

# Human Performance Implications Related to the Rapid Response Team Security Recommendations

Prepared for  
Air Transport Association (ATA)  
Washington, DC  
March 1, 2002

## ***Introduction***

The purpose of this report is to provide feedback related to the possible human performance implications of the Rapid Response Team's security recommendations. This feedback was requested by Al Prest of the Air Transport Association at a meeting of human factors researchers. The report was compiled after the meeting with input from the research group. The list of participants is included as Appendix A.

The information in this report includes human performance implications that may result from each recommendation as well as suggestions for strategies that may be used to address these implications. In many cases, specific research addressing these implications is recommended.

Almost any security measure that involves the flight deck crew during line operations has the potential of causing interruptions or distractions, changing the normal sequence of flight deck procedures, or increasing the crew's workload at crucial moments. This is of concern during all phases of flight, but especially during the period when the crew prepares the aircraft for departure and taxis to the runway. NASA research has shown that this period is quite vulnerable to disruptions that lead to crew errors that may affect flight safety.

## ***Feedback on Recommendations***

Each recommendation is presented as stated in the RRT report. The recommendation text is followed by a statement of the objective of the recommendation (as interpreted by the research group), then feedback about human performance implications, and strategies for addressing them for that particular recommendation.

***Recommendation 1: "We recommend that some appropriate barrier device be approved, and installation begin within 30 days. Installation throughout the entire U.S. fleet should be completed in 90 days. We recommend that FAA enable the installation of these devices through urgent regulatory action that provides the airlines with a simple, expedited method for approval and installation."***

The objective of this recommendation is to prevent unauthorized intrusion to the flight deck.

The human performance implications related to the implementation of this recommendation are:

- The pilots may not be able to evacuate in a timely manner.
- The pilots and cabin crew may not be able to communicate effectively during flight.
- The captain may need to include additional information in the crew preflight briefing to address communication requirements on the flight.
- Other adverse effects may result from restricting cabin crew entry into the flight deck such as fatigue and dehydration.

Strategies to compensate for these human performance implications may include:

- Modifying evacuation procedures and training for all crewmembers.
- Modifying crew interaction procedures and training for both flight deck and cabin crewmembers.
- Modifying pilot briefing training to include implications associated with procedures related to use of the new barrier device.
- Research may be conducted to understand better the full set of adverse effects of discouraging cabin crew entry into the flight deck.

***Recommendation 2: "We recommend that the industry identify and address the risks regarding rapid decompression and exit and rescue associated with the barrier devices that have been installed. Within 6 months, steps should be taken to accomplish the following:***

***(1) Approve a door design to ensure:***

- ***adequate venting of a closed and locked flight deck door in the event of a rapid depressurization in the flight deck area. Venting may involve provision of either a venting means or release of the door locking mechanism,***
- ***in the event of an emergency, exit and rescue of the flight crew, and***
- ***barrier against intrusion.***

***(2) Provide a barrier against access by an intruder through the venting feature of those flight deck doors having vents.***

***Within 1 year from approval of the door design, conduct a retrofit of the entire U.S. fleet of aircraft."***

The objective of this recommendation is to design a flight deck door that will allow adequate venting and prevent flight deck intrusion while maintaining safe means for the flight crew to exit the flight deck in an emergency.

The human performance implications related to the implementation of this recommendation are:

- The pilots may not be able to evacuate in a timely manner.
- The pilots and cabin crew may not be able to communicate effectively during flight.
- The captain may need to include additional information in the crew preflight briefing to address communication requirements on the flight.

Strategies to compensate for these human performance implications may include:

- Modifying evacuation procedures and training for all crewmembers.
- Modifying crew interaction procedures and training for both flight deck and cabin crewmembers.
- Modifying pilot briefing training to include implications associated with procedures related to the new door design.

***Recommendation 3: "We recommend that ongoing work in the Aviation Rulemaking Advisory Committee Design for Security Harmonization Working Group be completed within 60 days, with respect to door design standards."***

An evaluation of human factors considerations related to door design should be included in the work completed by the Design for Security Harmonization Working Group.

***Recommendation 4: "We recommend that a future design of the doors meet the requirements of rapid decompression, flight crew rescue and exit, and protection from intrusion caused by blunt force, ballistics, fragmentation, or other explosive effects. The new design should be required for new aircraft types. We recommend that as many elements of the new design as practical be retrofitted into the fleet."***

The objective of this recommendation, similar to recommendation 2, is to design a flight deck door that will allow adequate venting and prevent flight deck intrusion while maintaining safe means for the flight crew to exit the flight deck in an emergency.

The human performance implications related to the implementation of this recommendation are:

- The pilots must be able to easily access and actuate the door mechanism.
- The pilots must be able to positively identify those outside the flight deck door.
- The pilots and cabin crew may not be able to communicate effectively during flight.
- The captain may need to include additional information in the crew preflight briefing to address communication requirements on the flight.

Strategies to compensate for these human performance implications may include:

- Evaluating human factors considerations related to design of the door.
- Evaluating human factors considerations related to positively identifying those outside the flight deck door.
- Modifying evacuation procedures and training for all crewmembers.
- Modifying crew interaction procedures and training for both flight deck and cabin crewmembers.
- Modifying pilot briefing training to include implications associated with procedures related to the new door design.

***Recommendation 5: "We recommend that these flight deck procedural changes be made at all airlines within 30 days."***

- ***Prohibiting passengers from loitering at the forward lavatory and galley areas.***
- ***Leaving curtains/dividers open between cabins to allow for unobstructed views.***
- ***Strictly enforcing seatbelt signs.***
- ***Reinforcing crew coordination to facilitate immediate reporting of suspicious activities to other crewmembers.***
- ***Suspending preflight beverage service during the passenger boarding process to allow flight attendants to focus on passenger boarding.***
- ***Requiring the forward lavatory and the interphone to be operational for dispatch.***
- ***Positively identifying those entering the flight deck, using peepholes, codewords, or other similar methods.***
- ***Putting the jumpseat in the down position during flight if doing so inhibits access to the flight deck.***

The expected objectives of each of these procedural changes as well as potential human performance implications associated with the implementation of these changes will be addressed. Strategies that may prevent the occurrence of these potential negative outcomes will also be presented.

Each of these procedural changes requires that current crewmember tasks be modified or new crewmember tasks be added. Therefore, both procedural and training modifications must be developed and implemented for each recommended change.

***Prohibiting passengers from loitering at the forward lavatory and galley areas.***

The objective of this procedural change is to keep potential intruders away from the flight deck doors. This procedural change may also make the behaviors of those near the flight deck more identifiable and allow for faster crew response to suspicious behavior near the flight deck.

The human performance implications related to the implementation of this procedural change are:

- Passenger comfort, particularly for first class passengers, may be compromised.
- Given this restriction, an increase in passenger disruptive behavior may occur.
- Cabin crew workload will increase as crewmembers must enforce the policy and potentially deal with disruptive passengers as a result of enforcement.

Strategies to compensate for these human performance implications may include:

- Passenger education through the use of on-board videos or handouts at the gate to encourage cooperation with the new procedures.
- Carefully controlling the distribution of alcoholic beverages may contribute to avoiding disruptive passenger behavior (and may reduce necessary trips to the lavatory).
- Modifying procedures and training for all crewmembers to educate passengers, identify loitering, and to enforce the restriction.
- Modifying procedures and training for gate agents to include passenger education of the new restriction.
- Other methods of increasing first class passenger comfort may be necessary to offset decrements in passenger satisfaction caused by this procedural change.

***Leaving curtains/dividers open between cabins to allow for unobstructed views.***

The objective of this procedural change is to give the cabin crew (and the passengers) a view of the entire cabin. Providing a full view of the cabin should increase the cabin crew's awareness of passenger behavior throughout the aircraft.

The human performance implications related to the implementation of this procedural change are:

- Passenger traffic near the flight deck may increase (economy passengers may attempt to use the front lavatory).
- If an additional restriction was created to disallow economy passengers access to the front lavatory, the cabin crew workload would be increased due to enforcement of the restriction and potentially dealing with disruptive passengers as a result of enforcement.
- With curtains open, the first class cabin crew and/or an air marshal may react to a visible diversion in the rear of the aircraft, leaving the flight deck vulnerable to intrusion.

Strategies to compensate for these human performance implications may include:

- Passenger education through the use of on-board videos or handouts at the gate to encourage cooperation with the new procedures.
- Modifying procedures and training for the cabin crew to include passenger education and proper implementation of this procedural change.
- Modifying procedures and training for gate agents to include passenger education.

***Strictly enforcing seatbelt signs.***

The objective of this procedural change is to reduce passenger traffic throughout the cabin. By reducing passenger traffic, the cabin crew may be able to identify suspicious behavior and respond to potential flight deck intrusions more quickly and easily.

The human performance implications related to the implementation of this procedural change are:

- Cabin crew workload will increase as they must enforce the policy and potentially deal with disruptive passengers as a result of enforcement.
- Passengers may be aggravated by the inconvenience of being confined to their seats which could potentially lead to an increase in disruptive behavior.
- Inconsistent crewmember use and/or enforcement of seatbelt signs may lead to disruptive passenger behavior when strict enforcement does occur.

Strategies to compensate for these human performance implications may include:

- Passenger education through the use of on-board videos or handouts at the gate to encourage cooperation with the new procedures.
- Carefully controlling the distribution of alcoholic beverages may contribute to avoiding disruptive passenger behavior (and may reduce necessary trips to the lavatory).
- Modifying procedures and training for all crewmembers to educate passengers and to enforce the restriction.
- Modifying procedures and training to ensure that the seatbelt signs are consistently illuminated by all flight crews and consistently enforced by all cabin crews.
- Modifying procedures and training for gate agents to include passenger education of the new restriction.

***Reinforcing crew coordination to facilitate immediate reporting of suspicious activities to other crewmembers.***

The objective of this procedural change is to ensure that the appropriate crewmembers are given all the necessary information regarding suspicious behavior as quickly as possible to coordinate an intervention if necessary. Early identification and communication of suspicious activities may minimize the potential negative effects of any criminal intentions.

The human performance implications related to the implementation of this procedural change are:

- Cabin crewmembers may report a large number of false alarms to the pilots resulting in unnecessary distractions that may lead to other errors and unsafe conditions.
- The captain may need to include additional information in the crew preflight briefing to address communication requirements on the flight.

Strategies to compensate for these human performance implications may include:

- Developing guidelines and associated training to assist all crewmembers in identifying suspicious behavior.
- Modifying training so that pilots, cabin crews, and gate agents participate jointly in CRM training to establish effective communication of security-related information.
- Modifying pilot briefing training to ensure that all crewmembers appropriately understand the new procedures for communication of security information.

***Suspending preflight beverage service during the passenger boarding process to allow flight attendants to focus on passenger boarding.***

The objective of this procedural change is to allow the cabin crew to focus on the passengers in order to provide more and better information regarding the passengers.

The human performance implications related to the implementation of this procedural change are:

- By eliminating a situation (beverage distribution) where passengers must communicate with the crew, the cabin crew may lose a valuable opportunity to monitor the behavior of individual passengers.
- Termination of the preflight beverage service may annoy some passengers and potentially lead to disruptive behavior.

Strategies to compensate for these human performance implications may include:

- Modifying procedures and training to ensure that crewmembers are able to effectively monitor the passengers during preflight boarding.
- Modifying procedures and training to include methods that crewmembers may use to engage passengers in communication during preflight boarding to prevent the loss of any suspicious behavioral cues that might be observable during beverage distribution.
- Educating passengers prior to them boarding the aircraft (perhaps at the gate or ticket counter) that preflight beverage service is not available may help decrease incidents of disruptive behavior related to this procedural change.

***Requiring the forward lavatory and the interphone to be operational for dispatch.***

The objective of this procedural change is to prevent the cabin/flight crew from having to walk through the cabin to access the lavatory and/or interphone. Requiring that the interphone be functional would help ensure rapid and efficient communication between the cabin and flight crews.

The human performance implications related to the implementation of this procedural change are:

- Pilots may be more likely to commit errors during preflight checklist completion due to the interruption in normal checklist procedure of leaving the flight deck to check the operational status of the forward lavatory.
- Crewmembers and/or maintenance personnel may fail to communicate lavatory and interphone failures possibly preventing timely repair on the ground and therefore resulting in delayed or canceled flights.

Strategies to compensate for these human performance implications may include:

- Modifying procedures and training for pilot checklist completion to include these new checklist items in such a way that interruption in the normal checklist procedure is minimized.
- Modifying procedures and training for crewmembers and maintenance personnel to ensure timely and appropriate communication of interphone and lavatory maintenance issues.

Other related costs include developing procedures and training to determine what conditions must be met for a lavatory or interphone to be considered inoperable.

***Positively identifying those entering the flight deck, using peepholes, codewords, or other similar methods.***

The objective of this procedural change is to ensure the positive identification of crewmembers prior to entering the flight deck and to reduce the likelihood of flight deck intrusions.

The human performance implications related to the implementation of this procedural change are:

- Crewmembers may forget the necessary password, especially in stressful situations.
- Password may become compromised allowing unauthorized access.

Strategies to compensate for these human performance implications may include:

- Modifying procedures and training for all crewmembers to include the appropriate use of codewords and other identification methods.
- Modifying pilot briefing training to include the appropriate use of codewords and other identification methods.
- In the future, the problem of forgotten codewords when regulating access to the flight deck may be remedied through the use of new technologies such as biometric measurement devices like fingerprint readers or iris scanners.

***Putting the jumpseat in the down position during flight if doing so inhibits access to the flight deck.***

The objective of this procedural change is to provide an additional barrier against flight deck intrusion. The need for this stopgap measure should be eliminated in the future as effective flight deck doors are developed.

The human performance implications related to the implementation of this procedural change are:

- The jumpseat may create an obstruction for the flight crew in the event of an emergency evacuation.
- Crewmember workload may increase.

Strategies to compensate for these human performance implications may include:

- Modifying evacuation procedures and training for all crewmembers.
- Modifying pilot briefing training to include this procedural change.

***Recommendation 6: "We recommend that industry develop a plan of feasible alternatives for emergency warnings within 30 days."***

It is unclear specifically what type of emergency warnings is being referred to in this recommendation; therefore, we could not identify human performance implications for it.

***Recommendation 7: "We recommend that airlines and pilot unions develop procedures that will allow gate and flight deck personnel to verify the credentials of a non-company pilot or flight engineer who asks to occupy a jumpseat within 6-months."***

The objective of this recommendation is to prevent individuals that may be granted access to the flight deck from successfully misrepresenting their identity.

The human performance implications related to the implementation of this recommendation are:

- The distraction of the flight deck crew associated with verifying credentials may increase the likelihood of errors in other preflight tasks.
- The captain may need to include additional information in the crew preflight briefing to address the new credential verification process.

Strategies to compensate for these human performance implications may include:

- Modifying procedures and training for gate, cabin, and flight deck personnel.
- Modifying communication procedures and training for gate, cabin, and flight deck personnel.
- Modifying pilot briefing training to include the new credential verification process.

**Recommendation 8:** *"We recommend that industry define requirements for an automated system to validate, in real time, the identities of persons with legitimate access to the aircraft, within 6-months. (Universal access identification.) Implementation will be based on those requirements, when defined."*

The objective of this recommendation is to prevent unauthorized individuals from gaining access to the aircraft.

The human performance implications related to the implementation of this recommendation are:

- Complacency in monitoring the automated system and/or overconfidence/over-reliance in the automated system may deter recognition of suspicious behavior of persons validated by the automated system.

Strategies to compensate for these human performance implications may include:

- Evaluating human factors considerations throughout the development of the requirements and subsequent design process.

**Recommendation 9:** *"We recommend that industry evaluate the use of cameras and lighting outside the flight deck door within 6 months."*

The objective of this recommendation is to evaluate the use of cabin cameras to assess the value and feasibility of providing a means for visually identifying individuals trying to enter the flight deck and providing situational information to the flight deck crew about activities in the cabin. The evaluation process should include a systematic examination of the following assumptions:

- The flight crew can make use of visual information about activities in the cabin.
- Ground security organizations can use visual information from the cabin either for direct intervention, training, or planning.

The evaluation must consider these human performance implications related to the implementation of cameras outside the flight deck door:

- Flight crewmembers (or others designated to monitor the video) will not be able to continually monitor information on the display nor determine when they should pay attention to it. It has been shown that humans in general are not capable of effectively performing these types of monitoring tasks.
- Flight crewmembers (or others designated to monitor the video) may misinterpret information on display from cabin camera(s). This is particularly possible if no audio is presented with the video presentation.
- Audio may add to distraction causing pilots to block out other auditory channels and miss important auditory information.
- There is potential for a high number of false alarms if the crewmembers must continually monitor the information.

- Introducing an interfering task and distractions may increase flight crew workload. This can result in increased probability of performance errors. For example, checking cameras in preflight, during an already high workload period, may interrupt the normal sequence of checklist procedures and lead to errors.
- Video monitors may inappropriately attract attention. Video is potentially more compelling than other displays, such that pilots may become fixated on video and therefore situation awareness may be degraded. Further, pilots may monitor video more frequently than necessary because of increased sensitivity to security given recent events, again reducing overall situation awareness.
- Crewmembers may become confused about the appropriate times the cameras (and microphones) should be on and who should trigger the onset.
- All of the above implications are multiplied with the addition of more than one camera and required information display.
- Terrorists may use the system to create diversions, possibly making the flight deck vulnerable to intrusion.

Strategies to compensate for these human performance implications may include:

- Determining what information is going to be valuable to the flight deck crew and/or ground security organizations and specifically how each group might use the information.
- Determining the most effective methods for delivering this information (video, video supported by audio, as raw data or preprocessed / filtered, recording of data).
- Determining what policies, procedures and training must be developed and provided to the flight deck crew, cabin crew, and ground organizations so that the cameras and related displays can be safely used.
- Determining under what conditions the cabin, flight deck crew, or ground organization should be able to control the data acquisition and recording processes.
- Developing procedures for cabin and flight deck crews (and any other affected parties) about initiating the use of cameras and/or monitoring the video displays. One method would be to provide the cabin crew with the ability to provide an aural signal to notify the pilots that they should monitor the video display.
- Developing procedures and training for the flight crew about how to interpret the information and what actions to take based on the information.
- Evaluating human factors considerations in the design and installation of any displays added to the flight deck for the purpose of presenting cabin information. The purpose of the display must be defined to determine the appropriate location – e.g. for frequent access the monitor should be centrally positioned, for emergency use only the monitor should be peripherally positioned. Also, the effective method of displaying the video signals will depend on the number of different camera views utilized.
- Developing training for additions to the flight crew briefing because of the introduction of the cameras and associated displays.

For additional discussion of the implications related to the implementation of this recommendation refer to Appendix B.

***Recommendations for future research***

Research should be conducted to determine appropriate training for crew use of information gathered from camera(s), particularly cabin/flight deck crew coordination of interpretation of the information.

Research is needed on accurate assessment of situations based on verbal information only (such as an interphone call from flight attendant) vs. video only (with no audio).

***Recommendation 10: "We recommend industry work with the FAA to evaluate these factors and make recommendations for personal protection within 6 months. We recommend the implementation of defensive capabilities in accordance with the recommendations of the evaluation, within 1 year of receiving the recommendation."***

The objective of this recommendation is to evaluate the potential methods to increase the defensive capabilities of crewmembers so that they may defend themselves, the passengers, and the flight deck against individuals threatening flight safety and security.

The evaluation must consider these human performance implications related to the implementation of new defensive capabilities for crewmembers:

- If weapons are authorized, crewmembers may (unwillingly) allow unauthorized passengers to gain control of crew weapons.
- Crewmembers may use weapons inaccurately resulting in harm to themselves, innocent passengers, other crewmembers, or the aircraft.
- Crewmembers may misinterpret the behavior of a passenger and use a weapon to harm an innocent passenger.
- Crewmembers may unintentionally discharge weapons potentially causing harm to themselves, passengers, other crewmembers, or the aircraft.
- Armed pilots may be tempted to leave the flight deck to deal with disruptive behavior in the cabin that may ultimately serve as a diversion for hijackers to gain access to the flight deck.
- Additional training and continuous practice requirements may cause crewmember fatigue if appropriate scheduling adjustments are not implemented.

Strategies to compensate for these human performance implications may include:

- Evaluating human factors considerations related to design and implementation of any defense mechanisms.
- Developing procedures to determine appropriate use of defensive capabilities.
- Developing crewmember training in the use of any defense mechanism (use of a specific type of weapon and/or self-defense martial arts training) including when, how, and where to use the defense mechanism.

- Providing continuing practice of implementation of defensive capabilities for crewmembers to maintain a high level of proficiency.
- Making appropriate scheduling adjustments to accommodate new defense training and practice requirements in order to avoid increasing crew fatigue.
- Developing training for crewmembers in weapons retention to reduce the risk that an attacker could get access to and/or obtain a crewmember's weapon.
- If firearms are issued to pilots, developing training methods that include instruction on how to fire the weapon from the pilot seat and how to leave the pilot seat holding a weapon without unintentionally engaging/disengaging critical aircraft systems.
- Developing procedures and training to ensure secure storage of weapons during non-flight hours.
- Ensuring that the flight deck door is impenetrable in order to eliminate the need for additional defensive capabilities.

For additional discussion of the implications related to the implementation of this recommendation refer to Appendix C.

**Recommendation 11:**        *"ALPA recommends the FBI present reasons for or against its proposal to arm pilots."*

We have no comments with regard to this recommendation.

**Recommendation 12:** *"We recommend industry, unions, and FAA redesign security training to address newly-identified threats within 30 days, incorporate changes into the annual curriculum within 60 days, and provide security training to all crewmembers within 6 months after updating the curriculum."*

The objective of this recommendation is to provide updated security training for all crewmembers within 6 months. The updated security training should prepare all crewmembers for coordinated appropriate response to security threats.

The human performance implications related to the implementation of this recommendation are:

- After training, there is a potential for crewmembers to overestimate their "ability" to handle risky situations.
- The training may not be adequate or effective.

Strategies to compensate for these human performance implications may include:

- Using the train-to-proficiency approach for training development based on the Advanced Qualification Program training model. This approach includes developing specific performance standards. Thirty years of extensive research on

the advantages of systematic, analytic/prescriptive engineering approaches to the design and development of performance-based training and instruction over the artistic/intuitive content centered alternatives have clearly concluded that these instructional systems design approaches are immeasurably superior in terms of effectiveness and quality assurance.

- Including elements in the training program about the limitations of the crewmembers in the security roles.
- Providing training to flight deck, cabin, and ground crews in a combined program.

For additional discussion of the training development considerations related to this recommendation refer to Appendix D. Consideration of the role of explicit risk assessment and communication in security training and security-related decision making is included in Appendix E.

***Recommendation 13: "We recommend that each airline, in cooperation with the FAA or other Government entities, develop within 60 days a delivery system or procedure to provide Government security advisories to crewmembers in a timely manner, including immediate threat information to affected aircraft in flight."***

The objective of this recommendation is to keep crewmembers aware of all relevant security information. Implementation of this recommendation would provide crewmembers with security information from a reliable, authoritative resource.

The human performance implications related to the implementation of this recommendation are:

- Crewmembers may not receive the advisories in a timely manner.
- Security advisories that do not directly affect the notified flight crew may unnecessarily distract the pilots and therefore increase the opportunity for errors in pilot task performance.
- The captain may need to include additional information in the crew preflight briefing to address crew communication of security advisories and any related crew procedures.

Strategies to compensate for these human performance implications may include:

- Modifying procedures and training to ensure that advisories are delivered consistently in a timely manner (given the variation in infrastructure and existing procedures among air carriers creating a standardized procedure for all air carriers is not likely to be effective).
- Evaluating what type of information/advisory that would be useful to pilots in-flight.
- Modifying pilot briefing training to prepare the crew for dealing with security advisories.

**Recommendation 14:** *"We recommend the FAA provide more guidance on the conduct of cabin searches within 30 days. Airlines will continue to conduct the cabin search and to provide sufficient time and training for those personnel. No cabin search duties should be assigned to flight or cabin crew."*

The objective of this recommendation is to ensure that airlines continue to conduct cabin searches and train personnel (other than flight or cabin crew) to conduct these searches.

The human performance implications related to the implementation of this recommendation are:

- Cabin search personnel may fail to communicate necessary information to flight deck and cabin crewmembers and/or gate agents.
- Airline personnel may compromise the thoroughness of cabin searches in order to avoid flight delays.

Strategies to compensate for these human performance implications may include:

- Modifying search procedures and associated training to ensure that cabin searches are consistently complete and thorough.
- Training of search personnel to communicate search findings to crewmembers, gate agents, and other authorities as necessary.
- Allowing a Federal security agency, rather than the airline, to conduct the cabin searches may reduce the likelihood of a cabin search being completed without the necessary thoroughness in order to meet existing flight schedules.

**Recommendation 15:** *"We concur with the recommendation of the Airport Security Team to develop a new Federal security agency and we recommend that the new agency be responsible for conducting searches of aircraft cabins."*

The objective of this recommendation is to develop a Federal security agency that will conduct aircraft cabin searches, thus removing this responsibility from the airlines.

The human performance implications related to the implementation of this recommendation are:

- Cabin search personnel may fail to communicate necessary information to flight deck and cabin crewmembers and/or gate agents.

Strategies to compensate for these human performance implications may include:

- Modifying search procedures and associated training to ensure that cabin searches are consistently complete and thorough.
- Training of search personnel to communicate search findings to crewmembers, gate agents, and other authorities as necessary.

***Recommendation 16: "We recommend the creation of an FAA-industry task force to determine the necessary modifications to assure continuous transmission of a hijack signal, even if the flight deck-selected code or function is turned off. Recommended action is to be defined within 30 days. "***

The objective of this recommendation is to prevent termination of a hijack signal once it has been activated.

The human performance implications related to the implementation of this recommendation are:

- Pilots may inadvertently activate the signal, therefore a procedure (that would not be able to be forced by or directly implemented by the hijacker) to indicate a false activation of the hijack signal may be required.

Strategies to compensate for these human performance implications may include:

- Evaluating human factors considerations related to the design/functionality of the continuous transponder transmission system.
- Modifying procedures and training for any design/functionality changes that are implemented.
- Modifying pilot briefing training to include the new functionality of the hijack signal.

***Recommendation 17: "We recommend that within 30 days, airlines, pilots, and the FAA should jointly identify procedures in pilot training, including depressurization and rapid descent, that could be adapted in an attempted hijacking to control a hijacker."***

The objective of this recommendation is to identify procedures to disable a hijacker through control of the aircraft.

The human performance implications related to the implementation of this recommendation are:

- Pilots may attempt aggressive maneuvers that result in injury to innocent passengers and/or crewmembers.
- Pilots may attempt aggressive maneuvers that result in structural damage detrimental to the aircraft.

Strategies to compensate for these human performance implications may include:

- Modifying procedures and training for all crewmembers regarding aircraft maneuvers and/or depressurization as a means to disable hijackers.
- Modifying pilot briefing training regarding aircraft maneuvers and/or depressurization as a means to disable hijackers.

## **APPENDIX A**

### **LIST OF PARTICIPANTS**

David Baker – American Institutes for Research

Deborah Boehm-Davis – George Mason University

Clint Bowers – University of Central Florida

Judith Burki-Cohen – Volpe National Transportation Systems Center

Key Dismukes – NASA Ames Research Center

Tim Goldsmith – University of New Mexico

Michelle Harper – University of Texas

Greg Harron – Research Integrations, Inc.

Sharon Hecht – Research Integrations, Inc.

Robert Helmreich – University of Texas

Robert Holt – George Mason University

Florian Jentsch – University of Central Florida

Peder Johnson – University of New Mexico

Barbara Kanki – NASA Ames Research Center

Beth Lyall – Research Integrations, Inc.

John Moulton – University of New Mexico

Fred O’Neal – CSSI, Inc.

Judith Orasanu – NASA Ames Research Center

Eduardo Salas – University of Central Florida

Donald Sussman – Volpe National Transportation Systems Center

Rebecca Vint – Research Integrations, Inc.

# **APPENDIX B**

## **HUMAN FACTORS IMPLICATIONS OF COCKPIT-MOUNTED CABIN VIDEO DISPLAYS**

Prepared By  
Team Performance Laboratory  
Department of Psychology  
University of Central Florida  
Orlando, FL

### **Background**

With the current interest in security in the aviation industry, the safety of pilots in flight is of utmost concern. New regulations have been implemented to ensure that the cockpit is no longer accessible to passengers of the plane. The cockpit doors have been replaced or reinforced with stronger materials and are kept locked throughout the flight. Pilots no longer leave the cockpit, and crewmembers no longer enter the cockpit as frequently as they did before. Further security measures are also being suggested and investigated. One such suggestion is to place a camera in the cabin that feeds into a display monitor in the cockpit. This would give the pilots a visual of the cabin at all times throughout the flight. If someone were to knock on the cockpit door, the pilots would have a visual display of the person and could assess the situation more easily. Moreover, if there were disturbances in the cabin, the pilots would be able to view the goings on from the safety of the cockpit. Currently, JetBlue has plans to install such security systems into their airplanes (JetBlue, 2001), while other airlines, such as Delta, are in the process of testing such systems (Airfax2000, 2001).

There are obvious advantages to installing such systems. In fact, Swissair is reported as having been using security cameras for almost thirty years (McTague, 2001). Further, even FAA-approved (“TSO’d”) security camera systems are relatively inexpensive today. The cameras can either be hidden or overtly displayed, and can be installed in a relatively short period of time. However, while it may seem that putting a monitor in the cockpit for the pilots could only add to the safety of the entire plane, a closer look into this issue is warranted. What exactly would be the purpose of the display? Would it be used only in the case of an emergency, or would pilots continuously monitor the cabin for suspicious behavior? Depending on the specific intended use of the system, the human factors issues of concern are affected to varying degrees. Specifically, the location of the display, the physical characteristics of the display, mental workload, human error, and

attention must all be addressed when assessing the utility of a security camera system within any airplane.

## **Design Concerns**

### Location

Cockpit space is extremely limited already, and thus the addition of new instrumentation or displays must be carefully analyzed. The purpose of the display will dictate its proper place within the cockpit. Displays that are to be sampled most often should be located directly in front of the pilot (Senders, 1966). Thus, if the purpose of the display were to keep the pilot continuously aware of the activities occurring within the cabin, a more centrally located display would be appropriate. It should be noted though that the most important displays must be the most prominent (Wickens & Flach, 1988), and therefore, a new display should not overshadow such items as primary flight instrumentation and electronic alerting and system parameter displays. With the enormous amount of information and the limited space currently within the immediate perceptual view of the pilot, requiring a pilot to also monitor the cabin activities would necessitate the relocation or variable selection ability of less important displays. The judgment call here is whether monitoring the cabin activities is more important than other current monitoring tasks.

On the other hand, if the display were only to be used in emergency circumstances, then a central location would be unnecessary. Leibowitz (1986) suggests that the peripheral visual field is highly underused, and Stokes and Wickens (1988) state that delegating displays to the periphery should aid in performance by freeing up the central visual field detecting motion, and thus placing a display monitor with constant motion in the peripheral field may be more distracting than useful. In the case that the display will only be used in emergency situations, perhaps the best place to put the display would be behind the pilots, where it would be the least distracting. However, placing the display out of view of the pilots certainly contradicts the whole point of putting the display in the cockpit in the first place.

### Size

Obviously the size of the display would be limited by the amount of space available inside the cockpit. Coupled with the fact that the display would be fairly close to the pilots, considering the size of the cockpit, the display would not have to be very large. However, one consideration here must be the number of cameras and how they affect the size of the necessary displays. If there is only one display feeding from one camera, then the size requirements for that display would be extremely different than if there were multiple cameras with multiple displays required. Again, one must revert back to the original purpose of the camera and display. For continuous monitoring of the cabin, multiple cameras would be useful. This would require multiple displays, a split screen display, a scrolling display, or a variable selection display. The limited amount of space

deems multiple displays unrealistic. Similarly, a split screen display would require a larger overall display in order to ensure that each individual camera view would be large enough for the pilots to see. Finally, a scrolling display would not require a larger display, but scrolling displays are distracting because the flicker rate can make the display appear to be flashing (Sanders & McCormick, 1993). Although a display capable of calling up any camera location would provide more views of the cabin, a higher pilot workload would be imposed as well. Thus, if it were necessary to install a new display in the cockpit, the most efficient would be the simplest: one small display monitor that feeds from a single camera.

### Color

The use of color in displays adds both to the realism of a display as well as to its acceptance and likeability (Stokes & Wickens, 1988). Colors have been used to successfully code incoming information, especially in environments such as cockpits, where a large amount of information is being presented in a limited amount of space (Kopola, 1979). While using color has its benefits, one must take into account the fact that 8% of males are color-deficient (Sanders & McCormick, 1993). Considering that 94.1% of all pilots are male (Federal Aviation Administration, 2001), it is likely that some people interacting with this display will not be able to see the color. However, as long as color-deficient people could interact with the display effectively, this should not be a problem. With color displays being the norm these days, it would not cost considerably more to exploit their benefits.

### Sound

Functionally speaking, the addition of auditory information from the cabin would have its advantages and disadvantages. Auditory information is both attention getting and distracting, hence it is well-suited to present warnings and other information that call for immediate action (Sanders & McCormick, 1993). If the purpose of the security cameras were to alert the pilots in the case of an emergency, then auditory information would be a beneficial addition. Furthermore, if pilots were forced to interpret the activities in the cabin, auditory information would provide insight into why certain things were occurring. This might aid in better decision making on the part of the pilots in emergency situations.

However, currently the amount of auditory information presented to pilots is becoming as overwhelming as the amount of visual information within the cockpit (Stokes & Wickens, 1988). If the pilots were to have a constant auditory feed of all sounds coming from the cabin, they would no doubt begin blocking out certain channels of information in an attempt to take in the most important information. If they deemed the cabin information to be most important, they might miss critical warnings or alarms coming from other displays. If, on the other hand, they tuned out the cabin information, they may not be aware when a serious situation were occurring. Thus, a constant stream of sound from the cabin does not appear to be beneficial to the pilots.

Another consideration in the auditory modality would be the availability of aural warnings generated remotely from the cabin attendants. This would bring threat situations to the attention of the pilots. At this time, if audio were available from the system, the monitoring pilot could select it “on” only when there is a threat report. Even without the availability of audio, the ability to alert the pilots to monitor the video output would aid in situation assessment, without infringing on overall situation awareness of the flight deck crew.

## **Primary Performance Issues**

### Mental Workload

Mental workload is the ratio between the amount of resources that a person has available versus the amount of resources required by a given task (Sanders & McCormick, 1993). Considerable research has been performed in this area in the past thirty years, especially in relation to pilots in the cockpit (i.e., Hart, Houser, & Lester, 1984; Kantowitz, & Campbell, 1996; Roscoe, 1978). This research has been in three main areas: workload prediction, workload assessment imposed by environment, and subjective experienced workload (Wickens & Hollands, 2000). It is important to understand both the amount of workload pilots are actually experiencing and the amount they perceive to be experiencing in order to optimize performance and training.

Workload is an important concept to understand because it is one of the main causal factors of human error (Kantowitz & Sorkin, 1983). According to Kantowitz and Casper (1988) people are most efficient with stable, moderate workload levels. People begin to commit more errors when workload is either too high or too low, and when they encounter unpredictable, sudden changes. While flying is said to be the safest method of transportation, human error in aviation can have the most catastrophic consequences. Thus, pilot workload and error are important factors that must be taken into account when discussing the advantages and disadvantages of installing new display monitors within the cockpit.

Pilots work in an extremely complex environment, with constant visual and auditory information needing processing and interpretation. Throughout a flight, pilots experience differing levels of workload. The imposition of security cameras would thus affect the pilots variably at different times throughout the flight. During preflight procedures, pilots would have to check that the security cameras were functioning properly. Therefore, yet another step would be added to the already detailed list of procedures necessary for departure. With the addition of another step comes one more chance for human error. What if the cameras are not functioning properly? What would be included in the Master Minimum Equipment List? What would the ramifications of a maintenance deferral be with regard to flying without a working camera system?

Next, the effects that a camera system would have during the flight must be considered. This leads back to the original question of what the purpose of the camera system is. If

the display monitors were to be used only for emergency purposes, then they should not cause an excessive amount of extra workload. However, just because the purpose of the camera system would be to view the cabin in extreme circumstances, for example, someone knocking on the cockpit door or an air rage incident, this would not ensure that the cameras would not be used for other purposes. How would the use of these cameras be regulated? Would viewing session times be limited, for example, one minute at a time and then the display automatically turns off until activated again? Would pilots be given guidelines for the use of the cameras?

If, on the other hand, the purpose of the security camera system were to allow pilots to continuously monitor the cabin throughout the flight, then the workload factors would be extremely different and a multitude of other factors would need to be taken into account. Constant monitoring of another display would greatly increase pilot workload, especially with the security issue being so prominent in everyone's minds. Pilots would not only be monitoring the cockpit door, but they would be meticulously examining each passenger looking for suspicious behavior. They would be trying to spot weapons in advance, and they would be on constant alert for something out of the ordinary. This constant monitoring would take away from the other important tasks of the pilots. Obviously the flying of the plane is the most important task at hand, and additional tasks must not overshadow that.

### Attention

According to Sanders and McCormick (1993), there are four types of attention: selective attention (several sources of information monitored for a given event), focused attention (only one source of information attended to), divided attention (multiple sources of information attended to simultaneously), and sustained attention (one source of information attended to for extended periods of time). Implementing a security system into the cockpit would have different effects on each of the types of attention, depending on the purpose of the system and how the pilots actually use the system.

Most of the time, pilots are engaged in divided attention tasks. They must continuously attend to a variety of visual and auditory displays within the cockpit. Furthermore, they sample these displays based mainly on previous knowledge about the likelihood of an event occurring (Wickens, 1987). The installation of a display monitor of the cabin would add another channel that must be sampled by the pilots. Also, with the recent terrorist events, pilots may be biased in believing that these events are more likely to occur than they actually are. Thus, they might be sampling the cabin display much more than necessary and possibly overlooking other important sources of information.

Moreover, Wickens (1987) also states that stress affects the manner of sampling in divided attention tasks. During highly stressful situations, a judgment is made about the most important sources of information and only those are sampled. The other sources of information are consequently overlooked. However, the most important sources of information chosen by the person may not in fact be representative of the situation. This is an important point because any emergency situation within the cockpit is likely to be

extremely stressful to the pilots, resulting in their constant monitoring of the cabin situation and less attention devoted to the flying of the plane.

Focused attention could be a problem for the pilots no matter what the purpose of the system. Whether the system is constantly monitored or only used in emergency situations, the display still has the potential to draw all resources from the pilot, leaving nothing to attend to the other displays within the cockpit. The classic example of focused attention gone wrong is Eastern Airlines flight 401 that crashed into the Florida Everglades in 1972 (AviationCrashes, n.d.). The crew became so fixated on one of the main gear lights that was not lit that no one realized the plane had been slowly descending. In fact, this was something that would have only been noticeable by monitoring the flight displays. Thus, simple displays can lead to disaster, and this specific cabin display may be even more attention getting and misleading than the current displays within a cockpit.

Finally, in the case that the pilots would be monitoring the cabin specifically looking for suspicious behavior, sustained attention (vigilance) would be a factor that would need to be addressed. People who are engaged in these types of tasks, i.e., monitoring a single channel of information for extended periods of time, will experience a phenomenon called the vigilance decrement (Sanders & McCormick, 1993). In essence, they become slower and less accurate as a function of time. Thus, the longer pilots are focused on searching for suspicious behavior or weapons, the less likely they would be to detect them. This is an important point to note especially if pilots would be expected to perform such tasks.

## **Secondary Performance Issues**

### Situation Assessment

One of the greatest potential benefits of a surveillance system in the cabin is to provide additional, different modality information to more team members in order to assist in the evaluation of what is going on. In the past, a cabin attendant may call on interphone and describe what he or she perceives to be the situation, but this may not give a clear and accurate representation of the event to the pilots. On the other hand, interpreting the video data in the absence of sound or context is also likely to lead to errors. Currently, there is little scientific data to guide how best to manage this conflict.

### Situation Awareness

Although clearly related, total flight situation awareness has the potential to be degraded when dealing with a cabin threat event. The ability of the pilots to maintain adequate situation awareness will face the same challenges as with any other abnormal or emergency situation. That is, there is a need to be able to understand the situation and to predict accurately how it will change in the future. This is another area in which flight crews might be at risk for degraded performance.

## Decision Making

The overall greatest potential gain in safety and security due to the installation of cameras in the cabin is the enhancement to the decision making process. Once the video information is presented, viewed, and assimilated by the participating team members, the probability of a more optimum decision exists. However, there is a substantial amount of historical data that suggest that more information does not necessarily lead to better decisions. Consequently, there is very likely a need to provide training designed to assist crew members in using the video data to make decisions about the flight.

## Resource Management

The current environment has substantially changed the flight environment. More than ever, flight attendants are the “eyes and ears” for the flight crew. The introduction of video cameras might reduce this demand. However, the introduction of video is likely to require the flight attendants to assist the crew in interpreting the video signal. This will require effective communication among the crew members. Existing CRM training might need to be altered to account for this change.

## Policies and Procedures

The policies and procedures for the use and misuse of the equipment and information gleaned from them would have to be established well in advance of implementation. Depending on the type of system installed, specific parameters need to be established for all of the team members involved. Cabin crewmember instructions as to when to initiate and perhaps when not to initiate an alert call (if installed) would need to be delineated. Cockpit crewmember viewing and reviewing of (if recording function installed), interpretation of events, and actions required would need to be stated. This would add a set of new procedures and policies to an already large set. At the same time, pilots have demonstrated in the past that they can and will adopt new procedures and policies if these are framed correctly and appropriately described.

## Training

A final issue to be considered before introducing cabin-monitoring equipment into the cockpit is that of the training that would be required for their use. Training for the use of cabin monitoring cameras, however, will compete with many other training demands for training program footprint, and thus may not be cost-effective. In the following sections, we are describing some sample elements of a model training program on the use of cabin-monitoring equipment.

A model classroom-training module for the video system might include simulated scenarios with background information offered by the instructor. A "re-enacted cockpit view" would be played for the class with the option to manipulate the screen output in the

same manner as would be available from their unique installation. The class would be divided into realistic working teams and solutions to the presented situations could be presented and discussed.

Additional simulator training in the form of LOFT scenarios should also be incorporated into the training. Optimally, all potential team members would participate in the LOFT in their true operational positions such as Captain, First Officer, Cabin Attendant, Dispatcher, Safety Officer, and Maintenance Technician. The scenarios should be varied as in traditional LOFT training including somewhat ambiguous scripts. The LOFT debriefs need to reinforce the need to be aware of and avoid the potential hazards of the new equipment.

### **Conclusion**

As demonstrated above, the introduction of video cameras for use by the flight crew offers several potential advantages for flight crews. However, there exists the possibility of unexpected negative consequences. These risks are a consequence of potential distractions and the need to manage and use the additional information. Generally speaking, pilots have been very successful in managing multiple data sources. However, it is important to note that video data are different from the other data with which pilots must deal. Video data possess the risk of being much more compelling than other data sources. That is, attention might be drawn to video displays much more than other displays, leading to degraded situation awareness. However, this hypothesis needs to be evaluated scientifically before drawing firm conclusions.

## References

- Airfax2000. (2001). *Delta Launches Test of Aircraft Transponder and Video Camera Systems*. Retrieved February 6, 2002, from [www.airfax.com/releases/showrelease.asp?ID=461](http://www.airfax.com/releases/showrelease.asp?ID=461)
- AviationCrashes. (n.d.) *Eastern Airlines Flight 401 Special Report*. Retrieved February 10, 2002, from [www.aviationcrashes.com/special/eastern401.html](http://www.aviationcrashes.com/special/eastern401.html)
- Brunel, N., and Ninio, J. (1997). Time to detect the difference between two images presented side by side. *Cognitive Brain Research, Vol 5*(4), p 273-282
- Dixon, M. W., Wraga, M., Proffitt, D. R., Williams, G. C. (2000). Eye height scaling of absolute size in immersive and nonimmersive displays. *Journal of Experimental Psychology: Human Perception & Performance, Vol 26*(2), p 582-593
- Federal Aviation Administration (2001). *Administrator's Fact Book: October 2001*. Retrieved on Feb 4, 2002 from [www.atc.training.faa.gov/factbook](http://www.atc.training.faa.gov/factbook)
- Hart, S. G., Houser, J. R., & Lester, P. T. (1984). Inflight evaluation of four measures of pilot workload. *Proceedings of the 28<sup>th</sup> Annual Meeting of the Human Factors and Ergonomics Society* (pp. 945-949). Santa Monica, CA: Human Factors and Ergonomics Society.
- JetBlue. (2001). *JetBlue announces third quarter profit*. Retrieved Feb 6, 2002 from [www.jetblue.com/learnmore/pressDetail.asp?newsId=95](http://www.jetblue.com/learnmore/pressDetail.asp?newsId=95)
- Kantowitz, B. H., Campbell, J. L. (1996). Pilot workload and flightdeck automation. In R. Parasuraman & M. Mouloua (eds.), *Automation and Human Performance: Theory and Applications. Human Factors in Transportation* (pp.117-136). Hillsdale, NJ: Lawrence Erlbaum.
- Kantowitz, B. H., & Casper, P. A. (1988). Human workload in aviation. In E. L. Wiener & D. C. Nagel (Eds.), *Human Factors in Aviation* (pp. 157-187). San Diego, CA: Academic Press, Inc.
- Kantowitz, B. H., & Sorkin, (1983). *Human Factors: Understanding People-System Relationships*. New York: Wiley.
- Kopola, C. J. (1979). The use of color-coded symbols in a highly dense situation display. *Proceedings of the 23<sup>rd</sup> Annual Meeting of the Human Factors and Ergonomics Society* (pp.397-401). Santa Monica, CA: Human Factors Society.
- McTague, J. (2001). Keep 'em flying: A few simple steps could lure Americans back onto airlines. *Barron's*. Retrieved on Feb 6, 2002 from [www.iasa-intl.com/folders/Security\\_Issues/Keep%20FlyingA%20Few%20Simple%20Steps%20Could%20Lure%20Americans%20Back%20Onto%20Airlines.htm](http://www.iasa-intl.com/folders/Security_Issues/Keep%20FlyingA%20Few%20Simple%20Steps%20Could%20Lure%20Americans%20Back%20Onto%20Airlines.htm)
- Roscoe, A. H. (1978). Stress and workload in pilots. *Aviation, Space, and Environmental Medicine, 49*(4), 630-636.
- Sanders, M. S., & McCormick, E. J. (1993). *Human Factors in Engineering and Design*. (7<sup>th</sup> ed.). New York: McGraw-Hill, Inc.

- Senders, J. W. (1966). A reanalysis of the pilot eye-movement data. *IEEE Transactions on Human Factors in Electronics*, 7(2), 103-106.
- Stokes, A. F., & Wickens, C. D. (1988). Aviation Displays. In E. L. Wiener & D. C. Nagel (Eds.), *Human Factors in Aviation* (pp. 387-431). San Diego, CA: Academic Press, Inc.
- Wickens, C. D. (1987). Attention. In P. A. Hancock (Ed.), *Human Factors in Psychology*. Amsterdam: North Holland Publishing.
- Wickens, C. D., & Flach, J. M. (1988). Information Processing. In E. L. Wiener & D. C. Nagel (Eds.), *Human Factors in Aviation* (pp. 111-155). San Diego, CA: Academic Press, Inc.
- Wickens, C. D., & Hollands, J. G. (2001). *Engineering Psychology and Human Performance*. (3<sup>rd</sup> ed.). Upper Saddle River, NJ: Prentice Hall.

## **APPENDIX C**

### **ISSUES RELATED TO ARMING PILOTS**

Prepared By  
Florian Jentsch  
Team Performance Laboratory  
Department of Psychology  
University of Central Florida  
Orlando, FL

There are several concerns with the proposal to arm pilots. In addition to technical issues, such as the selection of weapons and ammunition (cf. Thompson, 2002), there are procedural questions. Finally, one of the most important questions may be how the pilots would be trained, and how they could achieve and maintain proficiency in weapons use.

#### **Initial Training**

Training for air marshals, for example, needs to be more than marksmanship training. As Thompson (2002, p. 52) pointed out:

One of the first specialized skills air marshals learn is where not to shoot. The film “Goldfinger” has, for years, perpetuated the myth that depressurization by bullet hole is the greatest danger. Normally, this is not the case. The pumps/compressors that keep a cabin pressurized can normally deal with a couple of small bullet holes.

A far greater danger is hitting hydraulic lines or electrical wiring. As a result, trainees learn where critical systems are located, so a shot may be placed without hitting them. Of course, the most important system to avoid shooting is the pilot or co-pilot. As a result, shot angles and ammunition type must be considered.

Another issue that must be trained is how to shoot from the pilot seat, and how to leave the pilot seat holding a weapon without unintentionally engaging/disengaging critical aircraft systems, such as flaps and slats, speedbrakes, the landing gear, or the fuel supply to the engines. Writing about the aircraft cabin (whose seats are much easier to get in and out of than pilot seats), Thompson (2002, p. 52) wrote:

Aircraft seats create additional problems. Even at the best of times, it’s [sic] difficult to pull yourself out of one. Under the stress of a hijacking, this can be even more difficult. As a result, the air marshal must train to take a shot while seated. He must also train to take a shot as he levers himself out of the seat. When I was training air marshals in the Persian Gulf, I always taught them to choose a seat on the aisle and on the left side of the aircraft looking forward if they were right-handed (on the right side if they were left-handed). This allowed them to take a lean-out shot while seated.

Note that the air marshals in Thompson's training described here were seated in the back of the cabin and were trying to make shots towards the front in the aircraft. For pilots, the reverse would be true, and a right-handed shooter would have to sit in the right (i.e., the traditional "copilot's") seat if they wanted to make a turn-around shot while seated. This brings up two additional human factors problems. First, the copilot would have to bring the weapon around to aim towards the rear of the cockpit and thus the captain would be in the aim-arc of the weapon. Secondly, the first officer, as the junior crew member, may have to obtain captain's consent before discharging a weapon in a threat situation, which adds to the complexity of who would be flying, who would be making the decision to shoot, and who would actually do the shooting.

### **Maintaining Proficiency**

With respect to the issue of maintaining weapons proficiency, there are some guidelines that may help to identify the amount of continuing practice realistically needed, so as to maximize the potential benefit of armed pilots while minimizing such potentially negative consequences as hurting innocent passengers or hitting critical aircraft systems, with their attendant civil and criminal liability. Professional anti-terrorist units commonly expend about 1,000 to 2,000 rounds per person per week (!) on personal weapons training (Thompson, 1986; Tomajczyk, 1997). While this amount of weekly practice is at the high end of weapons proficiency, Lonsdale (1995) has pointed out that anyone involved in carrying weapons to protect others (e.g., bodyguards, security personnel) should at least expend about 100-150 rounds in training per week. Given that the aircraft cabin is a specialized environment (i.e., extremely closed quarters, high potential for collateral damage), 150 rounds per week and person may not be adequate to achieve sufficient proficiency.

### **Weapons Retention**

Finally, armed pilots would also need to be trained in weapons retention. One of the most dangerous possibilities in a crowded environment such as the aircraft cockpit is that an attacker gets access to and/or obtains the pilot's weapon. In training for a similar environment, the serving of high risk warrants in residential structures (Lonsdale, 2000), great emphasis is therefore placed on weapons retention training. Similar training is also part of the air marshal training curriculum (Thompson, 2002). Indeed, Thompson (2002) reported that air marshals are given a monthly allowance for martial arts training and/or a gym membership, so that physical fitness and weapons retention skills remain high. Consequently, similar training and allowances may have to be given also to pilots.

### **Conclusion**

In summary, arming pilots presents numerous technical, procedural, and legal challenges. One of the greatest challenges, however, is how to provide (and pay for) adequate training and continuing practice to pilots before they carry guns into the cockpit. Pilots must receive initial training on when, how, and where to shoot, as well as continuing shooting practice and weapons retention training. This requires substantial amounts of

time and money (e.g., 100 rounds per week on the shooting range, martial arts training), and may – if scheduling changes are not concurrently made – lead to a very well trained, yet fatigued armed pilot. The latter may be much more dangerous than the small chance that an intruder would have to be shot by an armed pilot.

### REFERENCES

Lonsdale, M. V. (1996). Bodyguard : A guide to VIP protection. Los Angeles, CA: Specialized Tactical Training Unit.

Lonsdale, M. V. (2000). Raids : A guide to high-risk warrant service. Los Angeles, CA: Specialized Tactical Training Unit.

Thompson, L. (1986). The rescuers – The world’s top anti-terrorist units. New York: Dell.

Thompson, L. (2002, February). Air Marshals in training – Guns and techniques used to protect our airways. Guns & Ammo, 46(2), 50-56.

## **APPENDIX D**

### **SECURITY TRAINING DEVELOPMENT**

Prepared By  
Fred O'Neal  
CSSI, Inc.

Aviation security must now be considered in terms more expansive than the safety of individual aircraft. After 9/11 it is now clearly the case that we are dealing with preventing aircraft from becoming weapons. It is also clear that, as in all aviation mishaps, no single node in the overall security network can be relied upon for full prevention. The entire commercial aviation community must be able to act as a team to close the gaps in the security screen. And therefore, they must be trained to do this.

The stakes have been raised to the point where the training must be competency based. Training that is measured by “seat time”, content coverage and “box checking” has no place in the required training response. The trainees must demonstrate mastery of the required skills and knowledge in performance on appropriate assessment scenarios and instruments. This means that, for a very large set of the required competencies, multiple choice verbal knowledge tests will not be adequate.

Determining the required competencies and constructing appropriate and reliable assessment tools must not be left to tradition or to people unfamiliar with the rigorous accountability of this approach. Doing the job will require sophisticated task analytical and performance testing skills that are not readily available in many airlines, or in the FAA. In addition, it is often the case that individual fleets within many airlines take very different training approaches.

Training the whole security team requires a substantial level of training competency and assessment definition across airlines, providing the entire community with a common core of competency. Indeed, this training must affect the general public as well. We have already seen three times since 9/11 that the elements of the security network that did the job were the cabin crew and the passengers themselves. This “common core” should then be augmented by airline specific training, approved (and monitored) by the FAA in the context of the overall security training needs.

This comprehensive training response is urgently needed. We simply cannot afford to take the most efficient and economical approach to training development. We must marshal the resources needed to design and develop effective, competency-based instruction in the minimum possible time, yet do so within a system that ensures accountability and adaptability as the threat evolves.

- The individual airline components of the training should follow AQP principals, but a faster process must be invented, and soon.
- The analysis and design process must be initiated with a very rapid survey of the content area. Trained and experienced instructional development professionals are certainly capable of assessing the general behaviors and resulting instructional strategies – and must do so as soon as possible.
- Common core” training should be an FAA initiative with airlines and others participating.
- A complete job/task/skills analysis should be produced within 3months.
- Performance testing and security training assessment plan outlining how each task/skill should be tested must be developed in parallel with the requirements analysis, and completed at the same time.
- Development of training materials – both airline-specific and “Common Core” must begin as soon as tasks are validated. The first materials should be ready for testing and validation within two months after the start of the project, and should be fielded within 6 months.

Notice that this is a classical Instructional Systems Design (ISD) project in an obvious AAR-100 (Human Factors) context. Doug Farrow would be the natural FAA project monitor, and people with extensive aviation related ISD experience and training like Fred O’Neal, Jerry Bresee and others across the group would be natural participants.

Like AQP, this effort would never be “finished.” The initial intensive half-year of task analysis, assessment design and definition, and the first level of training development must be followed with on-going training upgrades, threat assessment and resulting training responses, and program monitoring and improvement.

### **Instructional Strategy Specifications**

The security task analysis will not be carried out in a vacuum. Experienced instructional designers will know that there are large and robust classes of skills, knowledge and performance (behaviors) that occur over and over in any field of endeavor. In addition, there is a considerable body of experience in aviation related instruction and testing, in particular, that can be brought to bear from the very beginning of this effort. Therefore it is essential to take advantage of this commonality to shorten the schedule of design and development activities. The immediacy of the need calls for carrying out the task analysis and the instructional strategy specification activities in parallel, each contributing to and being modified by the other.

In the teaching, practice, assessment and maintenance of complex human performance of all kinds, one size does not fit all. That is, the most effective and efficient way to teach, practice, test and maintain a sophisticated classification/discrimination task will be very different from the way you would train recall and performance of a sequential procedure. It is clear that both of these examples will be important in security training, and that the

clear specification of how each type of task should be taught, practiced, tested and maintained over time is important.

Experience tells us that more than the two classes of performance above will be uncovered by the task analysis. However, experience also tells us that the number of unique instructional strategies that will be needed for any training program will not be large. We know enough about the security problem to identify probably 4-8 instructional strategies which will be needed – and therefore to prepare for their development.

As soon as the subject matter experts for the task analysis can be convened, work should begin on the initial identification of the classes of skill/knowledge/performance that will be required in the security training. This initial taxonomy will be refined and modified as needed as the task analysis evolves. Definition and refinement of the corresponding instructional strategy specifications will also be developed and refined in parallel.

When the task analysis has identified the skills/knowledge/performance requirements for the security training, each task analysis element can be stated as a training objective with a measurable behavior, the conditions under which it is to be exhibited and the standard to which it will be judged. On the basis of the class of instructional problem the objective represents (determined primarily by the behavior), the objective will be assigned to one of the instructional strategy templates, which will then dictate how it is to be taught, practiced, tested and maintained.

We will gain significant ground on the threat if we focus our efforts on the performance we need from the people who maintain aviation security. We must not focus on content or subject areas. Traditionally taught security subjects may emerge from the training development process – or they may not. We care most about what the security team can do: identify a dangerous item, maintain sight of a suspicious person or object, communicate effectively with each other, and so on. We care about what people know only inasmuch as it affects what they can do.

## APPENDIX E

### EXPLICIT RISK ASSESSMENT AND COMMUNICATION

Prepared By

Judith Orasanu

NASA Ames Research Center

Moffett Field, CA

One area that traditionally has been ignored but that is critical in the arsenal being developed to counter security threats in the aviation industry is *explicit risk assessment and communication*. First, new threats to security are emerging throughout the aviation system. Thus, the *assessment* of these new threats is becoming even more critical in order to make safe decisions and to make appropriate decisions. Prior research on decision making indicates that these kinds of assessments are most difficult when the situations *are ill-structured*. Two components characterize ill-structured problems: those in which the cues signaling a potentially dangerous situation are ambiguous, or those in which the outcomes of different action options are uncertain. Obviously, the situation assessment component is primary; incorrect assessment can lead to missing or ignoring a potentially serious threat. By ambiguity, we mean that a complex of cues does not indicate a distinctly safe or unsafe situation; cues may conflict, or may be uninterpretable. Clearly, expertise is a major factor in making such judgments, but the big problem is training individuals with extremely varied levels of experience to be able to make safe assessments and judgments.

Part of the proposed cognitive task analysis that will feed into new security training should focus on procedures that can help individuals in varying jobs within the system to make their threat and risk assessment more EXPLICIT. While practically no solid research focuses on these specific skills with respect to security, we do know that when ambiguity exists on the flight deck, each crew member must pursue hunches that things may not be right. Risk typically is characterized by magnitude of negative outcomes and likelihood of occurrence. In security cases, the magnitude of an incorrect judgment is often huge. This means that ambiguous situations must be vigorously explored, despite potential costs associated with doing so, e.g., financial cost, social costs (face-to-face interactions with potentially dangerous people, as well as judgments by peers and managers of your handling of the situation), threats of lawsuits, etc. Management *policy must be clear* on this point, or individuals will not be willing to act.

Moreover, the risk assessment process should be externalized so that others can be involved. At this point, our current research on risk assessment by flight crews shows that it is a very implicit process. Crewmembers, like everyone else, *assume* that the other guy/gal knows what the risks are and understands threats the way they do. Clearly, this is not necessarily true. The likelihood that others perceive risks similarly decreases across

jobs because of different types of experience and training, as well as perspective differences, e.g., on board the aircraft (flight crews, cabin attendants, marshals), ground support (gate agents, dispatchers, maintenance personnel, etc.), and airspace controllers of various types. The related issue is COMMUNICATING perceived risks to others. We already know that social status/role factors play a major role in managing threatening situations on the flight deck (monitoring/challenging errors). These problems would be expected to be magnified in highly ambiguous threatening situations when individuals must communicate across borders. Obviously, management plays a CRITICAL role in establishing the norms and reward structures that support and encourage acting on hunches and helping to develop training procedures that support individual judgments and make the risk assessment and decision processes more explicit and effective.