Safety Regulation Group

Civil Aviation Authority

CAA PAPER 2002/04

A Benefit Analysis for Cabin Water Spray Systems and Enhanced Fuselage Burnthrough Protection

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A Benefit Analysis for Cabin Water Spray Systems and Enhanced Fuselage Burnthrough Protection

Report prepared by R G W Cherry & Associates Limited

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Contents

Executive Summary

A benefit analysis has been carried out to derive the life saving potential of a Cabin Water Spray system in conjunction with enhanced Fuselage Burnthrough Protection from large external pool fires. The effects of fire and evacuation related requirements that were introduced after the accident date have also been taken into account.

All benefits derived are based on the number of lives saved for the world fleet of western-built aircraft type certificated for more than 30 seats and are relative to the period 1967 to 1996.

Two configurations of Cabin Water Spray system have been considered in the benefit analysis - a Modular and a Singular system. It is assumed that a Modular system would consist of three separate water supplies located in the front, mid and rear sections of the fuselage and would be activated only in the areas affected by fire. A Singular system would have only one source of supply located in the centre section of the fuselage. It would provide benefit in this area should the nose and/or tail sections became detached in the accident.

Benefit has been determined for aircraft configurations having either enhanced Fuselage Burnthrough Protection or a Cabin Water Spray System. In addition, the study reassesses the benefit from Cabin Water Sprays on aircraft already configured with enhanced Fuselage Burnthrough Protection.

The analysis has been accomplished by analysing past accidents to western-built aircraft over the period 1967 to 1996. Two methodologies were used to determine the total assessed benefit for all accidents studied. The first was based on an assessment of the number of lives saved in each accident from which a determination was made of the average number of lives saved per year and its likely range. The second method was to determine the rate of occurrence per year of the number of accidents from which the improvements considered might yield benefit.

The merits of each method are discussed and it was considered that the best prediction of benefit is that derived from Method 2.

Enhanced Fuselage Burnthrough Protection has been reassessed and the life saving benefit increased from that previously estimated. The number of lives saved per year is estimated to be approximately 12.

The assessment for a Singular Cabin Water Spray system on aircraft that are configured without enhanced Fuselage Burnthrough Protection is approximately 27 lives per year.

The number of lives saved per year, by a Modular Cabin Water Spray system, on aircraft that are configured without enhanced Fuselage Burnthrough Protection is assessed to be approximately 34 lives per year.

The assessment for Singular Cabin Water Spray systems and enhanced Fuselage Burnthrough Protection combined is approximately 34 lives per year.

The number of lives saved per year by Modular Cabin Water Spray systems and enhanced Fuselage Burnthrough Protection combined is assessed to be approximately 46 lives per year.

For aircraft that are configured with enhanced Fuselage Burnthrough Protection, Cabin Water Spray systems would save a further 22 lives per year for a Singular system, and 34 lives per year for a Modular system.

1 Introduction

The purpose of this Analysis is to evaluate the potential benefit, in terms of lives saved, from enhanced Fuselage Burnthrough Protection and the implementation of Cabin Water Spray Systems. The benefit has been derived for each of these improvements being made separately and in combination. Both Singular and Modular Cabin Water Spray systems have been considered. A Singular system is one that has a single source of supply and a Modular system has multiple sources to provide improved protection from damage that might be incurred under impact conditions.

The analysis was based on a study of past accidents to western-built passenger carrying aircraft certificated for more than thirty seats.

The effect of fire and evacuation related requirements (e.g., Improved access to Type III exits, Fire Blocking layers for seats) that were introduced after the accident date has also been taken into account.

Two methodologies were used to determine the total assessed benefit for all accidents studied.

2 Objectives

The Objectives of the Analysis were to determine the benefit, in terms of number of lives to be saved per year, from accidents to western-built passenger carrying aircraft type certificated with more than 30 seats resulting from:

2.1 Enhanced Fuselage Burnthrough Hardening, providing five minutes of protection from large external pool fires, before the penetration of fire into the passenger cabin.

2.2 The incorporation of a Singular or Modular Cabin Water Spray system.

2.3 The incorporation of a Singular or Modular Cabin Water Spray system on aircraft configured with enhanced Fuselage Burnthrough Hardening providing five minutes of protection from large external pool fires.

The intention was that the analysis should be based on the outcomes of past accidents taking into account the effect of fire and evacuation requirements introduced after the accident dates.

3 Assumptions

A review was undertaken of published data on enhanced Fuselage Burnthrough Protection from pool fires and Cabin Water Spray systems. The more significant reference sources are contained in section 9. Based on these data a list of assumptions was compiled.

3.1 General

It was assumed that enhanced Fuselage Burnthrough Protection and Cabin Water Spray systems would have no opportunity to offer benefit in the following accident situations:

3.1.1 Where all fatalities were due to impact forces, e.g. aircraft impacted terrain, in-flight collisions with other aircraft and in-flight break-up of aircraft.

3.1.2 Where the aircraft fuselage was inverted at the end of the impact sequence. It was assumed that a Cabin Water Spray system would not operate under these conditions

and enhanced Fuselage Burnthrough Protection would only be effective on the bottom surface of the fuselage below window level.

3.2 **Burnthrough**

Enhanced Fuselage Burnthrough protection would provide five minutes of protection from a large external pool fire prior to penetration of the occupied areas of the aircraft.

3.3 **Cabin Water Spray**

3.3.1 Based on FAA full-scale fire tests, under different post crash fire scenarios, using both wide body and narrow body test articles it has been shown that the primary benefits of Cabin Water Spray systems are:

- Inhibiting flame spread and burning of cabin materials;
- Cooling cabin temperatures; and
- Delaying the onset of cabin flashover.

3.3.2 Cabin Water Spray systems would not be operated in flight.

3.3.3 Systems would use on-board dedicated water supplies.

3.3.4 The activation of systems would be automatic on the identification of a fire threat.

3.3.5 Systems would operate for three minutes.

3.3.6 All systems would have design features to ensure that they had the greatest chance of operating in accidents in which the fuselage breaks into sections. For example, pipes might contain check valves or self-sealing couplings installed such that, in the event of a pipe breaking, at least some of the system would remain effective.

3.3.7 A Modular system would consist of three separate water supplies located in the front, mid and rear sections of the fuselage and would be activated only in the areas affected by fire.

3.3.8 A Singular system would have only one source of supply and hence would be less crashworthy than a Modular system. It would be based in the centre section of the fuselage and provide some benefit in this area if the nose and/or tail sections became detached in the accident.

3.3.9 Whilst Cabin Water Spray systems might have some effect on the vision of evacuees, this is not considered an important factor in evacuation rates. From a study carried out by Cranfield University on behalf of the UK CAA (Ref. 9.8), it was concluded that:

"The results revealed that the evacuation times for the two conditions were virtually identical, the lack of a statistically significant difference suggesting that the presence of the water spray did not affect evacuation rates."

Hence, it has been assumed that a Singular Cabin Water Spray system might cause some minimal reduction in visibility in areas of the aircraft that are not immediately affected by the fire. A Modular system would have no effect on visibility within inactivated zones.

4 Selection of Accidents

4.1 Data Sources

The Cabin Safety Research Technical Group Accident Database (Ref. 9.3) was used as a basis for the selection and analysis of accidents supported by Accident Reports published by the National Investigating Authorities.

4.2 Accident Selection Criteria

Accidents, involving passenger-carrying western-built aircraft, were selected from the Accident Database over the period 1967 to 1996. The criteria used for the selection of accidents was as follows:

4.2.1 The accident resulted in at least one fatality.

4.2.2 The accident was fire related.

4.2.3 The aircraft was type certificated with more than 30 seats.

4.2.4 The aircraft was a western-built turbojet or turboprop.

4.3 Selection of Accidents for Analysis

Using the criteria defined in paragraph 4.2, 179 accidents were identified from the Accident Database that met all four criteria. These accidents were reviewed and those having insufficient information to determine whether enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems might have been of any benefit were removed from the data set. In particular, accidents were removed where cause of death or the condition of the cabin after impact could not be ascertained. This resulted in the selection of 136 accidents for analysis.

5 Method

5.1 Assessment of Benefit for Each Accident

5.1.1 General

Each of the accidents analysed is described in the Rationales contained in Appendix 1. As well as a Resume of the accident, these Rationales also contain the basis on which the benefit predictions were made. The assessments took into account the circumstances of the accident and in particular:

- The number of occupants injured as a result of the impact
- The orientation and number of breaks in the fuselage
- The level of damage to internal trim (for Cabin Water Spray performance)
- The level of damage to the fuselage skin
- The characteristics of the fire
- The fire entry points
- The number and position of useable exits
- The hazard presented to evacuees from external fires
- The time taken for the Crash Rescue Teams to arrive

5.1.2 Accident Scenarios

The severity of hazard in an accident can vary markedly throughout the aircraft. Experience has shown that considering occupant injuries on a "whole" aircraft basis

can be misleading when assessing the effects of improvements. It is therefore beneficial where sufficient data are available to divide the aircraft into Scenarios.

A Scenario is defined as:

"That volume of the aircraft in which the occupants are subjected to a similar level of threat."

A similar level of threat need not necessarily result in the same level of injury to occupants. The extent of injury sustained can vary with numerous factors including age, sex, adoption of the brace position etc. Furthermore, the threat to occupants can vary over relatively small distances. For example, a passenger may receive fatal injuries because of being impacted by flying debris, and a person in an adjacent seat may survive uninjured. Dividing accidents into scenarios provides a more meaningful basis on which to analyse accidents than considering the whole aircraft due to the marked variation in survival potential with occupant location.

The flight deck and flight attendant areas are generally considered as separate scenarios. The flight deck often has the potential for greater impact damage and crewmembers usually have full harness restraints. Furthermore, sliding cockpit windows in the area provide a nearby method of egress. Due to the significant differences in seating, restraint systems, and exit availability the forward flight attendant areas are normally considered as a separate scenario from the passenger cabin.

For these reasons, where sufficient data are available, the analytical work is based on assessments carried out for each scenario.

5.1.3 **Later Requirements**

Each accident was first analysed taking into account the improvements that might have been made to the number of fatalities and injuries if the aircraft had been configured to later requirements. Consideration was given to later requirements that improved the evacuation capability of the aircraft (e.g. Improved access to Type III exits) or the flammability characteristics of the cabin (e.g. Seat Blocking Layers). Changes to the requirements affecting the crashworthiness of the cabin have not been considered. Improvements that reduce the number of impact injuries will result in the potential for more lives being saved as a result of improvements to the flammability or evacuation capabilities of the aircraft. However, for the accidents analysed it is considered that changes in the crashworthiness standards of aircraft would have a minimal effect on the assessment of benefit from Cabin Water Spray systems or enhanced Fuselage Burnthrough Protection.

The later fire and evacuation related requirements that were considered in reassessing the accidents are:

- Seat blocking layers
- Floor proximity lighting/marking
- Reduced heat release of cabin interior materials
- Improved access to Type III exits
- Smoke detection in toilet compartments
- Additional fire extinguishers in passenger compartments

Where not known, it was assumed that aircraft in accidents after the end of 1987 would have had later fire and evacuation related requirements embodied. The exception was for reduced heat release of cabin interior materials, which applied to

newly manufactured aircraft or cabin interior renewal. Accidents soon after 1988 were reviewed in an attempt to determine whether such materials had been fitted.

5.1.4 Assessment of Benefit for enhanced Fuselage Burnthrough Protection

Each accident was analysed to assess the life saving potential that would result had the fuselage been able to withstand burnthrough from an external pool fire for a 5-minute period. This assessment was made taking into account the benefit from later fire and evacuation related requirements. The prime intent of assessing the benefit from enhanced Fuselage Burnthrough Protection was to establish a basis for the determination of Benefit from Cabin Water Spray systems. Therefore no attempt was made to determine a range for the prediction of number of lives saved.

The resultant number of Fatalities, Serious Injuries and Survivors formed a basis for the subsequent determination of benefit that might accrue for Cabin Water Spray systems for an aircraft configured to the latest fire and evacuation related requirements and with enhanced Fuselage Burnthrough Protection.

5.1.5 Assessment of Benefit for Cabin Water Spray Systems - Singular

Each accident was analysed to assess the benefit that would result had the aircraft been fitted with a Singular Cabin Water Spray system. The assessment took into account the likelihood that the system would remain in an operating condition following the impact sequence.

The benefit was assessed relative to later requirements and then reassessed relative to later requirements and enhanced Fuselage Burnthrough Protection.

An assessment was made for each accident of the maximum (High) and minimum (Low) number of lives to be saved as well as the best assessment (Median).

5.1.6 Assessment of Benefit for Cabin Water Spray Systems - Modular

Each accident was analysed to assess the benefit that would result had the aircraft been fitted with a Modular Cabin Water Spray system, having three separate systems in the front, centre and rear sections of the fuselage. The assessment took into account the likelihood that each of the three systems would remain in an operating condition following the impact sequence.

The benefit was assessed relative to later requirements and then reassessed relative to later requirements and enhanced Fuselage Burnthrough Protection.

An assessment was made for each accident of the maximum (High) and minimum (Low) number of lives to be saved as well as the best assessment (Median).

5.2 Assessment of Benefit for all Accidents Analysed

5.2.1 Method 1 Statistical Modelling

The assessments of the range of fatalities, for each accident, made following the introduction of Cabin Water Spray systems were subjected to a Monte Carlo simulation process with the intent of assessing the likely range of benefit from all accidents.

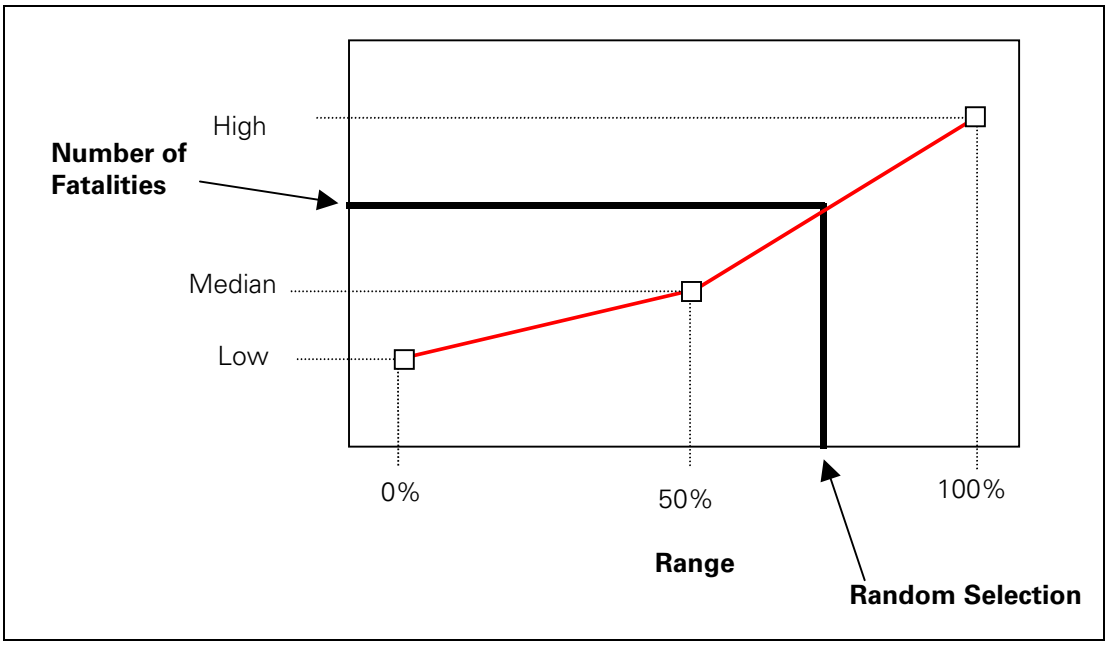

Figure 1 Random Selection of Number of Fatalities

It is assumed that there can be 100% confidence in the range between the High and Low prediction of number of fatalities for each accident with the Median prediction representing the 50 percentile as illustrated in Figure 1. A random selection is made over the range 0% to 100% to arrive at a particular number of fatalities. The number of lives saved is simply the difference between this number of fatalities and the number assessed for the accident had the aircraft been configured to the latest requirements and enhanced Fuselage Burnthrough Protection.

This process is repeated a number of times, typically 10,000, to produce a statistical distribution of the number of lives saved as illustrated in Figure 2.

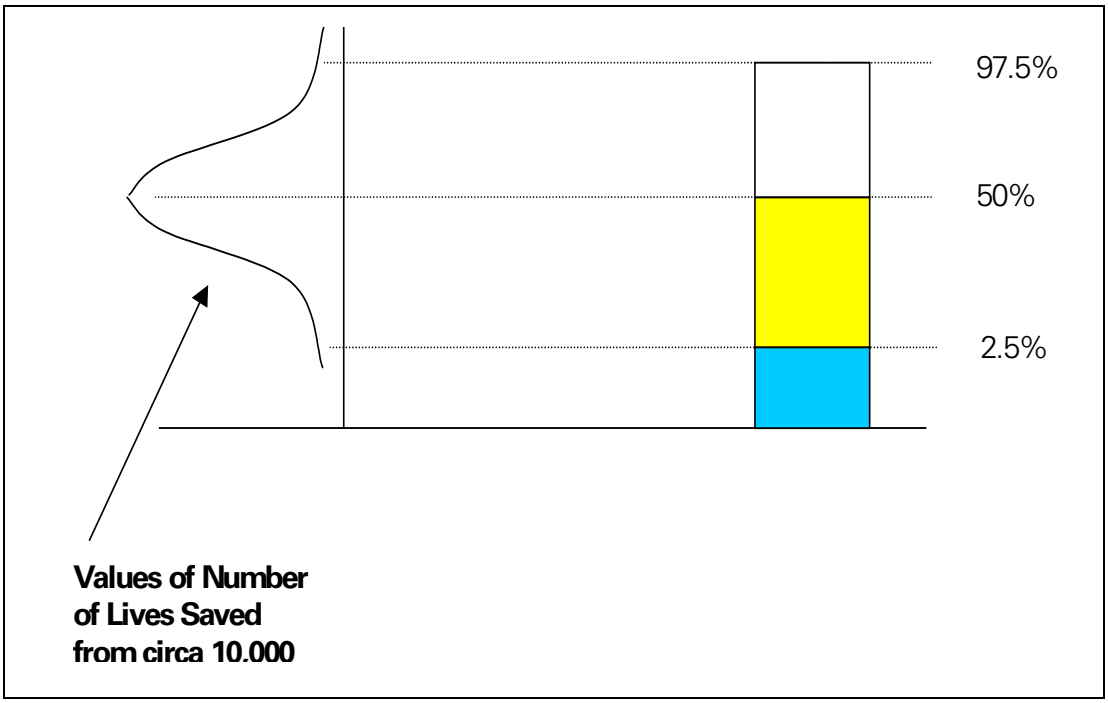

Figure 2 Distribution of Number of Lives Saved

The 2½, 50 and 97½ percentiles may be determined from the resulting distributions. In many instances, the Mean and Median (50 percentile) are not the same value since the derived distributions are not symmetrical. The best estimate of the number of lives saved is taken as the 50 percentile.

5.2.2 **Method 2 Rate of Occurrence Methodology**

Based on the assessment of lives saved, as described in paragraphs 5.1.1 to 5.1.6, a determination could be made of the number of accidents yielding benefit, N, for each of the improvements under consideration. By dividing this value by the period over which accidents were analysed, 30 years, an annual rate of occurrence of accidents providing benefit, n, could be determined.

From the determination of the number of lives that might be saved in each of the accidents, due to the improvements made, an assessment could be made of the change in Fatality Rate (See paragraph 10). This is simply the assessed reduction in the number of fatalities, or number of lives saved, divided by the total number of occupants on-board the accident aircraft. The average change in Fatality Rate, f, for all of the accidents yielding benefit, for the improvement under consideration, could then be determined.

An assessment was made of the average number of occupants, P, on-board all of the accident aircraft satisfying the selection criteria described in paragraph 4.2. By multiplying the average change in Fatality Rate, f, by the average number of occupants, P, an assessment may be made of the average number of lives to be saved in an accident in which benefit is assessed to occur. If this value is multiplied by the annual rate of occurrence of accidents providing benefit, n, then the average number of lives saved per year for the accidents analysed, b, may be determined.

Therefore, the expression for the number of lives saved per year, b, for the accidents analysed is given by:

b = n x f x P 1

5.3 **Assessment of Benefit for the World Fleet of Western Built Aircraft**

The assessment of benefit using the methodologies described in paragraph 5.2 relates to the accidents analysed. In order to determine the total benefit for all western-built aircraft allowance must be made for the number of lives that might be saved in accidents for which insufficient data exist to make determinations. This assessment is made on the basis that those accidents having insufficient information to make a determination are from the same data set as those accidents analysed and hence would yield similar levels of benefit.

As may be seen from paragraph 4 the number of fire related accidents selected from the Accident Database that satisfied the selection criteria was 179.

Of these, 136 Accidents had sufficient information available to assess benefit.

Over the period 1967 to 1996 there were 66 non-fire related accidents to western-built aircraft on the database and 181 accidents where insufficient data exists to establish whether they were fire related or not.

Of these 181 accidents it is likely that the number that were fire-related would be:

$$\frac{179}{(179 + 66)} \times 181$$

or approximately 132.

Therefore, the ratio of fire related accidents with sufficient information available to assess the nature of the fire and the likely total number of fire related accidents over the period 1967 to 1996 would be:

$$\frac{179 + 132}{136}$$

This is approximately equal to 2.29

It is assumed that the fire related accidents not having sufficient data to assess benefit would yield proportionate benefit to those where sufficient information was available to make a determination. On this basis, the derived benefit from the accidents analysed would need to be multiplied by the factor 2.29 to determine the number of lives saved for the world fleet of western-built aircraft over the period 1967 to 1996. The factor is to be applied to the benefit derived from both methodologies.

6 Analysis and Results

The rationales for each of the 136 accidents analysed appear in Appendix 1. A summary of the benefit assessment is contained in Appendix 2.

6.1 Method 1 Statistical Modelling

The methodology described in paragraph 5.1 was applied to the accidents selected for analysis. This resulted in an assessment of the resultant number of fatalities that might be expected had the aircraft been configured to the latest fire and evacuation related requirements, as shown in the Table contained in Appendix 2. An assessment was then made of the additional lives to be saved following the introduction of each of the improvements addressed by this analysis.

6.1.1 Benefit from enhanced Fuselage Burnthrough Protection

As may be seen from Appendix 2, for aircraft configured with enhanced Fuselage Burnthrough Protection alone, the benefit derived from accidents that were analysed is 207 lives saved over the period 1967 to 1996. This equates to a saving of 6.9 lives per year. By applying the factor of 2.29 derived in paragraph 5.3 the assessed benefit per year for the world fleet of western-built aircraft is:

16

6.1.2 Benefit from Cabin Water Spray systems

Cabin Water Spray systems without enhanced Fuselage Burnthrough Protection

Had the aircraft analysed been configured with a Cabin Water Spray systems (but without enhanced Fuselage Burnthrough Protection) it is assessed from the statistical model that the benefit would be as shown in Table 1.

Table 1 Benefit assessments for the aircraft analysed configured with a Cabin Water Spray system

	Singular Cabin Water Spray system	Modular Cabin Water Spray system
2½ percentile	13.0	16.4
50 percentile	15.8	19.6
97½ percentile	18.8	22.8

Applying the factor of 2.29 derived in paragraph 5.3 the assessed benefit per year for the world fleet of western-built aircraft would be as shown in Table 2..

Table 2 Benefit assessments for the world fleet of western-built aircraft over the period 1967 to 1996 configured with a Cabin Water Spray system

	Singular Cabin Water Spray	**Modular Cabin Water Spray**
2½ percentile	29.8	37.5
50 percentile	**36**	**45**
97½ percentile	43.0	52.2

Cabin Water Spray benefit in addition to enhanced Fuselage Burnthrough Protection

Had the aircraft analysed been configured with a Cabin Water Spray system and with enhanced Fuselage Burnthrough Protection, it is assessed from the statistical model that the benefit would be as shown in Table 3.

Table 3 Benefit assessments for the aircraft analysed configured with a Cabin Water Spray system in addition to enhanced Fuselage Burnthrough Protection

	Singular Cabin Water Spray	**Modular Cabin Water Spray**
2½ percentile	17.7	21.4
50 percentile	**21.0**	**25.3**
97½ percentile	24.5	29.7

Applying the factor of 2.29 derived in paragraph 5.3 the assessed benefit per year for the world fleet of western-built aircraft is as shown in Table 4.

Table 4 Benefit assessments for the world fleet of western-built aircraft over the period 1967 to 1996 configured with a Cabin Water Spray system in addition to enhanced Fuselage Burnthrough Protection

	Singular Cabin Water Spray	**Modular Cabin Water Spray**
2½ percentile	40.5	49.0
50 percentiles	**48**	**58**
97½ percentile	56.1	68.0

On this basis, Cabin Water Spray systems would provide an additional benefit on aircraft configured with enhanced Fuselage Burnthrough Protection of:

For a Singular system 48 - 16 = **32** lives per year

For a Modular system 58 - 16 = **42** lives per year

6.2 Method 2 Rate of Occurrence Methodology

6.2.1 Benefit from enhanced Fuselage Burnthrough Protection

By using equation 1 in 5.2.2 the number of lives saved per year for the accidents analysed, **b**, may be assessed by simply multiplying the derived values of **n**, **f** and **P**.

Of the accidents analyzed, 17 were found to yield benefit from enhanced Fuselage Burnthrough Protection.

The Number of Relevant Accidents per Year, **n**, is determined by simply dividing the number of accidents, 17, by the number of years analysed, 30. As may be seen from Table 6 this equates to 17 ÷ 30 = .57

For each of the seventeen accidents a determination was made of the number of Fatalities and Survivors had the aircraft been configured to the latest fire and evacuation related requirements. The additional lives saved from enhanced Fuselage Burnthrough Protection was then assessed. The Fatality Rate change may then be derived by simply dividing this assessed number of lives saved by the total number of occupants on board the accident aircraft. The Fatality Rate change is shown, for each of the seventeen accidents, together with the Average Fatality Rate Change, **f**, for all of the accidents, .088, in Table 5.

The assessment of the average number of occupants, **P**, on-board all of the accident aircraft satisfying the selection criteria described in paragraph 4.2 was found to be 105.8 as shown in the fourth column of Table 6.

As may be seen in Table 6:

$$\mathbf{b} = .57 \times .088 \times 105.8 = 5.3.$$

Applying the factor of 2.29 derived in paragraph 5.3 the assessed benefit per year for the world fleet of western-built aircraft, **B**, is:

$$5.3 \times 2.29 = 12.0$$

Table 5 Change in Fatality Rate for all accidents assessed to have the potential for Benefit from enhanced Fuselage Burnthrough Protection

ACCIDENT NUMBERS	FATALITY RATE CHANGE f
17	0.088
1	0.292
2	0.257
3	0.178
4	0.135
5	0.120
6	0.116
7	0.089
8	0.065
9	0.056
10	0.044
11	0.039
12	0.032
13	0.024
14	0.015
15	0.014
16	0.009
17	0.006

Table 6 Derivation of Burnthrough Benefit using Rate of Occurrence Methodology

NUMBER OF RELEVANT ACCIDENTS N	FATALITY RATE CHANGE	NUMBER OF ACCIDENTS PER YEAR n	AVARAGE NUMBER OF OCCUPANTS OVER THE 30 YEAR PERIOD P	LIVES SAVED PER YEAR FOR THE ACCIDENT ANALYSED b	LIVES SAVED PER YEAR FOR THE WORLD FLEET B
17	0.088	0.57	105.8	5.3	12.0

6.2.2 Benefit from Cabin Water Spray systems

Using the same methodology for enhanced Fuselage Burnthrough Protection, the Benefits were derived for Cabin Water Spray systems for each of the aircraft configurations under consideration. A summary of these benefits, derived from the Rate of Occurrence Methodology for the world fleet of western-built aircraft, is as shown in Table 7.

Table 7 Lives Saved per year based on the Rate of Occurrence Methodology

	NUMBER OF RELEVANT ACCIDENTS	FATALITY RATE CHANGE	NUMBER OF RELEVANT ACCIDNETS PER YEAR	AVERAGE AGE OF OCCUPANTS OVER THE 30 YEAR PERIOD	LIVES SAVED PER YEAR FOR THE ACCIDENTS ANALYSED
	N	f	n	P	b
BURNTHROUGH ONLY	17	0.088	0.57	105.8	5.3
SINGULAR CABIN WATER SPRAY	32	0.104	1.07	105.8	11.8
MODULAR CABIN WATER SPRAY	33	0.127	1.10	105.8	14.8
SINGULAR CABIN WATER SPRAY AND ENHANCED FUSELAGE BURNTHROUGH PROTECTION	33	0.129	1.10	105.8	15.0
MODULAR CABIN WATER SPRAY AND ENHANCED FUSELAGE BURNTHROUGH PROTECTION	39	0.146	1.30	105.8	20.0
ADDITIONAL BENEFIT PROVIDED BY SINGULAR CABIN WATER SPRAY FOR AIRCRAFT CONFIGURED WITH ENHANCED FUSELAGE BURNTHROUGH PROTECTION	26	0.106	0.87	105.8	9.8
ADDITIONAL BENEFIT PROVIDED BY MODULAR CABIN WATER SPRAY FOR AIRCRAFT CONFIGURED WITH ENHANCED FUSELAGE BURNTHROUGH PROTECTION	33	0.127	1.10	105.8	14.8

7 Discussion

7.1 Accuracy of Predictions

The analytical methods employed are intended to provide as accurate an assessment as is possible with the available data, using the mathematical tools currently in existence. However there will still remain an element of uncertainty associated with assessments of this kind, and this should be borne in mind when making decisions concerning aircraft safety that are predicated on the results of this analysis. Any analysis of this kind must involve a degree of subjective judgement and relies on the accuracy of the data available.

7.1.1 Assumptions

The methodologies utilised are aimed at providing a good indication of the benefit likely to be achieved. Certain assumptions have been made in the analysis of data and the more significant are described in section 3.

7.1.2 Sample Size

One hundred and thirty six accidents were analysed in this study. Sample sizes of this magnitude are likely to provide a reasonable representation of the world fleet of western-built aircraft. The ranges of benefit indicated in the section 6 of this report are representative of an error band in the assessment for the accidents that were studied.

7.2 Assessment of Benefit for Enhanced Fuselage Burnthrough Protection

7.2.1 Comparison of results from the two methods used in this analysis

The benefits derived in this analysis for enhanced Fuselage Burnthrough Protection were 16 and 12 from methods 1 and 2 respectively. The difference between these two values may be expected since the average number of occupants on board the seventeen aircraft from which benefit was found was 132 whereas the average for all accidents analysed was 105.8. The accidents for which benefit was found had approximately 25% more occupants than the complete data set of all accidents analysed. The 25% difference almost totally accounts for the difference in derived benefit. Method 2 is, in this respect, is more representative since the derived benefit is based on the average number of occupants likely to be on board aircraft meeting the criteria used in this analysis.

On this basis, it is considered that the best prediction of benefit is that derived from Method 2 i.e. 12 lives per year for western-built aircraft.

7.2.2 Comparison with earlier analyses

The benefit derived in the earlier Benefit Analysis for enhanced Fuselage Burnthrough Protection (Ref. 9.1) was 10.1 lives per year for 4 minutes of protection for the world fleet of aircraft.

The assumption made in this analysis was that the protection provided would be 5 minutes. However, this difference in protection time is not likely to affect significantly the derived benefit. The earlier study assessed that increases in protection time from 4 to 8 minutes would result in the benefit increasing from 10.1 to 10.5 lives per year for the world fleet.

Since the current analysis was based on western-built aircraft only, it might be expected that the benefit would be less than 10.1 rather than higher at 12. It is assessed that approximately 78% of accidents worldwide are to western-built aircraft. Therefore, based on the earlier assessment it might be expected that the benefit from western-built aircraft would be closer to 8 lives per year.

However, there are differences in the assessment of benefit made in the earlier study and that made in the current analysis. The most significant is the factor applied to escalate the benefit from the accidents studied to that for all accidents. The current Accident Database at version 16 contains significantly more data now than was the case at the time of the earlier study. Although for some accidents the data are still limited it might be expected that the assessment of benefit determined in this analysis would be more accurate than the earlier study because of improvements in the data.

As part of the earlier analysis, (Ref. 9.1) an assessment of benefit was based on a "Representative Set" of accidents. The "Representative Set" of 55 accidents was selected such that it had similar attributes to the entire population of survivable accidents. Within the set, there were four burnthrough accidents. It was assessed that the four accidents had the potential for 62 lives to be saved for an additional eight minutes of protection time for an aircraft configured to the latest fire and evacuation

related requirements. This amounted to 14 lives per year, which approximates to 11 lives per year for western built aircraft.

7.3 Assessment of Benefit for Cabin Water Spray Systems

7.3.1 Comparison of results from the two methods used in this analysis

The assessments of number of lives saved based on the two methodologies are shown in Table 8.

Table 8 Benefit assessments for the world fleet of western-built aircraft over the period 1967 to 1996 configured with a Cabin Water Spray system

	Singular Cabin Water Spray system	Modular Cabin Water Spray system
Method 1	36	45
Method 2	27	34

It may be seen that as with the assessments for enhanced Fuselage Burnthrough Protection, Method 2 produces lower assessments of benefit than Method 1. The reasons for the differences are also similar in that the accidents assessed to have benefit involved aircraft with a greater number of occupants than might normally be found on aircraft of the type considered in this analysis. The average number of occupants on-board the aircraft from which benefit was found was approximately 127 whereas the average for all accidents analysed was 105.8. The accidents for which benefit was found had approximately 20% more occupants than the complete data set of all accidents analysed. The 20% difference almost totally accounts for the difference in derived benefit. Method 2 is, in this respect, more representative since the derived benefit is based on the average number of occupants likely to be on board aircraft meeting the criteria used in this analysis.

On this basis, it is considered that the best prediction of benefit is that derived from Method 2.

7.3.2 Comparison with earlier analyses

An earlier Benefit Analysis (Ref. 9.2) concluded that:

> "today cabin water sprays would save on average 14 lives per year world-wide."

This compares with 34 lives per year for a Modular Cabin Water Spray system for western-built aircraft derived from this analysis. The prime reasons for the significant difference between these two are as follows:

1. There are a significant number of accidents with little or no information available and hence could not be analysed to determine benefit. All of the accidents over the period 1967 to February 1991, analysed in the earlier study, were considered in this study. However, it is assessed that this represents less than 50% (1/2.29) of the accidents that should have been analysed to determine benefit from improvements in the fire safety characteristics of aircraft. The availability of the Accident Database (Ref. 9.3) has enabled projections to be made for benefit appropriate to the world fleet of western-built aircraft based on an analysis of a limited data set of accidents. It may be seen from Table 7 that the lives saved per year for a Modular Cabin Water Spray system for the accidents analysed is 14.8. This is similar to the value of 14 derived in the earlier study even though the assessed benefit for some of the accidents was different in the two analyses.

It is therefore concluded that the application of the 2.29 factor in this study is the prime reason for the difference in the benefit derived from the earlier analysis.

2. This analysis considered 136 accidents over the period 1967 to 1996 whilst the earlier study considered 95 accidents over the period 1966 to February 1991- both to western-built aircraft. The differences in the size and time period of the two data sets would tend to produce some variations in the assessed benefit.

7.3.3 Modular v Singular

As might be expected the Modular system is assessed to save a greater number of lives than the Singular System. The prime reasons for this is that the Modular system has significantly greater crashworthiness than the Singular system.

7.4 Assessment of Benefit for Cabin Water Spray Systems in Combination with Enhanced Fuselage Burnthrough Protection

Cabin Water Spray systems have been assessed to show significant benefit to aircraft configured with enhanced Fuselage Burnthrough Protection. The primary reasons for this are:

- Cabin Water Spray systems will provide benefit in circumstances where fire enters the cabin via fuselage breaks, doors or windows. In circumstances such as these, the benefit from enhanced Fuselage Burnthrough Protection will be reduced. However, the combination of both systems can provide additional time for occupants to evacuate.
- In circumstances where the fire is internal to the cabin, enhanced Fuselage Burnthrough Protection would provide no life saving potential whereas a Cabin Water Spray system would.

For the reasons given in paragraph 7.2 and paragraph 7.3, Method 2 is considered to give the more representative assessment of benefit.

- Figure 3 and Figure 4 illustrate the resultant benefit in terms of number of lives saved per year by a Modular and Singular Cabin Water Spray system respectively. It may be seen that for a Modular System the assessed Benefit provided by a Cabin Water Spray system fitted to an aircraft configured without enhanced Fuselage Burnthrough Protection is 34 lives per year. The assessed Benefit for an aircraft configured with enhanced Fuselage Burnthrough Protection is also 34. The Benefit from the Cabin Water Spray system is reduced, to some extent, by the lives having been saved by enhanced Fuselage Burnthrough Protection. However, this is compensated for by the two improvements providing sufficient protection in combination than the sum of the two individually. This situation does not appear to be the same for the Singular Cabin Water Spray system in that the two improvements combined result in less Benefit than the sum of the two individually. However, it is considered that the levels of accuracy of the predictions of Benefit

are such that no firm conclusions can be made regarding the differences between the two types of systems in this respect.

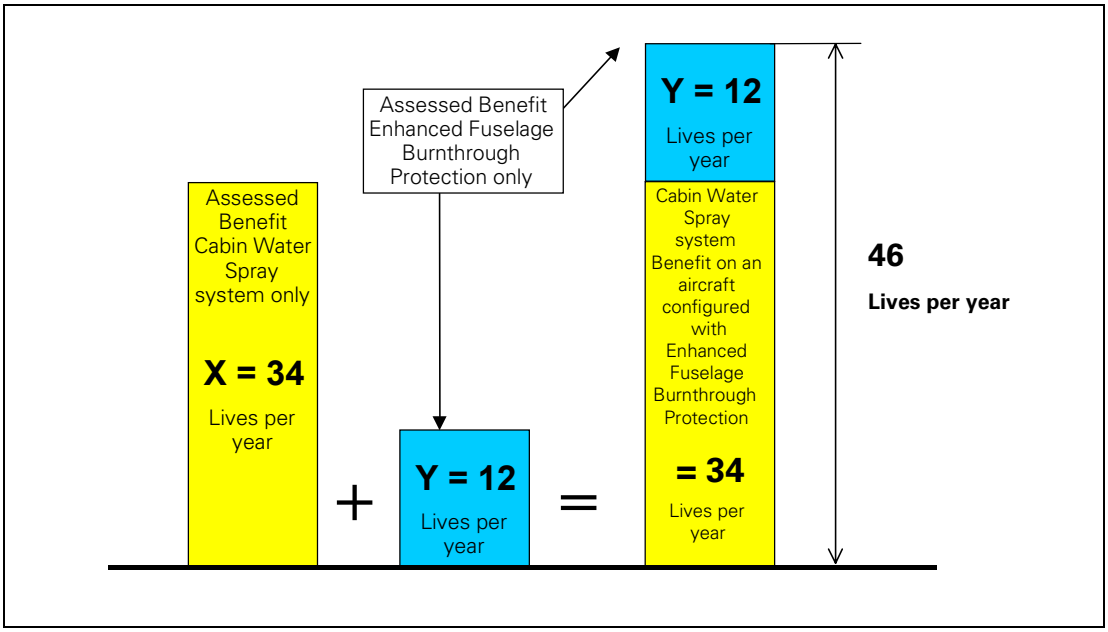

Figure 3 Illustration of Benefit combination for enhanced Fuselage Burnthrough Protection and a Modular Cabin Water Spray system

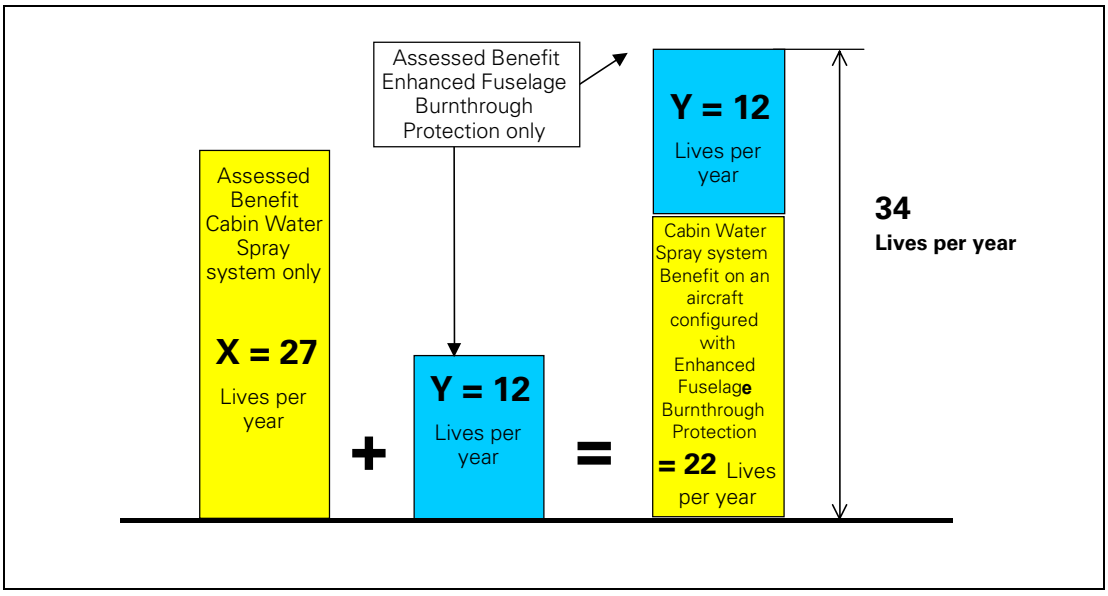

Figure 4 Illustration of Benefit combination for enhanced Fuselage Burnthrough Protection and a Singular Cabin Water Spray system

In summary, it is considered that the Benefit from Cabin Water Spray systems is:

- Reduced on aircraft fitted with enhanced Fuselage Burnthrough Protection due to the life saving already provided by this improvement.

  For example, when considering an accident scenario, following the application of later requirements, it might be assessed that the number of fire fatalities was five. If it were then assessed that all five could be saved by enhanced Fuselage Burnthrough Protection alone there would be no further benefit to be obtained

from a Cabin Water Spray system. However, if only a Cabin Water Spray system were fitted, with no enhanced Fuselage Burnthrough Protection, then it may still be assessed that the five fire fatalities might still be saved. Therefore, the addition of enhanced Fuselage Burnthrough Protection would reduce the assessed benefit for a Cabin Water Spray system by five

- Increased as a result of the two improvements combining in a synergistic way to provide additional Benefit

  For example, when considering an accident scenario, following the application of later requirements, it might be assessed that the number of fire fatalities was sixty. It may further be assessed that ten could be saved by enhanced Fuselage Burnthrough Protection alone and fifteen could be saved by a Cabin Water Spray system alone. However, if both were incorporated then it may be possible that there would be a significant increase in the time available for evacuation. With the enhanced Fuselage Burnthrough Protection slowing penetration of the fire into the fuselage, and the Cabin Water Spray system improving the cabin environment, significantly more than twenty-five lives might be saved.

7.5 Flight Time Prior to the Accident

For this analysis, it has been assumed that the Cabin Water Spray systems have dedicated water supplies. It has been suggested that use may also be made of the existing potable systems on aircraft. Since these systems would deplete during flight, they may be less likely to function effectively should the accident occur at the end of a flight. It was stated in the earlier benefit analysis (Ref 9.2) that:

> "From the information obtained it would appear that in only 50% of landings could it be safely assumed that sufficient water would remain available."

However, adequate quantities of water should always be available from potable systems if the accident occurred early in the flight.

For those accidents that were assessed to have benefit potential from a Cabin Water Spray system, more than 50 % occurred at, or shortly after, take-off. A more detailed study of the Accident Reports was made to determine the flight time prior to the accident where this information was available. The distribution of these flight times is shown in Figure 5.

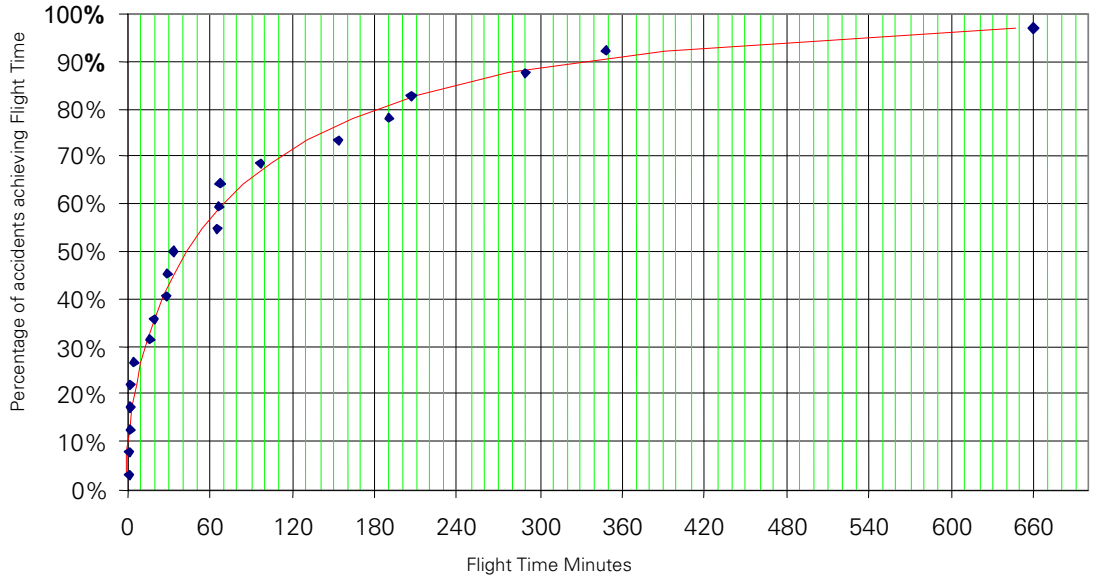

Figure 5 Distribution of Flight Times prior to an accident in which Cabin Water Sprays would be of benefit

The probability of there being sufficient water on-board at the time of an accident is dependent on many factors, other than simply flight time duration prior to the accident. These factors include the frequency of replenishment, the number of passengers on board and the system capacity. The earlier benefit analysis for Cabin Water Spray systems (Ref. 9.2) concluded that a system supplied by the on-board potable system would provide 44% of the benefit that might be obtained from a system with a dedicated supply. If it were assumed that all of the accidents represented in Figure 5 yielded equal benefit then 44% would involve flight times of less than 30 minutes. This is sufficiently low that a reasonable level of confidence may be attributed to a Cabin Water Spray system functioning adequately from the on-board potable water system.

However, aircraft with longer flight times tend to be larger aircraft and hence are likely to involve a greater number of fatalities in any accident. Therefore, it is likely that the aircraft, with longer flight times to the accident, would yield greater benefit from a Cabin Water Spray system provided there was water still available.

The precise determination of benefit that might be accrued from the use of on-board potable systems is outside the scope of this analysis. However, it is likely that for a significant proportion of accidents a Cabin Water Spray system would function adequately from this source.

8 Conclusions

It is assessed that for the fleet of western-built aircraft operating over the period 1967 to 1996 the number of lives to be saved from enhanced Fuselage Burnthrough Protection and Cabin Water Spray systems would be:

Table 9

	Benefit
Enhanced Fuselage Burnthrough Protection only	**12**
Singular Cabin Water Spray	**27**
Modular Cabin Water Spray	**34**
Singular Cabin Water Spray installed on an aircraft with Enhanced Fuselage Burnthrough Protection	**34**
Modular Cabin Water Spray installed on an aircraft with Enhanced Fuselage Burnthrough Protection	**46**
Additional Benefit provided by Singular Cabin Water Spray installed on an aircraft with Enhanced Fuselage Burnthrough Protection	**22**
Additional Benefit provided by Modular Cabin Water Spray installed on an aircraft with Enhanced Fuselage Burnthrough Protection	**34**

9 References

9.1 FAA Paper DOT/FAA/AR-99/57 Fuselage Burnthrough Protection for Increased Postcrash Passenger Survivability: Safety Benefit Analysis Based on Past Accidents. (August 1999)

9.2 UK CAA Paper 93010, Cabin Water Sprays for Fire Suppression: Design Considerations and Safety Benefit Analysis Based on Past Accidents. (August 1993)

9.3 UK Cabin Safety Research Technical Group Accident Database Version 4.3 Issue 16

9.4 UK CAA Paper 87017, Smoke hoods: net safety benefit analysis. (November 1987)

9.5 UK CAA Paper 93009, Cabin Water Sprays for Fire Suppression: An Experimental Evaluation (March 1993)

9.6 UK CAA Paper 93012, International Cabin Water Spray Research Management Group: Conclusions of Research Programme. (June 1993)

9.7 UK CAA Paper 93011, Cabin Water Sprays for Fire Suppression: A Cost Analysis (July 1993)

9.8 UK CAA Paper 93008, Aircraft Evacuations: The Effect of a Cabin Water Spray System upon Evacuation Rates and Behaviour (March 1993)

10 Definitions

Fatal Injury (Source: NTSB, ICAO)

"An injury resulting in death within thirty days of the date of the accident."

Fatality Rate

"The total number of fatalities divided by the total number of occupants aboard."

Scenario

"That volume of the aircraft in which the occupants are subjected to a similar level of threat."

Serious Injury (Source: NTSB, ICAO Annex 13, Eighth Edition, July 1994)

"An injury, which is sustained by a person in an accident and which:

a) Requires hospitalisation for more than 48 hours, commencing within seven days from the date the injury was received; or

b) Results in a fracture of any bone (except simple fractures of fingers, toes, or nose); or

c) Involves lacerations which cause severe haemorrhage, nerve, muscle or tendon damage; or

d) Involves injury to any internal organ; or

e) Involves second or third degree burns, or any burns affecting more than 5 per cent of the body surface; or

f) Involves verified exposure to infectious substances or injurious radiation."

Appendix 1 Accident Rationales

Accident Database Reference	Location	Aircraft
19670216A	MENADO AIRPORT, INDONESIA	L188
Date	**Operator**	**Regn**
16-FEB-1967	GARUDA	PK-GLB

Résumé of Accident

On 16-Feb-1967 Lockheed Electra L-188C registered as PK-GLB was on approach to Mapanget Airport, Menado, Indonesia.

The pilot-in-command adopted an awkward approach technique and the aircraft landed heavily 3 ft short of the runway manoeuvring area and some 156 ft short of the runway threshold. The undercarriage collapsed, the aircraft skidded, caught fire and came to rest on the runway.

The aircraft was destroyed by fire.

There were 8 crew and 84 passengers aboard. 22 passengers suffered fatal injuries. 12 passengers suffered serious injuries. 8 crew and 50 passengers escaped with minor or no injuries.

Summary of Assessment

Overall there were 22 fatalities, with all fatalities due to fire.

Later Requirements

It was assumed that application of later requirements would have significantly improved the situation in the rear cabin allowing more passengers to move forward. This is assumed to have reduced the overall number of fatalities to 11.

Enhanced Fuselage Burnthrough Protection

Burnthrough Protection would have allowed all passengers to evacuate forward. There would therefore have been no fatalities.

Cabin Water Spray systems (without Burnthrough Protection)

Cabin Water Spray systems would have significantly improved the situation in the cabin allowing additional time for evacuation. Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	11	11
High	7	5
Median	3	1
Low	0	0

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	0	0
High	0	0
Median	0	0
Low	0	0

Accident Database Reference	Location	Aircraft
19670305A	NR. MONROVIA, LIBERIA, AFRICA	DC8-33
Date	**Operator**	**Regn**
5-MAR-1967	VARIG AIRLINES	PP-PEA

Résumé of Accident

On 05-Mar-1967 a Varig Airlines DC-8-33 registered as PP-PEA was approaching Roberts International Airport, Monrovia, Liberia. The aircraft landed short of the runway and crashed after a long ground slide. Of the 19 crew and 71 passengers aboard, the flight engineer and 50 passengers suffered fatal injuries. 16 crew and 7 passengers suffered serious injuries. 2 crew and 14 passengers suffered minor or no injuries.

Summary of Assessment

Overall there were 51 fatalities of which it is assumed 45 fatalities were due to fire.

Later Requirements

It was assumed that application of later requirements would have made a significant improvement as the fire entered the cabin through an open over-wing exit and cabin windows, generating significant smoke. It is assumed that this would have reduced the overall number of fire related fatalities by 15 to a total of 30.

Enhanced Fuselage Burnthrough Protection

As the fire entered the fuselage through an exit and windows, Burnthrough Protection would have provided no benefit.

Cabin Water Spray systems (without Burnthrough Protection)

Cabin Water Spray systems would have provided significant benefit by delaying the start of the fire within the cabin. Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	30	30
High	22	22
Median	10	8
Low	4	2

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	30	30
High	22	22
Median	10	8
Low	4	2

Accident Database Reference	Location	Aircraft
19670309A	NR. URBANA, OHIO, U.S.A.	DC9-15
Date	**Operator**	**Regn**
9-MAR-1967	TRANS WORLD AIRLINES (TWA)	N1063T

Résumé of Accident

On 09-Mar-1967 a Trans World Airlines DC-9-15 registered as N1063T collided in flight with a Beech Baron (N6127V) near Urbana, Ohio.

The DC-9 had been cleared to descend from 20,000 ft to 3000 ft. While descending through 4,525 ft, the DC-9 collided with a Beechcraft Baron, which was on a flight to Springfield.

The Beechcraft was not under control of, or in radio contact with any FAA traffic facility.

There were 2 flight crew, 2 cabin crew and 21 passengers on board. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19670310A	STUKEL MOUNTAIN, KLAMATH FALLS, OREGON, U.S.A.	F27
Date	**Operator**	**Regn**
10-MAR-1967	WEST COAST AIRLINES	N2712

Résumé of Accident

On 10-Mar-1967 a West Coast Airlines (WC) Fairchild F-27 registered as N2712 was taking off from Kingsley Field, Klamath Falls, Oregon bound for Seattle, Washington, with scheduled stops at Medford, North Bend and Portland.

The aircraft, after being removed from the hangar, was exposed to falling snow for approximately 11 minutes prior to separating the ramp and for an additional 4 minutes prior to takeoff.

Just after the aircraft was airborne, the departure controller observed the aircraft target left of the extended centreline of the runway. The target continued to drift to the left toward the area of Stukel Mountain, where it subsequently disappeared off the radar display.

The aircraft struck the northwest face of Stukel Mountain (elevation 6,525 feet) 2 minutes after takeoff and was demolished by impact. The crash site was located 4.1 miles southeast of Kingsley Field at a terrain elevation of about 5,049 feet.

The aircraft was demolished by ground impact.

There were 3 crew and 1 revenue passenger aboard. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19670623A	NR. BLOSSBURG, PENNSYLVANIA, U.S.A.	BAC1-11 204AF
Date	**Operator**	**Regn**
23-JUN-1967	MOHAWK AIRLINES	N1116J

Résumé of Accident

On 23-Jun-1967, a Mohawk Airlines BAC 1-11 registered as N1116J was operating a scheduled flight from Elmira, New York to Washington DC.

While flying over Blossburg, Pennsylvania, large sections of the tail separated from the aircraft in flight, after which fire and smoke emitted from the tail as the aircraft dived into the ground.

There were 2 flight crew, 2 cabin crew and 1 company employee travelling non-revenue and 29 ticketed passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19670719A	HENDERSONVILLE, NORTH CAROLINA, U.S.A.	B727-22
Date	**Operator**	**Regn**
19-JUL-1967	PIEDMONT AIRLINES	N68650

Résumé of Accident

On 19-Jul-1967 a Piedmont Aviation B727 registered as N68650 was departing the Asheville Municipal Airport, North Carolina.

At an altitude of 6,132 feet, in the vicinity of Hendersonville, North Carolina, the aircraft collided with a Cessna 310, N3121S. Both aircraft were operating on IFR flight plans and were in radio contact with Asheville Tower. The Cessna had deviated from its IFR clearance and entered the airspace allocated to the B727.

The B727 was destroyed by collision forces, ground impact and ensuing fire.

There were 5 crewmembers and 74 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19671104A	BLACK DOWN HILL, SUSSEX, U.K.	CARAVELLE 10BIR
Date	**Operator**	**Regn**
4-NOV-1967	IBERIAN AIRLINES	EC-BDD

Résumé of Accident

On 04-Nov-1967, an Iberian Airlines SE-210 Caravelle was making a scheduled flight from Malaga to Heathrow Airport, London.

The aircraft first made radio contact with London Airways when it was over Alderney at FL 310. It was routed along airway Red One, identified by London Radar south of Ibsley and cleared to descend to FL 60 heading for Dunsfold.

The last communication from London Airways that the crew acknowledged was a direction to proceed to Epsom. Shortly after an alteration of course to comply with this communication, the aircraft flew into the southern slopes of Black Down Hill, near Fernhurst, Sussex.

The aircraft was destroyed.

There were 7 crew and 30 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19671106A	CINCINNATI, U.S.A.	B707-131
Date	**Operator**	**Regn**
6-NOV-1967	TRANS WORLD AIRLINES (TWA)	N821TW

Résumé of Accident

On 06-Nov-1967 a TWA B707-131 registered as N742TW was taking off from Cincinnati.

During the take-off roll at approximately Vl the aircraft passed an aircraft stuck close to the runway. The crew experienced a loud bang, believing a collision had occurred they aborted the take-off but overran the runway.

Of the 7 crew and 29 passengers aboard, 11 occupants were injured. One of the injured died 4 days after the accident.

Summary of Assessment

It was assessed that the fatality was due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19680306A	POINTE A PITRE, GUADELOUPE	B707-328C
Date	**Operator**	**Regn**
6-MAR-1968	AIR FRANCE	F-BLJC

Résumé of Accident

On 06-Mar-1968, an Air France B707-328C registered as F-BLCJ was approaching Pointe-à-Pitre/Le Raizet airport, Guadeloupe after a flight from Maiquetía Airport, Caracas, Venezuela

It was assessed that difficulties encountered by the flight in establishing communication with Pointe-à-Pitre rendered the pilot-in-command fairly impatient and that as a consequence he may have lost sight of the real passage of time and the fact that he was following a route different from the route normally followed. Under these circumstances, when a brightly lit town (Basse Terre) appeared as expected on the coast of Guadeloupe, he probably erroneously believed that it was Pointe-à-Pitre.

The aircraft was seen flying at an altitude and speed lower than normal and crashed into the southern slope of La Grande Découverte in the "La Soufrière" mountain, 27.5 km short of the airport.

The aircraft was destroyed by impact and subsequent fire.

There were 4 flight crew, 7 cabin crew and 32 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19680308A	BAJAY, AKLAN, PHILIPPINES	F27
Date	**Operator**	**Regn**
8-MAR-1968	AIR MANILA	PI-C-871

Résumé of Accident

On 08-Mar-1968, an Air Manila Fairchild F-27 registered as PI-C871 was en-route from Manila International Airport to Lapu-Lapu/Mactan International Airport, Philippines.

The aircraft flew through a thunderstorm cell and suffered an in-flight structural failure. The aircraft caught fire and fell into the sea.

There were 2 flight crew, 2 cabin crew and 10 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19680408A	LONDON (HEATHROW) U.K.	B707-465
Date	**Operator**	**Regn**
8-APR-1968	BOAC	G-ARWE

Résumé of Accident

On 08-Apr-1968 BOAC B707 registered as G-ARWE was taking off from London (Heathrow) airport.

Approximately one minute after take-off the No. 2 engine failed and a few seconds later caught fire. The fire did not go out and the aircraft was manoeuvred for the quickest possible return. During the approach, the No. 2 engine fell away from the aircraft. The aircraft made a successful landing but fuel released on the port side caught fire.

An emergency evacuation was initiated using exits on the starboard side as the fire and smoke spread from the rear forwards. The assist means did not perform well and as a result the crew lost valuable time during the evacuation.

Of the 11 crew and 116 passengers aboard, 1 crew member and 4 passengers suffered fatal injuries. 38 passengers suffered serious injuries. 10 crew and 74 passengers escaped with minor or no injuries.

Summary of Assessment

Overall there were 5 fatalities with all fatalities due to fire.

Later Requirements

It was assumed that application of later requirements would have reduced the number of fatalities by 2 to a total of 3.

Enhanced Fuselage Burnthrough Protection

It is assessed that Burnthrough Protection would have allowed sufficient additional time for all passengers and crew to evacuate.

Cabin Water Spray systems (without Burnthrough Protection)

It is assessed that Cabin Water Spray systems would have provided additional time to allow a complete evacuation. Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	3	3
High	1	0
Median	0	0
Low	0	0

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	0	0
High	0	0
Median	0	0
Low	0	0

Accident Database Reference	Location	Aircraft
19680503A	DAWSON, TEXAS, U.S.A.	L188A
Date	**Operator**	**Regn**
3-MAY-1968	BRANIFF AIRWAYS	N9707C

Résumé of Accident

On 03-May-1968, at about 1648 c.d.t, a Braniff Airways, Lockheed L-188, registered as N9707C, crashed approximately 1 mile east of Dawson, Texas.

Following a takeoff from Houston at 1611, the aircraft was approaching an area of severe thunderstorms astride the airway from Houston to Dallas at an altitude of 20,000 feet. The aircraft was destroyed by in-flight breakup, in-flight fire, impact, and post impact fire.

There were 5 crewmembers and 80 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19680612A	CALCUTTA, INDIA	B707-321C
Date	**Operator**	**Regn**
12-JUN-1968	PAN AMERICAN WORLD AIRWAYS	N798P

Résumé of Accident

On 12-Jun-1968 a PAWA B707-321C was approaching Calcutta, India.

During a night visual approach in rain the aircraft first struck a tree 1128m short of the runway then crashed and caught fire. The landing gear was broken off, the fuselage remained largely intact, there was no CFR response due to the terrain. It was assumed that the impact was survivable.

Of the 10 crew and 53 passengers aboard, 1 crew member and 5 passengers suffered fatal injuries due to the fire.

Summary of Assessment

Overall there were 6 fatalities with all fatalities due to fire.

Later Requirements

It was assumed that application of latest requirements would have allowed more time to evacuate reducing the fatalities by 3 to a total of 3.

Enhanced Fuselage Burnthrough Protection

It is assumed that Enhanced Burnthrough Protection would not have altered the situation as there is little information on the source or entry points of the fire.

Cabin Water Spray systems (without Burnthrough Protection)

It is assumed that a singular system would have functioned with some loss in performance due to fuselage damage and that the modular system would have performed better. Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	3	3
High	3	2
Median	1	0
Low	0	0

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	3	3
High	3	2
Median	1	0
Low	0	0

Accident Database Reference	Location	Aircraft
19680809A	LANGENBRÜCK, GERMANY	VISCOUNT
Date	**Operator**	**Regn**
9-AUG-1968	BRITISH EAGLE INTERNATIONAL AIRLINES	G-ATFN

Résumé of Accident

On 09-Aug-1968 a British Eagle International Airlines Viscount, registered as G-ATFN was operating a scheduled international public transport flight from London to Innsbruck.

Near the village of Langenbrück the aircraft struck the ground, after part of the port elevator and both outer wings had first become detached from the aircraft.

The aircraft was wrecked.

There were 4 crew and 44 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19680810A	CHARLESTON AIRPORT, U.S.A.	FH227B
Date	**Operator**	**Regn**
10-AUG-1968	PIEDMONT AIRLINES	N712U

Résumé of Accident

On 10-Aug-1968, at approximately 0857 eastern daylight time, a Piedmont Airlines Fairchild Hiller 227B registered as N712U crashed and burned while on an approach to Kanawha County Airport, Charleston, West Virginia.

The flight was conducting an Instrument Landing System (ILS) localiser (no glide slope) approach to Runway 23 when it crashed into a steep hillside approximately 250 feet short of the runway threshold and 33 feet below the threshold elevation.

At the time of the accident, a layer of dense fog estimated to be 150 feet thick was obscuring the threshold and approximately one-half of the approach light system for the runway. Outside of the fog area, visual flight conditions existed.

The aircraft was destroyed by impact and subsequent fire.

There were 3 crew and 34 passengers aboard. 3 crewmembers and 32 of the 34 passengers were fatally injured in the accident.

Summary of Assessment

The two survivors were thrown clear of the fuselage on impact. All fatalities were impact related. Therefore, it was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
A19681025A	HANOVER, NEW HAMPSHIRE, U.S.A.	FH227C
Date	**Operator**	**Regn**
25-OCT-1968	NORTHEAST AIRLINES	N380NE

Résumé of Accident

On 25-Oct-1968 a Northeast Airlines FH-227C registered as N380NE was approaching the Lebanon Regional Airport, West Lebanon, New Hampshire.

The crew was not able to determine accurately its position during a premature initiation of a descent.

The aircraft crashed 3.8 nautical miles northest of the VOR station into the side of a mountain at an altitude of approximately 2,237 feet. At this point in a standard instrument approach, the aircraft should have been no lower than 2,800 feet. Witnesses on the ground and survivors of the accident reported that the mountaintop was shrouded in cloud or fog at the time of the accident.

The aircraft was destroyed by impact and postimpact fire.

There were 3 crew and 39 passengers on board. 2 crew and 30 passengers suffered fatal injuries. 1 crew member and 9 passengers suffered serious injuries.

Summary of Assessment

Although there was a post crash fire, the survivors received impact related injuries only. It is believed that all fatalities were impact related. Therefore, there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19681202A	PEDRO BAY, ALASKA, U.S.A.	F27B
Date	**Operator**	**Regn**
2-DEC-1968	WIEN CONSOLIDATED AIRLINES	N4905

Résumé of Accident

On 02-Dec-1968 a Wien Consolidated Airlines, Inc. Fairchild F-27B, registered as N4905, crashed at Pedro Bay, Alaska, after it had been cleared for an approach to Iliamna Airport.

Investigation showed that the right outer wing, the empennage, portions of the left wing, and other components of the aircraft structure had separated from the aircraft in flight. The aircraft was destroyed by in-flight break-up and ground impact.

It was determined that the probable cause of this accident was an in-flight structural failure caused by an encounter with severe-to-extreme turbulence.

There were 3 crew and 36 passengers aboard and all suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19681227A	O'HARE, CHICAGO, U.S.A.	CV580
Date	**Operator**	**Regn**
27-DEC-1968	NORTH CENTRAL AIRLINES	N2045

Résumé of Accident

On 27-Dec-1968 a North Central Airlines Convair CV580 registered as N2045 was executing an instrument approach to O'Hare International Airport, Chicago, Illinois. Visibility was restricted due to fog and a light, misting rain.

According to information obtained from surviving passengers and the flight data and cockpit voice recorders, the approach was normal until the aircraft had descended to approximately 210 feet above the runway and 4,500 feet from the threshold. At this point, the aircraft entered a sustained climb for approximately 11 seconds, at which point go-around procedures were initiated by the captain. However the climb continued and the airspeed dropped off to the point where aerodynamic control of the aircraft was lost.

The aircraft struck the side of a hangar, located adjacent to the approach end of the runway, in a near inverted attitude, and was destroyed by impact and resultant ground fire.

Of the 4 crew and 41 passengers aboard, 3 crew and 24 passengers suffered fatal injuries. 1 crewmember and 17 passengers suffered serious injuries.

Summary of Assessment

It was assessed that as the aircraft wreckage came to rest inverted there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19681231A	PORT HEDLAND, AUSTRALIA	VISCOUNT
Date	**Operator**	**Regn**
31-DEC-1968	MACROBERTSON MILLER AIRLINES	VH-RMQ

Résumé of Accident

On 31-Dec-1968 a MacRobertson-Miller Airlines Pty. Viscount 720C, registered as VH-RMQ was approaching Port Hedland Airport in the State of Western Australia. The flight was operating a scheduled domestic flight from Perth to Port Hedland.

As the flight started its descent, all contact was lost with the aircraft and it was later found among high terrain 28.1 miles from the airport.

Detailed examination of the wreckage revealed fatigue cracking and primary failure of the starboard inner wing main spar lower boom. The whole of the starboard wing outboard of No. 3 engine separated from the remainder of the aircraft.

The aircraft was destroyed by severe impact forces and the major portion was also affected by an intense post-impact fire.

There were 2 flight crew, 2 cabin crew and 22 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19690105A	GATWICK, ENGLAND, U.K.	B727
Date	**Operator**	**Regn**
5-JAN-1969	ARIANA AFGHAN	YA-FAR

Résumé of Accident

An approach to land in dense fog was being made, the aircraft was allowed to descend below the glide slope. The crew attempted to recover but the descent was not arrested in time. The aircraft impacted trees, chimney pots and a house before coming rest 1 1/2 miles from the runway.

During the break-up of the structure after the collision with the house, some passengers and their seats were thrown out. The crew said that they escaped from the wrecked flight deck through the window escape exits. The flight engineer injured his ankle on dropping to the ground and was obliged to hobble away from the wreckages, while the commander and the first officer assisted a number of passengers from the burning wreckage.

One passenger went back to rescue members of his family, and beat out the flames on the clothing of another passenger who had been thrown clear.

Of the 62 persons on board the aircraft, 14 survived; 7 died from injuries sustained in the accident, and 41 died as a result of asphyxia or burns.

Summary of Assessment

Overall there were 48 fatalities of which 41 fatalities were due to fire.

Later Requirements

It was assumed that later requirements would have provided a benefit but that this would have been limited by the significant fuselage damage. It was assumed that an additional 10 people would have survived, reducing the total number of fatalities to 38.

Enhanced Fuselage Burnthrough Protection

Due to the significant fuselage damage, it was assumed that Burnthrough Protection would provide no benefit.

Cabin Water Spray systems (without Burnthrough Protection)

Cabin Water Spray systems would have provided additional time for rescues. It is assumed that a singular system would have functioned to some extent in the main cabin area. Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	38	38
High	38	38
Median	33	28
Low	28	18

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	38	38
High	38	38
Median	33	28
Low	28	18

Accident Database Reference	Location	Aircraft
19691119A	GLENS FALLS, NEW YORK, U.S.A.	FH227B
Date	**Operator**	**Regn**
19-NOV-1969	MOHAWK AIRLINES	N7811M

Résumé of Accident

On 19-Nov-1969 a Mohawk Airlines FH-227B registered as N7811M was turning to approach the Warren County Airport, Glens Falls, New York.

The flight had been cleared for a VOR approach to Runway 19. The flight overflew Glens Falls at 3,000 feet and proceeded north for about 1 minute and 15 seconds at which time a left turn was initiated preparatory to return to the airport to land.

The captain, while conducting the approach, exceeded his clearance limits and, thereafter flew the aircraft into a severe "lee of the mountain downdraft", at an altitude insufficient for recovery.

During the last portion of the turn, the aircraft contacted trees on the northwest slope of Pilot Knob Mountain on a heading of about 180°, approximately 1 nautical mile east of Kattskill Bay, New York. It then impacted the face of a rock cliff, after which it dropped approximately 38 feet, became lodged between trees and the side of the mountain, and burned.

The elevation of the initial impact with the rock face of Pilot Knob Mountain was approximately 1,960 feet.

The aircraft was destroyed.

There were 3 crew and 11 passengers on board. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19691120A	LAGOS, NIGERIA	VC10-1101
Date	**Operator**	**Regn**
20-NOV-1969	NIGERIAN AIRWAYS	5N-ABD

Résumé of Accident

On 20-Nov-1969, a Nigerian Airways VC10 was making a straight in approach over low- lying tree covered terrain to runway 19 at Lagos Airport, Nigeria.

The aircraft crashed following a collision with some trees 8 miles north of the airfield.

The aircraft broke up on impact and a severe fire occurred, which consumed the main part of the fuselage.

Of the 11 crew and 76 passengers aboard, all occupants suffered fatal injuries.

Summary of Assessment

There is a statement that the impact injuries were not fatal in every case. It has previously been assumed that of the 87 fatalities, 62 were due to fire. There is little further information, however it is known that the majority of the fuselage remained mostly intact, with the tail section becoming detached.

Later Requirements

It was assumed that later requirements alone would not have allowed evacuation.

Enhanced Fuselage Burnthrough Protection

It was assumed that the amount of fuselage damage would have negated any benefits from Burnthrough Protection.

Cabin Water Spray systems (without Burnthrough Protection)

As it is likely that there was a serious external fire, it is assumed that only a limited number of evacuees would survive.

Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	62	62
High	62	62
Median	52	51
Low	42	40

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	62	62
High	62	62
Median	52	51
Low	42	40

Accident Database Reference	Location	Aircraft
19700506A	MOGADISCIO, SOMALIA	VISCOUNT
Date	**Operator**	**Regn**
6-MAY-1970	SOMALI AIRLINES	60-AAJ

Résumé of Accident

A number of the passengers saw the outbreak of fire from under the cabin floor when the aircraft was on short final. The pilots unaware of the fire, experienced complete loss of control of the aircraft at a distance of approximately 2 kilometres from touchdown. The aircraft, however, continued to fly on the correct heading towards the runway and a slight nose-down attitude was corrected by the application of power. The aircraft landed heavily exactly on the centreline and on the threshold of runway 24. The nosewheel hit first and the gear sheared rearwards. The aircraft continued rolling on its main gear with the nose on the ground. It came to rest after nearly 900 metres; the fire then developed quickly and destroyed most of the aircraft fuselage.

The fire intensified after the aircraft came to rest and the fire brigade, who arrived at the scene within minutes, was unable to control the fire, which eventually destroyed the aircraft. The majority of the passengers and all the crew were able to evacuate the aircraft timely, however five children perished. A number of passengers and two crewmembers (cabin) sustained injuries and/or burns of varying degrees.

Summary of Assessment

Overall there were 5 fatalities with all fatalities due to fire.

Later Requirements

It was assessed that application of later requirements would have allowed the evacuation of all passengers and crew.

Accident Database Reference	Location	Aircraft
19700703	SIERRA DEL MONTENSY, GERONA, SPAIN	COMET 4
Date	**Operator**	**Regn**
3-JUL-1970	DAN-AIR SERVICES	G-APDN

Résumé of Accident

On 03-Jul-1970 a Dan-Air Comet 4 registered as G-APDN was operating a regular charter flight from Manchester to Barcelona.

While descending into Barcelona, the flight deviated from the intended course and crashed into high ground at Sierra Del Montseny, Gerona, Spain.

The aircraft was destroyed by impact and subsequent ground fire.

There were 3 flight crew, 4 cabin crew and 105 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19700707A	TORONTO, CANADA	DC8-63
Date	**Operator**	**Regn**
5-JUL-1970	AIR CANADA	C-FTIW

Résumé of Accident

On 05-Jul-1970, at 08:09 hours, eastern daylight saving time (EDT), an Air Canada McDonnell Douglas DC-8-63, registered as C-FTIW, crashed after a momentary touch down on runway 32 at Toronto International Airport, Malton, Ontario, Canada when attempting an en-route stop on a scheduled flight from Montreal, Quebec to Los Angeles, California, USA.

The spoilers were deployed when the aircraft was about 60 feet above the runway. As a result, the aircraft sank rapidly and struck the runway.

When the aircraft struck the runway, the number 4 engine and pylon separated from the aircraft and fell on the runway along with a piece of the lower wing plating, which allowed fuel to escape and subsequently ignite.

The Captain applied full throttle to all four engines and pulled back the control panel causing the nose of the aircraft to rotate upwards. The aircraft climbed to an altitude of 3,100 feet above the ground. Thereafter there were three explosions on the aircraft and finally the aircraft crashed to the ground.

There were 3 flight crew, 6 cabin crew and 100 passengers on board the aircraft. All the occupants were killed in the accident.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19701114A	TRI-STATE AP., HUNTINGTON, WEST VIRGINIA, U.S.A.	DC9-31
Date	**Operator**	**Regn**
14-NOV-1970	SOUTHERN AIRWAYS	N97S

Résumé of Accident

On 14-Nov-1970 a Southern Airways DC-9-31 registered as N97S was attempting a landing at the Tri-State Airport, Huntington, West Virginia.

The flight, chartered to transport the Marshall University football team and boosters from Kinson, North Carolina, to Huntington, West Virginia, was attempting a non-precision instrument landing approach to runway 11 at the time of the accident. The crash occurred following impact with trees on a hill approximately 1 mile west of the runway threshold. The elevation of the broken trees at the initial impact site was approximately 922 feet msl. The Minimum Descent Altitude, below which descent is not authorised until the runway environment is in sight, for this instrument approach was 1,240 feet msl.

The aircraft disintegrated and burned.

There were 2 flight crew, 2 cabin crew and 71 passengers on board. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19701127A	ANCHORAGE, ALASKA, U.S.A.	DC8-63F
Date	**Operator**	**Regn**
27-NOV-1970	CAPITOL INTERNATIONAL AIRWAYS	N4909C

Résumé of Accident

On 27-Nov-1970 a Capitol International Airways DC-8-63F registered as N4909C was taking off from Anchorage, Alaska. The main landing gear wheels did not rotate and the aircraft overran the end of the runway. Of the 10 crew and 219 passengers aboard, 1 crew member and 46 passengers suffered fatal injuries. 6 crew and 43 passengers suffered serious injuries. 3 crew and 130 passengers had minor or no injuries. Survivors reported that fire broke out on the left side of the aircraft following the first impact and continued throughout the crash sequence. Major structural damage occurred on the second impact, at which time the aft section of the cabin broke open and the right wing tore loose spilling the fuel contained therein. A large fire then erupted on the right side of the aircraft.

Summary of Assessment

Overall there were 47 fatalities with all fatalities due to fire.

Later Requirements

It was assessed that later requirements would have provided some benefit but that due to the fuselage break and the amount of fuel inside the cabin, the benefit would be limited. The overall number of fatalities would be reduced to 36.

Enhanced Fuselage Burnthrough Protection

No benefit is assumed because of the large fuselage break and the fuel inside the cabin.

Cabin Water Spray systems (without Burnthrough Protection)

The majority of the fatalities were in the rear part of the main cabin section, forward of the cabin break. Cabin Water Spray systems would provide benefit, however this is limited by the significant internal disruption due to the impact and the fuel inside the cabin. Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	36	36
High	30	28
Median	21	19
Low	11	9

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	36	36
High	30	28
Median	21	19
Low	11	9

Accident Database Reference	Location	Aircraft
19701228A	ST. THOMAS, VIRGIN ISLANDS	B727-200
Date	**Operator**	**Regn**
28-DEC-1970	TRANS CARIBBEAN	N8790R

Résumé of Accident

On 28-Dec-1970 a Trans Caribbean Airways B727-200 registered as N8790R was landing at Harry S Truman Airport, Charlotte Amalie, St Thomas, Virgin Islands.

The approach appeared to be normal until touchdown, after which the aircraft ascended to a height of about 50 feet above the runway. The aircraft touched down again very hard, became airborne again and touched down a third and last time about 2700 feet down the 4650 feet runway. Almost simultaneously with the last touchdown, the right wing tip settled to the runway. The aircraft then veered off the right side of the runway, continued along a grass median strip parallel to the runway, passed through the airport perimeter fence, crossed over a paved highway and came to rest against a hillside adjacent to the highway. The fuselage broke into 3 major sections.

A small fire ignited immediately but several minutes elapsed before a general conflagration developed. In the interim, 46 of the 48 passengers and all crew members escaped from the aircraft.

Of the 7 crew and 48 passengers aboard, 2 passengers suffered fatal injuries. 2 crew and 10 passengers suffered serious injuries. 5 crew and 36 passengers escaped with minor or no injuries.

Summary of Assessment

Overall there were 2 fatalities with both fatalities due to fire. One was a child trapped in the debris inside the cabin, and the other the child's father.

Later Requirements

It was assumed that as the fire entered the cabin from breaks in the fuselage, the small potential benefit would not have altered the outcome.

Enhanced Fuselage Burnthrough Protection

It was assumed that as the fire entered the cabin from breaks in the fuselage, the small potential benefit would not have altered the outcome.

Cabin Water Spray systems (without Burnthrough Protection)

It is feasible that a modular system could have allowed sufficient extra time for cabin crew or passengers to release the trapped child. Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	2	2
High	2	2
Median	2	2
Low	2	0

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	2	2
High	2	2
Median	2	2
Low	2	0

Accident Database Reference	Location	Aircraft
19701231A	SHAMSHERNAGAR, PAKISTAN	F27-200
Date	**Operator**	**Regn**
31-DEC-1970	PAKISTAN INTERNATIONAL AIRLINES	AP-AUV

Résumé of Accident

On 31-Dec-1970 PIA F27 registered as AP-AUV was approaching Shamshernagar in Pakistan.

After an uneventful scheduled flight, the captain concluded that the aircraft was too high. Instead of going around he selected GFP on both propellers at a height of a few hundred feet and a speed of about 125 knots.

Consequently the aircraft developed a high rate of descent and at about 20 feet height the pilot lost control, after which the aircraft crash-landed short of the runway. The right hand wing tip broke off at about 10 feet from the tip, allowing a large amount of fuel to be spilled. The fuselage turned over to the right ending up more or less upside down. A fire developed, with heavy smoke, in which 7 of the 31 passengers died. The others and the 4 crew escaped with only minor injuries.

It took about 4 hours for the fire brigade to reach the site.

Summary of Assessment

It was assessed that as the aircraft came to rest inverted, the Cabin Water Spray system and Fuselage Burnthrough Protection would be ineffective.

Accident Database Reference	Location	Aircraft
19710102A	TRIPOLI AIRPORT, LIBYA	COMET 4C
Date	**Operator**	**Regn**
2-JAN-1971	UNITED ARAB AIRLINES	SU-ALC

Résumé of Accident

On 02-Jan-1971 a United Arab Airlines Comet 4C registered as SU-ALC was approaching Tripoli International Airport, Libyan Arab Republic.

The accident occurred at night with reduced visibility.

The approach was made 1,000 feet lower than it should have been. Altimeter settings were such that the instruments could have been indicating that the aircraft was 1,000 ft higher than actual pressure altitude. Approximately 7 km before the threshold of the runway, the aircraft struck sand dunes and crashed.

The aircraft was destroyed by the impact and a subsequent fire.

There were 8 crew and 8 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19710606A	NR. DUARTE, CALIFORNIA, U.S.A.	DC9-31
Date	**Operator**	**Regn**
6-JUN-1971	HUGHES AIR WEST	N9345

Résumé of Accident

On 06-Jun-1971, at 1811 Pacific daylight time, a Hughes Air West DC-9-31, registered as N9345 collided with a US Marine Corps F-4B in flight near Duarte, California.

The aircraft was under radar control of the Los Angeles Air Route Traffic Control Centre, climbing to flight level 330. The F-4B was being flown under VFR when the collision occurred at an altitude of approximately 15,150 feet.

The visibility in the area at the time of the accident was good and there were no clouds between the two aircraft during the final minutes of flight.

Both aircraft were destroyed by the collision, ground impact and fire.

There were 2 flight crew, 3 cabin crew and 44 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19710607A	NEW HAVEN, CONNECTICUT, U.S.A.	CV580
Date	**Operator**	**Regn**
7-JUN-1971	ALLEGHENY AIRLINES	N5832

Résumé of Accident

On 07-Jun-1971 an Allegheny Airlines CV580 registered as N5832 was attempting an instrument approach to Tweed-New Haven Airport, New Haven, Connecticut.

In poor forward visibility the aircraft struck 3 beach cottages located on the northern shore of Long Island Sound, at a height approximately 25 feet above mean sea level, 4890 feet from the displaced threshold of the runway and approximately 510 feet to the right of the extended centreline of the runway. The fuselage came to rest 270 feet north of the point of initial impact.

An intense fire ensued immediately upon initial impact and continued to burn to the point of near total destruction of the upper portion of the fuselage and cabin area of the aircraft.

Of the 3 crew and 28 passengers aboard, 2 crew and 26 passengers suffered fatal injuries. 1 crew member and 2 passengers suffered serious injuries.

Summary of Assessment

Overall there were 28 fatalities with 27 fatalities due to fire. The two passengers who evacuated did so through an open over wing exit that other passengers did not find.

Later Requirements

It is assessed that the combination of reduced smoke and Floor Proximity Lighting would have allowed more people to use the over-wing exit. This would have reduced the total number of fire related fatalities to 23.

Enhanced Fuselage Burnthrough Protection

It is assumed that the fuselage would have had extensive damage to its underside, reducing the effectiveness of the Burnthrough Protection. It is therefore assumed that this would have provided additional time for one more passenger to evacuate (leaving total fire related fatalities at 22).

Cabin Water Spray systems (without Burnthrough Protection)

Cabin Water Spray systems should have a significant impact on the interior survivability, however the number of lives saved has been reduced due to the expected fatalities outside the aircraft if evacuation had been accomplished.

Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	23	23
High	23	23
Median	17	15
Low	12	10

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	22	22
High	22	22
Median	16	14
Low	11	9

Accident Database Reference	Location	Aircraft
19710904A	NR. JUNEAU, ALASKA, U.S.A.	B727-193
Date	**Operator**	**Regn**
4-SEP-1971	ALASKA AIRLINES, INC.	N2969G

Résumé of Accident

On 04-Sep-1971, at 1215 Pacific daylight time, an Alaska Airlines B727-193, registered as N2969G was approaching Juneau Municipal Airport, Juneau, Alaska, U.S.A.

The aircraft was operating a regularly scheduled passenger flight from Anchorage, Alaska to Seattle, Washington, with intermediate stops at Cordova, Yakutat, Juneau and Sitka, Alaska. The flight was operating under instrument flight rules (IFR).

The flight had been cleared for a Localiser Directional Aid (LDA) approach to Runway 8 and had reported passing the final approach fix. No further communications were heard from the aircraft.

The aircraft struck a slope in the Chilkat Mountain range at about the 2,500 foot level, 18.5 miles west of the airport and approximately on the inbound localiser course.

The aircraft was destroyed by impact and isolated post-crash fires.

There were 3 flight crew, 4 cabin crew and 104 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19710906A	NR. HASLOH, GERMANY	BAC1-11 500/515
Date	**Operator**	**Regn**
6-SEP-1971	PANINTERNATIONAL AIRLINES	D-ALAR

Résumé of Accident

On 06-Sep-1971 a Paninternational Airlines BAC 1-11 registered as D-ALAR was climbing out from Hamburg Airport, Germany.

In order to achieve the required take-off and climbing performance to miss radio beacons, take-off had to be carried out with water injection. Unfortunately the water tanks had been replenished with a mixture of water and fuel and as a result the engines failed during the climb out. The crew realised that they could not return to the airport and elected to land on a nearby autobahn.

The aircraft slid and rotated along the autobahn during which time the front fuselage section was cut off as a result of an impact with a road bridge. All injuries were impact related.

Of the 6 crew and 115 passengers aboard, 1 crew member and 21 passengers suffered fatal injuries. 5 crew and 52 passengers suffered serious injuries. 42 passengers suffered minor or no injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19720418A	ADDIS ABABA, ETHIOPIA	SVC10
Date	**Operator**	**Regn**
18-APR-1972	EAST AFRICAN AIRWAYS	5X-UVA

Résumé of Accident

A Super VC10 was taking off from Addis Ababa on 18-Apr-1972. Just prior to decision speed the nose-wheel tyre hit a jacking pad that has fallen from a Cessna 185 a few hours earlier. The tyre burst and the crew initiated an aborted take-off but were unable to stop the aircraft before the end of the runway.

The aircraft slid down an embankment at the end of the runway and struck a steel lattice tower, which ruptured the fuel tank. The spilling fuel ignited and the aircraft broke into three sections as it came to rest.

Survivors evacuated the aircraft through the fuselage breaks as the left emergency exits were jammed by impact damage and the right side exits were blocked by fire. 10 people had to walk away from the aircraft between streams of fuel, which subsequently caught fire and trapped them.

Of the 11 crew and 96 passengers aboard, 8 crew and 35 passengers suffered fatal injuries.

Summary of Assessment

Overall there were 43 fatalities of which 33 fatalities were due to fire inside the aircraft, and 10 outside.

Later Requirements

It was assumed that application of later requirements would have allowed additional time for 8 people to exit the aircraft and avoid the external fire. This reduces the total number of fatalities to 35.

Enhanced Fuselage Burnthrough Protection

Although there were breaks in the cabin, a large part of the fuselage was intact. It was therefore assessed that Burnthrough Protection would have provided some benefit, allowing an additional 7 people to evacuate. This reduces the total number of fatalities to 28.

Cabin Water Spray systems (without Burnthrough Protection)

It was assessed that the Cabin Water Spray system would also provide benefits, with the singular system functioning correctly in the largely intact centre section. Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	35	35
High	35	35
Median	28	26
Low	22	20

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	28	28
High	28	28
Median	23	21
Low	18	16

Accident Database Reference	Location	Aircraft
19720629C	LAKE WINNEBAGO, WISCONSIN, U.S.A.	CV580
Date	**Operator**	**Regn**
29-JUN-1972	NORTH CENTRAL AIRLINES	N90858

Résumé of Accident

On 29-Jun-1972, a North Central Airlines Convair CV580 registered as N90858 collided with a DHC-6 (N4043B) over lake Winnebago, near Appleton, Wisconsin.

Both flights were operating in accordance with visual flight rules and were within minutes of landing at their respective destinations. Visual meteorological conditions existed in the accident area.

Both flight crews failed to see the other aircraft in sufficient time to initiate evasive action.

Both aircraft were destroyed as a result of the in-flight collision and subsequent water impact.

There were 3 crew and 2 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19721208A	NR. MIDWAY AIRPORT, CHICAGO, U.S.A.	DC9-31
Date	**Operator**	**Regn**
8-DEC-1972	UNITED AIRLINES	N9031U

Résumé of Accident

On 08-Dec-1972 a United Airlines B737-222 registered as N9031U was approaching Midway Airport, Chicago.

While making a non-precision instrument approach in overcast conditions airspeed was allowed to decay and the aircraft entered a stall. The aircraft crashed about 1.5 nautical miles southeast of the runway into a residential area. The tail section came into contact with electrical wires just before the crash. Several houses were destroyed. The fuselage stopped in the debris of a destroyed house.

The aircraft was destroyed by the impact and a subsequent fire.

There were 6 crew and 55 passengers on board. 3 crew and 42 passengers suffered fatal injuries. 1 crew member and 9 passengers suffered serious injuries. 2 crew and 4 passengers suffered minor or no injuries.

Summary of Assessment

Overall there were 45 fatalities with 37 fatalities affected by fire.

Later Requirements

It was assessed that application of later requirements would have slowed the generation of smoke and allowed the more time for those in the centre/rear to reach the open rear exit. It is therefore assessed that the number of fire related fatalities would reduce by 4 to 33.

Enhanced Fuselage Burnthrough Protection

Due to the significant amount of fuselage damage, it is assumed that Burnthrough Protection would have provided little benefit.

Cabin Water Spray systems (without Burnthrough Protection)

Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	33	33
High	33	33
Median	27	24
Low	19	15

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	33	33
High	33	33
Median	27	24
Low	19	15

Accident Database Reference	Location	Aircraft
19721220A	CHICAGO, U.S.A.	DC9-31
Date	**Operator**	**Regn**
20-DEC-1972	NORTH CENTRAL	N954N

Résumé of Accident

A North Central Airlines DC-9-31 was taking off under poor visibility in fog. A Delta Airlines Convair CV-880 was taxiing across the runway at the same time due to poor air traffic control. The DC-9 collided with the tail of the CV-880 and as a result was unable to climb and landed back on the runway. The undercarriage collapsed and the aircraft caught fire.

There were 4 crew and 41 passengers aboard. 9 passengers failed to escape the cabin fire because they could not locate the exits in dense smoke and poor lighting conditions. One passenger later died.

Summary of Assessment

Overall there were 10 fatalities with all fatalities due to fire.

Later Requirements

It was assumed that Floor Proximity Lighting would have allowed two more people to find the main entry door as they had passed it looking for an exit. The smoke in the cabin is assumed to be mostly from the under-floor fire and so the other later requirements would not save additional lives.

Enhanced Fuselage Burnthrough Protection

It is assessed that Burnthrough Protection would have significantly delayed the entry of the fire and hence the smoke allowing all passengers to evacuate.

Cabin Water Spray systems (without Burnthrough Protection)

The Cabin Water Spray system would have prevented any smoke from cabin furnishings, improving the visibility and survivability within the cabin. Multiple burnthrough points may however have reduced the effectiveness of the system. Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	8	8
High	3	2
Median	1	0
Low	0	0

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	0	0
High	0	0
Median	0	0
Low	0	0

Accident Database Reference	Location	Aircraft
19730122A	KANO AIRPORT, NIGERIA	B707
Date	**Operator**	**Regn**
22-JAN-1973	ALIA ROYAL JORDANIAN AIRLINES	JY-ADO

Résumé of Accident

On 22-Jan-1973 an Alia Royal Jordanian Airlines B707 registered as JY-ADO was landing in poor visibility at Kano Airport, Nigeria.

The aircraft touched nosewheel first steady and heavy with main wheels barely in contact with the runway. The nosewheel entrenched itself then collapsed. The main gear contacted later in rapid deceleration, pierced the main wings and the aircraft collapsed along the runway centreline. A fire broke out and after a prolonged pause the passengers and crew evacuated.

Of the 202 occupants aboard, 176 suffered fatal injuries as a result of the fire.

Summary of Assessment

It was assessed that all fatalities were due to fire and the fuselage remained relatively intact, and there would be benefit from enhanced Fuselage Burnthrough Protection and Cabin Water Spray systems.

Later Requirements

It was assumed that application of later requirements would have resulted in additional evacuation time reducing the overall number of fatalities to 135.

Enhanced Fuselage Burnthrough Protection

Burnthrough from external fire was the main fire entry route and so enhanced protection would have provided additional evacuation time. It is assessed that this would reduce the overall number of fatalities to 83.

Cabin Water Spray systems (without Burnthrough Protection)

The condition of the cabin would have allowed the Cabin Water Spray system to perform and provide additional evacuation time. Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	135	135
High	115	110
Median	100	95
Low	80	75

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	83	83
High	73	68
Median	50	45
Low	10	5

Accident Database Reference	Location	Aircraft
19730219A	PRAGUE/RODNICE AIRPORT, CZECHOSLOVAKIA	TU154
Date	**Operator**	**Regn**
19-FEB-1973	AEROFLOT	CCCP-85023

Résumé of Accident

On 19-Feb-1973 an Aeroflot TU-154 registered as CCCP-85023 was approaching the Prague/Rodnice Airport in the Czechoslovak Socialist Republic.

During an ILS approach, the aircraft ducked under the glide path and struck the ground 467 metres before the threshold of the runway. Fuel, which had escaped from the burst right wing tanks, was ignited. Most of the aircraft became enveloped in flames.

The aircraft was destroyed by impact and a post-crash fire.

Owing to the high degree of destruction and total disintegration of the aircraft in the crash and ensuing fire it was not possible to establish the precise cause of the accident.

Of the 13 crew and 87 passengers aboard, 4 stewardesses and 62 passengers suffered fatal injuries. 3 crew and 15 passengers suffered serious injuries. 6 crew and 10 passengers escaped with no injuries.

Summary of Assessment

The cabin section came to rest inverted with fuel on fire inside the cabin. Rescuers managed to pull people out of the wreckage until the fire became too intense. Therefore, it was assessed that there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19730303A	SHEREMETIEVO AIRPORT, MOSCOW, RUSSIA	IL18V
Date	**Operator**	**Regn**
3-MAR-1973	BALKAN-BULGARIAN AIRLINES	LZ-BEM

Résumé of Accident

On 03-Mar-1973 a Balkan-Bulgarian Airlines IL-18 registered as LZ-BEM was approaching Sheremetievo airport, Moscow.

After a missed approach, the crew were executing a second attempt at landing, when the aircraft began to loose height rapidly, went into a nosedive, crashed into the ground, disintegrated and caught fire.

The exact cause of the accident could not be accurately determined, but it was thought that there was possibly icing on the stabiliser, a significant pitch manoeuvre and full landing flaps extended at the time of the accident.

Of the 8 crew and 17 passengers on board, all occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19730711A	ORLY, NR. PARIS, FRANCE	B707
Date	**Operator**	**Regn**
11-JUL-1973	VARIG	PP-VJZ

Résumé of Accident

On 11-Jul-1973 a Varig B707 registered as PP-VJZ was descending to Orly, near Paris, France.

The aircraft reported a problem with fire on board and requested an emergency descent. This request followed a report by cabin personnel of smoke in the rear of the passenger cabin. In reply to a request by control, the pilot reported total fire which was prompted by the alarming announcement of the chief steward, who stated that the situation was becoming more and more serious, that smoke had invaded the cabin and that passengers were being asphyxiated. At about this time smoke was smelled in the cockpit.

The crew members put on oxygen masks and anti smoke goggles but there was so much black smoke in the cockpit that the pilot could no longer see the instruments and the side windows were therefore opened. The captain then decided that, in view of the untenable situation, a forced landing was necessary. This was carried out with the pilots looking at the ground through the side windows.

The aircraft made a forced landing in level ground used for market gardening. The impact was very hard and the aircraft slid on its engines and then on its belly for almost 500 m. The aircraft came to rest having lost all its engines and half of the left wing but the fuselage sustained little damage.

According to eyewitnesses the only evidence of the fire when the aircraft had stopped was smoke issuing from the right of the fin root.

Of the 17 crew and 117 passengers aboard, 7 crew and 116 passengers suffered fatal injuries, 10 crew and 1 passenger suffered serious injuries.

Firemen evacuated 4 unconscious occupants, only 1 survived.

Analyses carried out showed that a major proportion (>75%) of the deaths, were caused by carbon monoxide poisoning. Most of the other deaths were apparently caused by the effect of inhaling other toxic gases.

Summary of Assessment

The medical reports suggest that at the time of the crash-landing the passengers would have been incapacitated/unconscious but alive. Therefore, it was assessed that there would be opportunity for benefit from Cabin Water Spray systems.

Later Requirements

Application of later requirements (including fire extinguishing in toilets) could have had a significant effect. It has been assumed that the fire would still have continued but to a reduced level, resulting in 22 additional passengers being able to evacuate.

Enhanced Fuselage Burnthrough Protection

Burnthrough Protection would have provided no benefit as the fire was internal.

Cabin Water Spray systems (without Burnthrough Protection)

Cabin Water Spray systems would have provided time for the crew and mobile passengers to rescue semi or unconscious passengers. Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	101	101
High	96	91
Median	81	71
Low	66	56

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	101	101
High	96	91
Median	81	71
Low	66	56

Accident Database Reference	Location	Aircraft
19730723A	NR. ST LOUIS, MISSOURI, U.S.A.	FH227B
Date	**Operator**	**Regn**
23-JUL-1973	OZARK AIRLINES	N4215

Résumé of Accident

On 23-Jul-1973 an Ozark Airlines FH-227B registered as N4215 was approaching Lambert-St Louis International airport, St Louis, Missouri.

While making an instrument landing system approach a severe thunderstorm with heavy rain, strong winds and roll clouds moved across the approach end of the runway. The aircraft descended below the glide slope, entered an area of heavy rain, was struck by lightning, and crashed.

The aircraft was destroyed by impact and fire.

There were 3 crew and 41 passengers on board. 1 crew member and 37 passengers suffered fatal injuries. 2 crew and 4 passengers suffered serious injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19730731A	LOGAN INT. AIRPORT, BOSTON, MASS. U.S.A.	DC9-31
Date	**Operator**	**Regn**
31-JUL-1973	DELTA AIR LINES	N975NE

Résumé of Accident

On 31-Jul-1973 a Delta Air Lines DC-9-31 registered as N975NE was executing an ILS approach to Logan International Airport.

The flight crew failed to monitor altitude and to recognise passage of the aircraft through the approach decision height during an unstabilised precision approach conducted in rapidly changing meteorological conditions.

The aircraft struck a seawall about 165 feet to the right of the extended runway centreline and about 3,000 feet short of the runway displaced threshold.

The aircraft was destroyed.

There were 5 crew, a cockpit observer and 83 passengers on board. All occupants, except 1 passenger, suffered fatal injuries. The lone survivor, who had been injured critically, died approximately 19 weeks after the accident.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19730927A	BLACK FORK MOUNTAIN, ARIZONA, U.S.A.	CV600 (240D)
Date	**Operator**	**Regn**
27-SEP-1973	TEXAS INTERNATIONAL AIRLINES	N94230

Résumé of Accident

On 27-Sept-1973 a Texas International Airlines Convair 600 registered as N94230 crashed into the steep, heavily wooded, north slope of Black Fork Mountain in the Ouachita Mountain Range. The aircraft was destroyed by impact and subsequent fire.

The aircraft was on its return flight (Flight 655) from Memphis to Dallas with en route stops at Texarkana, El Dorado, and Pine Bluff, Arkansas. The accident occurred during the westbound flight from El Dorado to Texarkana, 80 nmi north-northwest of Texarkana, and 8.5 nmi north-northwest of Mena, Arkansas. The flight was conducted at night under visual flight rules. The crew did not activate the computer-stored instrument flight plan before departing El Dorado.

A cold front with thunderstorms and instrument meteorological conditions existed between El Dorado and Texarkan. The crew deviated about 100 nmi north of the direct course to their destination and attempted to operate the aircraft visually in instrument meteorological conditions. No radio transmissions were made by the crew after the flight departed El Dorado.

There were 2 flight crew, 1 cabin attendant and 8 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19740101	TURIN, ITALY	F28-1000
Date	**Operator**	**Regn**
1-JAN-1974	ITAVIA	I-TIDE

Résumé of Accident

On 01-Jan-1974 an Itavia F-28 registered as I-TIDE was landing at Turin, Italy.

During its final approach the aircraft was flying under radar control in fog and unfavourable weather conditions It crashed before the threshold of the runway and caught fire.

After hitting a tree top, the aircraft collided with the top of a building under construction. This resulted in separation of the right wing trailing edge flaps and rupture of the lower wing surface. The aircraft started rolling to the right. The right wing and tailplane then hit the ground and both separated. While the aircraft kept rolling, the left wing hit the ground and separated as well. The fuselage hit the ground while inverted and came to rest, also inverted, against and partly in a farm building.

Of the 4 crew and 38 passengers aboard, 3 crew and 35 passengers suffered fatal injuries, 1 crew member suffered serious injuries and 3 passengers escaped with minor or no injuries.

Summary of Assessment

Therefore, it was assessed that as the fuselage was inverted that there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19740126A	COMAOVASI, TURKEY	F28-1000
Date	**Operator**	**Regn**
26-JAN-1974	THY	TC-JAO

Résumé of Accident

On 26-Jan-1974 a Turkish Airlines F-28 registered as TC-JAO was taking off from Izmir/Cumaovasi Airport after an overnight stay outside in freezing conditions. It is believed that frost accretion on the wings was not noticed during the walk-around inspection that would cause the aircraft to stall if it was over-rotated at take-off.

According to witnesses the aircraft had run approximately 3200 feet before becoming airborne. When about 8 to 10 m above the ground it yawed to the left and pitched nose down. Contact with the ground was made in a nearly level attitude, first by the outboard fairing doors of the left wing flap, then by the left side of the fuselage belly, hitting the bank of a drainage ditch, which parallels the left side of the runway.

The aircraft then disintegrated and caught fire within 100 m of travel.

Airport personnel and others who witnessed the accident ran towards the site and tried to assist in personnel evacuation. The fire fighters required outside assistance before they were able to control the fire and then extinguish it.

Of the 5 crew and 68 passengers aboard, 4 crew and 62 passengers suffered fatal injuries, 1 crew and 6 passengers suffered serious injuries.

Summary of Assessment

The fuselage broke into three sections with the large centre section extensively damaged and inverted. Therefore, it was assessed that all there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19740130A	PAGO PAGO, AMERICAN SAMOA	B707-321B
Date	**Operator**	**Regn**
30-JAN-1974	PAN AMERICAN WORLD AIRWAYS	N454PA

Résumé of Accident

On 30-Jan-1974, B707-321B was making an ILS approach at night to Pago Pago International Airport in American Samoa. The aircraft encountered destabilising wind changes, which resulted in an excessive descent rate and as a result the aircraft crashed short of the runway.

A fire broke out and the occupants could not open all the emergency exits. Of the 101 occupants, 97 suffered fatal injuries.

The aircraft was destroyed by the impact and subsequent fire.

Summary of Assessment

The fuselage and cabin interior were intact from the impact. The external fuel fed fire was mainly on the right side of the aircraft, however the left hand side also had burning fuel on the ground. 10 people evacuated the aircraft, but only 4 survived their injuries sustained outside the aircraft. In all assessments it was assumed that only 40% of evacuees would survive the external fire.

Overall there were 97 fatalities with all fatalities due to fire (1 crew member also had serious injuries from the impact.)

Later Requirements

It is assessed that although later requirements may have reduced the level of smoke in the cabin, it may not have been sufficient to allow the opening of the main exits. In addition a significant proportion of evacuees may not have survived the external fire. The assumption made is that the number of fatalities would have been reduced to 93.

Enhanced Fuselage Burnthrough Protection

Burnthrough Protection would have provided additional time for evacuation although smoke and fire would have entered through any exits that were opened. It is therefore assumed that the number of fatalities would have been reduced to 84.

Cabin Water Spray systems (without Burnthrough Protection)

The systems would have provided time for the crew to gain control of the situation and evacuate. The modular system would have made this easier due to improved visibility. Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	93	93
High	85	81
Median	72	67
Low	60	55

Cabin Water Spray systems (assuming Burnthrough Protection present)

The application of both systems should have resulted in an opportunity for all passengers/crew to attempt an evacuation from the best potential exit. The

assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	84	84
High	71	66
Median	57	52
Low	45	40

Accident Database Reference	Location	Aircraft
19740315A	TEHERAN, IRAN	CARAVELLE 10B3
Date	**Operator**	**Regn**
15-MAR-1974	STERLING AIRWAYS	OY-STK

Résumé of Accident

On 15-Mar-1974, a Stirling Airways Caravelle registered as OY-STK was taxiing at Teheran/Mehrabad International Airport, Teheran, Iran.

Shortly before the aircraft was going to initiate a left turn towards the run-up area two loud noises were heard in the aircraft and the right wing dropped to the ground and struck the runway. The aircraft came to a stop 90 metres further on and a heavy fire developed.

Evacuation of the aircraft was carried out through exits on the left side of the aircraft.

Preliminary investigation revealed that the right landing gear collapsed due to structural failure of a fitting (lower 'candelabra'). A rupture of the fuel tank resulted and the JP 1 fuel escaping from the tank ignited before the aircraft came to a stop. The source of the ignition was not determined.

There were 4 crew and 92 passengers aboard. 15 passengers suffered fatal injuries.

Summary of Assessment

Overall there were 15 fatalities with all 15 fatalities due to fire.

Later Requirements

It was assumed that with the fire burning through the fuselage in approximately 30 seconds, the application of later requirements would have given extra time for 2 passengers to evacuate.

Enhanced Fuselage Burnthrough Protection

Burnthrough Protection would have allowed all passengers to evacuate from the available exits.

Cabin Water Spray systems (without Burnthrough Protection)

Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	13	13
High	6	4
Median	3	2
Low	0	0

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	0	0
High	0	0
Median	0	0
Low	0	0

Accident Database Reference	Location	Aircraft
19740422A	DENPASAR, BALI, INDONESIA	B707-321C
Date	**Operator**	**Regn**
22-APR-1974	PAN AMERICAN WORLD AIRWAYS	N446PA

Résumé of Accident

On 22-Apr-1974, a Pan American World Airlines B707-321C registered as N446PA was en-route to Denpasar, Bali, Indonesia.

The crew, in an attempt to expedite their approach to Bali Airport, elected to execute an early right hand turn. By using this type of approach, they were prevented from knowing their exact position. Evidently, the right turn was made at the time when only one of the ADF needles swung and the aircraft was, in fact, 30 mn north of the beacon.

Although several attempts were made to regain proper indication on the ADF's after the turn, this would not have been possible since the aircraft would be shielded by a mountain range. However, the approach was continued as planned resulting in a collision with high ground.

The aircraft hit a mountain approximately 37 NM North-West of Ngurah Rai Airport, Bali.

The aircraft was totally destroyed.

There were 11 crew and 96 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19740608A	CERRO EL RETIRO, COLUMBIA	VISCOUNT
Date	**Operator**	**Regn**
8-JUN-1974	TAXI AÉREO OPITA (TAO)	HK-1058

Résumé of Accident

On 08-Jun-1974 a Taxi Aéreo Opita (TAO) Viscount 785, registered as HK-1058 was descending into Cúcuta, Bogota, Colombia.

All contact was lost with the aircraft and it was later reported that the aircraft crashed against Cerro El Retiro.

It was later determined that the tailplane spar had failed in flight.

The aircraft was destroyed.

There were 6 crew and 38 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19740911A	DOUGLAS AIRPORT, CHARLOTTE, N.C. U.S.A.	DC9-31
Date	**Operator**	**Regn**
11-SEP-1974	EASTERN AIRLINES	N8984E

Résumé of Accident

On 11-Sep-1974 an Eastern Airlines DC-9-31 registered as N8984E was approaching Douglas Municipal Airport, Charlotte, North Carolina.

The aircraft was conducting a VOR DME non-precision approach with visibility restricted by patchy dense ground fog. The aircraft descended too low, struck some small trees, struck larger trees and then impacted a cornfield 3.3 miles short of the runway. On impact the aircraft burst into flames and was destroyed by the impact and ensuing fire.

There were 4 crew and 78 passengers on board. 2 crew and 70 passengers suffered fatal injuries. 1 crew member and 8 passengers suffered serious injuries. 1 crew member escaped with minor or no injuries.

Most of the occupants who survived the impact were located in the tail section but died later in the post crash fire.

Summary of Assessment

The aircraft fuselage broke up extensively during the impact with trees and other obstacles. A fuel driven fire entered the main fuselage section before the wreckage came to rest.

The tail section however remained less damaged and had a useable and safe exit. Therefore, it was assessed that there would be the opportunity for benefit from a modular Cabin Water Spray system in this section.

Overall there were 72 fatalities with 40 fatalities due to fire. Of these 40 it is assumed that 15 were in the tail section and were mobile after the impact.

Later Requirements

It was assumed that because of the fuel driven fire that later requirements would not have reduced the number of fatalities.

Enhanced Fuselage Burnthrough Protection

It was assessed that due to the extensive fuselage damage, there would be no benefit from Burnthrough Protection.

Cabin Water Spray systems (without Burnthrough Protection)

Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	40	40
High	40	40
Median	40	35
Low	40	30

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	40	40
High	40	40
Median	40	35
Low	40	30

Accident Database Reference	Location	Aircraft
19741120A	NAIROBI, KENYA	B747-130
Date	**Operator**	**Regn**
20-NOV-1974	LUFTHANSA	D-ABYB

Résumé of Accident

On 20-Nov-1974 a Lufthansa B747-130 registered as D-ABYB was taking off from Nairobi Airport, Kenya. The aircraft became airborne in a partially stalled condition. The aircraft lost altitude and crashed. Of the 17 crew and 139 passengers aboard, 4 crew and 55 passengers suffered fatal injuries, 9 crew and 45 passengers suffered serious injuries and 4 crew and 39 passengers escaped with minor or no injuries.

Summary of Assessment

There is some doubt over the cause of death for a number of fatalities. In addition, 7 of those fatalities attributed to fire had injuries that would have precluded them from evacuating themselves.

Overall there were 59 fatalities with 16 of these being due to fire.

Later Requirements

It is assessed that the application of later requirements would have saved 33% of those able to self evacuate. This reduces the overall number of fatalities to 56 with 13 being due to fire.

Enhanced Fuselage Burnthrough Protection

There is some evidence that some of the fire entered through the lower fuselage although this is not considered to be the primary entry route. It is assessed that the application of Burnthrough Protection would have saved one additional life.

Cabin Water Spray systems (without Burnthrough Protection)

As the forward and centre sections of the fuselage remained in one piece it is assumed that a singular system would function, although its effectiveness would be reduced by interior cabin damage. A modular system is assumed to perform better. Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	13	13
High	13	13
Median	11	10
Low	9	8

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	12	12
High	12	12
Median	10	9
Low	8	7

Accident Database Reference	Location	Aircraft
19741201A	BERRYVILLE, VIRGINIA, U.S.A.	B727-231
Date	**Operator**	**Regn**
1-DEC-1974	TRANS WORLD AIRLINES	N54328

Résumé of Accident

On 01-Dec-1974 a Trans World Airlines, Inc. B727-231 registered as N54328 was landing at Dulles International Airport, Washington D.C. after a flight from Indianapolis, Indiana, with an intermediate stop at Columbus, Ohio. The captain was qualified to operate into Dulles under the provisions of 14 CFR 121.443.

During the VOR/DME approach in Instrument Meteorological Conditions the aircraft descended below minimum altitude and crashed 25 nautical miles northwest of the runway.

There were 7 crewmembers, and 85 passengers aboard. All occupants suffered fatal injuries. All of the occupants of the aircraft died of traumatic injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19741204A	ANJIMALI MOUNTAIN, SRI LANKA	DC8-55F
Date	**Operator**	**Regn**
4-DEC-1974	MARTINAIR HOLLAND	PH-MBH

Résumé of Accident

On 04-Dec-1974, a Martinair DC-8-55F registered as PH-MBH was approaching the Bandaranaike International Airport, Katunayake, Sri Lanka.

The aircraft was operating a non-scheduled transport service.

The aircraft was descended from 35,000 ft by Area Control and handed over to Approach Control, at 1634:14 hours and the aircraft contacted Approach Control at 1638:10 hours, informing Approach Control that they were out of 7,000 for 6,000 at a distance of ONE FOUR (14) miles out. Approach Control acknowledging this message cleared the aircraft to 2,000 ft with instructions to report "Kilo Alpha Tango" (Katunayake Non-Directional Beacon) or "airfield in sight". This message was acknowledged by the aircraft. There was no further communication with the aircraft.

Eyewitnesses state that the aircraft was sighted flying at an altitude lower than normal over Castlereigh, Bogawanthalawa and Agrapatana, and to all appearances the engines sounded normal and there was no evidence of any fire on board during flight.

The sound of the aircraft exploding on impact was heard clearly by residents close to the site of crash and subsequently it was discovered that the aircraft had crashed into the 5th mountain on the range of hills called "Anjimalai" at Maskeliya, with fatal injuries to all on board.

The aircraft was completely destroyed consequent to the impact. Of the 9 crew and 182 passengers aboard, all occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19750624A	KENNEDY AIRPORT, NEW YORK, U.S.A.	B727-225
Date	**Operator**	**Regn**
24-JUN-1975	EASTERN AIRLINES	N8845E

Résumé of Accident

On 24-Jun-1975 an Eastern Airlines B727-225 registered as N8845E was landing at the John F Kennedy International Airport, New York.

There was a very strong thunderstorm that was located astride the ILS localizer course. The aircraft encountered adverse winds and the resultant high descent rate caused the aircraft to crash into the approach lights to the runway.

The aircraft was destroyed by the impact and a fire.

Of the 8 crew and 116 passengers aboard, 6 crew and 107 passengers suffered fatal injuries, 2 crew and 9 passengers suffered serious injuries.

Summary of Assessment

The fuselage was completely destroyed in the impact. The survivors were generally thrown clear except two flight attendants whose seats and seat structure survived.

Therefore, it was assessed that although some fatalities were due to fire, there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19750830A	SEVUOKOK MOUNTAIN, GAMBELL, ALASKA, U.S.A.	F27B
Date	**Operator**	**Regn**
30-AUG-1975	WIEN AIR ALASKA	N4904

Résumé of Accident

On 30-Aug-1975 a Wien Air Alaska F-27B registered as N4904 was attempting to land at Gambell Airport, Gambell, Alaska.

Using instrument approach procedures in adverse weather conditions, the aircraft crashed into Sevuokuk Mountain, Gambell and was destroyed by impact and fire.

There were 4 crew and 28 passengers aboard. 3 crew and 7 passengers suffered fatal injuries. 1 crew member and 19 passengers suffered serious injuries. 2 passengers escaped with minor or no injuries.

The captain, first officer and cargo-loader received multiple extreme impact injuries. The captain and cargo-loader were burned severely. The seven fatally injured passengers sustained severe impact injuries and three of them were burned extensively; toxicological analyses of the latter revealed negative findings for carbon monoxide.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19760405A	KETCHICAN, ALASKA, U.S.A.	B727-81
Date	**Operator**	**Regn**
5-APR-1976	ALASKA AIRLINES	N124AS

Résumé of Accident

On 05-Apr-1976 an Alaska Airways B727-81 registered as N124AS was landing at the Ketchikan International Airport, Ketchikan, Alaska in conditions of low ceilings and low visibility onto a wet runway.

From an unstabilized approach there followed an excessively long and fast touchdown. The captain initiated a go-around after he was committed to a full stop landing. As a result, the aircraft overran the departure end of the runway and crashed into a ravine about 700 feet past the runway threshold.

The aircraft was destroyed by the impact, and a post crash fire. Of the 7 crew and 43 passengers aboard, 1 passenger died and 32 persons were injured. The fatally injured passenger died of impact trauma.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19760427A	ST. THOMAS, VIRGIN ISLANDS	B727-95
Date	**Operator**	**Regn**
27-APR-1976	AMERICAN AIRLINES	N1963

Résumé of Accident

On 27-Apr-1976 an American Airlines B727-95 registered as N1963 was landing at the Harry S Truman Airport, St Thomas. The aircraft overran the runway coming to rest against a building. The aircraft was destroyed by the impact and a post-crash fire. Of the 7 crew and 81 passengers aboard 2 crew and 35 passengers suffered fatal injuries, 2 crew and 17 passengers serious injuries. 3 crew and 29 passengers suffered minor or no injuries.

Summary of Assessment

The cabin broke in to four sections (cockpit, fwd fuselage, centre section to just forward of aft bulkhead, and tail section). The flight crew exited via a cockpit, opening window. The fwd fuselage suffered high impact loads, which broke many seats from their mountings. Fatalities from this section were mostly thrown forward into the cockpit section and into a fuel fire. It was assessed that these 9 passengers (one died from impact injuries) would not have been assisted by application of later requirements, Burnthrough Protection of Cabin Water Spray systems. The centre and tail sections contained 28 fatalities (although one died from impact injuries).

Overall there were 37 fatalities of which 35 fatalities were due to fire.

Later Requirements

It is assessed that the application of later requirements would have resulted in a improvement in the ability of the passengers to locate and use exits. It is assumed that this would result in a reduction in the number of fatalities in the centre and tail sections of 33%. This reduces the number of fire related fatalities to 26.

Enhanced Fuselage Burnthrough Protection

It is assessed that Fuselage Burnthrough Protection would not have assisted due to the large fuselage breaks and the source of the fire.

Cabin Water Spray systems (without Burnthrough Protection)

A singular Cabin Water Spray system based in the centre section could have reduced the number of fatalities in the centre section only. A modular system could have assisted both the centre and tail sections.

Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	26	26
High	26	26
Median	23	20
Low	20	14

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	26	26
High	26	26
Median	23	20
Low	20	14

Accident Database Reference	Location	Aircraft
19760604A	GUAM, MRIANAS ISLANDS, PHILIPPINES	L188A
Date	**Operator**	**Regn**
4-JUN-1976	AIR MANILLA INCORPORATED	RP-C1061

Résumé of Accident

On 04-Jun-1976 an Air Manilla Lockheed Electra L-188A registered as RP-C1061 was taking off from the Agana Naval Air Station, Guam, Marianas Islands.

When the aircraft lifted off the 10,015-foot runway, the No. 3 propeller feathered. The crew retracted the flaps as the aircraft lifted off the runway.

The aircraft climbed to between 75 and 100 feet, flew level for 1,600 feet and then struck gradually rising terrain in a tail-low attitude, 4,300 feet beyond the end of the runway. The aircraft dragged along the brow of the hill, dropped off a 13-foot embankment, crashed through a chain link perimeter fence, slid across a highway, struck a moving automobile and burst into flames.

The aircraft came to rest in a vacant area that was surrounded by 6 houses.

The driver of the automobile was killed. A woman and her young son, who were standing outside their residence just south of the impact site, were seriously injured by the intense heat and flying debris when the aircraft's fuel exploded.

There were 12 crew and 33 passengers on board. All occupants suffered fatal injuries.

The captain and first officer received fractures of both lower legs and the captain incurred a large laceration to his forehead. The flight engineer sustained a crushing injury to his chest. The 3 flightcrew members were severely burned and the captain and flight engineer had deposits of black soot in the tracheae. The captain and first officer died from suffocation by smoke inhalation and shock from severe burns. The flight engineer died from impact injuries.

The other 9 crewmembers were burned severely. 7 of them also had severe traumatic impact injuries to the head, chest and extremities. 3 of the 9 crewmembers had deposits of black soot in the tracheae and they died from suffocation by smoke inhalation and shock from severe burns. The other 6 died from impact injuries. Their blood samples contained levels of CO, which ranged from 4.1 to 21.8 percent.

23 of the passengers died from suffocation by smoke inhalation and shock from severe burns. The other 10 passengers died from various, severe impact injuries. All but one of the passengers was burned severely. The passengers' blood samples contained levels of CO, which ranged from 1.6 to 40.4 percent; nine of them showed levels of above 20 percent.

Summary of Assessment

Although there was significant impact damage to the fuselage and the cabin interior, it can be seen that a significant number of passengers and crew survived this impact. It is also plausible that although the fire engulfed the outside of the aircraft, a potential escape rout existed if the cabin interior had been a survivable environment for longer. Therefore this accident has been analysed in more detail.

Overall there were 45 fatalities with 28 fatalities due to fire.

Later Requirements

It was assumed that later requirements would have given an additional 30 seconds which is assessed would have resulted in one survivor.

Enhanced Fuselage Burnthrough Protection

It was assumed that although the fuselage was in one piece, that it would have damage allowing fire to bypass some of the Burnthrough Protection. It was assumed therefore that this would have given an additional 1 minute to evacuate. It is assessed that this would have resulted in an additional 2 survivors.

Cabin Water Spray systems (without Burnthrough Protection)

It was assumed that the singular system would function sufficiently to provide 1 to 2 minutes protection and the modular 2 minutes. Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	27	27
High	27	27
Median	25	24
Low	22	20

Cabin Water Spray systems (assuming Burnthrough Protection present)

It was assumed that the Cabin Water Spray and Burnthrough Protection together would have produced slightly longer times for evacuation, of up to 3 minutes. The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	25	25
High	25	25
Median	23	22
Low	21	19

Accident Database Reference	Location	Aircraft
19760910B	VROBEC, YUGOSLAVIA	DC9-32
Date	**Operator**	**Regn**
10-SEP-1976	INEX ADRIA AVIOPROMET	YU-AJR

Résumé of Accident

On 10-Sep-1976, an Inex Adria Airways DC-9-32, registered as YU-AJR, took-off from Split airport at 0948 (GMT) on flight JP 550, transporting 108 West German tourists to Cologne, Germany. The aircraft collided with a British Airways Trident 3B, flight BE 476, near Zagreb, Yugoslavia.

There were 5 crew and 108 passengers aboard. All occupants suffered fatal injuries in the accident.

Immediately before the collision the crew of the DC-9 were incorrectly informed that the Trident was flying on FL 335.

At this level, 9 seconds after it had levelled at FL 330, according to the flight recorder readout (altitude parameter) the DC-9 collided with the Trident-3 over ZAG VOR. The impact location of the DC-9 aircraft was 1 km eastward from the village Dvoriste. It fell in a forest area. The impact and fire damaged the forest vegetation over an area of approximately 70 x 70 m.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19761012A	BOMBAY, INDIA	CARAVELLE
Date	**Operator**	**Regn**
12-OCT-1976	INDIAN AIRLINES	VT-DWN

Résumé of Accident

On 12-Oct-1976, an India Airlines, Aerospatiale SE 210 Caravelle, registered as VT-DWN, crashed during approach to Bombay Airport, India, after an engine failure and fire. The aircraft was destroyed. There were 6 crewmembers and 89 passengers aboard, all were fatally injured.

The aircraft took off at Bombay Airport from Runway 027 at 0134 hours. During the initial climb the right engine failed and the pilot decided to attempt a single engine landing on Runway 09. Within seconds, the failed engine was on fire. During the approach pitch control was apparently lost and the aircraft plunged to the ground in a 45 deg nose down attitude from a height of approximately 300ft. The aircraft struck the ground 1000ft short of Runway 09 threshold.

Initial investigation revealed that the right engine compressor casing cracked due to 10th stage compressor disc failure. The fire appears to have originated from damaged fuel lines spanning the compressor casing.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19761225A	BANGKOK, THAILAND	B707-366C
Date	**Operator**	**Regn**
25-DEC-1976	EGYPT AIR	SU-AXA

Résumé of Accident

On 25-December-1976, an Egypt Air Boeing B707, registered as SU-AXA, crashed short of the runway into a textile factory. A fire occurred after impact. The aircraft wreckage and the textile factory were destroyed by impact and ground fire. There were 9 crewmembers and 43 passengers aboard and all suffered fatal injuries.

At 2030 hours GMT, the flight crew made initial contact with Bangkok approach control and reported 33nm DME from Bangkok. After having been vectored to the "BK" beacon an ADF approach to Runway 021L was carried out. After having reported that the runway was in sight the pilot was cleared to land and acknowledged the clearance. Shortly thereafter the aircraft crashed into a factory 2km before Runway 021L threshold.

The weather was: nil wind, visibility 4000m, clouds 2/8 to 4/8 at 300m, temperature 25 deg C, dew point 24 deg C, altimeter setting 1007mb.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19770115A	BROMMA AIRPORT, SWEDEN	VISCOUNT
Date	**Operator**	**Regn**
15-JAN-1977	SKYLINE SWEDEN	SE-FOZ

Résumé of Accident

On 15-Jan-1977, a Skyline Sweden Vicker-Armstrong VC-2 Viscount, registered as SE-FOZ, crashed on approach to Bromma Airport, Sweden. There were 3 crewmembers and 19 passengers aboard, all were fatally injured.

Just after passing the outer marker, during an ILS approach to Runway 12, the aircraft got out of control and struck the ground in an almost vertical attitude. The aircraft was destroyed by the impact and subsequent fire. According to other aircraft which landed at Bromma just before and after the accident, icing conditions existed.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19770327A	TENERIFE AIRPORT, CANARY ISLANDS	B747
Date	**Operator**	**Regn**
27-MAR-1977	PAA	N736PA

Résumé of Accident

On 27-Mar-1977 a PAA B747 registered as N736PA attempted to taxi onto a taxiway at Tenerife Airport in fog conditions and was forced to stop across the runway. A KLM B747 was taking off from the same runway and due to the fog did not observe the stationary PAA aircraft. The KLM aircraft started its take-off role and was just airborne when it collided with the PAA aircraft. There were no eye witnesses to the collision.

Of the 16 crew and 380 passengers aboard 9 crew and 326 passengers suffered fatal injuries. 7 crew and 52 passengers suffered serious injuries. 2 passengers escaped with minor or no injuries.

Summary of Assessment

The PAA 747 had significant damage to the roof of the cabin from the missing upper deck back to the fin. The fatalities were unable to move out of the fire affected areas due to the damaged fuselage roof structure. It is therefore assessed that neither the application of enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems would have resulted in fewer fatalities.

Accident Database Reference	Location	Aircraft
19770327B	TENERIFE AIRPORT, CANARY ISLANDS	B747-206B
Date	**Operator**	**Regn**
27-MAR-1977	KLM	PH-BUF

Résumé of Accident

On 27-Mar-1977 a KLM B747 registered as PH-BUF was taking off from the Los Rodeos (Tenerife) Airport in fog conditions. At the same time, a PAA B747 attempted to taxi onto a taxiway and was forced to stop across the same runway. The KLM aircraft started its take-off role and was just airborne when it collided with the PAA aircraft. Of the 14 crew and 234 passengers aboard, all occupants suffered fatal injuries.

Summary of Assessment

Although there were no survivors, there are aspects of the accident report which indicate that the accident may have been survivable to some extent. The following are sections taken from the accident report.

"The impact both against the PAA aircraft and against the ground could not have been excessively violent. However, an immediate and raging fire must have prevented adequate emergency operations because all the aircraft's evacuation doors remained shut even though the fuselage was not significantly deformed."

"When there was a slight clearing, they [the first fire crew] saw for the first time that there was an aircraft totally enveloped in flames, its only visible part being the rudder. This was the PAA aircraft.

After they had begun to fight the fire, they saw fire from the wreckage of the KLM B747, which had hit the PAA B747. They immediately concentrated their main effort on this second aircraft because the first was already totally irrecoverable."

"As a result of this action, they were able - in spite of the tremendous range of the fire in this second aeroplane - to save the left side, from which between fifteen and twenty thousand kg of fuel were subsequently removed."

Therefore, it was assessed that both Fuselage Burnthrough Protection and Cabin Water Spray systems had the potential to save lives in this accident.

Later Requirements

It was assumed that later requirements alone would not have allowed anyone to survive, as it is likely that the level of fire entry into the cabin would have been too severe.

Enhanced Fuselage Burnthrough Protection

As the cabin remained in one piece, it was assessed that Burnthrough Protection (in conjunction with later requirements) would have given the potential for a part of the cabin to be evacuated. The fire outside the aircraft appears to have been severe but with a large number of available exits, it is probable that at least one would have been usable. It is therefore assessed that the total number of fatalities would be reduced by 28 to 220.

Cabin Water Spray systems (without Burnthrough Protection)

The Cabin Water Spray system applied without Burnthrough Protection could provide a similar outcome to Burnthrough Protection, although this would obviously depend upon the magnitude and number of fire entry points. A modular system is likely to perform better in this situation, as some parts of the cabin may retain good visibility and a survivable atmosphere. The assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	248	248
High	248	248
Median	220	210
Low	160	150

Cabin Water Spray systems (assuming Burnthrough Protection present)

With Cabin Water Spray systems and Burnthrough Protection it is more probable that the conditions inside the cabin would have allowed a successful partial evacuation. The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	220	220
High	220	220
Median	180	150
Low	100	50

Accident Database Reference	Location	Aircraft
19770404A	EW HOPE, GEORGIA, U.S.A.	N DC9-31
Date	**Operator**	**Regn**
4-APR-1977	SOUTHERN AIRWAYS	N1335U

Résumé of Accident

On 04-Apr-1977 a Southern Airlines DC-9-31 registered as N1335U was en route from Huntsville Alabama to Atlanta, Georgia.

The aircraft entered a severe thunderstorm, both engines were damaged and all thrust was lost. The engines could not be restarted and the flightcrew attempted an emergency landing on State Spur Highway 92, which bisected New Hope.

As the aircraft hit the ground it struck road signs, utility poles, fences, trees, shrubs, gasoline pumps, 5 cars and a truck. The fuselage broke into 5 major sections and a fire ensued. The aircraft was destroyed.

There were 4 crew and 81 passengers on board. 2 crew and 60 passengers suffered fatal injuries. 1 crew member and 21 passengers suffered serious injuries. 1 crew member escaped with minor or no injuries.

Summary of Assessment

Some of the fatalities were due to fire. The fuselage however broke into 5 sections and fire entered the cabin before the aircraft came to rest. Therefore, it was assessed that there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19780211A	CRANBROOK B.C., CANADA	B737-275
Date	**Operator**	**Regn**
11-FEB-1978	PACIFIC WESTERN AIRLINES	C-FPWC

Résumé of Accident

On 11-Feb-1978 a Pacific Western B737 registered as C-FPWC was landing at Cranbrook, BC.

Cranbrook is an 'uncontrolled' airport without a control tower, but within controlled airspace, with an 'Aeradio' station providing communications, weather, and advisory service. At Cranbrook it was snowing with the visibility reported as 3/4 of a mile, and a radio equipped snow removal vehicle was sweeping the runway. The Aeradio operator at Cranbrook alerted the vehicle operator about the incoming aircraft and gave him the ETA; they both expected the flight would report by the 'Skookum Beacon' on a straight-in approach to the runway, thus giving the vehicle operator about seven minutes to get off the runway.

Cranbrook Aeradio advised the flight that snow removal was in progress and gave the latest visibility. The aircraft acknowledged. No further transmissions were received from the flight, by Aeradio or ATC.

Evidence indicates the aircraft passed the Skookum beacon inbound on a straight-in instrument approach, and flew the ILS to touchdown. According to witnesses and estimates partially derived from flight data recorder information, the aircraft touched down approximately 800 feet from the threshold and reverse thrust was selected.

A snow removal vehicle was spotted still on the runway so reverse thrust was cancelled immediately and a go-around was initiated. The aircraft became airborne prior to the 2000 foot mark, and flew down the runway at a height of 50 to 70 feet, flying over the snow removal vehicle. About this time the left engine thrust reverser doors deployed. A few seconds later, the flap was selected up from 40 deg to 15 deg. The landing gear remained down and locked. Six seconds before impact and just over 4000 feet from the runway threshold, the flight recorder data indicates that a large amount of left rudder was momentarily applied. The aircraft climbed to 300 or 400 feet above the airfield, banked steeply to the left, lost height and side-slipped into the ground to the left of the runway. Fire broke out on impact.

Of the 5 crew and 44 passengers aboard 4 crew and 39 passengers suffered fatal injuries.

Summary of Assessment

Although some of the fatalities were due to fire, the fuselage disruption was so severe that it was assessed that there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19780301A	LOS ANGELES, CALIFORNIA, U.S.A.	DC10-10
Date	**Operator**	**Regn**
1-MAR-1978	CONTINENTAL AIRLINES	N68045

Résumé of Accident

On 01-Mar-1978 a Continental Airlines DC-10-10 registered as N68045 was taking off from Los Angeles International Airport with wet runway conditions.

Multiple tyre failure occurred on the left main gear and the take-off was aborted. The aircraft overran the end of the runway and as it left the load-bearing surface of the runway, the left main landing gear collapsed and ruptured the left wing fuel tank. Fire erupted from the left wing area.

The aircraft slid to a stop about 664 feet from the departure end of the runway.

All exits were opened but some slide/rafts did not operate correctly. All slide/rafts failed before the evacuation was complete. The emergency evacuation was a success due to the efforts of the entire flight-crew and cabin crew in seeking alternate escape routes when normal routes were rendered useless.

The fuselage, though burned extensively on the left side, remained intact.

Of the 14 crew and 186 passengers on board, 2 passengers were killed by fire on the ground outside the aircraft. 3 crew and 28 passengers were seriously injured during the evacuation of the aircraft.

Summary of Assessment

It was assessed that all fatalities were due to fire outside the aircraft and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19780301B	KANO AIRPORT, NIGERIA	
Date	**Operator**	**Regn**
1-MAR-1978	NIGERIA AIRWAYS	5N-ANA

Résumé of Accident

On 01-Mar-1978, a Nigeria Airways Fokker F28 Mk 1000, registered as 5N-ANA, collided with a military jet trainer in mid air, 2km from Runway 05 at Kano Airport, Nigeria. The aircraft was destroyed. There were 5 crewmembers and 11 passengers aboard, all were fatally injured.

At 1231 hours the Fokker F28 was cleared by Kano Control Tower to descend to flight level 65. When reporting field in sight it was asked to maintain same flight level because a Nigerian Air Force jet trainer had been cleared to descend to 500m off (about 3,000ft QNH) and report overhead. When the jet trainer was on final it was cleared for a touch-and-go and while it was taking off the F28 reported left hand down wind Runway 05 still maintaining FL65. The F28 was then cleared to descend to circuit altitude and report final as number 1. The jet trainer was informed accordingly and was instructed to let the F28 land first. At 1242 hours the F28 was on final and cleared to land. At 1243 the duty controller observed the aircraft crashing in flames about 2km before Runway 05 threshold. The military controller called the jet trainer to no avail.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19780925A	SAN DIEGO, CALIFORNIA, U.S.A.	B727-214
Date	**Operator**	**Regn**
25-SEP-1978	PACIFIC SOUTHWEST AIRLINES (PSA)	N533PS

Résumé of Accident

On 25-Sep-1978 a Pacific Southwest Airlines B727-214 registered as N533PS was making a visual approach to runway 27 at Lindbergh Field, San Diego, California.

A nearby Cessna was under the control of San Diego approach control and was climbing on a northeast heading. The B727 had been advised of the location of the Cessna by the approach controller. The flightcrew told the approach controller that they had the traffic in sight and were instructed to maintain visual separation from the Cessna and to contact the Lindbergh Tower. The aircraft contacted the tower on its downwind leg and was again advised of the Cessna's position. The flightcrew did not have the Cessna in sight, they thought they had passed it, and continued the approach.

The two aircraft collided near 2,600 feet msl and fell to the ground in a residential area. 22 dwellings were damaged or destroyed.

There were 7 crewmembers, and 128 passengers aboard the B727. All occupants suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19781217A	HTDERABAD, INDIA	B737-200
Date	**Operator**	**Regn**
17-DEC-1978	INDIAN AIRLINES	VT-EAL

Résumé of Accident

Indian Airlines B737 registered as VT-EAL was taking off from Hyderabad Airport on 17-Dec-1978. The leading edge devices did not deploy and as a result the aircraft became aerodynamically unstable. The take-off was aborted and the aircraft was flared for a belly landing with undercarriage retracted. The aircraft belly-landed in nose up, left wing low attitude, on the centre line of the runway. It slid for 3080 feet, hit a boundary fence, crossed a drain and ploughed in rough terrain negotiating with small boulders and came to rest. Fire broke out on impact. The aircraft was completely destroyed by fire.

There were 6 crew and 126 passengers aboard, of which 1 passenger suffered fatal burn injuries, 1 cabin attendant and 3 passengers were seriously injured.

3 persons cutting grass near the boundary fence of the airport were killed.

Summary of Assessment

Later Requirements

It was assessed that later requirements would have provided more time for the evacuation, and allowed a successful evacuation of the one passenger who was fatally injured. There are therefore no fire fatalities to investigate for either enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19790313A	DOHA AIRPORT, QATAR	B727
Date	**Operator**	**Regn**
13-MAR-1979	ALIA ROYAL JORDANIAN AIRLINES	JY-ADU

Résumé of Accident

The accident happened at night when the aircraft was executing a missed approach procedure on Runway 34 at Doha International Airport. Following the initiation of the missed approach procedure and on reaching a height of approximately 750 ft above aerodrome level the aircraft encountered a thunderstorm the effects of which exceeded the climb performance of the aircraft and forced it to the ground.

The first impact occurred with the underside of the rear fuselage at a position and forward of the aft passenger stairway. The left wing tip and the left wing leading and trailing edge flaps struck at the same time. There was severe damage to the fuselage, aft cabin windows were broken and the rear baggage hold burst open. Both podded engines (Nos. 1 and 3) became detached. The first impact damage and ground markings indicated an impact attitude of about 10° nose up and 5° left wing low

Following the first impact the aircraft 'bounced' and re-impacted the ground about 100 m further on, the left wing demolishing the inside marker board for the displaced threshold of RW 16 to the west of the runway. The aircraft then swung to the left and skidded sideways down Taxiway 4. In the area of the intersection of Taxiways 4 and 5 the aircraft rolled to the right to become inverted, causing substantial damage to the right wing and detaching the right wing slats. An impact on the outboard upper surface of the right horizontal stabiliser fractured the horizontal and vertical stabilisers and removed the upper rudder. The major part of the wreckage then slid into the Fire Station garage, the fuselage lying on its right side and travelling rearwards. The fuselage came to rest in 3 sections; the flight deck and about 14 ft of forward fuselage, 5 ft section of centre fuselage with wing roots and the remaining tail section.

Fire started at the time the aircraft struck the Fire Station garage. The fire eventually consumed much of the centre fuselage section and inboard mainplanes. The tail section remained untouched by the fire; the flight deck section interior was destroyed.

Of the 45 persons who died in the accident it was ascertained that the main cause of death in the case of 20 of them was severe burns and the remaining 25 suffered fatal impact injuries.

Summary of Assessment

Due to the combination of severe fuselage damage, and the fact that the cabin sections were lying on one side, it was assessed that there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19790329A	QUEBEC CITY, CANADA	F27
Date	**Operator**	**Regn**
29-MAR-1979	QUEBECAIR	C-FQBL

Résumé of Accident

On 29-Mar-1979 a Quebecair F-27B registered as C-FQBL was climbing out of Quebec City Airport.

Shortly after lift-off there was a loud bang from the right engine. The section of the engine from the low pressure compressor forward separated and fell to the ground, including some cowlings. Fire broke out in the engine and wheel well.

The aircraft was seen making a low right hand circuit apparently attempting to make an emergency landing at the airport. With the fire continuing the aircraft flew, at a low airspeed, for 1 min 12 sec, then crashed.

An intensive fire broke out on impact consuming the flight deck and parts of the wings.

There were 3 crew and 21 passengers aboard. 3 crew and 14 passengers suffered fatal injuries. 6 passengers suffered serious injuries. 1 passenger escaped with minor or no injuries.

Summary of Assessment

Although fire broke out in flight, and there was a subsequent ground fire, all fatalities were due to impact. Therefore, it was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19790525A	CHICAGO-O'HARE AP., ILLINOIS, U.S.A.	
Date	**Operator**	**Regn**
	AMERICAN AIRLINES	N110AA

Résumé of Accident

On 25-May-1979 an American Airlines DC-10-10 registered as N110AA was taking off from Chicago-O'Hare International Airport, Illinois. The aircraft was operating as a regularly scheduled passenger flight.

During the takeoff rotation, the left engine and pylon assembly and about 3 ft of the leading edge of the left wing separated from the aircraft and fell to the runway. The aircraft continued to climb to about 325 ft above the ground and then began to roll to the left. The aircraft continued to roll to the left until the wings were past the vertical position and during the roll the aircraft's nose pitched down below the horizon.

The aircraft crashed into an open field just short of a trailer park, about 4,600 ft northwest of the departure end of the runway.

The aircraft was destroyed in the crash and subsequent fire. An old aircraft hangar, several automobiles and a mobile home were also destroyed.

There were 13 crew and 258 passengers on board. All 13 crew and 258 passengers suffered fatal injuries.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19791007A	ATHENS, GREECE	DC8-62
Date	**Operator**	**Regn**
7-OCT-1979	SWISSAIR	HB-IDE

Résumé of Accident

On 7-Oct-1979, a DC-8-62 was landing at night on a wet runway at Athens Airport, Greece.

After a late and fast touchdown and after ineffective breaking, the aircraft overshot the runway end and the overrun area, fell down a slope of 4 m and caught fire.

Of the 154 occupants, 14 suffered fatal injuries as a result of the fire.

The aircraft was destroyed by impact and fire.

Summary of Assessment

Later Requirements

It was assumed that the application of later requirements would have had a significant effect on the level of smoke within the cabin. This would have allowed additional time for evacuation and reduced the confusion. It is therefore assumed that the number of fatalities would have been reduced to 6.

Enhanced Fuselage Burnthrough Protection

The fire entry mechanism was by burnthrough from the large fuel fire around the ruptured wing tanks. It is assessed that Burnthrough Protection would have allowed the cabin crew to ensure a full evacuation through the useable exits, with no resultant fatalities.

Cabin Water Spray systems (without Burnthrough Protection)

The fuselage suffered some damage and the tail section in the region of the fin became separated. The impact speed was low (approx 20-25knots) and so it is assumed that both the singular and modular systems would be relatively intact. Use of a singular system may have resulted in areas of poor visibility and hence potential confusion.

Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	6	6
High	4	2
Median	2	0
Low	0	0

Cabin Water Spray systems (assuming Burnthrough Protection present)

There are assessed to be no resultant fatalities with Burnthrough Protection in place.

Accident Database Reference	Location	Aircraft
19791126A	JEDDAH, SAUDI ARABIA	B707-340C
Date	**Operator**	**Regn**
26-NOV-1979	PAKISTAN INTERNATIONAL AIRLINES	AP-AWZ

Résumé of Accident

On 26-Nov-1979, a Pakistan International Airlines (PIA) Boeing B707-300, registered as AP-AWZ, struck the ground while attempting to return to Jeddah Airport, Saudi Arabia. The aircraft was destroyed. There were 11 crewmembers and 145 passengers aboard and all suffered fatal injuries.

At 0105 hours, 21 minutes after take-off the flight crew reported smoke in the cockpit coming from the cabin area. They requested and received ATC clearance to return to Jeddah and to leave their cruising level. An emergency descent was executed while attempting to return to Jeddah. The aircraft struck the ground in a level rocky area at 3300ft, exploded and burned.

An inflight fire started in the aft cabin and rapidly spread throughout the aircraft. The origin of the fire was not determined. Incorrect emergency and smoke evacuation procedures were carried out and smoke incapacitated the flight crew.

Summary of Assessment

The fire started within the aft cabin and in flight caused incapacitation of the flight crew. Therefore, it was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19800121A	ELBURZ MOUNTAINS, TEHRAN, IRAN	B727-100
Date	**Operator**	**Regn**
21-JAN-1980	IRAN AIR	EP-IRD

Résumé of Accident

On 21-Jan-1980, an Iran Air Boeing B727-100, registered as EP-IRD, collided with Elburz Mountains whilst approaching Tehran Airport, Iran. The aircraft was destroyed. There were 8 crewmembers and 120 passengers aboard and all suffered fatal injuries.

The aircraft had been cleared for an ILS approach to Runway 29 at 1852 hours. At 1911 hours communication with the aircraft was lost and it was subsequently reported that the aircraft had crashed in the Elburz Mountains 18mi north of Teheran.

The investigation revealed that the pilot did not follow the ATS route, but proceeded straight to Mehrabad. About 6 minutes before impact ATC asked the pilot to make a 360 deg turn over Varamin Non-directional Radio Beacon (NDB). The pilot made this 17nm to the north without advising ATC. On approach the copilot pointed out VORTAC radial crossing on wrong track, but the pilot did not react.

Summary of Assessment

It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19800227A	MANILA, PHILLIPPINES	B707
Date	**Operator**	**Regn**
27-Feb-1980	CHINA AIRLINES	B-1826

Résumé of Accident

On 27-Feb-1980 China Airlines B707 registered as B-1826 was landing at Manila in the Philippines. During the final approach, the aircraft suffered a hard landing short of the runway, bounced onto the runway and slid along on fire. The two outboard engines separated during the impact but the aircraft remained relatively intact.

Of the 11 crew and 124 passengers aboard, 2 of the passengers died as a result of serious burns received outside of the aircraft.

Summary of Assessment

The 2 fatalities were due to burns suffered outside the aircraft. Therefore, it was assessed that there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19800425A	NR. TENERIFE NORTE AP., CANARY ISLANDS	B727-64
Date	**Operator**	**Regn**
25-Apr-1980	DAN-AIR SERVICES	G-BDAN

Résumé of Accident

On 25-Apr-1980 a Dan-Air Services B727-100/46 registered as G-BDAN was operating a charter flight from Manchester, UK, to Tenerife Norte Airport, Tenerife, Canary Islands.

The aircraft was flying in cloud and struck the side of a mountain.

The aircraft was totally destroyed by the impact.

There were 8 crewmembers and 138 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

The aircraft struck the mountain and was totally destroyed. Although there were signs of fire, these were all assessed to be from after the impact and not to be the cause of any of the fatalities. Therefore, it was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19800427A	NR. BANGKOK INTERNATIONAL AIRPORT, THAILAND	HS748 SERIES II
Date	**Operator**	**Regn**
27-Apr-80	THAI AIRWAYS COMPANY	HS-THB

Résumé of Accident

On 27-Apr-1980 a Thai Airways HS-748 Series II registered as HS-THB was on a scheduled domestic passenger flight. The flight operated on the route Bangkok - Khon Kaen - Udon - Nakhon Phanom - Udon - Khon Kaen - Bangkok.

On the last leg, during the approach to Bangkok International Airport at an altitude of 1,500 ft, the aircraft entered a severe thunderstorm, which had a severe downdraft. The aircraft crashed into the ground approximately 8 nautical miles northeast of the airport. Fire broke out in both wings.

The aircraft was destroyed.

There were 4 crew and 49 passengers aboard. 4 crew and 40 passengers suffered fatal injuries. 9 passengers suffered serious injuries.

Summary of Assessment

The fire was confined to both wings. It was therefore assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19800819A	RIYADH, SAUDI ARABIA	L1011
Date	**Operator**	**Regn**
19-AUG-1980	SAUDIA	HZ-AHK

Résumé of Accident

On 19-Aug-1980 a Saudia L1011 registered as HZ-AHK was taking off from Riyadh airport.

Seven minutes after take-off an aural warning indicated smoke in the aft cargo compartment. When the aircraft landed back at Riyadh, some 20 minutes later, the fire had penetrated into the cabin. The aircraft did not make an emergency stop but instead taxied off the runway and shut down the engines. An evacuation was never initiated. All 301 on board perished in the fire.

If the spread of fire had been contained by fire blocking materials and appropriate cargo compartment materials, all occupants might have been saved.

Summary of Assessment

Overall there were 301 fatalities with all fatalities due to fire.

Later Requirements

It was assumed that as the fire was moderate that application of later requirements would reduce the number of fatalities by 33%. This assumption results in 201 remaining fatalities.

Enhanced Fuselage Burnthrough Protection

As the fire started in flight either within a cargo compartment, or next to it, Enhanced Burnthrough Protection would not have changed the outcome of the accident.

Cabin Water Spray systems (without Burnthrough Protection)

It is assumed that much of the smoke generated within the cabin came from seats and trim materials. It is also assumed that most of the passengers were still alive at the point of landing (at which point the Cabin Water Spray system would have been activated).

Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	201	201
High	100	100
Median	50	50
Low	0	0

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	201	201
High	100	100
Median	50	50
Low	0	0

Accident Database Reference	Location	Aircraft
19801119A	SEOUL, KOREA	B747-100
Date	**Operator**	**Regn**
19-Nov-1980	KOREAN AIRLINES	HL-7445

Résumé of Accident

On 19-Nov-1980 a Korean B747 registered as HL-7445 was landing at Seoul/Kimpo International Airport in conditions of patchy fog. The aircraft landed 90 metres short of the threshold and contacted a 45 deg embankment slope. The main landing gear was pushed backward and up causing a rupture in the bottom of the plane into the cargo compartment where struts were ruptured. The plane slid down the runway on its nose gear and belly. The wings were intact. No fuel tanks were ruptured. Fire erupted in the cargo compartment area from sparks and hydraulic fluid from the ruptured struts. There was no fuel fire. The plane quickly filled with smoke. The fire entered and impinged on the seats from floor grills. Fire gutted the fuselage quickly. Evacuation was fairly orderly. There were some injuries getting off the plane. The smoke got heavy fairly rapidly. Some survivors suffered smoke inhalation. Of the 18 crew and 208 passengers aboard, 6 crew and 9 passengers suffered fatal fire injuries. 4 passengers were seriously injured.

Summary of Assessment

Overall there were 15 fatalities, all due to fire.

Later Requirements

As discussed in Ref 8.2, tests conducted at the FAA Technical Centre using the C133 full-scale test article indicated that the fire would not propagate in a cabin configured to the latest requirements. It is therefore assessed that all lives would have been saved.

Accident Database Reference	Location	Aircraft
19810727A	CHIHUAHUA, MEXICO	DC9
Date	**Operator**	**Regn**
27-Jul-1981	AEROMEXICO	XA-DEN

Résumé of Accident

During landing, the aircraft made contact with the ground 150 m to the right of the runway and 60 m after the threshold. The landing gear left a track of some 20 m. The aircraft bounced and struck the ground heavily, the fuselage then broke into two parts and caught fire.

Weather tropical air mass; conditionally unstable; isolated cumulo nimbus with strong squalls and showers.

Summary of Assessment

It was assessed that all 30 fatalities were potentially due to fire. The lack of information was taken into account when calculating the possible range of benefits.

Later Requirements

It was assumed that 33% of fatalities would have been saved by the application of later requirements (leaving 20 fatalities)

Enhanced Fuselage Burnthrough Protection

It was assessed that as the fuselage broke into 2 pieces, there would have been no benefit from the application of Enhanced Burnthrough Protection.

Cabin Water Spray systems (without Burnthrough Protection)

Due to the lack of available data a large spread was assessed on the likely benefits. Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	20	20
High	20	20
Median	10	8
Low	5	0

Cabin Water Spray systems (assuming Burnthrough Protection present)

As there was no assumed benefit with Enhanced Burnthrough Protection the results are identical to those without Enhanced Burnthrough Protection. The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	20	20
High	20	20
Median	10	8
Low	5	0

Accident Database Reference	Location	Aircraft
19820709A	KENNER, LOUISIANA	B727-235
Date	**Operator**	**Regn**
09-Jul-82	PAN AMERICAN WORLD AIRWAYS	N4737

Résumé of Accident

On 09-Jul-1982 a Pan American World Airways, Inc. B727-235 registered as N4737 was taking off from New Orleans International Airport, Kenner, Louisiana.

At the time of takeoff, there were showers over the east end of the airport and to the east of the airport along the aircraft's intended takeoff path. The winds at the time were gusty, variable and swirling.

The aircraft lifted off the runway, climbed to an altitude of between 95 feet to about 150 feet above the ground and then began to descend. It was concluded that the aircraft encountered a microburst-induced wind shear, which imposed a downdraft and a decreasing headwind.

The aircraft struck a line of trees about 2,376 feet beyond the departure end of the runway at an altitude of about 50 feet above the ground. The aircraft continued on an eastward track for another 2,234 feet hitting trees and houses and then crashed in a residential area about 4,610 feet from the end of the runway.

The aircraft was destroyed during the impact, explosion and subsequent ground fire.

There were 7 crewmembers, 1 non-revenue passenger on the cockpit jumpseat and 137 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

Disintegration of the aircraft's structure was described as 'extensive' and there was no reported evacuation attempt. Therefore, it was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19820913A	MALAGA, SPAIN	DC10
Date	**Operator**	**Regn**
13-Sep-82	SPANTAX	EC-DEG

Résumé of Accident

On 13-Sep-1982 a Spantax DC-10-30F registered as EC-DEG was taking off from Malaga Airport in Spain.

The pilot aborted the takeoff because of 'vibrations' of unknown origin. The aircraft proceeded off the end of the runway and struck a number of objects, creating sufficient damage to cause fuel spillage, but no fire, as it decelerated.

Approximately 700 feet from the end of the runway, the aircraft crossed a road and struck a house. This impact was quite severe, ripping off the right wing and creating a fireball. The fireball 'followed' the aircraft until it came to rest approximately 1000-1200 feet beyond the runway

Of the 13 crew and 381 passengers aboard, 3 crew and 47 passengers suffered fatal injuries. 40 passengers were seriously injured.

Summary of Assessment

All 50 fatalities were as a result of the fire.

Later Requirements

It is assessed that later requirements would have provided an additional 30 seconds of evacuation time to those in the rear passenger cabin area who only had L3 as an available exit. The evacuation rate on this exit was such that an additional 10 occupants would have been able to evacuate given an additional 30 seconds. This results in 40 remaining fatalities.

Enhanced Fuselage Burnthrough Protection

It is assessed that enhanced Fuselage Burnthrough Protection would have delayed the entry of fire and provided the passengers with additional time to make their way to the open L3 exit. It is further assessed that smoke was entering through the tear above door L4 and therefore approximately 18 occupants would still have succumbed even with Fuselage Burnthrough Protection.

Cabin Water Spray systems (without Burnthrough Protection)

If Cabin Water Spray systems had been able to improve visibility (potential with modular system) through the smoke filled rear cabin, then occupants may have been able to locate the forward exits and not been totally reliant on L3. However, hand carried luggage still caused a bottleneck that a Cabin Water Spray system would not be able to improve upon.

The fuselage remained in one section and upright, therefore it was assessed that both singular and modular systems would have both functioned correctly.

Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	40	40
High	40	40
Median	25	20
Low	0	0

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	18	18
High	18	18
Median	10	8
Low	0	0

Accident Database Reference	Location	Aircraft
19821209A	LA FLORIDA AIRPORT, LA SERENA, CHILE	F27A
Date	**Operator**	**Regn**
09-Dec-82	AERONOR CHILE	CC-CJE

Résumé of Accident

On 09-Dec-1982 an Aeronor Chile Fairchild F-27J registered as CC-CJE was landing at the La Florida Airport at La Serena, Chile.

On final approach, the aircraft lost power in one of the engines and crashed 1,000 m short of the runway. The aircraft struck the ground, flying on one engine, in a nose-up attitude and caught fire as a result of the impact.

Weather at the time of the accident allowed visual contact with the ground without any obstacles to horizontal or vertical visibility.

The aircraft was completely destroyed as a result of the fire which occurred due to impact with the ground.

There were 2 flight crew, 2 cabin crew and 42 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

The aircraft struck the terrain almost vertically and hardly moved on the surface of the ground. It is assessed that all fatalities were dominated by impact forces and therefore that there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19830602A	CINCINNATI INTERNATIONAL AIRPORT	DC9-32
Date	**Operator**	**Regn**
02-Jun-83	AIR CANADA	C-FTLU

Résumé of Accident

On 2-Jun-1983 Air Canada DC9-32 registered as C-FTLU was flying from Dallas to Montreal. While en route at 33,000 feet, the cabin crew discovered a hidden fire in the aft lavatory. After attempting to extinguish it an emergency descent and landing was made to Greater Cincinnati International Airport. After the subsequent evacuation a flash fire occurred within the cabin.

The Safety Board concluded the air conditioning packs were turned off at least 4 minutes before the aeroplane landed (almost two complete changes of cabin and cockpit air otherwise would have occurred). There was subsequently virtually no fresh air supply to the cockpit and cabin.

Of the 5 crew and 41 passengers, 23 passengers were not able to get out of the aircraft and died in the fire.

Summary of Assessment

The aircraft landed normally and there was no impact. All 23 passenger fatalities were due to the fire, presumably from smoke inhalation.

Later Requirements

It was assessed that seat fire blocking layers would have delayed the flashover and Floor Proximity Lighting would have aided location of the exits. Therefore, it is assessed that the number of fatalities would have been reduced to 16.

Enhanced Fuselage Burnthrough Protection

The fire started inside the fuselage, while the aircraft was in flight. Therefore, enhanced Fuselage Burnthrough Protection would not have provided any benefit.

Cabin Water Spray systems

As the fire started before landing and Cabin Water Spray systems would not be operated in flight, they would not have been able to control the fire until the aircraft landed. By then, the smoke was very dense in the cabin and it is unlikely that a Cabin Water Spray system would have provided any benefit at this time either.

Accident Database Reference	Location	Aircraft
19831127A	MADRID, SPAIN	B747
Date	**Operator**	**Regn**
27-Nov-83	AVIANCA	HK-2910

Résumé of Accident

The aircraft was making a night approach to Madrid when at 2242 ft, it collided with terrain about 12 km SE of the airport. There were three impacts, the second causing the aircraft to roll inverted and crash. Thereafter, the right hand wing detached, and the fuselage broke into 5 sections. Fire rapidly ensued engulfing all parts of the fuselage. 9 of the 11 survivors were expelled from the cabin, some with their seats. The other 2 escaped independently.

Of the 192 passengers and crew, 181 suffered fatal injuries.

Summary of Assessment

The aircraft collided with terrain with sufficient force to break the fuselage into 5 sections. Therefore, it was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19831128A	ENUGU, NIGERIA	F28
Date	**Operator**	**Regn**
28-Nov-83	NIGERIA AIRWAYS	5N-ANF

Résumé of Accident

A VOR approach was attempted although the airport visibility was reported to be below minima. While first maintaining MDA at or below 300 ft above local terrain and apparently manoeuvring to regain track while passing the VOR, the aircraft was suddenly made to descend, less than two miles short of the threshold. The aircraft was still in approach configuration. At initial impact, which was in a nearly level attitude in flat terrain covered with high grass, the landing gears were torn off or collapsed. The aircraft then slid on its belly, while shedding pieces, into a cassava-terrain consisting of a regular pattern of mounds of about 1 metre high and some trees. One of these trees cut the left wing slightly outboard of the root collector tank and the wing separated further on. The left engine and nacelle were torn off as well, including a large piece of side wall, floor structure and aft pressure bulkhead. Aft fuselage and empennage further separated behind the pressure bulkhead. In view of the damage to the aft fuselage parts, it is likely that the aircraft travelled in a taildown nose-high attitude during some part of the ground slide.

The front fuselage bottom was severely compressed, the cargo holds were ruptured and their contents dispersed. Due to the right wing trailing on the mounds and hitting some smaller trees, the final slide relative to the fuselage was sideward to the left.

A fire erupted at the separated wing and engine and gradually made its way towards the fuselage remains.

The surviving flight crew and the forward flight attendant escaped via the cockpit emergency windows. Some passengers, presumably from the most forward cabin part, also escaped via this route. The flight crew reported to have been overrun by these passengers.

Summary of Assessment

From the information available, it is assessed that the injury pattern was:

15 fatalities due to the impact

38 fatalities due to fire

9 serious injuries

10 escaped with minor or no injuries

Later Requirements

It was assessed that later requirements would have saved around 33% of the fire fatalities. Therefore, the injury pattern becomes:

15 fatalities due to the impact

25 fatalities due to fire

14 serious injuries

18 escaped with minor or no injuries

Enhanced Fuselage Burnthrough Protection

It was assessed that enhanced Fuselage Burnthrough Protection would not have provided any benefit as there were significant breaks in the structure that would have allowed the fire to freely enter the cabin.

Cabin Water Spray systems (without Burnthrough Protection)

It is assessed that a singular Cabin Water Spray system would not have operated after the impact because of the extent of the disruption. However, a modular system may have provided sufficient time for evacuation before the external fire reached the fuselage.

Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	25	25
High	25	25
Median	25	15
Low	25	0

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	25	25
High	25	25
Median	25	15
Low	25	0

Accident Database Reference	Location	Aircraft
19831207A	MADRID, SPAIN	B727-200
Date	**Operator**	**Regn**
07-Dec-83	IBERIA	EC-CFJ

Résumé of Accident

On 07-Dec-1983 an Iberia B727-200 registered as EC-CFJ was taking off from Madrid-Barajas Airport, Spain in fog conditions.

As the aircraft reached V1 speed, it collided with a DC-9 which had taxied onto the runway in error due to the poor visibility.

The aircraft spun round, caught fire and was destroyed.

Of the 9 crew and 84 passengers aboard, 1 crew member and 50 passengers suffered fatal injuries. 4 crew and 26 passengers suffered serious injuries. 4 crew and 8 passengers escaped with minor or no injuries.

Summary of Assessment

There were 5 fatalities due to impact trauma and the remaining 46 fatalities due to fire.

It is assessed that neither enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems would have affected the situation because the occupants who did not evacuate were incapacitated during the violent swing through 180 degrees and were unable to attempt an evacuation.

Accident Database Reference	Location	Aircraft
19831207B	MADRID, SPAIN	DC9-32
Date	**Operator**	**Regn**
07-Dec-83	AVIACO	EC-CGS

Résumé of Accident

On 07-Dec-1983 an Aviaco DC-9-32 registered as EC-CGS was taxiing at Madrid-Barajas Airport, Spain in fog conditions.

Due to the poor visibility, the aircraft had taxied onto the runway in error.

A B727 was taking off from the runway and as the aircraft reached V1 speed, it collided with the DC-9.

The DC-9 spun round, caught fire and was destroyed. The aircraft was destroyed by the impact of the port wing of the B727, which struck it head-on above the level of the passenger cabin floor, by the fire and subsequent explosions.

Of the 5 crew and 37 passengers aboard, all occupants suffered fatal injuries.

Summary of Assessment

All the occupants died instantly with severe traumatism as a result of the collision and subsequent explosions. Therefore, it was assessed that there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19840830A	DOUALA AIRPORT, CAMEROON	B737-200
Date	**Operator**	**Regn**
30-Aug-84	AIR CAMEROON	TJ-CBD

Résumé of Accident

Before take-off the right engine failed with significant damage to the engine and the right wing between the fuselage and the engine pod. Fragments from a high pressure compressor disc perforated the right integral wing tank.

Fuel leaked onto the ground and ignited. Fire destroyed the aircraft.

There was no impact damage.

There were 118 occupants aboard, of which 2 suffered fatal injuries due to fire outside the cabin environment.

Summary of Assessment

Two occupants suffered fatal injuries from the fire outside the aircraft. Therefore, it was assessed that there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19850121A	RENO, NEVADA	L188C
Date	**Operator**	**Regn**
21-Jan-85	GALAXY AIRLINES	N5532

Résumé of Accident

On 21-Jan-1985 a Galaxy Airlines Lockheed Electra L-188C registered as N5532 was departing from Reno-Cannon International Airport. The flight was operating under Title 14 Code of Federal Regulations Part 121.

Approximately 1 minute later the crew requested to return to the airport because of vibration in the aircraft caused by an improperly closed air start access door. In accordance with the request, the tower controller cleared the flight to make a left turn to a downwind traffic pattern. The flight path and airspeed of the aircraft was not controlled and monitored sufficiently and as a result a stall condition was not detected and the aircraft crashed 1.5 miles from the departure end of the runway.

The aircraft was destroyed by the impact and subsequent fire.

There were 6 crew and 65 passengers on board. 6 crew and 64 passengers suffered fatal injuries. 1 passenger suffered serious injuries.

Summary of Assessment

From the information available in the accident report, it is assessed that the injury pattern was:

29 fatal by impact (includes all crew as details were not stated)

25 fatal by impact and fire

16 fatal by fire alone

1 survivor thrown clear of the fire

Later Requirements

The aircraft was engulfed by fire, which spread back about 500 feet to the point of the wing tank rupture. If later requirements had retarded the spread of fire inside the cabin, the survivors of the impact would still have to negotiate a significant external fire and therefore the 16 fire fatalities would not have been reduced.

Enhanced Fuselage Burnthrough Protection

Although it was not explicitly stated in the accident report, the front of the fuselage must have ruptured significantly as 3 occupants were thrown clear of the wreckage. Therefore, it is assessed that fire would have entered through these ruptures and hence enhanced Fuselage Burnthrough Protection would not have provided any benefit.

Cabin Water Spray systems (without Burnthrough Protection)

Because of the significant external fire and the fact that the only survivor was thrown completely clear of the fire that engulfed the aircraft, it was assessed that Cabin Water Spray systems would only have protected the occupants for a short time and they would not have been able to escape the external fire.

Cabin Water Spray systems (assuming Burnthrough Protection present)

It is assessed that if the combination of 5 minutes Burnthrough Protection and an active Cabin Water Spray system could have protected the occupants until fire-fighters contained the fire from the outside, then there may have been some lifesaving potential. Otherwise, the external fire would not have been survivable, even if the occupants were initially protected inside the cabin.

Due to the disruption at the front of the cabin, it was assessed that a singular system would have operated to a very limited level after the impact

Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	16	16
High	16	16
Median	16	8
Low	12	0

Accident Database Reference	Location	Aircraft
19850802A	DALLAS FORT WORTH	L1011-385-1
Date	**Operator**	**Regn**
02-Aug-85	DELTA AIRLINES	N726DA

Résumé of Accident

On 2-Aug-1985, at 1805:52 central daylight time, Delta Airlines flight 191, a Lockheed L1011-385-1, N726DA, crashed while approaching to land on runway 17L at the Dallas Fort Worth International Airport, Texas. While passing through the rain shaft beneath a thunderstorm, flight 191 entered a microburst which the pilot was unable to traverse successfully. The aircraft struck the ground about 6300 feet north of the approach end of runway 17L, hit a car on a highway north of the runway killing the driver, struck two water tanks on the airport, and broke apart. Except for a section of the aircraft containing the aft fuselage and empennage, the remainder of the aeroplane disintegrated during the impact sequence, and a severe fire erupted during the impact sequence.

Of the 163 persons aboard, 134 passengers and crewmembers were killed; 26 passengers and 3 cabin attendants survived.

Summary of Assessment

Due to the severe nature of the impact, all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19850812A	MOUNT OSUTAKA, GUMMA, JAPAN	B747-SR-100
Date	**Operator**	**Regn**
12-Aug-85	JAPAN AIRLINES	JA-8119

Résumé of Accident

On 12-Aug-1985 Flight 123 of Japan Airlines B747-SR-100 registered as JA8119 crashed near the ridge of Mt. Osutaka, Gumma, Japan.

The aircraft took off from Haneda at 18:12 bound for Osaka. At 18:24 aft-pressure-bulkhead failed at an elevation of 7,200m. Consequently the greater mass of cabin air blew off the APU, hydraulic units and also the structure of vertical fin. The aircraft became uncontrollable. Without knowing the actual fact and cause, the cockpit crew tried to land it safely and flew more than 30 minutes in vain.

The cause of the fracture of the bulkhead was the propagation of multiple-site crack originated by the mis-repair of the fastener joint of the bulkhead by maintenance staff of the Boeing Company, which was conducted 7 years before the accident.

There were 15 crew and 509 passengers aboard. 15 crew and 505 passengers suffered fatal injuries. 4 passengers suffered serious injuries.

Summary of Assessment

Impact forces were quoted as high as 100g. Under those conditions it was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19850822A	MANCHESTER AIRPORT	B737-236 Sr1
Date	**Operator**	**Regn**
22-Aug-85	BRITISH AIRTOURS	G-BGJL

Résumé of Accident

At 0612 hrs G-BGJL, carrying 131 passengers and 6 crew on a charter flight to Corfu, took off from Manchester with the co-pilot handling. About 36 seconds later, as the airspeed passed 125 knots, the left engine suffered an uncontained failure, which punctured a wing fuel tank access panel. Fuel leaking from the wing ignited and burnt as a large plume trailing directly behind the engine. The crew heard a 'thud', and believing that they had suffered a tyre-burst or bird-strike, abandoned the take-off immediately, intending to clear the runway to the right. They had no indication of fire until 9 seconds later, when the left engine fire warning occurred. After an exchange with ATC, during which the fire was confirmed, the commander warned his crew of an evacuation from the right side of the aircraft, by making a broadcast over the cabin PA system, and brought the aircraft to a halt in the entrance to link Delta.

As the aircraft turned off, a wind of 7 knots from 250° carried the fire onto and around the rear fuselage. After the aircraft stopped the hull was penetrated rapidly and smoke, possibly with some flame transients, entered the cabin through the aft right door which was opened shortly before the aircraft came to a halt. Subsequently fire developed within the cabin. Despite the prompt attendance of the airport fire service, the aircraft was destroyed and 55 persons on board lost their lives.

Summary of Assessment

There were no impact injuries. All 55 fatalities were due to fire. The cabin is considered in three scenarios, where fatalities occurred:

Seat rows 6 to 8 5 fatalities

Seat rows 9 to 15 13 fatalities

Seat rows 16 to aft end 37 fatalities

Later Requirements

It is assessed that later requirements would have improved flammability standards such that the occupants would have had an additional 30 seconds of time to escape. This would have reduced the number of fatalities as follows:

Seat rows 6 to 8 2 fatalities

Seat rows 9 to 15 10 fatalities

Seat rows 16 to aft end 30 fatalities

Enhanced Fuselage Burnthrough Protection

It is assessed that enhanced Fuselage Burnthrough Protection would have delayed the entry of fire into the cabin and provided the passengers with additional time to locate and use the two forward exits and the available overwing exit. The number of fatalities would be reduced as follows:

Seat rows 6 to 8 0 fatalities

Seat rows 9 to 15 0 fatalities

Seat rows 16 to aft end 2 fatalities

Cabin Water Spray systems (without Burnthrough Protection)

There was no impact damage, so both singular and modular Cabin Water Spray systems would have been fully operable.

It is assessed that without Burnthrough Protection, fire would have penetrated the fuselage after about 30 seconds from when the evacuation was commanded. The Cabin Water Spray system would slow down the spread of the fire but would not offer the same protection as 5 minutes of Burnthrough Protection. Therefore, it is assessed that benefits would be around half those assessed for Enhanced Burnthrough Protection.

Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	42	42
High	23	23
Median	11	11
Low	0	0

Cabin Water Spray systems (assuming Burnthrough Protection present)

With enhanced Fuselage Burnthrough Protection present, there would only be 2 fatalities at the rear of the cabin where flame transients came through an open rear right door. It is unlikely that Cabin Water Spray systems would have protected those occupants from the direct assault of the flames.

Therefore, the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	2	2
High	2	2
Median	0	0
Low	0	0

Accident Database Reference	Location	Aircraft
19850906A	MILWAUKEE, WISCONSIN	DC9-14
Date	**Operator**	**Regn**
06-Sep-85	MIDWEST EXPRESS	N100ME

Résumé of Accident

On 06-Sep-1985 a Midwest Express Airlines DC-9-14 registered as N100ME was taking off from General Billy Mitchell Field, Milwaukee, Wisconsin.

During the initial climb, about 450 feet above ground level, there was a loud noise and a loss of power associated with an uncontained failure of the 9th and 10th stage high pressure compressor spacer of the right engine.

The aircraft continued to climb to about 700 feet and then rolled to the right until the wings were observed in a near vertical, approximately 90° right banked turn. During the roll, the aircraft entered an accelerated stall, control was lost and the aircraft crashed.

The aircraft crashed into an open field at the edge of a wooded area about 1,680 feet southwest of the departure end of runway 19R.

The aircraft was destroyed by impact and a postcrash fire.

There were 2 flight crew, 2 cabin crew and 27 passengers on board. All occupants suffered fatal injuries.

Summary of Assessment

The aircraft crashed with the wings nearly vertical and there were no survivors. Therefore, it was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19851212A	GANDER, NEWFOUNDLAND, CANADA	DC8-63
Date	**Operator**	**Regn**
12-Dec-85	ARROW AIR	N950JW

Résumé of Accident

On 12-Dec-1985, an Arrow Air DC-8-63 registered as N950JW was taking off from the Gander International Airport, Newfoundland.

The aircraft was on an international charter flight from Cairo, Egypt to Fort Campbell, U.S.A., with planned stops at Cologne, Germany and Gander Newfoundland.

During take-off from Gander, the aircraft crashed and burned approximately one-half mile off the departure end of runway 22.

The aircraft was destroyed by impact forces and a severe fuel-fed fire.

Of the 8 crew and 248 passengers aboard, all occupants suffered fatal injuries.

Summary of Assessment

The aircraft disintegrated as it crashed into trees. Therefore, it was assessed that there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19860831A	CERRITOS, CALIFORNIA	DC9-32
Date	**Operator**	**Regn**
21-Aug-86	AERONAVES DE MEXICO S.A.	XA-JED

Résumé of Accident

On 31-Aug-1986 an Aeronaves de Mexico S.A. DC-9-32 registered as XA-JED was descending from the last leg of an Instrument Flight Plan from Tijuana, Mexico to Los Angeles International airport.

While under radar control by the Los Angeles terminal radar control facility, the aircraft collided with a Piper PA-28-181 at 6,560 feet mean sea level. At the time of the collision, the sky was clear and the reported visibility was 14 miles. The air traffic controller did not observe the Piper's radar return on his display.

Both aircraft fell to the ground within the city limits of Cerritos, California. 5 houses were destroyed and 7 others damaged by aircraft wreckage and the postimpact fire.

There were 2 flight crew, 4 cabin crew and 58 passengers on board. All occupants suffered fatal injuries.

Summary of Assessment

The aircraft collided with a Piper PA-28 in flight and fell to the ground. Therefore, it was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19870404A	MEDAN SUMATERA, INDONESIA	DC9
Date	**Operator**	**Regn**
04-Apr-87	GARUDA INDONESIA	PK-GNQ

Résumé of Accident

On 4-Apr-1987 Garuda Indonesia DC9 registered as PK-GNQ was approaching Medan Sumatera.

On approach, the aircraft struck electrical power lines and crashed short of the runway. The aircraft broke up and the tail section separated from the main fuselage, which was immediately engulfed in fire.

The majority of the survivors reportedly escaped through fuselage breaks and 11 were thrown from the aircraft.

There were 8 crew and 37 passengers aboard. 4 crew and 19 passengers suffered fatal injuries due to smoke inhalation and burns. 4 crew and 18 passengers suffered serious injuries.

Summary of Assessment

There were 23 fatalities due to fire and no reported fatalities due to impact forces.

Later Requirements

There is little information on this accident, but it was assumed that later requirements would have saved 25% of the fatalities leaving a total of 18.

Enhanced Fuselage Burnthrough Protection

Breaks in the fuselage were large enough for survivors to escape. Therefore, it is assessed that fire would have entered through these breaks and there would have been no benefit from enhanced Fuselage Burnthrough Protection.

Cabin Water Spray systems (without Burnthrough Protection)

The fuselage suffered breaks on impact and the tail section separated. Therefore, it is assessed that with this disruption a singular Cabin Water Spray system would not have operated after the impact sequence, although a modular may have operated.

Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	18	18
High	18	18
Median	18	9
Low	18	0

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	18	18
High	18	18
Median	18	9
Low	18	0

Accident Database Reference	Location	Aircraft
19870509A	WARSAW-OKECIE AIRPORT, POLAND	IL62M
Date	**Operator**	**Regn**
09-May-87	LOT POLSKIE LINIE LOTNICZE)	SP-LBG

Résumé of Accident

On 09-May-1987, a LOT IL-62M, registered as SP-LBG was taking off from Warsaw-Okecie airport destined for New York. The aircraft was operating a scheduled passenger flight.

About 24 minutes after take-off, the crew reported on the failure of 2 engines and elevator control system, then on the decision to return to the Okecie airport. The accident resulted from the failure of the L.H. inner engine (No. 2). The low pressure turbine shaft broke loose. Then, as a result, the turbine reached its critical r.p.m., leading to the burst of the turbine disc whose fragments pierced the fuselage aft portion thus causing damage, among others, to engine No 1, to the elevator control system and giving rise to fire in the baggage compartment.

The return flight with 2 engines inoperative and the elevator out of control and the fire expanded, took about 31 minutes. The aircraft longitudinal control was accomplished by means of the horizontal stabiliser and elevator trim tab.

At a distance of 6 km from the threshold of Runway 33 at Okecie aerodrome, the aircraft became fully uncontrollable and struck the ground. The crash resulted in the remaining fuel exploding and a subsequent fire.

The aircraft was completely destroyed.

Of the 11 crew and 172 passengers aboard, all occupants suffered fatal injuries.

Summary of Assessment

The aircraft became uncontrollable, struck the ground and there were no survivors. Therefore, it was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19870804A	CALAMA, CHILE	B737-200
Date	**Operator**	**Regn**
04-Aug-87	LAN CHILE	CC-CHJ

Résumé of Accident

On 4-Aug-1987 a Lan Chile B737-200 was landing at Calama, Chile.

The threshold of Runway 27 was displaced by 880m due to runway repairs. The pilot approached the runway facing the sun and touched down before the displaced threshold and struck piles of gravel. The aircraft skidded along the runway, striking further piles of gravel until it came to rest.

All passengers evacuated within 2 minutes. 1 obese passenger was unconscious and could not be removed from the aircraft. 30 minutes after the impact, a fire broke out and engulfed the aircraft. The unconscious passenger died in the fire.

Summary of Assessment

It was assessed that if the obese passenger could not have been removed after 30 minutes then there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19870816A	DETROIT	DC9-82
Date	**Operator**	**Regn**
16-Aug-87	NORTHWEST	N312RC

Résumé of Accident

On 16-Aug-1987 a Northwest DC-9-82 registered as N312RC was taking off from Detroit Metropolitan Wayne County Airport, Romulus, Michigan. The crew had not used the taxi checklist and as a result the flaps and slats were not extended for takeoff.

According to witnesses, the aircraft began its take-off rotation about 1200 to 1500 feet from the end of the runway and lifted off near the end of the runway. After lift-off, the wings of the aircraft rolled to the left and the right about 35 deg in each direction. The aircraft collided with obstacles northeast of the runway when the left wing struck a light pole located 2760 feet beyond the end of the runway. Thereafter the aircraft struck other light poles, the roof of a rental car facility, and then the ground. It continued to slide along a path aligned generally with the extended centreline of the take-off runway. The aircraft broke up as it slid across the ground and post-impact fires erupted along the wreckage path. Three occupied vehicles on a road adjacent to the airport and numerous vacant vehicles in a rental car parking lot along the aeroplane's path were destroyed by impact forces and/or fire.

Of the persons on board, 148 passengers and 6 crew members were killed; the only survivor, a four year old child, was seriously injured.

Summary of Assessment

External examination of the occupants showed that all had sustained multiple injuries. Autopsies of the victims were not performed in view of obvious injuries, which caused instantaneous death. Therefore, it was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19871115A	DENVER, COLORADO	DC9-14
Date	**Operator**	**Regn**
15-Nov-87	CONTINENTAL	N626TX

Résumé of Accident

On 15-Nov-1987 a Continental Airlines DC-9-14 registered as N626TX was delayed in snow conditions at Stapleton International Airport, Denver while taking off and did not de-ice for a second time. Following a rapid rotation, control of the aircraft was lost and as a result it crashed off the right side of the runway and came to rest inverted. There was a fireball inside the fuselage for a short time during the impact sequence.

The 2 pilots, 1 flight attendant and 25 passengers were killed. 52 passengers and 2 flight attendants survived and either escaped or were extricated from the aircraft. Some of the passengers were trapped in the wreckage until they could be freed by rescuers.

Summary of Assessment

During the impact sequence the fuselage separated into 2 sections (at seat row 9) and the empennage separated. The forward fuselage came to rest on its left side and the remainder of the cabin came to rest inverted.

A fireball existed in the fuselage for a short time which started at row 11, moved down the aisle to row 16, and was gone very quickly. The fireball probably resulted from ignition of residual centre fuel tank fuel, extinguishing itself rapidly and did not affect passenger escape.

Because of the orientation of the fuselage and the fact that all fatalities were due to impact forces, there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19871128A	MAURITIUS, INDIAN OCEAN	B747-244B
Date	**Operator**	**Regn**
28-Nov-87	SOUTH AFRICAN AIRWAYS	ZS-SAS

Résumé of Accident

On 28-Nov-1987, a South African Airways Boeing B747-244B, registered as ZS-SAS, lost control and crashed into the Indian Ocean near Mauritius. The aircraft was destroyed. There were 19 crewmembers and 140 passengers aboard, all were fatally injured.

At 23:48 UTC, the pilot of the Boeing B747 reported an emergency descent due to smoke in the aircraft to FL140 and requested emergency services at Plaisance Airport. At 00:07 the aircraft crashed into the sea, 134nm northeast of Mauritius and was 13 hours later. Three minutes earlier the pilot had acknowledged an instruction from Mauritius approach control to report at FL50.

Analysis of recorders, all salvaged from the seabed at 4500m, indicated that the crew was alerted by the smoke detection system to a fire in the right forward pallet, in the main deck cargo compartment. Evidence of the presence of smoke was found in the passenger cabin and galley and in the passenger trachea. The aircraft crashed because of the fire damage to the controls, or crew incapacitation, or crew distraction or a combination of these factors. The crew may have not been able to deal with the fire.

FAA Airworthiness Directive 89-18-12 R1 has been promulgated.

Safety recommendations: installation of additional area microphones, increased recording time for the cockpit voice recorder and additional time sequence underwater locator beacons for the flight recorders.

Summary of Assessment

There was a fire in the cargo compartment, which damaged the aircraft's controls and it crashed. Therefore, it was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19880626B	HABSHEIM, FRANCE	A320-100
Date	**Operator**	**Regn**
26-Jun-88	AIR FRANCE	F-GKFC

Résumé of Accident

During an airshow on 26-Jun-1988, A320 F-GKFC made a level pass at about 30 ft, gear and flaps out, engines almost at idle and 130 passengers on board. After the go-around, the aircraft hit trees at the end of the runway. The right wing broke up and a fire erupted.

All passengers evacuated the aircraft except 3 who suffered fatal injuries as a result of the fire.

Summary of Assessment

All passengers were able to leave the aircraft, except three who succumbed to the fire. A disabled boy in 4F who remained in his seat, a little girl who was not able to open her seat belt and a woman who went back to help the little girl.

Later Requirements

It was assumed that due to the date of the accident, the aircraft was already configured to later requirements except for reduced heat release in cabin interior materials. However, it is assessed that the embodiment of later requirements would not have altered the number of fatalities, although it may have reduced fire related injuries.

Enhanced Fuselage Burnthrough Protection

It is assessed that Burnthrough Protection would have provided the additional time required for the woman to free the little girl and for both of them to escape. However, the disabled boy would have required someone to re-enter the fuselage and assist him out and it is considered that Burnthrough Protection would not have provided sufficient time. There would therefore still have been 1 fatality.

Cabin Water Spray systems (without Burnthrough Protection)

It is assessed that Cabin Water Spray systems would have provided the additional time required for the woman to free the little girl and for both of them to escape. However, the disabled boy would have required someone to re-enter the fuselage and assist him out and it is considered likely that 3 minutes of Cabin Water Spray system operation would not have provided sufficient time.

It is assessed that impact forces were not too high and both singular and modular Cabin Water Spray systems would have operated after the aircraft came to rest.

Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	3	3
High	1	1
Median	1	1
Low	0	0

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	1	1
High	1	1
Median	0	0
Low	0	0

Accident Database Reference	Location	Aircraft
19880831A	HONG KONG	TRIDENT 2E
Date	**Operator**	**Regn**
31-Aug-88	CAAC	B-2218

Résumé of Accident

On 31-Aug-1988 a CAAC Trident 2E registered as B-2218 was making an ILS approach to Hong Kong International Airport (HKIA) in heavy rain.

As the aircraft neared the runway the right outboard trailing edge wing flap struck the innermost approach light and the right main landing gear tyres hit the facing edge of the runway promontory. The right main gear was torn from the wing. The aircraft became airborne again and next contacted the ground 600 metres down the runway. It then veered off the runway to the right, yawed to the right and slid diagonally sideways across the grassed runway strip. The nosewheel and left main gear collapsed, and the aircraft continued until it crossed the parallel taxiway and slid sideways over the edge of the promontory into Kowloon Bay. The aircraft came to rest in the water with the rear extremity of the fuselage supported on a ledge of stone blocks that jutted out from the promontory. Part of the forward fuselage, including the flight compartment, was partially detached from the remainder of the fuselage and hung down at a steep angle into the water from control cables and secondary structure. A fire started in the centre engine intake duct.

The aircraft was carrying 78 passengers, 3 cabin attendants, 2 security officers and a flight deck crew of 6. 6 crew and 1 passenger suffered fatal injuries. 2 crew and 2 passengers suffered serious injuries. 3 crew and 75 passengers suffered minor or no injuries.

Summary of Assessment

Overall, there were 7 fatalities. There were 6 crew on the flight deck and they all drowned as the nose section hung down in the water. One passenger died from impact injuries.

Therefore, there were no fire fatalities and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19880831B	DALLAS FORT WORTH	B727-232
Date	**Operator**	**Regn**
31-Aug-88	DELTA AIRLINES	N473DA

Résumé of Accident

On 31-Aug-1988, B727-232 registered as N473DA was taking off from Dallas-Fort Worth International Airport, Texas. The slats and flaps were not properly configured and as a result the aircraft did not gain altitude after rotation.

The aeroplane struck an instrument landing system (ILS) localiser antenna array approximately 1000 feet beyond the end of the runway and came to rest about 3200 feet beyond the departure end of the runway. The flight was airborne approximately 22 seconds from lift-off to the first ground impact near the ILS localiser antenna. The aeroplane was destroyed by impact forces and the postcrash fire.

The combination of jammed left aft service door and the intense impenetrable fire trapped 12 occupants.

Of the 108 occupants aboard, 12 passengers and 2 crew members were killed by fire, 21 passengers and 5 crew members were seriously injured and 68 passengers sustained minor or no injuries.

The flight was conducted subject to the provisions of Title 14 Code of Federal Regulations (CFR), Part 121.

Summary of Assessment

The fuselage broke into three sections. In the mid section, 2 passengers were asphyxiated. In the rear section 12 occupants were asphyxiated.

Later Requirements

It was assumed that although seat fire blocking was fitted, reduced heat release cabin interior materials were not. Therefore, had the aircraft been configured to later requirements, a modest amount of additional time would have allowed 1 passenger to escape from the mid section and 2 from the rear section.

Enhanced Fuselage Burnthrough Protection

Because the fuselage broke into three sections, fire was able to enter the cabin freely at the extreme ends of the sections. However, the 1 passenger (after later requirements) that was asphyxiated in the mid section was located away from the ends and may have been saved by using the overwing exits with additional evacuation time from enhanced Fuselage Burnthrough Protection.

Cabin Water Spray systems (without Burnthrough Protection)

The 1 passenger (after later requirements) that was asphyxiated in the mid section was located away from the ends and may have been saved by using the overwing exits with additional evacuation time provided by Cabin Water Spray systems.

In the rear section, the fire entered the cabin through the floor after propagating through the missing external cargo door. The passengers were all found near the jammed left rear door. Therefore, it is assessed that the modular Cabin Water Spray system would have provided limited benefit.

Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	11	11
High	11	11
Median	11	8
Low	10	6

Cabin Water Spray systems (assuming Burnthrough Protection present)

It is assessed that in the mid section, Burnthrough Protection would have saved the only fatality, therefore no benefit potential remained for Cabin Water Spray systems.

Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	10	10
High	10	10
Median	10	8
Low	10	6

Accident Database Reference	Location	Aircraft
19880915A	BAHIR DAR, ETHIOPIA	B737-200
Date	**Operator**	**Regn**
15-Sep-88	ETHIOPIAN AIRLINES	ET-AJA

Résumé of Accident

During lift-off from Runway 04, the aircraft encountered a flock of pigeons. Several bangs were heard and both engines started surging and backfiring with excessive egt rise. With partial power on both engines, the crew turned right downwind to return to Runway 04. However, on base leg both engines flamed out. The crew landed the aircraft wheels-up in open terrain 10 km southwest of Bahir Dar Airport. The aircraft was destroyed by impact and subsequent fire.

Summary of Assessment

There were 35 fatalities and it is assumed that 18 were due to impact and 17 to fire.

Later Requirements

It was assumed that due to the date of the accident, the aircraft was already configured to later requirements and hence the injury pattern was not changed.

Enhanced Fuselage Burnthrough Protection

There is very little information about the post-crash condition of the fuselage skin. Therefore it is not possible to assess any benefit due to enhanced Fuselage Burnthrough Protection.

Cabin Water Spray systems (without Burnthrough Protection)

The aircraft landed wheels-up in open terrain and did not collide with any buildings or trees. Therefore, it is assessed that a Cabin Water Spray system would have had a reasonable chance of working after the impact, although a singular system would be less likely to.

Therefore, the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	17	17
High	17	17
Median	15	13
Low	10	8

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	17	17
High	17	17
Median	15	13
Low	10	8

Accident Database Reference	Location	Aircraft
19881025A	JULIACA, PERU	F28
Date	**Operator**	**Regn**
25-Oct-88	AEROPERU	OB-R-1020

Résumé of Accident

On take-off, the aircraft rotated, got airborne but failed to gain height. Gear was selected up, flaps retracted, but also power was retarded. The aircraft crossed the end of the runway and went very low over about 1800 m of flat hard soil, then impacted on a road which was about .8 m above the flat terrain with gulleys on either side of about 0.7 m deep. After several further impacts, it came to rest in a riverbed about 220 m from the road, about 1.5 m below the flat terrain.

The aircraft came to rest in several parts. The front fuselage had separated from the centre fuselage near the wing front spar and came to rest inverted, about 50 m from the aft fuselage. The lower fuselage of this section was damaged and crushed from the radome rearwards with progressively more damage further aft, towards the break. However, survival space in this section was basically not compromised. Most seats were still fully attached to the floor with only some fracture at/near the floor break.

The centre wing section, still connected to the RH wing was badly damaged with all seat tracks distorted and broken at the seat attachment. There were no seats remaining in the centre wing section. The LH wing had separated. The fuselage skin and top skin were torn from the centre section. A large number of broken seats and interior parts were found in an area aside the centre wing, presumably ejected from the centre wing/fuselage area upon impact with the sand in the river bed. Most of the fatalities were found here.

Structural integrity of the aft fuselage, which had separated from the centre wing section, was entirely lost. Although still grouped together, both engines had separated from the tail, and the fin showed unusually severe damage.

The occupants of the inverted forward section either evacuated on their own through the open end at the rear or with the assistance of others. It is believed that all of the occupants of the centre and aft cabin section were ejected.

Of the 69 passengers and crew, 1 crew member and 11 passengers suffered fatal injuries.

Summary of Assessment

The fuselage separated into at least 3 sections, the forward section coming to rest inverted. It was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19890208A	MT PICO ALTO, PORTUGAL	B707-331B
Date	**Operator**	**Regn**
08-Feb-89	INDEPENDENT AIR	N7231T

Résumé of Accident

On 08-Feb-1989, an Independent Air Boeing B707-300, registered as N7231T, collided with Mt. Pico Alto in Portugal. The aircraft was destroyed by impact and post crash fire. There were 7 crewmembers and 137 passengers aboard and all suffered fatal injuries.

The aircraft left Bergamo at 1004 hours for Santa Maria Eta. At 1343 the pilot requested the latest Santa Maria weather and was given: 260 deg /14kt maximum 24kt, visibility over 10km, temperature 17 deg C.

At 1356 the aircraft was transferred to ATC. The co-pilot reported passing FL200 for FL40. The aircraft struck Pico Alto mountain at 1730ft ASL. The aircraft altimeter was found set at 1027 and the altitude alert at 2000ft. There was no evidence of any in-flight emergency. The aircraft was on course 272 magnetic, about 1 minute from the airport.

Investigation revealed that the pilot levelled the aircraft at 2,000ft (1,000ft below minimum sector altitude) using erroneous QNH of 1027 HPA, given by Santa Maria ATC, instead of 1018 HPA. GPWS functioned properly for 7 sec. Due to inadequate simulator training, crewmembers took no action to avoid collision with the 1,795ft hill while aircraft was on course. Flight crew non-adherence to published operational procedures concerning cockpit discipline, approach briefing, read back of descent clearance. Defective communications procedures and no adherence to standard phraseology both by the crew and ATC.

Summary of Assessment

The aircraft flew into the side of a 1,795ft hill and there were no survivors. Therefore, it was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19890310A	DRYDEN, ONTARIO, CANADA	F28-1000
Date	**Operator**	**Regn**
10-Mar-89	AIR ONTARIO	C-FONF

Résumé of Accident

On 10-Mar-1989, at approximately 12:11p.m. Central Standard Time, Fokker F-28 Mk 1000 bearing Canadian registration C-FONF took off from the Dryden Municipal Airport. The aircraft failed to gain height in snow conditions and continued on a flat flight path, crashing into a densely wooded area.

Fuel from the damaged tank began vaporising and trailing behind the aircraft in the form of a mist. The mist ignited and the fire followed the aircraft to its resting position.

There were 65 passengers and a crew of four on board. In all, 21 passengers and 3 crew members, including the captain, the first officer and one of the two flight attendants died as a result of the crash and the fire.

Summary of Assessment

It was assessed that the injury pattern was:

9 fatalities by impact

2 fatalities by impact and then fire

13 fatalities by fire

Later Requirements

Although the cabin materials were not configured to the later requirements, it is assessed that this would have minimal effect on occupant injuries. The seats were fitted with fire blocking layers, therefore it was considered that the injuries sustained in this accident would have been similar for an aircraft configured to later requirements and hence the injury patterns remain unchanged.

Enhanced Fuselage Burnthrough Protection

There was massive disruption of the forward fuselage side and the separation of the nose and tail from the main cabin. Therefore it was assessed that fire entered through ruptures and enhanced Fuselage Burnthrough Protection would have not altered the injury pattern

Cabin Water Spray systems (without Burnthrough Protection)

There was considerable internal disruption in the cabin and impact forces were as high as 34g in some locations. Therefore, it is assessed that a singular Cabin Water Spray system would not have operated after the impact sequence. Further, the median assessment considers that a modular Cabin Water Spray system would probably not have operated, but the low assessment considers the possibility that it would have operated in the centre section.

Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	13	13
High	13	13
Median	13	13
Low	13	7

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	13	13
High	13	13
Median	13	13
Low	13	7

Accident Database Reference	Location	Aircraft
19890719A	SIOUX CITY	DC10-10
Date	**Operator**	**Regn**
19-Jul-89	UNITED AIRLINES	N1819U

Résumé of Accident

On 19-Jul-1989, at 1516, a DC-10-10, N1819U, operated by United Airlines as flight 232, experienced a catastrophic failure of the No. 2 tail mounted engine during cruise flight. The separation, fragmentation and forceful discharge of stage 1 fan rotor assembly parts from the No. 2 engine led to the loss of the three hydraulic systems that powered the aeroplane's flight controls. An off duty check airman assisted the crew by controlling the aircraft using only the engine power levers.

The aeroplane touched down on the threshold slightly to the left of the centerline on runway 22 at 1600. First ground contact was made by the right wing tip followed by the right main landing gear. The aeroplane skidded to the right of the runway and rolled to an inverted position. Witnesses observed the aeroplane ignite and cartwheel, coming to rest after crossing runway 17/35. Firefighting and rescue operations began immediately, but the aeroplane was destroyed by impact and fire.

There were 285 passengers and 11 crewmembers onboard. One flight attendant and 110 passengers were fatally injured.

The flight was conducted under Title 14 Code of Federal Regulations (CFR) Part 121.

Summary of Assessment

There was massive fuselage disruption as a result of impact with the ground and the largest fuselage section came to rest inverted. Therefore, it was assessed that there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19900214A	BANGALORE, INDIA	A320-231
Date	**Operator**	**Regn**
14-Feb-90	INDIAN AIRLINES	VT-EPN

Résumé of Accident

On 14-Feb-1990 an Indian Airlines A320-231 registered as VT-EPN was approaching Bangalore Airport, India.

During the final approach, the aircraft descended below the normal approach path and its wheels contacted ground in a golf course area about 2300 feet short of the runway and impacted an embankment at the boundary of the golf course. The aircraft thereafter hopped over a ditch and a road adjacent to it and landed on an area outside the boundary wall of the airport.

The aircraft was destroyed as a result of impact with ground and subsequent fire.

There were 7 crew and 139 passengers aboard. Both flight crewmembers, 2 flight attendants and 88 passengers suffered fatal injuries. 1 flight attendant and 21 passengers suffered serious injuries. 2 flight attendants and 30 passengers escaped with minor or no injuries.

Summary of Assessment

The information concerning the number of occupant injuries and cause of death in the accident report is conflicting. In order to carry out the benefit analysis, some assumptions were made concerning the injury pattern and it was concluded that the injuries were:

	Uninjured	Injured By Fire	Injured by Impact & Fire	Fatal by Fire	Fatal by Impact & Fire
Flight deck	-	-	-	2	-
Forward vestibule	-	-	-	-	2
Seat rows 1-10	-	-	8	31	21
Seat rows 11-13	-	10	-	5	1
Seat rows 14-21	-	4	-	21	3
Seat row 22-end	32	-	-	5	1
Total	32	14	8	64	28

Later Requirements

It was assessed that if the aircraft were configured to later requirements, the effect would be:

	Uninjured	Injured By Fire	Injured by Impact & Fire	Fatal by Fire	Fatal by Impact & Fire
Flight deck	-	-	-	2	-
Forward vestibule	-	-	-	-	2
Seat rows 1-10	-	-	8	31	21
Seat rows 11-13	-	11	-	4	1
Seat rows 14-21	-	5	1	20	2
Seat row 22-end	32	2	-	3	1
Total	32	18	9	60	27

Enhanced Fuselage Burnthrough Protection

The front fuselage was extensively damaged during impact and fuel had been spilled both inside and outside the lower fuselage skin. Therefore, it was assessed that fire entered through ruptures and enhanced Fuselage Burnthrough Protection would not have provided any benefit.

Cabin Water Spray systems (without Burnthrough Protection)

It is assessed that although impact forces did not break the fuselage into sections, they could have been severe enough to disrupt a singular Cabin Water Spray system and consequently the benefit for a singular system is reduced. Therefore the assessments are:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	87	87
High	82	71
Median	63	52
Low	43	34

Cabin Water Spray systems (assuming Burnthrough Protection present)

As there was no benefit from Fuselage Burnthrough Protection, the assessments are also:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	87	87
High	82	71
Median	63	52
Low	43	34

Accident Database Reference	Location	Aircraft
19900511A	MANILA, PHILLIPPINES	B737-300
Date	**Operator**	**Regn**
11-May-90	PHILLIPPINE AIRLINES	EL-BZG

Résumé of Accident

The aircraft was being towed from its stand to an area where the engines could be started. During the pre start sequence fuel vapour in the empty centre wing tank was ignited. The resulting explosion ripped the floor open and upwards into the cabin, breaking the legs of some passengers in the process, and a fireball erupted into the cabin. The force of the explosion had fractured the wing internally and fuel from the wing tanks fed back into the centre section area where a very large intense fuel fire developed in the cabin. The fuselage remained intact.

The evacuation was characterised by very rapid and determined efforts to evacuate.

Summary of Assessment

It is assumed that all 8 fatalities were as a result of the fire. It is not known how many occupants were injured by the initial explosion, so two seat rows of passengers assumed, i.e. 10.

Later Requirements

It was assumed that due to the date of the accident, the aircraft was already configured to later requirements and hence the injury pattern was not changed.

Enhanced Fuselage Burnthrough Protection

It was assessed that enhanced Fuselage Burnthrough Protection would not have improved the injury pattern as the explosion emanated from the centre fuel tank located within the Burnthrough Protection envelope.

Cabin Water Spray systems (without Burnthrough Protection)

It is assessed that if the 8 fatalities were not those injured by the force of the explosion, a Cabin Water Spray system would have provided the extra time to locate a useable exit. However, if the 8 fatalities were those with broken legs due to the explosion, then it is unlikely that they would have had sufficient time to be assisted to an exit.

It is assessed that there is a chance that the explosion may have inflicted a singular Cabin Water Spray system with sufficient damage to render it inoperable. However, it is assumed that a modular system would have performed better.

Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	8	8
High	8	8
Median	6	4
Low	4	0

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	8	8
High	8	8
Median	6	4
Low	4	0

Accident Database Reference	Location	Aircraft
19901121B	NR SAMUI AIRPORT, THAILAND	DHC8-100
Date	**Operator**	**Regn**
21-Nov-90	BANGKOK AIRWAYS	HS.SKI

Résumé of Accident

On 21-Nov-1990 a Bangkok Airways DHC-8-100 registered as HS-SKI was approaching Samui Airport, Surat Thani Province Thailand.

The aircraft was operating a domestic scheduled passenger flight.

The aircraft made an approach to land on runway 35 by joining right hand down wind, turning base leg and proceeding to the final. Due to bad weather, the pilot could not have had runway in sight and he failed to turn right when the aircraft entered the final point of runway 35. Instead, the pilot continued to proceed on the base leg direction. Shortly after, the aircraft crashed into the terrain. The accident site was in the vicinity of Chaweng Beach, Tambon Bo-Pud, Samui District of Surat Thani Province, about 5 kilometres southwest of Samui Airport.

The aircraft was destroyed.

There were 5 crew and 33 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

Both wings were torn off the aircraft, the wreckage disintegrated into parts and there were no survivors. Therefore, it was assessed that all fatalities were due to impact forces and there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19901203A	ROMULUS, DETROIT	DC9-14
Date	**Operator**	**Regn**
03-Dec-90	NORTHWEST AIRLINES	N3313L

Résumé of Accident

On 03-Dec-1990 a Northwest Airlines DC-9-14 registered as N3313L had just taxied onto the active runway at Detroit Metropolitan/Wayne County Airport, Romulus, Michigan in dense fog when it was hit by a B727 on its take-off roll.

The DC-9 was destroyed by the impact and a subsequent fire.

Contributing to the fatalities in the accident was the inoperability of the internal tailcone release mechanism which trapped occupants in a cabin fire.

Contributing to the number and severity of injuries was the failure of the crew to properly execute the passenger evacuation.

There were 4 crew and 40 passengers on board. 1 crew member and 7 passengers suffered fatal injuries. 10 passengers suffered serious injuries. 3 crew and 23 passengers suffered minor or no injuries.

Summary of Assessment

The right wing of the B727 penetrated the right side of the DC-9 fuselage cutting into the flight deck and forward service door. It then sliced the length of the cabin ejecting fuel from the damaged wing tip. On hitting the right hand engine of the DC-9 the outboard fuel tank was ruptured and a fireball erupted from the rear of the aircraft and fire traversed forward throughout the cabin.

It was assessed that enhanced Fuselage Burnthrough Protection would not have provided any benefit as the fuselage roof was severed and fire entered from the top of the cabin.

It was assessed that Cabin Water Spray systems would not have operated after the impact of the wing because the majority of the system would have been mounted in the DC-9's roof, which was destroyed.

Accident Database Reference	Location	Aircraft
19910201A	LOS ANGELES, CALIFORNIA	B737-300
Date	**Operator**	**Regn**
01-Feb-91	US AIR	N388US

Résumé of Accident

On 01-Feb-1991 a Boeing 737-300 registered as N388US was landing at Los Angeles International Airport. It collided with a Fairchild Metroliner that was positioned on the same runway awaiting clearance for take-off.

The aircraft slid to the left side of the runway and into an unoccupied fire station whereupon a fire broke out. An evacuation took place but 20 passengers and 2 crewmembers were fatally injured.

The aircraft was operated under Title 14 Code of Federal Regulation (CFR) Part 135.

Summary of Assessment

In the forward vestibule 1 flight attendant died from asphyxiation. It was assumed that the other suffered serious fire injuries.

Between seat rows 1 and 7, there were 17 fatalities from asphyxiation. It was assumed that 9 were seriously injured by the fire and 1 escaped with minor or no injuries.

Between seat rows 8 and 22, there were 3 fatalities from asphyxiation. It was assumed that 2 were seriously injured by the fire and 53 escaped with minor or no injuries

The total number of fatalities was 22 with 21 being due to fire.

Later Requirements

The aircraft was configured with Floor Proximity Lighting and seat fire blocking but did not meet the improved flammability standards.

Had the aircraft been configured to these improved flammability standards, it was assessed that additional time would have been provided to facilitate escape. Furthermore improved access to Type III exits is likely to have relieved the congestion at the overwing exit. However, due to the intensity of the fire, which was most probably increased in severity by the release of oxygen, the reduction in fatalities resulting from these improvements would have been modest.

The number of fatalities remaining would have been 16 with 15 being fire related.

Enhanced Fuselage Burnthrough Protection

In the front vestibule and seat rows 1 to 7, it was assessed that enhanced Fuselage Burnthrough Protection would not have affected the situation because fire entered through ruptures in the lower fuselage skin.

Between seat rows 8 and 22, it was assessed that enhanced Fuselage Burnthrough Protection would not have affected the situation because fire entered the area by propagating along the fuselage from the front section.

Cabin Water Spray systems (without Burnthrough Protection)

It was assessed that the impact was not severe, as there were no impact related injuries and the fuselage did not break into sections. Therefore, a singular Cabin Water Spray system would operate as well as a modular one.

Cabin Water Spray systems would have provided more time for the occupants in the front section to move to the rear and find a useable exit. However, there was a significant amount of fire coming from the burning Metroliner and occupants at the extreme front may still not have found their way to an exit in time. The ranges in the assessments reflect this situation.

Therefore the assessments are:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	15	15
High	9	9
Median	5	5
Low	0	0

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessments of benefit from Cabin Water Spray systems assuming Burnthrough Protection present are:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	15	15
High	9	9
Median	5	5
Low	0	0

Accident Database Reference	Location	Aircraft
19910303A	COLORADO SPRINGS	B737-291
Date	**Operator**	**Regn**
03-Mar-91	UNITED AIR LINES	N999UA

Résumé of Accident

On 03-Mar-1991 a United Airlines B737-291 registered as N999UA was turning onto final approach to Colorado Springs Municipal Airport, Colorado. The flight was conducted under the requirements of 14 CFR Part 121.

Evidence from the CVR indicated that the pilots were caught by surprise by a rapidly developing event during which control of the aircraft was lost.

Numerous witnesses reported that the aircraft rolled steadily to the right and pitched nose down until it reached a nearly vertical attitude before hitting the ground in an area known as Widefield Park.

The aircraft was destroyed by impact forces and a postcrash fire.

There were 2 flight crew, 3 flight attendants and 20 passengers aboard. All occupants suffered fatal injuries.

Summary of Assessment

The aircraft hit the ground in a nearly vertical attitude and there were no survivors. It is assessed that all fatalities were due to impact forces and there would have been no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19910405A	BRUNSWICK, GEORGIA, USA	EMB120
Date	**Operator**	**Regn**
05-Apr-91	ATLANTIC SOUTHEAST AIRLINES	N270AS

Résumé of Accident

On 05-Apr-1991 an Atlantic Southeast Airlines Embraer EMB-120 registered as N270AS was landing at the Glynco Jetport, Brunswick, Georgia.

The aircraft was operating a scheduled passenger flight according to instrument flight rules, under the provisions of Title 14 Code of Federal Regulations Part 135.

The flight was cleared for a visual approach a few minutes before the accident. Witnesses reported that as the aircraft approached the airport, it suddenly turned or rolled to the left until the wings were perpendicular to the ground. The aircraft then fell in a nose-down attitude and disappeared out of sight behind the trees.

Examinations of the left propeller components indicated a blade angle of about 3 degrees at impact while the left propeller control unit had commanded a blade angle of 79.2 degrees. The discrepancy was later found to have been due to extreme wear on the propeller control unit quill spline teeth brought about by materials of unlike hardness being using in the propeller system design.

The aircraft was destroyed.

There were 2 flight crew, a flight attendant and 20 passengers aboard. All occupants received fatal injuries.

Summary of Assessment

The aircraft hit the ground with the wings perpendicular and there were no survivors. It is assessed that all fatalities were due to impact forces and there would have been no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19910526A	PHU TOEY VILLAGE, THAILAND	B767-3Z9ER
Date	**Operator**	**Regn**
26-May-91	LAUDA AIRLINES	OE-LAV

Résumé of Accident

On 26-May-1991, a Lauda Airlines Boeing 767-300ER of Austrian nationality, registered as OE-LAV, departed from Bangkok Airport at 2302 hours (local time) and it disappeared from air traffic radar at 2317 hours about 94 nautical miles northwest of Bangkok.

The airplane was on scheduled flight NG004 from Hong Kong to Vienna, Austria, with an en route stop in Bangkok, Thailand. The airplane crashed in mountainous jungle terrain at 14 degrees 44 minutes North latitude and 99 degrees 27 minutes East longitude. Night time visual meteorological conditions prevailed.

The airplane was destroyed by in-flight breakup, ground impact and fire.

There were 10 crewmembers and 213 passengers aboard and all suffered fatal injuries.

Summary of Assessment

The aircraft broke up in flight and it was assessed that all fatalities were due to impact forces. Therefore, it is assessed that there was no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19910711A	KING ABDULAZIZ INT AP, JEDDAH, SAUDI ARABIA	DC8-61
Date	**Operator**	**Regn**
11-Jul-91	NATIONAIR	C-GMXQ

Résumé of Accident

On 11-Jul-1991, a Nationair DC-8-61 registered as C-GMXQ was taking off from the King Abdulaziz International Airport, Jeddah, Kingdom of Saudi Arabia. The flight was chartered to convey pilgrims from Saudi Arabia to Nigeria.

During the take-off roll, tyres and wheels failed on the left main undercarriage and a piece of a wheel rim damaged the airframe. Remnants of tyres on the bogie were burning when the gear was retracted after take-off.

A fire developed within the main wheel wells causing loss of pressurisation, loss of hydraulics, structural damage and finally loss of control.

During the final stages of the approach to runway 34C, witnesses reported a significant increase of fire and smoke and the aircraft dived and rolled to crash some 2,875 metres short of the threshold.

Of the 14 crew and 247 passengers aboard, all occupants suffered fatal injuries.

Summary of Assessment

The aircraft dived into the ground and it was assessed that all fatalities were due to impact forces.

A fire propagated from the wheel well into the cabin in flight. Burnthrough Protection would not have helped in this case because the fire caused the loss of hydraulics, located in the same area. Cabin Water Spray systems in the cabin would not be able to extinguish the fire in the wheel well and in any case would not be operated in-flight.

Therefore, it is assessed that there was no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19910816A	IMPHAL, INDIA	B737-2A8
Date	**Operator**	**Regn**
16-Aug-91	INDIAN AIRLINES	VT-EFL

Résumé of Accident

On 16-Aug-1991 an Indian Airlines Boeing 737-2A8, registered as VT-EFL, was landing at Imphal, India. The aircraft was operating a domestic scheduled passenger flight.

Whilst positioning for an ILS approach to runway 04, the aircraft was destroyed when it flew into a hillside 18.5nm from the airfield. The point of impact was approximately on the extended centreline of the runway. The accident happened in daylight but in poor weather with low cloud/mist and light rain. Last contact with the flight had been when the pilot reported at 5,000ft commencing the procedural turn onto the ILS. It is understood that the landing procedure for runway 04 at Imphal is to arrive overhead the VOR at 10,000ft and then to descend outbound on the 217deg radial. This outbound leg is to be flown for 2.5 min at a maximum speed of 170kt before making the turn back onto the ILS. It is believed that the pilot may have continued this outbound leg too far and subsequently attempted to turn onto the ILS further away than normal in an area of high ground.

There was a post-impact fire.

There were 6 crew and 63 passengers on board the aircraft. All occupants suffered fatal injuries.

Summary of Assessment

The aircraft flew into a hillside and there were no survivors. Therefore, it was assessed that all fatalities were due to impact forces and there was no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19910911A	EAGLE LAKE, TEXAS U.S.A.	EMB 120RT
Date	**Operator**	**Regn**
11-Sep-91	CONTINENTAL EXPRESS	N33701

Résumé of Accident

On 11-Sep-1991 a Continental Express Embraer EMB-120RT registered as N33701 experienced a structural breakup in flight and crashed in a cornfield near Eagle Lake, Texas. The aircraft was operating under the provisions of Title 14 Code of Federal Regulations Part 135.The aircraft was destroyed in the crash and fire. There were 2 flight crew, 1 cabin crewmember and 11 passengers aboard. All 3 crew and 11 passengers suffered fatal injuries.

Summary of Assessment

The aircraft broke-up in flight and there were no survivors. Therefore it is assessed that all fatalities were due to impact forces and there would have been no opportunity for benefit from from Enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19920120A	STRASBOURG, FRANCE	A320-111
Date	**Operator**	**Regn**
20-Jan-1992	AIR INTER	F-GGED

Résumé of Accident

On 20-Jan-1992 an Air Inter A320-111 registered as F-GGED was approaching Strasbourg, France.

The aircraft was inadvertently placed into a 3200 fpm vertical speed descent instead of the intended 3.2 degree flight path angle. The aircraft crashed into the top of a hill 10 nm short of the runway. The aircraft was destroyed by the impact forces and by a minor post crash fire. Of the 6 crew and 90 passengers aboard, 5 crew and 82 passengers suffered fatal injuries. 1 crew member and 4 passengers suffered serious injuries. 4 passengers suffered minor injuries.

Summary of Assessment

Although survivor reports indicate that two of the fatalities were caused by fire, it is assessed that the extensive damage to the aircraft on impact would result in no benefit from enhanced Fuselage Burnthough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19920322A	LA GUARDIA, NEW YORK	F28-4000a
Date	**Operator**	**Regn**
22-Mar-92	US AIR	N485US

Résumé of Accident

On 22-Mar-1992 a USAir F-28-4000a registered as N485US was taking off from LaGuardia Airport, Flushing, New York.

The aircraft was operating under Title 14 Code of Federal Regulations Part 121 as a scheduled passenger flight.

Due to departure delays the aircraft accumulated ice on the wings and in addition the flight crew attempted to rotate at a lower than prescribed air speed. As a result the aircraft suffered an aerodynamic stall and loss of control after liftoff.

The aircraft came to rest partially inverted at the edge of Flushing Bay and parts of the fuselage and cockpit were submerged in water. After the aircraft came to rest, passengers stated that several small residual fires broke out on the water and on the wreckage debris.

The aircraft was destroyed during the impact sequence and subsequent fires.

Of the 4 crew and 47 passengers aboard, 2 crew and 25 passengers suffered fatal injuries. 1 crew member and 8 passengers suffered serious injuries. 1 crewmember and 14 passengers escaped with minor or no injuries.

Summary of Assessment

The occupants of the front section were upside down and the occupants in the rear section were submerged in water over their heads. However, 2 fatalities were reported to be fire related, one died from burns and the other as a result of smoke inhalation/burns. Given the severity of the disruption and the additional threat of drowning, it is assessed that there would be no opportunity of benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19921221A	FARO, PORTUGAL	DC10-30F
Date	**Operator**	**Regn**
12-Dec-1992	MARTINAIR	PH-MBN

Résumé of Accident

On 21-Dec-1992 a Martinair DC-10-30CF registered as PH-MBN was approaching Faro Airport, Portugal.

After a flight of 2 hrs and 17 minutes the flight was cleared to descend to Faro.

At an altitude of 303m and 140kts speed the approach became unstable and at 177m the first officer switched the autopilot from CMD (command mode) to control-wheel steering. One minute later it was switched to manual and the airspeed began falling below approach reference speed. About 3-4 seconds short of touchdown elevator was pulled to pitch up and engine power was increased. When the no.3 and 5 spoilers extended, the aircraft had a 25deg. bank, left wing up. The right main gear contacted the runway with a 900ft/min descent rate at 126kts, +8.79deg, pitch up and +5.62deg roll. The right wing separated while the aircraft slid down the runway. The aircraft came to rest 1100m from the Runway threshold and 100m to the right of the centreline and caught fire.

There were 13 crew and 327 passengers on board. 2 crew and 54 passengers suffered fatal injuries.

Summary of Assessment

Overall there were 56 fatalities of which it has been assumed (by analysis of the available data) 33 fatalities due to fire. The fuselage broke into four sections during the impact. The fire related fatalities were all in the centre section (rows 20 to 27).

Later Requirements

It was assumed that due to the date of the accident, the aircraft was already configured to later requirements and hence the injury pattern was not changed.

Enhanced Fuselage Burnthrough Protection

The centre section suffered considerable impact damage both to the structure and the trim. It is therefore assessed that Burnthrough Protection would have given no benefit.

Cabin Water Spray systems (without Burnthrough Protection)

Due to the level of damage to the centre section on impact it is assessed that a singular Cabin Water Spray system would not have functioned. It is however assessed that a modular system could have functioned to a limited extent (limited due to the significant internal trim damage that occurred and the fact that the fire was driven by multiple explosions).

Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	33	33
High	33	33
Median	33	24
Low	33	15

Cabin Water Spray systems (assuming Burnthrough Protection present)

Due to there being no benefit from Enhanced Burnthrough Protection the results are the same as for the Cabin Water Spray system only. The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	33	33
High	33	33
Median	33	24
Low	33	15

Accident Database Reference	Location	Aircraft
19930914A	WARSAW, POLAND	A320-211
Date	**Operator**	**Regn**
14-Sep-1993	LUFTHANSA	D-AIPN

Résumé of Accident

On 14-Sep-1993 a Lufthansa A320 registered as D-AIPN was landing at Okecie in Warsaw, Poland.

The pilot in the left seat was subject to check but was the pilot flying at the time of the accident. The pilot in the right seat was the instructor who was in overall command of the aircraft.

Okecie tower warned the crew of windshear and so the flight crew increased the approach speed by 20 knots, in accordance with the Flight Manual. A storm front passed through aerodrome area at that time which produced a tail wind and as a result the aircraft touched down too fast. The very light touch of the runway surface with the landing gear and lack of compression of the left landing gear leg (to the extent understood by the aircraft computer as the actual landing) resulted in delayed deployment of spoilers and thrust reversers. Delay was about 9 seconds. Thus the braking commenced with delay and in a condition of heavy rain the aircraft did not stop on the runway.

The aircraft ran off the end of the runway, collided with an embankment and stopped the other side of it. The aircraft caught fire as a result of the impact.

There were 6 crew and 64 passengers aboard. 1 crew member and 1 passenger suffered fatal injuries. 2 crew and 49 passengers suffered serious injuries. 3 crew and 14 passengers escaped with minor or no injuries.

Summary of Assessment

There were 2 fatalities, a flight crewmember and a passenger. The right-seat pilot was killed outright due to collision with cockpit interior elements. In the blood of the fatally injured passenger 22.6% of carbon monoxide haemoglobin was found, and in the opinion of the person who performed the autopsy intoxication with carbon monoxide in the environment of the high temperature was the cause of the death.

Later Requirements

It was assumed that due to the date of the accident, the aircraft was already configured to later requirements and hence the injury pattern was not changed.

Enhanced Fuselage Burnthrough Protection

It has been assessed that Burnthrough Protection would have delayed the entry of the fire and provided the passengers with additional time to remove the immobilised passenger who was seated near to the forward passenger door. This would have reduced the fire related fatalities to 0.

Cabin Water Spray systems (without Burnthrough Protection)

It has been assessed that a Cabin Water Spray system would have delayed the entry of the fire and provided the passengers with additional time to remove the immobilised passenger who was seated near to the forward passenger door. Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	1	1
High	1	1
Median	0	0
Low	0	0

Cabin Water Spray systems (assuming Burnthrough Protection present)

As there were no fire related fatalities with Burnthrough Protection applied, the assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	0	0
High	0	0
Median	0	0
Low	0	0

Accident Database Reference	Location	Aircraft
19931110A	SANDY LAKE, ONTARIO, CANADA	HS748-234
Date	**Operator**	**Regn**
10-Nov-93	AIR MANITOBA	C-GQTH

Résumé of Accident

On 10-Nov-1993, 1805 central standard time, an Air Manitoba Hawker Siddeley 748, registered as C-GQTH, crashed during Climb at Sandy Lake, Ontario.

The aircraft took off from runway 29 at Sandy Lake at approximately 1805 and entered a right turn. Witnesses indicate that the aircraft appeared to fly at a lower than normal height throughout the turn. After turning through approximately 120 degrees, the aircraft descended into 100-foot trees and crashed. The aircraft struck the ground about one nautical mile northwest of the airport.

The aircraft was destroyed by the impact with the trees and the ground. There were 3 crew and 4 passengers aboard and all suffered fatal injuries. The accident occurred during the hours of darkness.

Summary of Assessment

There had been a small post-crash fire in the right engine nacelle area which caused little damage. There was a larger post-crash fire in the area of the left engine nacelle on the left wing, which caused some burning and melting of the wing metal. The fire did not spread more than a few feet in any direction, and it is believed the fire was of short duration. Soot was found in the snow around the area, suggesting that this was a fast-burning, fuel-fed fire. The fires self-extinguished, therefore it was assessed that there were no fire fatalities and hence there would be no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19940103A	MAMONY, IRKUTSK, RUSSIA	TU154M
Date	**Operator**	**Regn**
03-Jan-94	BAIKAL AIR	RA-85656

Résumé of Accident

On 03-Jan-1994 a Baikal Tupolev TU154, registered as RA-85656, was taking off from Irkutsk, Russia. The aircraft was operating a scheduled domestic passenger flight.

A fire warning for engine No.2 and the APU activated after take-off. The crew made three unsuccessful attempts to extinguish the fire. Approximately 8 minutes later pressure was lost in all the hydraulic systems causing a loss of aircraft control. The failure of and fire in engine No.2 may have been caused by the failure of the starter.

The accident occurred during the hours of daylight.

There were 9 crew and 116 passengers on board the aircraft. All occupants suffered fatal injuries.

Summary of Assessment

As the aircraft crashed after the crew lost control, it was assessed that all fatalities were due to impact forces. Therefore, there was no opportunity for benefit from either enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19940323A	NOVOKUZNETSK, RUSSIA	A310-304
Date	**Operator**	**Regn**
23-Mar-94	AEROFLOT	F-OGQS

Résumé of Accident

On 23-Mar-1994 an Aeroflot A310-304, registered as F-OGQS, was landing at Novokuznetsk Russia. The aircraft was operating an international scheduled passenger flight.

After passing Novokuznetsk at 10,100 m the crew did not establish communication at the estimated time. The aircraft was located under the airway completely destroyed and partially burnt out. The aircraft had impacted the ground in clean configuration (flaps and landing gear retracted) with left bank and considerable vertical speed. The engines were operative.

The accident occurred during the hours of darkness.

There were 12 crew and 63 passengers on board the aircraft. All occupants suffered fatal injuries.

Summary of Assessment

As the aircraft was completely destroyed after hitting the ground with considerable vertical speed, it was assessed that all fatalities were due to impact forces. Therefore, there was no opportunity for benefit from either enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19940426A	NAGOYA/KOMAKI AIRPORT, JAPAN	A300B4-622R
Date	**Operator**	**Regn**
26-Apr-94	CHINA AIRLINES	B-1816

Résumé of Accident

On 26-Apr-1994 Airbus A-300-600R registered as B-1816 and operated by China Airlines was approaching the Nagoya/Komaki Airport, Nagoya, Japan.

The first officer was manually flying the aircraft with the autopilot off. The Safety Board believes that the first officer inadvertently selected the autothrottle system to the go-around mode. The CVR transcript indicates that the flightcrew did not understand why the aircraft was not responding to the control inputs when the autopilot was engaged and apparently did not realise that the autopilot was trimming the aircraft nose up.

As a result, the aircraft entered an aerodynamic stall at approximately 1800 feet above ground level and the pilots were unable to regain control prior to striking the ground short of the runway.

The aircraft ignited and was destroyed.

There were 15 crew and 256 passengers aboard. 15 crew and 249 passengers suffered fatal injuries. 7 passengers suffered serious injuries.

Summary of Assessment

Due to the severe nature of the impact and destruction of the fuselage volume, it is assumed that all fatalities were due to impact forces. As a result, there is no opportunity for benefit from enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19940702A	CHARLOTTE AIRPORT, NORTH CAROLINA	DC9-31
Date	**Operator**	**Regn**
02-Jul-94	USAIR	N954VJ

Résumé of Accident

On 02-Jul-1994 a USAir DC-9-31 registered as N954VJ was executing an ILS approach to the Charlotte/Douglas International Airport, Charlotte, North Carolina. A severe convective activity existed that was conducive to microburst and windshear activity.

Shortly after initiating a go-around, the aircraft gained some altitude but subsequently descended in the heavy rain with controlled flight into the terrain, striking the ground in a field on airport property, continuing through a forest area and finally coming to rest impacting a private residence.

The aircraft was destroyed by the impact forces, and a post-crash fire.

There were 5 crew and 52 passengers on board. 37 passengers suffered fatal injuries. 2 crew and 14 passengers suffered serious injuries. 3 crew and 1 passenger suffered minor injuries.

The flight was conducted under 14 Code of Federal Regulations(CFR) Part 121 as a regularly schedule passenger flight.

Summary of Assessment

Of the 37 passengers who received fatal injuries, 32 were the result of blunt force trauma, 4 were due to thermal injuries and 1 was the result of carbon monoxide inhalation.

Later Requirements

It was assumed that due to the date of the accident, the aircraft was already configured to later requirements and hence the injury pattern was not changed.

Enhanced Fuselage Burnthrough Protection

All the fire fatalities were situated in a separated section of the cabin located over the wing. There was a significant fire at the extreme ends of the open fuselage section, therefore it was assessed that there would have been no benefit due to Burnthrough Protection.

Cabin Water Spray systems (without Burnthrough Protection)

Because the fuselage broke into 4 pieces, it was assessed that a singular Cabin Water Spray system would not have operated after the impact sequence. The separated section of the cabin located over the wing was relatively intact after the impact and therefore it was assessed that a modular Cabin Water Spray system could have survived and operated after the impact. Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	5	5
High	5	5
Median	5	2
Low	5	1

Cabin Water Spray systems (assuming Burnthrough Protection present)

The assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	5	5
High	5	5
Median	5	2
Low	5	1

Accident Database Reference	Location	Aircraft
19940908A	NR. ALIQUIPPA, PENNSYLVANIA, U.S.A.	B737-300
Date	**Operator**	**Regn**
08-Sep-94	USAIR	N513AU

Résumé of Accident

On 08-Sep-1994 a Boeing 737-300 registered as N513AU was manoeuvring to land at Pittsburgh International Airport, Pittsburgh, Pennsylvania.

The flight was operating under the provisions of 14 Code of Federal Regulations Part 121 as a scheduled domestic passenger flight from Chicago-O'Hare International Airport, Chicago, Illinois, to Pittsburgh. Visual meteorological conditions prevailed for the flight, which operated on an instrument flight rules flight plan.

The rudder surface most likely deflected in a direction opposite to that commanded by the pilots as a result of a jam of the main rudder power control unit servo valve secondary slide to the servo valve housing offset from its neutral position and overtravel of the primary slide. As a result, The aircraft entered an uncontrolled descent and impacted terrain near Aliquippa, Pennsylvania, about 6 miles north-west of the destination airport.

The aircraft was destroyed by impact forces and fire.

Of the 2 flight crew, 3 cabin crew and 127 passengers aboard, all were fatally injured.

Summary of Assessment

The Beaver County Coroner's Office investigative report stated that all aircraft occupants were killed as a result of "blunt force impact trauma." Therefore there was no opportunity for benefit from either enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19950821A	NR. CARROLLTON, GEORGIA, U.S.A.	EMB120RT
Date	**Operator**	**Regn**
21-Aug-95	ATLANTIC SOUTHEAST AIRLINES	N256AS

Résumé of Accident

On 21-Aug-1995 an Atlantic Southeast Airlines Embraer EMB-120RT registered as N256AS had taken off from the Atlanta Hartsfield International Airport, Atlanta and was climbing through 18,100 feet, en-route to Gulfport, Mississippi.

The aircraft was operating according to instrument flight rules, under the provisions of Title 14 Code of Federal Regulations Part 135.

The aircraft experienced the loss of a propeller blade from the left engine and then crashed during an emergency landing near Carrollton, Georgia.

The flightcrew declared an emergency and initially attempted to return to Atlanta. The flightcrew then advised that they were unable to maintain altitude and were vectored by air traffic control toward the West Georgia Regional Airport, Carrollton, Georgia, for an emergency landing. The aircraft continued its descent, passed through some trees and was destroyed by ground impact forces and a post crash fire.

There were 3 crew and 26 passengers aboard. 1 crewmember and 7 passengers suffered fatal injuries. 2 crew and 11 passengers suffered serious injuries. 8 passengers escaped with minor injuries.

Summary of Assessment

All 8 fatalities were due to fire.

Later Requirements

It was assumed that due to the date of the accident, the aircraft was already configured to later requirements and hence the injury pattern was not changed.

Enhanced Fuselage Burnthrough Protection

It was assessed that the significant size of the fuselage breaks would have provided sufficient paths for fire to enter the cabin. Therefore, it was assessed that there would have been no benefit.

Cabin Water Spray systems (without Burnthrough Protection)

It was assessed that a Cabin Water Spray system would have provided additional time to evacuate. A singular system would have been compromised by the fuselage breaks (particularly aft of the wing). The summary is as follows:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	8	8
High	8	6
Median	6	4
Low	1	0

Cabin Water Spray systems (assuming Burnthrough Protection present)

As there was no benefit from Burnthrough Protection, the assessment of benefit from the combination of enhanced Fuselage Burnthrough Protection and a Cabin Water Spray system is the same as that for a Cabin Water Spray system alone.

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	8	8
High	8	6
Median	6	4
Low	1	0

Accident Database Reference	Location	Aircraft
19960511B	EVERGLADES, FLORIDA, U.S.A.	DC9-32
Date	**Operator**	**Regn**
11-May-96	VALUJET AIRLINES	N904VJ

Résumé of Accident

On 11-May-1996, at 1413:42 eastern daylight time, a ValuJet Airlines, Douglas DC-9-32, registered as N904VJ, crashed into the Everglades about 10 minutes after takeoff from Miami International Airport, Miami, Florida.

Visual meteorological conditions existed in the Miami area at the time of the takeoff.

Flight 592, operating under the provisions of 14 CFR Part 121, was on an instrument flight rules flight plan destined for the William B. Hartsfield International Airport, Atlanta, Georgia.

There were 2 flight crew, 3 flight attendants and 105 passengers aboard. All occupants suffered fatal injuries.

ValuJet passenger records indicated that 104 passengers boarded the aircraft. A 4-year-old child also was aboard; however, the presence of this child was not shown on the passenger manifest or on the weight and balance and performance form.

Summary of Assessment

There was an in-flight cargo bay fire that rapidly developed and as a result, the crew lost control of the aircraft. The aircraft struck the ground in a nearly vertical attitude. It was assessed that there was no opportunity for benefit from either enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19960613A	FUKUOKA AIRPORT, JAPAN	DC10-30
Date	**Operator**	**Regn**
13-Jun-96	GARUDA INDONESIAN AIRWAYS	PK-GIE

Résumé of Accident

On 13-June-1996, a DC-10-30 operated as Flight 865 of Garuda Indonesian Airways registered as PK-GIE made a rejected take off at Fukuoka Airport, Japan.

After climbing 6-9m and touching down again, the aircraft overran across the perimeter fence and came to rest 320m from the end of the runway.

There were 14 crew and 261 passengers on board. 3 passengers received fatal injuries, 2 crew and 16 passengers received serious injuries.

Summary of Assessment

There were 2 fatalities due to impact forces and 1 fatality due to fire.

Later Requirements

It was assumed that due to the date of the accident, the aircraft was already configured to later requirements and hence the injury pattern was not changed.

Enhanced Fuselage Burnthrough Protection

It was assessed that the one fire fatality was seated just forward of the 4R door and next to a fuselage break, with a pool fire outside. Had the fuselage been fitted with enhanced Fuselage Burnthrough Protection, the level of protection would have been compromised by the local fuselage rupture. Therefore, it was assessed that there would have been no benefit.

Cabin Water Spray systems (without Burnthrough Protection)

The fuselage was not separated into sections, therefore it was assumed that a singular system would perform as well as a modular one. It was assessed that a Cabin Water Spray system would have provided additional time for fellow passengers or rescuers to remove the unconscious passenger from the aircraft. Therefore the assessment is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements	1	1
High	1	1
Median	0	0
Low	0	0

Cabin Water Spray systems (assuming Burnthrough Protection present)

Because it was assessed that there was no benefit from enhanced Fuselage Burnthrough Protection, the assessment of benefit from Cabin Water Spray systems assuming Burnthrough Protection present is:

	Fatalities - Singular	Fatalities - Modular
With Later Requirements & Burnthrough	1	1
High	1	1
Median	0	0
Low	0	0

Accident Database Reference	Location	Aircraft
19960717B	OFF LONG ISLAND, U.S.A.	B747-131
Date	**Operator**	**Regn**
17-Jul-96	TRANS WORLD AIRLINES (TWA)	N93119

Résumé of Accident

On 17-Jul-1996 a Trans World Airlines B747-131 registered as N93119 was taking off from John F. Kennedy Airport, New York, to Charles DeGaulle Airport, Paris, France. The scheduled air carrier flight was operated under 14 CFR Part 121. Visual meteorological conditions prevailed and an instrument flight rules (IFR) flight plan was filed.

As the aircraft was climbing, it exploded, broke up and flaming debris fell into the Atlantic Ocean at approximately 40°39'52" N, 72°37'46" W near East Moriches, New York.

The aircraft was destroyed.

Of the 18 crew and 212 passengers aboard, all occupants suffered fatal injuries.

Summary of Assessment

There was an in-flight fuel tank explosion and it was assessed that there was no opportunity for benefit from either enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Accident Database Reference	Location	Aircraft
19961112A	CHARKI DADRI, INDIA	B747-168B
Date	**Operator**	**Regn**
12-Nov-96	SAUDIA	HZ-AIH

Résumé of Accident

On 12-Nov-1996 a Saudi Arabian Airlines Boeing 747-168B, registered as HZ-AIH, was taking off from Charki Dadri, India. The aircraft was operating an international scheduled passenger flight.

The aircraft collided in flight with a Kazakh airliner near New Delhi, exploding in flames and sending fiery wreckage plunging into the fields. The Saudi plane had just taken off when it hit an IL-76 that was making its landing approach.

There were 23 crew and 289 passengers on board the aircraft. All occupants suffered fatal injuries.

Summary of Assessment

There was an in-flight collision with another aircraft and it was assessed that there was no opportunity for benefit from either enhanced Fuselage Burnthrough Protection or Cabin Water Spray systems.

Appendix 2 Summary of Benefit Assessment

ACCIDENT DETAILS					Total Fatalities with latest requirements	Burn through	Cabin Water Spray Only		Cabin Water Spray & Burnthrough * = Additional lives saved by Cabin Water Spray system on aircraft configure with Burnthrouth protection			
DATE	LOCATION	AIRCRAFT	REGN.	Total fatalities		Lives Saved	Lives Saved		Lives saved		Lives saved after Burnthrough	
							Sing	Mod	Sing	Mod	Sing	Mod
		TOTAL		9736	-	207	465	587	616	756	409	549
16-Feb-67	MENADO AIRPORT, INDONESIA	L188	PK-GLB	22	11	11	8	10	11	11	0	0
05-Mar-67	NR. MONROVIA, LIBERIA, AFRICA	DC8-33	PP-PEA	51	36	0	20	22	20	22	20	22
09-Mar-67	NR. URBANA, OHIO, U.S.A.	DC9-15	N1063T	25	N/A	0	0	0	0	0	0	0
10-Mar-67	STUKEL MT., KLAMATH FALLS, OR., U.S.A.	F27	N2712	4	N/A	0	0	0	0	0	0	0
23-Jun-67	NR. BLOSSBURG, PENNSYLVANIA, U.S.A.	BAC1-11 204A	N1116J	34	N/A	0	0	0	0	0	0	0
19-Jul-67	HENDERSONVILLE, N.C., U.S.A.	B727-22	N68650	79	N/A	0	0	0	0	0	0	0
04-Nov-67	BLACK DOWN HILL, SUSSEX, U.K.	CARAVELLE	EC-BDD	37	N/A	0	0	0	0	0	0	0
06-Nov-67	CINCINNATI,U.S.A.	B707-131	N742TW	1	N/A	0	0	0	0	0	0	0
06-Mar-68	POINTE A PITRE, GUADELOUPE	B707-328C	F-BLCJ	43	N/A	0	0	0	0	0	0	0
08-Mar-68	IBAJAY, AKLAN, PHILIPPINES	F27	PI-C-871	14	N/A	0	0	0	0	0	0	0
8-Apr-68	LONDON (HEATHROW), U.K.	B707-465	G-ARWE	5	3	3	3	3	3	3	0	0

ACCIDENT DETAILS					Total Fatalities with latest requirements	Burn through	Cabin Water Spray Only		Cabin Water Spray & Burnthrough * = Additional lives saved by Cabin Water Spray system on aircraft configure with Burnthrouth protection			
DATE	LOCATION	AIRCRAFT	REGN.	Total fatalities		Lives Saved	Lives Saved		Lives saved		Lives saved after Burnthrough	
							Sing	Mod	Sing	Mod	Sing	Mod
		TOTAL		9736	-	207	465	587	616	756	409	549
03-May-68	DAWSON, TEXAS, U.S.A.	L188A	N9707C	85	N/A	0	0	0	0	0	0	0
12-Jun-68	CALCUTTA, INDIA	B707-321C	N798P	6	3	0	2	3	2	3	2	3
09-Aug-68	LANGENBRÜCK, GERMANY	VISCOUNT	G-ATFN	48	N/A	0	0	0	0	0	0	0
10-Aug-68	CHARLESTON AIRPORT, U.S.A.	FH227B	N712U	35	N/A	0	0	0	0	0	0	
25-Oct-68	HANOVER, NEW HAMPSHIRE, U.S.A.	FH227C	N380NE	32	N/A	0	0	0	0	0	0	0
02-Dec-68	PEDRO BAY, ALASKA, U.S.A.	F27B	N4905	39	N/A	0	0	0	0	0	0	0
27-Dec-68	O'HARE, CHICAGO, U.S.A.	CV580	N2045	27	N/A	0	0	0	0	0	0	0
31-Dec-68	PORT HEDLAND, AUSTRALIA	VISCOUNT	VH-RMQ	26	N/A	0	0	0	0	0	0	0
05-Jan-69	GATWICK, ENGLAND, U.K.	B727	YA-FAR	48	38	0	5	10	5	10	5	10
19-Nov-69	GLENS FALLS, NEW YORK, U.S.A.	FH227B	N7811M	14	N/A	0	0	0	0	0	0	0
20-Nov-69	LAGOS, NIGERIA	VC10-1101	5N-ABD	87	87	0	10	11	10	11	10	11
06-May-70	MOGADISCIO, SOMALIA	VISCOUNT	6O-AAJ	5	0	0	0	0	0	0	0	0
03-Jul-70	SIERRA DEL MONTENSY, GERONA, SPAIN	COMET 4	G-APDN	112	N/A	0	0	0	0	0	0	0

ACCIDENT DETAILS					Total Fatalities with latest requirements	Burn through	Cabin Water Spray Only		Cabin Water Spray & Burnthrough * = Additional lives saved by Cabin Water Spray system on aircraft configure with Burnthrouth protection			
DATE	LOCATION	AIRCRAFT	REGN.	Total fatalities		Lives Saved	Lives Saved		Lives saved		Lives saved after Burnthrough	
							Sing	Mod	Sing	Mod	Sing	Mod
		TOTAL		9736	-	207	465	587	616	756	409	549
05-Jul-70	TORONTO, CANADA	DC8-63	C-FTIW	109	N/A	0	0	0	0	0	0	0
14-Nov-70	TRI-STATE AP., HUNTINGTON, W.VIR., U.S.A.	DC9-31	N97S	75	N/A	0	0	0	0	0	0	0
27-Nov-70	ANCHORAGE, ALASKA, U.S.A.	DC8-63F	N4909C	47	36	0	15	17	15	17	15	17
28-Dec-70	ST.THOMAS, VIRGIN ISLANDS	B727-200	N8790R	2	N/A	0	0	0	0	0	0	0
31-Dec-70	SHAMSHERNAGAR, PAKISTAN	F27-200	AP-AUV	7	N/A	0	0	0	0	0	0	0
02-Jan-71	TRIPOLI AP., LIBYA	COMET 4C	SU-ALC	16	N/A	0	0	0	0	0	0	0
06-Jun-71	NEAR DUARTE, CALIFORNIA, U.S.A.	DC9-31	9345N	49	N/A	0	0	0	0	0	0	0
07-Jun-71	NEWHAVEN, CONNECTICUT, U.S.A.	CV580	N5832	28	24	1	6	8	7	9	6	8
04-Sep-71	NEAR JUNEAU, ALASKA, U.S.A.	B727-193	N2969G	111	N/A	0	0	0	0	0	0	0
06-Sep-71	NR. HASLOH, GERMANY	BAC1-11 500	D-ALAR	22	N/A	0	0	0	0	0	0	0
18-Apr-72	ADDIS ABABA, ETHIOPIA	SVC10	5X-UVA	43	35	7	7	9	12	14	5	7
29-Jun-72	LAKE WINNEBAGO, WISCONSIN, U.S.A.	CV580	N90858	5	N/A	0	0	0	0	0	0	0
08-Dec-72	NR. MIDWAY AIRPORT, CHICAGO, U.S.A.	B737-222	N9031U	45	41	0	6	9	6	9	6	9

ACCIDENT DETAILS					Total Fatalities with latest requirements	Burn through	Cabin Water Spray Only		Cabin Water Spray & Burnthrough * = Additional lives saved by Cabin Water Spray system on aircraft configure with Burnthrouth protection			
DATE	LOCATION	AIRCRAFT	REGN.	Total fatalities		Lives Saved	Lives Saved		Lives saved		Lives saved after Burnthrough	
							Sing	Mod	Sing	Mod	Sing	Mod
		TOTAL		9736	-	207	465	587	616	756	409	549
08-Dec-72	NR. MIDWAY AIRPORT, CHICAGO, U.S.A.	B737-222	N9031U	45	41	0	6	9	6	9	6	9
20-Dec-72	CHICAGO, U.S.A.	DC9-31	N954N	10	8	8	7	8	8	8	0	0
22-Jan-73	KANO AIRPORT, NIGERIA	B707	JY-ADO	176	135	52	35	40	85	90	33	38
11-Jul-73	ORLY, NR. PARIS, FRANCE	B707	PP-VJZ	123	101	0	20	30	20	30	20	30
23-Jul-73	NR. ST LOUIS, MISSOURI, U.S.A.	FH227B	N4215	38	N/A	0	0	0	0	0	0	0
31-Jul-73	LOGAN INT. AIRPORT, BOSTON, MASS.	DC9-31	N975NE	89	N/A	0	0	0	0	0	0	0
27-Sep-73	BLACK FORK MOUNTAIN, ARIZONA, U.S.A.	CV600 (240D)	N94230	11	N/A	0	0	0	0	0	0	0
01-Jan-74	NR. TURIN, ITALY	F28-1000	I-TIDE	38	N/A	0	0	0	0	0	0	0
26-Jan-74	COMAOVASI, TURKEY	F28-1000	TC-JAO	66	N/A	0	0	0	0	0	0	0
30-Jan-74	PAGO PAGO, AMERICAN SAMOA	B707-321B	N454PA	97	93	9	21	26	36	41	27	32
15-Mar-74	TEHERAN, IRAN	CARAVELLE	OY-STK	15	13	13	10	11	13	13	0	0
22-Apr-74	DENPASAR, BALI, INDONESIA	B707-321C	N446PA	107	N/A	0	0	0	0	0	0	0
08-Jun-74	CERRO EL RETIRO, COLOMBIA	VISCOUNT	HK-1058	44	N/A	0	0	0	0	0	0	0

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							Sing	Mod	Sing	Mod	Sing	Mod
		TOTAL		9736	-	207	465	587	616	756	409	549
11-Sep-74	DOUGLAS AIRPORT, CHARLOTTE, N.C. U.S.A.	DC9-31	N8984E	72	72	0	0	5	0	5	0	5
20-Nov-74	NAIROBI, KENYA	B747-130	D-ABYB	59	56	1	2	3	3	4	2	3
01-Dec-74	BERRYVILLE, VIRGINIA, U.S.A.	B727-231	N54328	92	N/A	0	0	0	0	0	0	0
04-Dec-74	ANJIMALAI MOUNTAIN, SRI LANKA	DC8-55F	PH-MBH	191	N/A	0	0	0	0	0	0	0
24-Jun-75	KENNEDY AIRPORT, NEW YORK, U.S.A.	B727-225	N8845E	113	N/A	0	0	0	0	0	0	0
30-Aug-75	SEVUOKUK MOUNTAIN, GAMBELL, ALASKA,	F27B	N4904	10	N/A	0	0	0	0	0	0	0
05-Apr-76	KETCHIKAN, ALASKA, U.S.A.	B727-81	N124AS	1	N/A	0	0	0	0	0	0	
27-Apr-76	ST. THOMAS, VIRGIN ISLAND	B727-95	N1963	37	28	0	3	6	3	6	3	6
04-Jun-76	GUAM, MARIANAS ISLANDS, PHILIPPINES	L188A	RP-C1061	45	44	2	2	3	4	5	2	3
10-Sep-76	VROBEC, YUGOSLAVIA	DC9-32	YU-AJR	113	N/A	0	0	0	0	0	0	0
12-Oct-76	BOMBAY, INDIA	CARAVELLE	VT-DWN	95	N/A	0	0	0	0	0	0	0
25-Dec-76	BANGKOK, THAILAND	B707-366C	SU-AXA	52	N/A	0	0	0	0	0	0	0

ACCIDENT DETAILS					Total Fatalities with latest requirements	Burn through	Cabin Water Spray Only		Cabin Water Spray & Burnthrough * = Additional lives saved by Cabin Water Spray system on aircraft configure with Burnthrouth protection			
DATE	LOCATION	AIRCRAFT	REGN.	Total fatalities		Lives Saved	Lives Saved		Lives saved		Lives saved after Burnthrough	
							Sing	Mod	Sing	Mod	Sing	Mod
		TOTAL		9736	-	207	465	587	616	756	409	549
15-Jan-77	BROMMA AIRPORT, SWEDEN	VISCOUNT	SE-FOZ	22	N/A	0	0	0	0	0	0	0
27-Mar-77	TENERIFE AIRPORT, CANARY ISLANDS	B747-206B	PH-BUF	248	248	28	28	38	68	98	40	70
27-Mar-77	TENERIFE AIRPORT, CANARY ISLANDS	B747	N736PA	335	N/A	0	0	0	0	0	0	0
04-Apr-77	NEW HOPE GEORGIA, U.S.A.	DC9-31	N1335U	62	N/A	0	0	0	0	0	0	0
11-Feb-78	CRANBROOK B.C., CANADA	B737-275	C-FPWC	43	N/A	0	0	0	0	0	0	0
01-Mar-78	KANO AIRPORT, NIGERIA	F28-1000	5N-ANA	16	N/A		0	0	0	0	0	0
01-Mar-78	LOS ANGELES, CALIFORNIA, U.S.A.	DC10-10	N68045	2	N/A	0	0	0	0	0	0	0
25-Sep-78	SAN DIEGO, CALIFORNIA, U.S.A.	B727-214	N533PS	135	N/A	0	0	0	0	0	0	0
17-Dec-78	HYDERABAD, INDIA	B737-200	VT-EAL	1	0	0	0	0	0	0	0	0
13-Mar-79	DOHA AIRPORT, QATAR	B727	JY-ADU	45	N/A	0	0	0	0	0	0	0
29-Mar-79	QUEBEC CITY, CANADA	F27	C-FQBL	17	N/A	0	0	0	0	0	0	
25-May-79	CHICAGO-O'HARE AP., ILLINOIS, U.S.A.	DC10-10	N110AA	271	N/A	0	0	0	0	0	0	0
07-Oct-79	ATHENS, GREECE	DC8-62	HB-IDE	14	6	6	4	6	6	6	0	0
26-Nov-79	JEDDAH, SAUDI ARABIA	B707-340C	AP-AWZ	156	N/A	0	0	0	0	0	0	0

ACCIDENT DETAILS					Total Fatalities with latest requirements	Burn through	Cabin Water Spray Only		Cabin Water Spray & Burnthrough * = Additional lives saved by Cabin Water Spray system on aircraft configure with Burnthrouth protection			
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							Sing	Mod	Sing	Mod	Sing	Mod
		TOTAL		9736	-	207	465	587	616	756	409	549
21-Jan-80	ELBURZ MOUNTAINS, TEHRAN, IRAN	B727-100	EP-IRD	128	0	0	0	0	0	0	0	0
27-Feb-80	MANILA, PHILLIPPINES	B707	B-1826	2	N/A	0	0	0	0	0	0	0
25-Apr-80	NR. TENERIFE NORTE AP., CANARY ISLANDS	B727-64	G-BDAN	146	N/A	0	0	0	0	0	0	0
27-Apr-80	NR. BANGKOK INT. AIRPORT, THAILAND	HS748 Ser II	HS-THB	44	N/A	0	0	0	0	0	0	0
19-Aug-80	NR. RIYADH, SAUDI ARABIA	L1011	HZ-AHK	301	201	0	151	151	151	151	151	151
19-Nov-80	SEOUL, KOREA	B747-100	HL-7445	15	0	0	0	0	0	0	0	0
27-Jul-81	CHIHUAHUA, MEXICO	DC9	XA-DEN	30	20	0	10	12	10	12	10	12
09-Jul-82	KENNER, LOUISIANA, U.S.A.	B727-235	N4737	145	N/A	0	0	0	0	0	0	0
13-Sep-82	MALAGA, SPAIN	DC10	EC-DEG	50	40	22	15	20	30	32	8	10
09-Dec-82	LA FLORIDA AP., LA SERENA, CHILE	F27A	CC-CJE	46	N/A	0	0	0	0	0	0	0
02-Jun-83	CINCINNATI INT. AIRPORT, U.S.A.	DC9-32	C-FTLU	23	16	0	0	0	0	0	0	0
27-Nov-83	MADRID, SPAIN	B747	HK-291	0	181	N/A	0	0	0	0	0	0
28-Nov-83	ENUGU, NIGERIA	F28	5N-ANF	53	40	0	0	10	0	10	0	10

ACCIDENT DETAILS					Total Fatalities with latest requirements	Burn through	Cabin Water Spray Only		Cabin Water Spray & Burnthrough * = Additional lives saved by Cabin Water Spray system on aircraft configure with Burnthrouth protection			
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							Sing	Mod	Sing	Mod	Sing	Mod
		TOTAL		9736	-	207	465	587	616	756	409	549
07-Dec-83	MADRID, SPAIN	DC9-32	EC-CGS	42	42	N/A	0	0	0	0	0	0
07-Dec-83	MADRID, SPAIN	B727-200	EC-CFJ	51	N/A	0	0	0	0	0	0	0
30-Aug-84	DOUALA AIRPORT, CAMEROON	B737-200	TJ-CBD	2	N/A	0	0	0	0	0	0	0
21-Jan-85	RENO NEVADA, U.S.A.	L188C	N5532	70	70	0	0	0	0	8	0	8
02-Aug-85	DALLAS FORT WORTH, U.S.A.	L1011-385-1	N726DA	134	N/A	0	0	0	0	0	0	0
12-Aug-85	MOUNT OSUTAKA, GUMMA, JAPAN	B747-SR-100	JA-8119	520	N/A	0	0	0	0	0	0	0
22-Aug-85	MANCHESTER AP., U.K.	B737-236 Sr1	G-BGJL	55	42	40	31	31	42	42	2	2
06-Sep-85	MILWAUKEE, WISCONSIN, U.S.A.	DC9-14	N100ME	31	N/A	0	0	0	0	0	0	0
12-Dec-85	GANDER, NEWFOUNDLAND, CANADA	DC8-63	N950JW	256	N/A	0	0	0	0	0	0	0
31-Aug-86	CERRITOS, CALIFORNIA, U.S.A.	DC9-32	XA-JED	64	N/A	0	0	0	0	0	0	0
04-Apr-87	MEDAN SUMATERA, INDONESIA	DC9	PK-GNQ	23	18	0	0	9	0	9	0	9
04-Aug-87	CALAMA, CHILE	B737-200	CC-CHJ	1	N/A	0	0	0	0	0	0	0
16-Aug-87	DETROIT	DC9-82	N312RC	154	N/A	0	0	0	0	0	0	0

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							Sing	Mod	Sing	Mod	Sing	Mod
		TOTAL		9736	-	207	465	587	616	756	409	549
15-Nov-87	DENVER COLORADO U.S.A.	DC9-14	N626TX	28	N/A	0	0	0	0	0	0	0
28-Nov-87	MAURITIUS, INDIAN OCEAN	B747-244B	ZS-SAS	159	N/A	0	0	0	0	0	0	0
26-Jun-88	HABSHEIM, FRANCE	A320-100	F-GKFC	3	3	2	2	2	3	3	1	1
31-Aug-88	DALLAS FORT WORTH, U.S.A.	B727-232	N473DA	14	11	1	0	3	1	3	0	2
31-Aug-88	HONG KONG	TRIDENT 2E	B-2218	7	N/A	0	0	0	0	0	0	0
15-Sep-88	BAHIR DAR, ETHIOPIA	B737-200	ET-AJA	35	35	0	2	4	2	4	2	4
25-Oct-88	JULIACA, PERU	F28	OB-R-1020	12	N/A	0	0	0	0	0	0	0
08-Feb-89	MT. PICO ALTO, SANTA MARIA, PORTUGAL	B707-331B	N7231T	144	N/A	0	0	0	0	0	0	0
10-Mar-89	DRYDEN, ONTARIO, CANADA	F28-1000	C-FONF	24	N/A	0	0	0	0	0	0	0
19-Jul-89	SIOUX CITY, U.S.A.	DC10-10	N1819U	111	N/A	0	0	0	0	0	0	0
14-Feb-90	BANGALORE, INDIA	A320-231	VT-EPN	92	87	0	24	35	24	35	24	35
11-May-90	MANILA, PHILLIPPINES	B737-300	EL-BZG	8	8	0	2	4	2	4	2	4
21-Nov-90	NR SAMUI AP., THAILAND	DHC8-100	HS-SKI	38	N/A	0	0	0	0	0	0	0

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							Sing	Mod	Sing	Mod	Sing	Mod
		TOTAL		9736	-	207	465	587	616	756	409	549
03-Dec-90	ROMULUS, DETROIT, U.S.A.	DC9-14	N3313L	8	N/A	0	0	0	0	0	0	0
01-Feb-91	LOS ANGELES, CALIFORNIA, U.S.A.	B737-300	N388US	22	16	0	10	10	10	10	10	10
03-Mar-91	COLORADO SPRINGS, COLORADO, U.S.A.	B737-291	N999UA	25	N/A	0	0	0	0	0	0	0
05-Apr-91	BRUNSWICK, GEORGIA, U.S.A.	EMB120	N270AS	23	N/A	0	0	0	0	0	0	0
26-May-91	PHU TOEY VILLAGE , THAILAND	B767-3Z9ER	OE-LAV	223	N/A	0	0	0	0	0	0	0
11-Jul-91	KING ABDULAZIZ AP, JEDDAH, SAUDI ARABIA	DC8-61	C-GMXQ	261	N/A	0	0	0	0	0	0	0
16-Aug-91	IMPHAL, INDIA	B737-2A8	VT-EFL	69	N/A	0	0	0	0	0	0	0
11-Sep-91	EAGLE LAKE, TEXAS, U.S.A.	EMB120RT	N33701	14	N/A	0	0	0	0	0	0	0
20-Jan-92	NR STRASBOURG, FRANCE	A320-100	F-GGED	87	N/A	0	0	0	0	0	0	0
22-Mar-92	LA GUARDIA, NEW YORK, U.S.A.	F28-4000 a	N485US	27	N/A	0	0	0	0	0	0	0
21-Dec-92	FARO, PORTUGAL	DC10-30CF	PH-MBN	56	56	0	0	9	0	9	0	9
14-Sep-93	WARSAW, POLAND	A320-211	A320-211	2	2	1	1	1	1	1	0	0

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							Sing	Mod	Sing	Mod	Sing	Mod
		TOTAL		9736	-	207	465	587	616	756	409	549
01-Feb-91	LOS ANGELES, CALIFORNIA, U.S.A.	B737-300	N388US	22	16	0	10	10	10	10	10	10
03-Mar-91	COLORADO SPRINGS, COLORADO, U.S.A.	B737-291	N999UA	25	N/A	0	0	0	0	0	0	0
05-Apr-91	BRUNSWICK, GEORGIA, U.S.A.	EMB120	N270AS	23	N/A	0	0	0	0	0	0	0
26-May-91	PHU TOEY VILLAGE , THAILAND	B767-3Z9ER	OE-LAV	223	N/A	0	0	0	0	0	0	0
11-Jul-91	KING ABDULAZIZ AP, JEDDAH, SAUDI ARABIA	DC8-61	C-GMXQ	261	N/A	0	0	0	0	0	0	0
16-Aug-91	IMPHAL, INDIA	B737-2A8	VT-EFL	69	N/A	0	0	0	0	0	0	0
11-Sep-91	EAGLE LAKE, TEXAS, U.S.A.	EMB120RT	N33701	14	N/A	0	0	0	0	0	0	0
20-Jan-92	NR STRASBOURG, FRANCE	A320-100	F-GGED	87	N/A	0	0	0	0	0	0	0
22-Mar-92	LA GUARDIA, NEW YORK, U.S.A.	F28-4000 a	N485US	27	N/A	0	0	0	0	0	0	0
21-Dec-92	FARO, PORTUGAL	DC10-30CF	PH-MBN	56	56	0	0	9	0	9	0	9
14-Sep-93	WARSAW, POLAND	A320-211	A320-211	2	2	1	1	1	1	1	0	0
10-Nov-93	SANDY LAKE, ONTARIO, CANADA	HS748-234	C-GQTH	7	N/A	0	0	0	0	0	0	0

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							Sing	Mod	Sing	Mod	Sing	Mod
		TOTAL		9736	-	207	465	587	616	756	409	549
23-Mar-94	NOVOKUZNETSK, RUSSIA	A310-304	F-OGQS	75	N/A	0	0	0	0	0	0	0
26 Apr-94	NAGOYA/KOMAKI AIRPORT, NAGOYA, JAPAN	A300B4-622R	B-1816	264	N/A	0	0	0	0	0	0	0
02-Jul-94	CHARLOTTE AIRPORT, NORTH CAROLINA	DC9-31	N954VJ	37	37	0	0	3	0	3	0	3
08-Sep-94	NR. ALIQUIPPA, PENNSYLVANIA, U.S.A.	B737-300	N513AU	132	N/A	0	0	0	0	0	0	0
21-Aug-95	NR. CARROLLTON, GEORGIA, U.S.A.	EMB120RT	N256AS	8	8	0	2	4	2	4	2	4
11-May-96	EVERGLADES, FLORIDA, U.S.A.	DC9-32	N904VJ	110	N/A	0	0	0	0	0	0	0
13-Jun-96	FUKUOKA AIRPORT, JAPAN	DC10-30	PK-GIE	3	3	0	1	1	1	1	1	1
17-Jul-96	OFF LONG ISLAND, U.S.A.	B747-131	N93119	230	N/A	0	0	0	0	0	0	0
12-Nov-96	CHARKI DADRI, INDIA	B747-168B	HZ-AIH	312	N/A	0	0	0	0	0	0	0