MODIFICATION 0002

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. 0002 to the referenced agreement is to add FY 1998 funding in the amount of $1,147,293 for the tasks specified in ARTICLE II below to be accomplished in FY 1998, to add one new task (Task 8) to be accomplished in FY 1998, 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. NASA Ames Project Manager is Irv Statler, 650-604-6654. NASA shall accomplish the following:

- APMS entails the research and development of tools and methods for managing, processing, and analyzing digital flight-recorded data. The objectives of the project are to establish a sound technological basis for flight-data analysis, to define an open architecture for flight-data-analysis systems, and to articulate guidelines for a database structure on which to continue to build future flight-data-analysis extensions.

  There is available on the data bus of modern aircraft a gold mine of data on the aircraft and its performance, and modern technologies of recording and processing make it feasible to access these data. The question being addressed in the APMS project is how to convert flight-recorded **data** into **information** on the operational performance of the aviation system. An objective of the APMS research project is to demonstrate to US air carriers that very large quantities of flight-recorded data can be monitored, processed, and analyzed efficiently and usefully.

  The APMS research project is closely allied with the Flight Operations Quality Assurance Program (FOQA), but it is not synonymous with it. The current FOQA program that is funded and operated by the FAA is a flight-data collection and analysis program based entirely on the use of commercial off-the-shelf (COTS) hardware and software to analyze flight data for special events or exceedances. The APMS is the research element of the FOQA program to develop the next generation of tools, algorithms, and methodologies for extracting the maximum amount of information from all of the flight-recorded data.

APMS is developing tools that go substantially beyond the capabilities of the current commercially available analytic methods that are mainly designed to count special events. These existing capabilities, while of proven value, were created primarily with the needs of air crews in mind. There is a great deal of valuable information that is being ignored when one focuses on special events or exceedances. Exceedances are rare events. A focus on the identification of exceedances can fail to convey the whole picture, and may, in some instances, present misleading information. The information that is being discarded in the other 97% of the data can tell us about reality---what is really happening during normal flight operations. Furthermore, these other data provide the bases for meaningful trend analysis. APMS provides a capability, transparent to the user, to perform operationally relevant and meaningful statistical analyses of all of the data.

APMS serves the needs of the government and air carriers, as well as air crews. APMS is an integrated suite of tools that will assist analysts in evaluating the operational performance and safety of the national air transport system, the air carrier, and the air crew in support of their Flight Operations and Quality Assurance (FOQA) programs and Advanced Qualifications Programs (AQP). The APMS will be an element of a feedback process for timely and accurate "situational awareness" that is essential to the decision makers in airlines, at the manufacturers, and among the regulators for risk management and for assurance of quality performance of the aviation system.

The integrated suite of APMS tools is intended to serve multiple functions starting with the acquisition of data from flight recorders (QAR), and their storage into a database with a client-server management system. The database can be accessed to service the COTS tool that automatically identifies exceedances. APMS adds automated knowledge-based computer systems to this process to aid the analyst in detecting, verifying, interpreting, and tracking these events. The database can also be accessed to study the statistical characteristics and the trends of all of the data, and to service tools that will encourage and assist analysts in the exploration of the database. Flight animation is also serviced by the database to provide feedback to the flight crews and to assist the analyst in understanding the circumstances of an exceedance. Finally, the database is designed to support the sharing of information with other databases.

- Products: Currently, the APMS products are being developed in collaboration with Alaska Airlines and United Airlines (UAL). During FY'97, some of the tools including capabilities for statistical analyses of all flights to observe normal, routine operations of a fleet of aircraft, were demonstrated in the operational environment of Alaska Airlines using data collected on six MD-80 aircraft. These and new tools will continue to evolve in a series of iterative builds of APMS customized to the needs of Alaska Airlines. APMS will also be demonstrated to United Airlines in an initial build customized to UAL's fleet of about 40 A-320 aircraft with special emphasis on the automated aids to assist in analyses of special events.

Support the continued development of three specific tools that were demonstrated in initial prototype versions during FY'97 at Alaska Airlines. These specific products include the database management and architecture, the "Search Daemon", and the SVD "Flagging Filter".

Provide for cleaning up the APMS programs for database management and architecture as they were demonstrated at Alaska Airlines to enable their use in routine processing of flight data. NASA funding will be used to document these capabilities, the functionalities, and the interfaces for APMS tools in their current stage of development.

The “Search Daemon” enables the analyst to search any portion of, or the entire, database for any pattern of flight parameters that he/she specifies. The analyst is able to specify a complex set of criteria for identifying some data pattern of interest, such as an unstabilized approach. Having defined the criteria for each of the data patterns, the analyst assigns a name to that set, and, when he/she accesses the Search Daemon, the analyst can select from the list of these names the particular pattern of interest. The analyst then selects the portion of the database he/she wants to explore, and clicks on search. At the conclusion of the search, the Search Daemon produces a tabulation of the flights in which the specified criteria had been found. A click on any one initiates the presentation of the flight data in the Viewer.

In another mode, the Search Daemon could be implemented to search automatically and for a prescribed subset of such patterns as the data from each flight are routinely processed.

Provide for the development of a user-friendly interface for specifying patterns within the capability of the Search Daemon as it was demonstrated at Alaska Airlines. NASA funding will provide for further research to explore the feasibility of automated pattern recognition and pattern specification. We will also extend the capability of the current Search Daemon to provide knowledge-based guided exploration, and link it to the APMS Viewer.

The APMS Flagging Filter automatically reviews each flight and brings it to the attention of the safety manager when it is not considered typical compared to the normal baseline. It is based on a statistical concept called Singular Value Decomposition which provides a way to characterize a complex multivariate process such as a single total flight (from push back to taxi in) with a few definitive features.

The concept of searching for atypical flights, as it was demonstrated at Alaska Airlines, complements the process of searching for exceedances. If the rules are often "bent", the consequences may be identified in the search for special events, but may not be found in the search for atypically. On the other hand,

the search for atypically may reveal unexpected phenomena and/or emerging problems that cannot be detected by the existing prescribed definitions of exceedances.

This capability is essential to establishing a normal baseline, and maintaining it dynamically so that trends can be recognized and evaluated. It is a tool to encourage exploration because it may bring to the attention of the analyst unexpected occurrences even if it may be only some unusual manifestation of the failure of some sensor. A redirection of attention to what is typical may help the analyst to evaluate current SOPs, or, when applied to simulator data, to establish appropriate AQP standards.

A quite different potential for this tool is in the application to maintenance. When maintenance establishes for us the performance metrics for, say, a particular subsystem, and we have monitored its performance long enough to establish a baseline of normal operations, we can use this same process to watch for atypical operation that could be the basis for a strategy of on-condition maintenance.

Implement a working build of the initial approximation to an SVD flagging filter as demonstrated at Alaska Airlines in FY'97.

Evaluate SVD and related techniques to select the process that is most computationally efficient. We will select and develop practical tools for identifying atypical flights from among large masses of data and assigning operational significance to identified flights. We will also design user-friendly link to Viewer.

Task 2: CRM Training Evaluation; Integrating CRM Usability into Operating Documents. 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:

- Interruptions and distractions are the most common causes of pilot error, and have contributed to many accidents. One of the most striking of these accidents was the Eastern Airlines L-1011 accident in the Florida Everglades. Glass cockpits, rather than attenuating this problem, have, if anything, amplified it. To quote Hart Langer, "FMS CDUs…act as vacuum cleaners…that suck eyeballs and fingertips into them". Closely intertwined with the issue of interruptions and distractions are problems with habit capture, tunneling of attention, and failing to remember to perform deferred actions. To get at this problem, NASA will combine several approaches: (1) Analysis of ASRS incident data and NTSB accident reports; (2) Field observations of LOFTS/LOEs; and, (3) Experimental studies that probe the cognitive mechanisms pilots use to interleave concurrent tasks and manage attention in dynamic response to competing demands of the overall job.

- Product. (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 this form of crew error.

- Integrating CRM Usability into Operating Documents. The initial goal of this project was to integrate CRM principles into crew roles and procedures in order to improve the match between current procedures and operational reality, and to develop a process for adapting procedures to anticipated changes. The motivation behind this project was a lack of standardization of checklists and procedures due to a variety or organizational, industry, and technological changes.

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:

- Examine the current implementations of datalink (oceanic FANS) and domestic/enroute CPDLC Build One). Through the process of interviews, observations, and committee support, identify the issues that exist with those systems. Since FANS has been used for several years, conduct a Aviation safety Reporting System (ASRS) investigation of pilot/controller report identifying problems in the Future Aeronautics Navigation Systems (FANS) aircraft. These will include callback interviews using a structured questionnaire protocol to obtain more detailed information from the users. It will also include Australia/New Zealand airspace and users to reflect the different issues associated with different ground implementations of Oceanic Data Link. Also observe a training session of FANS at United Airlines Training Center to have a better understanding of the procedures and skills provided to the pilots. Additionally, continue committee support and continue to monitor CPDLC Build One concerns.

    - Product: The issues and concerns regarding current datalink implementations from all the above sources (ASRS report, ASRS callbacks, observations, interviews, and meetings) will be described and summarized.

- Explore the information requirements associated with data link based on airspace and information content. This will be conducted using some existing data derived from research conducted at NASA Ames, examining procedural differences and information transfer weaknesses based on message type and phase of flight. Also, examine some of the human factors documents available in the area of data link (e.g. SAE G-10 Human Factors Requirements Document) in which some of these same issues are addressed. Use the human performance modeling capabilities in Air MIDAS to examine the interface and procedural trade-offs in data link timing. This will offer some information on the appropriateness of the use of data link communications in the terminal area where timing becomes more critical. Also, address concerns related to the transition of airspace (e.g. terminal to enroute) associated with implementation and procedural differences that may exist. This will be conducted using analytic tools to explore the impact of data link services in airspace transitions.

- Product: A description of information transfer and timing concerns related to different usages of data link (based on message type and flight phase). Guidelines for interface and procedures for data link communications will be provided.

- The two tasks described above will be conducted in parallel. Depending on the data derived from the first two steps of describing and initially assessing data link, a field study or simulation will be conducted to further explore the data link concerns. The emphasis will be upon air-ground integration and data link communications. This will require an integration and coordination of ground and flight deck environments, which offer many challenges (both for development and for practical issues). However, the goal will be to examine particular issues that are most sensitive to the integration of the air and ground implementations and procedures.

    - Product: A systematic exploration of air-ground integration issues in a realistic environment, and preliminary recommendations and guidelines for mitigating some of the problems.

Task 4: Team Decision-making; Crew Communication; Crew Training Evaluation.
FAA Technical Point of Contact is Eleana Edens, 202-267-7867. NASA-Ames Project Manager is Judith Orasanu, 650-604-3404.

- This project consist of two tasks: (1) Assessment and Debriefing Tool for SPOT/LOS. The purpose is to design and validate a debriefing tool that supports training of Planning, Situation Awareness, and Decision-making skills in SPOT/LOS. The form will serve as a reminder of important crew actions for experiences instructors and as an observation guide for the increasing number of new instructors. As organizations move to using reconfigurable event sets, instructor familiarity with scenarios will decrease and the debrief form will become a guide for experienced instructors as well. The study will evaluate the utility of a debrief tool for both instructors and flight crew members. (2) Monitoring and Challenging on the Flight Deck. The purpose of this study is to identify interactional strategies by which crew members, 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 CRM courses emphasize assertiveness, exactly what constitutes effective challenging is not well specified. A combination of pencil/paper and flight simulator data will be used to determine the effectiveness of various interactional strategies under different risk conditions.

    - Products: Task 1. Debriefing guides for simulator instructors and flight crews focusing on planning, situation awareness, and decision-making skills, along with guidelines for their use in SPOT/LOS debriefing. We will also provide guidelines for developing instructor and crew debrief forms for future event sets. Task 2. Report on directness and effectiveness of interactional strategies for monitoring and challenging under various risk conditions.

Training guidelines for developing interactional strategies for avoiding or mitigating errors will also be provided.

Task 5: No additional funding in FY98

Task 6: Fatigue Countermeasure Training. FAA Technical Point of Contact is Ron Simmons, 202-267-758. NASA-Ames Point of Contact is Kevin Corker, 650-604-0055. NASA shall accomplish the following:

- Define and characterize human performance integrity (human fatigue) issues associated with regional and commuter airlines.

Product: Final report which defines and characterizes human performance integrity issues associated with regional and commuter airlines.

Task 7: No additional funding in FY98.

Task 8: Added for FY98. 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.

- 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:

1. Participant reaction to the intervention
2. Assessment of how well the participant has learned the content of the intervention
3. Assessment of the participant's behavior at the job site following the intervention
4. Objective measures of the organizational performance intended to be changed by the intervention

    - Product: technical report to document the scientific effort

- Other deliverable products: (1) 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; (2) Any

advisory or recommendations for incorporating interventions into training procedures fir airlines, airlines training facilities, and Aviation Maintenance Technicians.

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 Libby Waldman-Strugatch at the same address.

ARTICLE V – CHANGES, COMMENCEMENT, MODIFICATIONS, AND INTERPRETATIONS

Pursuant to the directions under this Article, the duration of this agreement shall be extended three years from the effective date of this contract.

ARTICLE VIII – FUNDING AND PAYMENT

The parties agree that no additional funding for FY 1998 is necessary for Tasks 5 and 7, as those tasks were completed in FY 1997 and there is no requirement for FY 1998 under the aforementioned Tasks. The parties agree that funding for Tasks 1,2,3,4,and 6 represent the required levels for research to be accomplished in FY 1998. Task 8 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 $1,147,293

Task 1 $300,000 01 W/088.0/G240/8AA/2596/081110
Task 2 $200,000 01 W/088.0/G240/8AA/2596/081110
Task 3 $400,000 01 W/088.0/G240/8AA/2596/081110
Task 4 $160,000 01 W/088.0/G240/8AA/2596/081110
Task 5 No funding
Task 6 $25,000 01 W/088.0/G240/8AA/2595/081110
Task 7 No funding
Task 8 $62,293 01 W/088.0/G240/8AA/2596/081110

The total value of the Agreement has increased from $1,995,000 by $1,320,000 (FY1997) and $1,147,293 (FY1998) to $4,462,293.

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

AGREED:

FEDERAL AVIATION ADMINISTRATION

By:_____ Date:
Name: Libby Waldman-Strugatch
Title: Contracting Officer

NATIONAL AERONAUTICS & SPACE ADMINISTRATION

By:_____ Date:
Name:
Title: