Executive Summary

This Policy Analysis Exercise (PAE) proposes a fee system, incorporating noise costs, to answer the question "what is the next best move for the South Shore Jet Pollution Council (SSJPC) to take, in order to reduce noise from Boston Logan International Airport?"

Noise is a social problem in which all stakeholders have an interest: those consuming it, in terms of social and environmental well-being; those producing it, in terms of economic efficiency. Since its formation in 2001, SSJPC has pursued various strategies to encourage Massport, owners and operators of Logan Airport, to reduce noise. These have met with limited success. However Massport is currently under court order to revise its landing fee to account for congestion. There is a window of opportunity to make any new fee structure also reflect noise costs.

This PAE calculates noise costs from Logan airport and finds them to be considerable. It then argues that the current landing fee can be modified to account for different noise emissions by different types of aircraft. In so doing, even if revenue neutral, it has the potential to change airline behavior and therefore reduce noise at its source.

SSJPC has so far not used an economic study to highlight the monetary cost of noise. This PAE provides such a study, by adopting a broader perspective, offering new data and providing new options for SSJPC to bring to future negotiations with Massport. It includes case studies highlighting precedents both in the United States and abroad.

Extensive interviews were conducted with members of SSJPC and local residents to gauge the depth of the problem. SSJPC then commissioned new noise contour maps for this study. Data from existing studies was analyzed to calculate monetary values for noise pollution under various scenarios. Using this qualitative and quantitative evidence, interviews were sought with staff at Massport and other key decision makers and stakeholders to probe possible solutions and gain new insights into the problem. The result of this PAE is a new fee proposal, drawing on existing studies, original research and case studies from the United States, United Kingdom, France, the Czech Republic and Germany. This PAE is intended to be a modest contribution towards more economically sound and socially just solutions for both parties.

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1 Scope of Analysis

What we are really talking about here is nothing more nor less than the traditional conflict between commercial business interests and profits on the one hand and public health and welfare on the other. This battle is as old as history itself…

Donald Goldman (1990)

Since its formation in early 2001, the South Shore Jet Pollution Council (SSJPC) has worked hard to try and persuade Massport, owners and operators of Boston Logan Airport, to reduce noise from the airport. It has employed several strategies to date. However, there is a deep level of frustration regarding lack of progress. There is a perceived lack of responsiveness from Massport and the issues have become more acute with the decision by Judge Botsford to allow construction of the Sixth runway. This will increase traffic over the South Shore by opening up a second approach route in the presence of north-westerly winds.

SSJPC has launched three lawsuits in a bid to halt the construction of the sixth runway. Two of these have been unsuccessful and construction will commence imminently, subject to a demand management study.[1] The legal route to decreasing noise from Logan seems limited in the near term. Reducing the noise threshold below 65 dB DNL[2] is also unlikely in the near term. This is primarily due to the Federal Aviation Administration (FAA). They currently pay 80% of noise mitigation costs within the 65 dB DNL contour.[3] As residential land use is deemed incompatible with figures higher than this threshold, reducing the threshold would expose FAA to increased liability, particularly as there are several airports with substantial urban populations nearby, including Chicago and Miami as well as Boston. While SSJPC can launch independent

[1] Massport, forthcoming; Third legal ruling on runway forthcoming.
[2] dB is decibel, a one-time noise level reading. DNL is the average dB over a period of time. See section 2 for explanation of noise terms
[3] Interview with Coy, 18 Feb 2004

legal challenges against Massport, it is harder for SSJPC to launch an independent campaign to reduce the nationally agreed 65 dB DNL level which has existed since FAA assumed responsibility for airport noise regulation from the Environmental Protection Agency (EPA). FAA Part 150 regulations provide funds for enhanced noise mitigation measures below the 65 dB DNL contour in certain situations. Cleveland and Minneapolis airports are pursuing this route, where affected residents in the 60-65 dB DNL contour are compensated through mitigation measures such as insulation. Logan joined this scheme last year.

Decreasing operational hours has been ruled out by Massport on the basis that it contradicts their mission of growth.[4] Logan operates 24 hours a day, 365 days a year. With the cargo customers making use of less busy night slots[5] and the recent introduction of low cost airlines to BOS[6] which often arrive during night hours, this option looks increasingly unlikely.

Soundproofing is ongoing but it does nothing to reduce noise in outside areas. Even within the INM[7] 65 dB DNL contour, Massport will only have insulated 90% of affected property by 2009.[8] There is currently limited funding for measures outside the 65 dB DNL contour. Even if this program were completed imminently, noise contours may expand as the airport increases operations with the sixth runway, extending the area requiring insulation.

The Public information campaign has been ongoing since 2001 when SSJPC was formed. This has consisted of contributions to local newspapers and full page ads from time to time,[9] SSJPC has also fund-raised, commissioned noise studies,[10] written letters and compiled reports for Congressional delegations. However both Massachusetts Senators and the relevant Congressman have not opposed the sixth runway construction[11] and they have not taken a stand on the noise issue in SSJPC's favor. Massport can continue to portray this issue as one of local concern by particular residents, rather than one of wider significance.

In particular it has reached the stage now where further publicity from SSJPC may in fact harm their cause as it will be associated with a particular area and the issue will be taken less and less seriously by Massport. For example, telephone calls to the hotline are quite concentrated in

[4] ibid.
[5] ibid.
[6] For example, Jet Blue arrives into Logan every day at 5.25 am from Long Beach, CA. Source: Jet Blue Aiways, 2004.
[7] Integrated Noise Model, FAA method of measuring noise contours, see Section 2.
[8] Interview with Coy, 18 Feb 2004. Subsequent interview with Desrosiers questioned this and argued that Massport would have insulated all residential areas by 2006. However there remained the additional impacts of the sixth runway.
[9] Interview with Oddleifson 2004
[10] For example, Schomer 2001, Timmerman 2004
[11] SSJPC, 2004

certain areas of the South Shore, and even by certain people which the CEO has come to know.[12] From Massport's perspective, this has a tendency to weaken, rather than strengthen SSJPC's case.

SSJPC has taken an active role on the Citizens Advisory Council (CAC), discussing re-routing plans with Massport and FAA. However, current plans are on hold pending the extensive joint noise study.[13] It is hoped that southerly approach routes can be changed to the east of the Hull peninsula with a cut west north of Hull before landing on Runway 33L. This is promising, subject to safety and security considerations, and will significantly reduce the noise burden on South Shore residents. Moving routes out over water would reduce costs as there is less property value to be affected.

Aircraft noise compliance is administered through a Stage/Chapter System. This is FAA's primary policy tool for reducing noise levels. 'Stage 1' was prohibited in 1985. Stage 2 represented an improved noise standard but this became prohibited in 2000. Stage 3 superseded Stage 2 but still includes retrofitted Stage 2 aircraft which barely comply with Stage 3 standards. So whilst all aircraft currently flying in the United States must comply with Stage 3 requirements, there is noise variation within this level. For example, some airlines have new 777 and Airbus aircraft which are "Full" Stage 3 compliant whilst others use 'hush-kitted' old Stage 2 aircraft that have been adapted. Therefore mandating 'Stage 3' at Logan ignores the differences in aircraft performance within this level. Mandating 'Full' Stage 3 aircraft would face legal challenge from the airlines when all Stage 3 are currently legal. Logan is legally compliant, but its fleet mix varies (see below for fuller discussion). Stage 4 is set to be introduced in 2006.[14]

Massport states it will "continue to explore new ways to enhance its noise abatement programs at Logan Airport, because it is an urban airport surrounded by residential communities".[15] Massport has committed to maintain the noise cap at 156.5 EPNdB,[16] stating "Logan is committed to keeping cumulative noise at or below the 1986 level, regardless of fluctuations in the number of passengers and operations".[17]

Given the above limitations with current strategies, this PAE takes a different approach and offers SSJPC a new argument to bring to the negotiating table. It attempts to be a dispassionate, economic argument which seeks to improve overall social welfare, recognizing the economic value of aviation.

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[12] During the interview, Coy pointed out the concentration in number of calls from particular residents. February 18 2004, 12 March 2004.
[13] Interview Coy 12 March 2004
[14] FAA, 2004, Stage 2 terminated 2000 and Stage 3 is superseded by Stage 4 in January 2006.
[15] Massport 2004
[16] Effective Perceived Noise Level in Decibels, usually measured at take off and landing
[17] Massport 2004

2 Noise from Boston Logan International Airport

There can be no doubt that Logan adversely impacts its surrounding community in terms of noise. "Although jet engines today are much quieter than they were even ten years ago, the huge rise in the number of flights makes the problem more pervasive".[18] As Whitelegg concludes, "Despite the introduction of quieter aircraft, the evidence suggests that the number of people affected by aircraft noise is rising, due to the rapid growth in air traffic".[19] The number of passengers through Logan was 15.1 million in1980 but this increased to c.25 million annually in the late 1990s.[20]

2.1 How noise is measured

While noise can be defined as "unwanted sound"[21] it is physically the same thing as sound, which is vibration, caused by air movements. This distinction and similarity is important because waves, wind and conversation are naturally occurring 'sound' that feed into airport noise measurements. The range of 'noise' detectable by the human ear is large and so a logarithmic scale is used, usually dB, or decibel. From this, an industry standard, is calculated; the Day/Night Average Noise Level (DNL).[22] DNL is an accumulated 24 hour average of the commonly used scale dB. Therefore readings become "dB DNL", or average dB. This originates in the 1972 Noise Control Act whereby the Environmental Protection Agency (EPA) was mandated to set appropriate levels for noise exposure. It tends to exaggerate low pressure sounds – but aircraft

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[18] Economist, 2001:3
[19] Whitelegg et al (2001:13)
[20] Massport, 2004; The number of people exposed to noise levels >67 dB LAeq at German airports increased by an average of 22% over the same period and this was attributed mainly to increased traffic between 1980 and 1990, OECD 1993 in Berglund et al (eds) 2000:64
[21] Berglund et al (eds) 2000:ix
[22] DNL is used interchangeably with DBa to remain true to the original sources from which they were taken, however DNL is an average measure of accumulated DBa, which is the actual measurement.

noise tends to be of a higher pressure form.[23] The averaging also obscures particularly noisy events. Commercial jet aircraft create c.103 dB at 1,000 ft.[24] An equivalent would be listening to a walkman on full volume which creates a reading of c.100 dB.[25] Planes approaching Logan fly overhead Hull High School at an altitude of c.1,500ft.[26]

Noise pollution has negative effects on residents in the vicinity of airports. Children have been found to suffer significant reading deficits due to overhead aircraft noise[27] and in some cases physiological damage[28] and feelings of helplessness.[29] Londoners have coined the term "jet-pause teaching" in the UK to highlight the fact that children taught in schools under flight paths can have worse academic performance than children in quieter schools, other factors held constant.[30] Periodic events can lead to sleep deprivation and these events are not captured by the DNL standard, as they are averaged out over the year.[31]

The FAA acknowledges that "because DNL combines both the intensity and number of single noise events (along with night-time weighting), it…is not a good estimator of the single-event sound levels which are experienced".[32] A 65 dB DNL level could therefore be composed of any of the following combinations in Table 2.1.

Exhibit 2.1 DNL composition example[33]

Average Sound Exposure Level	Effective Number of Events	DNL
87.4 dB	500	65 dB
94.4 dB	100	65 dB
97.4 dB	50	65 dB

Therefore from SSJPC's perspective, only a few planes need to be replaced to reduce the DNL measure. From Massport's perspective, they can replace a few noisy planes with a lot more quieter planes, with positive revenue and growth implications.[34]

[23] Berglund and Lindval [eds] 1995:15
[24] Andre, 2002:21
[25] ibid.
[26] Interview with Craig Coy 18 February 2004; SSJPC 2001
[27] Andre, 2002:19; Evans and Maxwell, 1997
[28] Evans, Bullinger and Hygge, 1998
[29] WHO, 2000
[30] Holland, 1997
[31] FAA gives a 10DNL weighting to night-time activity to try and reflect increased cost of sleep deprivation etc. and to penalize night time activity in comparison with day time operations. South Shore residents have been woken up at 3am by cargo flights into Logan.
[32] FAA, 2004
[33] Source: adapted from FAA, 2004

2.2 History of debate concerning Logan's noise levels

2.2.1 A key area of disagreement is the spatial impact of noise. The World Health Organization recommends that noise exposure should be mapped and that "where action is needed to lower noise levels, the absence of comprehensive information should not prevent the development of…noise exposure estimates…(which can) be used to develop and implement interim noise management plans".[35] The footprint maps in Section 3 show how the noise fallout follows the approach landing and runway take-off sequences from the five runways. In theory, they show that a lot of this fall-out occurs "over water".[36] However this assumes that aircraft adhere to the computer simulation model and actually make the necessary turns on take off and landing to avoid residential areas and fly over the sea. Often they do, but often they don't. Reasons given include fuel economy, weather conditions, or even pilot preference.[37] In addition they regularly fly over land as it is deemed to be <65 dB DNL according to computer modeling. The FAA advises pilots to "make every effort to fly not less than 2,000 ft above the surface, weather permitting"[38] but there remains a significant amount of pilot discretion.

2.2.2 Another disagreement concerns level of those impacts. FAA determined 65 dB DNL to be the appropriate level, however the EPA maintains 55 dB DNL as a figure to protect against interference with outdoor activities.[39] WHO guideline values recommend 55 dB DNL as the level compatible with outdoor residential land use.[40] 31% to 53% of noise monitors for the National and Dulles airports in Washington DC recorded DNL readings in excess of 65 dB DNL.[41] Yet several airports have voluntarily tried to mitigate effects under 65 dB DNL. The 60 dB DNL contour has been accepted by Cleveland airport and is being considered by Minneapolis. They have set aside a budget of $150M to deal with compensation requirements.[42]

There is disagreement over the noise level both in terms of an acceptable standard and what is actually recorded on the ground, irrespective of standards. For example, Massport

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[34] Whilst Schomer and other noise experts claim that eliminating c.8% of noisy operations could result in reductions in overall sound emission of up to 50%, Massport argues the figure to be nearer 20%, Interview with Coy and Desrosiers 12 March 2004
[35] Berglund et al, 2000:50-51
[36] Massport, 2003
[37] Timmerman, 2004, Oddleifson, 2004
[38] FAA, 1984
[39] Falzone, 1999:775
[40] Berglund et al (2000:45) Also The World Health Organization (WHO) stipulates a level of 55DbH as safe noise level consistent with a reasonable quality of life.
[41] Falzone, 1999:775. Also note because the Dbh scale is logarithmic the 65 versus 55 debate is one of significant difference, being a tenfold difference between the two.
[42] Laqve interview, 15 March 2004.

calculates the noise level at the tip of Hull peninsula to be 55 dB DNL[43] but noise meter readings show it to be 64 dB DNL.[44] The lower Massport figure could be explained by averaging out of noise that is an inherent part of the way DNL figures are calculated, but also could be attributed to a high reading of 'background' noise which is subtracted from the aircraft noise impact reading. According to Massport's own noise footprint maps[45] the Hull peninsula lies between 50 and 55 dB DNL, therefore rendering it an 'acceptable' noise level, compatible with residential land use.[46] [47]

2.2.3 Third, Aircraft noise emissions are not equal. Yet the current fee structure charges according to one variable only, weight, regardless of aircraft noise standards. For example, smaller regional jets and business jets are accorded the smallest fee yet can often make a disproportionate amount of noise and also disproportionately contribute to delays.[48] Recent work has shown[49] many business jets and other small aircraft to be least compatible with full Stage 3 requirements and least likely to meet new Stage 4 requirements in 2006. Smaller aircraft <75,000 lbs need only be Stage 2 compliant as they are exempt from Stage 3 regulations.[50]

Massport states that it has been "aggressive" at discouraging the use of hush-kitted, Stage-2- retrofitted aircraft.[51] The trend is definitely geared towards a phasing out of these planes. According to Massport, the proportion of "full" Stage 3 aircraft increased almost 23% from 1999 to 2002, reaching 92.8% of the fleet mix.[52] Massport had been working with Delta and US Airways to replace their noisy shuttle fleet (about 22,000 flights per year before 9/11) with quieter Boeing 737-800 and Airbus 319/320 aircraft.[53] However this trend was undoubtedly helped by many airlines retiring their oldest and noisiest aircraft in response to the drop in demand post September 11, 2001.

The airlines not 'full' Stage 3 are listed in the Appendices but include major carriers such

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[43] Massport 2004
[44] Timmerman 2004
[45] Massport 2003
[46] See map in Section 3 and Timmerman methodology in Appendices for further information.
[47] Timmerman 2004. For example levels of 64DNL have been recorded on the Hull peninsula, in spite of it lying at the INM 55DNL contour line. Note that 64DNL is a yearly average, incorporating episodes higher than this. Yet due to windy conditions and the microphone and sensor's susceptibility to wind interference and other 'background noise' adjustments are made reducing the level to an 'aircraft' level of c. 55DNL
[48] Schomer, 25 February 2004
[49] Gilbert 2004
[50] However the FAA is proposing change. "All subsonic jet and transport-category airplanes (…mtow of 12,500 pounds or more) for which application of a new type design is submitted on or after Jan. 1, 2006, will have to meet new noise certification levels", Gilbert, 2004
[51] Massport 2004
[52] Ibid.
[53] ibid.

as Air Canada, Airtran, Alaska Airlines, Delta, MidWest Express, Northwest and Transmeridian. The representative of one of these airlines commented that ”Northwest Airlines fundamentally disagrees with the FAA's suggestion that the number of Americans impacted by aviation noise remains significant and that aggressive new measures must be taken to address aviation noise without regard to the high cost of such measures relative to the modest incremental benefits of such expensive measures.”[54] Whilst most of the passenger carriers are ‘full' Stage 3 compliant, none of the cargo carriers are. Airborne Express, Capital Cargo International, DHL, Federal Express and UPS all operate aircraft into Logan that are not Full Stage 3 compliant.

Logan has maintained a decreasing trend beneath its noise cap of 156.5 ENPdB. However, non-jet aircraft are not included in the calculation. The highest reductions have been due to the phasing out of older Stage 2 aircraft, but the lowest reductions have continued to occur in cargo operations. A recent study has shown that in fact Regional Jets (RJs) may be noise preferable to turboprops as they have a faster ascent/descent, higher frequency sound emissions and typically have a higher load factor, thus permitting Massport's growth mission to work alongside noise reduction.[55]

[54] Tom Tinkham, in Blomberg and Sharp 2002:3
[55] Harris, Miller, Miller and Hanson, Inc. 2004, Regional Jets vs turboprop white paper http://www.flynaples.com/RJ_turboprop%20comparison.pdf

3 Calculating noise costs at Logan

Noise costs have been calculated at various airports around the world over the last several decades. There is an extensive literature which uses several pricing methods to try and calculate a lump sum in each instance. The most common method used is 'hedonic pricing' where the price of a good (house) is related to its characteristics, which include, for example, location, view and peacefulness. We can isolate and value the individual characteristics of houses (such as noise exposure) through assessing willingness to pay to avoid or keep these attributes. In this way, hedonics can analyze changes in property values with respect to one variable. Other variables are excluded so that the effect of increasing (or decreasing) noise on the dollar price of the property can be determined in isolation. Other methods include abatement costs, avoided costs, productivity loss and contingent valuation. Such survey-based methods are often more difficult and expensive to conduct and they rely on hypothetical 'what if' scenarios which are always less reliable than past data. Due to the variety of different methods used, cross comparisons between different studies are difficult. This is one of the main reasons this study uses hedonics, as it is the most common methodology for airport noise calculations.

3.1 Hawkins (1999) reviewed noise cost calculations from existing studies based on willingness to pay. Most of these are hedonic house pricing methods and use the Noise Depreciation Sensitivity Index (NDSI), which measures the average percentage change in property price for a one dB change in noise level. These twenty one studies were averaged to calculate an NSDI figure of 0.87.[56] This means 5 dB DNL reduction increments would be associated with a 4.35% increase in property value. See Exhibits 3.1 and 3.3.

[56] This was calculated from averaging 21 existing US studies ranging from 0.08 to 2.3. See Hawkins 1999 for more detail.

Exhibit 3.1 – Property value calculations

Contour	Town	Population (Year 2000)	Av.HH size (2000)	#HH (Year 2000)	Av. H price ($, 2002)	Total town property value ($)	Contour property value ($)
>65 dB DNL	INM 65DNL	8309	2.49	3343	300,000	1002874385	1002874385
>60 dB DNL	Chelsea	35080	2.87	11888	300,000	3566400000	
	Hull	11050	2.44	4522	343809	1554704298	7474004298
	Winthrop	18303	2.3	7843	300,000	2352900000	
>55 dB DNL	Cohasset	7261	2.69	2673	755942	2020632966	
	Everett	38037	2.45	15435	300,000	4630500000	
	Hingham	19882	2.72	7189	577608	4152423912	
	Nahant	3632	2.2	1629	300,000	488700000	25287947055
	Quincy	88025	2.22	38883	315819	12279990177	
	Swampscott	14412	2.48	5719	300,000	1715700000	

Note: For INM 65DNL area: 8,309 figure (Massport, 2004); 2.49 is average of other towns; $300,000 is assumed property value. Calculated using data from: US Census, 2000 and Boston South Real Estate, 2004.

3.2 Calculating noise costs

3.2.1 Integrated Noise Model (INM) contour

FAA developed INM in 1978 for assessing the noise impact of aircraft operations. "The Model Utilizes flight track information, aircraft fleet mix, standard and user defined aircraft profiles and terrain as inputs."[57] INM allows FAA and airport staff to produce noise contours and is compatible with Geographic Information Systems (GIS) to enable land use planning. Massport, in accordance with FAA guidelines, uses the INM 65 dB DNL level and determines that 8,309 people live within the contour line – see the noise contours map (Exhibit 3.2) and the *65 dB DNL (INM)* contour. Using the population data provided by Massport, an average house size of 2.49[58] and an average house price of $300,000, total noise external costs are estimated to be $65.4 million for a reduction from 75 dB DNL to 65dB DNL.[59] See Exhibit 3.3. Given the current legal maximum DNL level, Massport's population figures, and other assumptions noted, this figure, $65.4 million, is the PAE base figure for noise costs. This is because 65 dB DNL is currently the legal reality and these are the costs that fall within Massport's already agreed area of responsibility.

[57] FAA 2004
[58] Averaged from the other towns in this study which are based on US Census data (2000)
[59] Half of the 8,309 population were assumed to be exposed to 65-75DNL and half to only 65-70DNL. This makes the figure more conservative.

MAP

3.2.2 Measured 65 dB DNL contour

The 65 dB DNL contour was recalculated by Nancy Timmerman, former Noise Abatement Supervisor at Massport, and now an independent noise consultant. Timmerman used actual recorded data[60] based on background noise levels recorded during 11-13 September, 2001, when there were no aircraft operations. These were then subtracted from subsequent total readings. See the *65 dB DNL (Timmerman)* contour on the map (Exhibit 3.2). Aircraft disobedience of the computer generated model, seen in complaints to Massport's hotline which show a high number of callers from outside this area,[61] is confirmed by actual noise readings. These indicate that the contour encompasses a larger area than the INM model suggests. Whereas 8,309 people fall within the INM 65 dB DNL contour, more fall within the contour based on actual measured data. It is hard to quantify the external cost as the census data is not detailed enough to account for the contour shape and no towns lie wholly within it, but we can unequivocally conclude that it is higher than the base figure as shown in Exhibit 3.2.

Exhibit 3.3 – Noise cost calculations

dB DNL contour	70-75	65-70	60-65	55-60
% change house price (NSDI 0.87)	0.0435	0.0435	0.0435	0.0435
Property value ($)	501437193	1002874385	1002874385 7474004298	1002874385 7474004298 25287947055
Total property value ($)	501437193	1002874385	8476878683	33764825738
$ change (NDSI 0.87)	21812518	43625036	368744222.7	1468769920
Total ($)		65437554	434181776.4	1902951696
External noise cost	**$21.8Million**	**$65.4Million**	**$434.2Million**	**$1902.5 Million** **$1.9 Billion**
Annual payment ($) at 5% discount rate		3,271,877.68	21,709,088.82	95,147,584.80

Note: Parts of Cohasset, Hingham, Quincy, Everett and Swampscott lie outside the 55DNL contour but are included as >50% of the town lies within the contour. Scituate, Weymouth, Braintree, Milton, Boston, Somerville, Medford, Malden, Revere, Saugus, Lynn, Salem and Marblehead are partly affected but excluded as <50% of the town lies within the 55DNL contour. 2000 US Census data was used for this study but is broken down by town only. GIS applications would allow a more accurate population figure and real estate prices to be calculated. This would probably result in a higher external cost figure.

[60] Timmerman, 2004 – see Appendices for methodology
[61] The possibility of certain callers making repeated calls and driving up the complaints number can be cross checked with the actual meter readings.

3.2.3 Measured 60 dB DNL contour

Noise externality costs were then calculated to incorporate residences in the 60-65 dB DNL range – see the *60 dB DNL (Timmerman)* contour in Exhibit 3.2. This includes the towns of Chelsea, Hull and Winthrop and provides an external cost in the region of $434.2 million. The demographic data for the towns was sourced from the US census. This information was combined with house prices to calculate property values as shown in Exhibit 3.1. The property values per town were then used to calculate the value change according to decibel change. As each town fell within the contour, it was included in the calculation as seen in Exhibit 3.3. This contour also includes parts of Milton, Boston, and Nahant. If they were included in the population and household counts, the external cost figure would be higher.

3.2.4 Measured 55 dB DNL contour

The noise externality cost incorporating residences in the 55-60 dB DNL range was calculated, including all the towns detailed in the above tables, giving an external cost of $1.9 billion – see the *55 dB DNL (Timmerman)* contour in Exhibit 3.2. It should be noted that this figure excludes parts of several towns owing to non-compatible census data. In fact the 55 dB DNL contour can be considered to include at least parts of North Scituate, Weymouth, Quincy, Milton, Boston, Medford, Chelsea, Revere, Winthrop, Nahant and Swampscott as shown in the map. Including parts of these towns would increase the noise cost figure substantially.

3.3 Annual payments and average costs

The external cost figures from Exhibit 3.3 are one-off amounts, subject to revision in line with property prices and noise monitoring. They can be discounted as shown in the *Annual Payment* line in Exhibit 3.3, to provide annual payment costs as noise compensation. A figure of 5% is used, as this is a real (inflation free) rate which approximates closest to US base rates used in longer term discounting, such as 30 Year T-Bonds. This could obviously change according to time and circumstances. Noise costs are amortized over the expected life of the house, which in practice means the noise cost lump sums will be discounted indefinitely. These are then analyzed in Exhibit 3.4 to calculate base average costs. For example, using the PAE base figure (in bold) we get a per operation charge (take-off or landing fee) of $11.04 which is 14c per passenger or 0.4c per lb of cargo. Using the highest noise costs, we get a per operation charge (take-off or landing fee) of $321.05 which is $4.17 per passenger or 12.8c per lb of cargo. These are useful benchmarks when thinking about recuperating noise costs through charging. However, for fees to be seen as an incentive they have to vary by aircraft type, penalizing noisy planes and crediting quieter aircraft.

Exhibit 3.4 – Average costs

Annual payment ($)	# ops 2003[62]	Av cost/op ($)	# pax 2003[63]	Av cost/pax($)	# cargo (lbs)[64]	Av cost per lb ($)
3271877.68	296,366	11.04	22,791,169	0.14	744838287	0.004
21709088.82	296,366	73.25	22,791,169	0.95	744838287	0.029
95147584.80	296,366	321.05	22,791,169	4.17	744838287	0.128

62 Source: Massport fleet mix data 2004. Aggregate data states a higher figure but the data that was provided broken down by fleet mix is the figure used above and in further calculations herein.
63 Source: Massport 2004
64 ibid.

4 Landing fees incorporating noise

Landing fees are the charges levied by individual airports on each aircraft operation (take off and landing). Traditionally they have been use to recover the costs of building and maintaining the airfield and have only been based on one variable, aircraft weight. This is because heavier planes tend to cause more wear and tear and take up more space. In the last four decades, however, several airport operators and policy analysts have realized that airport costs are determined by more than this. Costs are not a function of, for example, runway thickness and length alone. As peak hour airport congestion became a problem in the 1960s, some aviation and policy analysts began arguing that landing fees ought to reflect congestion costs. However incorporating congestion did not overtly threaten the existing weight-based cost structure since heavy and light planes took similar amounts of time to land. The only change would be according to time of day; an additional aircraft causing a lot of congestion during the peak would be charged more than in the less busy off peak. With the rise in environmental concerns during the 1970s, economists began arguing that fees should reflect the noise damages caused by aircraft operations near residential areas. Such fees would encourage aircraft operators to use quieter aircraft or to fly at different times. Incorporating noise would change the weight-based cost structure, since noise is not closely correlated with aircraft weight.

The correlation between current fee and aircraft noise level is 0.58,[65] implying inefficient charging with respect to noise costs. It is clear that some aircraft are free riding on others, for example a Boeing 777 pays three times the amount paid by a DC-9-50, despite being quieter. Even modest fees increases could induce airlines to change their behavior. The fee increases proposed are calculated by percentage increase in the overall landing fee. A detailed breakdown

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[65] Calculated by ranking the fleet mix, corresponding them with weight, and calculating their fees, then ranking them with their corresponding approach noise levels. Based on FAA and Massport data 2004. See Appendix 2 for complete detailed breakdown.

is included in Appendix 2, but a summary follows here. Quieter aircraft either get credits or face modest increases in the overall landing charge. Noisier aircraft that have been previously undercharged on a weight-only basis face the highest increases in charges. The 64 aircraft[66] in Logan's 2003 fleet mix were researched and their respective weights and approach noise levels determined from FAA statistics.[67] The fleet mix was then ranked according to approach noise level – see Exhibits 4.1 and 4.2. The noisiest twelve aircraft stand out, shown by the clear and sudden increase in the log curve. By grouping all aircraft into one of 5 categories, a different fee can be charged according to noise emission level. Noise was compared with numbers of operations and Massport revenue, see Exhibits 4.3 and 4.4. This was to check that penalizing the noisiest planes would not overtly affect the number of Logan operations or overtly harm Massport revenue sources which may otherwise render the scheme cost prohibitive. In both cases it can be seen that the noisiest aircraft are not the majority of operations or Massport landing fee revenues.

4.1 Revenue-generating scheme

Landing fees for each aircraft were calculated according to their group whereby the two quietest groups did not pay any noise charge – see Exhibit 4.5. Based on the $65.4 m cost, the third quietest group was charged $13.70 per operation, which represents the average externality/operation amount, $11.04, x 1.2405. The two noisiest categories were charged $44.16 and $88.32 per operation, reflecting 4 and 8 times the average charge respectively. The associated figures for higher noise cost amounts are also shown in the table. Such a scheme could raise the annual externality fee amount for Massport to use for enhanced mitigation measures such as speeding up the soundproofing scheme, enhanced monitoring of noise, or funding the CAC. If noise costs changed then the fees could be recalculated using similar ratios.

[66] There were 68 aircraft types but 4 types had insufficient data available and have been omitted from the calculations. Further aircraft are part of Massport's fleet mix but did not operate in 2003.
[67] See aee.faa.gov for further information

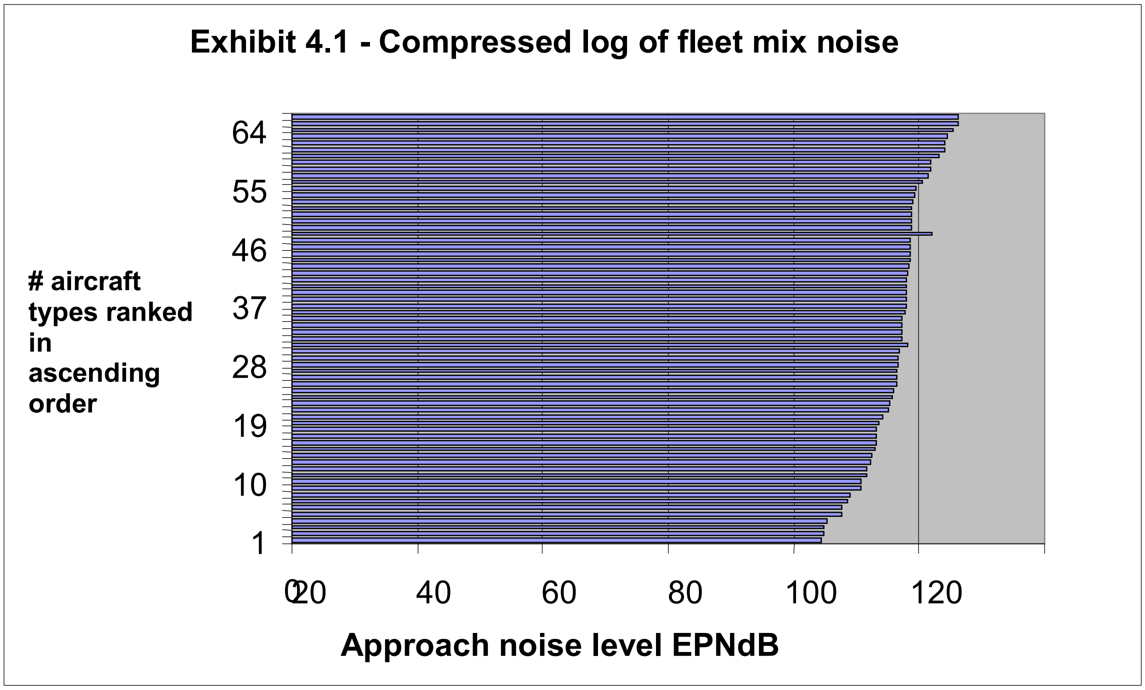


Exhibit 4.1 - Compressed log of fleet mix noise
aircraft types ranked in ascending order
64
55
46
37
28
19
10
1
0
20
40
60
80
100
120
Approach noise level EPNdB

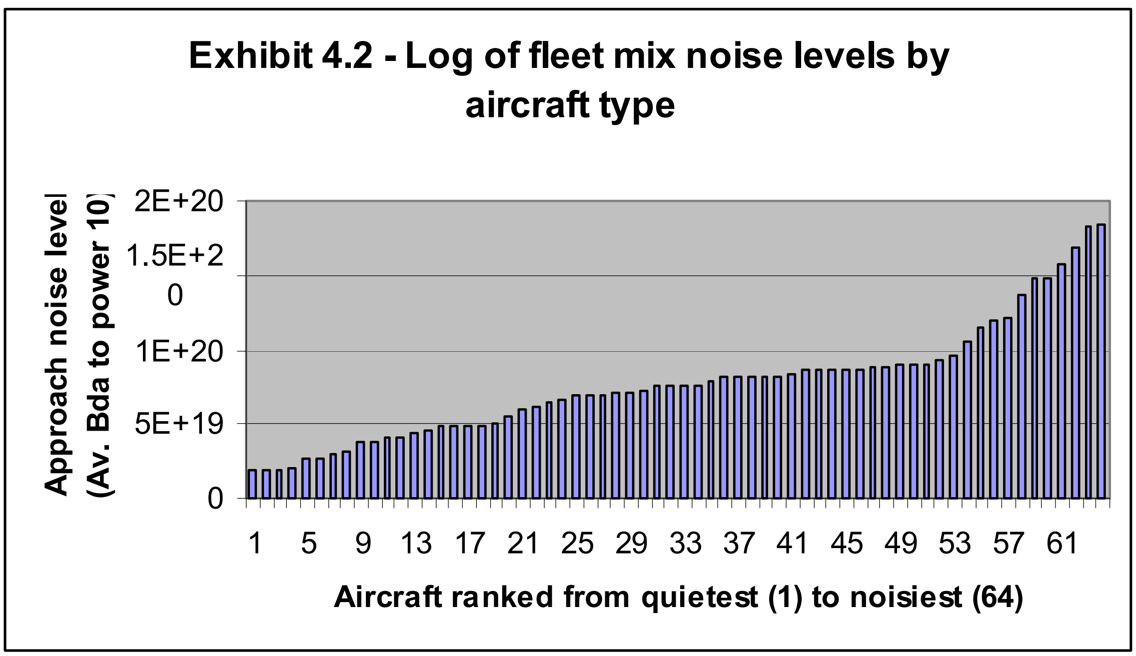


Exhibit 4.2 - Log of fleet mix noise levels by aircraft type
Approach noise level (Av. Bda to power 10)
2E+20
1.5E+20
1E+20
5E+19
0
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
61
Aircraft ranked from quietest (1) to noisiest (64)

Exhibit 4.3 Aircraft ranked according to noise level and operations

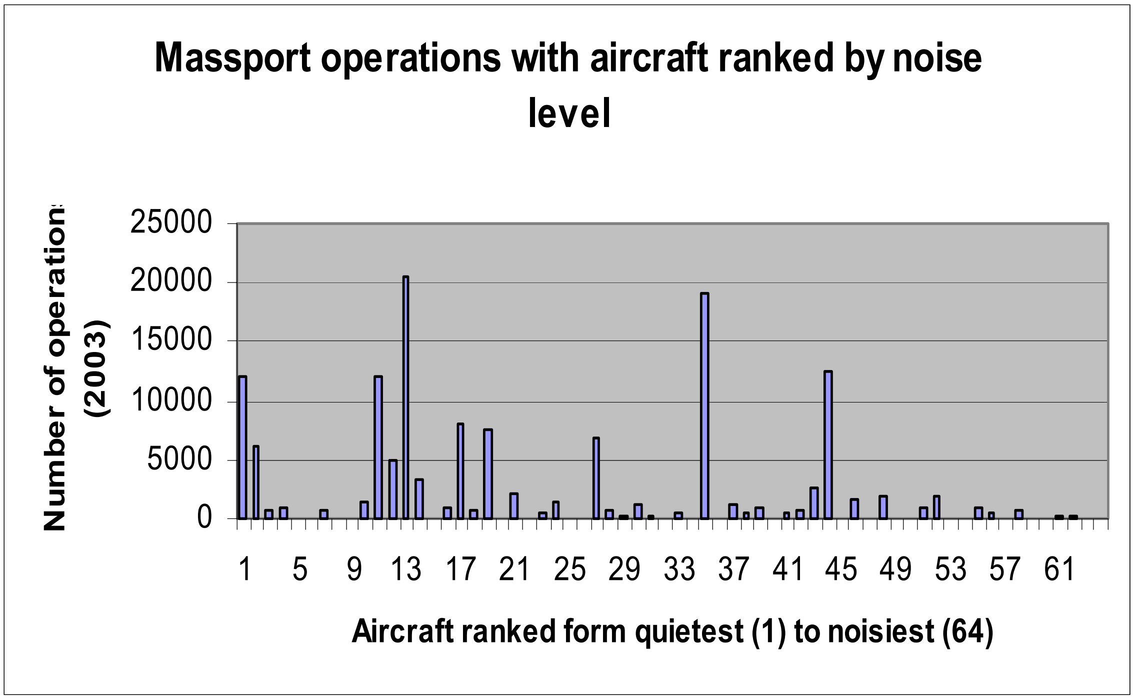
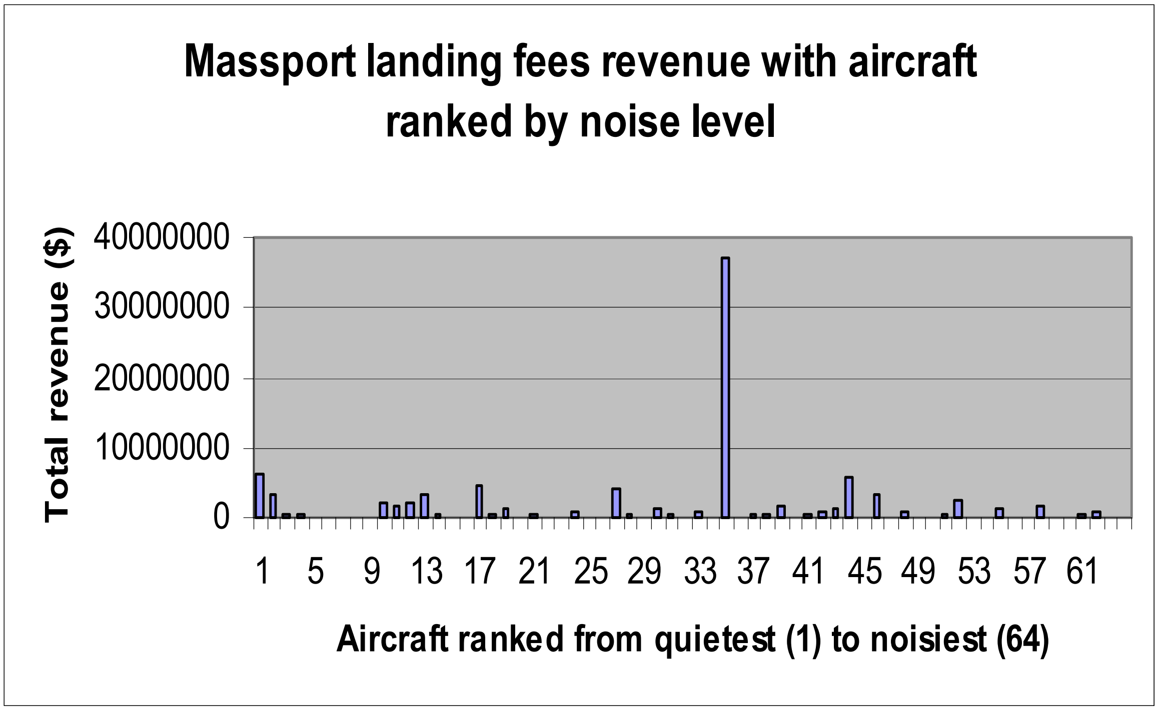


Exhibit 4.4 Aircraft ranked according to noise level and revenue to Massport



4.2 Revenue-neutral scheme

A revenue neutral fee system may be preferable to avoid or meet airline and/or other legal challenges. A revenue-neutral scheme is not revenue enhancing to Massport or any other party. As a group, the airlines pay, and are credited, the equivalent of the external cost amount. Based on the 3.27 m annual noise payment figure, the quietest group was credited $17.96 per operation, representing 1.6267 x average cost ($11.04), and the next quietest group $5.52 per operation, representing 0.5 x average cost – see Exhibit 4.5. The third group was charged nothing and the fourth and fifth groups were charged $33.12 and $99.36 per operation representing three times and nine times the average fee respectively. On balance, the two noisiest groups fund the credits to the two quietest groups. The relevant charges are shown for the higher noise costs, 21.7 m and 95.1 m as well.

Exhibit 4.5 Revenue schemes

Noise cost ($)	3.27 m	21.7 m	95.1 m	3.27 m	21.7 m	95.1 m
Noise Group	**Rev-generating** charge per op ($)			**Revenue-neutral** charge per op ($)		
1	0	0	0	-17.96	-119.16	-522.25
2	0	0	0	-5.52	-36.63	-160.52
3	13.70	90.88	398.32	0	0	0
4	44.16	293.00	1284.19	33.12	219.75	963.14

5	88.32	586.00	2568.38	99.36	659.26	2889.43
Revenue ($)	3.27 m	21.7 m	95.1 m	0	0	0
	Representing noise external costs annual payment			Representing noise external cost annual payment redistributed amongst airlines		

For 9 years now, Prague – Ruzyne airport has implemented a differentiated noise fee scale whereby the fee level is a factor of noise category. The airport states "this is an active approach motivating the airline companies to use more advanced and less noisy airplanes for their flights to Prague".[68] Noise fee revenues finance the airport's noise monitoring schemes and noise abatement measures. The fee is strictly non-profitable for the Czech Airports Authority and subsequently fee levels can be set so as to cover noise abatement costs. Massport already incorporates some noise monitoring costs into its landing fees, but on an aggregate scale. There is no external cost incorporation and, unlike the Czech example, there is no incentive for airlines to improve their performance as the fee is undifferentiated with respect to noise level.

4.3 Other variables in addition to noise requiring further incorporation

4.3.1 Time of day

Logan operates 24 hours a day, 365 days a year and there are currently no regulations for night flights.[69] One possible policy proposal is to limit these (further) or prohibit them at certain times, however Massport's *Demand Management Plan* could push aircraft to later or earlier hours to avoid peak pricing.[70] The main concern of citizens in a recent survey on aircraft noise was loss of sleep.[71] Many states, such as New Jersey, set night-time street noise limits at 50 dB DNL.[72] The FAA maintains its 65 dB DNL level arguing that it incorporates a weighting of 10 dB between 22.00 and 07.00 to compensate for sleep disturbance[73] and so the sensitivity of night-time quiet is reflected in the average yearly DNL figure.

Logan attempted to introduce a system based on time of day in 1990, but it was abandoned by Massport and the FAA, worried about 'interstate commerce'.[74] However Hanscom Field continues to have a fee based system according to time of day (see below). It is clear also

[68] http://www.csl.cz/en/spolecnost/tisk_media/tiskovezpravy/tiskovezpravy_1.htm

[69] Interview with Craig Coy, 18 February
[70] Awaiting Massport response
[71] Blumberg and Sharp 2002:11
[72] Ibid.
[73] FAA 2000
[74] Timmerman, 2004, Interstate Commerce is guaranteed under the US Constitution

that peak pricing works in many other locations, including large international airports such as London Heathrow and Paris Charles de Gaulle.[75] As an entrepreneur Massport should put forward proposals to introduce peak pricing to deal with delays as well as discourage night time traffic. The recent ruling by Judge Botsford in the Sixth Runway case mandates Massport to trial a peak pricing scheme and the results of this proposal are due imminently.

4.3.2 Cargo carriers

92.8% of BOS fleet mix was deemed Stage 3 High (non hush-kitted) in 2003.[76] A list of airlines not in full compliance is included in the Appendices. Of the 7.2% of noisier planes, the majority are cargo carriers who would not be able to spread the cost of fees over passenger seats or transfer the payment to a passenger facility charge. This means they will face some of the largest overall fee increases, as detailed in Appendix 2. However, average cost analysis suggests that per lb charges could be very small. For example, external costs could work out as low as 1/10th penny per lb. This could work something like the 100% bag-screening program which Massport has recently implemented. In it, the cost of new x-ray scanning machines was divided by all operations to result in a 47c fee per bag charged to airlines on a monthly basis.[77]

4.4 New fee system examples

Logan works on compensatory costs whereby 80% of BOS operating costs are divided by the number of aircraft operations and multiplied by the log of weight. Currently, the charges are $3.59 per 1000lb >75,000lb. To understand how noise charging would affect existing aircraft some sample calculations were undertaken, based on the revenue neutral system. A Saab 340 was used as this is in the quietest group (Group 1) and it serves dispersed communities which depend upon it. Under the revenue neutral system it would actually gain marginally as it received credits from higher groups. With higher noise annual payments, the situation may arise where the credit to a small aircraft becomes so large that it would end up paying no landing fee at all or even profiting. Under these few scenarios, the surplus credit should be used to reduce fees overall or should be used in line with revenue generating schemes. A British Airways 777 was chosen as this is one of the largest aircraft operating into Logan but it is comparatively quiet. At 49th noisiest it is in Group 4. Under the new system it would pay an additional $33.12 per

[75] Boeing, 2003, and see later case study discussion
[76] Massport, 2004
[77] Coy, 18 February 2004

operation and therefore lose marginally. However given the >200 passengers on board this cost is negligible on a per seat basis. It becomes much more significant with higher annual payments. The $33.12 represents only a 1.9% increase in overall landing charge. But with noise payments of $95.1 m the fee would increase by >55%. Northwest is a strong opponent of noise fees. Its DC10 aircraft is a similar weight to the 777 operated by BA, but significantly noisier. It is in the noisiest group (Group 5) and at the smallest annual noise payment it pays an additional $99.36 representing >6% increase in landing fee. In the highest annual noise payment scenario, Northwest would face the highest charges of all. See Appendix 2 for the full fleet calculations.

Exhibit 4.6 Aircraft fee calculation examples

Airline	Aircraft	Current fee ($)	Proposed fee ($) based on annual noise payment			Change
			3.27m	21.7m	95.1m	
US Air shuttle	Saab 340	Na	-17.96	-119.16	- 522.25	Decrease*
British Airways	777	1741.29	1774.41	1961.04	2704.43	(1.90% - 55.31%)
Northwest	DC10	1585.74	1685.10	2245.00	4475.17	(6.27% - 182.21%)

4.5 Potential objections

There are some serious counter-arguments to noise fee charging. It may be perceived as a punitive tax by the industry, particularly in light of the current operating climate, airlines' reliance on Federal aid, and Massport's decline in business. Airlines are trying to cut unit costs, for example by switching to regional jets with higher load factors and this scheme could increase them. However, the long term outlook for the airline industry is very good with significant growth forecast. Massport's temporary drop in business belies the long term growth trend. This fee system is not a tax per se because it is avoidable and it is based on actual costs, as calculated in Section 3, rather than an arbitrary marginal rate levied by the government and used to fund general services. A revenue-generating fee system could be viewed as most punitive by the airlines, particularly if Massport was the sole benefactor and it funded general expenses. By making it revenue-neutral and ring-fenced, it is not punitive to the airlines as a group. Some industry passenger facility charges are flat rate and increase unit costs irrespective of efficiency or performance. A revenue-neutral system is discriminatory because quieter airlines are credited and all airlines can avoid or reduce the charge by switching aircraft.

The evidence that fees reduce noise can be qualitative and anecdotal. Therefore airlines and others could argue that there are other ways to reduce noise that can be better measured and evaluated. For example, the amount that soundproofing reduces school classroom noise can be easily ascertained through measurements before and after. The impact of fees is harder to ascertain. It can be argued that fees simply accelerate an already present trend – airlines moving to more advanced aircraft with quieter technologies. However some airlines create more noise than others and this differential will always exist in a competitive market. Where airlines pay according to noise level, such as in many European airports, noise levels have declined. This is seen, for example in the case studies of Hamburg Airport and Prague Airport.[78] However further studies should be undertaken to correlate fees and overall airport emission levels, so that the particular effect of fees can be isolated from other variables.

One particular concern is the effect on airlines that serve small communities and their passengers, such as Cape Air flights to Cape Cod. Any flat rate fee would have to be divided by a very small number of seats. However the correlation between weight and fee is still 0.997 under the proposed revenue neutral system, so light aircraft are still charged less. In addition, most of the aircraft concerned are in Groups 1 and 2 and therefore would be omitted from the fee or credited anyway. Where fees do exist, any passenger charged is also a resident who may benefit from less noise. See Exhibit 4.6 and Appendices for further information.

5.6 Airline response

[78] http://www.ham.airport.de/en/laermreduktion.html,
http://www.csl.cz/en/spolecnost/tisk_media/tiskovezpravy/tiskovezpravy_1.htm

Many carriers, US carriers included, already comply with schemes they encounter in their existing operations. This is particularly true of carriers with extensive trans-Atlantic routes since many European countries have had schemes in operation for years. However, it is clear that many airlines are against any new fees. Northwest is currently engaged in legal proceedings with Minneapolis Airport over noise monitoring costs. Air France says its “indirect taxes of (US$ 245 million) and charges…are now 10 percent of operating costs, up from 8 percent a few years ago.”[79] It also cites environmental problems from reducing noise, "year after year we try to reduce the noise of our engines. The problem is that when you reduce the noise you also increase nitrogen oxide and carbon monoxide emissions," states the Air France source.[80]

However not all carriers are opposed. Switzerland was the first country in Europe to introduce an emission tax. Swissair said it viewed the charge as 'cost neutral', because it penalizes airlines which have older fleets and they have "a young fleet with low emissions and low noise."[81] Korean Air regularly publicizes its record in reducing noise pollution.[82]

Precedents

5.1 Foreign case studies

5.1.1 London Heathrow

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[79] http://traveltax.msu.edu/news/Stories/airlinebusiness.htm

[80] ibid

[81] ibid.

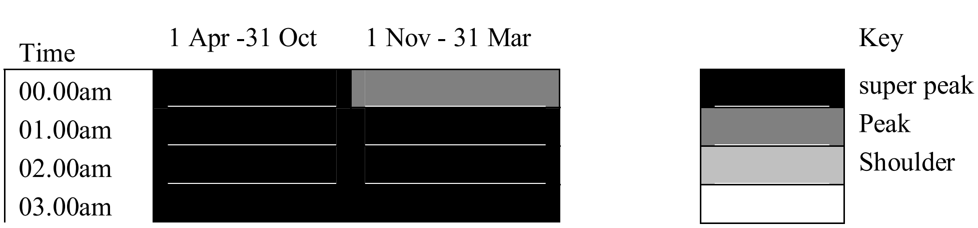
[82] http://www.koreanair.com/local/na/eng/gd/ak/ev/Environmental_Impacts_Control.htm

London Heathrow (LHR) is the world's busiest international airport[83] and has a fee system based on three variables, weight, time of day and noise level. Britain provides many good examples because, like Boston, its airports are often located in heavily built up areas, it has a similar level of economic development, and a strong airline lobby. This has resulted in government support for the airline industry and growth encouragement. However the UK government has committed to introducing further landing charges for "older, dirtier" planes.[84] In line with most British airports, LHR has adopted the IATA Airport and en route Aviation Charges code. This charges airlines landing fees according to aircraft weight and time of day. At minimum, airlines are charged a proportion (usually 30-60%) of the landing fee for excessive noise. However unlike peak pricing for car travel, which can be used to flatten the rush hour peaks, airline pricing also has to discourage night time operations, when it is less busy but more noise sensitive. Hence the charges reflect true peaks, but also noise sensitive times. As can be seen from Exhibit 5.2 below, aircraft pay more to fly in to LHR at certain times of the day. To fly in to LHR at super peak time, airlines pay 1.5 x peak price. LHR also distinguishes according to noise level. "Good' Stage 3 compliant aircraft are given a discount (Base) whereas 'poor' Stage 3 aircraft are charged more (High). Such aircraft are shown in Exhibit 5.1.

Exhibit 5.1 Noisy aircraft identified by London Heathrow[85]

AN 124	BAC1-11	Boeing 707/720B
DC8-50/62/63	DC9-30/40/50	Boeing 727-100/200
Fokker F28	DC10-10	Boeing 737-200
TU-134A	IL-62M	Boeing 747-100/200/300/SP
TU-154M	IL-86	YAK-42

Exhibit 5.2 Time/price schematic for London Heathrow[86]



[83] BAA, 2004
[84] BBC News Online 14 March 2004 http://news.bbc.co.uk/2/hi/uk_news/politics/3511674.stm
[85] Source: Boeing, 2004
[86] Source: Adapted by author from London Heathrow Airport data, Boeing, 2004

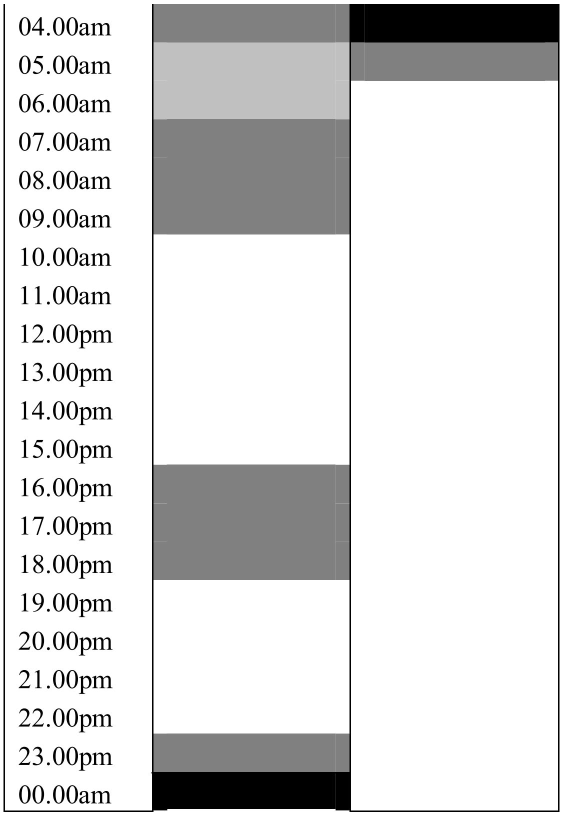


Exhibit 5.3 London Heathrow charges according to weight, time and noise level[87]

	Aircraft size											
	<16T				16-55T				>55T			
Time	C3	C3B	C3H	C2	C3	C3B	C3H	C2	C3	C3B	C3H	C2
Peak	90	90	90	90	450	500	750	1500	450	500	750	1500
Shoulder	90	90	90	90	261	290	435	870	436	485	727.5	1455
off peak	90	90	90	90	189	210	315	630	324	360	540	1080

Key	C3	Chapter 3 compliant
	C3B	Chapter 3 Base compliant
	C3H	Chapter 3 High compliant
	C2	Chapter 2 compliant
	T	Tonnes

[87] Source: Adapted by author from London Heathrow Airport/IATA 2003, Boeing, 2004

Time See accompanying table

All numbers in GBP Pounds sterling (1 GBP = 1.85 USD, April 2004)

Heathrow has "increased charges differentials, from April 2003, to create a greater incentive to shift to better technology."[88] They aim to reduce the number of Chapter 3 'high' aircraft to less than 1% of total operations by March 2005.[89] Exhibit 5.3 shows how charges on the aircraft in the same weight category, arriving at the same time period, can still vary by as much as GBP 450 – 750 (67%) within 'Stage 3'. Stage 3 is considered legally homogenous. However, as LHR has determined, there are wide variations within this standard.

5.1.2 Paris Charles de Gaulle

Paris Charles de Gaulle (CDG) is also one of the world's busiest airports. Like Heathrow, it has a fee system based on three variables including noise and time of day, as well as weight. France has implemented a tax system across most of its airports. This is in line with the French state's general tax on polluting activities (GTPA) and is in addition to the landing fee which is based on the aircraft's acoustic group.[90] The formula is applied to each take-off and can be summarized as Tax = b x t x log(MTOW) where b is a coefficient of departure time and acoustic group (see Exhibit 5.4), t is a unit rate (currently EUR 22.00 and adjusted each year based on the domestic retail price index) and MTOW is maximum take-off weight. Therefore every take off from CDG is charged according to time of day, noise level and weight.

Exhibit 5.4 French coefficient measures accounting for noise and time[91]

Aircraft Group	Coefficient	
	Departure time (local between)	
	0600-2200	2200-0600
1	24	48
2	12	24
3	6	12
4	2	4
5	1	2

88 BAA, 2004
89 ibid.
90 Boeing, 2004
91 Source: Boeing, 2003

5.1.3 Frankfurt

The B777/DC 10 calculation from section 4 was repeated using Frankfurt airport in Germany. The B777 was in their second quietest noise category and the DC10 in the fourth quietest category – see Exhibit 5.6. Holding other factors constant, the B777 was charged an additional EUR 21.00 per operation whereas the DC10 was charged an additional EUR 147.50 per operation – see Exhibit 5.5. This would have increased the B777 landing fee by 0.007% and the DC 10 landing fee by 5.5%.[92] This is in line with proposed fees at Boston, when using the $3.27 million annual payment figure. However, Frankfurt makes a good argument that the categories need to be constantly reviewed and extended (beyond five if necessary) to reflect new technological developments and to continue to penalize only the noisiest aircraft. Both London and Frankfurt agree on this policy and are moving ahead to make the categories even more representative of noise emission level.

Exhibit 5.5 Noise charges at Frankfurt in € [93]

Category 1	*Category 2*	*Category 3*	*Category 4*	*Category 5*	*Category 6*	*Category 7*
0.00	21.00	47.00	147.50	315.50	3,300.00	6,700.00

Night surplus charge for aircraft at Frankfurt (22.00 - 05.59 hrs) in €

Category 1	*Category 2*	*Category 3*	*Category 4*	*Category 5*	*Category 6*	*Category 7*
33.00	82.50	149.00	279.00	900.00	9,000.00	18,500.00

Exhibit 5.6 Example DC10 calculation at Frankfurt[94]

Airport Charges Frankfurt Main Effective as of January 1, 2004

Your Input	
A/C	DC10
A/C MTOW	517
Landing	30.3.2004 07:00 hrs.
Position	Pier Stand
Take-off	30.3.2004 09:00 hrs.
Position	Pier Stand
Destination (TLC)	BOS

[92] http://www.fraport.com/cms/default/rubrik/3/3007.noise_abatement.htm#Noise-related%20Charges
[93] ibid.
[94] ibid.

PAX Local boarding	200
PAX Transfer / Transit	0

Calculated Charges	Basis	Charge
Passenger Charges		3,352.00 €
Local Boarding	PAX Category: IC	3,352.00 €
Transfer / Transit	PAX	0.00 €
Landing Charges		1,000.55 €
Weight Charges	MTOW (in tons)	853.05 €
Noise Charge	**Category: 4**	**147.50 €**
Night Surplus Charge	Category: 4	0.00 €
Take-off Charges		1,000.55 €
Weight Charges	MTOW (in tons)	853.05 €
Noise Charge	**Category: 4**	**147.50 €**
Night Surplus Charge	Category: 4	0.00 €
Parking Charges		292.50 €
Basic and Surplus Parking	Stand size: 5 (2 h Day / 0 h Night)	110.00 €
Pier Charge	Pier stand in and outbound	182.50 €
Total Airport Charges		**5,645.60 €**
>> Charges for Financing a Passive Noise Abatement Program effective as of November 1, 2002		140.00 €
Landing Charges		
Noise Surcharge	Category: 4	20.00 €
Noise Surcharge during night time	Category: 4	0.00 €
Take-off Charges		
Noise Surcharge	Category: 4	20.00 €
Noise Surcharge during night time	Category: 4	0.00 €
Charge Based on Passengers	PAX	100.00 €
Charge Based on cargo and mail	per 100 kg or fraction thereof aboard the aircraft when departing	0.00 €
Total Charge (inclusive Noise Surcharges)		5,785.60 €

5.2 Domestic case studies

5.2.1 Minneapolis St Paul International (MSP)

MSP introduced a Noise Surcharge/ Differential Landing Fee in January 1990.[95] The purpose of the fee is "to recover a portion of the cost of noise monitoring and noise mitigation measures from airport users - the scheduled air carriers".[96] The fee is imposed on every Stage 2 and 3 landing at MSP and calculated on a monthly basis as an 'environmental surcharge' related to the volume of activity by a particular carrier. This is in addition to existing landing fees in operation prior to 1990.

MSP has a voluntary agreement with all scheduled airlines to "not conduct night-time operations from 22.30 to 06.00" as part of their Noise Compatibility Plan.[97] The ban is seen as rather ineffectual. Logan should still consider this, as a voluntary agreement would not counter the mission of growth, but serve to raise the issue in the minds of decision makers. MSP's Aviation Noise and Satellite Programs office has developed an interactive flight track module, similar to Logan's Airport Monitor. By including noise data in real time, on the Internet, MSP and Logan can allow the public to query flights according to noise events. MSP's system can map the requested data on screen and allow users to "replay, on their computer, aircraft operations and their associated noise events".[98] Although not "historically done" available data on particular aircraft making particular noise events can be matched with airline data.[99] If Logan were to do this, the public would come to know which airlines were responsible for most noise and this could influence their purchasing decisions.

Most notable though is MSP's involvement with Part 150 negotiations[100] over the recognition of the 60 dB DNL contour. Cleveland Airport has already passed such a measure but lacks funding.[101] MSP is working on securing $150M as mitigation/compensatory costs, primarily for soundproofing additional residences that would fall within an enlarged contour.[102] There are 256 US airports participating in the FAA Part 150 scheme, but Logan only joined last year. MSP's initiative comes despite the fact that Northwest Airlines, which represents c.80% of the MSP fleet mix, has "significant concerns" about the plan.[103]

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[95] Boeing 2004
[96] ibid.
[97] Interview with Chad Leqve, Manager, Aviation Noise and Satellite Programs, MSP, 15 March 2004; Boeing, 2004
[98] Boeing, ibid.
[99] Leqve, ibid.
[100] Part 150 is an FAA program initiative to provide additional compensation to owners of adjacent land use affected by airport noise.
[101] FAA, 2004. http://www.faa.gov/arp/environmental/14cfr150/index14.cfm?ARPnav=acs
[102] Interview with Chad Leqve, Manager, Aviation Noise and Satellite Programs, MSP, 15 March 2004. The funding would be for property in the 60-64DNL band.
[103] Ibid.

5.2.2 Hanscom Field (BED)

BED has a "curfew" from 23.00 to 07.00 enforced through a fee for each take off or landing. It charges more at night to reflect the increased irritation from noise during sleeping hours. The noise surcharge was established in 1980, 24 years ago. The fee is adjusted annually on April 1 and subject to annual review. From 1 July 2003 to June 2004 the "night-time field use charge" was $45 for aircraft <12,500lbs and $329 for aircraft >12,500 lbs.[104] Furthermore, aircraft pay double the relevant fee for "each night-time operation in excess of five night-time operations in a calendar year".

Exhibit 5.7 Hanscom's two variable fee system[105]

Weight	Day	Additional Night Charge
<3,000lbs	$10	$45
3,000-10,000lbs	$15	$45
<12,500lbs	Na	$45
>10,000lbs	$1.50 per 1,000lbs	$45 (<12,500lbs)
>12,500lbs	Na	$329

5.2.3 Palm Beach International (PBI) – 3 variables

PBI implemented a noise surcharge in 1985, Ordinance 89-29. This established a mechanism for the collection of "Environmental Operating Fees from aircraft". Certain aircraft with noise levels <83 dBA on landing and <73 dBA on take-off are exempt from this regulation. Palm Beach differentiates its fees according to time of day and type of aircraft (prior to Stage 2 becoming fully prohibited). Now that 2006 is approaching and the succession of Stage 3 to Stage 4 will occur, this model could be applicable, based on the prior differentiation of Stage 2 to 3.

Exhibit 5.8 PBI Operating Fee Schedule[106]

[104] Boeing, 2004
[105] Source: Interview with Sara Arnold, Manager, Airport Administration at BED 15 March 2004; Boeing, 2004

Aircraft Category	Time of Day/ Type of Operation	Fee Amount
Stage 2	Night/Landing	$ 260.00
Stage 2	Night/Takeoff	$2600.00
Stage 2	Day/Any Operation	$26.00
Stage 3	Night/Any operation	$20.00
Stage 3	Day/Any operation	Credit based on % Stage 3 ops

An exception is allowed to Stage 2 air carrier operations that can prove that the takeoff was due to unavoidable conditions such as weather delay, mechanical malfunction or air traffic control delay. No exceptions will be granted after midnight. No exceptions are allowed for private operation. A night operation is one that occurs between the hours of 10:00pm and 7:00am.

6 Recommendations

[106] Source: Boeing, 2004

SSJPC and those interested in reducing noise should now make a business and economic case for noise reduction, in addition to the social and environmental arguments already on the table. Most strategies are a net cost to airports and airlines. Fees, however, can be revenue generating or revenue neutral. Massport should therefore revise its landing fee system, that currently differentiates aircraft according to weight only, to also include noise.

6.1 The spatial impact and level of noise is bigger than currently acknowledged. SSJPC can use the following figures: Noise from Logan airport costs a minimum of $65.4 million within the existing legal 65DNL contour. If the 60DNL contour were acknowledged, noise costs would be a minimum of $434.2 million. If the 55DNL contour were acknowledged, noise costs would be a minimum of $1.9 billion. SSJPC should monitor new Sixth runway noise recorders, educate the public about using the online maps and track the spatial development of noise. SSJPC should monitor Logan's performance regarding the noise cap and encourage its reduction over time.

6.2 Certain aircraft and certain airlines are more responsible than others. SSJPC should highlight the minority of aircraft that are responsible for much of the noise. These can be called the "dirty dozen" and monitored over time. They can be targeted by Massport through fees with little implication on overall operations or revenue, while freeing up space for quieter aircraft. The noisiest airlines are detailed in the "bad guys" list and can be identified through Logan's existing system, which provides airline flight numbers alongside "positional data and aircraft types, to correlate noise complaints or events."[107] Therefore hotline calls should request this information and publicize it to affect consumer purchasing decisions. As Gilbert (2004) notes, "operators of non-Stage 3 airplanes sometimes suffer from negative public relations." **.**

6.3 Noise costs can be included in airport operations at relatively little cost overall. SSJPC can advocate that these substantial costs are in fact small, when applied to operations which cause the noise in the first place. Average costs per operation are as low as $3.68. Costs per passenger range from 5c to $8.35. Costs per lb cargo range from 0.1c to $0.26

6.4 A revenue-neutral scheme should be implemented in the first instance. This is more likely to avoid any potential legal challenges from the airlines. Under a revenue neutral scheme, most aircraft would gain or suffer no increases as a result of introducing noise fees.

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[107] Boeing, 2004. FAA controls collection and editing processes, including data reviews and release of pertinent information to airport noise abatement staffs in hard disk format. Ibid.

6.5 A revenue generating scheme could be implemented to raise funds for noise mitigation and worthwhile community projects. If advocating the revenue generating system then SSJPC should argue for productive and equitable use of the money. For example noise surcharges at Birmingham Airport in the UK are paid into a Community Trust Fund to support community projects in areas affected by the Airport's operations.[108] In Boston they could be used to fund the CAC and assist local schools that are most affected in the vicinity of Logan. Other redistributive mechanisms suggested are compensating residents through finishing the sound insulation program much sooner than currently planned, extending the contours through FAA Part 150 and using the revenue to mitigate noise for more people.

6.6 There are serious objections to a noise fee proposal. SSJPC should note these. SSJPC should also note the precedents that exist in the US and abroad plus the above arguments in countering opposition to noise-based fee charging.

6.7 The proposal should be developed over time. As Frankfurt and London have realized, the categories and groupings have to be constantly revised to account for (and reward) technological progress. The correlation between fee charged and noise level at Logan is currently 0.58 but this only increases to 0.61 under this proposal. Only as the number of categories/groups increases over time, will fees more truly reflect noise levels and the correlation between them improve. In addition, the external cost lump sum and discount rate will change over time. As noise costs are reduced, through quieter aircraft, re-routing and so on, the annual payments will decrease and the costs imposed on operations can decrease.

7 Summary and conclusion

[108] Boeing, 2004

"Let us hope that, as a democratic nation of both corporations and individuals, we will find the wisdom to create balanced and enduring answers to our mutual concerns."

Rae Andre (2002)

Judge Botsford's ruling approving the Sixth runway is subject to a peak pricing experiment. There now lies a window of opportunity in Boston.[109] Massport has been compelled to consider fees based on time of day. That would increase the number of variables from the current one only (weight) to two (weight and time of day). It is therefore not a great leap of faith to include a third noise variable into the equation. However Massport is reluctant to do so, citing the potential for legal challenge from airlines, FAA reluctance and effort as reasons.[110]

Fees are a tangible way to reduce noise, because they incorporate noise costs in a clear dollar format. Fees can be economically efficient, because they target noisy aircraft, rather than all aircraft. They can be politically savvy, by dividing the polluters according to their performance. Carriers operating quieter aircraft, such as the European carriers, are more likely to accept fees than other carriers. But the 'bad guys' can be increasingly isolated as the proportion of noisy planes decreases with time and they are publicized even more. Fees can be a revenue source for Massport or compensation for those affected. If they have to be revenue neutral they can be so, as the Czech example has highlighted.

Fees are not unprecedented. Massport's own property, Hanscom Field, has implemented time of day fees for 24 years. There are also many other precedents at successful airports which share Massport's mission of growth. By eliminating noisier aircraft more rapidly, they create room for a greater number of quieter aircraft. Fees also contribute to the larger competitiveness issue. Business and government has a vested stake in a more efficient airline industry but not in appeasing pressure groups per se. A recent National Research Council Report recommended "cleaner, quieter aircraft (as key) to increasing the system's capacity".[111] If SSJPC can latch on to that argument then both parties are talking the same language, albeit for different goals. At a local scale Massport needs to remain competitive and at a national scale there is concern that the US is losing ground to Europe as Airbus overtakes Boeing in new innovative technologies.[112]

Fees are perhaps the only strategy that is a net gain for Massport. Soundproofing, lawsuits and PR are net costs for Massport. Fees could be a new revenue source. The main reason, however, fees can work is because the market will accept them. Lobbying, complaining

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[109] Boston Globe 19 November 2003
[110] Interview with Coy 12 March 2004
[111] CNN 24 Sep 2003
[112] ibid.

and networking all rely on the benevolence of Massport. In addition these tactics may often be perceived as attacking the economic good of air travel. The challenge is to attack the economic bad, noise, not the economic good.

Many of the solutions proposed by SSJPC to date are, understandably, emotionally charged because "there is fundamental disagreement on the measurement and payment of environmental costs."[113] Fees offer a dispassionate economic solution to a social and economic problem. In democratic societies, with majority rule, democracy is no guarantor of a quieter existence. The numbers affected by flight path noise will always be relatively small, vis a vis the larger electoral population. This is true even with the expansion of airports, new runways and more flights. Factor in the lack of regulatory response and other solutions look even less appealing. While even the Economist acknowledges "putting a figure on such environmental cost is hard",[114] it is the most likely way of making noise costs affect airline behavior. It could be argued that with FAA introducing Stage 4 in 2006, fees are somewhat superfluous. It is useful to remember that the lag time between regulation and outcome can be long. For example Stage 2 airplanes were in use for another twelve years after they were last produced in 1988.[115] Rather than being superfluous, fees can also have a direct bearing on new Stage 4 regulations, as they can be based on Stage 4 compliance, not on Stage 3 compliance.

Fees are not without challenges, and there exist serious objections to their introduction at all. This suggests that it will take time to convince a cautious public body, like Massport, to adopt them. SSJPC should therefore continue to pursue the other solutions, which give leverage in negotiations with Massport over the introduction of fees SSJPC should argue that the United States has a vested national interest in having a more technologically efficient airline industry. Other business interests would be supportive. For example industry figures actively want tougher noise regulations so they experience greater demand. Martin Gardner is Director of Engineering at Quiet Technology Aerospace which developed Stage 3 hush kits for Gulfstream IIs and IIIs. He is actively calling for the FAA to require that the new Stage 4 rule should apply to all new jets, regardless of weight.[116] Gardner asked the FAA to revise the NPRM to "make Stage 3 and 4 noise levels applicable to all transport-category aircraft irrespective of mtow". By shifting some of the charging burden from weight to noise, this anomaly can be accounted for.

There are many possible solutions to the problem of noise pollution from Logan and SSJPC is aware of many of them. However these solutions are mired in the middle ground

[113] Oddleifson, 2004
[114] Economist, 16 Aug 2003
[115] Gilbert, 2004
[116] Gilbert 2004

between different jurisdictions and authorities, as well as complicated by disagreements over appropriate noise measures, readings and the spatial extent of pollution. What this study has sought to do is to put noise fee based charging on the table as a serious proposition for both SSJPC and Massport. This is not to deny the other solutions or to trivialize the inconclusive data and disagreements over data and readings. But given that air travel is an economic good that is going to increase in the future and that noise is an economic bad that needs to be controlled, fees offer a compromise that allows the most efficient and socially just option to be pursued.

Out of the mire of confused jurisdiction, buck passing and various readings there is an opportunity for action in Boston. The US has an important airline industry, organized citizens groups and a decentralized Federal structure. Rather than being a problem, it is precisely because "airports and their surrounding communities are left to decipher their correct role"[117] that a window of opportunity exists. Boston, and the US, remains behind the UK and other countries in respect of incorporating noise costs for overall efficiency and social efficacy. As Rae Andre concludes, "let us hope that, as a democratic nation of both corporations and individuals, we will find the wisdom to create balanced and enduring answers to our mutual concerns". This is the challenge. To incorporate such a solution contained herein, palatable to both parties, so that it may truly better social welfare.

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9 Appendices

1 Interview schedule

2 Fleet mix calculations

3 Percentage of Airline Operations in Full Stage 3 Aircraft During 2002

4 Current "Bad Guys" list (airlines operating sub-'Full' Stage 3 aircraft in 2002)

5 Current "Dirty Dozen" list (aircraft ranked highest by noise level in 2003)

6 Noise contour measurement methodology

Appendix 1	**Interview schedule**
2-3 December	Mary Ann Frye, Don Levi, Peter Gile, Ansley Purse, Stephen Lathrop, Ralph Dormitzer (Co-Chair, Massport Community Advisory Committee), SSJPC meeting
22 December	Les Blumberg, Noise Pollution Clearinghouse, VT
Ongoing	Nancy Timmerman, Noise Consultant
26 January	Les Blumberg, Noise Pollution Clearinghouse, VT
Ongoing	Eric Oddleifson, Founding Member, SSJPC

18 February	Craig Coy, CEO, Massport
	Ted Frier, Speechwriter, Massport
25 February	Paul Schomer, Schomer and Associates Inc., Consultants in Acoustics and Noise Control, Member, Board Certified Institute of Noise Control Engineering
	Greg Fleming, VOLPE Federal Transportation Research Systems Center
12 March	Craig Coy, CEO, Massport
	Betty Desrosiers, Director, Strategic Projects and Technology Integration, Massport
15 March	Chad Laque, Manager, Aviation Noise and Satellite Programs, Minneapolis Saint Paul International Airport (MSP)
	Sarah Arnold, Manager, Airport Administration, Hanscom Field Airport (BED)
17 March	Steve Bush, Director of Finance, Metropolitan Airports Commission, Minneapolis Saint Paul

Appendix 2 Fleet mix calculations

FLEET MIX SPREADSHEET – 1

FLEET MIX SPREADSHEET – 2

Appendix 3 Percentage of Airline Operations in Full Stage 3 Aircraft During 2002[118]

Airline	**Percentage of Full Stage 3 Operations**[119]	
	2001	**2002**
Aer Lingus	100%	100%
Air Canada	91%	90%
Air France	100%	100%
Air Jamaica	100%	100%
Air Nova	100%	100%

[118] Source: adapted from Massport, 2004

[119] "Full Stage 3" = originally manufactured as Stage 3 aircraft under FR Part 36. Airlines having <100% full Stage 3 fleet, operated the balance of their flights in hushkitted or re-engined aircraft that have been recertified as Stage 3. Airlines with a plus operate the balance of their operations in recertified Stage 3 as well as some Stage 2 aircraft weighing less than 75,000 pounds."

Air Transat	100%	100%
Air Transport International	100%	100%
Airborne Express	0%	0%
Airtran Airways	40%	93%
Alaska Airlines	N/A[120]	99%
Alitalia	100%	100%
Allegro	0%	0%
America West	100%	100%
American Airlines	100%	100%
American Eagle Airlines	100%	100%
American Trans Air	40%	99%
Atlantic Coast Airlines	100%	100%
Atlantic Southeast Airlines	N/A	100%
British Airways	100%	100%
Capital Cargo International Airlines	N/A	0%
Chautauqua	100%	100%
Comair	100%	100%
Continental	100%	100%
Continental Express	100%	100%
Crossair	N/A	100%
Delta	67%	75%
DHL Airways	15%	6%
Emery Worldwide	94%	35%
Federal Express	66%	74%
Frontier	100%	100%
Gold	0%	0%
Icelandair	100%	100%
Jazz by Air Canada	N/A	100%
Kalitta Air	N/A	0%
Kittyhawk+	1%	4%
KLM	N/A	100%
LACSA	N/A	100%
Lufthansa	100%	100%
Miami Air Int'l	0%	29%
Midway Airlines	87%	100%
Midwest Express	15%	9%

[120] N/A = not flying at Logan in 2001

North American	100%	99%
Northwest	78%	81%
Pan Am	0%	0%
Royal Air Freight+	0%	0%
Ryan International	4%	23%
Sata International Airlines	100%	100%
Skytrek Airlines	N/A	0%
Sun Country	100%	63%
Swiss Air	0%	100%
Transmeridian	100%	12%
United	100%	100%
United Parcel Service	92%	97%
US Airways	96%	100%
VG/Delsey Airlines	N/A	100%
Virgin Atlantic	85%	100%
World	100%	100%

Appendix 4 Current 'bad guys' list

(airlines using sub-Full Stage 3 Aircraft During 2002)[121]

Rank	Airline	Percentage of Full Stage 3 Operations	
		2001	**2002**
=1	Airborne Express	0%	0%
=1	Allegro	0%	0%
=1	Capital Cargo International Airlines	N/A	0%

[121] Source: adapted from Massport, 2004

=1	Gold	0%	0%
=1	Kalitta Air	N/A	0%
=1	Pan Am	0%	0%
=1	Royal Air Freight+	0%	0%
=1	Skytrek Airlines	N/A	0%
9	Kittyhawk+	1%	4%
10	DHL Airways	15%	6%
11	Midwest Express	15%	9%
12	Transmeridian	100%	12%
13	Ryan International	4%	23%
14	Miami Air Int'l	0%	29%
15	Emery Worldwide	94%	35%
16	Sun Country	100%	63%
17	Federal Express	66%	74%
18	Delta	67%	75%
19	Northwest	78%	81%
20	Air Canada	91%	90%
21	Airtran Airways	40%	93%
22	United Parcel Service	92%	97%
=23	Alaska Airlines	N/A	99%
=23	American Trans Air	40%	99%
=23	North American	100%	99%

Appendix 5 Current 'dirty dozen' list

(top twelve aircraft ranked according to approach noise level, 2003)

1	BOEING 747-300/747-200 SUD (MIXED CONFIG -WIDE BODY JET)*
2	BOEING 747-300/747-100/200 SUD-WIDE BODY JET*
3	BOEING (DOUGLAS) DC10-WIDE BODY JET
4	BOEING 747-WIDE BODY JET

5	BOEING (DOUGLAS) MD11 (MIXED CONFIG)-WIDE BODY JET*
6	BOEING (DOUGLAS) MD11-WIDE BODY JET
7	BOEING 747-400-WIDE BODY JET
8	LOCKHEED L1011 TRISTAR-WIDE BODY JET*
9	BOEING (DOUGLAS) DC9-50-NARROW BODY JET
10	BOEING 767-WIDE BODY JET
11	FOKKER F28 FELLOWSHIP-NARROW BODY JET*
12	BOEING 727-200-NARROW BODY JET

These aircraft face an average landing fee increase of 12.6% to account for their noise level. Some aircraft (*) were not operating in 2003. As they are retired from service, they can be replaced with the next five noisiest aircraft:

8	BOEING 767-300-WIDE BODY JET
9	MCDONNELL DOUGLAS DC9 (SERIES 30/40/50) -NARROW BODY JET
10	BOEING (DOUGLAS) DC9-NARROW BODY JET
11	BOEING 737-400-NARROW BODY JET
12	BOEING 737-500-NARROW BODY JET

For further information refer to Appendix 2.

Appendix 6 Noise contour measurement methodology[122]

Task

The task was to construct a noise contour map for Logan airport that was based on actual measured data and not on the Integrated Noise Model (INM) predictions. The INM is believed to be inaccurate at locations further from the airport and only accounts for aircraft noise in isolation rather than the cumulative effect of aircraft activity on top of existing noise.

[122] Timmerman, 2004.

Noise monitoring system data

Massport's system has 29 microphones located around Logan Aiport, measuring total DNL. Since 1997, Massport has been reporting 'aircraft only' DNL so as to better correlate INM figures and actual readings. These are dependent on computer identification of noise which is only from aircraft. Because of the use of event thresholds, not all aircraft sound will be included in the measurement, even with correctly identified events.

Aircraft only DNL

Three estimates were generated:

1 Generated from Massport's Noise Monitoring system

2 Based on 2002 Total DNL minus lowest reported daily DNL from week of September 11

3 Based on 2002 Total DNL minus average of September 12-14 daily DNL

Contours

The 65 dB DNL contour was adjusted to agree with the median aircraft values obtained above.

The 60 dB DNL contour showed inaccuracies at Nahant and Hull. Therefore estimates of downwind arrival flows were made over Nahant and the South Shore as well as estimates of shoreline crossings for departure flows southbound.