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MEMORANDUM

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SUBJECT: DTFA01-87-P-0812: Addendum to "A Review of the FAA Aeromedical Research Program"  
Deliverable: Appendix to Phase II Report

This Appendix supplements the Phase II report to the Federal Aviation Administration (FAA) entitled, "A Review of the FAA Aeromedical Research Program", prepared by the Life Sciences Research Office (LSRO) of the Federation of American Societies for Experimental Biology (FASEB) (Leukroth et al., 1987). It details suggested procedures for improving the scope, content, and effectiveness of FAA's Aeromedical Research Program (ARP) in terms of planning and management. The findings and suggestions presented are based on the discussions of the LSRO ad hoc Working Group during its meeting at the Civil Aeromedical Institute in December 1986 (see Talbot et al., 1987) and on follow-up interactions between LSRO and the Working Group members. This addendum is cross-referenced to specific pages in the Phases I and II reports that detail the findings and suggestions of the Working Group. In accordance with the Statement of Work of FAA Purchase Order No. DTFA01-87-P-08012, LSRO has identified the following items for emphasis in planning and managing the FAA Aeromedical Research Program. The addendum was prepared by Richard M. Leukroth, Jr., M.S., Staff Scientist and John M. Talbot, M.D., Senior Medical Consultant.
1. **Initiation, Review, and Approval of Research Projects**

As noted on page 4 of the Phase I report, the Office of Aviation Medicine (OAM) conducts an annual solicitation of aeromedical research requirements throughout the Agency. However, at present there is a general lack of appreciation within segments of FAA for the life sciences and the resources of the ARP available through OAM. This has led to a segmentation of the ARP rather than its integration into FAA program planning and forecasting. A possible impediment to integration is the absence of a common terminology to permit potential users of the ARP the opportunity for early identification of information needs and services that could benefit from contributions of the applied life sciences. If the OAM is to be perceived as the FAA's primary resource in the life sciences, then the full value of ARP products must be recognized as more than medical evaluation and certification services.

To improve procedures for initiation, review, and approval of ARP research projects, OAM must take additional measures to inform the FAA user community about existing ARP research requirements solicitation channels; update the Medical Research Program Guides; and, be permitted a more active role in the Aviation Standards Requirements Review Process (AVS/RRP) where greater consideration should be given to the biomedical and behavioral problems of the human operator.

a. The annual, formal solicitation of aeromedical research requirements should be (and in some cases, is) augmented by a continuous informal effort to identify new or to modify extant requirements. Position descriptions and staff authorizations at both headquarters and center levels should reflect this added management responsibility.

ARP managers involved in the research requirements process should assist FAA operational and managerial staff in conceiving and promulgating research requirements. An important aspect of this process is to participate in a variety of activities that will promote a better understanding about the relevance of the applied life sciences as they influence/impact other programs and Research, Engineering and Development (R,E&D) projects at FAA.

**SUGGESTION:** The OAM should develop an annual, 1-day workshop program to outline research requirements procedures and discuss ARP interface opportunities within the Agency. Attendance at the workshop would include representatives from FAA offices that may generate research requirements and invited FAA program managers as well as contributors from other government agencies, regional offices, and FAA research facilities.
To improve the effectiveness of the process of initiation, review, and approval of research projects, ARP managers should take every opportunity to participate in meetings where FAA operational problems and plans are identified and discussed and to interact continually with the users of ARP products. While the scope of the ARP is sufficiently broad to embrace numerous programs at multiple levels, this suggestion may be difficult to accomplish as the complement of research staff at OAM headquarters is currently insufficient to carry out this suggestion effectively.

b. On page 6 of the Phase II report, the Medical Research Program Guides (MRPG) (Federal Aviation Administration, 1974) are described as an important mechanism for evaluation and approval of ARP research proposals. However, review of the MRPG indicates they are not current.

SUGGESTION: The MRPG should be revised to: (1) reflect ARP objectives that correspond to the National Airspace System (NAS) Plan; (2) reflect the present organizational structure of OAM and other FAA activities involved; (3) identify available ARP resources; and, (4) specify present ARP task approval policy. In addition, OAM should consider the advantages of outside peer review of ARP task proposals as part of ARP management. Such an activity could involve an oversight advisory panel of, for example, six experts with a 2-year term (see Phase II report, page 23).

c. In discussions with FAA headquarters personnel, LSRO staff were informed that the OAM participates infrequently in the AVS/RRP (see Phase II report, page 7). The written criteria for review of the engineering programs R,E&D proposals that are of primary interest to AVS are not appropriate to review proposals for research on aspects of the life sciences critical to the ARP or for giving consideration to the life sciences in general.

SUGGESTION: Appropriate life sciences review criteria should be incorporated into the AVS/RRP guidelines and the membership of the AVS Research Review Group should include OAM staff scientists. Such a team approach should provide an ongoing exchange of trouble forecasting/problem solving that will encourage information exchange and the development of ARP research requirements. This concept is also supported by the organizational location of OAM and the ARP staff as a part of AVS and the potential importance of the AVS/RRP for ARP proposals. The AVS Research Review Group should be a forum for interaction between various offices such as OAM and major FAA R,E&D initiatives.
2. Management and Administration of Life Sciences Research at FAA

LSRO considers the management procedures for the ARP as outlined in the Phase II report (see pages 3 and 4) to be conceptually sound with the exception of staff allocations to operate the plan. Furthermore, the organizational location of the ARP within the OAM as administered under the authority delegated to the Federal Air Surgeon (FAS) is appropriate to an efficient aeromedical program at FAA. Adequate management of ARP life sciences research requires a headquarters staff of scientific experts. However, the effective management and monitoring of life sciences research at FAA are seriously compromised.

a. It is unrealistic to expect the OAM staff scientists (FTE = 2.0) to manage the ARP, participate in service-oriented tasks, crisis interventions, and simultaneously function as principal investigators for numerous research tasks, and as contracting officer's technical representatives to oversee Agency interests in the promulgation and conduct of contractual scientific studies.

SUGGESTION: The FAA policy that headquarters-level staff scientists be liaison representatives with other activities at FAA and function as research project principal investigators (in addition to their full workload as ARP managers) indicates that staff augmentation is mandatory. If this is not feasible, the functions of OAM staff scientists should be ranked according to priority, with either higher or lower priority functions delegated to contractual support efforts as appropriate. Alternatively, lower priority functions could be transferred to a research facility such as the Civil Aeromedical Institute (CAMI).

b. The viability of the ARP should be the main determinant of its organizational relationship within the Agency. Ideally, management of the ARP at FAA headquarters should be situated where the most favorable climate prevails to interface the ARP with R,E&D support including program review, funding, and management. In the opinion of the LSRO ad hoc Working Group, (see Phase II report), FAA would clearly benefit from closer identity of the ARP with a higher administrative level active in well-defined, long-range R,E&D objectives. For various reasons FAA has not considered it necessary to establish a separate staff for consolidating its R,E&D management. Consequently, opportunities for improving this organizational assignment of the ARP management at FAA headquarters were not identified in this study. Integration of life sciences research products should be given higher priority in the R,E&D projects of AVS and other FAA engineering initiatives.

SUGGESTION: This should be the subject of periodic internal review at FAA.
3. **ARP-NAS Plan Interaction**

There is general agreement in FAA that implementation of the NAS Plan and the FAA objectives of increasing productivity while reducing work force numbers will affect both airmen and ground controllers in several ways that will require ARP efforts. Criteria for selection, training, and performance measurement will need revision, backed by new human resources and aeromedical research data related to increasing systems automation. Job satisfaction, productivity, motivation, and coping with job-related stress will require careful study and management. It is imperative that the scientific database for responding to the associated human operator problems stay ahead of the systems automation.

**SUGGESTION:** The Human Resources Research Branch of CAMI should undertake the activities to develop new criteria for selection, training, and performance evaluation of Air Traffic Control Specialist (ATCS) personnel and the psychophysiological aspects of aircrew and ground controller issues resulting from new systems that feature increased sophistication and automation (see Phase I report, page 18). Examples of applicable ongoing research include items 8 and 9 of Table 1 and items 3 and 4 of Table 4 (see Phase I report, pages A-2 and A-5). Liaison with laboratories conducting parallel research of interest to aeromedical and human factors aspects of the NAS Plan should be activated and/or maintained. Examples include the NASA-Ames Research Center, California, and at Wright-Patterson AFB, Ohio, the Harry G. Armstrong Aerospace Medical Research Laboratory, the Flight Dynamics Laboratory, and the Avionics Laboratory (see Phase I, pages 11-12). Other parallel programs include the Centers for Disease Control Injury Prevention Program (1987 Conference on Injury in America; Reese and Mills, 1986) and the NIOSH employee-related stress program (Hurrell, 1988; Murphy, 1984).

As the NAS plan evolves, opportunity should be provided to identify additional research requirements which could be integrated into the ARP. The activities of the National Airspace Review Enhancement Committee (NAREC) are an important element of this process. Several NAREC subcommittees and working groups have already identified human factors problems related to air traffic controller response and perception of airspace capacity when employing newly installed NAS equipment. There is need for the NAREC to establish a subcommittee dedicated to all aspects of the ARP to advise the FAA in aeromedicine and related life sciences which affect the evolving NAS.
Appendix to Phase II Report
Page 6

4. Topics for Interactive Workshops to Improve ARP Planning

FAA should sponsor a series of interactive workshops, symposia, and conferences involving multidisciplinary groups from within FAA. Invitees should include NAS and Advanced Automation System (AAS) managers and project leaders, aeromedical and human factors scientists including those from various FAA research centers (i.e., Technical Center, Transportation Systems Center, and the Civil Aeromedical Institute), and selected leading investigators from the Department of Defense, the National Aeronautics and Space Administration, and other federal agencies, academia, and industry. The objective of such activities would be to develop an integrated aeromedical research program plan to address not only scientific and technical program content, but also a coordinated FAA investment strategy for its execution. In addition, such activities would enrich the ARP by increasing awareness and collaboration with leading investigators outside of FAA who are advancing knowledge and technology pertinent to biomedical and behavioral problems of human operators in civil aviation. Further, such activities would also upgrade communications and awareness among all FAA activities involved in developing the NAS.

SUGGESTED WORKSHOP/SYMPHOSIA TOPICS:

- Methods to improve the effectiveness of Aviation Medical Examiner (AME) investigations of aircraft accidents.
- Group structure and cohesiveness as related to the effects of the NAS on integrated performance of ATCS, ATCS-pilot interface, and coordinating aircrew operations with advanced automation systems and advanced flight deck control and data systems.
- Selection criteria, performance motivation, job-satisfaction, productivity, and job-related stress in the future FAA workforce.
- NAS Plan interface workshop to communicate life sciences R,E&D needs within FAA and assure integration with biomedical and behavioral science products of the ARP.
- Scientific evaluation of aeromedical, behavioral, and human factors issues associated with the integration of computer-managed, highly automated, dynamic systems with individual or clusters of human operators on the ground or aloft. Appropriate agenda items would include:
  - Man-machine interface (MMI) problems associated with AAS and research needs
  - Perceptual problems of wide-scale CRT technology
Appendix to Phase II Report
Page 7

- Comprehension, situational awareness, and performance of pilots and ATCS using symbolic data presentations

- Information overload, MMI, and the optimum division of functions between the human operator and the machine

- Design modeling of multinodal command and control networks including operator work stations (see Phase I report, page 12)

- Optimal dialogue requirements between human operators and the "electronic copilot", the flight environment, and the aircraft subsystems (see Phase I report, page 12, item 4)

- Use of evolving three dimensional, virtual image presentation (see Phase I report, page 12, item 5)

- Workloads on single pilots flying IFR, and improved instrumentation, controls, and layout in single pilot airplanes

- Enhanced databases for identifying emerging medical and behavioral problems of flight crew personnel related to changes in equipment, schedules, and procedures

- Use of physical anthropometry to update standards of body dimensions, performance capabilities, and tolerances for general aviation pilots and airliner crew members.

Methods to enhance interaction with extra-FAA research and development scientists and laboratories. Suggested agenda items might include:

- Adjunct professorships for ARP scientists at universities and colleges

- Postdoctoral positions for visiting scientists at CAMI and other FAA activities

- Collaborative research with investigators at universities, other federal laboratories, and industry

- Augmenting of contractual R,E&D.
5. Procedures for Interpreting and Integrating Existing Biomedical Information for Use by Operational and Regulatory Agency Personnel

Existing biomedical information is defined as all published scientific and technical information that is pertinent to FAA's interests in the broad fields of aviation medicine and psychology including engineering psychology (human factors engineering). This information is available in the published scientific literature and internal governmental and contractor research and development reports.

There is a need for: (1) an information system to keep FAA staff informed about the state-of-the-art in applicable biomedical sciences; (2) a dissemination of life sciences information in a style suitable for use by nonbiomedical FAA regulators, program managers, and project scientists; (3) a systematic means of updating biomedical data banks and other sources of life sciences information for use within FAA; (4) a system of R&E&D management that requires timely ARP input to major FAA R&E&D initiatives at all decision-making levels; and, (5) a means of authorizing and stimulating wider participation by ARP scientists in extramural scientific activities.

SUGGESTION:

- Generate written topical reviews in the form of monographs, collections of abstracts, and annotated bibliographies. When intramural resources are not available for this, commission the reviews by outside experts or organizations familiar with all aspects of analysis and evaluation of scientific information and the peer review process (American Chemical Society, 1985; Fisher, 1982; Jones et al., 1985; Siu et al., 1977).

- Sponsor seminars, symposia, workshops, and conferences on selected topics (see section 4, preceding).

- Develop and/or revise compendia of biomedical information in handbook or manual style such as the triservice "Human Engineering Guide to Equipment Design" (Morgan et al., 1963); "Handbook of Instructions for Aircraft Design" (Air Force Systems Command, 1960); "Design Handbook 2-2, Crew Stations and Passenger Accommodations" (Air Force Systems Command, 1969); and "Psychophysical Criteria for Visual Simulation Systems" (Kraft et al., 1980).
Explore and implement methods for enhancing dissemination of ARP data into the peer-reviewed scientific literature and the general public via mechanisms such as FAA-sponsored symposia at national scientific meetings and increased publication of manuscripts based on ARP studies. Opportunities should be provided for ARP scientists to join major scientific societies and participate in associated programs. FAA-sponsored travel support should be provided.

Both prescheduled and ad hoc ARP briefings should be planned for key FAA executives, program managers, and project leaders involved with the NAS Plan. Whenever feasible, these should be coupled with topical ARP summary papers targeted to selected R,E,D initiatives in the NAS Plan.

Procure the services of intra- or extramural science and technical writers to translate highly complex biomedical scientific information into a format suitable for use by FAA personnel who are not versed in the biological sciences. This is already done by FAA in instances where complex engineering reports and directives are summarized for administrative and regulatory purposes.

Develop means to include ARP representation and input in all R,E,D initiatives that impact the human operator in civil aviation. Such representation should commence at the stage of exploratory development and continue through systems acquisition and deployment.

6. **Rationale and Procedures for Generating and Applying Biomedical Information to Operational and Regulatory Issues of Concern to FAA**

To meet its responsibilities for airworthiness of aircraft, reliable and effective performance of aviators and ground controllers, protection of aircrews and passengers, and the efficient and safe operation of the civil aviation system, FAA relies not only upon extant knowledge and experience, but also must seek to improve all applicable scientific databases including those of the life sciences. A major driving force for enhancing and integrating the technology base at FAA is the NAS Plan (Federal Aviation Administration, 1981). The primary objective of the NAS is to upgrade the efficiency, productivity, and safety of the civil aviation system. At stake is the overwhelming issue of flight safety in the face of an expanding industry that operates increasingly sophisticated aircraft in highly congested airspace and terminal facilities.
The Agency has been criticized when major initiatives fall short of anticipated goals because the human element was insufficiently considered during development. It is suggested that application of available or specifically derived new biomedical and human factors data for use in the technical decision-making process be strengthened. Both long-standing and newly emerging biomedical, psychological, and bioengineering problems affecting the performance, safety, and well-being of key operational personnel in civil aviation as well as the traveling public were documented in the Phase I report (e.g., pages 9-11, 16-25). Suggestions for resolving the specified problems are presented on pages 16-25 in the Phase I report and for correcting inadequacies of the ARP (as perceived by the ad hoc Working Group) and improving its corporate management, on pages 19-26 of the Phase II report.

The rationale for maintaining a program of research and development in the life sciences is an essential part of FAA's mission of maintaining and improving an efficient and safe civil aviation system. It is important to impress upon the user community the contributions in the area of the life sciences. The ARP is the vital component of the OAM that bridges the gap between basic and applied knowledge in the life sciences.
LITERATURE CITED


