the preventions of the hazard
92A45426
TAKSAWA, KINGO; SAKA, MITSUO (National Aerospace Laboratory, Tokyo, Japan); (Japan Air System, Tokyo) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings (A92-45376 19-01). Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 569-580.
In the present analytical study of slush-sticking and freezing phenomena associated with the tail surfaces of a commuter airliner during ground operations, a simple model describing outflows of heat from slush to the surrounding airflow, involving both conduction and evaporation, has given attention to meteorological and operational conditions' effects on the heat-transfer rate. Also noted is the effect of the spraying of aircraft deicing fluid, as reflected by a survey of pilots' experiences.

Aircraft longitudinal dynamics equations including wind shear effects
92A51946
SHENOY, AJIT R.; ANANTHKRISHNAN, N.; SUDHAKAR, K. (Indian Institute of Technology, Bombay, India) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 43, no. 4, Nov. 1991, p. 331-335.
Linearized equations are developed by means of a body-fixed axis system that describe the longitudinal motion of an aircraft experiencing wind shear. The resulting equations are applied to the case of an aircraft experiencing wind gradients in the form of vertical wind shear. The analytical results give the eigen values, frequencies, and damping modes associated with the short-period and phugoid modes, and phugoid stability is shown to be highly sensitive to wind gradient.

The importance of proper aviation weather dissemination to pilots - An airline captain's perspective
93A22115
SUMWALT, ROBERT L., III (Air Line Pilots Association, Washington) In: International Conference on Aviation Weather Systems, 4th, Paris, France, June 24-28, 1991, Preprints (A93-22101 07-47). Boston, MA, American Meteorological Society, 1991, p. 60-65.
The importance of proper aviation weather dissemination to pilots is illustrated via several NTSB aircraft accident and incident reports. The disadvantages of the most commonly used method of relaying convective weather information to pilots (preflight and inflight), the 'connect the dots' game, are discussed. ATIS and weather information datalink are being developed so that pilots can receive this information on a cockpit CRT instead of having to leave the ATC frequency to obtain it on another frequency.

Anemometer sighting criteria for low level wind shear alert system
93A22178
PETERKA, JON A. (Cermak Peterka Petersen, Inc., Fort Collins, CO) In: International Conference on Aviation Weather Systems, 4th, Paris, France, June 24-28, 1991, Preprints (A93-22101 07-47). Boston, MA, American Meteorological Society, 1991, p. 365-369. Research supported by NCAR.
The development of an anemometer siting guide for Federal Aviation Administration use is described. The siting guide included the influence of change in surface roughness, placement within a forest with upwind fetch, the influence of 2D obstacles such as tree lines, the influence of 3D bluff obstacles such as buildings or clumps of trees, the influence of forests on winds downwind of the end of the forest, the influence of 2D and 3D isolated hills on the acceleration of flow over a hilltop, and shielding downwind of hills. A physical model study was performed in a boundary layer wind tunnel capable of simulating wind flow in the atmospheric boundary layer. Profiles of mean velocity were measured for neutrally stable wind flow over proposed anemometer sites to determine the minimum anemometer height required to escape most the shielding effects of the surroundings. Wind velocity profiles in complex terrain compared to runway wind speed are illustrated.

Status of the Terminal Doppler Weather Radar one year before deployment
93A22184
EVANS, JAMES E. (MIT, Lexington, MA) In: International Conference on Aviation Weather Systems, 4th, Paris, France, June 24-28, 1991, Preprints (A93-22101 07-47). Boston, MA, American Meteorological Society, 1991, p. J1-J6. Research sponsored by FAA.
The current status and deployment strategy for the

operational systems of the Terminal Doppler Weather Radar are described, and recent results from extensive testing of the radar system concept and weather information issemination approach are presented. Tables show microburst detection performance, gust front detection performance as a function of gust front strength, and gust front/wind shift planning product performance.

Performance results and potential operational uses for the prototype TDWR microburst prediction product
93A22190
CAMPBELL, STEVEN D. (MIT, Lexington, MA)
In: International Conference on Aviation Weather Systems, 4th, Paris, France, June 24-28, 1991, Preprints (A93-22101 07-47). Boston, MA, American Meteorological Society, 1991, p. J33-J36. Research sponsored by FAA.
The study presents a proposed new Terminal Doppler Weather Radar (TDWR) product for microburst prediction (MBP), which provides the ability to predict microbursts prior to the onset of surface outflow. The MBP product uses the ability of the TDWR to scan aloft for precursor signatures which indicate that a microburst is about to occur. The potential usefulness of the MBP product is illustrated with an example that occurred during operational testing during the summer of 1990.

An improved gust front detection algorithm for the TDWR
93A22191
EILTS, MICHAEL D.; OLSON, STEPHEN H.; STUMPF, GREGORY J.; HERMES, LAURIE G.; ABREVAYA, ADAM; CULBERT, JAMES; THOMAS, KEVIN W.; HONDL, KURT; KLINGLE-WILSON, DIANA (NOAA, National Severe Storms Lab., Norman, OK); (MIT, Lexington, MA) ; (NOAA, National Severe Storms Lab.; Cooperative Inst. for Mesoscale Meteorological Studies, Norman, OK); (NOAA, National Severe Storms Lab., Norman, OK); (MIT, Lexington, MA); (NOAA, National Severe Storms Lab.; Cooperative Inst. for Mesoscale Meteorological Studies, Norman, OK); (MIT, Lexington, MA)
In: International Conference on Aviation Weather Systems, 4th, Paris, France, June 24-28, 1991, Preprints (A93-22101 07-47). Boston, MA, American Meteorological Society, 1991, p. J37-J42. Research sponsored by FAA.
The study describes a new algorithm which provides improved gust front detection for the TDWR using additional radar signatures of gust fronts. The novel algorithm enhances detection and prediction of gust fronts by merging radial convergence features with azimuthal shear features, thin line features, and the predicted locations of gust fronts which are passing over the radar. The rule base used to combine detections from the four components of the algorithm into single gust front detections is described. The final product of the gust front algorithm is a smooth curve representing the location of the gust front, 10- and 20-min forecasts of gust front location, an estimate of the speed and direction of the wind behind the gust front, and an estimate of the wind shear hazard.

Anti-icing failure detection instrumentation using realtime optical measurement of anti-icing fluid properties
93A24836
MULLER, MICHAEL R.; POLOMSKI, PETER P.; LA DUE, JAMES C. (Rutgers Univ., Piscataway, NJ) AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993. 10 p. Research supported by FAA.
Performance and limitations of three techniques for providing different information about the makeup of the thin anti-icing film used have been studied experimentally. These techniques include critical angle refractometry at the solid-liquid interface, analysis of the secondary reflection from the liquid-air interface, and determination of critical angles at internal positions within the deicing film. It is considered to be unlikely that any of these techniques can be totally sufficient for determining the onset of icing. The methods vary in complexity and what information they provide and all of them or certain methods may be useful in various applications.

Field studies of hold-over-times for type II anti-icing fluids - Results and insights
93A24837
POLOMSKI, PETER P.; MULLER, MICHAEL R. (Rutgers Univ., Piscataway, NJ) AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993. 9 p. Research supported by FAA.
In situ testing of deicing/anti-icing fluids intended to protect the flying public during frozen precipitation events by establishing holdover time guidelines is reviewed. Emphasis is placed on the analysis of the 1991-1992 data, the implications of the data, and recommendations for future work.
It is noted that the most important variable is the determination of frosticator plate failure. Current test guidelines allow for failure criteria to be influenced entirely by the judgment of the operator based on visual insight which can be influenced by visibility, glare from indirect lighting, and individual bias. Standardization of failure must be based more on scientific principles to achieve scatter reduction.

Flying qualities criteria for adverse weather
93A31059
GILLETTE, DARRELL E.; PAGE, MARK A.; HODGKINSON, JOHN (McDonnell Douglas Aerospace, Long Beach, CA) AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993. 11 p.
A new approach to establishing aircraft handling qualities criteria in the presence of adverse weather is proposed. This approach, based on the Cooper-Harper rating scale, is both numeric and systematic. It formally accounts for the influence of adverse weather in the absence of mechanical failures, a safety state which is not yet explicitly addressed in most safety analysis criteria. Since adverse weather is a factor in a large percentage of aircraft accidents, designing aircraft to have good handling qualities despite adverse weather conditions may be a high-leverage means of improving overall flight safety.

Wind shear training applications for 91/135
91N24173
ARBON, ED In NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 p 143-152 (SEE N91-24166 16-03) Avail: CASI HC A02/MF A04
Flight Safety Foundation, Inc., Arlington, VA.
The requirement for wind shear training of all pilots has been demonstrated too often by the accident statistics of past years. Documents were developed to train airline crews on specific aircraft and to teach recognition of the meteorological conditions that are conducive to wind shear and microburst formation. A Wind Shear Training Aid program is discussed.

Aircraft icing handbook, volume 1
91N29154 393 PAGES
HEINRICH, A.; ROSS, RICHARD; ZUMWALT, GLEN; PROVORSE, JOHN; PADMANABHAN, VISWA Avail: CASI HC A17/MF A04
Aircraft icing handbook, volume 2
91N29155 604 PAGES
HEINRICH, A.; ROSS, RICHARD; ZUMWALT, GLEN; PROVORSE, JOHN; PADMANABHAN, VISWA Avail: CASI HC A99/MF A06
Aircraft icing handbook, volume 3
91N29156 242 PAGES
HEINRICH, A.; ROSS, RICHARD; ZUMWALT, GLEN; PROVORSE, JOHN; PADMANABHAN, VISWA Avail: CASI HC A11/MF A03
Gates Learjet Corp., Wichita, KS.
The design and validation of adequate aircraft ice protection has evolved into a specialized and technical complex area where many engineering disciplines are involved; namely, aeronautical, electrical, mechanical, electronics, chemical simulations, mathematical modeling, airframe/engine systems design, atmospheric physics, and meteorology. Research advances in any one discipline have a direct effect on updating the procedural technology used in the design and validation of ice protection configurations, equipment, and systems. Periodically the Federal Aviation Administration (FAA) provides documentation to assist regulatory certification teams and industry design engineers in standardizing testing and validating procedures. Examples of such documentation are Engineering Summary of Airframe Icing Technical Data, FAA Report No. ADS-4 dated December 1968, and Engineering Summary of Powerplant Icing Technical Data, FAA Report No. RD-77-76 dated July 1977. Although most of the information contained in these reports is still valid, some is outdated, and more usable information is now available through recent research and experience. Therefore, this work was directed towards developing an updated and more comprehensive combined version of Report ADS-4 and RD-77-76 that includes reference material on ground and airborne icing facilities, simulation procedures, and analytical techniques.

Process for detecting the likelihood of ice formation, ice warning system for carrying out the process, and utilization thereof
91N31107
LUSTENBERGER, MARTIN Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada HC $4.00 CAN, MMF $2.75 CAN
Vibro-Meter S.A., Fribourg (Switzerland).
This invention relates to a process and apparatus for detecting the likelihood of natural ice formation on the surface of an aircraft, to a warning system, and to a utilization thereof. The process consist of: positioning a diaphragm having a fundamental resonant frequency and harmonic frequencies on an exposed surface of the aircraft; exciting the diaphragm at one of its resonance frequencies; alternately cooling and heating the diaphragm such that its temperature falls below and rises above the temperature of the exposed surface to alternately create and melt an accretion of ice when the ambient temperature is near or below the freezing point; and measuring any variation in the resonant frequency of the vibration of the diaphragm which occurs during the heating and cooling steps. The fundamental resonance frequency will decrease and the harmonic frequencies increase in the presence of an accretion of ice. An alarm is set off when the variation exceeds a predetermined value. In addition, the process measures the ambient temperature, measures the temperature of the diaphragm, and controls the heating and cooling cycle such that

the duration of the cycle is dependent on the ambient temperature.

Engine icing criticality assessment
91N31161
BROOK, E. In AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 6 p (SEE N91-31144 23-07) Avail: CASI HC A02/MF A03 Rolls-Royce Ltd., Derby (England).
Assessment of an engine design for icing risk is important at both the design stage and for development and certification testing. Icing must be included with aerodynamic and noise constraints during the design phase to minimize the risk of design change during development, and the compromise tested must be tested at the extremes of the atmospheric icing, and aircraft and engine operating envelopes most appropriate to the particular components. The type of assessment necessary is addressed and illustrated mainly by reference to high bypass ratio turbofans. The approach to identifying critical conditions is presented and areas where research can provide basic data for the development of design methods are discussed.

Developments in icing test techniques for aerospace applications in the RAE Pyestock altitude test facility
91N31173
HOLMES, M.; GARRATT, V. E. W.; DRAGE, R. G. T. In AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 15 p (SEE N91-31144 23-07) Avail: CASI HC A03/MF A03 Royal Aerospace Establishment, Farnborough (England).
The altitude test facilities at the Royal Aerospace Establishment at Pyestock are used in support of clearance of aero-engines, intakes, and helicopter rotors to operate under severe icing conditions. An important aspect of the work is the simulation of the wet icing cloud in terms of water concentration, mean droplet size and spectrum. Water spray rakes or booms were developed for this activity and individual nozzles were calibrated in a wind tunnel built for this purpose. A laser particle sizer was used to calibrate typical spray nozzles and attempts were made to establish a traceable standard. The development of cloud simulations is discussed as well as facilities for monitoring ice formation and shedding.

Lightning threat to aircraft: Do we know all we need to know?
91N32600
MAZUR, VLADISLAV In NASA. Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 8 p (SEE N91-32599 24-47) Avail: CASI HC A02/MF A06 National Severe Storms Lab., Norman, OK.
The problem of lightning threat to aircraft has two aspects: strike avoidance and aircraft protection. These two issues are addressed under the following topics: (1) lightning strikes, weather conditions, and natural lightning rate; (2) the engineering vs. scientific approach to aircraft protection; and (3) the additional information needed to understand lightning threat to aircraft.

Effects of Adverse Weather on Aerodynamics
92N21679 287 PAGES
Meeting held in Toulouse, France, 29 Apr. - 1 May 1991 Avail: CASI HC A13/MF A03 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
This meeting was organized to provide a timely review of the progress being made in advancing the state of the art in predicting, simulating, and measuring the effects of icing, anti-icing fluids, and various forms of precipitation on the aerodynamic characteristics of flight vehicles. Topics included results from both theoretical and experimental programs and material related to procedures and regulations for certification and operation. International participation for the meeting included authors from eight nations and representatives from most of the 16 NATO nations. For individual titles, see N92-21680 through N92-21698.

Method for calculating the three-dimensional water concentration coefficients and its industrial applications
92N21685
PREL, P. In AGARD, Effects of Adverse Weather on Aerodynamics 12 p (SEE N92-21679 12-03) Avail: CASI HC A03/MF A03 Aerospatiale, Toulouse (France).
A three dimensional method for calculating the concentration coefficients of water droplets, its general principles, as well as the details of the calculating computer programs that were used, are described. The applications are presented for locating probes on the Airbus 340 and ATR 72 airplanes, mainly showing the effect of the drop diameter on the measured concentration.

The effect of hoar-frosted wings on the Fokker 50 take-off characteristics
92N21692
VANHENGST, J.; BOER, J. N. In AGARD, Effects of Adverse Weather an Aerodynamics 9 p (SEE N92-21679 12-03) Avail: CASI HC A02/MF A03 Fokker B.V., Schipol-Oost (Netherlands).
Reviewed here is how contamination resulting from ice, snow, or frost accumulated during ground icing degrades the Fokker 50 aircraft aerodynamics and leads to reduced flight safety during takeoff. From

simulation tests it was concluded that wing contamination due to ground frost seriously deteriorates the aircraft behavior in takeoff, leading to reduced flight safety. A large increase in takeoff distance is experienced. No improvement was found from cleaning the wing leading edge only or by increasing rotation speed. The results clearly demonstrate the importance of Advisory Circular AC 20-117 emphasizing the 'clean aircraft concept' under adverse weather conditions before takeoff.

Aircraft accident report: L'Express Airlines, Inc., Flight 508, Beech C99, N7217L weather encounter and crash near Birmingham, Alabama, July 10, 1991
92N32455 143 PAGES
Avail: CASI HC A07/MF A02 National Transportation Safety Board, Washington, DC.
This report explains the weather encounter and crash of L'Express Flight 508 while the airplane was conducting an instrument landing system approach on runway 5 at the Birmingham Airport, Birmingham, Alabama. The safety issues discussed in this report include pilot training in recognizing thunderstorm hazards and recovering from unusual attitudes, radar interpretation, and the relaying of complete weather information to pilots by air traffic controllers. Recommendations concerning these issues were made to the Federal Aviation Administration.

Optimal recovery from microburst wind shear
93N22574
MULGUND, SANDEEP S. In NASA. Langley Research Center, Joint University Program for Air Transportation Research, 1991-1992 p 129-140 (SEE N93-22561 08-01) Avail: CASI HC A03/MF A02 Princeton Univ., NJ.
Severe low-altitude wind variability represents an infrequent but significant hazard to aircraft taking off or landing. During the period from 1964 to 1985, microburst wind shear was a contributing factor in at least 26 civil aviation accidents involving nearly 500 fatalities and over 200 injuries. A microburst is a strong localized downdraft that strikes the ground, creating winds that diverge radially from the impact point. The physics of microbursts have only been recently understood in detail, and it has been found that effective recovery from inadvertent encounters may require piloting techniques that are counter-intuitive to flight crews. The goal of this work was to optimize the flight path of a twin-jet transport aircraft encountering a microburst during approach to landing. The objective was to execute an escape maneuver that maintained safe ground clearance and an adequate stall margin during the climb-out portion of the trajectory.

A procedure for defining lightning risk to air vehicles
93N24885
BEEMAN, DAVID; MORITA, NAOMI In FAA, The 1992 International Aerospace and Ground Conference on Lightning and Static Electricity: Addendum 18 p (SEE N93-24875 09-47) Avail: CASI HC A03/MF A03 Northrop Corp., Pico Rivera, CA.
The risk of a lightning-induced failure is a function of the atmospheric conditions which produce lightning and the protective characteristics of the vehicle. Contemporary air vehicle designs - which incorporate 'wet' wings and extensive composite skin and structures - require thorough consideration of this risk to balance performance of lightning protection measures against other performance parameters (i.e., cost, weight, manufacturability, maintainability). An analytic procedure to investigate the risk of lightning-induced fuel vapor ignition is described in this paper. Sensitivity of the risk to various atmospheric and air vehicle design parameters was examined and is discussed.

Lightning phenomenology bases for full threat return stroke occurrence following extended leader sweep at flight altitudes
93N24895
PLUMER, J. ANDERSON In FAA, The 1992 International Aerospace and Ground Conference on Lightning and Static Electricity: Addendum 18 p (SEE N93-24875 09-47) Avail: CASI HC A03/MF A03 Lightning Technologies, Inc., Pittsfield, MA.
It has been recognized that lightning leaders sweep aft from initial attachment points on aircraft forward extremities prior to arrival of the first return stroke, which, in a cloud-to-earth flash, is not initiated until a branch of the leader reaches the earth. This process has lead to more realistic procedures for locating lightning strike Zone 1A on aircraft surfaces, with the result that Zone 1A covers considerably more of the aircraft surfaces than previous zone location methods (i.e., 'the 18-inch criteria') would indicate. Some observers have suggested that, whereas the leader may indeed sweep a considerable distance alongside fast moving aircraft at flight altitudes, the intensity of the ensuing first return stroke will be less than it would be at the ground terminus of the lightning channel, because a portion of leader charge is below, not above, the airplane. Analytical models of lightning channels are often cited to support this, since such models often show reduction of the stroke intensity (i.e., peak current and action integral) with distance from the earth terminus. Physical damage on aircraft struck in flight belies this contention, however, as damage indicative of severe return strokes is often seen well beyond 18 inches aft of initial leader attachments. This paper discusses the natural

lightning characteristics that explain why severe first return strokes may arrive well aft of forward extremity tips of aircraft, and why zone location methods must account for this. It is the third paper in a series begun in 1980 by the author on the topic of swept leader and zone location methodology, and presented at these conferences.

Pilot guide. Large aircraft ground deicing
93N70414 39 PAGES
Sept. 1992 Avail: CASI HC A03 Federal Aviation Administration, Washington, DC.
This advisory circular (AC) contains recommendations for ensuring the safe operation of large airplanes during icing conditions and guidelines for the development of adequate procedures for the deicing of large airplanes. It is designed for the use of flight crewmembers, maintenance and serving personnel, and other aviation personnel responsible for ground deicing and aviation safety in general. The guidelines and procedures offered in this AC are advisory in nature and do not carry the force of a regulatory requirement. However, prudent operators will find that this information can further enhance safe operations and procedures. In addition to a brief summary of the information contained in AC 20-117, Hazards Following Ground Deicing and Ground Operations in Conditions Conducive to Aircraft Icing, this AC contains recent information and guidance materials regarding advanced deicing and anti-icing fluids and procedures for their use. It recommends adherence to the clean aircraft concept which proposes 'get it clean and keep it clean' during operations in adverse weather conditions.

J.
Maintenance of Aircraft

Windscreen departure
92A42500
Aerospace (UK) (ISSN 0305-0831), vol. 19, no. 6, June 1992, p. 8-14.
A review is presented of a commercial aircraft incident that occurred in June 1990, involving the inflight blowout of a British Airways One-Eleven windshield as a result of its having been installed with the wrong bolts during maintenance. An analysis of the complex events leading to this human maintenance error is provided by the report of the accident review board.

Key trends in human factors of aircraft maintenance; Proceedings of the Conference, London, United Kingdom, Oct. 31, 1991
93A18754
London, Royal Aeronautical Society, 1991, 109 p.
The present conference discusses the European viewpoint in aircraft maintenance developments, design-for-safety criteria and practices, the role of human factors considerations in aircraft maintenance and ground handling, the changing demands of technical training for aircraft maintenance personnel, and the benefits of ground maintenance simulators. Also treated are the aircraft maintenance effects of built-in test equipment relative to the exercise of human judgment, the effect of aircraft maintenance on human factors, the use of information systems in association with new aircraft maintenance technologies, and the integration of requirements for ground-based maintenance data systems. (For individual items see A93-18755 to A93-18760)

The National Plan for Aviation Human Factors - Maintenance research issues
93A27132
JOHNSON, WILLIAM B. (Galaxy Scientific Corp., Atlanta, GA) In: Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 (A93-27126 09-54). Santa Monica, CA, Human Factors Society, 1991, p. 28-32. Research sponsored by FAA.
The National Plan for Aviation Human Factors addresses Human Factors research associated with pilots, controllers, maintenance technicians, and their respective work environments. In each of the sections the plan addresses issues related to topics such as automation and advanced technology, basic scientific knowledge about human performance, information transfer, performance measurement, training and selection, and certification. This paper describes the portions of the National Plan related to maintenance. It includes discussion of problems shared in the maintenance of aircraft and in the maintenance of the 'electronic highways' called airway facilities. The paper describes the Plan's research recommendations. In addition the paper elaborates on the current Office of Aviation Medicine Human Factors in Aviation Maintenance research, associated with the National Aging Aircraft Research Program.

Errors in aviation maintenance - Taxonomy and control
93A27135
DRURY, COLIN G. (New York State Univ., Buffalo) In: Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 (A93-27126 09-54). Santa Monica, CA, Human Factors Society, 1991, p. 42-46. Research supported by FAA.
Maintenance errors account for a small, but highly visible, portion of aviation-related accidents and fatalities. To measure, and hence eventually control, errors in any field requires a taxonomy which enumerates and classifies the errors. This taxonomy

can come from reported errors, but a pro-active system is needed to cover potential errors, as well as those which happen to have been committed and recorded so far. A standard starting point for human and system errors is the description and analysis of those tasks necessary to complete the maintenance-inspection requirements of aircraft in an approved manner. As each step of this Task Description is listed, the failure modes associated with that step can be logically deduced. Following an extensive Task Description and Analysis of aircraft maintenance, an error taxonomy was developed from the failure modes of each task. From current theoretical approaches to human error come ways of extending this classification, and of relating potential errors to levels of human functioning within the system.

Human factors issues in aircraft maintenance and inspection: Information exchange and communications
91N20634 139 PAGES
PARKER, JAMES F., JR.; SHEPHERD, WILLIAM T. Avail: CASI HC A07/MF A02 BioTechnology, Inc., Falls Church, VA.
The Federal Aviation Administration sponsored a 2-day meeting in December 1989 as part of a continuing program to address issues of human factors and personnel performance in aviation maintenance and inspection. This meeting focused on issues of information exchange and communications. The primary goal was to consider means of ensuring that the exchange of information within the industry responsible for the maintenance of the U.S. air carrier fleet is accurate, efficient, and responsive to the particular needs of this industry. Presentations were given by representatives of commercial aviation interests and covered related efforts from other fields and new technologies having possible application to aviation maintenance. Each presentation was recorded and transcribed for purposes of study and publication. Eight recommendations were made to the Federal Aviation Administration regrading effective communications methodology among the various members of the maintenance industry.

K.
Future Requirements

European transporter concepts today for tomorrow's twenty-first-century missions - High technology serves as a pacesetter in the ambitious aircraft design
91A29027
New-Tech News (ISSN 0935-2694), no. 4, 1990, p. 26-29.

The current tactical concepts call for a simple rugged aircraft with new but tried and true technology. While the aircraft should not be considerably larger than its predecessors, its transportational capacity is to be greater than that of C-130 or C-160. Emphasis is placed on the European Future Large Aircraft Group consortium created with the goal of the development, production, product support, and marketing of the program, and the contribution of Deutsche Airbus to the program. The development of digital technology, cockpit displays, and cargo doors for the aircraft is outlined, along with requirements for short takeoff and landing distances, the use of composites, the reduction of radar cross section, and mission-specific aspects such as night and poor-weather visual capabilities, terrain/threat avoidance, and high-precision navigation for load discharges.

New aircraft technologies - Challenges for dependability
92A56225
SHARMA, TILAK C. (Boeing Commercial Airplane Group, Seattle, WA) IN: Annual Reliability and Maintainability Symposium, Las Vegas, NV, Jan. 21-23, 1992, Proceedings (A92-56201 24-38). New York, Institute of Electrical and Electronics Engineers, Inc., 1992, p. 243-248.
Advances being planned in the commercial aircraft business, which include those in the areas of E-ETOPS, HSCT, fly-by-wire, and fly-by-light pose the question of their dependability. The paper defines the concept of dependability as it refers to aircraft equipment, the characteristics which a dependable aircraft equipment should possess, the use of the Dependable Computing techniques during the design and development of new equipment, and the new technology application to the current 777 program. Consideration is also given to the certification requirements for transport aircraft systems in terms of reliability, integrity, and availability.

Identification of high-level functional/system requirements for future civil transports
92N15991 151 PAGES
SWINK, JAY R.; GOINS, RICHARD T. Avail: CASI HC A08/MF A02 Douglas Aircraft Co., Inc., Long Beach, CA.
In order to accommodate the rapid growth in commercial aviation throughout the remainder of this century, the Federal Aviation Administration (FAA) is faced with a formidable challenge to upgrade and/or modernize the National Airspace System (NAS) without compromising safety or efficiency. A recurring theme in both the Aviation System Capital Investment Plan (CIP), which has

replaced the NAS Plan, and the new FAA Plan for Research, Engineering, and Development (RE&D) rely on the application of new technologies and a greater use of automation. Identifying the high-level functional and system impacts of such modernization efforts on future civil transport operational requirements, particularly in terms of cockpit functionality and information transfer, was the primary objective of this project. The FAA planning documents for the NAS of the 2005 era and beyond were surveyed; major aircraft functional capabilities and system components required for such an operating environment were identified. A hierarchical structured analysis of the information processing and flows emanating from such functional/system components were conducted and the results documented in graphical form depicting the relationships between functions and systems.

High-speed civil transport flight- and propulsion-control technological issues
92N21253 161 PAGES
RAY, J. K.; CARLIN, C. M.; LAMBREGTS, A. A. Prepared for PRC Kentron, Inc., Edwards, CA and NASA- Hugh L. Dryden Flight Research Facility, Edwards, CA Avail: CASI HC A08/MF A02 Boeing Commercial Airplane Co., Seattle, WA.; PRC Kentron, Inc., Edwards, CA.; National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
Technology advances required in the flight and propulsion control system disciplines to develop a high speed civil transport (HSCT) are identified. The mission and requirements of the transport and major flight and propulsion control technology issues are discussed. Each issue is ranked and, for each issue, a plan for technology readiness is given. Certain features are unique and dominate control system design. These features include the high temperature environment, large flexible aircraft, control-configured empennage, minimizing control margins, and high availability and excellent maintainability. The failure to resolve most high-priority issues can prevent the transport from achieving its goals. The flow-time for hardware may require stimulus, since market forces may be insufficient to ensure timely production. Flight and propulsion control technology will contribute to takeoff gross weight reduction. Similar technology advances are necessary also to ensure flight safety for the transport. The certification basis of the HSCT must be negotiated between airplane manufacturers and government regulators. Efficient, quality design of the transport will require an integrated set of design tools that support the entire engineering design team.

The 1991 Federal Aviation Administration plan for research, engineering and development
92N32453 171 PAGES
Prepared for Congress of the United States, Washington, DC Avail: CASI HC A08/MF A02 Federal Aviation Administration, Washington, DC.; Congress of the United States, Wash., DC.
The FAA's Research, Engineering and Development (R,E&D) Program is very forward looking, and concentrates on the known needs of the aviation system and it constituency. The FAA has published a vision of the future system which has been broadly accepted by the industry. The vision is rooted in the pursuit of a safe system that does not constrain flight. The system that results from this work will be more capable, efficient, and economical to operate. Increased automation will involve the controller, pilot, and maintenance technicians in different roles than today's system requires. Specific areas of this project which are discussed at length include the following: quality control; R,E&D goals; past lessons learned; planning for future aviation systems; R,E&D plan components; and system engineering.

M.
Miscellaneous
(none of the other topics)

Continuing airworthiness - Requirements and substantiation
91A24487
FICKEISEN, F. C. (Boeing Commercial Airplanes, Seattle, WA) IN: ICAS, Congress, 17th, Stockholm, Sweden, Sept. 9-14, 1990, Proceedings. Vol. 2 (A91-24301 09-01). Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1990, p. 1844-1848.
Requirements to show that airplane systems continue to operate with levels of safety demonstrated during initial certification processes have been established. These requirements take two forms: (1) Follow approved maintenance procedures and schedules to assure continuation of design reliability levels, and (2) measure reliability levels by use of in-service data and take action when measured values approach levels shown to be necessary by certification analyses. Both processes are used successfully, and each has some inherent limitations. The second process requires in-service data sources, data reduction and analysis, and a method to compare in-service results to predictions. Though the second process is generally more complicated, it has the advantage of providing some insight into corrective actions that may enhance system reliabilities.

Aviation security and Pan Am Flight 103 - What have we learned?
91A27829
STRANTZ, NANCY JEAN Journal of Air Law and Commerce (ISSN 0021-8642), vol. 56, Winter 1990, p. 413-489.
The changes in aviation law and security occasioned by the disaster of Pan Am Flight 103 are reviewed. The most important changes are the recent reexamination of the proposed reforms to the Warsaw Convention and related compensation plans, the introduction in 1989 of both the Aviation Airport Technology and Research Act and the Aviation Security Act, and the release of a report by the President's Commission on Aviation Security and Terrorism and the introduction in 1990 of the Aviation Security Improvement Act. Detailed attention is given to the legislative initiatives and the prospects for their success.

Pre-flight risk assessment in emergency medical service (EMS) helicopters
92A11171
SHIVELY, ROBERT J. (NASA, Ames Research Center; U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA) IN: Human Factors Society, Annual Meeting, 34th, Orlando, FL, Oct. 8-12, 1990, Proceedings. Vol. 2 (A92-11126 01-54). Santa Monica, CA, Human Factors Society, 1990, p. 1052-1056. National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.; Army Aviation Research and Development Command, Moffett Field, CA.
A preflight risk assessment system (SAFE) was developed at NASA-Ames Research Center for civil EMS operations to assist pilots in making a decision objectively to accept or decline a mission. The ability of the SAFE system to predict risk profiles was examined at an EMS operator. Results of this field study showed that the usefulness of SAFE was largely dependent on the type of mission flown.

United 232 - Coping with the 'one-in-a-billion' loss of all flight controls
92A36349
HAYNES, ALFRED C. (United Airlines, Chicago, IL) SAFE Journal, vol. 22, no. 2, Mar.-Apr. 1992, p. 37-46.
Attention is given to a flight made on July 19, 1989, in which the uncontained disintegration of the No. 2 engine's fan rotor caused the loss of all three of the aircraft's redundant hydraulic flight control systems and made the aircraft almost uncontrollable. The major factors involved in making it possible to cope with a major inflight emergency such as the one-in-a-billion loss of all flight controls are discussed. They are: luck, communications, preparation, execution, and cooperation.

Noise abatement procedures vs. safety
92A39977
DEEDS, RICHARD A. (Air Line Pilots Association, Washington, DC) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Sept. 23-26, 1991. 7 p.
The impact of aircraft noise abatement in the airport terminal area on the safety of air carrier operations is considered. Problems discussed include vertical take-off profiles that require less than minimum certified climb gradients; curfews which deny the availability of the airport to pilots; runways and conditions recommended by the National Transportation Safety Board; flight paths which do not provide in-cockpit electronic guidance to the pilot; and establishment by airports of local noise standards.

Continuous flying quality improvement - The measure and the payoff
92A55171
HODGKINSON, J.; PAGE, M.; PRESTON, J.; GILLETTE, D. (Douglas Aircraft Co., Long Beach, CA) IN: AIAA Guidance, Navigation and Control Conference, Hilton Head Island, SC, Aug. 10-12, 1992, Technical Papers. Pt. 1 (A92-55151 23-63). Washington, American Institute of Aeronautics and Astronautics, 1992, p. 172-180.
A measure that aids the integration of flying qualities into the design of transport aircraft is suggested. The measure is based on a statistical interpretation of the Cooper-Harper pilot rating scale, and is a first step in a more structured and formalized process for incorporating flying qualities requirements into the design process.

Breaking through the 10 exp 6 barrier
93A11498
HOWARD, RONALD W. (GEC Avionics, Ltd., Rochester, United Kingdom) Aeronautical Journal (ISSN 0001-9240), vol. 96, no. 957, Aug.-Sept. 1992, p. 260-270.
Possible means for overall increase in the safety of air transport are discussed using the fatal accident levels as presented by the statistics. It is suggested that planned improvements quantified by statistical safety assessment methods will be required in future. This assessment should encompass the totality of an integrated air transport system, air traffic management, flight operations management, and air navigation systems in isolation. An integrated systems approach should be used for setting new targets for overall safety.

An integrated team approach to prototype flight certification - YF-22A Advanced Tactical Fighter (ATF)
93A13375

LOREN, J. R.; KERR, M. I.; GREEN, J. S. (Boeing Defense & Space Group, Seattle, WA); (Lockheed Aeronautical Systems Co., Marietta, GA); (General Dynamics Corp., Fort Worth, TX) AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992. 12 p.
This paper describes various processes used by the Lockheed/Boeing/General Dynamics Advanced Tactical Fighter (ATF) Team to plan and manage safety-of-flight (SOF) certification of the two YF-22A prototype aircraft. During this time our tri-Company organizations and associated procedures served as early examples of the Integrated Product Team (IPT) and Analysis/ Integration (A&I) Team concepts now used on the F-22 Engineering and Manufacturing Development (EMD) program. Our success in effectively pre-implementing such Team concepts was a key part of the System Test Plan submitted with our F-22 EMD proposal. Details of actual aircraft equipment and technologies are limited to information in the public domain; flight test program results are not discussed, since the primary objective of SOF certification efforts was achieved with completion of all reviews and release for first flight.

The employment of artificial intelligence for analyzing air accidents
93A14375
ZHANG, F. M.; SU, E. Z. (Air Force College of Engineering, Xian, China) In: ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 (A93-14151 03-01). Washington, American Institute of Aeronautics and Astronautics, Inc., 1992, p. 1810-1818.
The necessity and possibilities of developing a computer-aided system to analyze aviation accident causes with the AI expert system are presented. The recently developed design concept and structure of the aviation accident analysis expert system are reviewed. The bidirectional knowledge representation technique in the area of aviation accident analysis, the model of interactive automatic knowledge acquisition, and control strategies and reasoning mechanism in the accident analysis process are discussed.

Location of commercial aircraft accidents/incidents relative to runways
91N11738
DAVID, ROBERT E. Avail: CASI HC A05/ MF A01 Federal Aviation Administration, Washington, DC.
The location of an aircraft involved in an accident or incident may be documented by the National Transportation Safety Board and the Federal Aviation Administration during the course of their investigation. When available, it will appear in the record of the individual investigation. However, this location information is not available from either of these agencies in a summary form. Compiled in this document is the location relative to the runway of these accidents/incidents for aircraft involved in commercial air transportation in the United States. Accidents/incidents that occurred from 1978 to 1987 were studied. Since it is intended that this information will be used mainly to make decisions on individual airports, no attempt was made to reach conclusions or make recommendations based on the data. The accidents/incidents used were categorized as undershoots, landings off the runway, veeroffs, overruns, and other in the vicinity of the airport. The aircraft location was recorded in terms of the distance along the runway centerline or extended centerline (X distance) and the perpendicular distance from the centerline or extended centerline (Y distance).

Analysis of helicopter accident risk exposure near heliports, airports, and unimproved sites
92N26028
ADAMS, R. J.; MCCONKEY, E. D.; DZAMBA, L. D.; SMITH, R. D. (Advanced Aviation Concepts, Jupiter, FL.); (Systems Control Technology, Inc., Arlington, VA.); (Systems Control Technology, Inc., Arlington, VA.); (Federal Aviation Administration, Washington, DC.) Avail: CASI HC A04/MF A01 Systems Control Technology, Inc., Arlington, VA.
The development of relevant safety indicators to be used in the assessment of risk exposure due to heliport design and operational standards is discussed. Since helicopter accidents have been relatively rare events, historical data at heliports are somewhat limited. Therefore, the approach described herein is to develop the total helicopter risk exposure due to all causes and then estimate what proportion of that risk should be allocated to various circumstances associated with specific heliport design and helicopter operational characteristics. This approach introduces the need for analysis and quantification of risk using a parameter or parameters that both industry and government agree are within a logical framework. Data on the number of helicopter accidents per year, accidents per 100,000 hours of flight time, accidents per 100,000 mission segments, accident rates for selected mission types, occupant risk of serious injury, and neighborhood risk are presented. Finally, civil helicopter accidents are categorized by the facilities near which they occur (heliport, airport, etc.) and by the operating facility design parameters that impact operational risk.

Technical measures for the attenuation of aircraft noise and their applicability to GAF combat aircraft
93N10690

TOENSKOETTER, H.; BLAECK, S.; RICHTER, R. In AGARD, Combat Aircraft Noise 8 p (SEE N93-10666 01-71) Avail: CASI HC A02/MF A03 Industrieanlagen-Betriebsgesellschaft m.b.H. Ottobrunn (Germany).
Possible technical measures for the reduction of aircraft engine noise are evaluated with respect to the noise attenuation potential at take-off, low level flight and landing and their applicability to the combat aircraft of the German Air Force (GAF) is discussed. Based on this analysis short and mid term solutions for Tornado are proposed and investigated with respect to noise attenuation, integration, weight, flight performance, operational impact and safety. The design concept of a 'Low Noise Training-Tornado' with reheatless RB199 engines and ejector nozzles is described.

Hermes CX-7: Air transport system design simulation
93N18056 121 PAGES
AMER, BRIAN; BARTER, JOHN; COLUCCI, JAY; FOLEY, CARYN; KOCKLER, JAMES; RAPP, DAVID; ZEIGER, MATTHEW Sponsored in cooperation with Boeing Commercial Airplane Co. Avail: CASI HC A06/MF A02 Notre Dame Univ., IN.
The Hermes CX-7 has been designed to service the overnight parcel package delivery needs of the cities of Aeroworld as determined in the G-Dome Enterprises market survey. The design optimization centers on the prime goal of servicing the needs of these cities as efficiently and profitably as possible. The greatest factors which affect the design of an aircraft for the mission outlined in the Request for Proposal are cost, construction feasibility and effectiveness of the design. Other influencing factors are given by the constraints of the market, including a maximum takeoff and landing distance of 60 feet, storage capability in a container of size 5 ft. x 3 ft. x 2 ft., cargo packages of 2 inch and 4 inch cubes, and ability to turn with a radius no larger than 60 feet. Safety considerations such as flying at or below Mach one and controllability and maintainability of the aircraft must also be designed into the aircraft. Another influential factor is the efficiency of the aircraft which involves optimizations and tradeoffs of such factors as weight, lifting surface sizing, structural redundancy, and material costs.

The UK perspective on aviation security
93N21858
DONEY, RICHARD H. In FAA, Proceedings of the First International Symposium on Explosive Detection Technology p 19-20 (SEE N93-21856 07-03) Avail: CASI HC A01/MF A10 Department of Transport (England).
This presentation summary is divided into two parts. The first sets out the views of the UK government on aviation security in general and identifies the major thrusts of its policy. The second part describes how that perspective affects our attitude toward technology. It discusses a number of questions which will have to be satisfactorily answered before we can come to place reliance on explosive detection systems.

X. General
(more than one topic)

The final call: Why airline disasters continue to happen
91A34250
BARLAY, STEPHEN New York, Pantheon Books, 1991, 469 p.
Technological, economic, and political issues of commercial airline accidents are examined critically in a book for general readers. Detailed accounts of a large number of recent accidents are given, and the redundant and avoidable nature of most accidents is stressed. It is argued that stronger, more strictly enforced government regulations are needed to assure that cost-cutting measures and shortcuts do not have a negative effect on passenger safety.

Airline fitness for duty
91A48575
DENNIS, JERRY T. SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990. 12 p.
The use of risk management techniques as an adjunct to internal audit procedures is considered. The principles of risk management and its basic objective are reviewed, and management techniques oriented toward loss control and risk financing are outlined. Focus is placed on problem avoidance or elimination, rational acceptance of risk, separation in aviation, predictability, and duplication. The financial side of risk management including retention and transfer is analyzed, and management responsibility is outlined. It is recommended that all airlines should establish a professional safety manager and should support such flight safety functions as organization of accident prevention programs, collection/analysis/communication of safety information, technical and training safety coordination, and corporate emergency response procedures.

High-reliability through systems design and quality practices
91A54005
COX, TONY D. (General Electric Co., Aircraft Control Systems Dept., Binghamton, NY) IN: Institute of Environmental Sciences, Annual

Technical Meeting, 36th, New Orleans, LA, Apr. 23-27, 1990, Proceedings (A91-53976 23-38). Mount Prospect, IL, Institute of Environmental Sciences, 1990, p. 729-736.
A total quality approach has been implemented to ensure the reliability of the Low-Altitude Safety and Targeting Enhancement System designed for the A-10 aircraft. The approach emphasizes elements of teamwork, customer satisfaction, continuous improvement, robust designs, statistical thinking, management responsibility, and supplier integration. The key aspects of the program are discussed, and the effect of each implemented change or practice on reliability is assessed.

New way of flying (1990 Sir Charles Kingsford Smith Lecture)
92A33461
ZIEGLER, BERNARD (Airbus Industrie, Blagnac, France) IN: Australian aeronautics, 1989-90 (A92-33460 13-01). Mascot, Australia, Royal Aeronautical Society in Australia, 1991, p. 1-6.
Changes in aerospace technology and aviation in general are examined in this review of the requirements of air transportation. Specific attention is given to system cost and efficiency, passenger comfort, environmental constraints, and flight safety. Flight-control technology is shown to be advancing in the fields of electronics-assisted aerodynamic stability, and some examples of novel optronic and electronic systems are examined. The importance of effective flight scheduling and traffic control are mentioned, and the role of automatic systems in flight safety is analyzed. The role of automatic systems is characterized by the three subgroups of regulation, protection, and piloting. It is concluded that automatic systems can be incorporated to a greater degree in existing and developing aircraft, and that automation can improve many of the characteristics of air transport.

Canada making many changes in wake of Dryden crash report
92A33799
HUGHES, DAVID Aviation Week and Space Technology (ISSN 0005-2175), vol. 136, April 13, 1992, p. 34, 38.
The substantial changes being made to many air safety rules and procedures in Canada prompted by the 1989 Fokker F-28 accident at Dryden, Ontario are reviewed. Though the basic cause of the accident is directly attributed to snow/ice accumulation on the wings at takeoff, numerous other physical and human related factors are considered contributory to the accident. Specific operational recommendations considered or implemented include the stationing of inspectors to visually check aircraft wings prior to takeoff and radio warning to the pilot when safe deicing time limits are approaching. Other deficient areas to be addressed for correction include, maintenance operations, flight dispatch, training, and crash fire rescue teams.

Joint Aviation Authorities: Development of an international standard for safety regulation - The first steps are being taken by the JAA
92A43548
ARRIGONI, NICOLA Air & Space Law (ISSN 0927-3379), vol. 17, no. 3, June 1992, p. 130-132.
An overview is presented of the Joint Aviation Authorities (JAA), an organization of 19 European countries set up originally to establish joint certification requirements for the approval of aircraft design. JAA's work has broadened to include operations, airworthiness, noise, and flight crew licensing and certification.

The Eurofar program - An European overview on advanced VTOL civil transportation system
92A56299
RENAUD, J.; HUBER, H.; VENN, G. (Aerospatiale, Paris, France); (MBB GmbH, Ottobrunn, Germany); (Westland Helicopters, Ltd., Yeovil, United Kingdom) European Rotorcraft Forum, 17th, Berlin, Germany, Sept. 24-26, 1991, Paper. 10 p.
A summary is presented of several European overviews of three years of activity on the development of an advanced VTOL civil transportation system based on tilt-rotor (the Eurofar program). The vehicle requirements, the design process, the aircraft performance, and the technological innovations introduced during the development process are described. Special attention is given to the conditions for the acceptance of the tilt-rotor aircraft as a civil transportation vehicle, including the cost efficiency, the safety requirements, and the civil marketing issues involved in the transportation system introduction.

Composite profiles of helicopter mishaps at heliports and airports
92N28052
DZAMBA, L. D.; SAMPSON, W. T., III; ADAMS, R. J. Avail: CASI HC A05/MF A01 Systems Control Technology, Inc., Arlington, VA.
In a companion report entitled Analysis of Helicopter Mishaps at Heliports, Airports, and Unimproved Sites, DOT/FARD-90/8, National Transportation Safety Board and U.S. Army mishap reports were reviewed in order to determine the types of mishaps that have occurred at helicopter landing sites. Based upon these mishap records, helicopter composite mishap profiles were developed and are presented here in order to demonstrate the types of mishaps that have occurred at or near heliports and airports. Each

composite profile includes a description of the mishap, facility design factors which contributed to the mishap, nondesign-related contributing factors, and operational safety enhancements where appropriate. This document is intended to be a learning and teaching aid. The intended audience includes helicopter landing area designers, managers, and operators, as well as pilots. The goal of the report is to broaden awareness in the helicopter community in order to promote safety. This report is one in a series of three dealing with helicopter mishaps at landing sites. The other reports are: Analysis of Helicopter Mishaps at Heliports, Airports and Unimproved Sites, DOT/FARD-90/8, and Analysis of Helicopter Accident Risk Exposure near Heliports, Airports, and Unimproved Sites, DOT/FARD-90/9.

The designs for safety
93A18755
SOUTHCOMBE, G. (British Aerospace Commercial Aircraft, Ltd., Airbus Div., Bristol, United Kingdom) In: Key trends in human factors of aircraft maintenance; Proceedings of the Conference, London, United Kingdom, Oct. 31, 1991 (A93-18754 05-01). London, Royal Aeronautical Society, 1991, p. 2.1-2.7.
The paper outlines the numerous activities during the design process where human factors have some bearing on maintenance. Apart from the operational requirements the processes which are dictated by the airworthiness requirements are numerous and very demanding. Considerations to be taken into account are: latent failures, checkability, zonal safety, maintenance errors, software design errors, M.S.G. Analysis, and ETOPS requirements.

Aircraft accident report: Atlantic Southeast Airlines, Inc. Flight 2311, uncontrolled collision with terrain, an Embraer EMB-120, N270AS, Brunswick, Georgia, 5 April 1991
93N11471
Avail: CASI HC A04/MF A01 National Transportation Safety Board, Washington, DC.
This report explains the loss of control, in flight, and crash of Atlantic Southeast Airlines, Inc., Flight 2311, while the airplane was conducting a landing approach to runway 07 at the Glynco Jetport, Brunswick, Georgia. The safety issues discussed in the report include the certification and inspection requirements for the Hamilton Standard model 14RF and other model propeller systems, and the scheduling of reduced flightcrew rest periods that are beyond the intent of Federal regulations. Safety recommendations concerning these issues were made to the Federal Aviation Administration, Atlantic Southeast Airlines, Inc., and the Regional Airline Association.

Special investigation report: Piper Aircraft Corporation PA-46 Malibu/Mirage Accidents/ Incident, 31 May 1989 - 17 March 1991
93N15577 101 PAGES
Avail: CASI HC A06/MF A02
National Transportation Safety Board, Wash., DC.
Between May 31, 1989 and March 17, 1991, Piper PA-46 series Malibu and Mirage airplanes were involved in seven fatal accidents in the United States, Mexico, and Japan following departures from controlled flight. In addition to the seven accidents, another PA-46 airplane was involved in an incident that included substantial departures from controlled flight. In July 1990, following the fourth U.S. fatal accident, the Safety Board initiated a special investigation of the facts, conditions, and circumstances that led to the loss of the four Malibu/Mirage airplanes in the U.S. As other accidents occurred, they were included in the special investigation. Two of the seven fatal accidents occurred in Japan and Mexico, and the available information on the accidents was included in the special investigation. The special investigation included a review of the relevant design features of the Malibu and Mirage airplanes, including structural integrity, flight control systems, and operating limitations. The investigation also focused on the flight experience and training of the pilots of the airplanes, particularly as these factors related to flying the Malibu/Mirage airplanes in instrument meteorological conditions (IMC) at and above the freezing level with relatively sophisticated integrated flight guidance and control systems. As a consequence of the accidents, the Federal Aviation Administration, with the Safety Board's encouragement, conducted a special certification review of the airplanes, and the results are included in the report.

Aviation safety research at the National Institute for Aviation Research Wichita State University: A report to the FAA Technical Center
93N16455 120 PAGES
WENTZ, WILLIAM H.; HUTCHINSON, JOHN J.; ELLIS, DAVID R. Avail: CASI HC A06/MF A02 Wichita State Univ., KS.
Viewgraphs of a report presented to the FAA Technical Center on Aviation Safety Research is included. Topics covered include a review of 1990 contract tasks, report of 1989 contract, program plan for 1991 contract, follow-on items, and schedule for next program review. These projects covered topics such as scratch effects on fatigue of new alloys; survey of automated scanning and robotics system for aircraft inspection; crash analysis of aircraft seats; toward standardization of design procedures for rotor containment - turbine engine failure; and failure mechanisms in composite structures manufactured using contemporary techniques.

Combat and training aircraft class A mishaps in the Belgian Air Force 1970-1990
93N19677
BIESEMANS, I.; VANDENBOSCH, P. In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 12 p (SEE N93-19653 06-03) Avail: CASI HC A03/MF A04 Belgian Air Force, Brussels.
The authors reviewed the files of 114 combat and training aircraft class A mishaps in the Belgian Air Force during the period from 1970-1990 with the cooperation of the office of the 'Belgian Accident Investigation Board'. They searched for the causes of these accidents, i.e., Operational related, Logistics related and environmental factors, as well as contributory factors which played a role in these mishaps. While considering the causes of these accidents, they found that 71 percent were operational related, 22 percent logistics related and 7 percent were caused by environmental factors, such as birdstrike, foreign object damage (FOD) to the engine and unknown. From the 23 training aircraft lost, only one single aircraft crash was caused by a technical failure. The overall attrition rate for the period was 1.08/10.000 Aircraft Hours (C) hours, being 1.43/10.000 for combat C and 0.55/10.000 for training C. The introduction of the agile F-16 fighter in the early 1980's, coinciding with a serious decrease of the annual flying time and an undermanning in terms of experienced pilots in the squadrons was most probably responsible for the negative trend in the evolution of the annual attrition rate until 1989. Although the Belgian Air Force remained two years without a major accident, it must resolutely continue its effort in the field of accident prevention. By extending the time spent by aircrews in an operational squadron, supervised by experienced pilots, the Belgian Air Force should be able to reduce class A mishaps in the future.

Royal Naval helicopter ditching experience
93N19684
STEELE-PERKINS, A. P.; JOHNSTON, R. P.; BARTON, P. (Royal Naval Air Medical School, Hillhead , England); (Royal Naval Air Medical School, Hillhead, England) In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 6 p (SEE N93-19653 06-03) Avail: CASI HC A02/MF A04 Naval Aviation HQ, Yeovil (England).
Controlled or uncontrolled water entry (ditching) by Royal Naval helicopters continues to occur and is a significant loss of resource - both human and aircraft. Accidents over a ten year period (1982-1991) are listed, causation and trends analyzed, and preventative measures put forward, as are initiatives to increase post ditching survivability.

The role of university research in aviation safety and competitiveness: Testimony to the US Congress
93N22379
WENTZ, WILLIAM H., JR. Avail: CASI HC A03/MF A01 Wichita State Univ., KS.
Presented here are the written and oral testimony of the Executive Director of the National Institute for Aviation Research as it was given before the U.S. House of Representatives Committee on Science, Space, and Technology, Subcommittee on Technology and Competitiveness. Reasons for, and returns on, investment in university-based aviation research are discussed. Some specific activities at Wichita State University that were funded by the Federal Aviation Administration (FAA) include research on crashworthiness, stall-spin safety, electro-impulse-de-icing, the reliability of computer software used in aircraft, structural integrity, aging aircraft, human factors, advanced cockpits, propulsion and fuel systems, atmospheric hazards, flight safety, and other mostly safety-related aviation subjects. Wichita State University has conducted a number of workshops and seminars with the FAA, established a cooperative educational program with the FAA Technical Center, and participated in their Summer Faculty Research program. Barriers to innovation and competitiveness, and examples of successful research, development, and use of new information and technology are also given, as well as suggestions for improving aviation safety and competitiveness.

Aircraft accident report: United Airlines flight 585, Boeing 737-291, N999UA, uncontrolled collision with terrain for undetermined reasons, 4 miles south of Colorado Springs Municipal Airport, Colorado Springs, Colorado, 3 March 1991
93N23191 168 PAGES
Avail: CASI HC A08/MF A02
National Transportation Safety Board, Wash., DC.
This report documents the inexplicable loss of United Airlines flight 585, a Boeing 737-291, after the airplane had completed its turn onto the final approach course to runway 35 at Colorado Springs Municipal Airport, Colorado Springs, Colorado, on 3 Mar. 1991. The safety issues discussed in the report are the potential meteorological hazards to airplanes in the area of Colorado Springs, potential airplane or systems anomalies that could have precipitated a loss of control, and the design of the main rudder power control unit servo valve that could present significant flight control difficulties under certain circumstances. Recommendations concerning these issues were addressed to the Federal Aviation Administration.

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Contains a bibliography of publications held by NASA on aspects of aircraft flight safety. The abstracts are listed by the following topics: human errors, injury reduction, engines, structures and materials, aircraft ageing, fire, adverse weather, aircraft maintenance, future safety requirements, and miscellaneous items. The bibliography was compiled originally as a contribution to a conference on aircraft flight safety, sponsored jointly by AGARD and the Russian International Integration Association, which was held in Russia in August/September 1993.

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