BEFORE THE CHRISTCHURCH REPLACEMENT DISTRICT PLAN INDEPENDENT HEARINGS PANEL

IN THE MATTER of the Resource Management Act 1991 and the Canterbury Earthquake (Christchurch Replacement District Plan) Order 2014

AND

IN THE MATTER of the General Rules and Procedures Proposal (Stage 3)

REBUTTAL BY JOHN-PAUL BARRINGTON CLARKE ON BEHALF OF SUBMITTERS:

BRUCE CAMPBELL (2489); DAVID LAWRY (2514); MIKE MARRA (2054); VANESSA PAYNE (2191); JOHN SEGRUE (2567); GERRIT VENEMA (2091).

ACOUSTICS

25 FEBRUARY 2016

Introduction

1. My full name is John-Paul Barrington Clarke.

2. I am a Professor at the Georgia Institute of Technology (Georgia Tech) in Atlanta, Georgia, USA; where I have appointments in the Daniel Guggenheim School of Aerospace Engineering and the H. Milton Stewart School of Industrial and Systems Engineering, and serve as Director of the Air Transportation Laboratory.

3. I have three degrees from the Massachusetts Institute of Technology (MIT) in Cambridge, Massachusetts, USA. I received the Bachelor of Science (S.B.) in Aeronautics and Astronautics in June 1991; the Master of Science (S.M.) in Aeronautics and Astronautics in September 1992; and the Doctor of Science Degree (Sc.D.) in Aeronautics and Astronautics in February 1997.

4. I am a globally recognized expert in aircraft trajectory prediction and optimization, especially as it pertains to the development of flight procedures that reduce the environmental impact of aviation. My research has been instrumental in changing both the theory and the practice of flight procedure design, and has spurred the global effort to reduce the environmental impact of aviation via changes in operational procedures.

5. I am also recognized globally for my work in noise propagation modelling. I was an integral member of the team that was the first to quantify how the noise directivity patterns of aircraft with wing-mounted engines differ from the noise directivity patterns of aircraft with fuselage-mounted engines, and then subsequently developed the state-of-the-art model that is used in the Integrated Noise Model (INM) to predict the "excess ground attenuation" that is observed for aircraft that are close to the ground, as they are near airports (Fleming et al., 2002). I have also developed multiple models for predicting the propagation of noise in non-standard atmospheric conditions. One such model is particularly useful for predicting noise propagation at night, when temperature inversions increase the distance over noise propagates (Clarke et al., 2004).

6. Further, I am an expert in the development and use of stochastic models and optimization algorithms to improve the efficiency and robustness of airline, airport, and air traffic operations. My research has changed long-established views regarding the need for and the best way to achieve robust schedules, particularly in the airline industry.

7. I have received several awards for my work. Those most relevant to the matters being addressed are the 1999 AIAA/AAAE/ACC Jay Hollingsworth Speas Airport Award, the 2003 FAA Excellence in Aviation Award, the 2006 National Academy of Engineering Gilbreth Lectureship, the 2012 AIAA/SAE William Littlewood Lectureship, and the 2015 SAE Environmental Excellence in Transportation (E2T) Award.

8. In addition to my work in academia, I have served as a consultant for airports and community groups around the world on matters of noise prediction and regulations for over 20 years. Further, I have consulted for several airlines around the world on matters pertaining to their operations, including the schedule of flights and maintenance events.

9. In 2007, I was engaged by the Selwyn District Council to serve as their expert in the deliberations surrounding the appropriate extent of the noise contours around Christchurch International Airport. I ultimately ended up chairing the group, often referred to as the 'Panel of Experts,' that estimated the future operations at Christchurch International Airport and subsequently developed noise contours.

10. On this occasion I have been engaged as an expert by the following submitters (with associated submitted number): Bruce Campbell (2489); David Lawry (2514); Mike Marra (2054); Vanessa Payne (2191); John Segrue (2567); Gerrit Venema (2091).

11. Although this is not an Environment Court hearing (or a hearing being conducted under the Resource Management Act 1991), I have reviewed the code of conduct for expert witnesses contained in part 7 of the Environment Court Practice Note 2014, and have complied with it in preparing my evidence. I confirm that the issues addressed in this statement of evidence are within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Scope of Evidence

12. My rebuttal, which is based on my aforementioned expertise, will be focused on the following evidence:

    12.1. The evidence of Christopher Day regarding "Ground Run-Up Enclosures;"

    12.2. The evidence of Christopher Day regarding the "District Plan General Noise Limits;"

    12.3. The evidence of Christopher Day regarding "Sound Insulation."

Ground Run-Up Enclosures

13. Mr. Day argues in paragraph 122 of his evidence that "...while the performance of the GRE may be 10 to 15dB close to the enclosure, at large distances the noise reduction will be very much less – 0 to 5dB."

14. While meteorological conditions, such as wind and temperature inversions, can affect the performance of a GRE, these effects must obey the laws of physics. Without abnormally high levels of diffraction, a localized increase in sound must be accompanied by a decrease in sound in another location. In other words, energy must be conserved.

15. Increases in sound at specific locations are typically due to the focusing of noise by such meteorological conditions as temperature inversions. Because these effects are transient, the noise at each location will vary over time and from day to day.

16. GREs are an effective noise mitigation option which is considered the worldwide standard. The typical configuration is a 3-sided facility without a roof, although other variants have been constructed. They provide the most significant noise reduction at homes that are close to the engine testing location, i.e. the homes with the greatest need for noise reduction. To my knowledge, there is no case where a GRE has been installed and the neighbours have subsequently complained that it has not been effective.

17. The design of a GRE can be optimized to meet specific requirements with respect to the DNL at specific locations. Further, the sound levels outside the airport boundary can be further reduced by jointly optimizing the design of the GRE and the location where engine testing is conducted.

18. Of course, customization comes with greater costs. But, if the engine testing activities at Christchurch Airport are as lucrative as has been stated, then CIAL should be able to justify the investment in a GRE rather than impose limitations on their neighbours.

District Plan General Noise Limits

19. Mr. Day argues strongly for the 50 DNL "District Plan General Noise Limit" and for limitations on the activities that are conducted within the associated boundary.

20. I strongly disagree with Mr. Day.

21. In the residential neighborhoods to the east of Christchurch Airport, the population density is sufficiently high that the day-night sound level due to background noise (excluding highway traffic noise) would be greater than 55 DNL.

22. My estimate for the background noise was derived by converting a very conservative value for the population density of 20 persons per hectare (the actual value is probably closer to 30 persons per hectare) to 2,000 persons per square kilometer, and then using the graph below for the relationship in the United States between population density and background DNL.

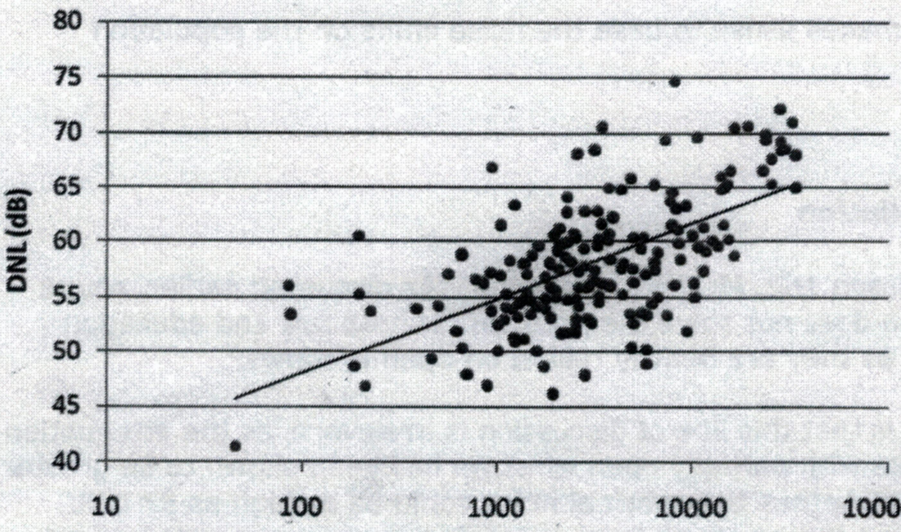

FIGURE 1: Background DNL versus Population Density in the United States [Source: Schomer et al. 2010]

23. As can be seen, a population density of 2,000 persons per square kilometer corresponds to background DNL that is at or above 55 DNL.

24. While there might be some differences in background noise between the United States and New Zealand, there is no reason from the scientific literature to believe that these differences would be significant.

25. Therefore, my view is that it does not make sense to control activity in a sound level range that is lower than the background sound level.

26. Further, it seems to me that it would be quite logical to base the noise limits in the district plan (with appropriate transitions) on the population density in each neighborhood.

27. In fact, such an approach would actually be consistent with Mr. Day's assertion in paragraph 161 of his evidence that "The third difficulty with sound insulation is that it does not deal with the outdoor noise environment. New Zealanders in general, enjoy an 'outdoor' type of lifestyle that includes barbecues and gardening. This is particularly the case in rural areas where people have more outdoor space and an expectation of enjoying it."

28. Noise limits are not a "one size fits all" parameter.

29. Outdoor activity is negatively correlated with population density -- the higher the population density the lower the outdoor activity.

30. Thus, it makes sense to base the noise limits on the population density.

Sound Insulation

31. In paragraph 162, Mr. Day states that "As discussed earlier, sound insulation does not solve the problem for hospitals and education facilities as they are heavily reliant on open windows."

32. My view is that this line of discussion is irrelevant, as the attenuation in a house with partially open windows has been shown to be greater than 12 dBA, thus the external noise could be as high as 57 DNL without the indoor sound level exceeding the recommended sound level of 45 DNL.

33. On the other hand, if the discussion of sound insulation has been motivated by a concern that sound insulation would be prohibitively costly, then I am certain that a ground run-up enclosure would be a far more cost effective option for acoustic mitigation.

John-Paul Clarke

John-Paul Barrington Clarke
25 February 2016

References

Clarke J.-P., Huber J., Sizov N., and Maloney S. (2004). "Weather Specific Noise Abatement Procedures: A Case Study of Departure Procedures for Runway 4R at Boston Logan Airport." *Air Traffic Control Quarterly* 12(2):165-192.

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Schomer P., Machesky A., Luo C., Dossin C., Nookala N., Pamdighantam A., Freytag J. (2010). "A Re-Analysis of Day-Night Sound Level (DNL) as a Function of Population Density in the United States," United States Department of Transportation Contractor Report DTOS59-09-P-00129.