U.S. Department of
Federal Aviation Administration

Aeromedical Research Resume
Research Project Initiative Subtask for FY01

1. Title:	***2. Sponsoring Organization/Focal Point:***	***3. Originator Name, Organization***
Cabin Safety Research: Aircraft Systems, Emergency Procedures, and Survival Equipment	AIR-3; Nancy C. Lane AAM-1; Jon L. Jordan M.D.	Van Gowdy AAM-630 Civil Aeromedical Institute (405) 954-5510
		4. Origination Date: August 10, 2000 ***Start Date***: October 1, 2000
5. Parent RPI Number:	***6. Subtask Number:***	***7. Completion Date:***
2	AM-B-00-PRS-93	September 30, 2003
8. Parent MNS:	***9. RPD Manager Name, Organization, Phone:***	
Aeromedical Research (159)	James E. Whinnery Ph.D., M.D. AAM-600, FAA CAMI (405) 954-4808	

10. Research Objective(s):

This task is comprised of two distinct research activities performed by two teams: 1) cabin safety research and 2) environmental physiology research. The objectives of the research performed by the teams under this task are to provide state-of-the-art information, procedures, and equipment designed to enhance survivability of passengers and crewmembers during and after emergency events, such as in-flight fires, aborted takeoffs, and crash landings over land or water. Information, procedures, and equipment will also be developed and tested to protect against the effects of hypoxia and reduced atmospheric pressure at altitude. Hazardous environmental conditions that could develop for all aircraft occupants that are associated with aviation emergency situations will also be investigated.

11. Technical Summary:

Research designs typically employing human subjects will determine the suitability of aircraft cabin designs, emergency equipment and procedures, and survival systems, as related to emergency events. Evacuation studies will assess proposed changes to aircraft system designs, aircraft interior configurations, emergency procedures, crewmember training, and passenger education techniques. Technological advancements in emergency equipment and survival systems will be tested, as appropriate, in aircraft cabin simulators, water survival tank exposures, and/or field environments. The goal of this research is to enhance post-emergency event survivability of passengers and crewmembers.

Research will be conducted by cabin safety scientists to support development and enhancement of software and parameter data sets to analytically simulate emergency evacuations of aircraft cabins. The goal of this cabin safety research is to develop data for use by analytical tools to ultimately replace the need for operational testing with human subjects and enable reconstructions of aircraft accidents.

Applied research will be conducted by environmental physiologists to evaluate the performance requirements and function of protective breathing systems. These include flight deck oxygen masks and related support equipment along with other crew/passenger protective devices. The exact nature of each test or group of tests is dictated by the nature of the device being tested and/or developed and its intended use.

12. Resources Requirements:	FY01	FY02	FY03
FAA Staff Years	**12**	**12**	**12**

13. Description of Work:

(1) Brief Background:

Cabin Safety Research. Applied research will be conducted on the suitability of aircraft systems designs, aircraft interior configurations and furnishings, emergency procedures, and survival equipment for use within the civil aviation system. Typical protocols will involve human subjects engaged in simulated emergency egress from aircraft or aircraft simulators. Variables of interest include interior cabin arrangements and fixtures, emergency procedures utilized by flight attendants and passengers, and the impact of survival equipment on egress and survivability. Comparisons of such effects in both narrow and wide body aircraft designs are planned. Studies of the efficacy of survival equipment outside the aircraft will also be conducted, using such facilities as the CAMI water survival tank, and/or field environments, to determine factors that influence performance of survival equipment such as lifevests, infant flotation cots, and slide/rafts. Testing of new equipment designs or proposed improvements to such equipment will be conducted as appropriate. The goal is to understand the best way to maximize the integration of the aircraft / survival equipment flight attendant / passenger into the most functional survival system possible when an emergency arises, while simultaneously maximizing the function of each of these components individually. Software and parameter data sets will be developed to model the emergency evacuation of passenger aircraft cabins.

Environmental Physiology Research. Aspects of protective breathing equipment previously investigated have generated follow-on research questions. Previously, an inconsistency in the requirements for the use of supplementary oxygen was investigated, and recommendations were offered to resolve these differences. Recommendations appropriate for an older, perhaps less healthy population (but still a large part of the flying population), will be studied and developed during the period of FY-00-01. Approved allergy medications, both over-the-counter and prescription, may have significant impacts on pilot performance particularly when used in combination with the reduced pressure and oxygen available at altitude. Cooperative Research and Development Agreements (CRDAs) with manufacturers of emergency equipment will be pursued. These CRDAs will permit the facilities and professional expertise of the laboratory to be applied to the development and distribution of improved emergency equipment and survival technology. Research activities have been recommended to address the potential threats of chemical or biological weapons and the development of protective breathing devices to reduce the risks of exposure to such agents.

(2) Statement of Work:

Cabin Safety Research

Aircraft Evacuation Evaluations: Studies of aircraft evacuations will be performed to assess the impact of changes in the design and/or implementation of aircraft systems, interiors, emergency equipment, and emergency procedures. Such studies will typically employ human subjects, who will be required to navigate interior aircraft configurations/obstacles, egress through overwing and floor-level exits, and deplane onto emergency evacuation slides or other descent assisting means. Studies involving the wide body aircraft cabin simulator will employ protocols designed to assess the impact of multiple aisles and variable exit configurations. Cabin crew procedures related to attaining the most effective and efficient evacuations will be investigated, as will passenger exit selection when several exits are available. Additional evacuation issues and protocols are under discussion with research sponsors.

Survival Equipment Evaluations: Studies of water survival equipment and techniques for its use will continue. These studies will also typically use human subjects to assess the performance of lifevests, infant flotation cots, and slide/rafts. State-of-the-art technological advancements also require reassessment of the relative safety benefits that such equipment provides. Current efforts assess innovative approaches in lifevest technology and flotation seat cushion usage. Assessments continue of emergency survival kit contents, emergency locator technologies, training of flight attendants in techniques employed by rescue personnel, and advisability of repositioning a slide/raft from an inoperative exit to a functional exit during an emergency water evacuation. Longer-term efforts are planned to derive a set of recommended procedures for use of survival equipment aboard aircraft and after emergency landings.

Computerized Cabin Evacuation Model Development: Parameter data sets will be developed that are suitable for use in simulating evacuation of wide-body aircraft. Experiments necessary to derive these data sets and to validate the results will be performed. Parameter data sets for new, perhaps radically different passenger cabin configurations (such as the blended wing body aircraft currently being developed by Boeing) will also be forthcoming as design developments allow.

Environmental Physiology Research

Improved Oxygen Mask Designs: Previous research at CAMI has identified a number of comfort and convenience factors that serve as dis-incentives to oxygen mask usage by pilots. In addition, manufacturers of protective breathing systems are developing new equipment designs that will meet the challenges of future aircraft operations. Through Cooperative Research and Development Agreements (CRDAs), CAMI's experimental facilities, and professional expertise related to physiological requirements for oxygen systems, and comfort and convenience factors of mask design, will all be made available to the manufacturers of these type of systems.

Use of Supplemental Oxygen: Studies of the optimal altitude, below 15,000 feet, to initiate use of supplemental oxygen concluded in FY-97. In FY-01 the influence of pilot age on the need for supplemental oxygen will be reviewed. Another study will address the impact on pilot performance that common OTC medications (such as anti-histamines) have when used in the reduced oxygen and pressure found at altitude.

14. Intended End Products / Deliverables:

The results of this research program will take several forms: 1) direct reporting of research results to the requesting organization, 2) publication of the research findings in Office of Aviation Medicine Reports and in the open scientific literature, 3) dissemination of findings to associated regulatory agencies on request, 4) presentation of findings at scientific and aviation conferences, 5) dissemination of findings through hands-on activities for aviation industry personnel at Cabin Safety Workshops held at CAMI and at other aviation forums, as appropriate, 6) dissemination of findings through on-site consultations at airframe manufacturers, airlines, and emergency equipment manufacturers 7) publication of materials for public education programs, and 8) maintenance of an on-site cabin safety database.

15. Schedule/Milestones:

Detailed research protocol content is updated with the sponsor quarterly, and all protocols utilizing human subjects are subject to CAMI Institutional Review Board review.

		FY01	*FY02*	*FY03*
Cabin Safety Research				
	Emergency Evacuation Evaluations:			
a)	Publication of findings on bioaeronautical effects in evacuation studies	Q1		
b)	Conduct of follow-up research on passenger management at overwing exit	Q1		
c)	Analysis of passenger timing techniques for use in evacuation studies	Q2		
d)	Publication of findings on passenger management techniques at overwing exit	Q3		
e)	Publication of findings from interview study of child restraint usage	Q4		
f)	Analysis of parameters for studies of wide-body exit distribution and access		Q1	
g)	Analysis of passenger management techniques for wide-body evacuation study topics		Q2	
h)	Study of wide-body aircraft factors in passenger selection of exit to use		Q3	
k)	Publication of findings from wide-body exit distribution and access study		Q4	
j)	Study of passenger management effects on selection of wide-body exits			Q1
	Cabin Evacuation Modeling			
a)	Parameter data sets for wide body aircraft			Q2
b)	Parameter data sets for passenger exit selection			Q2
Environmental Physiology Research				
a)	Performance Standard: Crew Protective Breathing and Vision Equipment	Q3		
b)	Review of oxygen supplementation requirements in older pilots		Q2	
c)	Initial assessment of medications used at altitude		Q4	
d)	Development of new technology through CRDAs - Improved mask designs	Continuous	Continuous	Continuous
e)	Assessments and studies of equipment/procedures impacted by environmental hazards or respiratory physiological limitations		Continuous	Continuous

16. Procurement Strategy/Acquisition Approach/Technology Transfer:

CRDAs with manufacturers of emergency equipment are being pursued. These CRDAs will make available to the manufacturers CAMI's unique facilities and professional expertise in aircraft evacuation performance and aviation physiology. A CRDA on escape path marking systems is currently being investigated with the system manufacturer, and the CRDA on oxygen mask design will provide insight into the most effective means of safe and efficient oxygen delivery on the flight deck.

Equipment purchases above $5K per item may be required to continue development of the B-747 wide-body evacuation simulator to support the defined evacuation projects. Significant in-house design and development of simulator subsystem improvements are underway and identification of specific hardware to implement these improvements remains. Contracting for outside expertise may also be required for some tasks.

17. Justification/History:

This research is responsive to the needs of the primary sponsor (Aircraft Certification Service). Additionally, this research is consistent with the FY 2001 Research, Engineering, and Development (RE&D) Plan, and directly supports the Bioaeronautics portion of the National Plan for Civil Aviation Human Factors.

18. Issues:

Human subjects may be employed in this research. Any protocols calling for human subjects shall be approved by an Institutional Review Board (IRB) either within OAM or at the site of the performing contractor. Such review and approval will ensure strict adherence with all federal guidelines.

19. Transition Strategy:

The findings of this research project will include the basis for changes to Federal Aviation Regulations (FAR), Technical Standard Orders (TSO), Advisory Circulars (AC), airline training programs, and public educational materials. Publication of the results in Office of Aviation Medicine Reports and/or in the open scientific and technical literature provide a mechanism for formal dissemination of such findings; specific requests from Aircraft Certification, Flight Standards, etc., will be honored with detailed inputs for FAR's, TSO's, and AC's. Participation in the Aviation Rulemaking Advisory Committee's (ARAC) Emergency Evacuation Performance Standards Working Group assures coordinated input into the rulemaking process; similar coordination is achieved with regular participation in Society of Automotive Engineer (SAE) technical committees, as appropriate. Liaisons with the military services extend the relevance of research results. The official publications will also be available to other interested FAA offices, such as the Office of Aviation Safety Analysis, where such results are prepared for public dissemination, as well as airlines and other interested aviation safety groups, nationally and internationally. In addition, such results will be presented through CAMI activities such as the Cabin Safety Workshops, where industry participants are immersed in hands-on activities involving state-of-the-art emergency equipment and procedures and Aeromedical Examiner (AME) courses.

20. Impact of Funding Deferral:

Inadequate funding of this project will seriously impair the scientific basis for FAA regulations regarding emergency aircraft evacuation, survival equipment, emergency procedures and breathing equipment for use at altitude.

Funding deficiencies or deferrals related to improvement of the wide-body evacuation simulator could seriously delay or prevent accomplishment of defined wide-body aircraft evacuation studies.

21. R&D Teaming Arrangements:

CAMI personnel are involved in a wide array of technical and administrative alliances such as the Aviation Rulemaking Advisory Committee's Emergency Evacuation Performance Standards Working Group, the Society of Automotive Engineers (SAE) S-9 (Cabin Safety Provisions), A-10 (Breathing Equipment), and A-20C (Aircraft Interior Lighting) Technical Committees, EuroCAE WG-36 committee, and the Southern California Safety Institute, as well as direct consultations with airlines, airframe manufacturers, aviation equipment manufacturers, and aviation industry operational personnel.

An International Cabin Safety Research Technical Group has been implemented to coordinate worldwide research on aircraft cabin safety. In addition to the Protection and Survival Laboratory staff, members include representatives from the FAA Aircraft Certification Service, the FAA Technical Center, the Joint Aviation Authorities, the British Civil Aviation Authority, Transport Canada and the French Aviation Authority. The goal of this Group is to provide a multidisciplinary perspective to guide strategic research planning, and to insure that cabin safety research conducted throughout the world is coordinated and responsive to the needs of aviation authorities and industry.

As part of an international collaboration, a joint research effort with the Cranfield Institute of Technology is devoted to understanding the role of flight attendant behavior, competitive passenger behavior, and egress route in emergency evacuations.

22. Special Facility Requirements:

Activities conducted under this task generally require specialized research environments such as those operated by the Protection and Survival Laboratory at CAMI. At present, evacuation activities must be conducted within the Aircraft Cabin Evacuation Facility (ACEF), a narrow body aircraft cabin simulator. A wide-body aircraft has been purchased and it will become operational as an evacuation simulator as soon as adequate funds become available. A new research altitude chamber has restored altitude chamber research capability previously lacking. These enhancements in infrastructure have provided a significant expansion of the research avenues that can be pursued. A water survival tank is also operational at CAMI and is devoted to questions associated with water survival equipment and procedures.

23. Approvals (Signature Authority):			***Performing Organization***
		Name:	William E. Collins, Ph.D.
Nancy C. Lane, AIR-3	***Date***	***Title:***	Director, FAA Civil Aeromedical Institute, AAM-3
Jon L. Jordan, M.D., AAM-1	***Date***	***Date:***	