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AIRCRAFT NOISE AT AIRPORT - FUTURE NEEDS

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ABSTRACT
Quieter aircraft are the key to ensuring future growth of air transport. Reduction of noise at its source is the most effective means of reducing its impact, and the most universal expression of aircraft noise levels is embodied in ICAO Annex 16, Volume 1, Chapter 3 aircraft noise certification standards. The prime purpose of these standards is to ensure that the latest available noise reduction technology is incorporated into aircraft design. According to ICAO policy, the number of noise impacted population in the surrounding of airports should not increase in the future. Therefore, future traffic growth must be offset by continual improvement in noise reduction technology. Such a reduction can only be achieved by a combination of "non addition rules" and "phase-out rules" of present aircraft types especially of those which are only marginally complying with present Chapter 3-standards.

1 - INTRODUCTION
Continued efforts of the aircraft industry in the development of improved aircraft engine and airframe technology have resulted in considerable reductions of noise impact per aircraft movement and − despite the growth of traffic volume up to now − also resulted in a reduction of the total noise impact in the surroundings of many airports. Nevertheless, opposition to aviation has grown in the past years, and environmental pressure and constraints have increased, becoming in many cases the major impediment to airport capacity development. Future growth of aviation will therefore depend to a very significant extent upon the ability of the industry to manage the impact of aircraft noise.

2 - THE AIRPORTS' POLICY
Airports support an integrated, environmental approach for addressing aircraft noise at airports. This approach consists of: a) encouraging further noise reduction at source, i. e. the aircraft; b) promoting State legislation and strict enforcement of noise-compatible land-use planning and control around airports; and c) introducing or improving operational noise abatement measures.

Reduction of noise at its source in this context is the most effective means of reducing its impact. Quieter aircraft are the key to ensuring the future growth of air transport with minimum restrictions and maximum flexibility to the benefit of the travelling public, the airlines, the airports and their neighboring communities.

The airports' policy on aircraft noise is not only geared to reduce its present impact on the surrounding communities, but also to avoid further public, legal or political interference in the requirements of aviation and the continued proliferation of different and uncoordinated local, national or regional noise regulations and measures with a risk of a fragmented civil aviation system. Many airports − among which are the 20 busiest airports, which handle 28 percent of the world's air traffic − are already subject to such regulations and measures, which usually consist of noise contours or noise budgets that must not be exceeded. Restrictions once introduced hardly can be removed. Hence it is of first importance to avoid their introduction.

Therefore future traffic growth should be offset by continual improvement in noise reduction technology and the introduction of this improvement into ICAO Annex 16 noise certification requirements. A traffic growth rate of 4 or 5 percent a year, for example, will require an increased stringency of approximately

1 EPNdB every 5 years at each of the three measuring points in Chapter 3 standards in order to enable the future growth of air transport without increasing noise levels around airports.

3 - TRAFFIC GROWTH AND NOISE EXPOSURE

To grow or not to grow – that is not the question; aviation will grow in the future according to all forecasts. The following calculations give some principle impressions of the relation between traffic growth, aircraft source noise reduction and the area encircled by a noise contour around an airport. The noise contour area has been chosen as a criterion according to ICAO's policy that in future the number of noise affected population should not increase.

Figures 1, 2, 3, 4, 5 and 6 show examples of the development of traffic volume and noise contour area for an average airport situation assuming a 100 % Chapter 3 aircraft fleet in the reference year 2002. Aircraft type mix in 2002, flight distribution and other variables are not taken into account. Therefore, the figures should not be misinterpreted to precisely quantify future noise developments, but they are intended to give a general trend from which principle conclusions can be drawn.

Figure 1 shows the development of traffic volume for some constant yearly growth rates. The dotted line in figure 1 is based on a reduction of the growth rate by 1 % point every 5 years, i. e. between 2002 and 2007 a yearly growth rate of 6 % is assumed, between 2007 and 2012 the yearly growth rate is 5 % and so on. This rather simple assumption reflects the fact that growth of aviation will not be going on indefinitely, but will approach a certain saturation in the future.

Figure 2 shows the increasing area within a noise contour of e. g. Ldn=65 dB. Studies showed that the area A within a noise contour is approximately proportional to the noise energy to the power of 0.8: $A \sim 10^{0.8L/10}$. This relation is the basis for all following figures. Figure 2 shows the trivial result that the noise area will increase with increasing traffic volume, if the aircraft type mix does not change relative to 2002.

The dashed line in figure 2 and all results shown in figure 3, figure 4, figure 5, figure 6 are based on the decreasing yearly growth rate of figure 1.

Figure 3 shows the effect of a non addition rule, which means that the fleet of 2002 remains unchanged and all the traffic growth is carried out by new aircraft, which on an average are DL quieter than the average 2002 aircraft fleet. Other aircraft are not allowed to be added to the fleet. It is obvious that the noise area still increases but less, depending on the value of DL.

In figure 4 an additional phase-out rule is assumed, i. e. the original Chapter 3 fleet of 2002 is stepwise – 5 % per year – phased-out between 2002 and 2022 and replaced by new aircraft with DL quieter average level as in the non addition rule case of figure 3. From this figure it can be seen that a combination of a non addition rule and a phase-out rule will result in no increase of the noise contour area for ΔL=-4 dB. For ΔL<-4 dB the noise area decreases despite the increase of traffic volume. It is essential that both rules start in 2002.

Phase-out in this context can be the replacement of noisier by less noisy Chapter 3-aircraft on economical grounds or due to an introduction of operational restrictions for noisier Chapter 3-aircraft.

The present position of aviation industry is that phase-out rules start some years later than non addition rules. The effect of this is shown in figure 5, figure 6. In both cases the non addition rule starts in 2002. In figure 5 a late and slow phase-out rule between 2012 and 2022 is assumed, whereas in figure 6 an early and fast phase-out rule is assumed between 2007 and 2012. It again is obvious that the noise area will increase until the start of the phase-out rule.

Summarizing the above calculations, continuously constant or decreasing noise areas only can be achieved when non addition rule and phase-out rule start at the same time.

Figure 7 shows the relation between the traffic growth rate and the period of years in which the fleet noise has to be reduced by 1 dB in order to allow for the future growth of air transport without increasing the noise contour area around an airport. All points above the curve indicate combinations of noise reduction and growth rate for which the noise contour area increases; all points below the curve result in a decrease of noise areas.

4 - ICAO NOISE CERTIFICATION

An important driving force for the noise emissions reduction during the past decades was the international standard ICAO Annex 16 "Aircraft Noise" [1], an addendum to the 1944 Chicago Convention on Civil Aviation. Annex 16, which contains procedures and limits for the noise certification of civil aircraft, has been introduced in 1971. New aircraft then had to comply with the noise limits contained in Chapter 2 of Annex 16. This was already an improvement in terms of noise compared to the first generation of jet aircraft. At the time of the introduction of the Chapter 2 limits, most existing aircraft exceeded these limits; therefore Annex 16 was an incentive for the development of quieter aircraft.

In October 1977 more stringent limits became applicable, which are laid down in Chapter 3 of Annex 16. Since that time aircraft and engine noise technology have been further developed so that aircraft which incorporate present state of the art technology, comply with the limits with significant margins. Therefore, the Annex 16 noise standards no longer have any incentive effect for future technology developments; market forces following public pressure and legal constraints have taken over this incentive.
Annex 16 should therefore be revised to reflect, with immediate effect, current available technology. On the longer term, Annex 16 standards should again give incentives for new technology and with this, ICAO avoids the danger of loosing international leadership in the area of aircraft noise standardization and certification. In this sense, within ICAO's Committee on Aviation Environmental Protection, CAEP, a new definition of aircraft noise certification has recently been formulated:
The prime purpose of certification is to ensure that the latest available noise reduction technology is incorporated into aircraft design, demonstrated by procedures which are relevant to day to day operations, to ensure that the noise reduction offered by technology is reflected in reductions around airports.
Airports agree with this new definition, because it implies the necessary substantial increased stringency of the present standards and introduces the principle of updating the standards on a regular basis. Future updated standards should contain level reductions combined with a future date, which will reflect the principle relation shown in figure 7.

5 - MARGINALLY COMPLIANT CHAPTER 3 AIRCRAFT

The noise climate around airports is dominated by the still operating old and noisy Chapter 2-jet aircraft. These aircraft types are mainly responsible for the continuing or even increasing pressure from the noise impacted communities, which then is directed uniformly against aviation in general. In order to ensure and improve operational possibilities of the quieter aircraft types with less constraints and limitations, it is essential to avoid the use of Chapter 2-aircraft and to give the population a clear prospect of the end of operation of these aircraft types. In order to solve this problem, the European Community in 1992 has introduced a directive, which sets a final date (1 April 2002) after which no Chapter 2-aircraft is allowed to be operated in the European Union member states. The United States of America have introduced a comparable regulation. A similar ICAO resolution contains a somewhat less strict regulation.
The intention of these Chapter 2-phase-out regulations was to reduce noise levels around airports considerably. Unfortunately, new technologies are being developed, by which these old aircraft are modified so that they comply with Chapter 3-standards. Such modifications are e. g. the application of hush-kits, minor modification of the airframe or other measures, which decrease the noise levels in such a way that the certificated noise data contained in the documents just meet the Chapter 3-limits, whereas the actual noise impact during daily operations has been decreased very insignificantly or not at all. These Chapter 3-aircraft are dramatically noisier than aircraft manufactured to meet Chapter 3-specifications incorporating present state of the art. Allowing those marginally compliant aircraft to continue to fly indefinitely would run counter to the purpose of the phase-out regulations, would negatively affect the above described development of noise contour areas and would violate the trust between airports and their surrounding communities.
Airports therefore support the introduction of operating restrictions on the noisiest Chapter 3-aircraft at noise sensitive airport.

REFERENCES

1. **International Civil Aviation Organization**, *International Standards and Recommended Practices, Environmental Protection, Annex 16 to the Convention on International Civil Aviation*, Aircraft Noise, Third Edition, 1993

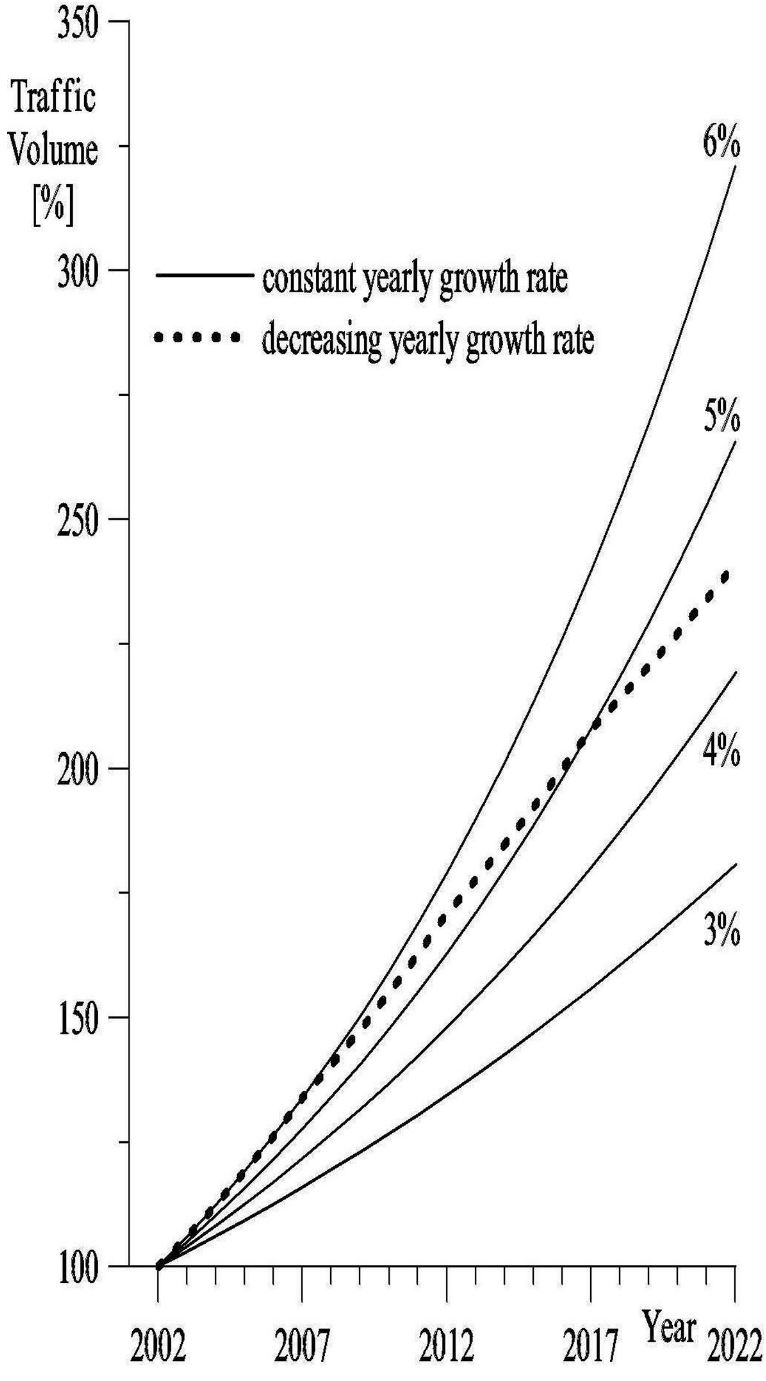

Figure 1: Development of traffic volume.

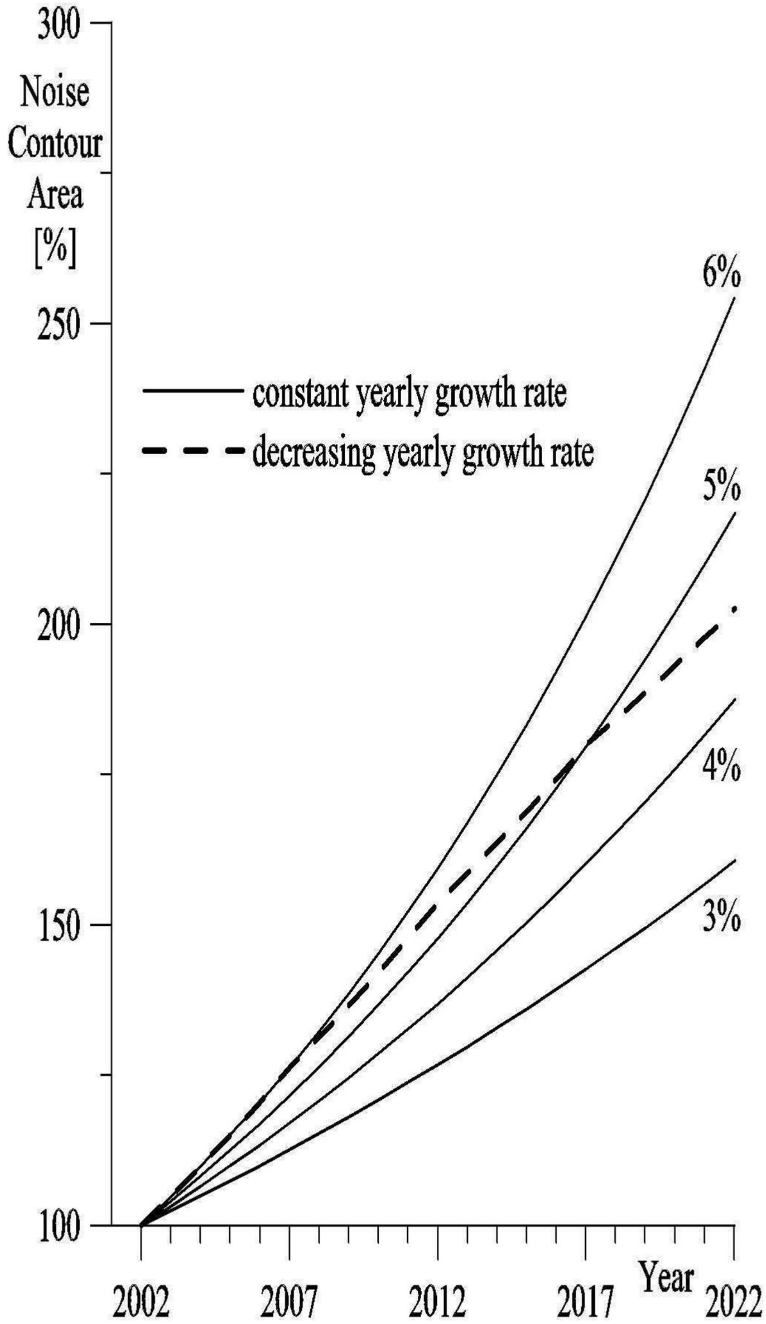

Figure 2: Development of noise contour area; base case: no change of traffic mix relative to 2002.

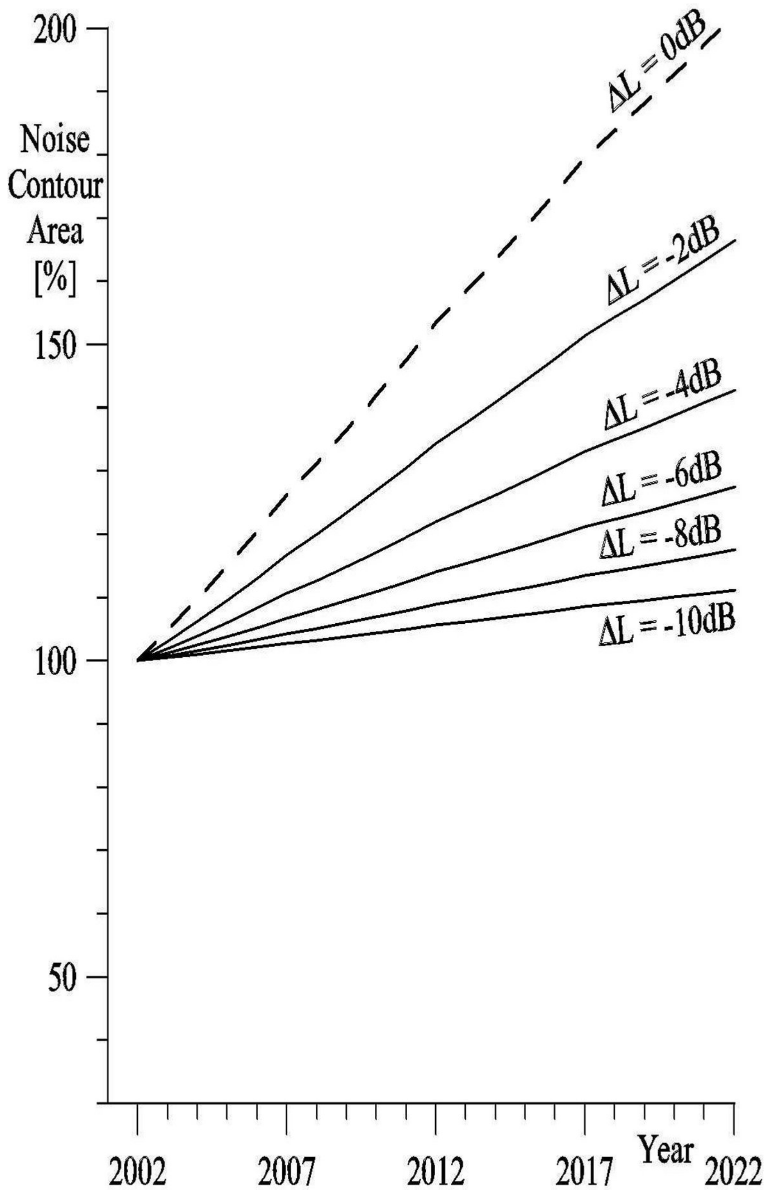

Figure 3: Development of noise contour area; case 1: non addition rule 2002; traffic increase only by new aircraft; new aircraft ΔL dB below 2002 fleet noise; no phase-out rule.

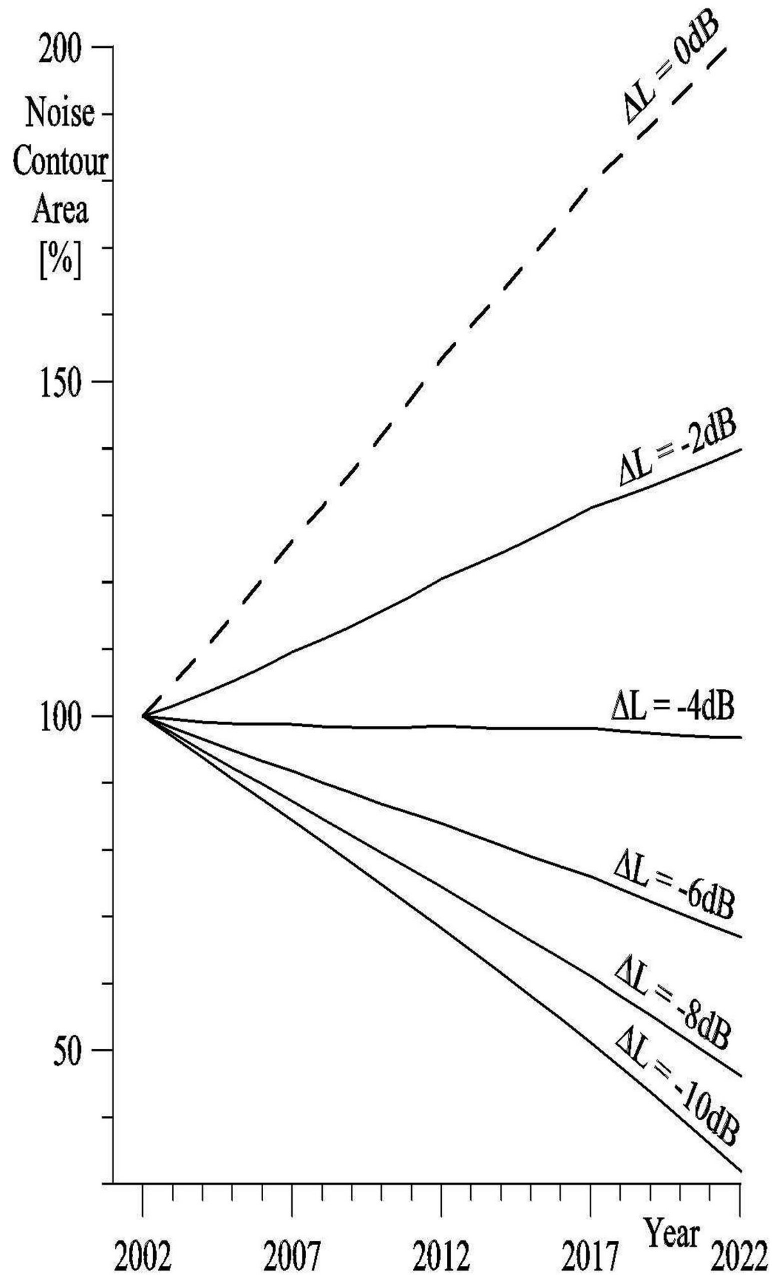

Figure 4: Development of noise contour area; case 2: non addition rule 2002; phase-out rule 2002-2002.

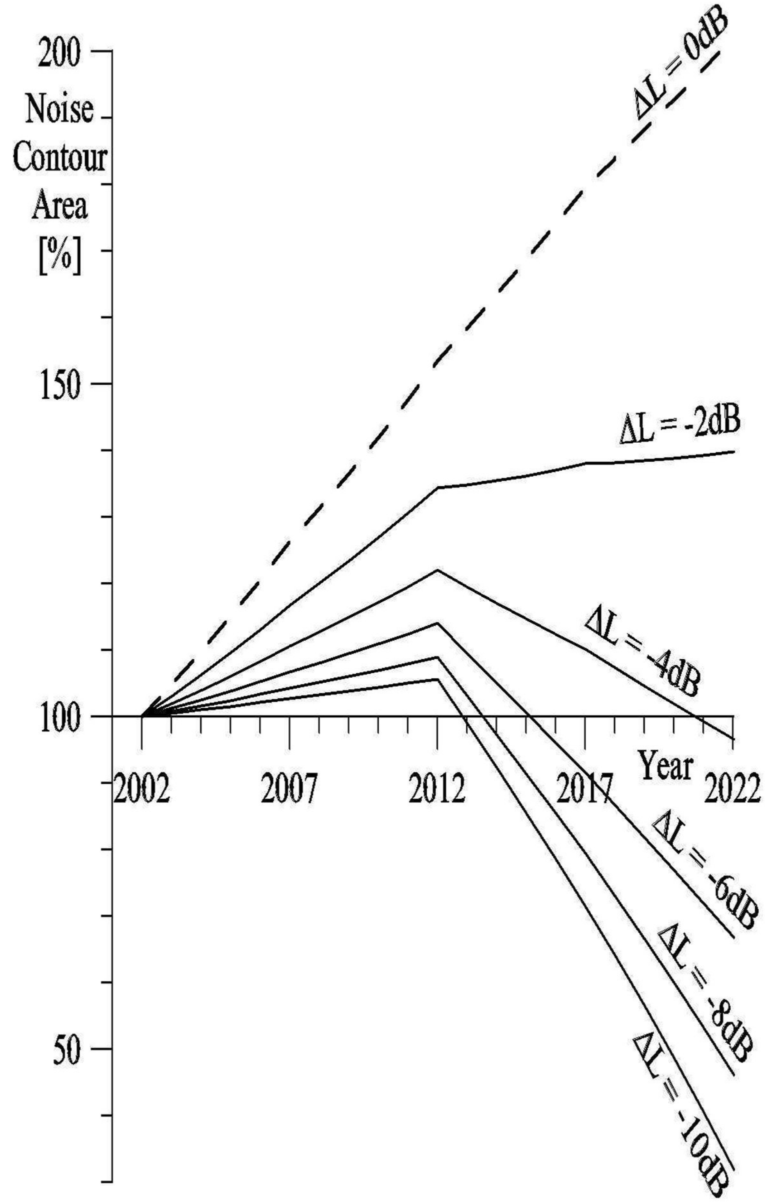

Figure 5: Development of noise contour area; case 3: non addition rule 2002; phase-out rule 2012-2022.

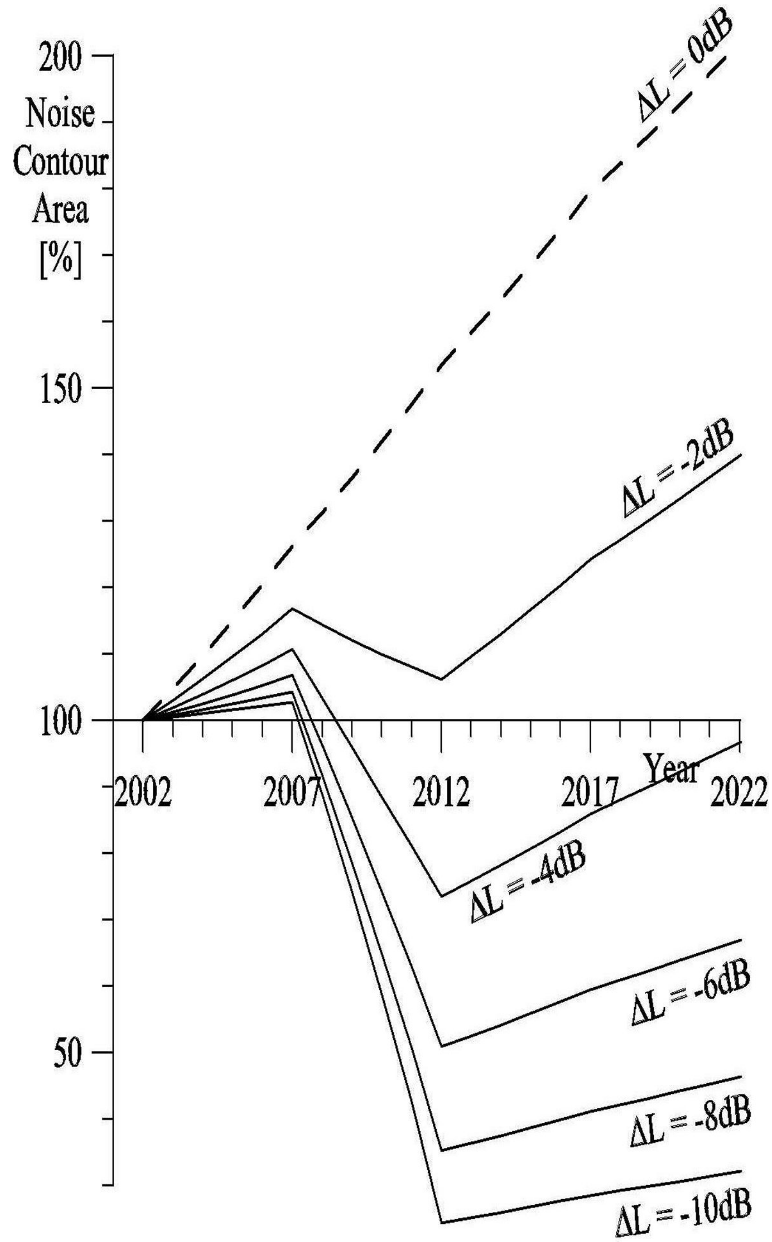

Figure 6: Development of noise contour area; case 4: non addition rule 2002; phase-out rule 2007-2012.

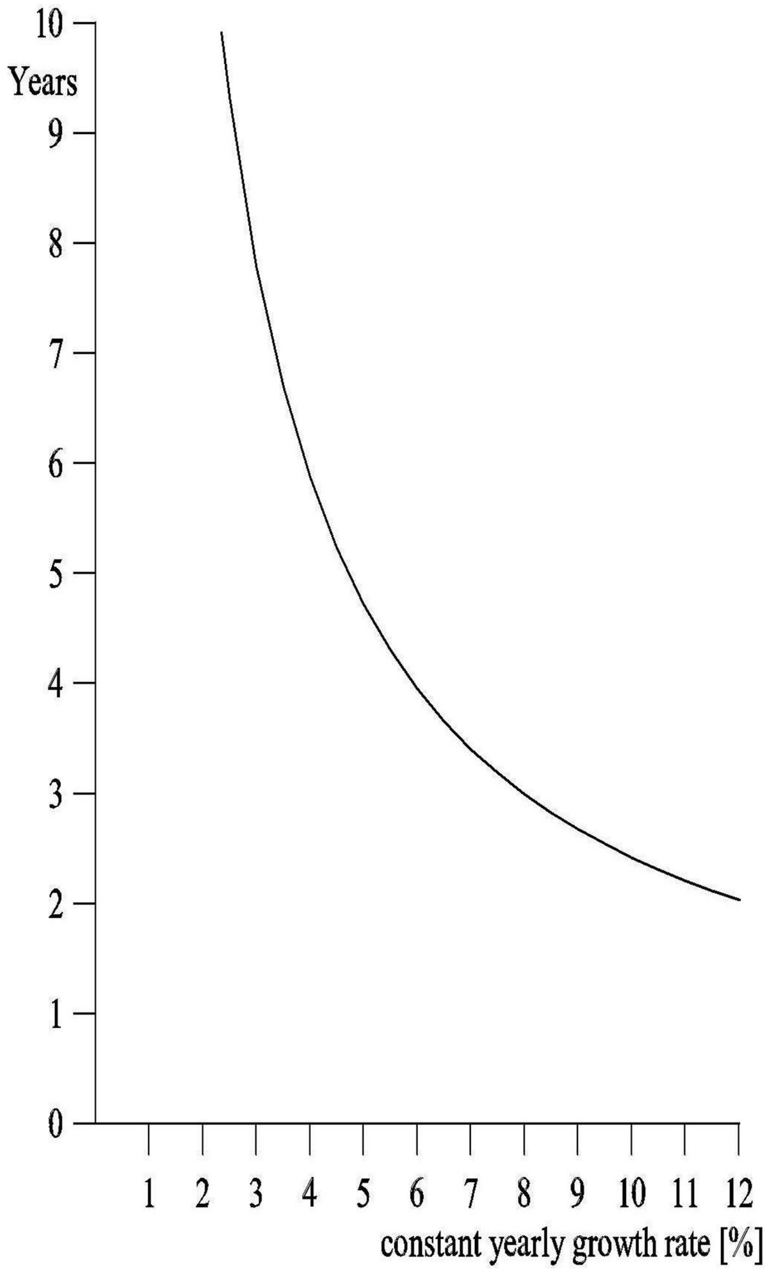

Figure 7: Period of years in which the fleet noise has to be reduced by 1dB in order to allow for the future growth of air transport without increasing the noise contour area around an airport.