Sustainability in hospitality industry engineering essay

Engineering

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Executive Summary

Noise pollution, traditionally defined as " unwanted or disturbing sound" is excessive and displeasing human, animal, or machine created environmental noise that disrupts the activity of human or animal life and lead to health effects. Aircraft noise is defined as the noise pollution produced by any aircraft and/or its components such as airframe, landing gear and the engine during take-off and landing. There are three spectrum components that contribute to fan noise: broadband noise, multiple pure tones and tonal noise. Minton (2005) has suggested utilizing Wake Filling Techniques, to design a flow control scheme capable of reducing the momentum deficit in a rotor wake and reduce the amount of required blowing air to fill the wake which will significantly reduce the engine noise levels. From the recent research conducted by the National Research Council of Canada (NRC), the airframe and landing gear are the major sources of pollution while the engine noise is only half of the noise equation when the aircraft is near the ground. To curb this problem, International Civil Aviation Organization (ICAO) created the Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft (Doc 9501) which advises strict regulations and guidelines for aircrafts to meet and which has successfully reduced the amount of aircraft noise produced by 50% in the last 40 years. (Aircraft Noise) Although countless methods have been devised, the main problems are the airframe and engine designs. Other than following the guidelines

specified by ICAO, many research have provide many recommendation while airline companies come up with their own initiative while compiling with the ICAO stringent standard to reduce aircraft noise. Contents

Introduction

Noise pollution, traditionally defined as " unwanted or disturbing sound", is excessive and displeasing human, animal or even machine created environmental noise that disrupts the activity of human or animal life. The source of most outdoor noise worldwide is mainly from machines such as transportation systems, motor vehicles, aircrafts and trains. (Noise Pollution, 2013) For this report, I will focus on the noise created by aircrafts, commonly known as aircraft noise. Aircraft noise is defined as the noise pollution produced by an aircraft or its components during take-off and landing, and the airframe, landing gear and engines which generate fan noise. Different aircraft types produce different noise levels and frequencies. Out of the three main sources of noise, I will focus on the first two which are aerodynamic noise and engine and other mechanical noise. Aerodynamic noise increases with aircraft speed and is also present at low altitudes due to the density of the air. This noise is generated when flow passes an object on the aircraft, such as the wings, landing gear or airframe and can be broadly classified as two main types, bluff body noise (alternating vortexes from either side of bluff body create low pressure regions which manifest themselves as pressure waves) and edge noise (when turbulent flow passes the airframe or the gaps which resulted in the fluctuations of pressure). (Aircraft Noise)Aircraft gas turbine engines, also known as jet engines, are usually the

culprit contributing to the aircraft noise during takeoff and climb, such as the bassoon noise generated. (Aircraft Noise, 2013)

Health Issue

Below are the different types of negative health effects caused by constant exposure to noise pollution.

Hearing Issues

Although exposure to sound level below 70dB will not cause any damage to our hearing regardless of the duration of exposure. However, exposure of more than 8 hours to sound levels upward of 85dB is potentially hazardous. Exposure to sound over 100dB for a short period will cause damages so great to the ear that may lead to permanent hearing loss.

Interference with Spoken Communication

Noise pollution will interfere with people’s ability to understand daily speech and may lead severe cases such as lack of concentration, fatigue, lack of confidence, easily irritated, unsatisfying work capacity, increase in stress level, accidents, disruption of communication and poor academic result.

Sleep Disturbances

Uninterrupted sleep is known to be physically and mentally good to an individual. The primary sleep disturbances are the difficulty in falling asleep, frequent awakenings, or waking too early. When sleep disruption get severe it will lead to the same effect as mentioned above.

Cardiovascular Disturbances

The nervous system can be temporarily or permanently affected by noise. Noise acts as a biological stressor, triggering a negative response in the cardiovascular system increasing the risk of cardiovascular disease.

Disturbances in Mental Health

Constant exposure to noise can accelerate and intensify the development of latent mental noise exposure conditions such anxiety, stress headache and nervousness. From research, elderly and those suffering with depression are vulnerable to these effects.

Impaired Task Performance

Noise pollution causes decrease of performance in both school and work, increasing errors and decreasing motivation. Concentration, attention and memory are most strongly affected by noise. Decrease in awareness and performance may lead to severe case such as accidents because of the physical and mental stress. (Noise Pollution a A Health Hazard for Seniors, 2013)

Cognitive function

Constant exposure to loud noise will not only cause one to lose the reading, understanding and learning abilities, it also affects the problem solving abilities and may cause short term memory loss. This noise pollution will raise the level of error and will decrease one’s productivity during work. (Noise pollution causes and effects, 2013)

Guidelines and Standards

Many guidelines and standards are developed to reduce the impact of noise pollution on human health, for example, the ICAO guidelines.

International Civil Aviation Organization (ICAO)

ICAO is a specialized agency established by the United Nations in 1944 to promote the safe and orderly development of international civil aviation throughout the world. It sets standards and regulations necessary for aviation safety, security, efficiency and regularity, as well as for aviation environment protection. The main objective is to reduce the noise at the source. (ICAO in Brief, 2013)Much of ICAO’s effort over the past 40 years was to reduce the noise at source. Aircraft today are required to meet the noise certification standards adopted by the Council of ICAO which are recorded in Annex 16 – Environmental Protection, Volume I – Aircraft Noise to the Convention on International Civil Aviation. The first generation of jet-powered aircrafts developed was not covered by Annex 16, referred to as non-noise certification aircrafts, such as the Boeing 707. The initial standards for jet-powered aircrafts developed before 1977 were introduced in Chapter 2 of Annex 16. Subsequently, newer aircraft such as the Boeing 737, 767 and the Airbus A319 must compile with the standards of Chapter 3. After the fifth meeting of the Committee on Aviation Environmental Protection (CAEP/5) in June 2001, the Council adopted the new Chapter 4 noise standard; at least one third quieter than the Chapter 3 standard. With effect from 1 January 2006, all new aircraft must meet the standards of Chapter 4 while all Chapter 3 aircraft were to be re-certified to Chapter 4. Noise technical groups were requested to reanalyze the noise levels for subsonic jet and heavy propeller

driven-aircraft and develop a range of increased stringency options. Based on the success of the independent expert process to set medium and long term noise reduction goals, a similar process was launched for noise reduction technologies. The goals for four categories of the aircraft are as follows: Aircraft CategoryMargin to Chapter 4 (EPNdB)Mid-Term (2018)Long-Term (2028)Regional Jet13. 0±4. 620. 0±5. 5Small-Med, Range Twin21. 0±4. 623. 5±5. 5Long-Range Twin20. 5±4. 623. 0±5. 5Long-Range Quad20. 0±423. 5±5. 5(Technology Standards, 2013)With the more stringent standards established by ICAO, I shall now discuss the approach taken by each airline company in reducing noise emissions.

Singapore Airlines

Singapore Airlines (SIA) has always followed the noise certification standard set by ICAO. All of their aircraft are certified with the ICAO Chapter 3 standard for noise, and they also meet the more stringent Chapter 4 requirements. For example, the fleet of B777-300ERs and A380-800s are certified with the ICAO Chapter 4 noise standard which has a noise footprint at 90dB, more than 50 times less than that of the B707’s. They believe that investing in new aircraft such as Airbus A350 and Boeing 787 will harness the benefits of modern technologies to further reduce aircraft emissions and noise. (Airlines, 2011/2012)

Cathay Pacific

With the same approach as SIA, Cathay Pacific purchases new aircraft as it is one of the most significant ways that an airline can reduce its environmental impact. The Boeing 747-8F they own features a smaller noise footprint aided

by improved engine technologies, inlet acoustic treatments and aerodynamics while their Airbus A350-900 features an advanced wing tip design that reduces noise and drag. (Cathay Pacific Sustainable Development Report, 2011) Currently, the ongoing noise-reduction efforts include: communication with airport authorities to more effectively address noise issues, working with manufacturers and other airline partners on noise-mitigation measures, liaising with the Hong Kong Civil Aviation Department to reduce the noise impact of aircraft operations in Hong Kong and finally, working with industry groups in the promotion of the " balanced approach" to noise management. (Fact Sheet, 2012)

Korean Air

Every aircraft of Korean Air satisfies Chapter 4, which is the highest level of the ICAO noise pollution standard. Korean Air will continue to endeavor to reduce aircraft noise pollution through aggressive investment in aircraft with lower noise pollution and improvement in noise-abatement procedures during takeoff and landing. Their endeavor for quiet operation consists of three categories. First, the investment in aircraft and R&D through the introduction of Airbus A380 and Boeing 787 which are quieter than the current Boeing 747-400 for long distance travel. Second, support for local anti-noise measures through the promotion of anti-noise measures in airport surroundings in and out of the country. Last, the improvement in infrastructure and noise-abatement procedures during takeoff and landing. Through investment in technology development of aircraft, noise pollution from aircraft has decreased by up to more than 75% compared to 40 years ago. Efforts together with government and residents for limiting the

expansion of residences near the airport and the planning and management of appropriate land usage were required. The next step is improvement in noise-abatement procedures during takeoff and landing while executing the continuous descent approach. (Sustainability/Green Management, 2013)

All Nippon Airways (ANA)

The countermeasures taken by ANA are to ensure all aircraft, including leased aircraft, conform to ICAO noise standards Chapter 4. ANA has come out with an Efficient Flight Program (EFP) Promotion Project where flight crews take personal initiative in discussion about how they can make their flights Eco Flights, which is compiled as an Eco Flight guidebook. They also implemented many primary noise abatement procedures for takeoff and landing to reduce noise emission. For more detailed information of the procedures, please refer to ANA annual report 2012. (Annual Report 2012, 2013)

Recommendation

As the airlines discussed above focus mainly to comply with the ICAO chapter 4 standards, I will list down recommendations and techniques suggested by research groups, theses and engineers that can reduce aircraft noise emission that may be employed by airlines.

Power generated from aircraft wheels

As mentioned by Daily Mail Reporter (2012): " enormous amounts of kinetic energy generated from landing a passenger aircraft could be used to power the wheels when the plane is taxiing to and from airport buildings." A group of engineers, from the University of Lincoln discovered that kinetic energy

produced during when aircraft is landing could be converted and stored as electricity, to operate the wheels when the aircraft need to taxi. At present, the energy is wasted as heat produced by friction in the aircraft’s disc brakes. Professor Paul Stewart, who led the research, said: " Taxiing is a highly fuel-inefficient part of any trip by plane, with emissions and noise pollution caused by jet engines being a huge issue for airports all over the world. If the next generation of aircraft that emerges over the next 15 to 20 years could incorporate this kind of technology, it would deliver enormous benefits, especially for people living near airports."

Continuous Descent Approach

Two primary sources of noise were identified when an aircraft descent: the engine noise and the aerodynamic noise generated by the drag along the flaps on the edge of the wing. This approach prescribes for the aircraft to maintain a cruise altitude until it is relatively close to an airport, at which point it makes an even, continuous descent to the runway. This can more than halve the noise level as compared to the old method where airplanes typically land in " staircase-like" paths, reducing their altitude in a series of steps towards an airport. Each step requires a noisy engine thrust to level the aircraft, and the most noise is generated at the lowest step, closest to the ground. (Reducing Airplane Noise, 2013)

Reduce Airframe and Landing gear noise

Flaps and slats, which extend out on the wing when an aircraft needs a boost in lift at slow speeds and the landing gear creates drag and helps aircrafts slow down for descent and landing. They are also major sources of noise. The

engine roar is only half of the noise equation when a plane is near the ground, according to NRC aero acoustics researcher Jerry Syms. The industry has focused on measuring and reducing the noise generated by engines alone. As such, turbofan-powered airliners and business jets have become progressively quieter through higher bypass ratios, acoustic materials, and nacelle design techniques to meet the increasingly stringent noise reduction targets. Because of that focus, some lost sight of the fact that the airframe also generates significant noise because of airflow turbulence. Stuart McIlwain, Group Leader of Fixed-Wind Aerodynamics at NRC, said: " Turbulent flow around landing gear generates a significant proportion of the total noise output of an aircraft in close proximity to the ground." This information is used to redesign or alter parts so they create less noise when exposed to fast moving air. (Broge, 2013)

Metallic Foam to Reduce Turbofan Engine Noise

Acoustic liners have desirable acoustic attenuation properties and are thus commonly used to reduce noise in jet engines. The liners are typically placed upstream and downstream of the rotors to absorb sound before it propagates out of the inlet and exhaust ducts. Noise attenuation could be dramatically improved by increasing the area over which a noise-reducing material is applied and by placing the material closer to the noise source. Researchers at National Aeronautics and Space Administration (NASA) Glenn and Langley have discovered that the Haynes® 25 metallic foam is compatible with the environment in the region close to the rotor blades. The Haynes® 25 metallic foam achieves the twin goals of increasing the area covered by the noise-attenuation material and bringing it closer the noise

source. NASA also is working on alternative foam materials that are lighter and provide acceptable acoustic performance. By increasing the noise-suppression treatment area and its proximity to the noise source, the foam absorbs more sound from the aircraft engine fans. (Woods, 2013)

Wake Filling Technique

As mentioned by Minton (2005), this is a technique to design a flow control scheme capable of reducing the momentum deficit in a rotor wake and reduce the amount of required blowing air to fill the wake which will significantly reduce the engine noise levels. From his research experiment, one of his models, the SS and PS jets SLA modeled with the objective to enhance mixing by injecting a minimal percentage of mass flow from inclined jets into the cross flow of both pressure and suction surfaces proved to be the most efficient way to reduce fan rotor wake for this application. Thus, the engine was re-designed using this method of wake filling and is to be tested at the NASA’s Aeroacoustic Propulsion Laboratory. (Minton, 2005)

Conclusion

Noise pollution created by aircraft has always been an issue the world is trying to reduce because for the multiple negative health effects on humans, especially those who live near the airport. Precautious have been taken by the ICAO to help reduce the noise emission through establishing guidelines and standards and are making good progress over the years. But, the airline companies selected focus mainly on ICAO chapter 4 standards, such as SIA, instead of going the extra miles in further reducing the noise emissions as done by Cathay Pacific to collaborate with the Hong Kong Civil Aviation

Department. Although new aircraft designs will help in reducing the noise emission where the aircraft companies agreed, but, if the aircraft companies are not doing anymore other than the specified standards in reducing the noise emission of their current fleet, it is pointless. As seen from the recommendations section, there are many modifications or techniques that can be used to reduce noise emissions. I do agree that looking forward to a better future is good, but if we do not protect the present, there will be no future for us or our descendants.