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BOEING

B-H300-03-JGD-023
February 28, 2003

Docket Management System
Docket No. FAA–2002–13464
U.S. Department of Transportation
Room Plaza 401
400 Seventh Street, SW.
Washington, DC 20590-0001

Subject: Comments to Docket FAA-2002-13464

Reference: Supplemental Notice of Proposed Rulemaking (NPRM), Notice 02-11, "Improved Seats in Air Carrier Transport Category Airplanes"

Dear Sirs:

Enclosed are comments from Boeing Commercial Airplanes concerning the referenced Supplemental NPRM.

Please direct any comments or questions to Ms. Jill DeMarco of this office at (425) 965-2015.

Sincerely,

Jim Draxler
Director, Airplane Certification and
Regulatory Affairs

Enclosure

cc: Aerospace Industries Association
Attention: Engineering and Certification
1250 Eye Street, NW., Suite 1200
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Boeing Commercial Airplanes
Comments on Supplemental NPRM, Notice 02-17,
Docket FAA-2002-13464
"Improved Seats in Air Carrier Transport Category Airplanes"

Executive Summary

The FAA is proposing an overwhelming investment in seating upgrades at a time when the entire commercial transport aviation industry is struggling to survive. This proposed regulation is not consistent with the Safer Skies industry-government partnership intended to direct safety investment where it has the most leverage.

The cost/benefit analysis supporting the 16g Seat Retrofit Rule must be re-examined. There are fundamental, fatal flaws in both the analysis of benefits and the analysis of costs. Re-examination of the FAA assumptions and calculations, as required by Executive Order 12866, will clearly show that the benefits are very small and disproportionate to the high costs of seat retrofit.

Finally, if the FAA finds it necessary to implement regulation for retrofit seat upgrades, current FAA policies for the certification of passenger and flight attendant seats will make this effort cumbersome and costly. There are changes to the regulatory policy that would be necessary to minimize the impact on industry without compromising the safety benefit. New policies should be in place before publication of any new regulation.

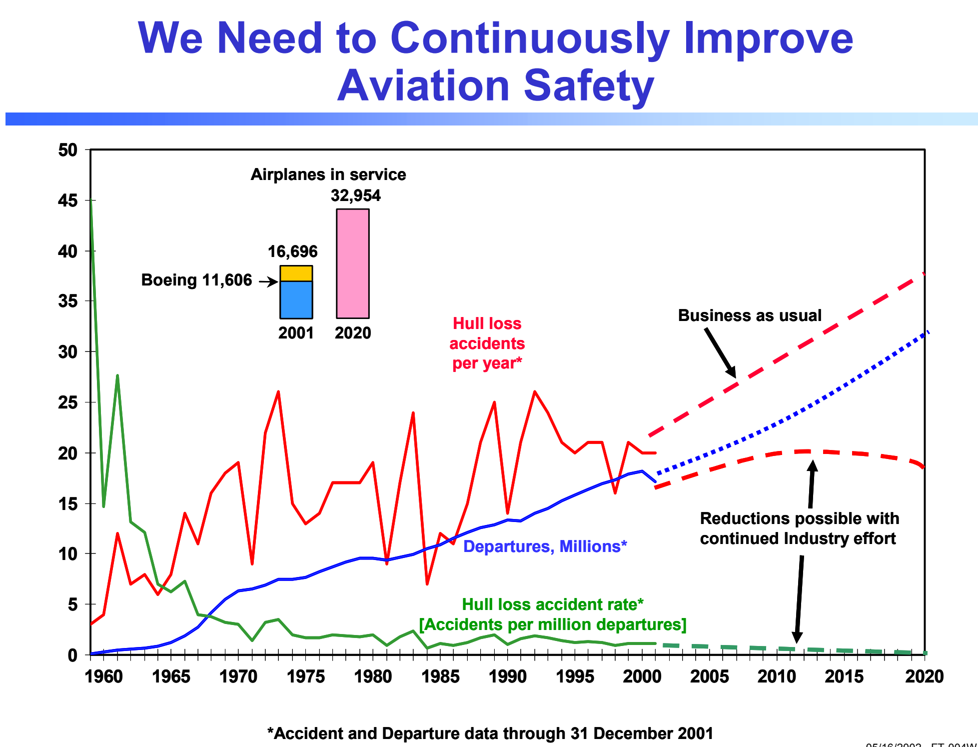
Investing in Aviation Safety

It is the common goal of airlines, airframe manufacturers, and government to provide safe, reliable air transportation to the public. This partnership in safety is the common ground on which we build the initiatives to prevent accidents and provide safer skies. Each segment of the industry must perform its role in contributing to this team: airframe manufacturers develop safe airplane designs with safety enhancing technology; operators have safe operating policy and procedures with focused training; and government provides safety regulations and services.

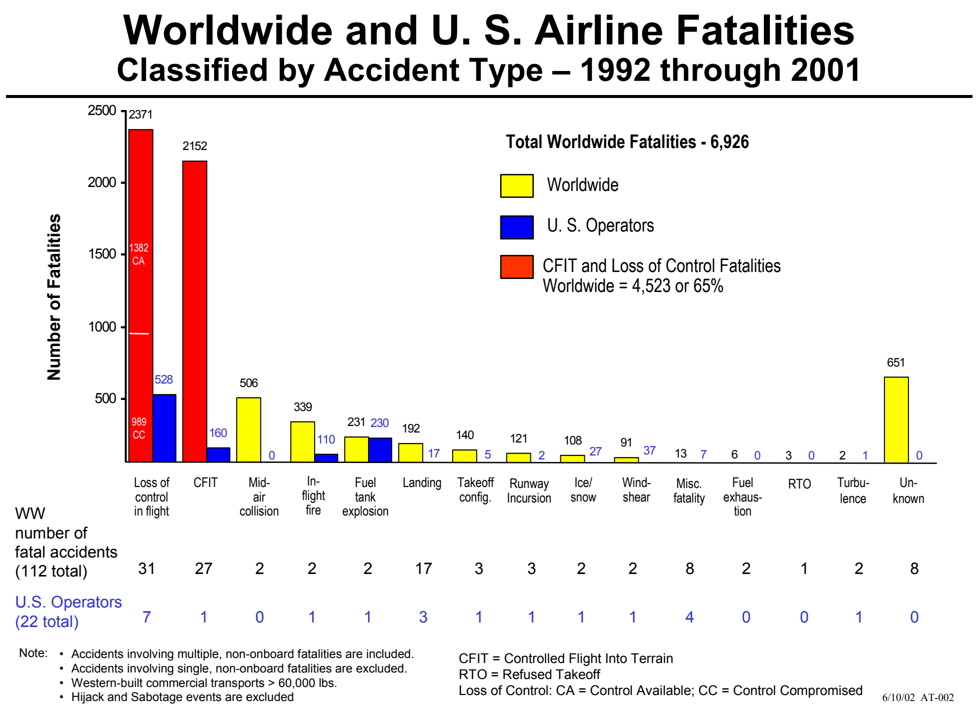
Through this industry-government partnership, accident rates have declined significantly over the past 10 years. An excellent example of this industry-government cooperation is the reduction of wind shear accidents, by combining training, aircraft technology and airport facilities to address this serious issue. Accident prevention like this provides the most value for the investment of limited resources.

For more than a year, the aircraft and airline industries have been reeling from some of the worst economic conditions in its history. Now, more than ever, it is important to invest in the safety initiatives that provide the best return. The industry-government partnership must work together to maximize the safety benefit for its investment. This is the basis for the Safer Skies initiative that provides focus on the highest regulatory priorities.

This partnership in determining priorities is driven by a fact-based approach to determine regulations and safety projects. Focused efforts have resulted in a significant reduction in the accident rate over the past decade.



In addition to the overall reduction in the accident rate, the industry-government partnership has provided focus on improvements to the most common types of accidents. These efforts have provided an improved return on the investment of the finite safety resources.



As we look toward future enhancements, we must ensure that the safety investment the industry-government partnership makes is focused on the initiatives that provide the most benefit.

Does the significant investment of government and industry resources in the 16g Seat Retrofit Rule fit within the framework established as part of this partnership? Upon inspection, it is clear that it does not. It is not part of the Safer Skies initiative and does not influence the types of accidents that have the most fatalities. In addition, Safer Skies is focused on elimination of typical approach/landing and takeoff accidents. Those accidents constitute the bulk of survivable accidents where improved seats might have their greatest benefit. Thus, any small benefits that might exist today should essentially disappear as a result of the demonstrated success of the Safer Skies initiative.

It is important to point out that seats partially or fully compliant with the dynamic seat requirements found in Federal Aviation Regulation (FAR) section 25.562 are already being introduced into service in large numbers by both the airframe manufacturers and airline operators. The FAA proposal is only directed at speeding up the introduction of these seats on some in-service and newly produced airplanes.

Benefits and Costs

The original NPRM for the 16g Seat Retrofit Rule was based on a naïve cost/benefit analysis. Industry experience over more than a decade has demonstrated that the benefits originally proposed have not been observed and the costs of compliance have been grossly underestimated. The new analysis of benefits and costs is similarly naïve.

The benefits analysis cited by the FAA has many, fundamental flaws in both the assumptions and the calculations. *Appendix A* of this document outlines many of these shortfalls. These shortfalls significantly *over-estimate* the benefits associated with the regulation. In summary, the benefits analysis:

- Vastly overstates the expectation of 16g seat performance in past accident scenarios.
- Does not take into account the decline in accident rates over the past decade.
- Does not take into account a declining future accident rate that is consistent with Safer Skies goals.
- Gives credit to seat improvements for lives already saved by other safety initiatives.
- Does not take into account the change in fleet capacity and fleet age that have occurred as a result of recent world events.

The cost analysis is similarly flawed. *Appendix B* of this document outlines many of the shortfalls associated with incorporation of this regulation for new production aircraft. These costs are *in addition to* the burden of the airlines in retrofit. The airline costs will be summarized by the ATA and submitted to the docket separately. In summary, the cost analysis ***does not*** include:

- Costs borne by the airframe manufacturer for the added complexity of the additional certification requirements.
- The impact of the regulation on aircraft structure and monuments that is currently mandated by FAA policy.
- The impact of this regulation on seating arrangements at monument locations and the cost of new technologies necessary to mitigate this impact.
- The increased weight of monuments necessary to support seats with the higher loading capability.

With the benefits over-stated and the costs under-stated, the net result is a cost/benefit ratio that does not justify the regulation. Re-examination of, and additional public comment on, both the benefits and costs is essential for ensuring the FAA can make a properly informed decision on seat retrofit.

Conclusion

The proposed 16g Seat Retrofit Rule falls short in many areas.

- It is not consistent with the Safer Skies initiative.
- It does not target accident-types that are significant for either the worldwide fleet or the U.S. fleet.
- The benefits have been miscalculated and are overstated.
- The costs are significantly understated.

Proposal

In light of the data supplied as a part of these comments, in addition to the comments from the ATA and other industry groups, the FAA should:

1) Re-calculate the benefits using appropriate factors for anticipated accident rates, fleet size, fleet capacity and realistic performance expectations for 16g seats.

2) Re-calculate the costs, including those borne by the airframe manufacturers and the airlines.

3) If, after careful consideration of the priority of this rule making and the revised cost/benefit ratio, the FAA determines that some action is necessary to upgrade seat certification, careful consideration should be made to implement the portions of the rule that have the most safety benefit while minimizing the burden on industry. *Appendix C* provides a proposal to use a standard seat track cross section to minimize the cost of seat certification over several aircraft models. *Appendix D* provides a proposal on implementing part of the proposed rule, taking full advantage of the industry-government effort on streamlining seat certification.

Boeing remains committed to aircraft safety. Data-driven safety initiatives are the key for maximizing our safety investment.

APPENDIX A

Assessment of FAA Seat Retrofit Regulatory Analysis

SUMMARY

This is an assessment of the regulatory analysis and referenced documents that were prepared by the FAA in support of Notice of Proposed Rulemaking (NPRM) Number 02-17, Improved Seats in Air Carrier Transport Airplanes. These reports are referred to in the below assessment as references (a), (b), and (c) respectively.

a. "Preliminary Regulatory Evaluation, Initial Regulatory Flexibility Determination, Trade Impact Assessment, and Un-funded Mandates Assessment for Supplemental Notice of Proposed Rulemaking: Improved Seats in Air Carrier Transport Category Airplanes", dated April 2002.

b. Final report entitled "Improved Seats in Transport Category Airplanes: Analysis of Options", dated November 2000.

c. Report DOT/FAA/AR-00/13/April 2000, "Benefit Analysis for Aircraft 16g Dynamic Seats" (Commonly referred to as the "Cherry report").

The overall methodology applied by the FAA to calculate the safety benefits of this proposed rule appears sound, however the use of outdated, misapplied, inappropriate, missing, or erroneous data in various parts of the analysis have totally undermined the validity of the results. The volume and magnitude of these errors make a strong case for a need to revise the FAA regulatory analysis, and publish it again for comment before final action is taken on the proposed seat retrofit rule.

SAFETY BENEFITS

The eight steps in the FAA benefits analysis in reference (b) is listed below. The steps that have asterisks after them are steps with one or more flaws, and will be the focus of this section of the comments.

1) *Construct an estimate of the future number of enplanements*. *
2) *Construct a baseline estimate of the distribution of seat types*. *
3) *Forecast fatality and injury rates*. *
4) *Estimate the reduction in fatalities and injuries during the study period (1984-1998) **

5) *Estimate the percentage reduction in fatalities and injuries during the study period*.
6) *Determine adjustment factors for each seat group*.
7) *Forecast baseline fatality and injury rates*.
8) *Forecast the effect of each option on the distribution of seats*.

In addition, the estimate of benefits of additional functioning flight attendants will be addressed.

1) Construct an estimate of the future number of enplanements

FAA Approach

Estimates of the number of future enplanements were derived from the *FAA Aerospace Forecasts, Fiscal Years 1999-2010*. The average annualized growth rate for the forecast period 2000-2010 was applied to years 2011-2020.

Comment

The FAA Aerospace Forecasts has been updated March 2001 for the years 2001-2012, in which the future number of enplanements has been slightly decreased due to the slowing world economy. This forecast does not take into account the effects of the Sept. 11, 2001 terrorist attacks on US transport aviation.

Recommendation

The benefit analysis should be updated to reflect new future enplanement estimates, either from the 2001 report, or preferably an estimate based on 2002 data.

2) Construct a baseline estimate of the distribution of seat types

FAA Approach

This analysis divides the projected population of seats into different groups depending on the date of aircraft manufacture and the projected date of seat replacement. The distribution of enplanements across seat groups is assumed to be proportional to the number of seats in each group. Replacement seats are distributed according to the estimated proportion of full 16g, partial 16g, and 9g seat certification programs. For example, if 10% of seat certification programs are 9g, it is assumed approximately 10% of seats installed or replaced will be 9g.

Comment

The current Part 121 fleet has changed dramatically since the terrorist attacks of Sept. 11, 2001. Many airlines are retiring their oldest airplanes due to industry overcapacity. Most likely these airplanes have 9g seats.

Recommendation

Benefit analysis revised to reflect changes in Part 121 fleet. See comments submitted by the ATA.

3) Forecast fatality and injury rates

FAA Approach

This analysis postulates that the projected rates of fatalities and injuries per enplanement during the forecast period are equal to the rates observed during the period 1984-1998 (U.S. 14 CFR part 121 fleet only). Key assumptions:

1) The rate is assumed to reflect a 9g baseline,

2) No improvements in historical fatality or injury rates are expected to occur during the forecast period

3) The risk reduction potential of 16g seats is not expected to improve (e.g., due to the introduction of additional cabin safety measures).

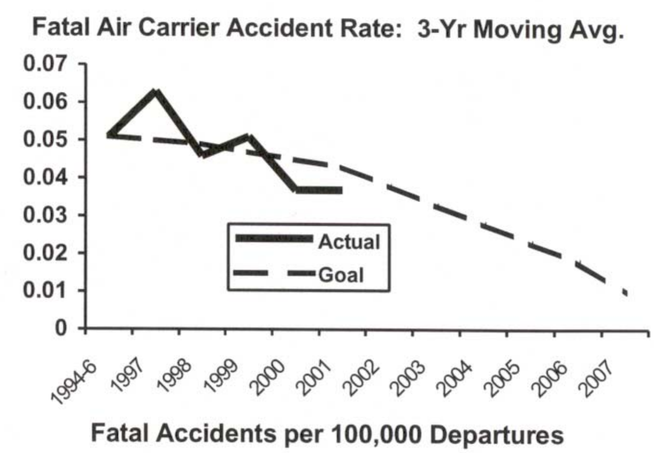
> *Example: Three-hundred-and-twenty-nine (329) injuries were recorded during 14 CFR part 121 operations during the study period (1984-1998—see Table II.3 of this document). In the same period, part 121 operators accumulated 7540.9 million enplanements. Therefore, the historical (and projected) rate of injuries is 329 ÷ 7540.9 = 0.0436 per million enplanements.*

Comment

The key assumption that is most questionable is #2. It is quite puzzling why the FAA chose not to acknowledge the impressive improvements in transport aviation safety in the United States. Table II.3 on page 19 of reference (b) presents the scheduled and nonscheduled air carrier accident and activity data for the years 1982-1998, and cites the NTSB website as the basis of that data. The table shows the number of accident fatalities and serious injuries that occurred in each year, along with the number of departures and enplanements. This enables the calculation of average rates of fatalities and serious injuries per departure and enplanement. For the study period (1984-1998), the FAA calculated that 7.5409 billion departures had occurred and that there were 329 serious injuries and 2163 fatalities aboard air carrier airplanes. That yields a fatality rate of 0.2868 and a serious injury rate of 0.0436 per million departures, which formed the baseline for the regulatory analysis.

The accident statistics used by the FAA to support this proposal are not consistent with existing safety improvements and accident rates. The FAA analysis assumes a constant level of safety for the period 2000 -2020 that is equal to the overall level of safety in the U.S. between the years 1984 and 1998. That assumption does not recognize that the fatal accident rate, as measured by the FAA using a three-year rolling average, has been consistently declining since 1990 (almost in a linear manner). The NTSB data shows there has been a 50% reduction in the three year rolling average fatal accident rate during the eight-year period between 1990 and 1998, and another 50% reduction between 1998 and 2000. With the accident rate steadily declining during and after the FAA study period, a more accurate baseline of the average fatality and serious injury would be the three-year average for the years 1998 to 2000, which is 0.0508 fatality rate and 0.0286 serious injury rate per million departures. This would be consistent with the FAA's 2002 Strategic Plan. Accident and departure data from 2001 could also be used, however the period after the terrorist attacks of September 11 would have to be excluded from the evaluation due to its unprecedented effect on U.S. transport aviation.

Below is a figure plotting the three-year rolling average of commercial air carrier fatal accident rate for the period 1994 to 2001 (page 9 of the 2002 FAA Strategic Plan). This plot, with the exception of 1997, shows a decreasing accident rate and it is logical to assume that the death and serious injury rate would also be declining over that period.



In addition, it is unreasonable to think the FAA would be satisfied with even a constant accident rate from 2007 to 2020. The regulatory analysis should be based on the FAA published goals of accident reduction up to 2007 and a reasonable linear reduction of accidents through 2020. Again, this more appropriate approach will further significantly reduce the possible benefits associated with the proposed seat retrofit.

Recommendation:

The regulatory analysis used to support the FAA proposal must start with a three-year rolling average accident rate that exists at the time of the regulatory analysis and account for an ever decreasing accident rate from that time forward. With all of the emphasis on reducing the accident rate embodied in the FAA Safer Skies effort, the regulatory analysis must be revised to match FAA published safety goals. Therefore, the analysis should use a 0.0508 fatality rate and 0.0286 serious injury rate as a baseline for calculating potential benefits.

4) Estimate the reduction in fatalities and injuries during the study period (1984-1998)

FAA Approach

The benefit analysis depended upon accidents that are not well correlated with the types of accidents where 16g seats would have been an influence in saving lives. *Example: Based on the Cherry analysis (part 121 benefits based on worldwide fleet accident characteristics), the fleet wide use of full 16g seats would have averted 79 injuries (net) during the study period*.

Comment

The Use Of Accidents Where Survivability Was A Matter Of Chance

In developing the 16g seat standards, the FAA only addressed certain types of survivable accidents:

- Ground-to-ground accidents, such as take-off abort or landing overrun, which occur at a low forward speeds of 40 to 130 knots, with the landing gears extended and the airplane in a level and symmetrical attitude.
- Air-to-ground hard landing accidents, such as touchdown just short of the runway. On the average, the sink rate was in the vicinity of 17 feet per second and the forward velocity was in the range of 126 to 160 knots. The airplane was assumed to land in a nose-up symmetrical attitude ranging from zero to 14 degrees.
- Air-to-ground impact accidents on hard or soft ground with a sink rate in the range of 33 feet per second and a forward velocity in the range of 126 to 160 knots. The airplane was assumed to land with the gears extended or retracted in an unsymmetrical attitude of plus or minus 10 degrees of roll or yaw, in addition to a pitch attitude from zero to 14 degrees.

The 16g seat standards are a safety improvement for many types of accidents that closely parallel those listed above. In its past rulemaking the FAA addressed “survivable accident scenarios,” where the airplane structure remains substantially intact and provides a livable volume for the occupants throughout the impact sequence. In its Part 25 seat rulemaking, the FAA did not use accidents to support its regulatory proposal where survivability was a matter of chance. Since this was the basis of the Part 25 seat standards, then any accidents where passenger survivability was a matter of chance should not be used to justify the retrofit of those Part 25 seats. The Cove Neck and Sioux City accidents, found in the Cherry report study of 25 accidents, are examples of accidents that are atypical of those used to justify the Part 25 seat standards. It is recognized that 16g seats might, by chance, improve the survivability of passengers in severe accidents, as does the basic airplane structure in some cases. It is inappropriate, though, to use these severe accidents to justify the need for equipment that was not specifically designed to be effective in these severe events.

Double Counting Of Benefits

In any regulatory analysis it is important to ensure that the benefits assumed for the proposed regulatory action have not already been used to justify other regulations or safety programs imposed by the FAA. A subset of the accident scenarios that were used to justify 16g seats in Part 25 would include controlled flight into terrain (CFIT), windshear, takeoff with improper flap/slat settings, and approach and landing accidents. Several of these accident types have already been used to justify regulatory actions so it is inappropriate to use these accidents in further benefit analyses. A good example is the TAWS regulations that were issued to eliminate the CFIT accidents and the windshear detection equipment and mandatory training requirements imposed to eliminate windshear accidents. In calculating the average fatality and serious injury rates in the U.S. for the basis of comparison with world rates, it is essential to remove any accidents that would result in a double counting of benefits. Such accidents should also be removed from the 25 used in the Cherry report to calculate specific benefits for the seat retrofit rule.

Analysis of the Cherry Report 25 Accidents

It must be said that the Cherry report did an excellent job assessing the survivability of an accident by scenarios, however the assessment of whether the use the 16g seats would have actually improved the number of fatalities and serious injuries is inadequate. The assessment approach described by the Cherry report sounds nothing more than guesswork.

> *Example: "It is assessed that around half of the fatal injuries would be reduced to serious injuries and that the other half would be reduced to minor or no injuries. Furthermore, it is assumed that all adult serious injuries would be reduced to minor or no injuries. " (Assessment of Scenario 3 of the Cove Neck accident).*

There is no analysis to determine whether the types of injuries seen by the passengers would have been mitigated by the specified performance standards outlined in FAR 25.562(c), or that the loads seen by the seat structure were at or below loads defined in FAR 25.562(b). Therefore, the quantitative assessment of benefits in the Cherry report is highly questionable. Further analysis is needed for those scenarios where it is speculated that 16g seats would mitigate injuries and fatalities.

The Cherry study started with 393 impact-related accidents and was quickly whittled down to 25 accidents that were applicable to this study. Of the remaining 25 accidents, only two, an MD-11 accident near Shemya, Alaska, and a 707 accident in Cove Neck, NY were estimated to have significantly benefited by the use of 16g seats. The results of the benefits analysis was heavily biased on the Cove Neck, NY accident benefits estimate, as the Cove Neck accident accounted for 37% of the estimated fatalities avoided and 32% of the estimated serious injuries avoided. The Shemya, AK accident accounted for 38% of the estimated serious injuries avoided.

Cove Neck, NY

In this case a foreign registered airplane crashed into a residential area after running low on fuel. The accident investigation by the FAA led to the creation of their present

International Aviation Safety Assessment (IASA) Program whereby air carriers operating into the U.S. are assessed for their compliance with minimal International Civil Aviation Organization (ICAO) standards. The FAA also proposed that ICAO conduct its own assessment of countries to make sure they meet minimum ICAO standards, which ICAO implemented. As a result of those actions, there have not been any further accidents of this type in the U.S. This accident should not be used to justify the seat retrofit rule because the lives lost have already been counted in justifying the IASA Program, and this type of accident has virtually been eliminated in the U.S.

Also, the type of impact characteristics the airplane experienced in the Cove Neck accident are more severe than those outlined in the development of the rule and mentioned earlier. The airplane impacted and slid up a wooded hillside, impacted multiple trees, and broke into multiple pieces. Whether the improvement of the seats would have mitigated the severity and number of injuries is undetermined.

Shemya

This accident was caused by the inadvertent deployment in flight of the leading edge slats on an MD-11. The slat deployment resulted in significant pitch oscillations of the airplane, exacerbated by pilot induced inputs, which resulted in significant injuries in the rear of the airplane.

In investigating the accident the FAA discovered other slat deployments had occurred on American Airlines MD-11 airplanes and in all cases the wild oscillations that occurred in the Shemya accident never occurred in the American incidents. Differences in crew training and regulatory differences between the U.S. and the country or registry of the airplane involved in the Shemya accident are at least two obvious reasons for the different results give the same airplane malfunction. Since similar accidents did not occur in the U.S. under identical situations, what occurred on this foreign airplane is not a good predictor of accident potential in the U.S.

It is also important to note that the airplane accelerations never exceed 3g. In addition, the persons that were injured either did not have their seat belts buckled or they did have them buckled and were injured by passengers and other objects that were airborne in the cabin. It is difficult to see how 16g seats would have prevented any of the injuries.

As a result of this accident there was regulatory action taken, in the form of an airworthiness directive, to change the design of the slat deployment system to virtually eliminate this type of accident from occurring in the future. Since this accident was already used to justify regulatory action, its use to justify seat retrofit amounts to a double counting of safety benefits. In addition, future type certifications will use the lessons learned from this accident to ensure that new airplanes do not suffer the same fate.

Its also curious that the benefits analysis used the high benefit estimates of the Cherry report due to possible unmeasured benefit of “better than 9G” seats. There were only 25 accidents analyzed in the Cherry report, and from a quick overview many of those airplanes most likely did not have “better than 9g” seats (DC9, DC10, F28, L1011, etc.). Others such as accidents involving 737s did not have enough impact loads for 16g seats to make a difference. Five accidents definitely involved “better than 9g” seats (Kegworth and the 4 A320 accidents). Therefore, any unmeasured benefit of “better than 9g” seats should be specific to those five accidents.

Recommendation:

The Cherry report needs to be thoroughly revised to:

1. Eliminate accidents where survivability was a matter of chance
2. Eliminate accidents where the benefits of preventing fatalities and injuries have already been counted in previous regulatory action
3. Do a more thorough job in assessing the effect of 16g seats in mitigating fatalities and serious injuries.

5) Benefit of additional functioning flight attendants

Boeing agrees with the FAA's position that flight attendants play a crucial role in the protection and expedient evacuation of passengers and crew from an accident. What Boeing would like to see revised in this part of the analysis is the following:

1. The Cherry report focused on passenger seats. No analysis was completed on the possible benefits of retrofitting 16g flight attendant seats. The FAA's assumes that since the ratio of flight attendant seats to passenger seats is 1 to 50, the benefits are also 1 to 50. Flight attendant seats are significantly different to passenger seats in terms of seat construction, mounting structure (many are wall mounted), type of restraint (shoulder harness in addition to lap belt), and direction (a significant number are aft facing). To properly account for the benefits of retrofitting 16g flight attendant seats, a thorough benefits analysis of retrofitting flight attendant seats must be performed.

2. The FAA has not sufficiently documented the justification in the Federal Register. In order for the public to fully understand the formulation of the FAA's estimated benefits, additional documentation is required

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Summary of All Benefits Recommendations

Re-calculate the benefits by addressing the following issues:

- Update the enplanement estimates used, either from the 2001 report, or preferably an estimate based on 2002 data.
- The analysis should reflect the changes in the Part 121 fleet. See comments submitted by the ATA.
- The analysis should use a 0.0508 fatality rate and 0.0286 serious injury rate as a baseline for calculating potential benefits.
- Eliminate survivable accident types in the benefit analysis that are substantially different than the ones used to define the dynamic loading conditions of FAR 25.562 (survivability a matter of chance).

- Accident types that have already been used to justify previous regulatory actions should not be used in this benefit analyses.

- For the accidents where the implementation of 16G seats has the potential to mitigate injuries, further analysis is required to quantify benefits.

- Calculate the benefit of 16g flight attendant seats in the same manner as the passenger seat analysis.

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APPENDIX B

Additional Costs for Production Incorporation of the 16g Seat Retrofit Rule

At the FAA's public meeting held on December 8-9, 1998, the Aerospace Industries Association (AIA) provided extensive information on the cost impact of the proposed rule on the aviation industry. Our comments in this appendix are intended to supplement those AIA comments by highlighting some of the major cost categories that were omitted from the FAA cost analysis and the consequent order of magnitude of the FAA's omission.

In addition, it is important to note that the costs categories highlighted here only address the impact to the airframe manufacturer for new production airplanes. The more significant cost impact will be to the airlines. Please refer to the comments from the Air Transport Association (ATA) on this rulemaking, submitted separately, for detailed airline costs. The information outlined here is in addition to the ATA cost calculation.

- ***Taking advantage of the Seat Streamlining activity***

  The SNPRM has clearly stated that the cost of seat certification now is lower than in past years due to the FAA-Industry Seat Certification Streamlining activities. Although the industry is committed to working closely with the FAA to improve the seat certification process, the efforts over the past several years have ***not*** materially improved the cost or flow time to certify seats. Before the FAA can take the benefit from these activities, it is important that it be based on demonstrated results.

- ***Costs borne by the airframe manufacturer for the added complexity of the additional certification requirements.***

  Certification to the dynamic requirements of FAR 25.562 is more complex and time consuming than certification to the static testing requirements. This added complexity takes more time and resources for the airframe manufacturer as well as the seat supplier and the airlines. This complexity-factor is overlooked in the FAA cost analysis.

- ***The impact of the regulation on aircraft structure and monuments that is currently mandated by FAA policy.***

  FAA policy requires that the attachment of a flight attendant seats to the aircraft structure be substantiated to the dynamic loads of FAR 25.562. This requirement has had two primary impacts to monument design that the FAA has overlooked in the cost analysis:

  1. The walls of lavatories, galleys and closet must be modified to have additional load carrying capability. Even though only the attendant seat and

attachment bolts need to be dynamically tested, the monument walls must meet a minimum strength requirement that is driven by the flight attendant seat dynamic response. If this requirement is replicated in the 16g Seat Retrofit Rule, monuments on many aircraft models would need to be modified or replaced.

2. Wind Screens and Partitions are required by FAA policy to be dynamically tested along with the flight attendant seats (reference FAA letter 92-120S-20). This policy has led to a great deal of certification complexity. All partitions have had to be redesigned and tested in order to comply with the policy. In addition to the cost and flow time of testing, partitions that meet the dynamic testing requirements are thicker, having an impact to nearly every airplane interior configuration in which they are installed. Because the flight attendant seat and partition are tested as a system, any changes to one or the other will require re-testing of the two together. For example, changing a piece of emergency equipment mounted on the partition has the potential to require the seat/partition system to be dynamically tested again. This policy is not accounted for in the FAA cost analysis and has the potential for a very large cost impact in new production aircraft and in retrofit applications.

- ***The impact of this regulation on seating arrangements on monument locations and the cost of new technologies necessary to mitigate this impact.***

It is clear, based on over a decade of experience installing 16g seats in new production aircraft, that the occupant injury requirements (specifically row-to-row and front-row HIC) have an impact on airplane configurations. Row-to-row HIC can require changes to the seat pitch (spacing) to accommodate available test data. Front row HIC can require the front row seats to move aft in the aircraft cabin to make room for the occupant head path, or in some cases removing a row of seats from the cabin to create enough room. These regulatory impacts have not been accounted for in the FAA cost analysis, but are easily foreseen in the retrofit application of the 16g rule.

In order to mitigate these impacts, the development and installation of new technologies will be required. The FAA identified industry efforts to develop these technologies (seat-belt airbags, energy absorbing pads, etc.), but did not include the cost of development, certification or installation as part of the impact of this rulemaking.

- ***The increased weight of monuments necessary to support seats with the higher loading capability.***

As mentioned above, there will be an expected impact to the design of monuments in the cabin associated with implementing the 16g Seat Retrofit Rule. The FAA policies associated with flight attendant seat upgrades and testing will definitely increase the weight of the monuments that the flight attendant seats are mounted upon. This weight increase should be accounted for in the final rule making cost analysis.

APPENDIX C

Selection of a Standard Aircraft Seat Track Cross-Section for Dynamic Testing

Section C1 - Cross-Section Selection

The current policy used for certification to FAR 25.562 requires that the seat be dynamically tested on the most critical seat track that those seats will be installed on. At this time, the industry is unable to test using only one seat track, because each airframe manufacturer has its own track cross-section. We recommend that one seat track be chosen as a “standard track” for dynamic test purposes. This would reduce the number of required tests for certification of seats, while still allowing the seat to be fully substantiated for the dynamic loads. The suppliers would be able to evaluate the criticality of their testing, and test only one track set up, covering all seat track installations.

Use of a standard seat track is consistent with the development of 25.562. After a series of tests and analysis, the FAA determined that two types of dynamic tests would be representative of all survivable crash scenarios (reference FAA document DOT/FAA/CT-88/15, dated March 1990). It is clearly understood that the two tests do not replicate all airframe types and loading scenarios. Two standard tests were developed as a benchmark to improve seat strength. Furthermore, the 50% Anthropomorphic Test Device (ATD) was specified because it was a standard used to represent a broad spectrum of seated occupants. Using a standard aircraft seat track is consistent with these fundamental parts of the FAA requirement.

In order to be consistent with other conventions of dynamic testing and certification of seats, we propose that an average track crown be defined. We propose that the requirements of the 16g Seat Retrofit Rule should allow a specific seat track crown section to be used for all certification testing and compliance findings.

As a first step in the creation of a “standard track” cross-section, a method has been developed to evaluate the in-service fleet of airplanes to determine an “average” seat track cross-section. To start this process, an evaluation was conducted of all Boeing and McDonnell Douglas production and post-production models currently used for passenger service, and the most critical seat track cross-section has been documented for each of these. In this evaluation the track crown was evaluated per the guidance in AC 26.562-1A, section 10(b)(3), and summarized per airplane model for which the track was the most critical for testing. An evaluation was then completed for each of these cross sections, and the crown sections were ranked according to the method noted in section C2 of this Appendix. (The rating is based on the cross section and material properties of a single lip.) These rating factors were used to compare each track crown. Table C1 presents the Track Rating as a function of the airplane model.

To determine the amount of each seat track type in the fleet, the evaluation considered all currently active Boeing and McDonnell Douglas passenger carriers. The evaluation did not include airplanes manufactured by other companies (Airbus, Lockheed, etc.), in use by the military, NASA, cargo carriers, or aircraft originally designated as freighters. From this data, a determination was made for the length of seat track (in feet) currently in service.

Using both the Track Rating, and the Total Track Length, a determination was made that the average track would have a rating of approximately 2,600. This was derived by taking the summation of each track length multiplied by its rating, and dividing that by the summation of the track lengths. [Σ(length x rating)/ Σ (length)].

It is worth noting that some of the post-production models may never be retrofit with new seats and may be dropped from the evaluation, but for this exercise they have been included. Many of the tracks have similar ratings and the airplane quantity helps illustrate the impact that use of airplane specific seat track would have on increasing the number of tests required to show compliance for a particular seat model that has multiple installations.

The data in Table C1 provides a wide cross-section of the track used in the worldwide fleet. Although not inclusive of every aircraft model type, it provides a broad enough view to allow for the selection of an industry standard track.

Table C1

Aircraft Model	Total Aircraft Quantity	Total Track Length (Feet)	Track Rating Factor
707	0		
717	110	29,150	2200.8
727	1000	335,960	3487.9
737 Classic	2890	711,956	3487.9
737 Next Gen.	1241	380,502	3487.9
747 Post-Prod.	448	448,323	876.6
747-400	510	755,484	2248.3
747-400 Combi*	69	4,416	876.6
757-200	903	391,902	3487.9
757-300	38	20,039	3487.9
767-200/-300	799	700,450	2248.3
767-400ER	37	40,466	3971.2
777	424	486,725	3971.2
DC-10	155	166,889	697.7
DC-8	78	31,106	2332.1
DC-9	621	466,693	2200.8
MD-11	106	129,882	697.7
MD-80	1166	435,086	2200.8
MD-90	115	45,805	2200.8

** The Model 747-400 Combi has a short section of track in the aft section that does not exist on the standard passenger airplane.*

There are several options for the selection of a standard track to use for certification testing. Two types of Boeing track would include extrusion BAC1520-1547 currently in use by the 747, and extrusion BAC1520-2357 (if made of aluminum 7150-T77511) used by the 767, The FAA should develop a proposed standard track for industry use by considering a broader spectrum of track types. Boeing will provide assistance upon request.

With some of the current production airplanes having a track lip that is rated higher than the proposed “standard seat track”, there is a possibility that a currently certified seat may have taken advantage of the higher seat track lip strength. As a result, the FAA should allow a seat to be either certified using the standard seat track, allowing installation on all aircraft types, or to a higher-rated track with an installation restriction for that type of aircraft.

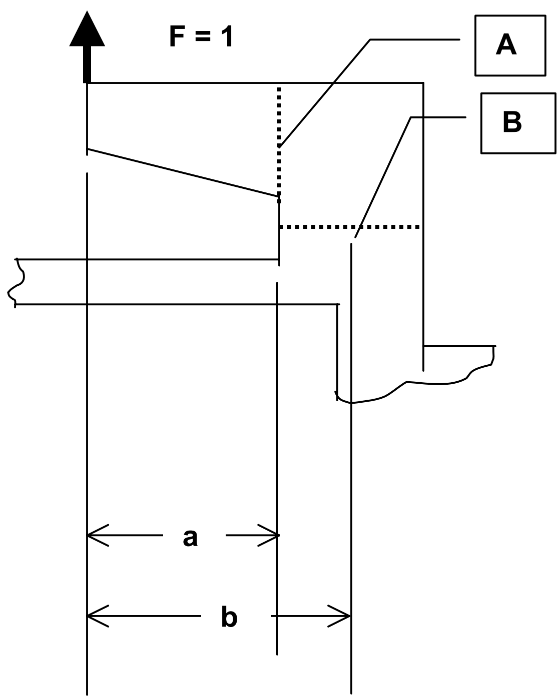
Section C2 – Calculation of Seat Track Rating Factor

Procedure for calculating the Rating Factor of a seat track lip:

Ref. [1]: *Roark's Formulas for Stress & Strain – Sixth Edition*

- Assume the track lip to be subject to a Unit Force as shown in Figure C1.

Figure C1



(Fillets not shown for clarity)

- The track strength is evaluated at the Sections **A** and **B**
- At the sections under evaluation the Unit Force shall give the Bending Moments

$$\mathbf{M_A = a} \quad \text{and} \quad \mathbf{M_B = b}$$

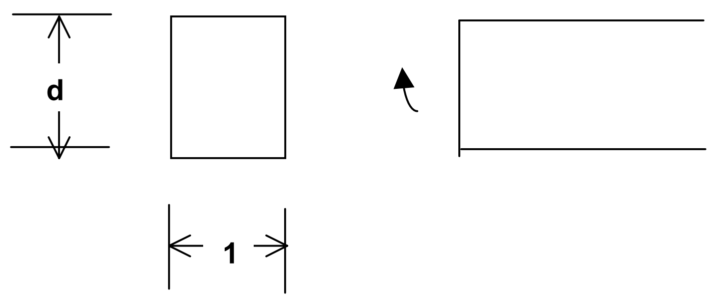
- From Ref. [1], Sec. 7.15, page 217, the Maximum Bending Moment that the section can bear is

$\mathbf{M_P} = \sigma_y Z$ where Z is the *Plastic Section Modulus*
and σ_y is the tensile yield stress

- From Ref. [1], Table 1.2, a rectangular section having base **1** and height **d**, loaded as shown in Figure C2 has a *Plastic Section Modulus* given from

$$Z = \mathbf{0.25\ d^2}$$

Figure C2



- The Rating Factor is the minimum, among critical sections, of

$$\mathbf{RF = M_P / M}$$

Note:

- Any consistent set of units can be used.
- Yield Stress has to be taken in the Long Transverse Grain direction.
- Yield Stress is taken for every section, according to local thickness.

APPENDIX D

Proposed Alternate Rulemaking Concept that Maximizes the Certification Streamlining Effort

With over a decade of experience certifying 16g seats, there are many factors that drive up the cost of certification without any significant safety benefit. The best efforts to date in improving and streamlining the certification process have revolved around allowing the seat design and the seat installation certifications to be independent of each other. Once this happens, incremental improvement to these efforts can happen between the certification applicant and the local regulatory agency.

The seat design is certified by meeting a Technical Standard Order (TSO). The industry has been working closely with the FAA to improve this process. Further to that improvement, Appendix C contains a proposal to use a standard seat track for dynamic testing. This will allow seat models to be tested on one type of track and used on multiple aircraft installations.

If the FAA determines that seat upgrades are necessary in light of an accurate cost/benefit analysis, the following is proposed:

Passenger Seats

It would be reasonable to require that, after four years from the date of rulemaking, new seat part numbers installed on new production aircraft be required to meet the minimum requirements of TSO C127. This would ensure that any new seat family installed in new production aircraft has been dynamically tested.

In order to minimize the impact on the industry, it is further proposed that the installation limitations relative to seat dynamic testing be consistent with the Aircraft Type Certificate. For example, aircraft that have partial FAR 25.562 compliance as part of their certification basis would continue to install the TSO C127 seats to those same requirements. Aircraft that already meet full FAR 25.562 compliance would continue to do so.

It is important to note that the installation-unique aspects of 25.562 significantly drive up the cost of certification without the comparable increase in benefits. The intent here is to have “design approval” of a 16g seat without the corresponding installation related issues driven by current policy. This will ensure the seat models have been dynamically tested to the 16g forward and 14g down criteria, which is the intent of the rule.

Flight Attendant Seats

Boeing already installs TSO C127 flight attendant seats on all new production aircraft. As with passenger seats, it is proposed that any Part 121 requirement levied on new production aircraft allow for the installation of TSO C127 flight attendant seats.

Current policy for full compliance to FAR 25.562 requires upgrade of the monuments that the flight attendant seat mounts upon. This violates the assumption in the SNRPM about minimizing the impact to the aircraft structure. Any implementation of flight attendant seat upgrades should explicitly exclude an upgrade requirement for galleys, lavatories, partitions or other items that the attendant seat is mounted upon.

These comments only apply to new production aircraft. The ATA will provide comments on the practical aspects of retrofitting flight attendant seat in service.

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