Hal Beck, P.Eng. January 11th, 2022

Speaking Notes for the Port Authority meeting on 'slots,' Jan 13, 2022.

There are a few noise engineering issues related to number of flights being calculated which were not documented in the 2019 Master Plan nor in any other studies for some reason. The flight numbers are being calculated solely based on NEF software output, so I focussed the following issues list on NEF modelling errors and omissions only. Please forward these issues to the noise engineers so they can speak to next steps and timing regarding their slot reduction calculations.

There have been systemic errors and omissions in applying the NEF noise engineering principles over the years, leading to excessive flight numbers having been calculated. It has not been helpful that the five noise engineering consultants retained separately by the City and Port Authority over the years since 2008, who presented noise capacity material to the public, confirmed they were not intimately familiar with the NEF noise energy calculation formula, nor underlying EPNL calculation methodology, when making their presentations. It is also not reasonable that any of the airport decision makers and policy makers should be assumed to have detailed working knowledge of NEF noise engineering calculations.

1. Incorrect interpretation of modelled flight numbers

The NEF calculation methodology calculates the theoretical total number of flights possible for a 24-hour operation, not the 16.25 operating hours available, resulting in excessive flight numbers being proposed during operating hours.

To recap noise calculation methodology, the NEF formula uses the decibel-seconds of noise energy of every modelled flyby (normalized over 10 seconds), and sums these decibels over 24 hours, to calculate an average decibel per hour ie. an NEF value (NEFdB) for the given location. The resulting NEF values are then plotted on the map, and contours of equal value are compared to the geographic location of the control contour noise envelop to confirm if the modelled flight scenario is within the noise envelop.

Airport decision makers have not documented that they have been informed by their noise engineers that the total modelled flights calculated using the NEF formula are for 24 hours of continuous airport activity. Per the NEF formula calculation methodology, the modelled total number of flights per day needs to be pro-rated (lowered) over the fewer number of hours the airport is actually approved for operation. For example, regarding commercial flights, the 202 slots modelled over 24 hours multiplied by 16.25/24 equals 136 slots during airport operating hours. Furthermore, the NEF calculation methodology assumes the total EPNL noise energy from the total modelled flybys is equally distributed over each hour over the 24-hour period, not loaded up in specific hours. No specifics related to these flight calculations were appended to the Master Plan or otherwise to support flight numbers.

2. Incorrect ground noise attenuation assumptions

NEF software includes a ground noise attenuation algorithm which assumes modelled fly by noise is being absorbed by the lake surface, resulting in excess noise capacity assumptions and excessive flight volumes proposed.

The algorithm calculates an increasing volume of noise being absorbed by the ground surface during a flyby noise event when the plane is closer to the horizon or ground surface relative to a viewer

location. The modelled NEF values have been lowered accordingly. This assumed noise reduction due to ground surface attenuation does not apply to the water surfaces of Toronto waterfront. This issue is especially important at the Island Airport where planes are accelerating or decelerating from runway ends that are surrounded by Lake Ontario in front of residential towers. The lower noise values thus being modelled for each flyby (before being plotted on the noise map for comparison to the official noise control contour), results in additional noise capacity inside the control contour limit than is otherwise possible in real life. This leads to additional excessive flight numbers being proposed or assumed potentially possible.

Also related to this are the flight reductions that need to be calculated with respect to the anticipatable increased noise propagation (not attenuation) in the marine environment of the modelled NEF noise. The NEF software was designed to produce output for use on stereotypical suburban subdivisions on tableland, and explicitly does not consider reflective water surfaces or inversions. Airport decision makers have to date assumed the NEF noise maps for the Island Airport already include for Lake Ontario noise effects and have not documented that they have been informed otherwise by their noise engineers.

3. Flyby noise energy omitted from NEF calculations

The established NEF calculation procedure (more specifically the underlying EPNL) is excluding some of the fly by noise energy of louder planes (eg. Q400) from the NEF analysis, resulting in noise capacity exceedances of the 25 NEFdB zoning standard.

As detailed in the EPNL calculation procedure, the NEF noise maps only show that portion of modelled noise energy (decibel-seconds) which occurs within the duration of time in which the top 10 decibels of a given flyby are emitted. If there is any remaining fly by noise energy modelled to occur outside this defined window of time, it is automatically excluded from the NEF calculation. To illustrate this important issue (ignoring the typical PNdb to dBA conversion), the maximum fly by noise level of a Q400 aircraft in the harbourfront is sometimes 73dBA. Only the loudest portion of the noise energy that the Q400 emits during a fly by (occurring immediately before and after the maximum decibel), is included for in the NEF calculation (ie. the noise during the fly by from 63dBA to the 73dBA max, then back down to 63 dBA is included in NEF calculation). Whereas the balance of the noise energy the same Q400 emits during the same fly by, before and after the flyby peak (between 63dBA to below the background sound level of roughly 50dBA), is <u>not</u> accounted for in the modelled results.

Airport decision makers to date have assumed the NEF contour maps account for the "total noise exposure". This is also stated in Transport Canada's TP1247 'Land Use in the Vicinity of Airports' which is the document intended to guide them. Airport decision makers have not documented that they have been informed otherwise by their noise engineers.

Based on the EPNL calculation procedure, the NEF formula was envisioned for application where the maximum decibel in any modelled fly by would be within 10 decibels of the background sound level for a given location, in order for the calculated NEF values to contain the "total noise exposure". When a flight mix contains louder aircraft exceeding this 10 dB limit, where it is therefore known that some of their modelled fly by noise energy will automatically being omitted through typical EPNL calculation, conditions exist for the NEF software output to produce a false or misleading 25 NEF contour compliance. In this instance, even though the NEF model output is plotted to show compliance with the 25 NEF noise envelop, the 25 NEFdB per hour fly by noise limit being relied upon by the previously zoned

residential lands will be exceeded by the noise omitted from the calculations. The total noise energy for the hour in which the high decibel aircraft will be flying must be checked to ensure the flight mix and flight numbers proposed for that hour will still meet the overall 25 NEFdB per hour noise compliance standard. Such careful assessment of the fly by noise energy that was omitted from the NEF analysis was not appended to the Master Plan to support the number of flights calculated in each hour. Airport decision makers have not documented that they have been informed by their noise engineers of this fundamental noise engineering check with respect to Q400 at Island Airport.

The NEF model output is supported by a logarithmic formula containing the terms: EPNL=PNLTM + D. The Master Plan should have a tabulation of these terms for each of the modelled aircraft at the three ICAO reference locations (ie. lateral, takeoff and approach). From a community perspective, the key aircraft whose values need to be highlighted are those for the Q400 aircraft.

4. Terrain noise modelling not completed

The typical NEF modelling process was designed to model noise at ground surface elevations only, and not at the various elevations of 50 storey residential towers constructed 500m from the flightpath outside of the official noise envelop. Urban terrain modelling details have not been made available. Airport decision makers have not documented if they have been informed by their noise engineers that these matters need to be reviewed when calculating proposed flight numbers so that they address the 25 NEF noise standard re exterior walls of residential buildings.

5. NEF model scale not considered

There are important considerations when applying the typical NEF software process to the small Island Airport site. The NEF methodology (more specifically the underlying EPNL) was envisioned, designed, and tested empirically to model noise at ground surface elevations, and primarily for situations where the altitude of the observed aircraft is above 500' to 2,000' ie. not when the aircraft is at lower altitudes (below 350' or 35 storeys) or within a 10 second proximity of the end of runway. Also, given that NEF modelling typically generates 25 NEF contour lines for residential zoning that extend 3km or farther away from airports, the NEF software outputs are typically mapped at a larger 1:50,000 scale, exceeding the scale of the Island Airport. Similarly, the ICAO lateral certification point located 450m perpendicular to runway centerline is typically well inside the residential zoning contour line and not outside of it as at Island Airport. The Airport decision makers have not documented if they have been informed by their noise engineers of the above matters (affecting public health, safety, and well-being), with respect to confirming the noise studies required to support the necessary flight number reductions.

6. Airport site ground noise resulting from NEF flight numbers not considered

The noise roar from the airport grounds due to the number of modelled flights exceeds site noise capacity.

Airport decision makers have to date assumed that stationary source noise (eg. the ground roar resulting from flight activities) is included for in the NEF noise contour mapping. This analysis requirement might sometimes be forgotten by technologists when modelling NEF scenarios, as the residential zoning limit is normally established much farther away from the airport, over which distance the ground roar from airport site may be otherwise assumed to have dissipated. Reductions to flight numbers need to be calculated to contain the on-site ground roar, so that the average hour noise levels

meet the provincial stationary source noise limits. The entire waterfront tower corridor has been approved and constructed to meet those limits. The initial residential buildings in harbourfront were planned by a federal development agency to meet the stationary source noise limit requirements, and bedrooms were subsequently constructed facing the airport without noise protection nor central air conditioning as a result. Airport decision makers have not documented that they have been informed by their noise engineers that public health, safety, and well-being are affected in this regard when excessive flight numbers are not meeting the federal or provincial residential NEF standards.

7. NEF compliance studies not yet completed to confirm flight numbers

Per 1996 NEF Validation Study, which confirmed the NEF process for Canada, the NEF software modelling work needs to be supplemented with single fly by event analyses to ensure the 25 NEF noise standard is met at small footprint airports like the Island Airport. The NEF modelling software was designed for a continuous noise environment such as when there are two or more descents and/or ascents taking place simultaneously. The Island Airport site is primarily dominated by single fly by noise events, which have never been studied to confirm 25 NEFdB average hour noise compliance at Island Airport. Airport decision makers have not documented that they have been informed by their noise engineers of this study requirement to confirm flight numbers.

Conclusion

The above key issues list is not exhaustive. It is separate from matters related to outstanding certification requirements for a noise impact assessment study of the airport. In the absence of report sealed by a licensed professional noise engineer, public health, safety, and well-being have to date not yet been assured by any of the airport decision makers at Transport Canada, City of Toronto, and the Port Authority.