MODIFICATION 0003
INTERAGENCY AGREEMENT DTFA01-96-Z-02035
BETWEEN THE
FEDERAL AVIATION ADMINISTRATION
AND THE
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
AERONAUTICAL SAFETY AND HUMAN FACTORS

PURPOSE: The purpose of this modification No. 0003 to the referenced agreement is to revise tasks for FY99, add a new task (Task 9), add FY 1999 funding in the amount of $917,000 for the tasks, and to make other administrative changes.

ARTICLE II – STATEMENT OF WORK

Section II. Specific Tasks are revised as follows:

Task 1: Automated Performance Measuring System (APMS). FAA Technical Point of Contact is Eleana Edens, 202-267-7867.

- No additional funding for FY 1999

Task 2: Strategies to Mitigate Crew Error; Integrating CRM Usability into Operating Documents; Realistic Radio Communications Simulation. FAA Technical Point of Contact is Eleana Edens, 202-267-7867. NASA-Ames Project Managers are Key Dismukes, 650-604-0150 and Barbara Kanki, 650-604-5785. NASA shall accomplish the following:

- Strategies to Mitigate Crew Error. Interruptions and distractions are two of the most common causes of pilot error, and lapses of attention have contributed to many accidents. To get at this problem, NASA will combine several research approaches: (1) analysis of ASRS incident data and NTSB accident reports, (2) knowledge elicitation from subject-matter experts such as check pilots and instructors, and (3) experimental studies of the cognitive processes involved in concurrent tasks such as those that frequently occur together in the cockpit.

    - Products. (1) Characterization of types of interruption, types of situations conducive to distraction, and factors that impede recovery from distraction; (2) Specific techniques crews can be trained to use to control interruptions, recover from distractions, avoid habit capture, and prevent tunneling of attention; (3) Ways to systematically design interruptions and distractions into LOFT/LOE scenarios to realistically challenge crews' task management skills; and (4) ways to modify cockpit SOP to reduce these forms of crew error.

- Integrating CRM/Usability into Operating Documents. The goal of this project is to identify and assemble guidelines that will help carriers in the design and development of operating documents. It builds upon the recognition that the design of operating

documents is incomplete without a consideration of the entire system of documents and procedures of the organization. Operating documents must show internal consistency across fleets, departments, and other documents as well as external consistency with regulations and manufacturers. Thus, standardization and usability issues are intricately tied into the philosophies, policies and procedures incorporated in the document system as a whole. Human Factors guidelines which integrate the most critical issues related to the design and development of a system of operating documents need to be identified and assembled. In order to organize a guidelines document, NASA Ames Research Center and George Mason University have brought together air carriers (majors, regionals, and cargo), manufacturers, and the FAA to work on a human-centered approach to procedure and document design. To date, two workshops have been held and proceedings from each workshop were distributed to participating organizations. The current emphasis of the project is the preparation of an operating documents manual organized around topics of importance to the air carriers including: organization of documents, standardization of documents, usability of documents, developing and maintaining documents, and transition to electronic media.

    - Products. (1) Proceedings from Operating Documents Workshop I, (2) Proceedings from Operating Documents Workshop II, (3) Draft of Operating Documents Manual, (4) Review Process Summary for Operating Documents Manual, (5) Future Focus Groups and/or Operating Documents Workshop III

- Realistic Radio Communications Simulation (RRS). Line pilots are trained and evaluated in sophisticated simulators and scenarios designed to elicit critical crew responses. The simulation of air traffic control (ATC), however, is often left to an already overburdened instructor, who must attend to many other administrative, training, and evaluation tasks. Radio communications are an integral part of every flight and require not only procedural, but also resource allocation, situation assessment, and decision-making skills. The lack of realistic radio communications simulations (RRS) impoverishes the simulation environment and compromises the transfer of skills between simulator and airplane. Full skill transfer to and from the airplane, however, is critical, given FAA plans to mandate simulator use for training and evaluation. The goal of this Volpe/NASA Ames collaborative research is to conduct a feasibility study for the development and implementation of realistic and demanding radio communications (ATC and carrier) in line operational simulations (LOS). We will review existing products and explore new technologies for their compatibility with simulators in use and with other training aids such as the rapidly reconfigurable line operational evaluation (RRLOE) being developed by the FAA. We will survey the current practices of radio communications simulation in training (both flight and ATC) and explore the appropriate levels of realism for different training functions.

    - Product. Feasibility Study Report

Task 3: Air-Ground Communication and Data Link Interface Design. FAA Technical Point of Contact is Tom McCloy, 202-267-7167. NASA-Ames Project Manager is Sandy Lozito, 650-604-0008. NASA shall accomplish the following:

Note: NASA-Ames will work with the Data Link Human Factors Working Group in the development and continuing modifications required for the Roadmap for Human Factors Activities. This will serve as one of the guidance documents for the human factors work on CPDLC Builds 1, 1A, 2, and 3, and will rely on current experience from data link operational trials and tests.

- Lessons- learned Compendium from Previous Data Link Efforts. NASA ARC will work with MITRE, Eurocontrol, and the FAA to help compile the lessons learned from the FANS, Oceanic Data Link, and PETAL trials. This will involve gathering the information about the field studies and operational trials in these areas from the relevant sources. With the other organizations, NASA will then try to determine how the experiences from those events can impact the development of systems and procedures in the trials for the various builds of CPDLC. The compendium of lessons learned from the previous Data Link tests will be structured to help serve FAA Certification and Flight Standards specialists, along with manufacturers, airlines, and user groups (e.g., pilot unions). Of primary interest will be CPDLC Build 1A and beyond, which occur later in the development and testing cycles and allow us to have some effect upon the human factors issues for the users.

  In anticipation of this, NASA has already assisted in preparing a document that modified the SAE G-10 ARP 4791A. This document helps to provide human factors guidance for developers and users of Data Link; however, it had not been updated since the specific details for CPDLC Builds 1/1A/2/3 became known. Recently, relevant issues to the latest CPDLC builds were pulled from that document and compiled, in an attempt to customize it for use at this time. NASA representatives have also attended meetings for the preparation of the CPDLC Roadmap for human factors, and provided feedback based on previous work in this area of Data Link.

  Requirements: NASA will need to be able to interact with American Airlines to determine the flight deck interface requirements for the early trials, and to help define the early concerns from Build 1A. NASA must also have access to some of the FAA and Eurocontrol information regarding the use of Data Link in the ODL and PETAL trials, including some opportunities to interact and observe the use of the ground Data Link. NASA has been able to conduct these observations informally with Oakland Center for the ODL trials, but has not established a contact with Eurocontrol representatives working specifically on PETAL. NASA has contacts in the FAA and Eurocontrol who can help make those contacts, and NASA will attempt to work through those individuals.

  - Products: Lessons-learned compendium for issues relevant to CPDLD Build 1, 1A, 2, 3. The document will be intended to be used by Flight Standards and Certification, manufacturers, and user communities.

- HCI Checklist for Flight Deck Data Link. NASA ARC will work to develop an HCI checklist for CPDLC Build 1A and beyond. The development of this checklist will be the result of extensive literature reviews, collaboration with other experts in the field of communications and HCI checklist development (e.g., Volpe NTSC), and working with other organizations who have valuable data and experience. The purpose of the checklist will be to offer various individuals involved in buying, building, testing, and using Data Link some guidance based on human factors research and expertise in the area of flight deck Data Link. The topics will range from high-level human factors principles to more specific details on the usage of flight deck Data Link for ATC clearance information.

  Requirements: Interact with the users mentioned above that are relevant to CPDLC Build 1, FANS, ODL, PETAL trials.

  - Product: Flight deck Data Link HCI checklist appropriate for Flight Standards and Certification, manufacturers, and user communities.

- Refinement of the Usability Process for Data Link and Feedback into the Current Data Link Efforts. NASA ARC will help coordinate the efforts to gather and provide data on the current data link efforts as they continue in the field or in testing. This effort will include assisting the William J. Hughes Technical Center in their pilot participant feedback for the CPDLC Build 1 testing. The testing for the CPDLC Build 1 is scheduled for April 1999, July 1999, and October 1999. Additionally, NASA will continue to focus some of their ongoing efforts in the oceanic environment of data link, where data link is currently being used and realistic data for both ground and air users are already available. There are pilot questionnaires that have been administered to a large group of commercial pilots using FANS. The questionnaires will continue to come in, and will continue to provide current feedback on the human factors issues associated with oceanic data link. NASA will also have observational efforts and questionnaire data related to the various types of air and ground data link available through the various providers, including the other international ground facilities and air carriers. As the data are provided to NASA from these various questionnaire and observational sources, NASA will continue to feed that information into the CPDLC process for insight into development, testing, certification, and procedures.

  Requirements: NASA will need to have access to the appropriate data and personnel from the William J. Hughes technical Center for the pilot feedback in the CPDLC Build 1 testing. NASA will also need access to the various users and facilities for the oceanic uses of data link that are currently available.

  - Product: Data and modifications from the current trials and usage of data link into CPDLC plans for development, testing, and use of data link.

- General Support of Committees Supporting Data Link Human Factors. NASA ARC will continue to support the FANS Interoperability Team, hosted by Boeing, that address the FANS/ODL problems that are currently being reported by the builders

and the users. NASA will also continue to support the Data Link Human Factors Team as it works to create, modify, track, and evaluate the methods and approaches for assessing CPDLC Builds 1, 1A, 2, 3.

- Products: Clear support and direct feedback into documentation and development of efforts towards oceanic and domestic data link initiatives.

Task 4: Team Decision-making. FAA Technical Point of Contact is Eleana Edens, 202-267-7867. NASA-Ames Project Manager is Judith Orasanu, 650-604-3404. NASA shall accomplish the following:

- Monitoring and Challenging on the Flight Deck. The goal of this research is to identify interaction strategies by which crewmembers, especially junior ones, can effectively call attention to problems and prevent or mitigate errors in flight.

  Accident analyses have shown the importance of monitoring and challenging to aviation safety. While Crew Resource Management (CRM) courses emphasize assertiveness on the flight deck, exactly what constitutes effective challenging is not well specified. Prior work on this project has examined responses by both captains and first officers to scenarios that vary in level of risk and degree to which a challenge poses a "face" threat to the other crewmember. Current efforts examine (a) which forms of challenge are seen by pilots (both captains and first officers) to be more direct and binding on action, and (b) which forms of challenge are judged to be most effective in correcting the problem, while maintaining a positive crew climate.

  The initial study is being replicated with several carriers in Europe to determine whether their pilots' responses differ from those of US pilots, and whether they are in keeping with cross-cultural differences in attitudes toward authority. The task requires pilots to state what they *would* say to correct the problem. A replication of the study in a full-motion transport simulator at NASA-Ames Research Center is addressing what US pilots *actually* say in response to errors and oversights on the part of the other pilot. It will examine the extent to which pilots' responses in simulated flight correspond to the verbal responses obtained in the written task. The simulator study will also examine the extent to which monitoring and challenging errors reflect pilots' failure to detect the error, vs. detecting but deciding not to respond to it or responding in an ineffective or inappropriate manner.

Products/Milestones:

1. August 1999: Report on variations in error-challenging strategies used by captains and first officers in the US and foreign carriers, and by male and female US pilots.
2. December, 1999: Report on pilot ratings of strategies they judge to be most effective in correcting problems on the flight deck, while also maintaining a positive crew climate.
3. February, 2000: Training requirements to develop pilot interaction strategies for preventing, detecting and correcting decision errors in flight.

- Contributions of Cognitive and Contextual Factors on Aviation Decision Errors. The goal of this research is to reduce the frequency of decision errors on the flight deck by (a) identifying factors that contribute to those errors, and (b) developing strategies to aid crews in avoiding or mitigating those errors.

  Recent analyses of worldwide hull-loss accidents have recognized the prevalence of certain types of decision errors by flight crews. These decisions have played a causal or contributing role in a large proportion of accidents. NASA's preliminary examination of US accidents suggests a number of cognitive and contextual factors that may contribute to inappropriate crew decisions. Contextual features establish the requirement to make decisions, provide reasons for making those decisions, and impose constraints on what decisions are possible. A series of studies is being conducted to determine how situational variables, lack of knowledge, decision processes, and social/organizational factors affect decisions that are made under a variety of circumstances. An aviation decision process model developed in prior work will serve as a frame for the studies. The impact of error-inducing factors will be examined on the two primary model components: situation assessment (understanding the problem, assessing risk and time available) and on choice of a course of action. Studies will focus on decisions in ambiguous dynamically changing situations. A second set of studies will determine the leverage points for assisting pilots in coping with error-inducing factors, and will seek to exploit pilots' existing knowledge and skills.

  - Products/Milestones:
    December, 1999: Report on vulnerabilities in situation assessment processes and situational features that contribute to decision error.
    June 2000: Report on factors that influence decisions about courses of action in response to anomalous or changing conditions and possible mitigating strategies.
    December 2000: Training recommendations for preventing decision errors and for exploiting pilot expertise in making effective decisions.

Task 5: Air Traffic Control Fatigue Research. FAA Technical Point of Contact is Larry Cole, 202-267-7867

- No additional funding in FY99

Task 6: Fatigue Countermeasure Training. FAA Technical Point of Contact is Ron Simmons, 202-267-758.

- No additional funding in FY99

Task 7: Information Flow and Collaborative Decision-Making in the Air Traffic Management System**.** FAA Technical Point of Contact is Larry Cole, 202-267-7867.

- No additional funding in FY99

Task 8: Effectiveness of Maintenance Resource Management . FAA Technical Point of Contact is Jean Watson, 202-267-8393. NASA-Ames Project Manager is Barbara Kanki, 650-604-5785. NASA shall accomplish the following:

- Describe and Validate the Effectiveness of Four Maintenance Resource Management (MRM) Evaluation Models Developed for Technical Operations Managers, Aviation Maintenance Technicians, and Inspectors in Large Transport Category US Airlines. The overall goal of these MRM programs is to establish and maintain long-term commitment to providing safe, dependable and efficient performance through effective communication at all levels in airline maintenance operations.

    - Product: Technical report which describes and validates the effectiveness of four MRM evaluation models developed for Technical Operations Managers, Aviation Maintenance technicians, and inspectors in large category US airlines.

- MRM Criteria. The evaluation and validation will be based on the following criteria that will assist in analysis of the effectiveness of interventions introduced by MRM programs: participant reaction to the intervention; assessment of how well the participant has learned the content of the intervention; assessment of the participant's behavior at the job site following the intervention; objective measures of the organizational performance intended to be changed by the intervention

    - Products: Technical report to document the scientific effort; documentation required to implement and evaluate the interventions developed, such as computer software, syllabi, worksheets, and all other material generated from this project, upon completion of the effort; any advisory or recommendations for incorporating interventions into training procedures fir airlines, airlines training facilities, and Aviation Maintenance Technicians.

Task 9: Added for FY98. Human Error Risk Analysis in Aviation Maintenance and Flight Line Operations. FAA Technical Point of Contact is Jean Watson, 202-267-8393. NASA-Ames Project Manager is Barbara Kanki, 650-604-5785. NASA shall accomplish the following:

- Development of a Multi-dimensional Framework to Support the Investigation, reporting, and Analysis of Commercial Aviation Maintenance and Flight Line Human factors Mishaps and Incidents. Based on Reason's conceptualization of human error in accident causation, the US Navy safety Center (NSC) derived a taxonomy entitled the Human Factors Accident Classification System, or "HFACS". HFACS captures the active failures that are proximate causes of a mishap and the latent conditions which "set the stage" for a mishap. An HFACS analysis of major US Navy flight mishaps involving aircrew error revealed trends, which are guiding current human factors intervention efforts. HFACS is now an integral component of the Naval Aviation Safety Program (NASP) mishap investigation and reporting process. Furthermore, the DOD Joint service Safety Chiefs adopted HFACS as the standard taxonomy for mishap data comparison and aggregate data analysis. Finally, HFACS is being applied to the systematic analysis of aircrew errors found in commercial aviation mishaps.

The US Navy Postgraduate School, in conjunction with NSC, has developed a Maintenance extension for HFACS. It too has proven helpful in identifying active and latent human factors problem areas in major and minor Navy aviation mishaps involving maintenance and flight line operations, and is also being added to the NASP. Currently, there is much interest in the application of the HFACS Maintenance Extension to not only other DOD aviation maintenance related mishaps, but also commercial mishaps as well. For example, a subset of readily available NTSB reports involving several major incidents is being analyzed under the FAA Aviation Maintenance and Inspection Human factors Research Program using the HFACS framework

Research will apply the present HFACS Maintenance Extension framework to a range of Part 121 organization incidents to identify human factors trends. It will not only seek to quantify the numerator of incident occurrence, but also to construct a denominator that estimates the risk based on exposure, number of operations, etc. Further, it will provide for weighting incidents based on severity of outcome. Collectively, this data can then be used to construct a realistic risk assessment of identified human factors concerns in incidents that can be used to help prioritize and focus intervention efforts.

Research will develop a system that would not only capture the essence of mishap events and causes, but would also lend itself to the identification of development of intervention strategies. The objective of the effort is to take the HFACS Maintenance Extension and use it in the analysis of Part 121 to generate such a framework. Furthermore, the results would also be tied to variables such as exposure to calculate rates and outcomes to establish weights to provide for corresponding risk assessment and control effort prioritization.

The outcome of this research will be development of a multidimensional framework to support the investigation, reporting, and analysis of commercial aviation maintenance and flight line human factors mishaps and incidents. Based on Part 121 organization incident reports, classified using an adaptation of the HFACS Maintenance Extension taxonomy, the end product would support detection and identification of human factors problems, present trends, and associated risks in commercial aviation. In addition to development of the framework, by-products would include: improvements in the investigation, collection, and reporting of maintenance mishap data; potential for training investigators to better detect, recognize, and identify human factors problems causing a mishap associated with a situation, process, and/or organization; and a management tool for prioritizing intervention development efforts.

- Products. A comprehensive literature review of issues related to accident investigation, reporting and analysis, with special emphasis on human factors; a complete framework suitable for use as a training vehicle, investigator reference, etc.; an analysis of a range (major to minor) of Part 121 organization mishaps obtained from the commercial airlines, rework facilities, transient lines, etc.; a

documented risk assessment process suitable for each type of Part 121 organizations covered; and a human factors-based risk assessment for identified problems in the analyses for each of the Part 121 organizations covered.

ARTICLE IV – FAA Point of Contact, is revised as follows:

FAA Contract Administration – The Contract Specialist is Lola Palmer, ASU-340, Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591. Voice 202-267-7690, FAX 202-267-5142. The Contracting Officer is William Spear at the same address.

ARTICLE VIII – FUNDING AND PAYMENT

The parties agree that no additional funding for FY 1999 is necessary for Tasks 1, 5, 6, and 7. The parties agree that funding for Tasks 2,3,4,8, and 9 represent the required levels for research to be accomplished in FY 1999. Task 9 is an added requirement to support Aviation Maintenance Human Factors.

The FAA shall reimburse NASA for services and supplies furnished under this agreement upon submission of a properly executed voucher. A detailed itemized schedule of expenditures shall be included for each task including equipment purchased, personnel labor hours, and contractor support. The voucher shall be submitted in an original and two copies to the accounts payable organization identified in ARTICLE IV. A properly executed SF 1080 shall reference the Interagency Agreement number and the following appropriation data:

- The total funding amount added under this modification is $917,000

Task 1	No funding	
Task 2	$270,000	01 W/088.0/G240/8AA/2596/081110
Task 3	$300,000	01 W/088.0/G240/8AA/2596/081110
Task 4	$120,000	01 W/188.0/G240/8AA/2596/081110
Task 5	No funding	
Task 6	No funding	
Task 7	No funding	
Task 8	$127,000	01 W/188.0/G240/8AA/2596/081110
Task 9	$100,000	01 W/188.0/G240/8AA/2596/081110

The total value of the Agreement has increased from $1,995,000 by $1,320,000 (FY1997), $1,297,293 (FY1998), and $917,000 to $5,529,293.

Except as modified above, all other provisions remain unchanged and in full force and effect.

AGREED:

FEDERAL AVIATION ADMINISTRATION

By:_____ Date:
Name: William Spear
Title: Contracting Officer

NATIONAL AERONAUTICS & SPACE ADMINISTRATION

By:_____ Date:
Name:
Title: