RUSSELL ACOUSTICS, LLC
Consulting Engineers in Sound and Vibration

1525-A Beaver Dam Road
Point Pleasant, NJ 08742
973.283.0001
973.464.9724 (Cell)

6 August 2017

Mr. Dennis Morelli, AIA
Manager of Facilities Development
Maine Medical Center
22 Bramhall Street, Portland, ME 04102

Re: Heliport Relocation Project
Sound Exposure Study Methodology

Dear Mr. Morelli:

Russell Acoustics LLC was retained to participate in a study of your new proposed rooftop heliport configuration. Maine Medical Center (MMC) has operated a heliport at this site for several years, on the roof of the parking garage, but increased need for emergency services necessitates a second pad. Further, the need to take down the parking garage means a new location is needed for the heliport.

Over a three day period – 1-3 May, 2017 – sound measurements were made around the hospital and into the nearby neighborhoods to assess both existing ambient sounds (without any helicopter activity) and sounds from a helicopter flying in and out of the proposed routes. Figure 1 shows where the instruments were located during the study; these locations were chosen to be close to where sound measurements were made several years ago as part of the original use application for the heliport.

As the new rooftop pads necessitate some changes in the flight routes into and out of the new heliport the new routes have been defined by Heliports International, LLC; these are shown and named on Figure 2. Figure 3 shows the tracks that were actually flown during our testing, based on on-board GPS data from the helicopter.

Instruments & Measurements

The instruments used for the long-term sound measurements are Larson-Davis Model 703 and 705P digital time-history sound level meters equipped with instrumentation microphones and windscreens. They meet ANSI requirements for Type 2 sound level meters. They measure and store the overall A-weighted sound pressure level ("dBA"), at programmed intervals, for programmed measurement times. Each instrument has an internal clock. These were all set and synchronized using a common digital clock, which was set using time from a GPS receiver.

Each instrument was calibrated prior to the test, and the calibration checked after the tests, with a Bruel & Kjaer Type 4230 sound level calibrator. The calibrator's own calibration is done annually and is traceable to the National Institute of Standards and Technology (NIST), following good acoustical practice. Sound levels in this report are expressed in terms of decibels relative to the ANSI-preferred reference pressure of 20 uPa. The instrument detectors were set for "slow" response. They stored various sound level metrics at 5-second intervals.

The A-weighted sound pressure level ("dBA") is a measurement method that is modeled after the frequency response of the human ear. Measurements of sound using this frequency weighting correlate very well with how "loud" sounds are. It is probably the single most commonly used method for measuring sound on a world-wide basis. Within the U.S. five major Federal agencies - FAA, DOT, DOL (OSHA), HUD and DOD - use it. The study done several years ago used dBA measurements.

Weather over the three days of the study varied considerably in visibility and cloud ceiling, so we were often uncertain as to when (even if) the helicopter could even fly. The temperature typically was in the 40 to 60 degrees Fahrenheit range, but it wasn't until Wednesday (3 May) afternoon the dew point dropped and visibility improved to where the flights could be made.

The first round of testing was done assuming the helicopter would not be flying and so the goal was to get ambient sound measurements. The nine environmental sound monitors were set up at the locations shown on Figure 1. They operated from noon on Monday, 1 May for 24 hours until noon on Tuesday, 2 May; there were no helicopter flights during this time. The data were then read out and the instruments reprogrammed to run from 2 PM on 2 May until 3 PM on Wednesday, May 3, for 25 hours of data. The hope was the weather would clear enough in this time to get in the flights, the only condition being I wanted them all done within one whole hour so we would have the other 24 (out of 25 overall test hours) for ambient sound data if that detail was later needed. In fact the weather did clear Tuesday afternoon and the flight tests were all done in the 5 to 6 PM hour.

The specific helicopter used for the testing was an Agusta A109E, ID N102H, from LifeFlight of Maine.

Data Files

There are a lot of different way to process and display the resulting data. The direct measurements, on both days, were made at 5-second intervals to be consistent and compatible with what you had done in the study several years ago for the original application. But we can process the data to make longer intervals to use for various presentations. For example, in a previous presentation the 1-minute average levels were plotted. We typically show long-term ambient sound levels in 1-hour increments over several days.

Not knowing at this time what format you'll want for your future work, I've provided you with spreadsheets containing different time intervals for the data, all starting with the 5-second direct readings. If you need them for other intervals (longer than 5 seconds) I can generate them for you.

In an overall spreadsheet you'll see multiple tabs, each for a particular instrument and its data in a time increment. The naming convention of the tabs tells you what's what.

Each tab starts with "MM" for "Maine Medical," followed by an "A" or "H" for ambient or helicopter. Next is a three digit number for the instrument serial number; you can map the instrument to its measurement location during the study with the table below, where the "CP" numbers are shown on the map in Figure 1, which also correspond to the locations used in your previous study.

A two-character (letter and number) indicates the time interval of the data. H, M or S correspond to hours, minutes or seconds. The number that follows shows how many of those units are covered by each row in the "Time History" section of the spreadsheet tab. "H1" indicates 1-hour intervals. "S5" indicates 5-second readings. "M1" has 1-minute increments.

Finally, the tab label ends with an "A" or "H" to indicate whether the measurements were made on the first day, only for "A"mbient readings, or on the second day, when the "H"elicopter was flown during one of the hours.

Thus, the tab "MMA469H1" shows measurements made at CP-6, on the second day of testing when the helicopter was present, and the time history in the spreadsheet is in 1-hour increments

Test Location	Instrument #
CP-1	464
CP-2	471
CP-3	904
CP-4	460
CP-5	911
CP-6	469
CP-7	910
CP-8	907
CP-9	461

Graphs

There are also many ways to present/graph the data. The temptation might be to plot all the 5-second levels for 24 hours. This can be done but there are 17,280 5-second intervals in 24 hours; you will probably end up with a mess. Generally, if you want to examine detailed sound levels (e.g., when the helicopter flew in and out) using the 5-second values will work.

When discussing the ambient sound (what some mistakenly call "background," but we'll go along with the term for now) it really isn't the sound level on a moment-by-moment basis that determines a person's attitude or assessment of their environment. Rather, it is the ongoing, around-the-clock, long term sound levels that correlate best with attitudes about whether one lives in a "quiet" or "noisy" neighborhood or something in between. My neighbor mows his lawn once a week for about 20 minutes, and I can clearly hear the sound. Yet I live on a quite dead-end street and that's how I'd characterize it.

Both the FAA and HUD (U.S. Housing and Urban Development) use a dBA-based metric of sound, the "day-night sound level", abbreviated DNL or Ldn. This is a long-term (as in an annual average) measure; what happens on a given day or even for some minute or so during a day has little effect on the annual average sound level. (Conversely, this is why we don't put much faith in "ambient noise studies" that measure the sound at a location for 10 minutes or so and declare that to be the ambient level.)

One sample graph (Figure 4) shows both overall sound level information for the 24-houe study and an hourly breakdown of the sound. The "overall" statistics cover, in this case, all 24 hours of the study. The "Leq" is the average sound level (technically, the energy average, as a decibel is a logarithmic function); Leq weights the average somewhat higher than a straight arithmetic average. The L10 and L90 are the sound levels exceed, respectively, 10% and 90% of the time and are common metrics use with sound measurements. From these we can also say that for 80% of the time the sound levels were between the L10 and L90 levels. For the measurements shown on Figure 4 this means the sound was between 50.5 and 70 dBA at this location for 80% of the 24 hours.

Each hour also shows its Leq average with the green line and the L10 and L90 levels with the range of the blue bar. In addition the red vertical lines show, for each hour, the minimum and maximum sound levels, which are called Lmin and Lmax.

I've not done it but with a little processing of the second day of measurements, one could take out the one hour when the helicopter was flying and the second 24 hours of measurements could be combined into graphs of the ambient sounds over 48 hours. (This is why I wanted all the helicopter testing done within a single hour.) Other than this one test hour there were no helicopter operations at the hospital during any of our sound testing. Alternatively, the test hour could be included so a comparison can be made between when the helicopter was in use and the other 48 hours when it wasn't.

If you want to drill down to look at specific things I suggest trying to balance the specifics of those things (e.g., the actual helicopter flights) with other times when there weren't flight times. You often find other events having nothing to do with the helicopter that were at similar sound levels.

Figure 5 is a graph showing CP-3 covering eight hours of 5-second data, including the hour when the helicopter was flying. This graph has "only" 5,760 data points. Notice that at about 19:40 – two hours after the helicopter was around - there was something that made a burst of sound that was actually a bit louder than the helicopter. You want to look at not just the sound when the helicopter was present but also at other times. People are frequently surprised at the sounds actually present in what they will insist is a "quiet" area. They are familiar with these other sounds and tend to "tune out" sounds from sources like local vehicle traffic, lawn care or snow removal equipment, swimming pool pumps, appliances, etc. The measurement instruments don't ignore any sounds.

There are times when you really want to drill into the individual measurements, as seen on Figure 6. This graph covers part of the eight hours shown on Figure 5, concentrating on a 20 minute period when the helicopter was actually flying into and out of the proposed new heliport area. We can see details of the individual events that we really can't make out in the 8-hour version of the same kind of data on Figure 5.

This also lets us see the "duration" of each event, as defined for aircraft by the FAA. Duration is the time from when the increasing sound level gets to within 10 dBA of the maximum level to when the sound drops down to 10 dBA below the maximum. The duration depends on what the helicopter is doing (flying by or near a pad where it is slowing down or starting to move away) and, from our experience, how familiar the pilot is (i.e., how comfortable [s]he is) with the setting (the test site was new; yet to be built). It is typically around 20 to 30 seconds and is of significance because about 90% of the total sound energy from the takeoff or landing (out of all the sound made for the entire length of the takeoff or landing) occurs during this duration. (The measurements were made at 5-second intervals to be compatible with the previous sound study, so the measured duration will be in 5-second steps.)

So if the hospital has, say, three helicopter operations per day – three approaches and three departures – each with a duration of 30 seconds, that means that 90% of all the sound from all the helicopter operations occurs in a total of 180 seconds over the day of 86,400 seconds.

Finally, we provided you with Excel spreadsheets with data from both days of testing, ambient only and with the test helicopter in operation, for various time intervals. If you need other time intervals prepared, or want other graphs prepared we will be glad to assist you.

Yours truly,

Norman R. Dotti, PE, PP, INCE
Principal

NRD/me

enclosures

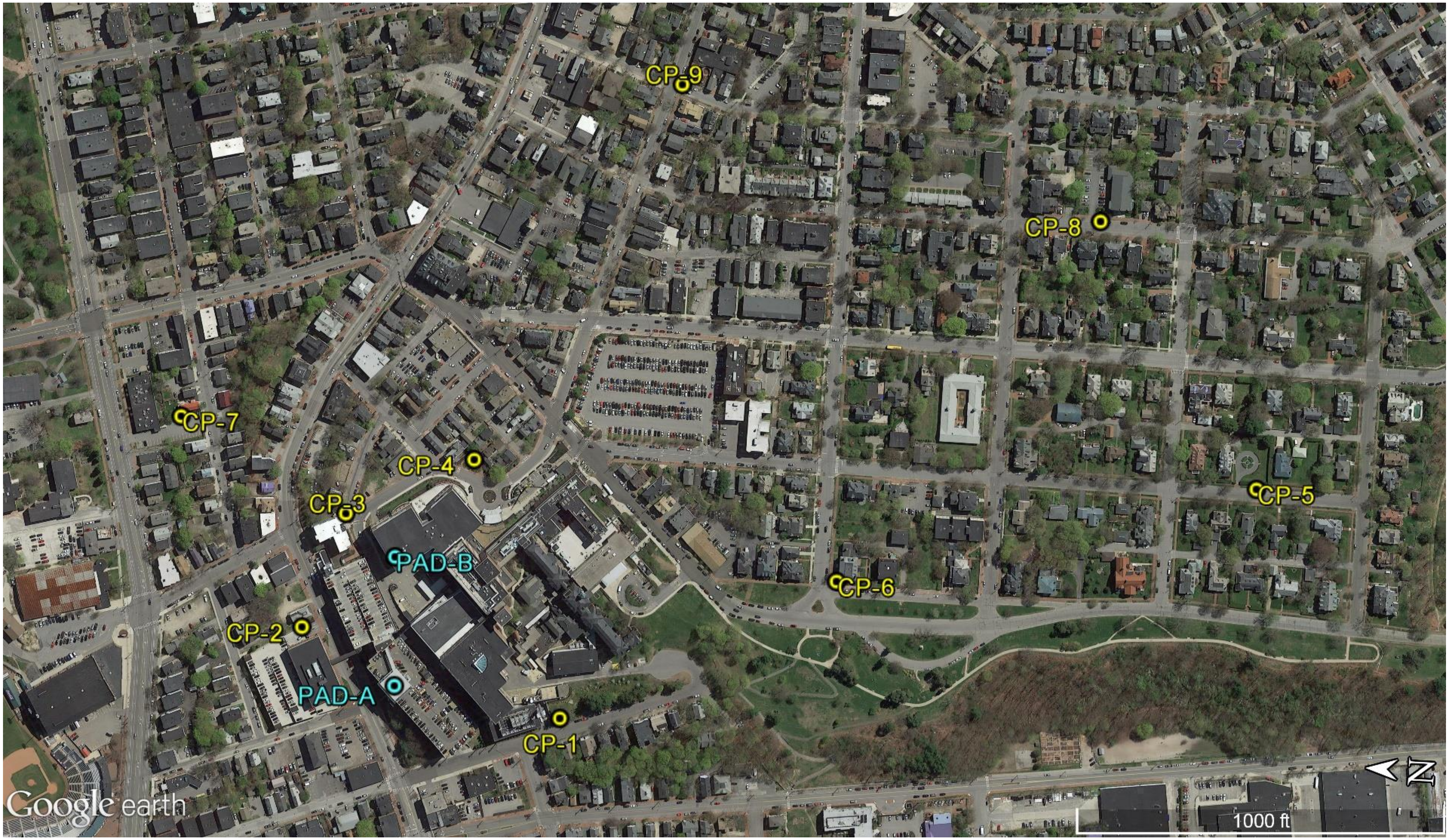

Figure 1 – Sound Measurement Locations

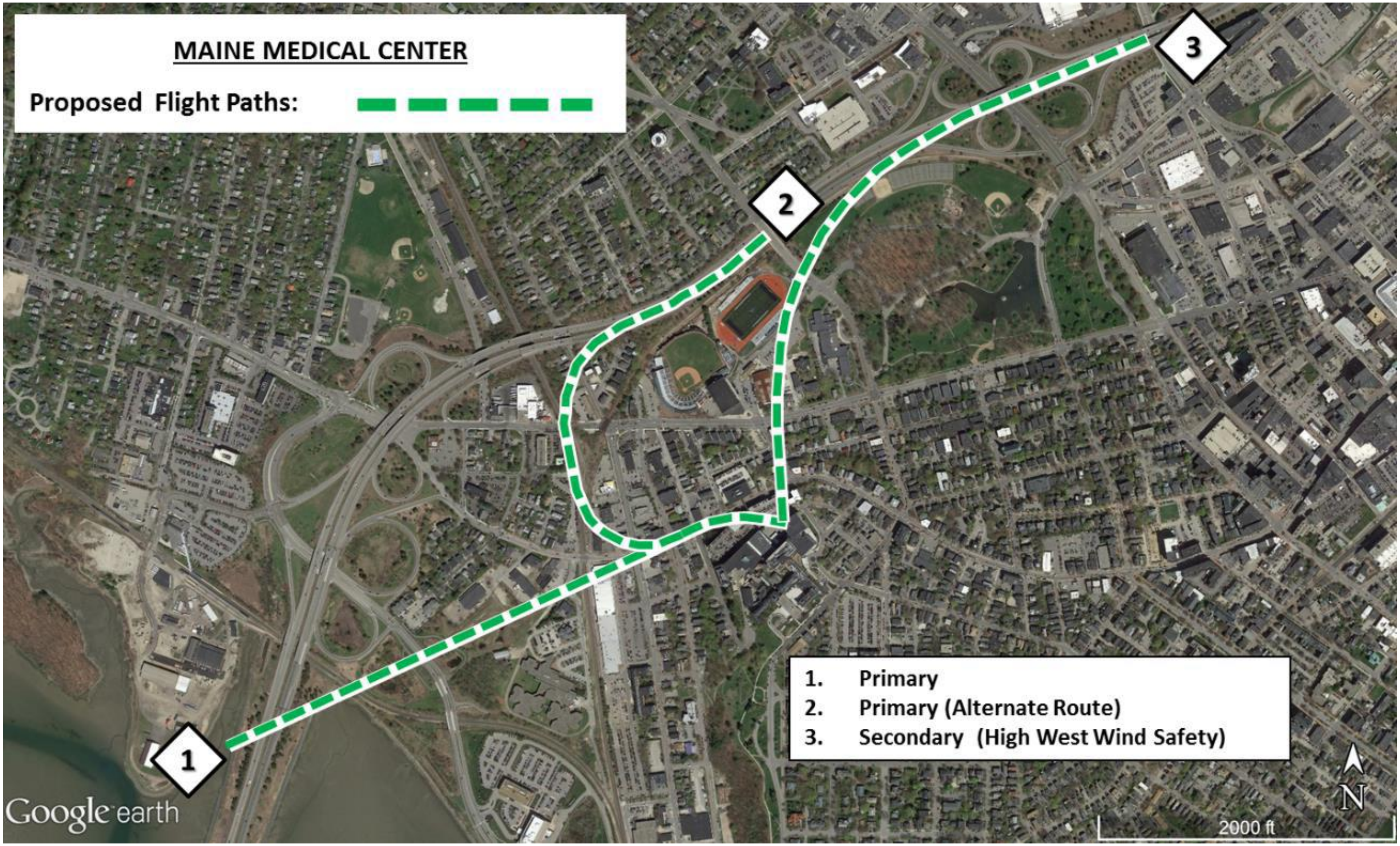

Figure 2 – Planned Flight Tracks

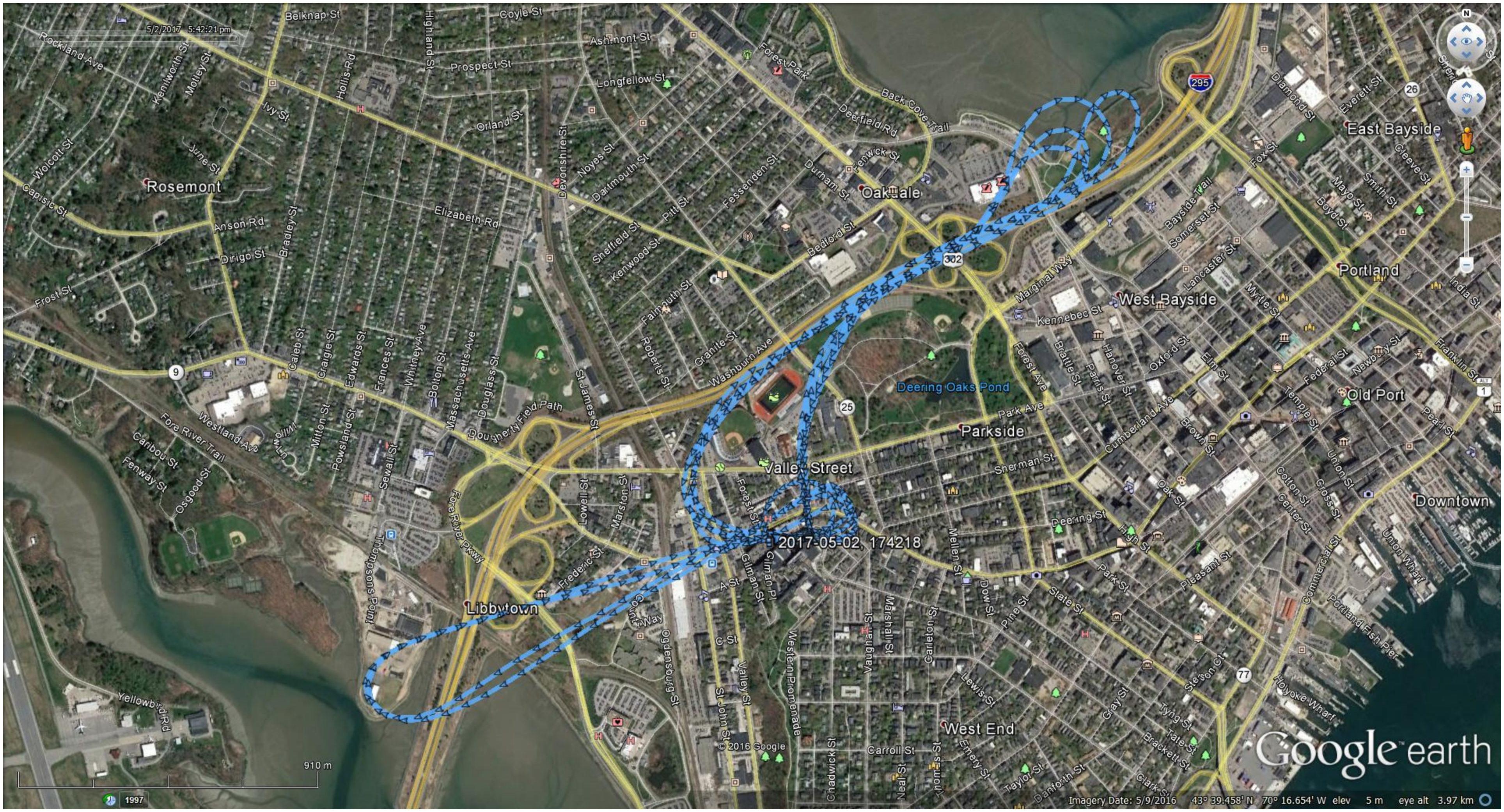

Figure 3 – Flown Tracks (from on-board GPS)

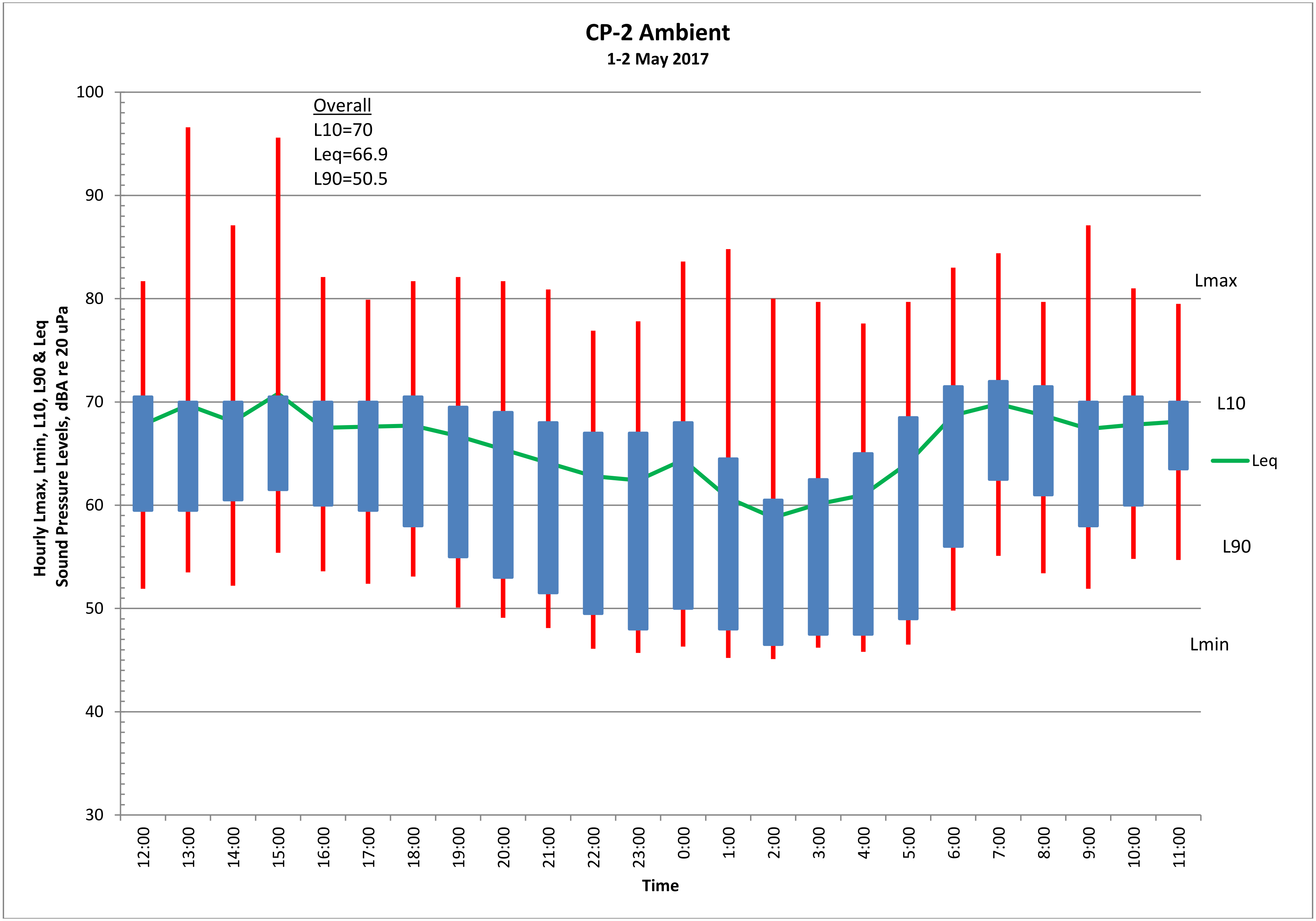

Figure 4 – Sample 24-Hour Ambient Graph

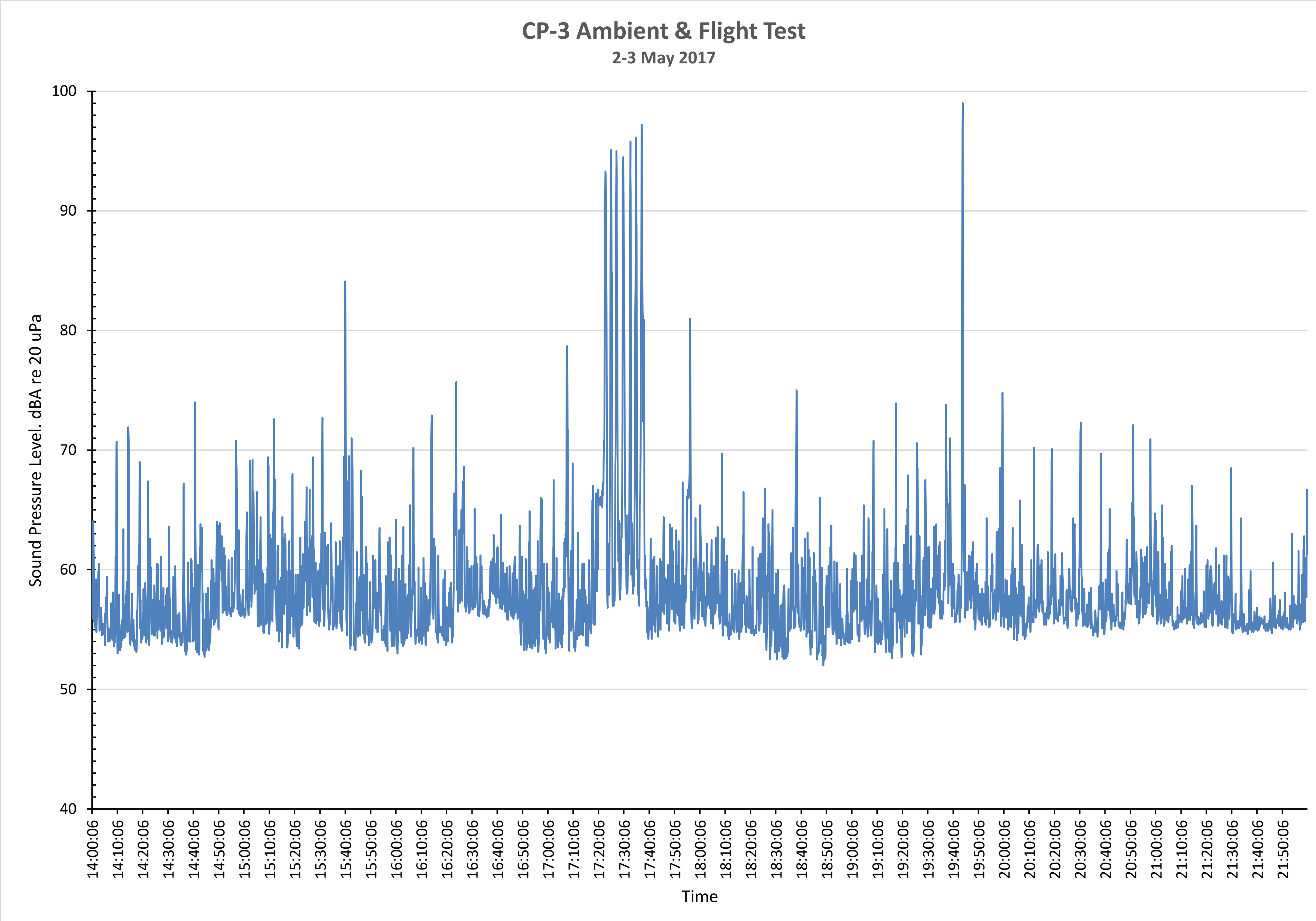

Figure 5 – Sample 8-hour Graph of 5-Second Measurements

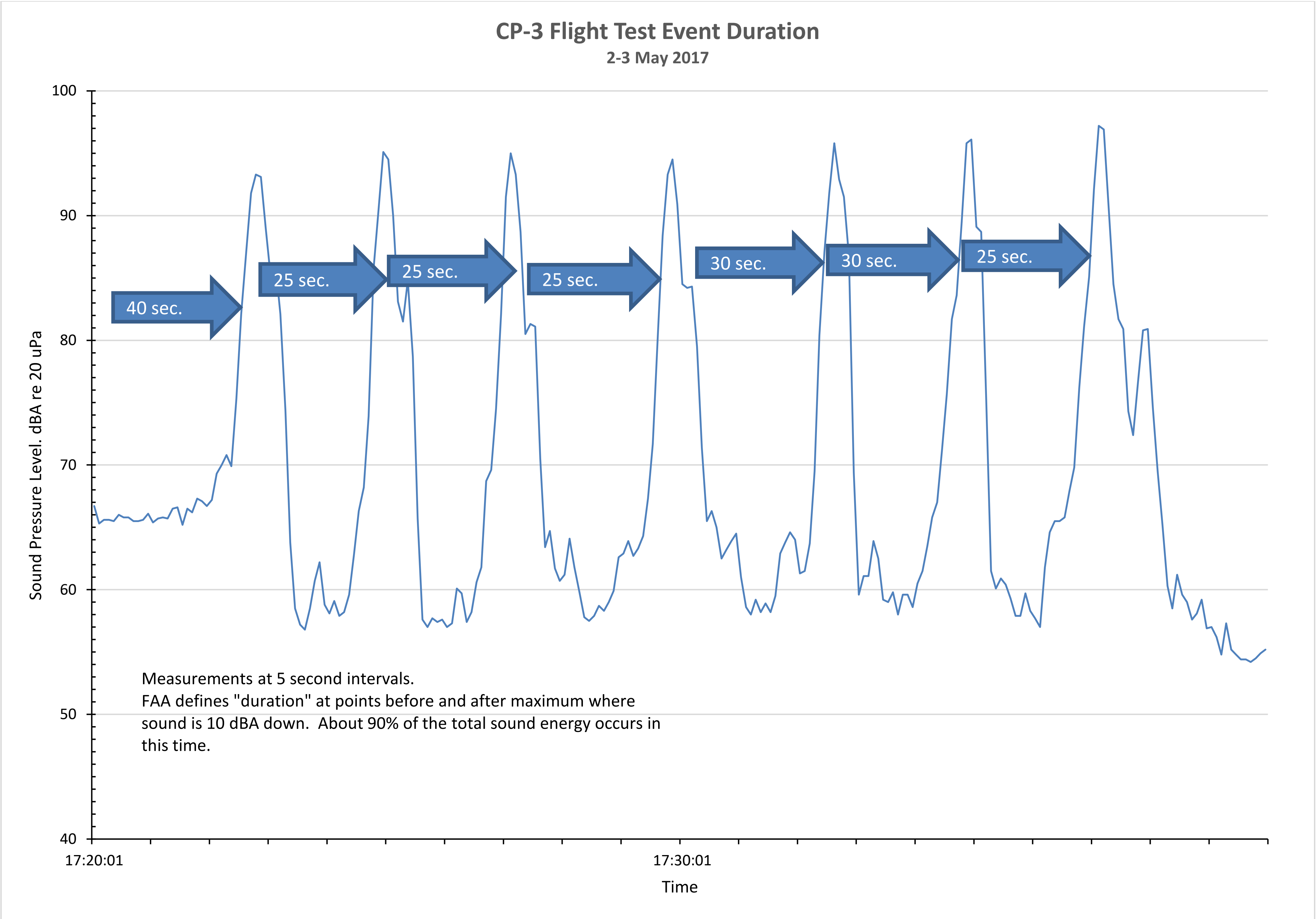

Figure 6 – Individual Helicopter Events with Durations