ONBOARD CABIN WATER SPRAY PROGRAM

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Full-scale fire tests, conducted in the United Kingdom (U.K.) under the auspices of the Civil Aviation Authority (CAA), have demonstrated the feasibility of an onboard cabin water spray system for providing a marked improvement in survivability during a postcrash fuel fire. Developed and evaluated by SAVE, Ltd., the system produces a fine water spray or mist consisting of a "range of water droplet diameters." A fine water spray system, such as developed by SAVE, Ltd., is capable of providing fire protection with relatively low flow rates of water. The spray system that has been tested is a "breadboard" design for the purpose of demonstrating concept feasibility.

An outline of a program to develop a cabin water spray system for safe and effective installation in a commercial transport airplane has been prepared and is shown in a flow diagram (figure 1) depicting major projects and order of accomplishment. Initially, controlled full-scale tests are being conducted to document the additional time available for escape as provided by the current SAVE system. Concurrently, a study is being undertaken to address the various problems associated with an inadvertent discharge of the water spray system while an airplane is in flight or on the ground. The results of these initial studies will be factored into a benefit analysis to determine the potential for lives saved (similar to analyses conducted by the Federal Aviation Administration (FAA) and CAA for passenger protective breathing equipment).[1] Presuming that the benefits will outweigh the disbenefits, the next steps will be to optimize the spray system for installation in an airplane and to develop design requirements and specifications. Additional full-scale tests would follow to verify the additional time available for escape provided by the optimized system. Another benefits analysis would determine potential lives saved for the optimized system. Finally, a decision would be made as to whether to proceed with a regulation requiring an onboard spray system for the commercial airplane fleet.

The following is a brief description of the major projects:

1. FULL-SCALE EFFECTIVENESS TESTS (SAVE SYSTEM)

Purpose: Evaluate and determine the additional time available for escape provided by SAVE water spray system under controlled full-scale test conditions for several postcrash fire scenarios.

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[1]Hill, R.G., and Speitel, L., "Study of Benefits of Passenger Protective Breathing Equipment from Analysis of Past Accidents," Federal Aviation Administration Technical Center, Report No. DOT/FAA/CT-88/03, March 1988.

Method: Full-scale tests will be conducted under controlled conditions utilizing both a narrow body and wide body fuselage for several postcrash fire scenarios. One test will be conducted with the SAVE system installed and one test without the SAVE system for each fire scenario in order to determine the additional time available for escape. A section of the test article will be completely furnished with materials marginally compliant with the seat cushion and low heat release standards.

Responsibilities:

FAA - Preparation and conduct of full-scale tests.
CAA - Coordinate delivery of "SAVE" system to FAA.

Expected Outcome and Utilization:

Determination of additional time available for escape provided by SAVE water spray system for several important postcrash fire scenarios for input into benefit analysis computer program.

STATUS:

Full-scale tests were completed using a narrow body fuselage (707). Four scenarios were studied; (1) a large fuel fire entering a fuselage with zero wind, (2) a large fuel fire entering a fuselage with low wind, (3) a large fuel fire entering a fuselage with high wind, and (4) a large fuel fire burning through the fuselage skin and entering the cabin. The water spray system was extremely effective in prolonging survival time in all cases except the high wind condition.

Full-scale tests are presently underway in a wide body fuselage (similar in size to a DC-10). Final test results should be available by the end of 1990.

2. SERVICE CONSIDERATIONS AND DISBENEFIT STUDY (SAVE SYSTEM)

Purpose: Determine consequences of an accidental discharge of an onboard cabin water spray system both on the ground and in flight.

Method: A contract will be awarded to a major airframe manufacturer. The study will include, but will not be limited to, the following:

A. Effect of accidental water spray activation on safe operation of aircraft in flight.

B. Effect of water spray on rapid passenger evacuation and hypothermia during cold weather.

C. Impact of accidental water spray on aircraft airworthiness and extensiveness of repair work necessary to restore aircraft to service.

Responsibilities:

Contracts sponsored mainly by FAA and CAA. Coordination in preparation of work statement.

Expected Outcome and Utilization:

Input into benefit analysis computer program and identification of problem areas that need to be considered during optimization project.

STATUS:

Contractual study presently being conducted by Airbus Industries. Report should be available early 1991. Study by Boeing expected to commence in fall of 1990, to be completed by summer of 1991.

3. BENEFIT ANALYSIS STUDY (SAVE SYSTEM)

Purpose: Calculate the potential lives saved from the mandatory requirement for an onboard water spray system (SAVE, Ltd., design) based on an analysis of worldwide fire accidents in transport aircraft.

Method: Employ benefit analysis computer program developed by FAA Technical Center, utilizing data and information obtained from the previous projects, to determine potential savings in lives and cost of system weight and disbenefits. Perform computer analysis for 20 accidents with adequate information on fire development/evacuation and extrapolate results for remaining data base.

Responsibilities:

CAA, FAA, and Transport Canada Airworthiness Group (TCAG) team to work on computer analysis of 20 accidents.
CAA responsible for extrapolation to remaining data base and net safety benefit analysis.

Expected Outcome and Utilization:

Benefit/cost ratio of mandatory requirement of onboard spray system. Basis for decision as to whether or not to proceed to optimization and development of design requirements/ specifications.

STATUS:

The CAA is presently collecting data to update existing data base.

4. OPTIMIZATION OF SYSTEM

Purpose: Evaluate important parameters for water spray systems in order to optimize the effectiveness of spray per unit weight of water.

Method: Small-scale tests that lend themselves to parametric studies and complex measurements (such as droplet size distributions) will be conducted to determine the effect of droplet size/distribution and flowrate on water spray effectiveness. Full-scale or mockup tests will be needed to study system parameters. For example, method and time of activation and length of discharge will be studied, as well as possible effects of additives to the water (gas scrubbers and/or antifreeze agents). In addition, the pros and cons of a zoned versus total spray system will be evaluated.

Responsibilities:

CAA, FAA - Full-scale or mockup tests; small-scale tests

Expected Outcome and Utilization:

Information will be input to develop requirements and specifications.

STATUS:

Preliminary optimization tests sponsored by the CAA have been conducted by the Fire Research Station in the United Kingdom. Some full-scale tests are scheduled for early fall using a 707 fuselage. Results should be available early in 1991.

Various private companies in the U.K. have been conducting tests on their own. The FAA and CAA are monitoring the results of their tests. FAA plans to begin optimization tests in 1991.

5. SOLVE PROBLEMS OF DISBENEFITS

Purpose: Determine system design features for eliminating or reducing the likelihood or impact of problem areas uncovered during service consideration/disbenefits study.

Method: Will depend on problem areas encountered. May include the need for full-scale or small-scale tests or contractual studies.

Responsibilities: To be determined.

Expected Outcome and Utilization:

Input to develop requirements and specifications.

6. DEVELOPMENT OF REQUIREMENTS AND SPECIFICATIONS

Purpose: Develop requirements and specifications for regulatory provision for an onboard water spray system.

Method: Integrate needed test work with data from previous test work to develop minimum standards. One possible method of approach would be similar to the United States National Fire Protection Association (NFPA) Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Mobile Homes, NFPA 13D-1980. In this standard, certain design requirements, such as minimum flow rate per sprinkler head, area of coverage per sprinkler head, maximum distance between sprinklers, and maximum distance to a wall or partition are specified. Also, areas of the fuselage where mandatory water spray protection is required must be defined.

Expected Outcome and Utilization:

Minimum standards for possible regulatory action.

7. DETERMINE OTHER AREAS OF APPLICABILITY

Purpose: Determine if stored water from this system could be used for fire extinguishment suppression in other required areas of the aircraft.

Method: Test various potential usage areas for water spray application; e.g., cargo compartment and lavatory waste paper bin.

Responsibilities: To be determined.

Expected Outcome & Utilization: Input into benefit analysis

8. FULL-SCALE VALIDATION TESTS

Purpose: To validate the effectiveness of a water spray system designed to the minimum requirements for wide body and standard body aircraft and several postcrash fire scenarios.

Method: Full-scale tests will be conducted for several fire scenarios utilizing wide and standard body cabin configurations.

Responsibilities:

FAA conduct tests with input from CAA.

Expected Outcome and Utilization:

Input to final benefit analysis and decision on regulatory action.

9. BENEFIT ANALYSIS STUDY (MINIMUM STANDARD)

Note: Purpose, method and responsibilities identical to benefit analysis study for SAVE system except in this case the analysis will be done for a system compliant to the minimum standard. Similarly, the results of the study will be input into the decision on rulemaking.

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