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U.S. Departmerit
of Transportation

FEDERAL AVIATION ADMINISTRATION

Washington, D C 20591

FAA-1999-6482-3

PRELIMINARY REGULATORY EVALUATION, INITIAL REGULATORY FLEXIBILITY ANALYSIS AND TRADE IMPACT ASSESSMENT

FOR

PROPOSED RULE:

REVISIONS TO DIGITAL FLIGHT DATA RECORDER RULES FOR BOEING 737 AIRPLANES AND FOR PART 125 OPERATIONS

OFFICE OF AVIATION POLICY AND PLANS
AIRCRAFT REGULATORY ANALYSIS BRANCH, APO-320
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August 1999

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EXECUTIVE SUMMARY

In the past 10 years, there have been two Boeing B-737 accidents for which the National Transportation Safety Board (NTSB) could not completely determine the cause of the accident. On March 3, 1991, United Airlines Flight 585, a Boeing B-737-291 crashed during an approach to the Colorado Springs, Colorado airport causing the deaths of all 25 passengers and crew. The airplane was destroyed by the impact and a post-crash fire. Three years later, on September 8, 1994, USAir Flight 427, a Boeing B-737-3B7 crashed while on approach to Pittsburgh International Airport, causing the deaths of all 132 passengers and crew. The airplane was destroyed by the impact.

The NTSB believes that if the B-737s recorded additional flight data parameters then there would be a lower likelihood that the cause of a future B-737 accident would remain undiscovered. Consequently, the NTSB issued recommendations on April 16, 1999, that all existing and future B-737 airplanes should be required to record the flight data parameters represented by the existing § 121.343 (a)(18) through (a)(22), (a)(88), and 3 new parameters that would become (a)(89), (a) (90), and (a) (91).

The proposed rule would require all B-737s flight data recorder systems to be retrofitted in order to record these flight data parameters. The proposed rule would affect 1,306 existing B-737s operated by 24 airlines, 3 foreign airlines, and 16 other private businesses. Nearly 80 percent of these airplanes are operated by 7 airlines (Southwest, United, USAirways, Continental, Delta, America West, and Alaska Airlines).

The costs of compliance include only the direct costs of complying with the proposed rule. No costs resulting from future rules that would be developed based on the data collected due to this proposed rule are Included in these estimated compliance costs. On that basis, the estimated compliance cost varies by B-737 series, by date of manufacture, and by the existing capability of the flight data recorder system in the airplane. For airplanes with a flight data acquisition unit, the per airplane costs would range from about $42,000 to $110,000. For airplanes without that unit, the per airplane costs would range from about $178,000 to $222,000. A substantial source of these costs is that the airplane would need to be taken out of service and the amount of out-of-service time, if not completed during a regularly scheduled major maintenance session, would take between 4 days and 9 days - depending upon the series and the flight data recorder system's capabilities.

The one-time, first year cost of this retrofitting would be about $160 million; of which $125 million would be for the labor and equipment costs, $25 million would be for the net revenue losses due to the out-of-service time, and $10 million would be for the engineering costs to redesign the flight data recorder system for the various B-737 series and airlines and to obtain the necessary supplemental type certificates.

There would be additional annual expenses for maintenance and for increased fuel burn due to the greater weight of the modified flight data recorder systems. The present value of these costs over 20 years would be about $5 million.

Finally, the cost to manufacture the average B-737 would increase by about $39,000, which would have a present value cost of about $40 million over the next 20 years to the approximately 2,150 B-737s expected to be sold in the United States.

In 1997, the FAA revised these flight data recorder rules for all affected airplanes, including B-737s. The FAA has calculated that the present value of the costs for B-737 operators to comply with that revision were about $58.8 million. If that revision and this proposed rule are viewed as two parts of one rulemaking over time, the FAA has estimated that the present value of the overall compliance costs with these two actions would be about $264.1 million for the B-737 operators and for Boeing.

Thus, the estimated present value of the total costs over 20 years of the proposed rule would be about $205 million.

The benefits from preventing a typical B-737 catastrophic accident are about $315 million. However, these potential benefits are difficult to quantify because it cannot be known with certainty whether the additional flight data to be recorded would, in fact, provide the necessary information to prevent such future accidents. With that in mind, the FAA has determined that the proposed rule would be cost beneficial if it would prevent one such accident in the first 6 years after its promulgation.

The proposed rule would be a "significant regulatory action" as defined by Executive Order 12866 and it has a significant impact upon a substantial number of small airlines. It would have minimal effects on international trade. Finally, it would not contain a significant intergovernmental mandate but it would contain a significant private sector mandate by imposing a cost of more than $100 million in one year.

I. INTRODUCTION

A. BACKGROUND

In the past 10 years, there have been two Boeing 737 (B-737) model airplane accidents for which the National Transportation Safety Board (NTSB) could not definitively establish a cause. On March 3, 1991, United Airlines Flight 585, a Boeing B-737-291 crashed during an approach to the Colorado Springs, Colorado airport causing the deaths of all 25 passengers and crew. The impact and the post crash fire destroyed the airplane. Three years later, on September 8, 1994, USAir Flight 427, a Boeing B-737-3B7 crashed near Aliquippa, Pennsylvania, while on approach to Pittsburgh International Airport, causing the deaths of all 132 passengers and crew. The impact and the post crash fire destroyed the airplane. Both accidents appear to have been caused by a rudder hardover roll and resultant sudden descent while the airplanes were at low altitude.

The NTSB has determined that the rudder on B-737 airplanes may experience sudden uncommanded movement or movement opposite the pilot's input, which may cause the airplane to roll suddenly. In addition, foreign investigative authorities suspect that two accidents outside the United States involving B-737 airplanes may also have been caused by sudden uncommanded rudder movement. Incidents of suspected uncommanded rudder movement continue to be reported, including two incidents in the United States in February and March 1999, and one in Canada in March 1999.

The B-737 airplanes involved in the United and USAir accidents and in the recent rudder incidents were equipped with the flight data recording (FDR) systems required at the time of those accidents, but neither of the FDR systems provided information about the airplanes' movement about their three axes or the positions of the flight control surfaces immediately preceding the accidents or incidents. To date, corrective measures taken to resolve the suspected problem have been limited by the lack of data being recorded.

The FAA has issued 17 airworthiness directives (ADs) for the B-737 as a result of the investigation into the USAir accident, including one that addresses an upgraded rudder power control unit (PCU) designed to remedy the rudder upset problem. Suspected rudder upsets continue to occur, however, and some of the B-737 airplanes that recently experienced suspected uncommanded rudder movement had been modified with the upgraded rudder PCU. Nevertheless, not all of the ADs have been fully implemented on all B-737s.

On March 23 and 24, 1999, the NTSB held a public meeting to discuss its investigation of the causes of the USAir flight 427 accident. To some extent, the NTSB concluded that its ability to definitively determine the cause of this accident was particularly hampered by the absence of certain flight data on the airplane's recorder.

On April 16, 1999, the NTSB submitted two safety recommendations (A-99-28 and A-99-29) to the FAA stating that all B-737 airplanes should record pitch trim, trailing and leading edge flaps, thrust reverser position, yaw damper command, yaw damper status (on/off), standby rudder status (on/off), and control wheel, control column, and rudder pedal forces. In response to those two NTSB recommendations, the FAA is proposing this Notice of Proposed Rulemaking (NPRM).

II. FLIGHT DATA RECORDING TECHNOLOGY

A. INTRODUCTION

For the purposes of analyzing the economic impact of the proposed rule, the Initial Regulatory Evaluation contains this short chapter to briefly summarize the workings of a B-737 FDR system. It consists of a description of the FDR system components and then a discussion of the technical impact that the proposed rule would have on various B-737 FDR systems.

B. FLIGHT DATA RECORDING COMPONENTS

II.B.1. Introduction

A FDR system is designed to record the activities of an airplane's mechanical, hydraulic, electronic, etc. systems (referred to as "flight data parameters"). Without proceeding into a detailed technical discussion, an FDR system's basic components are the actual recorder, the sensors to record various electrical, hydraulic, and mechanical flight activities that will be captured by the recorder, and the wiring to transmit the flight data from the sensors to the recorder. In addition, an FDR system may also have a flight data acquisition unit (FDAU) which gathers and transmits the flight activity information to the recorder.

It should be noted that, although the rest of this Initial Regulatory Evaluation will refer to an individual paragraph in section 121.344 (a) as a "flight data parameter", in reality, several of these individual paragraphs require the recording of more than one actual flight data parameter. For example, 121.344 (a) (22), which requires recording thrust reverser flight data, involves 4 flight data parameters - the fore and aft positions for each reverser on each engine - for a two-engine airplane. Thus, there is not a one-to-one correspondence between a "parameter" in section 121.344 (a) and the actual number of flight data inputs recorded by the FDR system.

II.B.2. Flight Data Recorders

The recorder is the component that collects and stores the flight data. Its capacity to record flight data is reported in words per second (wps). By way of illustration, if the flight data parameters are being sampled once every second, a recorder with a capacity of 64 wps would be capable of recording a maximum of 64 parameters. If the flight data parameters are being sampled twice every second, then a recorder with a capacity of 64 wps would be capable of recording a maximum of 32 parameters because those 32 parameters would be generating 64 bits of information per second.

The two types of recorders are analog and solid state. The analog recorder is, basically, a tape recorder using magnetic tape as its recording medium. It costs between $5,000 and $10,000, depending upon the quality and capacity of the unit. The best of them are capable of processing 64 wps but they cannot be upgraded to a higher capacity. These are no longer manufactured because solid state recorders are superior in performance and involve much less maintenance than analog recorders.

The solid state recorder has no moving parts and consists of 3 modules - a power supply, a computer board, and memory. It costs between $20,000 and $25,000, depending upon the quality and capacity of the unit. The earliest models had a capacity of 64 wps, but most of these models can be reprogrammed to have a capacity of 128 wps or 256 wps. The "reprogramming" of a recorder can involve both hardware and software modifications. The newest recorders have capacities in the thousands of wps and can process flight data transmitted in digital form.

II.2.c. Sensors

Sensors are the devices that sample the flight activities. Depending upon the complexity of the sampling task, sensors can be either relatively simple and inexpensive devices (e.g., measuring the direction of an airplane part's movement) or complex and expensive devices (e.g., measuring the force of an airplane part's movement). As a result, industry sources have reported that these units can cost between $200 and $12,000.

II.2.d. Flight Data Acquisition Units (FDAU)

The necessity of having a FDAU in an FDR system depends upon the number of flight data parameters being recorded. A FDAU is a computer that acquires data from various forms (analog, digital, pneumatic, etc.) throughout an airplane, transforms those data into a digital format, and sends the data to a digitalrecorder. Effectively, the FDAU condenses the flight data being received so that the recorder's memory is not exceeded. All FDAUs being manufactured today are digital flight data acquisition units (DFDAUs), which cost about $50,000 a unit.

III. PROPOSED RULE

A. HISTORY OF PREVIOUS FDR RULEMAKING

The Boeing 737s involved in the two previously noted accidents were equipped with FDR systems that recorded a limited number of parameters. One B-737 FDR system recorded 6 parameters while the other' FDR system had been retrofitted to record 13 parameters. Although both B-737 FDR SYSTEMS s were in compliance with section 121.343 that existed at that time, the NTSB was unable to determine the probable cause(s) due to the paucity of recorded information and the nearly total destruction of the airplanes. As a consequence, on February 22, 1995, the NTSB submitted recommendations A-95-25, A-95-26, and A-95-27 to the FAA recommending that the FAA require FDR-system upgrades for all transport category airplanes to record selected additional parameters that were not required by the regulation that existed at that time.

In response to these safety recommendations, the FAA promulgated revisions to the DFDR requirements for all airplanes. (Revisions to Digital Flight Data Recorder (DFDR) Rules; Final Rule (62 FR 38362, July 17, 1997)). With respect to B-737s, the DFDR regulations require that a B-737 manufactured on or before October 11, 1991, and not equipped with a FDAU must record the 18 flight data parameters listed in paragraphs (a)(1) through (a)(18) of 14 CFR §§ 121.344 and 125.226 by August 20, 2001. A B-737 manufactured on or before 'October 11, 1991, and equipped with a FDAU must record the 22 flight data parameters listed in paragraphs (a) (1) through (a)(22) of 14 CFR §§ 121.344 and 125.226 by August 20, 2001. A B-737 manufactured after October 11, 1991, must record the 34 flight data parameters listed in paragraphs (a) (1) through (a)(34) of 14 CFR §§ 121.344 and 125.226 by August 20, 2001. A B-737 manufactured after August 20, 2000, must record the 57 flight data parameters listed in paragraphs (a)(1) through (a)(57) of 14 CFR §§ 121.344 and 125.226. Finally, a B-737 manufactured after August 19, 2002, must record the 88 flight data parameters listed in paragrapns (a)(1) through (a)(88) of 14 CFR §§ 121.344 and 125.226.

B. PROPOSED RULE

Although there have been no additional B-737 accidents that have not been explained because of lack of recorded flight data; there have been a continuing series of incidents involving B-737 rudders for which flight data have not been recorded. There is a strong potential that these incidents may be caused by a systematic structural problem in the B-737 and these incidents portend a future accident. However, the NTSB and the FAA do not believe that the flight data required to be recorded by the 1997 DFDR regulations are capable of providing the information necessary to recommend regulatory action to prevent a future B-737 accident.

In light of that belief, the proposed rule would amend the FDR regulations for U.S.-registered B-737s operated under parts 91, 121, 125, and 129 to largely incorporate the two 1999 NTSB recommendations. It would require each B-737 equipped with a FDAU as of July 16, 1996 or manufactured after July 16, 1996, to have, by August 18, 2000, an FDR system that 'records the following flight data parameters in addition to those currently required: (1) (a)(19) through (a)(22) (pitch trim; trailing edge flaps; leading edge flaps; thrust reverser position (each engine)); (2) (a)(88) at increased sampling rates; and (3) proposed new flight data parameters (a)(89) through (a)(91) (yaw damper command; yaw damper on/off discrete; standby rudder on/off discrete; and control wheel, control column, and rudder pedal forces. It would also require by August 18, 2001, that each B-737 without a FDAU record flight parameters (a)(18) through (a)(22), (a)(88) at an increased sampling rate, and the proposed (a)(89) through (a)(91). Finally, it would require by August 18, 2002, that each B-737 that was retrofitted with a FDAU after July 16, 1996, record flight parameters a (18) through (a)(22), (a)(88) at an increased sampling rate, and the proposed (a)(89) through (a)(91). The yaw damper command, yaw damper on/off discrete, and control wheel, control column, and rudder pedal forces would be required to be sampled at a minimum rate of twice per second.

Primarily due to the two previously discussed B-737 accidents, the proposed rule would treat the B-737 airplane model differently than it would treat other transport category airplanes. As described earlier, the current rule contains different requirements for transport category airplanes based on their certification date and their date of manufacture, but it does not have different requirements based on airplane model. The proposed rule, however, would alter that approach by establishing one common set of requirements (after August 18, 2002) for all B-737s regardless of when they were manufactured, while maintaining the different requirements for all other transport category airplanes based on their certification dates and dates of manufacture. Another change in approach is that the proposed rule would specifically require a B-737's FDR system to record more flight data parameters than are recorded by FDR systems in other transport category airplanes of. similar age. The final change would be that the proposed rule would require the B-737 to record 3 new flight data parameters that no other transport category airplane would be required to record.

Although the proposed rule would not require that a FDAU be retrofitted into the B-737 FDR system, industry sources have reported that the alternative of retrofitting a second recorder into the FDR system would be more expensive than retrofitting a FDAU into the FDR system. In addition, there are technical difficulties that have not been evaluated in integrating two separate FDR systems into one coherent, synchronized system. From a practical standpoint, only a B-737 equipped with a FDAU would have the capability to record all of the additional flight data parameters. Retrofitting an airplane with a FDAU involves substantial airplane structural work (with the associated costs in labor and airplane out-of-service time) whereas adding flight data parameters to an upgraded recorder is considerably less costly in labor and airplane out-of-service time. In order to moderate the potential expense to operators of B-737s that do not have FDAUs, the proposed rule would grant those B-737 operators an additional year to retrofit FDAUs and to comply with the proposed rule. Granting those operators an extra year would make it more probable that the airplane would undergo a regularly scheduled major maintenance check within the time between the final rule promulgation date and the compliance date. By retrofitting the airplane with the FDAU during this scheduled maintenance time (when the airplane panels would generally be opened up to check the wiring and other systems) the operator would reduce the costs of retrofitting the airplane with a FDAU and adding the new flight data parameters - in particular, the operator would reduce the airplane's out-of-service time because additional maintenance personnel-could be used to retrofit the airplane with a FDAU while the other scheduled required maintenance is being performed.

IV. INDUSTRY PROFILE

A. INTRODUCTION

There are more B-737s currently in service than any other airplane model in the world. Consequently, any proposed rule that would impose costs on B-737s would affect a large segment of the aviation world. Not every air carrier would be equally affected by the proposed rule because the B-737 fleet varies both as a total number and as a percentage of different air carriers' fleets. In this chapter, the FAA estimates the current and future numbers of B-737s by individual operator. In addition, the FAA estimates the expected number of future flight hours of the B-737 fleet because that would be a critical determinant of the potential benefits as well as a source of future compliance costs.

B. METHODOLODY

For the purpose of quantifying the potential benefits and costs of the proposed rule, the FAA has determined that a 20-year time frame would be the appropriate length of time to evaluate the costs and benefits and the economic impact of the proposed rule. The FAA anticipates that the B-737 model will continue in production for the next 20 years (at least) and the analysis of the potential effects of the proposed rule should include the anticipated long-run effects and not focus solely on the more immediate effects.

On its face it can be asserted that any attempt to predict the U.S. air carrier industry's use of B-737s for the-next 20 years would be plagued with so many potentially erroneous assumptions about the long-term (as well as general uncertainties about the industry and the world political and economic conditions) that the entire effort would provide a textbook case of an exercise in futility. However, some such predictions need to be made in order to develop an economic analysis of the proposed rule. Consequently, these predictions should be viewed not as what will happen but, rather, as what is likely to happen if certain reasonable assumptions and projections prove to be valid and if there are no significant changes in the world economy (e.g., wars, depressions, etc.) or in the airline industry (oil embargoes, airline re-regulation, etc.). The FAA requests comments on the validity and propriety of the assumptions and projections made in constructing these predictions.

C. CURRENT NUMBERS AND USES OF U.S.-REGISTERED B-737s

C.1. Total Number of U.S.-Registered B-737s by Owner/Operator

In the United States, almost all B-737s are used exclusively in passenger service. The FAA is aware of one U.S.-registered B-737 that has been reconfigured as an all-cargo airplane, although about a dozen have been reconfigured as a combination passenger/cargo (combi) airplane.

Table IV-1 is a list of the U.S.-registered B-737s by operator/owner as of the end of 1998. This Table separates the owners/operators of U.S.-registered B-737s into five categories: (1) air carriers providing passenger service under part 121 (A); (2) non-U.S. air carriers operating U.S. -registered B-737s under part 129 (F);(3) lessors and brokers who had possessionof B-737s that were not leased to an operator when the B-737 airplane data were collected (L); 4) private operators, including VIP/Executive users, of B-737s (P); and (5) aviation equipment manufacturers (M).

In addition, the type of use the B-737 provides is listed (where known) for each of these operators/owners. These uses are classified as (1) Passenger (P); (2) Combi (C); (3) Freighter (F); VIP/Executive (V); and Experimental (X).

TABLE IV-1[1]

NUMBER OF U.S.-Registered B-737s AND THEIR USE BY OPERATOR/OWNER AT END OF 1998

Operator/Owner	Category	Use	Number of B-737s	
Southwest Airlines	A	P	280	
United Airlines	A	P	190	
US Airways	A	P	189	
Continental	A	P	170	
Delta Air Lines	A	P	86	
America West	A	Total	65	
		P		63
		C		2
Alaska Airlines	A	Total	45	
		P		37
		C		8
Aloha	A	Total	18	
		P		12
		C		5
		F		1
Frontier Airlines	A	P	17	
Metrojet	A	P	13	
Winair	A	P	10	
Vanguard	A	P	9	
Airtran Airways	A	P	8	
Eastwind Airlines	A	P	5	
Pro Air	A	P	5	
Accessair	A	P	3	
Pace Airlines	A	Total	3	
		P		2
		V		1
Casino Express	A	P	2	
Ryan International Airlines	A	P	2	
American Airlines	A	P	1	
Lorair	A	P	1	
Nations Air Express	A	P	1	
North American	A	P	1	
Sierra Pacific	A	P	1	
TOTAL for A	24		1,125	
TACA International Airlines	F	P	15	
Aerolineas Argentinal	F	P	2	
China Southern Airlines	F	P	1	
TOTAL for F	3		18	

[1] The source is Jet Information Servicea, Inc. World Jet Inventory Year-End 1998, March, 1999.

AAR Corporation	L		5
PLM Air Group	L		4
Jetz Inc. -	L		3
Triton Aviation	L		3
Jet Avan Corp.	L	C	2
Northstar Presidio Mgmt.	L		2
Wilmington Trust	L		2
9 Lives Holdings	L		1
Boeing Capital	L	X	1
Cit Group	L		1
Ea-727 Inc.	L		1
Fin. Inst. US	L		1
First Security Bank	L		1
Gecas	L		1
ILFC	L		1
International Pacific Trading	L		1
Pegasus Aviation Group	L		1
Powerhouse Corp.	L		1
TOTAL for L[2]	17		31
ARAMCO	P	Total	6
			3
		C	3
EG&G	P		5
Arco	P		2
Southern Aircraft Services	P	V	2
Club Excellance	P		1
Davis Oil Co.	P		1
GE Air Transport Services	P	V	1
Gund Business Ent.	P		1
ITT Flight Operations	P	V	1
Magic Carpet Avn.	P	V	1
Northeast-Delaware	P	V	1
Picton Ltd.	P		1
Sky King Inc.	P		1
Sports Jet	P		1
Tag Group-USA	P	V	1
Tracinda Corp.	P		1
TOTAL for P	16		27
Boeing	M	V	1
Northrup-Grumman	M	X	1
TOTAL for M	2		2
GRAND TOTAL,	62		1,205

C.2. Distribution of B-737s by Series and Year of Manufacture

[2] These are B-737s that were in the physical possession of the broker or lessor at the end of 1998. Although they were not in active service,

The proposed rule would impose different compliance costs depending upon whether the B-737 is equipped with a FDAU and upon the number of flight data parameters currently being recorded. As detailed in Section III.A. of this Preliminary Regulatory Evaluation, under the 1997 DFDR regulations, the FAA established different minimum numbers of flight data parameters required to be recorded based primarily upon the year of manufacture. Although some B-737 operators have exceeded the FAR minimum flight data recording requirements on their B-737s manufactured before October 11, 1991, most have elected to only meet the minimum FAA flight data recording requirements due to the expense of adding a FDAU to record the additional flight data parameters (as discussed in Chapter II of this Preliminary Regulatory Evaluation). In fact, the FAA is aware of only Southwest Airlines and United Airlines that have (or are in the process of) retrofitting all of their B-737s to record 22 flight data parameters. Consequently, for most B-737s, the date of manufacture is a good indicator of the FDR system's capabilities and the number of flight data parameters that are being collected in that airplane.

The existing B-737 fleet has been grouped into the following 3 categories: (1) B-737s manufactured before October 11, 1991, that have not been retrofitted (or would not have been retrofitted by August 1, 2001) with a FDAU; (2) B-737s manufactured before October 11, 1991, that have been retrofitted (or would have been retrofitted by August 1, 2001) with a FDAU; and (3) B-737s manufactured after October 11, 1991.

The FAA did not query every B-737 owner or operator to determine how many of these B-737s have been retrofitted (or would have been by August 1, 2001) with a FDAU, but the Air Transportation Association (ATA)

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they are available to be leased and, as such, are included in the total surveyed their members (who reported that they currently operate 1,079 B-737s) concerning the number they operate in each of the individual B-737 series and the FDR system capabilities of their airplanes. In addition, several of these same airlines provided information directly to the FAA concerning whether they have or intended to have their B-737s retrofitted with FDAUs.[3] Appendix A to this document duplicates the Jet Information Services, Inc. report of the age distribution of the B-737 fleet for all U.S. owners and operators.[4]

On that basis, as seen in Table IV-2,[5] the FAA has estimated that of the existing 1,205 B-737s affected by the proposed rule, 851 were manufactured before October 11, 1991, while 354 were manufactured after October 11, 1991. Of the 851 manufactured before October 11, 1991, the FAA estimated that 529 have not and would not be retrofitted with FDAUs whereas 322 have or will be retrofitted with FDAUs.

D. FUTURE PRODUCTION OF U.S.-REGISTERED B-737s

In order to estimate the future production of U.S.-registered B-737sm the FAA has adopted its estimate[6] of a 4.1 percent annual net increase in the two-engine U.S. narrowbody airplane fleet during the next 10 years. The FAA has further assumed for the purpose of this analysis

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number of U.S.-registered B-737s.

[3] For 1991, the FAA has assumed that about 75 percent of the B-737s delivered in 1991 were delivered before October 11, and are assumed to have been delivered without FDAUs.

[4] The totals found in Appendix B and Table IV-2 differ by 7 because Appendix includes the 11 U.S. government owned B-737s and does not include the 18 U.S.-registered B-737s operated by non-U.S. air carriers. The FAA has assumed that the age distribution of these two groups would be the same as that for the rest of the B-737 fleet.

[5] The primary source is Jet Information Services, Inc. World Jet Inventory Year-End 1998, March, 1999. However, these data were provided as 3 groups of these airplanes rather than by individual B-737 series. As a result, these data have been modified based on FAA data from its National Aviation Safety Data Analysis Center (NASDAC).

that this annual net increase will continue through years 11 to 20. Finally, the FAA has assumed that this annual net increase for the two-engine U.S. narrowbody fleet is a close proxy for the annual net increase of the U.S.-registered B-737 fleet.

TABLE IV-2

NUMBER OF B-737s BY SERIES, DELIVERED YEAR, AND FDAU STATUS

737 Series	Pre Oct. 11, 1991	Post Oct. 11, 1991	Total With No FDAU	Total With FDAU
100	8	0	8	0
200	62	0	31	31
200-Advanced	254	0	186	68
300	429	130	245	316
400	59	37	59	37
500	39	114	0	153
600	0	0	0	0
700	0	73	0	73
800	0	0	0	0
900	0	0	0	0
TOTAL	853	354	529	678

However, as production is also related to replacement, the FAA has accepted the Boeing estimate[7] that about 30 percent of the world fleet will be retired between 1997 and the year 2017, for a FAA-calculated annual retirement rate of about 1.35 percent. The FAA has assumed that this annual world fleet retirement rate (hence, the replacement rate): (1) can be extended for the years 2018 and 2019; (2) is a reasonable proxy for the world narrowbody fleet retirement (i.e., replacement) rate; and (3) is a reasonable proxy for the U.S.-registered B-737 fleet retirement (i.e., replacement) rate.

[6] Federal Aviation Administration Office of Aviation Policy and Plans, Aerospace Forecasts Fiscal Years 1999-2010, March, 1999, p. III-45.
[7] Boeing Corporation, "Welcome to Boeing, Commercial Aviation, Market Information," May 17, 1999. Boeing Internet site.

Thus, adding that estimated 1.35 percent annual replacement rate to the FAA's estimated annual net increase of 4.1 percent produces an estimated annual B-737 production rate of 5.45 percent of the previous years' U.S.-registered B-737 fleet.

Therefore, as shown in Table IV-3, on the bases of these assumptions and predictions, the FAA has estimated that the proposed rule would affect 2,402 B-737s that would be manufactured between 2000 and 2020 and would become part of the U.S.-registered fleet.

E. NUMBER OF FLIGHT HOURS OF U.S.-REGISTERED B-737s

E.1. Introduction

The FAA has estimated the number of annual flight hours for the current U.S.-registered B-737 fleet and for the future U.S.-registered B-737 fleet.

E.2. Current Flight Hours

The different types of operations and uses of the B-737 imply that there would be different "average" annual flight hours for specific operations and uses. In reality, even within a specific type of operation (e.g., passenger airlines) there are differences in "average" annual flight hours among operators. However, for the purpose of this initial regulatory evaluation, one "average" number of annual flight hours is estimated for each of the following categories of operation: (1) B-737

TABLE IV-3

ESTIMATED NUMBER OF ADDITIONAL AND REPLACEMENT PRODUCTION B-737s IN THE U.S.-REGISTERED FLEET[3]

YEAR	B-737 FLEET	TOTAL NUMBER PRODUCED	NUMBER TO INCREASE FLEET	NUMBER TO REPLACE FLEET
1998	1,205			
1999	1,254	66	49	16
2000	1,306	68	51	17
2001	1,359	71	54	18
2002	1,415	74	56	18
2003	1,473	77	58	19
2004	1,534	80	60	20
2005	1,596	84	63	21
2006	1,662	87	65	22
2007	1,730	91	68	22
2008	1,801	94	71	23
2009	1,875	98	74	24
2010	1,952	102	77	25
2011	2,032	106	80	26
2012	2,115	111	83	27
2013	2,202	115	87	29
2014	2,292	120	90	30
2015	2,386	125	94	31
2016	2,484	130	98	32
2017	2,586	135	102	34
2018	2,692	141	106	35
2019	2,802	147	110	36
2020	2,917	153	115	38
TOTAL	2000-2020	2,144	1,613	531

regularly scheduled passenger service operated under parts 121 or 129; (2) broker/lessor B-737s; (3) private operators of B-737s, including VIP/Executive users; (4) operators of freighters or combi B-737s; and (5) all other operations, including school, training, experimental, or test operations.

Based on its data on the number of U.S. commercial air carriers' two-engine large narrowbody airplanes in 1998 (3,056) and the number of total flight hours flown by those same airplanes (8.642 million),' the FAA has calculated that the typical U.S. commercial air carrier two-

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* Any individual year's total production may not be the sum of the new and replacement production due to rounding error.

[9] Federal Aviation Administration Office of Aviation Policy and Plans, Aerospace Forecasts Fiscal Years 1999-2010, March, 1999, Table 17, p. X-19 and Table 18, p. X-20.

engine large narrowbody flies an annual average of 2,825 hours. For the purpose of this initial regulatory evaluation, the FAA has assumed that this narrowbody fleet estimate is applicable to the B-737 fleet operated under parts 121, 125, and 129.

Although the majority of the B-737s in the possession of brokers/lessors are not currently flying, they are included in the FAA data because they have not been permanently retired.[10] Consequently, for the purposes of this regulatory evaluation, the FAA has assumed that these airplanes will average the same number of flight hours as their counterparts currently active under parts 121, 125, and 129.

For those B-737s operating as freighters or combis, the FAA has previously estimated[11] that these airplanes fly, on average, about two thirds of the hours flown by their commercial passenger counterparts. On that basis, the FAA has estimated that these B-737s will have an annual average of 1,885 flight hours.

A B-737 operating as a private or VIP/Executive airplanes would typically fly fewer hours than would the average commercial passenger B-737. However, at this point in time, the FAA does not have a direct measure of the number of those hours. Consequently, for the purpose of this initial Regulatory Evaluation, the FAA has assumed that these B-737s will have one quarter of the annual flight hours (about 700 hours) logged by their commercial passenger counterparts.

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[10] The FAA has assumed that all of these B-737s will be leased or sold for use in the United States and, thus, would be affected by the proposed rule.
[11] In a not-yet-released Initial Regulatory Evaluation for TCAS II in All Cargo Airplanes.

Paralleling the discussion in the preceding paragraph, the FAA does not have a direct measure of the number of average annual flight hours for those B-737s operating for school, training, experimental, or test purposes. Consequently, for the purpose of this initial Regulatory Evaluation, the FAA has assumed that these B-737s will also have one quarter of the annual flight hours (about 700 hours) logged by their commercial passenger counterparts.

As shown in Table IV-1, of the current B-737 fleet of 1,205 airplanes, the FAA has estimated that 1,128 are in commercial passenger service, 29 are currently under the control of brokers/lessors, 14 serve as freighters or combis, 20 are private or Executive/VIP airplanes, and 13 are used for school, training, experimental, or test operations.

Using the number of estimated annual flight hours in conjunction with the number of B-737s in each of the various categories, the FAA has calculated that the U.S.-registered B-737 fleet logged 3.308 million flight hours in 1998, which, in turn, produces a weighted average of 2,750 flight hours per B-737 in 1998.

E.3. Future B-737 Flight Hours

In order to estimate the future number of total B-737 flight hours, the FAA has assumed that the estimated number of flight hours per B-737 in 1998 will remain constant during the 20-year time period. Under that assumption, the annual rate of increase in the B-737 fleet flight hours will be identical to the annual net rate of increase in the B-737 fleet, which would be 4.1 percent.

Thus, as shown in Table IV-4, using a 4.1 percent annual increase in the number of U.S.-registered B-737 fleet flight hours results in them growing from 3.318 million in 1998 to 7.119 million in 2017.

TABLE IV-4

ESTIMATED TOTAL NUMBER OF FUTURE B-737 FLIGHT HOURS

Year	Number of B-737 Flight Hours (in millions of hours)
1998	3.318
1999	3.454
2000	3.596
2001	3.743
2002	3.897
2003	4.056
2004	4.223
2005	4.396
2006	4.576
2007	4.764
2008	4.959
2009	5.162
2010	5.374
2011	5.594
2012	5.824
2013	6.062
2014	6.311
2015	6.570
2016	6.839
2017	7.119
2018	7.411
2019	7.715
2020	8.031
TOTAL (2000-2020)	108.190

V. BENEFITS

A. INTRODUCTION AND BACKGROUND

An FDR system does not, in and of itself, prevent accidents; it is an investigative tool that has traditionally been used after an accident or an incident to provide a greater understanding of its dynamics and probable causes. Recently, several airlines are beginning to collect FDR system information about routine flight operations in order to share (through developing Flight Operations Quality Assurance Programs (FOQA)) and facilitate identifying trends in an airplane's performance and flight crew actions that may identify potential problems before an accident occurs. Discovering these trends may allow the airlines and the FAA to take corrective action without necessarily waiting for an accident to reveal a potential problem.

Based on the two B-737 accidents for which the NTSB could not definitively determine the causes, the FAA has concluded that B-737 FDR systems do not record all of the appropriate flight data parameters. Consequently, increasing the number of flight data parameters recorded by B-737 FDR systems would increase the probability that it would record flight data that could conclusively establish the causes of some future B-737 accidents. Without these flight data, the causes of some future B-737 accident may not be discovered. Further, these flight data may reveal a potential accident cause after an incident investigation and subsequent corrective action may be taken to prevent the first potential accident. Thus, this increase in recorded B-737 flight data could increase the probability that corrective actions may be taken that would prevent a similar, future B-737 accident.

B. ORGANIZATION OF THIS CHAPTER

It is difficult to quantify the benefits of increased information because an FDR system is an investigative tool, and unlike a safety device, absent flight data neither causes nor contributes to an airplane accident. Therefore, any safety benefits of recording additional flight data parameters would arise from the additional information's contribution to discovering a potential accident cause, which then results in corrective measures to prevent a future accident. However, the FAA has no generally accepted method to measure the increased probability that additional flight data would identify a potential accident cause that would not otherwise have been identified.

As a result, this chapter is organized to first present a qualitative discussion of the potential benefits that may be the result of recording additional flight data parameters. It then presents, to illustrate the general types of benefits that may arise from recording additional flight parameters, a brief discussion of how recording additional flight data parameters led to discovering the hazards caused by windshear and the resultant development of rules and training programs that have successfully reduced that hazard.

In addition to those qualitative discussions, this chapter contains an estimated range of quantified benefits that may result from the proposed rule. It first presents the potential quantified benefits from preventing a B-737 catastrophic accident. It then presents an estimated number of potential B-737 accidents with a quantitative estimate of the potential benefits that may occur <u>if</u> the future B-737 rate of accidents with an undiscovered cause would be the same as the future rate of similar B-737 accidents. It concludes by providing several alternative probabilities concerning the effectiveness of the proposed rule in preventing these potential, future B-737 catastrophic unexplained accidents.

C. QUALITATIVE BENEFITS

C.1. General Benefits from Increased Flight Data Information

It needs to be noted that the following discussion of the potential qualitative benefits from this proposed rule for B-737s parallels that same discussion in the FAA's January, 1997, Final Regulatory Evaluation of the Final Rule Revisions to Digital Flight Data Recorder Rules (1997 DFDR Regulations). The similarity arises because the central underlying principle of both this proposed rule and the 1997 DFDR Regulations is that the cause of a future accident may not be discovered unless additional flight data information were available to the accident investigators.

Previous increases in the number of recorded flight data parameters required have enhanced the investigators' ability to determine the causes of airplane accidents. The benefits from this enhanced ability to establish the causes of airplane accidents have been two-fold. One benefit has been that knowledge about the causes of airplane accidents has directly led to corrective actions (i.e., airplane modifications or changes in operating procedures) that has prevented future accidents. A second benefit is that this knowledge about the causes of airplane accidents has more precisely defined those airplane modifications and operational problems that need to be addressed by research and development programs.

An emerging potential benefit from recording additional flight data parameters would occur in conjunction with the developing FOQA programs. The success of these programs in enhancing airplane safety will depend upon the success of analysts to evaluate recorded data from routine flight operations to spot potential emerging problems from trends revealed by those data. Consequently, recording additional flight data parameters may increase the likelihood of these types of analyses discovering potential airplane problems before they cause an accident.

Nevertheless, precisely because the cause of the two B-737 accidents is unknown, the FAA cannot state with certainty whether the conditions that caused these two accidents will recur. Further, even if those conditions were to recur, the FAA cannot state with certainty that these proposed additional flight data parameters would capture those conditions because those conditions may not be detected by the proposed additional flight data parameters. Thus, the FAA cannot determine with certainty the potential increase in the probability of determining a future B-737 accident's cause that this rule would provide.

However, two B-737 accidents in the past 10 years far which the causes could not be definitively determined provide the FAA with a reasonable basis to conclude that, had more flight data information been recorded, the investigators would have had a greater probability of discovering the causes and recommending appropriate corrective action. Further, the NTSB and FAA both believe that, based on their evaluations of the two B-737 accidents, these additional flight data parameters would, in fact, provide the necessary answers if a similar future B-737 accident were to occur.

C.2. An Illustrative Example of the Benefits from Increased Flight Data - Windshear Related Accidents

The current situation, in which the investigations of the two B-737 major accidents could not definitively determine their causes, is, in important respects, similar to the history of accidents caused by windshear. At first, there were a series of accidents for which the cause could not be determined. Then, through the accumulation of pertinent FDR system information over a period of time, the cause of the accidents was determined to be windshear and corrective actions were taken.

Windshear has been a cause of accidents since the beginning of aviation; however, until the early to mid-1970s the aviation community did not fully appreciate the effects of windshear on a low-flying airplane. Although the 6-parameter FDR systems in use at that time were sufficient to determine that windshear was present, the available information was insufficient to determine airplane performance and flight crew response in those situations (information that would have been extremely useful in developing appropriate corrective measures). To a large extent, therefore, the realization of this windshear effect resulted from the analyses of data from engine, flight control, and aerodynamic parameters recorded on enhanced 17-parameter FDR systems equipped on the newer wide-bodied airplanes.

The value of increased flight data information as an investigative tool is seen in the following three examples of investigations of major accidents involving windshear:[12]

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[12] Federal Aviation Administration, Final Regulatory Evaluation of the Final Rule Revisions to Digital Flight Data Recorders Rules, Jan. 1997.

- The December 17, 1973, Iberia Li, DC-10-30 crash at Boston, became the first U.S. accident where windshear could be positively identified as a cause of a large airplane accident. The DC-10's 96-parameter FDR system provided investigators with their first real glimpse at the windshear phenomenon. The accurate and detailed record of critical airplane performance and configuration produced by the FDR system provided investigators their first opportunity to substantiate the effects of windshear. As a direct result of the information obtained from the FDR system, the NTSB was able to determine that the aircraft encountered windshear.

- The investigation of the Eastern Air Lines Jamaica, New York crash on June 24, 1975 made extensive use of the FDR system's recorded information. The investigation centered on the flight recorder data from the Boeing 727 that crashed, and two DC-8s and an L-1011 that encountered weather difficulties in New York that day. The best information came from the L-1011, which had an expanded parameter FDR system. The microburst phenomenon was first described from this investigation and, as a result, training programs were developed to teach flight crews to recognize microburst situations and to instruct them in the appropriate maneuvers to undertake in such situations.

- The Pan Am July 9, 1982 is another example where the accident investigation made extensive use of the FDR system's recorded information. From investigations of the FDR system's data it was determined the probable cause to be windshear.

Without flight recorder data, the causes for many of these accidents would probably have been labeled as pilot error. However, once the cause was properly identified, government and industry combined their efforts to develop ground based and airborne windshear detection systems, improved flight guidance systems, to make changes in training techniques, and to take other corrective measures. In addition, the FAA adopted a rule in 1990 specifically targeted to prevent windshear-related accidents. As seen in Table V-l, the number of windshear related accidents has become nearly zero since the introduction of the 1990 rule and the other actions.

The FAA believes that a similar result for the currently unidentified causes of the two B-737 accidents may be obtained by recording the additional flight data parameters.

TABLE V-1

WINDSHEAR-RELATED AVIATION ACCIDENTS TO TRANSPORT CATEGORY AIRPLANES[13]

Year	Number of Accidents	Fatalities	Serious Injuries	Minor Injuries
1975	2	112	12	N/A
1976	3	9	93	N/A
1977	1	0	0	0
1978	1	0	0	0
1979	1	4	2	0
1980	1	1	1	0
1981	0	0	0	0
1982	6	155	21	0
1983	1	0	0	0
1984	3	0	0	0
1985	3	135	17	0
1986	1	0	2	0
1987	2	0	0	0
1988	1	0	0	0
1989	1	0	0	0
1990	1	73	81	0
1991	0	0	0	0
1992	0	0	0	0
1993	0	0	0	0
1994	0	0	0	0
1995	1	0	1	0
1996	1	0	0	5
1997	0	0	0	0
1998	0	0	0	0
TOTAL	30	489	230	5

D. ESTIMATED QUANTIFIED BENEFITS FROM PREVENTING A CATASTROPHIC B-737 ACCIDENT

D.1. Methodology and Assumptions

D.1.a. Methodology

Several different methodologies can be used to quantify the potential benefits of preventing a catastrophic B-737 accident, but given the time

[13] Sources are Federal Aviation Administration, Final Regulatory Evaluation of the Final Rule Revisions to Digital Flight Data Recorder Rules, January 1997, TABLE 1; and recent data from the National Aviation Safety Data Analysis Center.

and resource constraints, the FAA has concentrated on only two. The first methodology constructs a hypothetical scenario involving an "average" scheduled airline B-737 flight that suffers a catastrophic accident. The second methodology constructs a "worst case" scenario in which the largest B-737 series is completely filled with passengers and suffers a catastrophic accident.

Another methodological consideration is whether or not to discount the quantified benefits. The advantage of discounting is that the quantified benefits and costs would be estimated using the same methodology. The disadvantage of discounting is that it may give the impression that preventing a fatality today has a greater value than preventing a fatality 10 years from today. Similarly, the advantage of not discounting is that the assigned monetary value of preventing a fatality would be the same whenever the fatality would have been prevented. The disadvantage is that undiscounted quantified benefits cannot be validly compared to discounted costs. As a result, the FAA has determined that discounting the quantified benefits is the appropriate methodology in order to allow a valid cost and benefit comparison.

D.1.b. Assumptions

The FAA has made the following assumptions to quantify the benefits from preventing a B-737 accident:

(1). The future B-737 accidents that the additional flight data parameters would prevent (if the parameters were to reveal a specific problem that would be correctable) are catastrophic accidents that result in the deaths of all aboard and the total destruction of the airplane.

(2). The average annual net rate of growth in the total number of B-737 flight hours will equal the projected average annual net rate of growth of 4.1 percent[14] in the number of B-737s.

(3). Based on the Department of Transportation's latest estimate, the value of a fatality avoided is $2.7 million in year 2000 dollars.

(4). The average value of a destroyed B-737 would be about $20 million[15] - noting that this is a weighted average value based on the current distribution of B-737s airplanes by series and age in the U.S.-registered fleet.

(5). Based on the Lockerbie, Scotland, investigation (updated to year 2000 dollars), the FAA estimates that an airplane crash investigation would cost the U.S. government, the airline, and the manufacturer about $31 million.

(6). The ground collateral damage would average about $5 million per accident with no fatalities among the ground personnel.[16]

(7). A 20-year time frame because these have been infrequent accidents and a sufficient period of time is needed in order for the probability of a potential accident to be greater than 0.5.

(8). The discount rate used is the OMB-mandated 7 percent rate that government regulatory agencies use in their cost/benefit analyses.

D.2. Quantified Benefits for Avoiding a "Typical" B-737 Accident

In the two B-737 accidents whose causes are not established, one of them was near passenger load capacity and the other was well below capacity, a pattern that is not typical of these airplanes in U.S. domestic

[14] FAA Aerospace Forecasts Fiscal Years 1999-2010, March, 1999, p. III-45.
[15] Avitas, Jet Aircraft Values, 2nd Half 1997, 1997.
[16] Obviously a truly "worst case" scenario would have a B-737 crashing into a nuclear power plant or the Trump Towers at 2:30 P.M. on a Wednesday. However, the FAA believes that using that extreme example stretches the example into the realm of fantasyland.

scheduled commercial aviation service. Consequently, the FAA constructed a hypothetical model of an "average" number of passengers in an average B-737 U.S. domestic scheduled flight rather than using an average of the two previous accidents.

The listed maximum seating capacities for the various B-737 models range from 110 passengers to 175 passengers for the B-737-900, with the weighted average of the current fleet (based on the number of B-737s by individual model in service) being about 130 passengers. The FAA has estimated that the average domestic Part 121 aircraft operates at a 70.1 percent load factor,[17] which yields an average of 91 passengers and 5 crew members (pilot, co-pilot, and three flight attendants) per B-737 flight. Thus, the FAA has determined that the "average" B-737 U.S. domestic scheduled passenger flight transports about 96 people.

On that basis, the FAA has estimated that an "average" B-737 accident would incur "costs" of about $259.2 million for the 96 fatalities, about $20 million for the destroyed B-737, about $5 million for the collateral ground damage, and about $31 million for the accident investigation. Thus, the quantified benefits from preventing an "average" B-737 accident would be about $315.2 million.

D.3. Quantified Benefits for a "Worst Case" B-737 Accident

With a listed maximum seating capacity of 175 passengers, the B-737 would be required to have 6 flight crewmembers (pilot, co-pilot, and 4 flight attendants) for a maximum of 181 people. In addition, this maximum seating capacity would be for in a new B-737-900, which has an average cost of about $57.5 million.

On that basis, the FAA has estimated that a "worst case" B-737 accident would "cost" about $488.7 million for the 181 fatalities, about $57.5 million for the B-737-900, about $5 million for the collateral damage, and about $31 million for the accident investigation. Thus, the total quantified benefits from preventing one "worst case" B-737 catastrophic accident would be about $582.2 million.

E. ESTIMATED RATE OF B-737 UNEXPLAINED CATASTROPHIC ACCIDENTS AND PROJECTED NUMBER OF FUTURE SIMILAR ACCIDENTS

B-737s have logged about 92 million flight hours in the United States since the first B-737-100 entered commercial service in 1968[18]. Dividing that 92 million flight hours into the 2 B-737 catastrophic accidents whose causes have not been discovered generates an historical accident rate per flight hour of 2.17 E-8 for catastrophic, unexplained B-737 accidents.

As developed in Table IV-4, the FAA has projected that there would be about 108 million B-737 flight hours in the United States during the 20-year time frame of this analysis. Multiplying the historical B-737 accident rate by the number of projected future B-737 flight hours generates an estimate of between 2 and 3 (the statistical expected number would be 2.34) unexplained catastrophic B-737 accidents in the United States that would occur during the next 20 years if the following assumptions are accurate:

(1). The flight data parameters needed to determine the causes of these accidents would not have been recorded under the 1997 DFDR

[17] FAA Aerospace Forecasts Fiscal Years 1999-2010, March, 1999, Table 14, p. X-16.
[18] Source is the National Transportation Safety Board.

regulations.

(2) - The historical B-737 accident rate would continue in the absence of recording the additional flight data parameters required by the proposed rule.

F. ESTIMATED POTENTIAL QUANTIFIED LOSSES FROM B-737 UNEXPLAINED FUTURE CATASTROPHIC ACCIDENTS

F.1. Expected Years of the Future B-737 Accidents

The impact that discounting has upon the present value of the prevented accident critically depends upon the date it would have occurred. For example, the impact of discounting on the present value of the prevented accident would be minimal if the prevented accident would have occurred within a year or two after the promulgation of the final rule, whereas the impact of discounting on the present value of the prevented accident would be at its greatest if the prevented accident would have occurred 19 years after the promulgation of the final rule. When determining the probable date of the potential prevented accident, the appropriate statistical approach is to determine the year in which the cumulative probability of the accident occurring reaches 0.5.

Using that theoretical approach and remembering that the number of flights is increasing by 4.1 percent every year, if 2 accidents were to occur during the 20-year time period, the statistically likely years of their occurrences would be in 2006 and 2016. If the statistically expected value of 2.34 accidents were used, the statistically likely years of the two accidents occurrences would be in 2005 and 2014. Finally, if 3 accidents were to occur during the 20-year time period, the statistically likely years of their occurrences would be in 2004, 2011, and 2017.

F.2. Estimated Potential Quantitative Losses for "Typical" B-737 Accidents

Thus, as seen in Table V-2, using the "average" estimated number of fatalities, the present value of the total cost of the B-737 accidents would be between $296 million and $458 million over the 20-year period, with the expected average value of $343 million.

F.3. Estimated Potential Quantitative Losses for "Worst Case" B-737 Accidents

Thus, as seen in Table V-2, using the "worst case" estimated number of fatalities, the present value of the total cost of the B-737 accidents would be between $547 million and $846 million over the 20-year period, with the expected average value of $633 million.

F.5. Summary of the Potential Quantitative Losses for B-737 Accidents

Thus, as seen in Table IV-2, the present value of the potential losses over 20 years discounted at 7 percent can range from $296 million to $846 million, depending upon the assumptions. If the expected value of the number of B-737 accidents (2.34) were used, the present value of the losses would be between $340 million to $633 million.

TABLE V-2

PRESENT VALUE OF THE QUANTIFIED LOSSES FROM THE POTENTIAL B-737 ACCIDENTS
(in $ millions)

CATEGORY	NUMBER OF ACCIDENTS		
	2 ACCIDENTS	2.34 ACCIDENTS	3 ACCIDENTS
1. Worst Case	547	633	846
2. Average	296	343	458

G. ESTIMATED POTENTIAL QUANTIFIED BENEFITS OF THE PROPOSED RULE

G.1. Effectiveness of the Proposed Rule

Since the 1997 DFDR regulations, several incidents of uncommanded rudder movement have occurred for which the FDR systems were unable to record their causes. This experience has demonstrated that, until the cause of these uncommanded rudder movements can be determined, proposed FDR system enhancements can not be assumed to be completely effective a priori. Nevertheless, it is the expert judgment of the NTSB and the FAA that this proposed rulemaking would identify the causes of these uncommanded rudder movements.

G.2. Decision Errors

There are two possible decision errors from this rulemaking. The first error is that the expert judgment of the NTSB and the FAA is accepted when this judgment is incorrect. The cost of this error is equal to the cost of this rulemaking, if no other benefit occurs. The second error is that of rejecting the expert judgment when in fact it is correct and one or more unexplained B-737 accidents occur as a result. Using the previously described benefit methodology, one avoided B-737 accident in the next six years would offset the estimated $205 million incremental compliance cost of this proposed rule. As the cost of the rule, once the rule would be implemented, would occur regardless of the outcome, the decision error of rejecting the expert judgment when it is correct increases as an otherwise avoidable B-737 accident occurs closer to the present, i.e., if an accident occurs this year the loss would be about $315 million.

G.3. Quantified Potential Benefits from the Proposed Rule

With an expected value of 2.34 B-737 unexplained accidents during the next 20 years, the present value of the losses is estimated to be between $340 million to $633 million. The benefit of these expected preventable accidents must be allocated between identifying the problem and the implemented solution; i.e., the resultant regulatory action. The purpose of this proposed rulemaking is to identify the cause of the uncontrolled rudder movements.

As the existing onboard flight data recorders did not provide enough information to determine the cause of uncontrolled rudder movements in several separate incidents, the risk of an accident is likely to be real and the cause remains undetermined. Even if it cannot be specified, a priori, how effective this proposed rulemaking will be, it 'is clear the identification for the cause of these uncontrolled rudder movements is a necessary condition for a solution.

If the proposed diagnostic improvements from this proposed rule correctly identify the causes of these incidents, then at least one . expected avoidable accident can be attributed to this rulemaking. Without diagnostic improvements to the existing B-737 FDR systems, the sequence of incidents with indeterminate cause(s) may continue until an uncontrolled rudder accident occurs and the cause is then determined from the wreckage. While more than one accident could be attributed to this proposed rulemaking, one prevented B-737 accident today is worth approximately $315 million, or a present value exceeding $200 million any time within the next six years.

VI. COMPLIANCE COSTS

A. INTRODUCTION

The proposed rule would impose compliance costs on several different parties, but the three principle parties would be Boeing, third-party holders of certain B-737 FDR system Supplemental Type Certificates (STC), and owners/operators of B-737s. The proposed rule would affect all existing U.S.-registered B-737s as well as all future manufactured B-737s that would have a U.S.-registry.

B. FAA REQUEST FOR COMMENTS AND DATA

The estimated incremental compliance costs in this Initial Regulatory Evaluation critically depend upon the underlying methodology, assumptions, and data. The FAA requests comments on the methodology, assumptions, data, and estimates made in this analysis. The FAA also requests that commenters provide supporting data to correct any errors or to increase the accuracy of the FAA estimates.

C. AVALABILITY OF SPREADSHEETS

The spreadsheets that are the bases of the numbers reported in the text are available in the Appendices to this report.

D. BASELINES, METHODOLOGY, AND DATA SOURCES

D.1. Baselines

The baselines used to compute the incremental compliance costs with this proposed rule are (1) current industry practice; and (2) the expected future industry practices were the proposed rule not promulgated. Some B-737 operators currently record more flight data parameters than the minimum number required by the 1997 DFDR regulations. As the estimated compliance costs are incremental (the "delta" in engineer-speak) costs, those operators whose B-737s already record some of the proposed additional flight data parameters would not incur compliance costs for those particular flight data parameters. However, those same operators would incur compliance costs to retrofit their B-737s to record the proposed new flight data parameters that are not being recorded. Consequently, different operators will start from different initial baselines and the resultant incremental compliance costs will differ depending on the FDR system and the number of flight data parameters being recorded.

In addition, the compliance costs with this proposed rule are calculated from the baseline that the B-737 operators and Boeing have incorporated (or will incorporate) the 1997 revisions to the flight data recorder rule. Further, any costs to comply with those 1997 revisions are not included as a cost of this proposed rule. The FAA contends that those expenditures are, in economist-speak, "sunk costs" that would been spent regardless of whether this proposed rule is promulgated. Nevertheless, the FAA has provided some estimates of those compliance costs for the B-737s in this Initial Regulatory Evaluation in order to provide a more complete picture of the total costs of complying with recent and proposed future flight data recorder requirements.

The other baseline used is that the incremental compliance costs are calculated over the same 20-year time-frame starting in the same year (2000) as is used to quantify the estimated potential benefits.

D.2. Methodology

The estimated compliance costs of this proposed rule do not include any estimates of future costs rules that the FAA may develop in response to the additional recorded flight data.

The two analytically equivalent methods to express compliance costs are: (1) the discounted present value; and (2) the annualized cost. The discounted present value is the sum of each future year's costs over the appropriate time period discounted by the rate of return back to the first year. The principle governing this procedure is that, independent of inflation, a dollar spent (or received) in the future is valued less than a dollar spent (or received) today. Discounting is simply the means to calculate the current year's equivalent value of a future payment or receipt. The annualized cost is calculated by transforming the discounted present value into a yearly cost based on the rate of return over the entire time period. Analytically, these two methods are equivalent to a property purchase in which the value of the mortgage (assuming no down payment) would be the discounted present value while the yearly mortgage payment would be the annualized cost.

The FAA has chosen to use the discounted present value compliance costs because about 80 percent of the costs would be incurred by August 18, 2001. Using an annualized cost would be somewhat misleading because it would give the impression that these costs could be spread out over the 20-year time-period.

The rate of return is a critical factor affecting the compliance cost calculations. This Initial Regulatory Evaluation has used a 7 percent rate of return because, in order to ensure consistency among Federal regulatory agencies, OMB has mandated that Federal agencies use a 7 percent rate of return when evaluating proposed and final regulatory actions.

D.3. Data Sources Used to Estimate the Compliance Costs

The FAA has relied upon several different data sources for the estimated incremental compliance costs. As described in Chapter III of this Initial Regulatory Evaluation, the FAA has used an ATA survey in conjunction with both the 1999 World Jet Survey and the FAA National Aviation Safety Data analysis Center (NASDAC) system to determine the number of U.S.-registered B-737s by operator, series, and airplane age. This information, in turn, allowed the FAA to estimate the number of these airplanes that have a FDAU as well as the number of flight data parameters currently recorded by each B-737.

To determine the individual FDR system equipment costs, the FAA has used cost data supplied by 2 recorder and FDAU manufacturers as well as cost data supplied by several airlines. The ATA survey also reported its members' estimates of the costs of complying retrofitting their B-737s to comply with the proposed rule. Further, representatives of 6 airlines" directly provided estimates to the FAA of their actual and expected costs to retrofit FDAUs and to rewire their B-737s to increase the number of recorded flight data parameters from 18 to 22. A representative of a repair facility provided estimates of the costs to obtain STCs as well as the costs to retrofit the new proposed flight data parameters (a)(89) through (a)(91) and (a)(88) with its increased sampling rates to existing B-737s. Boeing also provided a preliminary

[19] Allied Signal and Teledyne.
[20] Southwest, United, USAirways, Continental, Delta, and America West.

estimate of the anticipated costs of manufacturing future B-737s with the capability of recording the proposed new flight data parameters.

Finally, the FAA has relied on its analysis and expertise to provide certain individual cost and hour estimates when other data were not available or could not be obtained.

E. GENERAL DISCUSSION OF THE COSTS OF COMPLYING WITH THE PROPOSED RULE

E.1. General Categories of B-737s Used to Estimate Potential Compliance Costs

The FAA basic unit for calculating the compliance costs was the B-737 series (i.e., 200, 300, 400, etc.). In addition to those 8 basic series,[21] the FAA also differentiated between the B-737-200 and the B-737-200 Advanced. Finally, for the B-737-300, -400, and -500, the FAA separated each of those 3 models into 2 groups; those manufactured before October 11, 1991, and those manufactured after October 11, 1991. This separation was made because all airplanes manufactured after October 11, 1991, were manufactured with a FDAU. Thus, there are 12 basic categories of B-737s for which the FAA estimated an individual compliance cost. However, it should be noted that there is sufficient similarity among these B-737 series that these individual compliance costs are the same for several of these different series.

Finally, these categories were further divided into 4 sub-categories because the same series airplane would incur different unit compliance

[21] The FAA believes that no B-737-100 FDR system would be retrofitted to comply with the proposed rule due to the expense and the very short future life expectancy of those airplanes in scheduled service.

costs depending upon its FDR system's capability. These 4 sub-categories of B-737s are: (1) pre-October 11, 1991, B-737s that do not have a FDAU and have (or will be) upgraded to record the 18 flight data parameters; (2) pre-October 11, 1991, B-737s that have a FDAU and have been (or will be) upgraded to record the 22 flight data parameters; (3) post-October 11, 1991, B-737s that have a FDAU and record at least the 34 flight data parameters; and (4) B-737-600/700/800/900s (Next Generation (NG) B-737s) that have a FDAU and record at least 57 flight data parameters.

E.2. Causes of the Compliance Costs with the Proposed Rule

The causes of the compliance costs with the proposed rule would be the following: (1) One-time costs to reengineer existing B-737 FDR systems; (2) One-time equipment and labor costs to retrofit additional FDR system equipment in existing B-737s; (3) One-time lost revenue from additional out-of-service time to complete a retrofit; (4) One-time equipment and labor costs to install additional FDR system equipment on future manufactured B-737s; (5) Annual operational costs for parts and labor to inspect, maintain, and replace the additional FDR system equipment; and (6) Annual operational costs of additional fuel consumption due to the increased weight from the additional FDR system equipment.

E.3. Assumptions Used to Estimate the Unit Labor Costs

The FAA does not have the resources to visit each company and evaluate -its salary and internal review structures to determine that company's specific cost structure. Rather, the FAA has assumed that a standard level of engineering competence is required to complete a reengineering design analysis and that there is an average aerospace engineer's hourly wage rate across all companies that would perform this analysis. This average design engineer's hourly wage rate is then adjusted to account for fringe benefits, which makes it hourly engineer's compensation rate. This hourly total compensation rate is then further adjusted to account for the compensation paid for the supervisory, clerical, administrative, legal, etc. time associated with the completion of a FDR system reengineering design analysis. These non-engineering hours are not directly included in the estimated time to complete the FDR system reengineering. On that basis, the FAA has calculated that the adjusted engineer hourly total compensation rate would be $100. Further, the average engineer work year is assumed to be 2,000 hours, for an adjusted engineer year labor cost of $200,000.

The FAA has followed that same approach in establishing an adjusted hourly total compensation rate for airplane mechanics. That is, hourly fringe benefits are added to the hourly airplane mechanic wage rate to obtain an hourly compensation rate. Then, rather than estimating the individual numbers of additional supervisory, clerical, administrative, etc. hours that would be required to complete the installation and then multiplying those hours by the various compensation rates, the FAA adjusted the mechanic hourly compensation rate to account for those other labor costs. On that basis, the FAA has calculated an adjusted hourly total compensation rate of $75 an hour for a maintenance mechanic (which is $15 an hour more than the FAA has used in its calculations of labor costs in airworthiness directives (ADs).

F. ENGINEERING TIME COSTS FOR B-737 STC HOLDERS

F.1. Introduction

As this is a part 121 and part 125 operating rule, the ultimate responsibility for compliance with the proposed rule lies with the B-737 owner/operators. In complying with previous FDR system changes in response to an FAA rule change or an issued AD, the general historical pattern has been for the larger airlines to either use their own maintenance or a third-party modification shop and the smaller airlines to use either the maintenance facilities of larger airlines or of other third parties. Assuming that this pattern would continue for this proposed rule, then the FDR system STC holders (the larger airlines and the larger third-party maintenance facilities) would need to obtain a modified STC for any substantial alteration of a B-737 FDR system.

The standard practice associated with past changes in B-737 FDR systems has been for Boeing to perform the initial reengineering and then to issue a service bulletin, which serves as the basic blueprint used by the FDR system STC holders. However, Boeing has not developed service bulletins for flight data parameters (a)(19) through (a)(22), (a)(88), or the proposed (a)(88) through (a)(91). Thus, the proposed rule would require each FDR system STC holder to complete its own engineering analysis or to purchase the STC rights from an organization that has done the engineering analysis and received the STC.

F.2. Acceptable Level of Measurement for Compliance

In order to estimate the amount of engineering time needed to redesign the FDR system, the STC holder needs to know the performance requirements that the modified FDR system must meet in order to be in compliance with the proposed rule. In light of that factor, Boeing expressed concern about the requirements of flight data parameter (a)(88) and presented the following two interpretation options: (1) Boeing Option 1 is that the proposed flight data parameter for rudder control measurement would require only combined pedal input; and (2) Boeing Option 2 is that the proposed flight data parameter for rudder control force input measurement would require individual rudder pedal force input.

Boeing Option 1 is consistent with its current B-737 manufacturing specifications. Boeing Option 2 presents a different situation. With respect to Option 2, Boeing has reported that they

> "do not have a viable design solution that does not entail major underfloor structural modification and/or is a significant new design and packaging development for the necessary transducers. My current assessment is a design development phase of 18 to 24 months culminating in a new production solution with kits to retrofit the extensive 737 fleet being available about 6 months later. . . . Although Boeing does not have a promising alternative to address the individual pedal force requirement, our aviation industry has demonstrated time and time again the ability to develop creative and clever solutions. To ensure that we are seeking the best available knowledge, it would be prudent to collect the information for two alternatives in the public comment."[22]

Although the NTSB has recommended that the Boeing Option 2 be considered the appropriate interpretation for compliance with (a)(88), the FAA has interpreted its (a)(88) requirement to be consistent with the interpretation in Boeing Option 1. Therefore, the engineering time costs for the B-737 FDR system STC holders has been estimated based on that Option 1.

F.3. Cost of Engineering Hours for B-737 FDR System STC Holders

[22] T.D. Fehr, Vice President, BCAG Airplane Systems, Fax Transmittal to Jim Jones, Federal Aviation Administration, May 26, 1999.

There are two general types of engineering design costs associated with the proposed rule. The first type is the manufacturer's or airline's engineering time required to design the FDR system including the parts (i.e., the recorder and the FDAU) to be used in a retrofitted B-737 FDR system. The second type is the engineering time required for the airline or repair station to obtain a FAA Supplemental Type Certificate /Parts Manufacturing Approval (STC/PMA) for the revised FDR system.

With respect to the recorder manufacturers' engineering costs, industry has reported that the increased number of recorded flight data parameters would require that a solid state recorder (installed to comply with the 1997 Revisions to the Flight Data Recorder Rule) with a memory capacity of 64 words per second (wps) would need to increase its. memory to 128 wps. This increase would involve a software change that would require FAA approval. The FAA has estimated that these one-time recorder engineering costs would be about $5,000 per airline per B-737 series. The FAA has further estimated that about 40 of these FDR recorder approvals would be required, for a total one-time engineering cost of about $200,000 for the upgraded recorders.

Although the proposed rule would not specifically mandate a FDAU in every B-737, airline and repair station avionics engineers were unanimous in stating that retrofitting an airplane with a FDAU would be less expensive than retrofitting it with a second FDR system (and coordinating it with the first FDR system) to record the additional flight data parameters. Consequently, the FAA has assumed that an owner of a B-737 that does not have a FDAU would have the FDAU retrofitted in order to keep the airplane in service. Unlike upgrading recorder memory, installing a FDAU would be a substantial modification to the airplane and a FDAU manufacturer has estimated that obtaining FAA approval to integrate its FDAU in an FDR system would take between 16 and 26 weeks and would cost about $200,000 for each airline B-737 series/FDAU combination. However, the FAA has determined that after about 5 such approvals, a manufacturer could use commonality demonstrations to reduce this estimated time to between 8 and 12 weeks and reduce the estimated cost to about $25,000 per approval. It should be noted that several of these applications can be submitted at one time and the parts manufacturer would not wait for one airline's FDAU approval before submitting the next airline's FDAU for approval. The FAA has estimated that about 40 of these FDAU approvals would be required, for a total one-time engineering cost of about $2.75 million for the FDAU approvals.

Even though each individual B-737 FDR system modification would need its own STC, the actuality is that an STC holder would submit one basic STC for the B-737 series that would apply to all of its B-737s in that series. As noted earlier, most of the major airlines would perform their own engineering although a few would contract it out to a few large third-party maintenance facilities. However, most, if not all, of the small fleet operators (20 or fewer B-737s) would contract out their maintenance to those third-party maintenance facilities. As a result, not every B-737 owner/operator would need to perform the reengineering in order to obtain an STC because the major airlines or large third-party maintenance facilities would obtain a few and apply them to multiple client/operators.

With respect to airline or repair station engineering time to obtain an FDR system STC, its engineering staff would need to redesign the FDR system, ground test it, flight test it, and submit the drawings and data to the FAA. Airlines reported in the ATA survey that it would take between 3 months and one year to complete the entire engineering/FAA approval process. The FAA believes that the higher estimates reflect a worst case situation that would not represent the average amount of time for this process to be completed. As a result, the FAA has determined that 4 months would be the average amount of time required for the entire process. The FAA has also estimated that 3 industry engineers would work full-time on each STC approval. Consequently, the FAA has estimated that each STC application would cost about $200,000. The FAA has further estimated that about 32 of these STC applications would be made. On that basis, the FAA has estimated that the one-time engineering cost for the FDR system STC applications would be about $6.4 million.

Thus, the FAA has estimated that the total one-time engineering costs for obtaining FAA-approved equipment and STCs would be about $9.15 million and would take about 5 months to be fully operational.

G. ESTIMATED NUMBER OF EXISTING B-737s THAT WOULD BE AFFECTED BY THE PROPOSED RULE

G.1. Introduction

The number of B-737s that would be affected by the proposed rule is, of necessity, an estimate because the number of newly manufactured U.S.-registered B-737s as well as the number of B-737s that would leave U.S. service cannot be precisely predicted. In addition to the total number of B-737s, the numbers of individual B-737 models need to be estimated because the airplanes in different B-737 series would incur different compliance costs.

G.2. Assumptions

In order to determine the composition of the B-737 fleet that would be affected by the proposed rule, the FAA has assumed that every B-737 that will leave the U.S. registry in the next few years would be the older B-737-100/200/300s not equipped with FDAUs. The FAA has also assumed that the composition of the B-737 fleet at the end of the year 2000 is the composition of the B-737 fleet affected by the proposed rule. The logic for these assumptions is that, as will be seen, compliance with the proposed rule would be very expensive for older B-737s and those types of airplanes would be more likely to be retired or sold out of the United States than newer B-737s that would have longer remaining lifespans, lower maintenance costs, lower operational costs, and lower compliance costs. The end of year 2000 has been selected even though the final compliance date is August 18, 2001, because there are costs associated with prematurely retiring or selling airplanes and these costs have not been addressed in this Initial Regulatory analysis. A further consideration is that the B-737s that Southwest and United intend to retire during this time have been numbered among the airplanes with FDAUs. Thus, though the year 2000 date may slightly increase the numbers of the older B-737s, the FAA contends that this would not significantly exaggerate the estimated compliance costs.

G.3. Estimated Number -of B-737s Affected by the Proposed Rule

Therefore, combining Tables IV-2 and IV-3 along with the FAA's projections concerning the numbers of the various B-737 series that would be delivered in 1999 and 2000, the FAA has estimated, as shown in Table VI-l, that the proposed rule would affect 1,306 B-737s, of which

310 would have a FDAU and 496 would not have a FDAU before the proposed rule's compliance dates.

TABLE VI-1

NUMBER OF B-737s BY SERIES, DELIVERED YEAR, AND FDAU STATUS AT END OF YEAR 2000

737 Series	Pre Oct. 11, 1991	Post Oct. 11, 1991	Total With No FDAU	Total With FDAU
100	0	0	0	0
200	54	0	23	31
200-Advanced	246	0	178	68
300	420	154	236	338
400	59	37	59	37
500	39	130	0	169
600	0	0	0	0
700	0	73	0	73
800	0	46	0	46
900	0	48	0	48
TOTAL	818	488	496	810

H. ESTIMATED EQUIPMENT AND LABOR COSTS TO RETROFIT FDR SYSTEMS

H.1. Introduction

Compliance with the proposed rule would generate both one-time retrofitting costs and increased annual operational costs for existing B-737s. The incremental one-time compliance costs would consist of the following 3 components: (1) the cost of the additional FDR system equipment (i.e., a FDAU (if necessary) and the additional wiring and sensors); (2) the labor costs to retrofit the additional FDR system equipment; and (3) the lost revenue from the time the B-737 would be out-of-service to complete the retrofit.

The increased annual operational costs would consist of the following two components: (1) the increased inspection and maintenance time as well as the costs for repairs and maintenance; and (2) the increased aviation fuel consumption due to the additional weight of the additional FDR system equipment.

H.2. Costs to Retrofit FDR Systems

H.2.a. Introduction

The costs to retrofit any individual FDR system would depend on its existing equipment and the number of flight data parameters it currently records. In general, the FDR system components that would be affected by the proposed rule would be the recorder, the FDAU, flight data sensors, and the wiring.

H.2.b. Summary of Costs to Retrofit FDR Systems

The summary of the total compliance costs with the proposed rule has been provided in Table VI-2, which summarizes the spreadsheet found in Appendix B. As shown in Table VI-2, the total retrofitting compliance cost would be about $124.3 million of which about $10 million would be for replaced recorders, about $7.2 million would be for reprogrammed recorders, about $30.1 million would be to retrofit a FDAU into the airplane, about $7.5 million would be to reprogram existing FDAUs, and about $69 million would be for additional sensors and FDR system rewiring.

A summary of the retrofitting compliance costs for an individual B-737 by series and by number of flight data parameters currently recorded is provided in Table VI-3, Table VI-4, and Table VI-5. As shown in those Tables, there is a significant difference in these retrofitting costs.

For example, the costs to retrofit a newer B-737 that records at least 34 parameters would be about $35,100, while the costs to retrofit a B-737 that records 22 parameters would be between $68,800 and $90,000, and the costs to retrofit a B-737 that records 18 parameters would be between $160,200 and $191,400.

The bases for and estimates of the unit retrofit costs are described in greater detail in the following sections.

H.2.c. Costs to Retrofit Flight Data Recorders

Based on industry estimates, the FAA has determined that: a new recorder would cost about $25,000; upgrading the memory of an older recorder that records 18 flight data parameters would cost about $10,000; upgrading the memory of a recorder that records 22 flight data parameters would cost about $5,000; and upgrading the memory of a newer recorder that records at least 34 parameters would cost about $1,900.

With respect to the number of recorders in each of these categories, the FAA has estimated that 20 percent of the recorders in the 496 FDR systems that do not have a FDAU (99) recorders) would need to be replaced while the remaining 397 recorders would need a $10,000 upgrade. In addition, 322 recorders would need a $5,000 upgrade while 488 recorders would need a $1,900 upgrade.

TABLE VI-2

TOTAL COSTS OF COMPLIANCE FOR RETROFITTING TO MEET THE PROPOSED RULE

TABLE IV-3

PER AIRPLANE COSTS OF COMPLIANCE FOR RETROFITTING B-737s THAT CURRENTLY RECORD AT LEAST 34 PARAMETERS

	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
5	RETROFITTING COST	SPECIAL SESSION												
6	PER 737 COMPLIANCE COST													
7	NUMBER WITH 34, 54, OR 89 PARAMETERS													
8	737 MODEL	COST FOR FDAU REPROGRAM	LABOR TIME FOR FDAU REPROGRAM	LABOR COST FOR FDAU REPROGRAM	COST FOR FDR REPROGRAM	LABOR TIME FOR FDR REPROGRAM	LABOR COST FOR FDR REPROGRAM	COST OF WIRING AND SENSORS	LABOR TIME TO RETROFIT WIRING AND SENSORS	LABOR COST TO RETROFIT WIRING AND SENSORS	RETROFIT COST	OUT OF SERVICE DAYS	LOST REVENUE	RETROFIT COST + LOST REVENUE
9	100	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0
10	200	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0
11	ADVANCED 200	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0
12	PRE 10/91 300	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0
13	POST 10/91 300	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	4	$21,556	$56,656
14	PRE 10/91 400	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0
15	POST 10/91 400	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	4	$25,238	$60,338
16	PRE 10/91 500	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0
17	POST 10/91 500	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	4	$19,101	$54,201
18	600	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	4	$30,762	$65,862
19	700	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	4	$34,674	$69,774
20	800	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	4	$41,578	$76,678
21	900	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	4	$43,879	$78,979
22														
23	TOTAL													

TABLE IV-4

PER AIRPLANE COSTS OF COMPLIANCE FOR RETROFITTING B-737s THAT CURRENTLY RECORD 22 PARAMETERS

	U	V	W	X	Y	Z	AA	AB	AC	AD
5	RETROFITTING COST PER 737	SPECIAL SESSION								
6	COMPLIANCE COST									
7	NUMBER WITH 22 PARAMETERS									
8	737 MODEL	COST FOR FDAU REPROGRAM	LABOR TIME FOR FDAU REPROGRAM	LABOR COST FOR FDAU REPROGRAM	COST TO REPLACE FDR	LABOR TIME TO REPLACE FDR	LABOR COST TO REPLACE FDR	COST FOR FDR REPROGRAM	LABOR TIME FOR FDR REPROGRAM	LABOR COST FOR FDR REPROGRAM
9	100	$10 000	40	$3,000	$20,000	32	$2 400	$5,000	16	$1 200
10	200	$10 000	40	$3,000	$20,000	32	$2 400	$6 000	16	$1 200
11	ADVANCED 200	$10 000	40	$3,000	$20,000	32	$2 400	$6,000	16	$1 200
12	PRE 10/01 300	$10,000	40	$3,000	$20,000	32	$2 400	$6,000	16	$1 200
13	POST 10/01 300	$0	0	$0	$0	0	$0	$0	0	$0
14	PRE 10/01 400	$10,000	40	$3,000	$20,000	32	$2 400	$6,000	16	$1 200
15	POST 10/01 400	$0	0	$0	$0	0	$0	$0	0	$0
16	PRE 10/01 500	$10,000	40	$3,000	$20,000	32	$2 400	$6,000	16	$1 200
17	POST 10/01 500	$0	0	$0	$0	0	$0	$0	0	$0
18	600	$0	0	$0	$0	0	$0	$0	0	$0
19	700	$0	0	$0	$0	0	$0	$0	0	$0
20	800	$0	0	$0	$0	0	$0	$0	0	$0
21	900	$0	0	$0	$0	0	$0	$0	0	$0

	U	AE	AF	AG	AH	AI	AJ	AK	AL	AM
8	737 MODEL	COST OF WIRING AND SENSORS	LABOR TIME TO RETROFIT WIRING AND SENSORS	LABOR COST TO RETROFIT WIRING AND SENSORS	RETROFIT COST REPLACE FDR	RETROFIT COST REPROGRAM FDR	OUT OF SERVICE DAYS	LOST REVENUE	RETROFIT COST (FDR REPLACE) + LOST REVENUE	RETROFIT COST (FDR REPROGRAM) + LOST REVENUE
9	100	$22 000	360	$27 000	$80 000	$88 800	4	$153	$80 153	$88 95
10	200	$22 000	360	$27 000	$80 000	$88 800	4	$400	$80 400	$89 20
11	ADVANCED 200	$22 000	360	$27 000	$80 000	$88 800	4	$4 810	$84 810	$73 71
12	PRE 10/01 300	$22 000	360	$27 000	$80 000	$88 800	4	$13 570	$103 570	$82 37
13	POST 10/01 300	$0	0	$0	$0	$0	0	$0	$0	$
14	PRE 10/01 400	$22 000	360	$27 000	$80 000	$88 800	4	$17 337	$107 337	$86 13
15	POST 10/01 400	$0	0	$0	$0	$0	0	$0	$0	$
16	PRE 10/01 500	$22 000	360	$27 000	$80 000	$88 800	4	$13 425	$103 425	$82 22
17	POST 10/01 500	$0	0	$0	$0	$0	0	$0	$0	$
18	600	$0	0	$0	$0	$0	0	$0	$0	$
19	700	$0	0	$0	$0	$0	0	$0	$0	$
20	800	$0	0	$0	$0	$0	0	$0	$0	$
21	900	$0	0	$0	$0	$0	0	$0	$0	$

TABLE IV-5

PER AIRPLANE COSTS OF COMPLIANCE FOR RETROFITTING B-737s THAT CURRENTLY RECORD 18 PARAMETERS

	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP
6	PER 737 COMPLIANCE COST									
7	NUMBER WITH 18 PARAMETERS AND NO FDAU									
8	737 MODEL	COST OF NEW FDAU	LABOR TIME FOR FDAU RETROFIT	LABOR COST FOR FDAU RETROFIT	COST TO REPLACE FDR	LABOR TIME TO REPLACE FDR	LABOR COST TO REPLACE FDR	COST OF FDR REPROGRAM	LABOR TIME FOR FDR REPROGRAM	LABOR COST FOR FDAU REPROGRAM
9	100	$50 000	200	$15,000	$26,000	32	$2 400	$10 000	16	$1 200
10	200	$50 000	200	$15,000	$26,000	32	$2 400	$10 000	16	$1 200
11	ADVANCED 200	$50 000	200	$15,000	$26,000	32	$2 400	$10 000	16	$1 200
12	PRE 10/81 300	$80 000	200	$15,000	$26,000	32	$2 400	$10.000	16	$1 200
13	POST 10/81 300	$0	0	$0	$0	0	$0	$0	0	$0
14	PRE 10/81 400	$50.000	200	$15.000	$26,000	32	$2 400	$10.000	16	$1 200
15	POST 10/81 400	$0	0	$0	$0	0	$0	$0	0	$0
16	PRE 10/81 500	$50 000	200	$15,000	$26,000	32	$2 400	$10 000	16	$1 200
17	POST 10/81 500	$0	0	$0	$0	0	$0	$0	0	$0
18	600	$0	0	$0	$0	0	$0	$0	0	$0
19	700	$0	0	$0	$0	0	$0	$0	0	$0
20	800	$0	0	$0	$0	0	$0	$0	0	$0
21	900	$0	0	$0	$0	0	$0	$0	0	$0

	BG	BQ	BR	BS	BT	BU	BV	BW	BX	BY
8	737 MODEL	COST OF WIRING AND SENSORS	LABOR TIME TO RETROFIT WIRING AND SENSORS	LABOR COST TO RETROFIT WIRING AND SENSORS	RETROFIT COST (FDR REPLACE)	RETROFIT COST (FDR REPROGRAM)	OUT OF SERVICE DAYS	LOST REVENUE	RETROFIT COST (FDR REPLACE) + LOST REVENUE	RETROFIT COST (FDR REPROGRAM) + LOST REVENUE
9	100	$42 000	760	$57 000	$191 400	$175 200	9	$345	$191 745	$175 54
10	200	$42 000	560	$42 000	$176 400	$160 200	7	$805	$177 205	$161 00
11	ADVANCED 200	$42 000	560	$42 000	$176 400	$160 200	7	$8 562	$184 962	$168 78
12	PRE 10/81 300	$42.000	760	$57 000	$191 400	$175 200	9	$30 551	$221 951	$206 75
13	POST 10/81 300	$0	0	$0	$0	$0	0	$0	$0	$
14	PRE 10/81 400	$42 000	560	$42 000	$176 400	$160 200	7	$30 340	$206 740	$190 54
15	POST 10/81 400	$0	0	$0	$0	$0	0	$0	$0	$
16	PRE 10/81 500	$42 000	760	$57.000	$191 400	$175 200	9	$30 205	$221 605	$205 40
17	POST 10/81 500	$0	0	$0	$0	$0	0	$0	$0	$
18	600	$0	0	$0	$0	$0	0	$0	$0	$
19	700	$0	0	$0	$0	$0	0	$0	$0	$
20	800	$0	0	$0	$0	$0	0	$0	$0	$
21	900	$0	0	$0	$0	$0	0	$0	$0	$

Although all FDR systems have a recorder, it would take more labor time to install a new recorder than to upgrade a **recorder's** memory because the former activity would involve more FDR system testing and verifications than would the latter activity. The FAA has estimated that installing a new recorder would require 32 labor hours to remove the old recorder and to install and to test the new recorder (for a unit labor cost of $2,400) while upgrading a recorder would require 16 labor hours to remove, to reprogram, to reinstall, and to test (for a unit labor cost of $1,200).

On that basis, the FAA has estimated that the present value of the equipment cost for replaced or upgraded recorders would be about $17.5 million.

H.2.d. <u>Costs to Retrofit FDAUs</u>

Based on industry estimates, the FAA has determined that a new FDAU would cost about $50,000, reprogramming an existing FDAU in a B-737 that is recording either 22 flight data parameters would cost about $10,000, and reprogramming an existing FDAU in a B-737 that is recording at least 34 flight data parameters would cost about $5,000. In the former FDAU "reprogramming"case, the reprogramming would include both hardware modifications and software revisions while the latter FDAU "reprogramming" case would only include software modifications.
With respect to the FDAUs, the FAA has estimated that a FDAU would need to be retrofitted into 496 B-737s, the $10,000 FDAU reprogramming would occur in 322 B-737s, and the $5,000 FDAU reprogramming would occur in 488 B-737s.

Retrofitting a B- 3 a FDAU would necessi ate complete rerouting of the FDR system wiring because the recorder itself (where the wires formerly terminated) is located aft, while the FDAU would be located in the front of the airplane. Thus, the wiring would now run from the sensors to the FDAU and then back to the recorder. Relying primarily on estimates provided by airlines that have retrofitted FDAUs into their B-737s, the FAA has estimated that this retrofitting would take about 200 labor hours, which includes the associated labor hours to rewire the existing FDR system. The FAA has also estimated that the labor hours to remove, ship to the manufacturer, reinstall, and test a reprogrammed FDAU would take 48 hours for an older FDAU and about 40 hours for a newer FDAU.

On that basis, the FAA has estimated that the present value of the FDAU equipment and associated labor costs would be about $37.6 million.

× 2 e <u>Costs to Retrofit Sensors and Wiring</u>

With respect to the additional sensors and wiring, the FAA has divided the equipment and labor costs into two components: (1) the equipment and labor costs to add flight data parameters (a)(19) through (a)(22); and (2) the equipment and labor costs to add the proposed new flight data parameters (a)(89) through (a)(91) and to add flight data parameters found in (a)(88) with the proposed increased sampling rates

The FAA estimates of the costs of sensors and wiring to add parameters (a)(19) through (a)(22) is based on industry sources that have reported that the sensors to supply these additional flight data parameters can cost anywhere from $200 to $2,000 apiece - although one individual force sensor is reported to cost $12,000. These additional sensors would also need wiring to transmit their inputs to the FDAU. Consequently, the FAA has estimated that the cost of the sensors and wiring for a B-737 FDR system to add parameters (a)(19) through (a)(22) would be about $20,000.

The FAA has primarily used the estimated labor hours supplied by airlines that have retrofitted flight data parameters (a)(19) through (a)(22) in their B-737s. On that basis, the FAA has estimated that, in addition to the 200 labor hours associated with the FDAU rewiring, rewiring the sensors and wiring for flight data parameters (a)(19) through (a)(22) would take 200 labor hours for a B-737-200, a B-737-200 Advanced, or a B-737-400. It would take 400 labor hours for a B-737-300 or a B-737-500. Thus, the labor costs of adding flight data parameters (a)(19) through (a)(22) would be about $15,000 for a B-737-200, a B-737-200 Advanced, or a B-737-400, while it would be about $30,000 for a B-737-300 or a B-737-500.

On that basis, the FAA has estimated that the equipment and labor costs of adding flight data parameters (a)(19) through (a)(22) would be about $35,000 for a B-737-200, a B-737-200 Advanced, or a B-737-400 while it would be about $50,000 for a B-737-300 or a B-737-500.

The difficulty in estimating the potential labor hours to retrofit proposed flight data parameters (a)(89) through (a)(91) is that these flight data parameters have not previously been recorded in the B-737. As a result, only limited engineering analyses are available to serve as an experienced basis for an estimate. Consequently, the FAA has adopted some <u>preliminary</u> industry estimates that it would cost about $10,000 for the additional sensors and wiring to retrofit flight data parameters (a)(88) at a higher sampling rate and flight data parameters (a)(89) through (a)(91) (a)(88) in a B-737 FDR system that now records 22 flight data parameters. In addition, the FAA has estimated that this retrofit would involve about 200 labor hours. On that basis, the FAA has estimated that these labor costs would be about $15,000 per airplane.

Thus, the FAA has estimated that the per airplane equipment and labor costs of adding flight data parameters (a)(88) through (a)(91) to a B-737 currently recording 22 flight data parameters would be about $25,000.

Finally, the FAA has adopted some preliminary industry estimates that it would cost about $12,000 for the additional sensors and wiring to retrofit flight data parameters (a)(88) at a higher sampling rate and flight data parameters (a)(89) through (a)(91) (a)(88) in a B-737 FDR system that now records 88 flight data parameters. In addition, the FAA has estimated that this retrofit would involve about 160 labor hours for these airplanes. On that basis, the FAA has estimated that these labor costs would be about $12,000 per airplane.

Thus, the FAA has estimated that the per airplane equipment and labor costs of adding flight data parameters (a)(88) through (a)(91) to a B-737 currently recording 88 flight data parameters would be about $24,000.

Therefore, the FAA has estimated that the per B-737 retrofitting sensor and wiring costs would be: about $84,000 - and take about 560 labor hours for a B-737-200 or a B-737-400 without a FDAU; about $100,000 and take about 760 labor hours for a B-737-300 and B-737-500 without a FDAU; about $49,000 and take about 360 labor hours for an older B-737 airplane with a FDAU; and about $24,000 and take about 160 labor hours for a newer B-737 airplane.

On that basis, the FAA has estimated that the present value of the total sensor and wiring equipment and labor costs to retrofit the B-737 FDR systems would be about $69 million.

I. NET REVENUE LOSS FROM OUT-OF-SERVICE TIME

I.1. Introduction

In previous FAA rulemakings in which airplanes were required to be retrofitted with safety or improved equipment, FAA estimates of the potential lost net revenue associated with out-of-service time estimates have been less than airline industry estimates. The reasons for these differences have been several and varied. One reason may be that the airline industry may have anticipated a longer out-of-service time than the out-of-service time anticipated by the FAA. Another reason may be that the FAA had anticipated that the airplane would be retrofitted during a regularly scheduled major maintenance check, while the airline industry may have anticipated that it would not have that amount of scheduling flexibility and would have to pull the airplane out of service before the scheduled maintenance check. Another reason may be that the FAA analysis was based on the net after-tax lost revenue whereas the airline industry analysis estimate was based on the lost gross revenue minus the unspent operating costs. Another explanation may be that the FAA is mandated by OMB to use 7 percent as the after-tax riskless rate of return, whereas most business financial analysts would argue that a 15 percent to 20 percent after-tax rate of return is the more appropriate value.

The proposed rule would, effectively, require a B-737 to be taken out of service due to the high number of labor hours for an FDR system retrofit and the fact that only a few mechanics can work on the airplane's FDR system simultaneously because of the limited physical work space. An out of service airplane does not generate net revenue and the longer the airplane is out of service, the greater the airline's net revenue loss. However, if a retrofit were completed while the B-737 is undergoing a regularly scheduled maintenance check, only the net revenue lost from any additional out-of-service time could be considered a cost of the proposed rule. For example, if an FDR system retrofit would take 6 days and the B-737 is scheduled for a 3-day maintenance check, only the lost net revenue from the additional 3 out-of-service days would be a cost of the proposed rule. Thus, the lost net revenue due to an FDR system retrofit of a given duration depends upon whether the retrofit is performed during a regularly scheduled maintenance check or whether the airplane must be taken out of service solely to perform the retrofit.

I.2. Methodology

The methodology used by the FAA in this Initial Regulatory Evaluation to estimate the lost net after-tax revenue is based on the principle that a commercial airplane is a piece of capital equipment. In economic theory, the after-tax return on a piece of capital equipment will be equal, in equilibrium, to its capital value (price) multiplied by the risk-free rate of return. Thus, the FAA has calculated the potential lost net after-tax revenue on the B-737 (expressed as the average price of the various B-737 models multiplied by the OMB-mandated 7 percent rate of return) multiplied by 1/365.

The basic source of the FAA's estimated average values of its 11 B-737 series is the AVITAS 2nd Half 1997 Jet Aircraft Values adjusted for the rate of inflation and for the anticipated depreciation rate to the year 2000. For newer B-737 series, the FAA has used the B-737 prices found on the Boeing Internet Site as of May 26, 1999.

As shown in Table VI-6, the FAA has estimated that the average value of a B-737 can widely vary from about $600,000 for a B-737-200 to about $45.2 million for a new B-737-900. Similarly, the average lost net revenue per out-of-service day would vary from about $125 for a B-737-200 to about $11,000 for a B-737-900.

I.3. Estimated Out-of-Service Time to Retrofit the FDR System

The factors affecting the length of incremental out-of-service time from compliance with the proposed rule are whether the B-737 FDR system retrofit would occur during a specially scheduled session devoted primarily to the retrofit or during a regularly scheduled major maintenance check.

If the retrofit were to be accomplished during a special retrofit session, the FAA has estimated that retrofitting a B-737 with a FDAU and adding flight data parameters (a)(19) through (a)(22) would require 3 days out-of-service time for a B-737-200, a B-737-200 Advanced, or a B-737-400 while it would require 5 days out-of-service time for a B-737-300 or a B-737-500. Based on a preliminary industry estimate, the FAA has also estimated that, for B-737s that currently record at least 22 flight data parameters, adding proposed parameters (a)(89) through (a)(91) and flight data parameter (a)(88) with the proposed increased sampling rates, would require 4 days out-of-service time. The FAA has

TABLE VI-6

AVERAGE VALUE AND AVERAGE NET REVENUE LOST PER OUT-OF-SERVICE DAY BY B-737 SERIES

B-737 Series	Average Value (in $millions)	Average Net Revenue Lost Per Day
200	0.6	$125
200-Advanced (No FDAU)	6.4	$1,250
300 (No FDAU)	17.7	$3,400
300 (FDAU)	28.1	$5,400
400 (No FDAU)	22.6	$4,400
400 (FDAU)	32.9	$6,300
500 (No FDAU)	17.5	$3,400
500 (FDAU)	24.9	$4,800
600	40.1	$7,700
700	45.2	$8,700
800	54.2	$10,400
900	57.2	$11,000

further estimated that a B-737 adding the flight data parameters ((a)(19) through (a)(22) plus (a)(88) through (a)(91)) would require 7 days out-of-service time if retrofitting a B-737-200, a B-737-200 Advanced, or a B-737-400. It would require 9 days out-of-service time if retrofitting a B-737-300 or a B-737-500.

The length of time an airline uses for a regularly scheduled major maintenance check varies because different airlines have a variety of different maintenance programs. Consequently, the term "regularly scheduled major maintenance check" can have several different meanings. For example, some airlines have a maintenance program in which a "C" check is completed approximately every 18 months or so and a "D" check is completed every 6 to 8 years. In these programs, a complete "C" check generally takes 3 to 4 days during which the airplane's interior is typically opened up, whereas a complete "D" is the major overhaul and takes about 3 weeks. However, airlines still exhibit differences even when they are following this general maintenance program. For example, some airlines may spread out the "C" check over 2 or 3 separate visits to the maintenance facility. Under this approach, the airplane's interior is not typically opened up on each visit.

Other airlines have a maintenance program in which the maintenance checks are classified as being "light", "heavy", and "major." In that system, a "light" check may occur every year but only take 1 to 2 days, a "heavy" check may occur every 4 to 5 years and take about 2 to 3 weeks, and a "major" check may occur every 10 years and take 3 to 4 weeks.

Finally, it should be noted that most of the smaller airlines that contract with third parties for their maintenance tend to follow the "C" and "D" maintenance program in which the "C" check occurs every 18 to 24 months and lasts 3 to 4 days.

The significance of these different types of "regularly scheduled maintenance checks" is that the potential increased out-of-service time (hence, lost net airline revenue) for a B-737 would vary by type of maintenance program. The most efficient retrofitting method for these FDR systems would be to complete the work at one time in one continuous activity. Thus, the longer the scheduled maintenance check, the shorter the additional out-of-service time to complete an FDR system retrofit.

If the retrofit were to be completed during a 3-day maintenance check, the FAA has estimated that the incremental out-of-service times due to the retrofit would be 2 days for a B-737 that has a FDAU, 4 days for a B-737-200 that does not have a FDAU, and 6 days for a B-737-300 or -500 that does not have a FDAU. If the retrofit were to be completed during a 14-day or a 21-day major maintenance check, the FAA has determined that the retrofit would create no incremental out-of-service time. Those estimates are based on two assumptions. The first assumption is that a major maintenance check routinely requires the opening of the B-737 interior, thereby providing access to the FDR system. The airlines surveyed reported that a major maintenance check did, in fact, require that the B-737 interior be opened. The second assumption is that these maintenance facilities work 20 to 24 hours a day. Those same airlines also reported that this was the case, particularly when facing a heavy workload.

Finally, the FAA has assumed that one 3-day maintenance check will occur every 18 months for each B-737 and that a major 14-day or 21-day maintenance check will occur every 5 years.

On that basis, the FAA has estimated that the present value of the total out-of-service lost net revenue due to retrofitting the B-737 FDR systems would be about $25.2 million.

J. POTENTIAL NET REVENUE LOSSES CURRENTLY UNQUANTIFIABLE

The FAA's analysis of the net revenue losses for an out-of-service airplane, although appropriate for the individual airplanes within an airline's system, may not capture all of the potential lost revenue when the entire system must comply within a short period of time. In recognition of this potential analytical shortcoming, the FAA had queried airlines concerning the potential system impacts. However, the

FAA has also realized that much of the information needed to perform a more complete airline system analysis is proprietary and airlines are extremely reluctant to provide it for fear of the data being inappropriately or inadvertently disseminated to competitors. Nevertheless, following discussions with the aviation industry, the FAA believes that there are two areas of potential economic impact that may need additional investigation, but for which the FAA does not have adequate information.

The first area is that the FAA analysis has assumed that the time to obtain the FAA approvals and the STC would not significantly affect the airlines' abilities to meet the compliance dates. However, there is a possibility that several of the airlines or repair stations would not be able to obtain the requisite FAA approvals to be able to complete these retrofits (particularly those for the proposed new flight data parameters (a)(89) through (a)(91)) in the time between the promulgation of the final rule and the August 18, 2000, or even the August 20, 2001, compliance date. If, in fact, airline maintenance and repair facilities would be overwhelmed with idle B-737s that cannot return to service until they have been retrofitted, then the FAA may have significantly underestimated the actual out-of-service times.

The second area is that the FAA does not have an appropriate model to determine the impact on the number of available flights when, for 18 months, large numbers of airplanes would be taken out of service for several days. For example, there is the possibility that air travel service in certain markets would be disrupted, fares would increase, load factors would increase and flights would become more crowded, some passengers would choose not to fly, some passengers would be unable to obtain flights at the times and dates they are accustomed to flying, flight delays due to weather or mechanical problems would be longer because there would be fewer airplanes available to fill in, etc.

In order to attempt to develop some estimates of the economic impacts of these economic effects that have not been quantified, the FAA specifically requests comments and supporting data on the magnitude of these potential effects, including any presumptions applicable to an individual operator or the industry as a whole.

K. TOTAL ONE-TIME FDR SYSTEM RETROFITTING COSTS

K.1. Per B-737 Retrofitting Costs and Lost Revenue Costs

As seen in Table VI-6, the total compliance costs plus lost net revenue.. for an individual B-737 would vary depending upon the FDR system capability and the series of the airplane. In general, the newer the B-737, the greater the costs of complying with the proposed rule.

K.2. Total B-737 Retrofitting Costs and Lost Net Revenue

In summary, as shown in Table VI-2, the FAA has estimated that the present value of the total one-time compliance costs to retrofit all B-737 FDR systems by the proposed compliance dates would be about $150 million. .

L. ANNUAL COSTS FROM FDR SYSTEM RETROFITTING

L.1. Introduction

The proposed rule would generate annual compliance costs from (1) the additional airplane weight from the retrofitted FDR system equipment and

TABLE VI-6

PER AIRPLANE COMPLIANCE COST BY 737 SERIES AND FDR SYSTEM

737 SERIES	EQUIPMENT AND LABOR COSTS	OUT-OF-SERVICE DAYS	OUT-OF-SERVICE LOST NET REVENUE	TOTAL COSTS AND LOST NET REVENUE
200	$160,200-176,400	4-7	$250-800	$160,450-177,200
200-Advanced (No FDAU)	$160,200-176,400	4-7	$4,900-8,600	$160,690-185,000
200-Advanced (FDAU)	$68,800-90,000	2-4	$2,450-4,900	$71,250-94,900
300 (No FDAU)	$175,200-191,400	6-9	$20,375-30,550	$195,575-221,950
300 (FDAU)	$35,100-90,000	2-4	$6,800-21,550	$41,900-111,550
400 (No FDAU)	$160,200-176,400	6-9	$17,350-30,350	$177,550-206,750
400 (FDAU)	$35,100-90,000	2-4	$8,675-25,250	$43,775-107,350
500 (No FDAU)	$175,200-191,400	6-9	$20,150-30,200	$195,350-221,600
500 (FDAU)	$35,100-90,000	2-4	$6,700-19,100	$41,800-109,100
600	$35,100	2-4	$15,375-30,750	$50,475-65,850
700	$35,100	2-4	$17,350-34,675	$52,450-69,775
800	$35,100	2-4	$20,800-41,575	$55,900-76,675
900	$35,100	2-4	$21,950-43,875	$57,050-76,975

wiring; and (2) the additional maintenance costs annually to validate the FDAU.

L.2. Annual Costs for Additional Weight

The FAA has estimated that the proposed rule would add about 40 pounds to a B-737 without a FDAU currently recording 18 flight data parameters and about 10 pounds to a B-737 currently recording at least 22 flight data parameters. Based on a study that calculated the additional fuel consumption in gallons from adding weight to specific airplane models,[13] the FAA has assumed a per-B-737 yearly average of 2,750 flight hours, a price of $0.61 per gallon of aviation fuel, and 0.23 additional gallons consumed per additional pound per flight hour, resulting in per-airplane annual costs of about $400 for a B-737 that would add 40 pounds and about $100 for a B-737 that would add 10 pounds. On that basis, the FAA has estimated that the present value of the increased fuel consumption over the next 20 years would be about $3.6 million dollars.

L.3. Payload and Flight Limitations from Additional FDR System Weight

Another consideration when weight is added to an airplane is that payload and flight distance limitations could be imposed on some flights if the additional weight is sufficiently heavy. However, the FAA's evaluation has indicated that even 40 additional pounds would be insufficient to impose any weight or distance limitations on any B-737 flight. As a result, the FAA has determined that this additional weight would impose no revenue loss or increased cost from payload or distance limitations.

L.4. Annual Costs for Additional Maintenance

The FAA has further estimated that annual validation of a FDAU would cost about $750. This incremental compliance cost would be incurred only for B-737s retrofitted with FDAUs because the operators of the other B-737s have had this equipment installed and, therefore, the validation cost would not be attributed to the proposed rule. Based on the number of B-737s that would have had FDAUs retrofitted and their expected retirement rates over the 20-year time-frame, the FAA has calculated that the present value of this annual FDAU validation over the next 20 years would be about $2.7 million.

L.5. Total Annual Costs

On that basis, the FAA has estimated that the present value of the annual compliance costs over the next 20 years would be about $6.3 million.

M. COMPLIANCE COSTS FOR FUTURE MANUFACTURED B-737

M.1. Introduction

The potential compliance costs have been based on the assumption that Boeing Option 1 would be the appropriated compliance interpretation for flight data parameter (a) (88). If it is not, then the FAA could not provide a compliance cost estimate until an extensive engineering analysis could be performed.

The *incremental manufacturing compliance cost with the proposed rule for a future newly manufactured B-737 would consist of the following 2 components: (1) the cost of the additional FDR system equipment (i.e., an upgrade to the recorder and the additional wiring and sensors); and (2) the additional labor to install the additional FDR system equipment.

[23] Washington Consulting Group, Impact of Weight Changes on Aircraft

M.2. Equipment and Labor Costs of the Modified FDR System

As discussed in Chapter III of this Initial Regulatory Evaluation, every B-737 manufactured after October 11, 1991, has been equipped with a FDAU that would be able to add the additional flight data parameters with no upgrade. Consequently, the proposed rule would impose no FDAU equipment or installation costs on future manufactured B-737s.

The proposed rule would require B-737s manufactured after August 18, 2000, to record flight data parameters (a)(19) through (a)(22) whereas the 1997 regulation had required them to be recorded after August 18, 2001. However, all B-737s currently manufactured already record these 4 parameters.

The proposed rule would also require that 3 additional flight data parameters (proposed (a)(89) through (a)(91)) be recorded in B-737s manufactured after August 18, 2000. In addition, for 3 other flight data parameters in (a)(88) required under the 1997 regulation for airplanes manufactured after August 19, 2002, the proposed rule would double the sampling frequency of those 3 flight data parameters in B-737s manufactured after August 18, 2000.

Boeing has reported that the B-737 recorders would need to be upgraded to record all of the proposed parameters. The FAA has estimated that this upgrade would cost about $1,900. In addition, the FAA has estimated that a midstream rudder force transducer would cost about $12,000. Finally, the FAA has estimated that the additional wiring and testing and labor for production would cost about $25,000 per B-737.

Fuel Consumption, March, 1994, p.11.

Thus, the FAA has estimated that the increased equipment and labor cost per production B-737 would be about $38,900.

M.3. Lost Revenue from Increased Time to Manufacture the Airplane

As additional workers could be utilized to complete this wiring during the manufacturing process, the FAA has determined that there would be no increase in the manufacturing time for a B-737 and, therefore, no lost revenue from delaying the delivery of a future manufactured airplane.

M.4. Present Value of the Total Compliance Costs for B-737s Manufactured during the Next 20 Years

Using the projected number of B-737s manufactured during the 20-year time-frame as presented in Table IV-3, the FAA has estimated that the present value of the increased manufacturing cost of complying with the proposed rule would be about $40.4 million.

N. CONCLUSION: TOTAL COSTS OF COMPLIANCE WITH THE PROPOSED RULE

On the basis-of the previously estimated cost of compliance sections, the FAA has estimated, as shown in Table VI-8, that the present value of the total engineering costs, retrofitting costs, lost net revenue, annual costs, and increased costs for future manufactured B-737s would be about $205 million.

TABLE VI-8

PRESENT VALUE OF THE COSTS OF COMPLIANCE WITH THE PROPOSED RULE

Source Of Cost	Present Value of the Compliance Costs (in $millions)
Engineering	9.2
Retrofitting	124.2
Lost Net Revenue	25.2
Additional Fuel	3.6
Additional Maintenance	2.7
Higher Price of New B-737	40.4
TOTAL	205.3

O. COSTS OF COMPLIANCE WITH THE 1997 REVISIONS TO THE DIGITAL FLIGHT DATA RECORDER REGULATIONS

As previously discussed, the FAA revised its transport category airplane, which includes B-737s, digital flight data recorder rules in 1997. In the Final Regulatory Evaluation for that final rule, the FAA estimated at that time that the present value in 1997 of the costs to comply with the revised regulations during the 4-year time for compliance was about $48 million ($58.8 million in year 2000 present value terms) for the B-737 airplane operators and for Boeing."

Thus, if that revision and this proposed rule are viewed as two parts of one rulemaking extended over time, the FAA has calculated that the present value of the overall compliance costs associated with these two

[24] The present value of the total compliance costs for all airplanes affected by the 1997 flight data recorder revisions was estimated to be

parts would be about $264.1 million for the B-737 operators and for Boeing.[25]

The per airplane compliance costs associated with the 1997 revision were not disaggregated on a B-737 series basis. As a result, the FAA has calculated in this Initial Regulatory Evaluation that the present value of the per B-737 compliance costs associated with the 1997 revision would be about $45,000.

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about $316.3 million (about $387.5 million in year 2000 present value terms).

[25] The estimated compliance costs reported in the 1997 Final Regulatory Evaluation have not been independently reanalyzed for this Initial Regulatory Evaluation.

VII. BENEFIT-COST COMPARISON

A. BACKGROUND

Before the benefit-cost comparison of this proposed rulemaking is discussed, the costs and benefits of the previous 1997 Revisions to Flight Data Recorder Rules are first addressed. The 1997 Revisions covered nearly all of the commercial fleet, so neither the entire benefits nor costs should be attributed to solely identifying the cause of B-737 uncontrolled rudder movements. The Final Regulatory Evaluation of the 1997 Revisions to Flight Data Recorder Rules did not cite specific benefits attributed to the rule and allowed that future costs could exceed the costs of the current rulemaking. In the benefits-cost comparison discussion of that Final Regulatory Evaluation, the FAA stated:

> "Future FAA actions could take the form of Advisory Circulars, Airworthiness Directives, or possibly, additional rulemakings. The costs of these follow-on FAA actions could vary from negligible costs to considerable costs of some unknown amount.[26]"

Further, the FAA has now determined that the 1997 Flight Data Recorder Revisions have been insufficient to identify the causes of several incidents of B-737 uncontrolled rudder movements. As a result, with regard to the B-737 uncontrolled rudder movements, the incremental benefit and cost of this rulemaking properly should be assessed separately from those of the 1997 DFDR rule.

[26] Federal Aviation Authority, Final Regulatory Evaluation, Final Regulatory Flexibility Determination, and International Trade Impact Assessment, Final Rule Revisions to Digital Flight Data Recorder Rules, January 1997, page 28.

B. BENEFIT-COST COMPARISON OF THE PROPOSED RULE

Based upon the historic B-737 accident rate the expected number of such accidents over 20 years is 2.34, if the following assumptions are accurate:

1) Flight data parameters are needed to determine the cause of these accidents in addition to the information, which would be reported under the 1997 DFDR regulations.
2) The historical B-737 accident would continue in the absence of recording the additional flight data parameters required by the proposed rule.

The Poisson distribution best describes the probability space of expected future B-737 unexplained accidents. For a Poisson distribution with a mean of 2.30, there is a 90 percent probability of one or more accidents, with a nearly a 40 percent probability of 3 to 5 accidents. Thus, under the above assumptions and conditions without this rulemaking, it is highly likely that one or more future accidents will occur.

While perfect effectiveness of the improved diagnostic FDR system capability can not be assured, without this proposed rule an accident is likely and no determined cause. The expert judgment of the NTSB and the FAA is that the proposed improvements to the flight data recorder system would likely record the cause of a B-737 uncontrolled rudder movement. With an incremental cost of $205 million, the benefits of this proposed rulemaking will exceed the cost if one accident is prevented anytime in the next six years. Net benefits increase, as a potential avoided accident occurs sooner.

VI. ALTERNATIVES TO THE PROPOSED RULE

The FAA has determined that its responsibilities under the Regulatory Flexibility Act and the Unfunded Mandates Act require an analysis of alternatives to the proposed rule for each purpose. Rather than repeating the alternatives in each of those two sections, they are listed, discussed, and analyzed in this separate chapter.

The FAA has evaluated three alternatives to the proposed rule. In formulating the alternatives, the FAA focused on its responsibility for aviation safety and its particular obligation under 49 USC 44717 to ensure the continuing airworthiness of airplanes. As a result, the three evaluated alternatives to the proposed rule differ only with respect to the dates of compliance - not on the content of the proposed rule.

Alternative 1: Require all B-737s that currently have FDAUs (not just those B-737s that had a FDAU installed prior to July 11, 1996) to record all of the proposed flight data parameters by August 18, 2000, rather than by August 20, 2001. This would shorten the compliance date for an estimated 197 B-737s by one year. Alternative 1 would increase compliance costs not because the actual retrofitting costs would change but because the lost net revenue from out-of-service time would be greater for some airplanes. A shorter compliance time increases the likelihood that the retrofit would be done as a special project and not as part of a regularly scheduled maintenance check. On that basis, the FAA has estimated that the compliance costs of Alternative 1 would be $2.4 million greater than the compliance costs of the proposed rule. However, this alternative could be considerably more expensive than the proposed rule, particularly if the idle airplane and scheduling costs that the FAA could not quantify are substantial. In that case, the shorter the compliance period, the greater the idle airplane costs and scheduling costs. As a result, in comparison to Alternative 1, the proposed rule would offer considerably more relief to the airlines than is evidenced by the quantified difference between them.

Alternative 1 would not significantly increase the estimated quantitative benefits because the probability of one of these 197 airplanes having an accident whose cause would not have been discovered within a one-year time frame is extremely remote. As a result, the FAA has determined that a commensurate increased level of benefits would not match the increased cost of this Alternative 1.

Alternative 2: Delay the compliance date for all B-737s to August 20, 2001. This would extend the compliance date by one year for about 292 airplanes. The FAA has determined that Alternative 2 could reduce compliance costs by about $13.5 million. This alternative would provide all B-737 operators with greater scheduling flexibility in determining when to have the airplane retrofitted. A greater number of these operators would be able to delay compliance until a regularly scheduled maintenance check and, thereby, reduce the lost revenue from out-of-service time. However, the FAA must also note that the converse to the effect described under Alternative 1 would be a factor. Again, the greater the unquantified costs, the greater the reduction in costs associated with delaying compliance dates, As Alternative 2 would allow greater flexibility than the proposed rule, the estimated compliance cost reduction from Alternative 2 could be substantially underestimated.

However, Alternative 2 could reduce the expected quantitative benefits.

There is a probability that one of these 292 airplanes could have an accident or an incident whose cause would have been discovered only if the additional flight data parameters had been recorded. In light of the fact that the NTSB has recommended the August 18, 2000, compliance date, the FAA has decided to meet the majority of the NTSB recommendations and not propose a later compliance date for all B-737s.

. Alternative 3: Delay the proposed compliance date for every B-737 until either its next scheduled major (4 days or more) maintenance check or by August 18, 2004. Alternative 3 would give an operator its maximum retrofitting scheduling flexibility. As the FAA has determined that nearly *every* B-737 will have at least one scheduled major maintenance check within any 4½-year time period, Alternative 3 would allow the operator to perform the retrofit during a scheduled major maintenance check, which would eliminate the additional out-of-service time and, hence, the potential lost net revenue from compliance with the proposed rule. In addition, Alternative 3 would spread the cost of the retrofits over a 4½-year time period. By doing so, the present value of the compliance cost from Alternative 3 would be about $130 million, which would be about $34 million less than the compliance cost of the proposed rule. Further, the FAA reiterates that the greater the unquantified costs, the greater the reduction in costs associated with delaying compliance dates. As Alternative 3 would allow greater flexibility than the proposed rule, the estimated compliance cost reduction associated with Alternative 3 could be substantially underestimated.

Alternative 3 would reduce the expected quantitative benefits because it would reduce the number of flight hours that the B-737 fleet would have recorded the additional flight data parameters by about 6.6 million flight hours during those 4.5 years. Further, it would reduce the cumulative probability that the additional recorded flight data parameters from an incident involving a B-737 could provide information that would result in preventive regulatory or industry action. Consequently, since the FAA agrees with the NTSB recommendation that this information is important, the FAA has not proposed the delayed compliance date presented in Alternative 3.

Thus, in comparison to the one higher cost alternative and the two lower cost alternatives evaluated by the FAA, the FAA has determined that the proposed rule would be the best method to address this safety issue.

IX. INITIAL REGULATORY FLEXIBILITY ANALYSIS

A. INTRODUCTION

The Regulatory Flexibility Act of 1980 establishes "as a principle of regulatory issuance that agencies shall endeavor, consistent with the objective of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the business, organizations, and governmental jurisdictions subject to regulation." To achieve that principle, the Act requires agencies to solicit and consider flexible regulatory proposals and to explain the rationale for their actions. The Act covers a wide range of small entities, including small businesses, not-for-profit organizations, and small governmental jurisdictions.

Agencies must perform a review to determine whether a proposed or final rule will have a significant economic impact on a substantial number of small entities. If the agency determines that it will, the agency must prepare a Regulatory Flexibility Analysis (RFA) as described in the Act. However, if an agency determines that a proposed or final rule is not expected to have a significant economic impact on a substantial number of small entities, section 605(b) of the Act provides that the head of the agency may so certify, and an RFA is not required. The certification must include a statement providing the factual basis for this determination, and the reasoning should be clear.

Recently, the Office of Advocacy of the Small Business Administration (SBA) published new guidance for Federal agencies in responding to the requirements of the Regulatory Flexibility Act. Application of that guidance to the proposed rule indicates that it could have a significant economic impact on a substantial number of small airlines. Accordingly, a complete initial regulatory flexibility analysis was conducted for the proposed rule and is summarized as follows:

The FAA requests comments on all facets (methodology, assumptions, data, analyses, etc.) of the Initial Regulatory Flexibility Analysis and also requests that commenters supply supporting data or analyses.

B. INITIAL REGULATORY FLEXIBILITY ANALYSIS

B.1. Reasons why the FAA is considering the proposed rule

The flight data being recorded have not been sufficiently comprehensive to determine the causes of several B-737 accidents and incidents. As a result, the FAA and the aviation industry have been unable to develop specific actions that may prevent similar future B-737 accidents and incidents.

B.2. The objectives and legal basis for the proposed rule.

The objective of the proposed rule is to require the B-737 fleet to record additional flight data parameters that may help determine the cause(s) of a B-737 accident, and, thereby allow the development of regulatory and industry actions that could prevent similar future accidents. The legal basis for the proposed rule is 49 USC 44901 et seq. As a matter of policy, the FAA must, as its highest priority (49 USC 40101(d)), maintain and enhance safety and security in air commerce.

B.3. All relevant federal rules that may duplicate, overlap, or conflict with the proposed rule.

The FAA is unaware of any federal rules that would duplicate, overlap, or conflict with the proposed rule.

B.4. A description and an estimate of the number of small entities to which the proposal would apply.

The proposed rule would apply to the operators of all U.S.-registered B-737 airplanes operated under part 91, part 121, part 125, or under part 129.

Nearly all of the 16 operators flying B-737s under part 91 (under deviation authority from part 125) use the airplane as an ancillary part of their primary business (e.g., oil, automobile manufacturing, etc.). As a result, these operators are distributed across a spectrum of Standard Industrial Classification (SIC) codes, and, as listed in the Initial Regulatory Evaluation, few are small businesses.

The FAA has determined that the 3 non-U.S. operators of U.S.-registered B-737s operating under part 129 are not small entities.

However, as shown in Table IX-1, based on a SBA definition that a small airline has fewer than 1,500 employees, the FAA has determined that 14 small airlines (assuming Accessair is a small airline and noting that Metrojet is owned by USAirways) operating under part 121 would be affected by the proposed rule. The number of affected B-737s reported in Table IX-1 is a FAA estimate of the number of those airplanes by airline at the end of year 2000.

TABLE IX-1

AFFECTED AIRLINES BY NUMBER OF B-737s

OPERATOR	NO B-737	NO EMPLOYEES	OPERATING REVENUES (in $millions)	NET PROFIT (in $millions)
Southwest	322	19,933	3,438.762	413.602
USAirways	205	43,100	8,556.000	965.182
United	190	76,000	17,472.106	774.128
Continental	185	40,700	7,155.384	389.816
Delta	90	58,097	14,584.906	1,073.535
America West	70	10,013	1,962.480	104.350
Alaska	50	10,137	1,553.158	106.162
Aloha	20	2,365	231.141	6.278
Frontier	19	440	174.713	(3.308)
Metrojet	15			
Winair	12	52	4.939	(1.150)
Vanguard	10	480	97.755	(7.460)
Airtran	9	600		(6.985)
Eastwind	6	800	22.641	(8.684)
Pro Air	6	110	11.247	(18.849)
Accessair	3			
Pace	3	20	4.914	0.256
Casino Express	2	102	15.692	(2.676)
Ryan Int.	2	575	138.769	
American	1	111,300	16,394.548	1,097.339
Lorair	1	23		
Nations Air	1	154	6.724	0.299
North American	1	127	61.473	1.434
Sierra Pacific	1	35	6.650	0.631

B. 5. The projected reporting, recordkeeping, and other compliance requirements of the proposed rule.

Existing 14 CFR part 43, in part, already prescribes the content, form, and disposition of maintenance, preventive maintenance, rebuilding, and alteration records for any aircraft having a U.S. airworthiness certificate or any foreign-registered aircraft used in common carriage under part 121. There would be one-time paperwork costs of about $9.15 million to obtain FAA parts approvals and STCs for the modified FDR systems, but nearly all of these costs would be incurred by large airlines and large repair stations and large parts manufacturers. Finally, the proposed rule would necessitate minimal additional annual maintenance, which would require minutes of annual recordkeeping per airplane and negligible recordkeeping costs.

B.6. Regulatory Flexibility Cost Analysis.

The compliance costs associated with the proposed rule are almost completely specific to an individual airplane. There would be minimal economies of scale in completing the FDR system retrofits. Thus, the compliance cost for an individual B-737 is largely independent of the size of the airline. The estimated present value of the compliance costs per B-737 by series and FDR system capability is summarized in Table VI-6. However, as noted in that section, if the 1997 flight data recorder revisions and this proposed rule are viewed as two parts of one rulemaking extended over time, then the per airplane cost would be increased by about $45,000.

B.7. Affordability Analysis.

As seen in Table IX-1, the FAA has obtained 1997 net profit data for 11 of the 14 affected small airlines, although the FAA lacks detailed financial data for most of them. Of those 11 small airlines, 7 reported negative net profits. Of the remaining 4 small airlines, the compliance costs would have turned one airline's profit into a loss, cut another's profit in half, and reduced the others' profits by 16 percent and by 7 percent. When coupled with the costs to comply with the 1997 flight data recorder revisions, these profits would be further reduced and the losses would be further increased. Consequently, the FAA has concluded that some of these small airlines may face financial difficulties in offsetting these compliance costs. The FAA solicits comments on the affordability of the proposed rule for small airlines and requests that all comments be accompanied with clear supporting data.

B.8. Disproportionality analysis.

As noted earlier in this regulatory flexibility cost analysis, the incremental compliance costs for a B-737 operated by a large airline and those costs for an identical B-737 operated by a small airline would be nearly identical. However, to the extent that financing charges tend to be larger for a small airline than for a large airline with a good credit line, the financing costs for the retrofits would be dieproportionally larger for a small airline than for a larger airline. The FAA does not have information concerning this potential differential impact. Nevertheless, the significant disproportionality that may occur would depend upon the percentage of an airline's fleet that is composed of B-737s. The higher the percentage of B-737s, 'the greater the impact of this proposed rule on that airline. In reviewing the composition of these various fleets, the FAA has determined that there is not a significant difference, on average, between the group of large airlines and the group of small airlines - although there are certainly differences among individual airlines. As a result, small airlines operating B-737s would not be disadvantaged, as a group, relative to the group of large airlines operating B-737s.

B.9 Competitiveness Analysis.

The proposed rule would impose significant first-year costs on all operators of B-737s and, as a consequence, may affect the relative position of these airlines in their markets. As the proposed rule would impose no costs on other small operators using McDonnell Douglas or Airbus airplanes, the FAA has determined that there could be a significantly adverse competitiveness effect on certain small (and large) airlines that operate B-737s. The principle beneficiaries would be other small and large airlines that do not operate B-737s.

B.10. Business Closure Analysis.

The FAA is unable to determine with certainty whether any of these small airlines would close their operations. Many very small operations (1 to 4 airplanes) operate very close to the margin, as evidenced by their constant exit from and entry into various markets. As noted, most of the small airlines reported losses, but, in the absence of sufficiently detailed financial data, the FAA cannot determine which, if any, of these small airlines would close due to the proposed rule.

B.11. Description of Alternatives.

The three alternatives evaluated by the FAA are discussed in an earlier preamble section. As described, delaying the compliance dates would provide some relief to the affected small and large airlines. However, the proposed rule would still provide a competitive advantage to airlines operating airplanes other than B-737s over small and large airlines that operate B-737s.

B.12. Special Considerations.

Although the proposed rule would have a significant economic impact on small airlines, the FAA has not exempted them from the proposed rule. The principal reason for not exempting them is that B-737 accidents and incidents whose causes have not been determined are not related to the size of the operator; both large and small airlines have been affected. For example, have occurred to B-737s operated by small airlines. In particular, the 1996 Eastwind Airline B-737 incident is very similar to the two B-737 accidents. That airplane recorded only 11 flight data parameters and, consequently, that incident's cause has not been fully determined. Thus, the FAA has determined that special considerations for small airlines would not be appropriate.

C. CONCLUSION

The FAA has determined that there are no viable alternatives to the proposed rule for small airlines. Consequently, the FAA has concluded that exempting B-737s or delaying compliance dates for B-737s operated by small airlines would be an inappropriate action and inconsistent with the FAA mandate to ensure aviation safety. The FAA requests comments on this initial regulatory flexibility analysis and requests commenters to supply supporting data for the comments.

X. INTERNATIONAL TRADE ASSESSMANT

Consistent with the Administration's belief in the general superiority, desirability, and efficacy of free trade, it is the policy of the Administrator to remove or diminish, to the extent feasible, barriers to international trade, including both barriers affecting the export of American goods and services to foreign countries and those affecting the import of foreign goods and services into the United States.

In accordance with that policy, the FAA is committed to develop as much as possible its aviation standards and practices in harmony with its trading partners. Significant cost savings can result from this harmonization, both to American companies doing business in foreign markets, and foreign companies doing business in the United States.

This proposed rule would have a minimal impact on international trade. Although it would increase the cost of manufacturing a future B-737 by about $39,000, the FAA does not believe that this increase would have a significantly negative effect on Boeing's future domestic or international markets for the B-737.

XI. UNFUNDED MANDATES ASSESSMENT

Title II of the Unfunded Mandates Reform Act of 1995 (the Act), enacted as Pub. L. 104-4 on March 22, 1995, requires each Federal agency, to the extent permitted by law, to prepare a written assessment of the effects of any Federal mandate in a proposed or final agency rule that may result in the expenditure by State, local, and tribal governments, in the aggregate, or by the private sector, of $100 million or more (adjusted annually for inflation) in any one year. Section 204(a) of the Act, 2 U.S.C. 1534(a), requires the Federal agency to develop an effective process to permit timely input by elected officers (or their designees) of State, local, and tribal governments on a proposed "significant intergovernmental mandate." A "significant intergovernmental mandate" under the Act is any provision in a Federal agency regulation that will impose an enforceable duty upon state, local, and tribal governments, in the aggregate, of $100 million (adjusted annually for inflation) in any one year. Section 203 of the Act, 2 U.S.C. 1533, which supplements section 204(a), provides that before establishing any regulatory requirements that might significantly or uniquely affect small governments, the agency shall have developed a plan that, among other things, provides for notice to potentially affected small governments, if any, and for a meaningful and timely opportunity to provide input in the development of regulatory proposals.

Under 49 USC. 40101(d)(1), the FAA Administrator is required to consider the following matter, among others, as being in the public interest: maintaining and enhancing safety and security as the highest priorities in air commerce. Additionally it is the Administrator's statutory duty to perform the responsibilities "in a way that best tends to reduce or eliminate the possibility or recurrence of accidents in air transportation. " (See 49 USC 44701(c).)

The FAA has determined that this proposed rule would not contain a significant intergovernmental mandate as defined by the Act because the FAA has no knowledge of any State, local, or tribal government operating a B-737.

However, the FAA has determined that this proposed rule would contain a significant private sector mandate as defined by the Act because the compliance costs over the first 18 months would be about $243 million for the private sector. Thus, the FAA has evaluated the three previously described alternatives in order to determine if the burden could be reduced in a manner consistent with the FAA's mandate to provide aviation safety. Of the three alternatives, only Alternative 3 (delaying compliance until a scheduled major maintenance check) would lower the compliance costs below $100 million for every year. Nevertheless, for the reasons discussed in that earlier section, the FAA has determined that Alternative 3 would not attain the same level of B-737 risk reduction at a lower cost than the proposed rule.

APPENDIX A

AGE DISTRIBUTION OF U.S.-REGISTERED B-737s BY DATE OF INITIAL DELIVERY

YEAR OF B-737 MANUFACTURE FOR ALL U S OWNERS AND OPERATORS

Model	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	Total
737-100/200/T43A	21	20	1	5	2	5	16	2	2	5	20	31	23	35	39	41	43	10	7	II	2	0	0	0	0	0	0	0	0	0	0	341
737-300/400/500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	70	72	96	97	61	70	40	53	28	47	43	28	39	33	784
737-600/700/800/900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	70	73
TOTAL	21	20	1	5	2	5	16	2	2	5	20	31	23	35	39	41	50	80	79	107	99	61	70	40	53	28	47	43	28	42	103	1198

NOTE 1: Foreign owned U.S.-Registered B-737s not included. U.S. gvt.-owned B-737s are included

NOTE 2: Data Source: Jet Information Services, Inc. World Jet Inventory Year-End 1998, March 1999, Section 3 Table 2, p. 33.

APPENDIX B

VALUE OF INDIVIDUAL B-737 SERIES

	B	C	D
2	MAINTENANCE HOURLY. - COMPENSATION		
3	$75		
4			
5	RETROFITTING COST	SPECIAL SESSION	
6			
7			
9	107 MODEL	AVERAGE VALUE (in $m)	NUMBER IN SERVICE
10	100	0.6	54
11	ADVANCED 200	6.4	246
12	PRE 10/91 300	17.7	420
13	POST 10/91 300	28.1	154
14	PRE 10/91 400	22.6	59
15	POST 10/91 400	32.9	37
16	PRE 10/91 500	17.5	39
17	POST 10/91 500	24.9	130
18	600	40.1	0
19	700	45.2	73
20	800	54.2	46
21	900	57.2	48
22			
23	TOTAL		1306

APPENDIX C

COMPLIANCE COST SPREADHSEETS BY INDIVIDUAL B-737 SERIES FOR RETROFIT PERFORMED BY TAKING THE AIRPLANE OUT-OF-SERVICE

	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
5	RETROFITTING COST	SPECIAL SESSION												
6	PER 737 COMPLIANCE COST													
7	NUMBER WITH 34, 54, OR 89 PARAMETERS													
8	737 MODEL	COST FOR FDAU REPROGRAM	LABOR TIME FOR FDAU REPROGRAM	LABOR COST FOR FDAU REPROGRAM	COST FOR FDR REPROGRAM	LABOR TIME FOR FDR REPROGRAM	LABOR COST FOR FDR REPROGRAM	COST OF WIRING AND SENSORS	LABOR TIME TO RETROFIT WIRING AND SENSORS	LABOR COST TO RETROFIT WIRING AND SENSORS	RETROFIT COST	OUT OF SERVICE DAYS	LOST REVENUE	RETROFIT COST + LOST REVENUE
9	100	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0
10	200	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0
11	ADVANCED 200	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0
12	PRE 10/91 300	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0
13	POST 10/91 300	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	4	$21,556	$56,656
14	PRE 10/91 400	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0
15	POST 10/91 400	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	4	$25,238	$60,338
16	PRE 10/91 500	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0
17	POST 10/91 500	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	4	$19,101	$54,201
18	600	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	4	$30,762	$65,862
19	700	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	4	$34,674	$69,774
20	800	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	4	$41,578	$76,678
21	900	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	4	$43,879	$78,979

	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM
5	RETROFITTING COST	SPECIAL SESSION																	
6	PER 737 COMPLIANCE COST																		
7	NUMBER WITH 22 PARAMETERS																		
8	737 MODEL	COST FOR FDAU REPROGRAM	LABOR TIME FOR FDAU REPROGRAM	LABOR COST FOR FDAU REPROGRAM	COST TO REPLACE FDR	LABOR TIME TO REPLACE FDR	LABOR COST TO REPLACE FDR	COST FOR FDR REPROGRAM	LABOR TIME FOR FDR REPROGRAM	LABOR COST FOR FDR REPROGRAM	COST OF WIRING AND SENSORS	LABOR TIME TO RETROFIT WIRING AND SENSORS	LABOR COST TO RETROFIT WIRING AND SENSORS	RETROFIT COST REPLACE FDR	RETROFIT COST REPROGRAM FDR	OUT OF SERVICE DAYS	LOST REVENUE	RETROFIT COST (FDR REPLACE) + LOST REVENUE	RETROFIT COST (FDR REPROGRAM) + LOST REVENUE
9	100	$10,000	40	[illegible]	[illegible]	32	$2 400	$6,000	16	$1 200	$22,000	380	$27 000	$80 000	$68 800	4	$153	$80 153	$68 95
10	200	$10 000	40	[illegible]	[illegible]	32	$2,400	$6,000	16	$1 200	$22 000	380	$27 000	$80 000	$68 800	4	$480	$80 480	$69 28
11	ADVANCED 200	$10,000	40	[illegible]	[illegible]	32	$2 400	$6 000	16	$1 200	$22 000	380	$27 000	$80 000	$68 800	4	$4 910	$84 910	$73 71
12	PRE 10/01 300	$10,000	40	[illegible]	[illegible]	32	$2,400	$6,000	16	$1,200	$22,000	380	$27 000	$80 000	$68 800	4	$13 578	$103,578	$82 37
13	POST 10/01 300	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0	$0	0	$0	$0	$
14	PRE 10/01 400	$10,000	40	$3,000	$25,000	32	$2,400	$6,000	16	$1,200	$22,000	380	$27 000	$80 000	$68 800	4	$17 337	$107 337	$86 13
15	POST 10/01 400	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0	$0	0	$0	$0	$
16	PRE 10/01 500	$10,000	40	$3,000	$25,000	32	$2,400	$6,000	16	$1 200	$22,000	380	$27 000	$80 000	$68 800	4	$13 425	$103 425	$82 22
17	POST 10/01 500	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0	$0	0	$0	$0	$
18	600	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0	$0	0	$0	$0	$
19	700	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0	$0	0	$0	$0	$
20	[illegible]	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0	$0	0	$0	$0	$
21	[illegible]	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0	$0	0	$0	$0	$

	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP
5	RETROFITTING COST	SPECIAL SESSION								
6	PER 737 COMPLIANCE COST									
7	NUMBER WITH 18 PARAMETERS AND NO FDAU									
8	737 MODEL	COST OF NEW FDAU	LABOR TIME FOR FDAU RETROFIT	LABOR COST FOR FDAU RETROFIT	COST TO REPLACE FDR	LABOR TIME TO REPLACE FDR	LABOR COST TO REPLACE FDR	COST OF FDR REPROGRAM	LABOR TIME FOR FDR REPROGRAM	LABOR COST FOR FDAU REPROGRAM
9	100	$60,000	200	$16,000	$28,000	32	$2,400	$10,000	16	$1,200
10	200	$60,000	200	$16,000	$28,000	32	$2,400	$10,000	16	$1,200
11	ADVANCED 200	$60,000	200	$16,000	$28,000	32	$2,400	$10,000	16	$1,200
12	PRE 10/01 300	$60,000	200	$16,000	$28,000	32	$2,400	$10,000	16	$1,200
13	POST 10/01 300	$0	0	$0	$0	0	$0	$0	0	$0
14	PRE 10/01 400	$60,000	200	$16,000	$28,000	32	$2,400	$10,000	16	$1,200
15	POST 10/01 400	$0	0	$0	$0	0	$0	$0	0	$0
16	PRE 10/01 500	$60,000	200	$16,000	$28,000	32	$2,400	$10,000	16	$1,200
17	POST 10/01 500	$0	0	$0	$0	0	$0	$0	0	$0
18	600	$0	0	$0	$0	0	$0	$0	0	$0
19	700	$0	0	$0	$0	0	$0	$0	0	$0
20	800	$0	0	$0	$0	0	$0	$0	0	$0
21	900	$0	0	$0	$0	0	$0	$0	0	$0

	BG	BQ	BR	BS	BT	BU	BV	BW	BX	BY
8	737 MODEL	COST OF WIRING AND SENSORS	LABOR TIME TO RETROFIT WIRING AND SENSORS	LABOR COST TO RETROFIT WIRING AND SENSORS	RETROFIT COST (FDR REPLACE)	RETROFIT COST (FDR REPROGRAM)	OUT OF SERVICE DAYS	LOST REVENUE	RETROFIT COST (FDR REPLACE) + LOST REVENUE	RETROFIT COST (FDR REPROGRAM) + LOST REVENUE
9	100	$42,000	700	$57,000	$181,400	$175,200	8	$345	$181,745	$176,54
10	200	$42,000	500	$42,000	$176,400	$180,200	7	$806	$177,206	$181,00
11	ADVANCED 200	$42,000	500	$42,000	$178,400	$180,200	7	$8,582	$184,982	$188,78
12	PRE 10/01 300	$42,000	700	$67,000	$181,400	$175,200	8	$30,561	$221,961	$208,75
13	POST 10/01 300	$0	0	$0	$0	$0	0	$0	$0	$
14	PRE 10/01 400	$42,000	500	$42,000	$176,400	$180,200	7	$30,340	$206,740	$180,54
15	POST 10/01 400	$0	0	$0	$0	$0	0	$0	$0	$
16	PRE 10/01 500	$42,000	700	$57,000	$181,400	$175,200	8	$30,206	$221,606	$206,40
17	POST 10/01 500	$0	0	$0	$0	$0	0	$0	$0	$
18	600	$0	0	$0	$0	$0	0	$0	$0	$
19	700	$0	0	$0	$0	$0	0	$0	$0	$
20	800	$0	0	$0	$0	$0	0	$0	$0	$
21	900	$0	0	$0	$0	$0	0	$0	$0	$

APPENDIX D

COMPLIANCE COST SPREADSHEETS BY INDIVIDUAL B-737 SERIES FOR RETROFIT PERFORMED DURING REGULARLY SCHEDULED MAINTENANCE CHECK

	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
25	RETROFITTING COST	REGULAR CHECK												
26	PER 737 COMPLIANCE COST													
27	NUMBER WITH 34, 54, OR 89 PARAMETERS													
28	737 MODEL	COST FOR FDAU REPROGRAM	LABOR TIME FOR FDAU REPROGRAM	LABOR COST FOR FDAU REPROGRAM	COST FOR FDR REPROGRAM	LABOR TIME FOR FDR REPROGRAM	LABOR COST FOR FDR REPROGRAM	COST OF WIRING AND SENSORS	LABOR TIME TO RETROFIT WIRING AND SENSORS	LABOR COST TO RETROFIT WIRING AND SENSORS	RETROFIT COST	OUT OF SERVICE DAYS	LOST REVENUE	RETROFIT COST + LOST REVENUE
29	100	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0
30	200	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0
31	ADVANCED 200	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0
32	PRE 10/91 300	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0
33	POST 10/91 300	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	2	$10,778	$45,878
34	PRE 10/91 400	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0
35	POST 10/91 400	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	2	$12,619	$47,719
36	PRE 10/91 500	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0
37	POST 10/91 500	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	2	$9,551	$44,651
38	600	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	2	$15,381	$50,481
39	700	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	2	$17,337	$52,437
40	800	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	2	$20,789	$55,889
41	900	$5,000	40	$3,000	$1,900	16	$1,200	$12,000	160	$12,000	$35,100	2	$21,940	$57,040

	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM
25	RETROFITTING COST	REGULAR CHECK																	
26	PER 737 COMPLIANCE COST																		
27	NUMBER WITH 22 PARAMETERS																		
28	737 MODEL	COST FOR FDAU REPROGRAM	LABOR TIME FOR FDAU REPROGRAM	LABOR COST FOR FDAU REPROGRAM	COST TO REPLACE FDR	LABOR TIME TO REPLACE FDR	LABOR COST TO REPLACE FDR	COST FOR FDR REPROGRAM	LABOR TIME FOR FDR REPROGRAM	LABOR COST FOR FDR REPROGRAM	COST OF WIRING AND SENSORS	LABOR TIME TO RETROFIT WIRING AND SENSORS	LABOR COST TO RETROFIT WIRING AND SENSORS	RETROFIT COST REPLACE FDR	RETROFIT COST REPROGRAM FDR	OUT OF SERVICE DAYS	LOST REVENUE	RETROFIT COST (FDR REPLACE) + LOST REVENUE	RETROFIT COST (FDR REPROGRAM) + LOST REVENUE
29	100	$10,000	40	$3,000	[illegible]	32	$2,400	$5,000	16	$1,200	$22,000	360	$27,000	$80,000	$68,800	2	$77	$80,077	$68 87
30	200	$10,000	40	$3,000	[illegible]	32	$2,400	$5,000	16	$1,200	$22,000	360	$27,000	$80,000	$68,800	2	$230	$80,230	$69 03
31	ADVANCED 200	$10,000	40	$3,000	[illegible]	32	$2,400	$5,000	16	$1,200	$22,000	360	$27,000	$80,000	$68,800	2	$2,456	$82,456	$71 25
32	PRE 10/01 300	$10,000	40	$3,000	[illegible]	32	$2,400	$5,000	16	$1,200	$22,000	360	$27,000	$80,000	$68,800	2	$6,700	$86,700	$75 50
33	POST 10/01 300	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0	$0	0	$0	$0	$
34	PRE 10/01 400	$10,000	40	$3,000	[illegible]	32	$2,400	$5,000	16	$1,200	$22,000	360	$27,000	$80,000	$68,800	2	$8,688	$88,688	$77 48
35	POST 10/01 400	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0	$0	0	$0	$0	$
36	PRE 10/01 500	$10,000	40	$3,000	[illegible]	32	$2,400	$5,000	16	$1,200	$22,000	360	$27,000	$80,000	$68,800	2	$6,712	$86,712	$75 51
37	POST 10/01 500	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0	$0	0	$0	$0	$
38	[illegible]	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0	$0	0	$0	$0	$
39	700	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0	$0	0	$0	$0	$
40	800	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0	$0	0	$0	$0	$
41	[illegible]	$0	0	$0	$0	0	$0	$0	0	$0	$0	0	$0	$0	$0	0	$0	$0	$

	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP
25	RETROFITTING COST	REGULAR CHECK								
26	PER 737 COMPLIANCE COST									
27	NUMBER WITH 18 PARAMETERS AND NO FDAU									
28	737 MODEL	COST OF NEW FDAU	LABOR TIME FOR FDAU RETROFIT	LABOR COST FOR FDAU RETROFIT	COST TO REPLACE FDR	LABOR TIME TO REPLACE FDR	LABOR COST TO REPLACE FDR	COST OF FDR REPROGRAM	LABOR TIME FOR FDR REPROGRAM	LABOR COST FOR FDAU REPROGRAM
29	100	$60,000	200	$16,000	$25,000	32	$2 400	$10,000	16	$1 200
30	200	$60,000	200	$16,000	$25,000	32	$2,400	$10 000	16	$1 200
31	ADVANCED 200	$60,000	200	$16,000	$25,000	32	$2,400	$10 000	16	$1 200
32	PRE 10/01 300	$60,000	200	$16,000	$25,000	32	$2,400	$10,000	16	$1,200
33	POST 10/01 300	$0	0	$0	$0	0	$0	$0	0	$0
34	PRE 10/01 400	$60,000	200	$16,000	$25,000	32	$2,400	$10,000	16	$1 200
35	POST 10/01 400	$0	0	$0	$0	0	$0	$0	0	$0
36	PRE 10/01 500	$60,000	200	$16,000	$25,000	32	$2,400	$10,000	16	$1 200
37	POST 10/01 500	$0	0	$0	$0	0	$0	$0	0	$0
38	600	$0	0	$0	$0	0	$0	$0	0	$0
39	700	$0	0	$0	$0	0	$0	$0	0	$0
40	800	$0	0	$0	$0	0	$0	$0	0	$0
41	900	$0	0	$0	$0	0	$0	$0	0	$0

	BG	BQ	BR	BS	BT	BU	BV	BW	BX	BY
28	737 MODEL	COST OF WIRING AND SENSORS	LABOR TIME TO RETROFIT WIRING AND SENSORS	LABOR COST TO RETROFIT WIRING AND SENSORS	RETROFIT COST (FDR REPLACE)	RETROFIT COST (FDR REPROGRAM)	OUT OF SERVICE DAYS	LOST REVENUE	RETROFIT COST (FDR REPLACE) + LOST REVENUE	RETROFIT COST (FDR REPROGRAM) + LOST REVENUE
29	100	$42 000	760	$57 000	$191 400	$175 200	6	$230	$191 630	$175 43
30	200	$42 000	560	$42 000	$176 400	$160 200	4	$480	$176 880	$160 68
31	ADVANCED 200	$42 000	560	$42 000	$176 400	$160 200	4	$4 910	$181 310	$165 11
32	PRE 10/01 300	$42 000	760	$57,000	$191 400	$175 200	6	$20,387	$211 787	$195 56
33	POST 10/01 300	$0	0	$0	$0	$0		$0	$0	$
34	PRE 10/01 400	$42 000	560	$42,000	$176,400	$160 200	4	$17 337	$193 737	$177 53
35	POST 10/01 400	$0	0	$0	$0	$0		$0	$0	$
36	PRE 10/01 500	$42 000	760	$57 000	$191,400	$175 200	6	$20 137	$211 537	$195 33
37	POST 10/01 500	$0	0	$0	$0	$0		$0	$0	$
38	600	$0	0	$0	$0	$0		$0	$0	$
39	700	$0	0	$0	$0	$2		$0	$0	$
40	800	$0	0	$0	$0	$0		$0	$0	$
41	900	$0	0	$0	$0	$0		$0	$0	$

APPENDIX E

COMPLIANCE COST SPREADSHEETS FOR THE 4 ALTERNATIVES

	EQ	ER	ES	ET	EU	EV	EW	EX
5	RETROFITTING COST	SPECIAL SESSION						
6	TOTAL 737 COMPLIANCE COST							
7	OPTION 1 NTSB RECOMMENDATION							
8	737 MODEL	NUM NEED FDAU INSTALL	COST FDAU INSTALL	NUM NEED FDAU REPROGRAM	COST FDAU REPROGRAM	NUM NEED FDR REPLACE	COST FDR REPLACE	NW NEED FDR REPROGRAM
9	100	a	a	0	0	0	0	0
10	200	23	1,397,198	31	394,019	11	469,613	43
11	ADVANCED 200	178	10,813,084	68	864,299	49	2,988,381	197
12	PRE 10/91 300	236	14,336,440	184	2,338,692	84	5,241,153	336
13	POST 10/91 300	a	a	154	1,151,402	a	0	154
14	PRE 10/91 400	59	3,584,112	0	0	12	1,141,115	47
15	POST 10/91 400	a	a	37	276,636	a	0	37
16	PRE 10/91 500	a	a	39	495,701	a	213,720	31
17	POST 10/91 500	a	a	130	971,963	a	0	130
18	600	a	. a	0	0	a	0	0
19	700	a	a	73	545,794	a	0	73
20	a m	a	0	46	343,925	a	0	46
21	900	a	a	48	358,879	a	0	48
22			a		0			
23	TOTAL		30,130,841		7,741,308		10,053,982	

	EQ	EY	EZ	FA	FB	FC	FD	FE
8	737 MODEL	COST FDR REPROGRAM	NUM NEED WIRING AND SENSORS	COST OF WIRING AND SENSORS	RETROFITTING COST	NUM TAKEN OUT OF SERVICE	LOST REVENUE	RETROFITTING COST + LOST REVENUE
9	100	0	0	0	0	0	0	$0
10	200	346,358	54	3,324,607	5,959,375	54	31,583	$5,990 958
11	ADVANCED 200	1,827,822	246	17,305,832	33,859,919	246	1,763,139	$35,623 058
12	PRE 10/91 300	2,888,864	420	30,851,514	55,820,380	420	9,236,649	$65,057 029
13	POST 10/91 300	477,400	154	3,696,000	5,405,400	154	3,319,649	$8,725 049
14	PRE 10/91 400	494,056	59	4,631 776	9,851,059	59	1 672 938	$11,523,997
15	POST 10/91 400	114,700	37	888,000	1,298,700	37	933 819	$2 232,519
16	PRE 10/91 500	193,440	39	1,911,000	2,848,560	39	523 562	$3 372 122
17	POST 10/91 500	403,000	130	3,120,000	4,563,000	130	2,483,178	$7 046 178
18	600	0	0	0	0	0	0	$0
19	700	226,300	73	1,752,000	2,562 300	73	2,531 200	$5 093 500
20	a m	142 600	46	1,104,000	1,614,600	46	1,912,592	$3,527 192
21	900	148,800	48	1,152,000	1,684,800	48	2,106 214	$3 791 014
22								
23	TOTAL	7,263,341		69,736,729	125,468,092		26,514,522	$151 982 615

	FG	FH	FI	FJ	FK	FL	FM	FN	FO	FP	FQ	FR	FS	FT	FU
5	RETROFITTING COST	SPECIAL SESSION													
6	TOTAL 737 COMPLIANCE COST														
7	OPTION 2 PROPOSED RULE														
8	737 MODEL	NUM NEED FDAU INSTALL	COST FDAU INSTALL	NUM NEED FDAU REPROGRAM	COST FDAU REPROGRAM	NUM NEED FDR REPLACE	COST FDR REPLACE	NUM NEED FDR REPROGRAM	COST FDR REPROGRAM	NUM NEED WIRING AND SENSORS	COST OF WIRING AND SENSORS	RETROFITTING COST	NUM TAKEN OUT-OF-SERVICE	LOST REVENUE	RETROFITTING COST + LOST REVENUE
9	100	0	$0	0	$0	0	$0	0	$0	0	$0	$0	0	$0	$0
10	200	23	$1,397,196	31	$373,943	11	$461,524	43	$339,036	54	$3,252,276	$5,851,557	54	$26,050	$5,877,607
11	ADVANCED 200	178	$10,813,084	68	$820,262	49	$2,970,637	197	$1,811,762	246	$17,147,170	$33,623,416	246	$1,633,690	$35,257,106
12	PRE 10/91 300	236	$14,336,449	184	$2,219,533	84	$5,193,139	336	$2,845,407	420	$30,422,194	$55,180,430	420	$8,267,924	$63,448,354
13	POST 10/91 300	0	$0	154	$1,151,402	0	$0	154	$477,400	154	$3,696,000	$5,405,400	154	$3,319,649	$8,725,049
14	PRE 10/91 400	59	$3,584,112	0	$0	12	$1,141,115	47	$494,056	59	$4,631,776	$9,851,059	59	$1,672,938	$11,523,997
15	POST 10/91 400	0	$0	37	$276,636	0	$0	37	$114,700	37	$888,000	$1,298,700	37	$933,819	$2,232,519
16	PRE 10/91 500	0	$0	39	$470,445	8	$203,543	31	$184,229	39	$1,820,003	$2,712,918	39	$320,554	$3,033,473
17	POST 10/91 500	0	$0	130	$971,963	0	$0	130	$403,000	130	$3,120,000	$4,563,000	130	$2,483,178	$7,046,178
18	600	0	$0	0	$0	0	$0	0	$0	0	$0	$0	0	$0	$0
19	700	0	$0	73	$545,794	0	$0	73	$226,300	73	$1,752,000	$2,562,300	73	$2,531,200	$5,093,500
20	800	0	$0	46	$343,925	0	$0	46	$142,600	46	$1,104,000	$1,614,600	46	$1,912,592	$3,527,192
21	900	0	$0	48	$358,879	0	$0	48	$148,800	48	$1,152,000	$1,684,800	48	$2,106,214	$3,791,014
22															
23	TOTAL		$30,130,841		$7,532,781		$9,969,957		$7,187,290		$68,985,419	$124,348,180		$25,207,809	$149,555,989

	FW	FX	FY	FZ	GA	GB	GC	GD	GE	GF	GG	GH	GI	GJ	GK
5	RETROFITTING COST	SPECIAL SESSION													
6	TOTAL 737 COMPLIANCE COST														
7	OPTION 3 COMPLIANCE BY 2001														
8	737 MODEL	NUM NEED FDAU INSTALL	COST FDAU INSTALL	NUM NEED FDAU REPROGRAM	COST FDAU REPROGRAM	NUM NEED FDR REPLACE	COST FDR REPLACE	NUM NEED FDR REPROGRAM	COST FDR REPROGRAM	NUM NEED WIRING AND SENSORS	COST OF WIRING AND SENSORS	RETROFITTING COST	NUM TAKEN OUT-OF-SERVICE	LOST REVENUE	RETROFITTING COST + LOST REVENUE
9	100	0		0		0		0		0		$0	0	$0	$0
10	200	23		31		11		43		54		$5,912,944	54	$20,620	$5,933,564
11	ADVANCED 200	178		68		49		197		246		$34,121,856	246	$1,195,353	$35,317,209
12	PRE 10/91 300	236		184		84		336		420		$55,902,640	420	$6,671,819	$62,574,459
13	POST 10/91 300	0		154		0		154		154		$5,140,182	154	$1,993,341	$7,133,523
14	PRE 10/91 400	58		0		12		47		59		$10,023,452	59	$1,164,484	$11,187,937
15	POST 10/91 400	0		37		0		37		37		$1,234,979	37	$560,728	$1,795,707
16	PRE 10/91 500	0		39		8		31		39		$2,708,794	39	$314,382	$3,023,176
17	POST 10/91 500	0		130		0		130		130		$4,339,114	130	$1,491,067	$5,830,182
18	600	0		0		0		0		0		$0	0	$0	$0
19	700	0		73		0		73		73		$2,436,580	73	$1,519,903	$3,956,482
20	800	0		46		0		46		46		$1,535,379	46	$1,148,449	$2,683,828
21	900	0		48		0		48		48		$1,602,135	48	$1,264,712	$2,866,847
22															
23	TOTAL											$124,958,054		$17,344,858	$142,302,912

	GM	GN	GO	GP	GQ	GR	GS	GT	GU	GV	GW	GX	GY	GZ	HA
5	RETROFITTING COST	SPECIAL SESSION													
6	TOTAL 737 COMPLIANCE COST														
7	OPTION 4 MAJOR CHECK														
8	737 MODEL	NUM NEED FDAU INSTALL	COST FDAU INSTALL	NUM NEED FDAU REPROGRAM	COST FDAU REPROGRAM	NUM NEED FDR REPLACE	COST FDR REPLACE	NUM NEED FDR REPROGRAM	COST FDR REPROGRAM	NUM NEED WIRING AND SENSORS	COST OF WIRING AND SENSORS	RETROFITTING COST	NUM TAKEN OUT-OF-SERVICE	LOST REVENUE	RETROFITTING COST + LOST REVENUE
9	100	0		0		0		0		0		$0	0	0	$0
10	200	23		31		11		43		54		$5,532,334	0	0	$5,532,334
11	ADVANCED 200	178		68		49		197		246		$31,925,466	0	0	$31,925,466
12	PRE 10/91 300	236		184		84		336		420		$52,304,243	0	0	$52,304,243
13	POST 10/91 300	0		154		0		154		154		$4,809,313	0	0	$4,809,313
14	PRE 10/91 400	59		0		12		47		59		$9,378,253	0	0	$9,378,253
15	POST 10/91 400	0		37		0		37		37		$1,155,484	0	0	$1,155,484
16	PRE 10/91 500	0		39		8		31		39		$2,534,432	0	0	$2,534,432
17	POST 10/91 500	0		130		0		130		130		$4,059,810	0	0	$4,059,810
18	600	0		0		0		0		0		$0	0	0	$0
19	700	0		73		0		73		73		$2,279,739	0	0	$2,279,739
20	800	0		46		0		46		46		$1,436,548	0	0	$1,436,548
21	900	0		48		0		48		48		$1,499,007	0	0	$1,499,007
22															
23	TOTAL											$116,914,629	0	0	$116,914,629

APPENDIX F

SPREADSHEET FOR FUEL, MAINTENANCE, AND NEW PRODUCTION COSTS OF COMPLIANCE

YEAR	NO.OF 737 IN FLEET	NO.OF 737 TOTAL PRODUCTION	NO OF 737 NET ADDITION	NO.OF 737 REPLACEMENT	NO. OF 737 FLEET FLIGHT HRS (millions)	CUMULATIVE ND 737 FLIGHT HOURS	NO OF DEPARTURES	NO 737 WITH FDAU	No 737 WITHOUT FDAU
1998	1206				3 318			676	529
1999	1254	66	49	16	3 454			742	513
2000	1306	68	51	17	3 596	3 596		810	496
2001	1359	71	54	18	3 743	7 339		881	478
2002	1415	74	56	18	3 897	11 235		955	460
2003	1473	77	58	19	4 056	15 292		1032	441
2004	1534	80	60	20	4 223	19 514		1113	421
2005	1596	84	63	21	4 396	23 910		1196	400
2006	1662	87	65	22	4 576	28 486		1283	379
2007	1730	91	68	22	4.764	33 250		1374	356
2008	1801	94	71	23	4.959	38.209		1468	333
2009	1875	98	74	24	5.162	43 371		1566	308
2010	1952	102	77	25	5 374	48 745		1668	283
2011	2032	106	80	26	5.594	54.339		1775	257
2012	2115	111	83	27	5 824	60 162		1886	229
2013	2202	115	87	29	6.062	66.225		2001	201
2014	2292	120	90	30	6.311	72 536		2121	171
2015	2386	125	94	31	6 570	79.105		2246	140
2016	2484	130	98	32	6.839	85.944		2376	108
2017	2586	135	102	34	7.119	93.064		2511	74
2018	2692	141	106	35	7.411	100 475		2652	40
2019	2802	147	110	36	7 715	108 190		2799	3
2020	2917	153	115	38	8.031	116.221		2917	
TOTAL		2057	1547	510	108 190				
TOTAL		2210	1662	547	116 221				

'CT)F 737 WITH DAU	PER 737 ADD PROD COST		ADD. 737 WT.	ADD GALLONS PER POUND PER HOUR			TOTAL ADD GALLONS PER POUND PER HOUR		TOTAL FLIGHT HOURS	TOTAL ADD GALLONS PER AIRPLANE	COST PER GALLON	ADD FUEL COST PER AIRPLANE	ADD MAIN PER YEAR
	$38,90(		40	0.005789			0.231560		2800	648	$0.61	$395.50	$75(
			10	0.005789			0.057890		2800	162	$0.61	$98.88	

YEAR	TOTAL ADD PROD COST	P.V. ADD. PROD. COST	ADD. FUEL COST OLD 737	ADD FUEL COST NEW 737	TOTAL ADD FUEL COST	P V TOTAL ADD FUEL COST	TOTAL ADD MAINTENANCE COST	P V TOTAL ADD MAINTENANCE COST	TOTAL ADD OPERATIONAL COST	P V TOTAL ADD OPERATIONAL COST	ANNUALIZED ADD OPERATIONAL COST
1998											
1999											
2000	2,659,401	$2,659,401	$196,090	$129,116	$325,206	$325,206	$371,849	$371,849	$3,356,456	$3,356,456	
2001	2,768,437	$2,587,324	$189,118	$134,410	$323,528	$302,362	$358,627	$335,165	$3,450,592	$3,224,852	
2002	2,881,943	$2,517,200	$181,860	$139,921	$321,780	$281,056	$344,863	$301,217	$3,548,586	$3,099,473	
2003	3,000,102	$2,448,977	$174,304	$145,657	$319,962	$261,184	$330,535	$269,815	$3,650,599	$2,979,976	
2004	3,123,107	$2,382,603	$166,439	$151,629	$318,068	$242,653	$315,620	$240,785	$3,756,794	$2,866,040	
2005	3,251,154	$2,318,028	$158,251	$157,846	$316,097	$225,373	$300,093	$213,962	$3,867,344	$2,757,363	
2006	3,384,451	$2,255,203	$149,727	$164,318	$314,045	$209,261	$283,929	$189,194	$3,982,425	$2,653,658	
2007	3,523,214	$2,194,080	$140,854	$171,055	$311,909	$194,241	$267,103	$166,338	$4,102,225	$2,554,660	
2008	3,667,665	$2,134,615	$131,617	$178,068	$309,685	$180,239	$249,587	$145,262	$4,226,937	$2,460,116	
2009	3,818,040	$2,076,761	$122,001	$185,369	$307,370	$167,189	$231,353	$125,840	$4,356,762	$2,369,790	
2010	3,974,579	$2,020,475	$111,991	$192,969	$304,960	$155,026	$212,371	$107,958	$4,491,910	$2,283,459	
2011	4,137,537	$1,965,714	$101,571	$200,881	$302,452	$143,693	$192,611	$91,508	$4,632,599	$2,200,915	
2012	4,307,176	$1,912,438	$90,724	$209,117	$299,840	$133,133	$172,040	$76,388	$4,779,057	$2,121,958	
2013	4,483,770	$1,860,605	$79,431	$217,690	$297,122	$123,295	$150,626	$62,505	$4,931,519	$2,046,405	
2014	4,667,605	$1,810,178	$67,676	$226,616	$294,292	$114,131	$128,335	$49,770	$5,090,231	$1,974,080	
2015	4,858,977	$1,761,117	$55,439	$235,907	$291,346	$105,597	$105,129	$38,104	$5,255,452	$1,904,818	
2016	5,058,195	$1,713,386	$42,700	$245,579	$288,279	$97,650	$80,972	$27,428	$5,427,446	$1,838,464	
2017	5,265,581	$1,666,948	$29,438	$255,648	$285,086	$90,251	$55,824	$17,673	$5,606,492	$1,774,872	
2018	5,481,470	$1,621,769	$15,633	$266,130	$281,763	$83,363	$29,646	$8,771	$5,792,879	$1,713,904	
2019	5,706,210	$1,577,815	$1,262	$277,041	$278,303	$76,953	$2,394	$662	$5,986,907	$1,655,430	
2020	5,940,164	$1,535,051	$0	$288,400	$288,400	$74,528	$0	$0	$6,228,564	$1,609,579	
OTAL	$85,958,778	$40,360,286	$2,206,128	$4,044,248	$6,054,285	$3,261,178	$4,183,507	$2,468,346	$96,521,776	$46,089,810	$4,350,552

	FG	FH	FI	FJ	FK	FL	FM	FN	FO	FP	FQ	FR	FS	FT	FU
5	RETROFITTING COST	SPECIAL SESSION													
6	TOTAL 737 COMPLIANCE COST														
7	OPTION 2 PROPOSED RULE														
8	737 MODEL	NUM NEED FDAU INSTALL	COST FDAU INSTALL	NUM NEED FDAU REPROGRAM	COST FDAU REPROGRAM	NUM NEED FDR REPLACE	COST FDR REPLACE	NUM NEED FDR REPROGRAM	COST FDR REPROGRAM	NUM NEED WIRING AND SENSORS	COST OF WIRING AND SENSORS	RETROFITTING COST	NUM TAKEN OUT-OF-SERVICE	LOST REVENUE	RETROFITTING COST + LOST REVENUE
9	100	0	0	0	$0	0	$0	0	$0	0	$0	$0	0	$0	$0
10	200	23	1,307,186	31	$373,943	11	$461,524	43	$339,036	54	$3,252,276	$5,851,557	54	$26,050	$5,877,607
11	ADVANCED 200	178	10,813,084	68	$820,262	49	$2,970,637	197	$1,811,762	246	$17,147,170	$33,623,416	246	$1,633,690	$35,257,106
12	PRE 10/91 300	236	14,336,440	184	$2,219,533	84	$5,193,139	336	$2,845,407	420	$30,422,194	$55,180,430	420	$8,267,924	$63,448,354
13	POST 10/91 300	0	0	154	$1,151,402	0	$0	154	$477,400	154	$3,696,000	$5,405,400	154	$3,319,649	$8,725,049
14	PRE 10/91 400	59	3,584,112	0	$0	12	$1,141,115	47	$494,056	59	$4,631,776	$9,851,059	59	$1,672,938	$11,523,997
15	POST 10/91 400	0	0	37	$276,636	0	$0	37	$114,700	37	$888,000	$1,298,700	37	$933,819	$2,232,519
16	PRE 10/91 500	0	0	39	$470,445	8	$203,543	31	$184,229	39	$1,820,003	$2,712,918	39	$320,554	$3,033,473
17	POST 10/91 500	0	0	130	$971,963	0	$0	130	$403,000	130	$3,120,000	$4,563,000	130	$2,483,178	$7,046,178
18	600	0	0	0	$0	0	$0	0	$0	0	$0	$0	0	$0	$0
19	700	0	0	73	$545,794	0	$0	73	$226,300	73	$1,752,000	$2,562,300	73	$2,531,200	$5,093,500
20	800	0	0	46	$343,925	0	$0	46	$142,600	46	$1,104,000	$1,614,600	46	$1,912,592	$3,527,192
21	900	0	0	48	$358,879	0	$0	48	$148,800	48	$1,152,000	$1,684,800	48	$2,106,214	$3,791,014
22															
23	TOTAL		$30,130,841		$7,532,781		$9,969,957		$7,187,290		$68,985,419	$124,348,180		$25,207,809	$149,555,989