London Heliport: Noise emissions and the effect on Local Residents

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**Abstract**

The noise emissions from the operation of heliports situated in cities can have significant adverse impacts on a large number of local residents. Despite its significance,the effect of noise from rotary aircraft operation in an urban setting has not been extensively studied.This paper presents for the first time an objective and subjective investigation into the noise emissions from the London Heliport and the associated impact on local residents.Long-term noise monitoring measurementswere taken at four locations and a social survey was implemented involving over 1500 respondents. A new objective measurement methodology was designed and developed that allowed individual air movements from the Heliport to be acoustically identified. Subjective results were contrastedwith relevantsocial surveys and to the objective results. Objective results were also compared to planning guidance, local operation conditions and national and international based noise assessment criteria. Excessive sound levelswere found, both internally and externally, which can be attributed directly to the operation of the Heliport. The high participation rate obtainedin the social survey confirmed that noise emissions from the heliport operation cause important/substantial adverse impact on quality or life and well-being of the majority of respondents. The level of annoyance reported by respondents appeared higher than the level of annoyance attributed to the noise measurements at monitoring sites.As a study first of its kind, it is expected that the findings will inform and influence future regulatory policy and consequently improve the well-being of many residents.

Key-Words: subjective survey, measurement methodology, helicopters

Key Message: Heliport operations in an urban setting are an under investigated but a highly disturbing activity to local residents. Careful design of building facades and amenity areas need to be considered at the planning stage to ensure the future harmony of all stakeholders

# Running Title: London Heliport

# Introduction

Heliports located in metropolitan and urban areas offer convenient and swift airborne transport to strategic locations in the middle of densely populated areas. Essential services such as police,ambulance, emergency services and the military may use these heliports. However, typically most flights from privately owned heliports are allocated for business activity and recreational purposes [1]. Despite the economic and civil benefits that urban heliports can bring to the host city, there has been increasing concern amongst members of the public on the adverse effects of helicopter noiseon the well-being and quality of life [2][3]. Numerous and interrelated factors can be involved in the acceptability of heliport operations in densely populated urban areas. These factors can be acoustically related such as the close proximity of the heliport and flight routes to residences, building vibration and the distinctive nature of helicopter noise.

Non-acoustical factors such visual intrusion, fear of crashing, air pollution, opinion on purpose of the flights, lack of control and property devaluation can be significant contributors to the lack of acceptability and subsequence annoyance experienced by local communities [4].

Only a limited number of relevant studies [3] [5][6-10] could be found in the literature investigatingthe noise emissions from urban heliport operations and their impact on the local community some of which focused on London, UK [8-10]. However, most of those can be considered relatively dated when considering the recent advances in helicopter noise control. This suggests a lack of research attention on this significant urban environmental issue, but the recent EU European Helicopter Noise Model, NORAH (Noise of Rotorcraft Assessed by a Hemispheric Approach) project [11], is currently addressing this.

A holistic studywas undertakenon the noise emissions and their impact on local residents from the operation of London Heliport (UK). This study consisted ofa long-term noise monitoring exercise (Objective survey) and a community response survey (Subjective survey). Theresearch was undertaken over a six-month period, April-September 2017. Section 2 details the heliport and operational parameters. The subjective survey collected information on the perceptions and attitudes of local residents from the noise emissions using on-line methods aredetailed in Section 3. Section 4 reports on the objective survey using a specifically developed methodology that captures the noise environment around a heliport. Section 5 draws conclusions and recommendation from the study.

# London Heliport

The London Heliport is located by the south bank of the river Thames in Battersea, London SW11 3BE,and is London’s only remaining commercial heliport.The Heliport was built on the river bisecting Wandsworth and Hammersmith and Fulham boroughs. The installation was constructed in 1959, as “The Vertical Gateway to London”. At the time, the docks were derelict and the local urban landscape consisted of light industry and a small amount of terraced housing. Over the intervening 60 years, the local area has undergone significant development with blocks of flats being given planning consent along the river-front, Figure 1.

The former Greater London Council (GLC) first imposed local operational restrictions on the heliport during the 1970’s. The maximum number of annual movements was limited to 12,000 with a maximum of 80 movements per day. This allowance does not include air ambulance,police or military aircraft [12]. In addition, a local criterion was set for helicopter fly-by,take-off and landings. Currently, noisy commercial helicopters are limited to 1500 movements per year [13], see Section 4.1.5 for noise classification information. The Heliport can operate from 0700-2300 hours, 7 days a week. Most helicopters flying to or from the heliport are instructed, when possible, fly over the centre of the river Thames and be at the highest possible safe altitude while approaching or taking off from the helipad which built over the Thames [2]. From 2005, the minimum flying altitude for helicopters to fly over London was reduced to 300m [2]. London Heliport operates a “Fly Neighbourly” policy [1] in attempt to minimise the potential environmental noise impact on the local community.

Figure 1a.Left, Aerial view of London Heliport (red dots) and the surrounding housing developments,©GoogleMaps; Figure 1b Right, London Heliport landing pad view from the north bank.

# Subjective Survey

The community response to the noise emissions was captured through a subjective survey in the form of an online based questionnaire. This section details the design of the questionnaire, an analysis of the type of respondents, analysis of the results covering home, noise and attitudes. This is followed by a selection of quotations and concludes with a discussion section includes the design of the questionnaire, an analysis of the type of respondents, analysis of the results covering home, noise and attitudes, a selection of quotations and concludes with a discussion.

## Questionnaire Design

An online survey questionnaire was chosen as the most suitable tool to obtain information from a large and representative sample of the target population. The design aimed to collect demographic, perceptual and attitudinal data from residents of the three boroughs surrounding the Heliport namely: Wandsworth, Hammersmith and Fulham (H&F), Kensington and Chelsea (K&C). The survey was publicised through each boroughs’ online communication channels between July and September 2017. In addition, residents were also made aware of the survey through local community and pressure groups, resident meetings, posters and leaflets.The participation in questionnaire was of opted-in basis and anonymous.

Eligible respondents were defined as any resident of any of the three boroughs of interest above the age of 18. The questionnaire consisted of 33 close-ended multi-choice type of questions. The last question allowed the respondent to add comments in a free text box. This consultation period was made to approximately coincide with the objective survey period (April 2017- September 2017). Summer months were defined in the questions as the period between 2nd May and 2nd September.

Questions were grouped in three sections relative to the type of data intended to be gathered. These sectionswere called: 1- About your home, 2- About the noises you hear and related issues 3- Some information about you.The questionnaire development consisted of a series of draft iterations and pilot runs to help to provide confidence in the validity and reliability of the final version of the questionnaire and its results.

## Overall Results

A total of 1570 valid completed online questionnaires were received and processed. The total number of residents in three boroughs was 661,200 (2016 UK Census). It was found that 61.2% of the respondents declared that have lived in their property between 5 and 10 years or more; 21.2% between 2 and 5 years. Only 7.6% declared to have lived in their property one year or less. This shows that a large proportion of the respondents (sample) have lived long enough in their property to have experienced noise emissions from the heliport.

Almost half of the responses were received from Wandsworth residents (49.4%), while almost the other half came from H&F (48.6%). Response rate from K&C was extremely low (2%). Thisis attributed to weak promotion of the survey in that borough in the wake of the Grenfell Tower Fire, 14th June 2017. The proportion of male respondents was 50.5%, andfemales, 44.5%, respectively.The majority of respondents (89%) were aged between 25 and 75 years old.

## Detailed Results

**Home**: More than three quarters of the sample (78.3%) own their home, while 19.9% declared that they rent their home.42.7 % of the respondents have their home in direct line of sight or slightly off line of sight of the heliport. 31.8% have their home not facing the river shore or in a street set back.The proportion of respondents whose home was within 1600m from the heliport is 61.7%. It is worth to note that 17.2% situated their home at more than 1600m from the heliport and 21.2% responded that they did not know the approximate distance of their home from the heliport. This data suggests that substantial proportion of the respondents live within an area affected by the heliport or by the approach and take of flight paths.

Almost three quarters of the respondents, (73.4%) reported to have openable double glazed or better windows where they spend most of their time at home, while one quarter (25.1%) declared to have single glazed windows.

**Noise annoyance**: A large proportion of respondents (84.8%) felt highly annoyed by helicopter noise during summer months when windows are more likely to be open.

On the other hand, 57.5% of respondents felt highly annoyed by helicopter noise over the summer months with windows closed.The majority of respondents (57 %) felt able to differentiate clearly between helicopters flying overhead without interacting with the heliport and helicopters approaching to land or leaving the heliport. The vast majority of respondents (80.6%) expressed that on average they heard very frequently or frequently helicopter noise during an average summer day.

Between 72% and 82% of respondents declared that helicopter noise in the summer time interfered with the following activities: having a conversation, quiet leisure activities, listening to the radio, spending time in the accessible outdoor area of the home, or having the windows open.

The majority of respondents (52.4%) felt that helicopter in the summer time (2nd May – 2nd Sept) noise interfere with sleeping patterns, “e.g. the time you go to bed or get up, or are kept awake”. It should be remembered that the heliport does not operate during night-time, so these responses are likely to concern police, ambulance and military helicopters.

The vast majority of respondents (95.8%) believed that helicopter noise sounded much louder than the background noise in their home at the time of fly-pasts. This result is consistent with the relevant results obtained in the objective (noise monitoring) survey, as much louder is normally considered 20 dB higher than the existing condition.

From other questionnaire responses the two most selected factors that most disturb residents from the heliport operation were: loudness of helicopter noise (30.6%) and frequency content of helicopter noise (14.2%).

**Attitudinal Information**: 46.1 % of respondents have considered “sometimes” “often” or “very often” moving out of their home because the helicopter noise.

Regarding awareness of information and resources on Heliport Noise,only 8.2% of the respondents stated they knew about boroughs’relevant webpagesand 5.8% about Heliport’sown webpage. Two thirds of the respondents (66%) stated not to be aware of any information, communication initiative, policy or consultative committee. This absence of information and support resources can be seen as lack of effective engagement by the local authorities and the offending Heliport with the affected community of residents.

Despite the proportion of affected residents seen in results reported above, only 11.1% of the respondents declared they have made a formal complaint about the helicopter noise.Of those, 35.1% were male, 28.7% were female and 85.1% are owners of their residency. Their age distribution was evenly spread across a middle age group ranging between 35 and 74 years old which accounted for 71.8% of all complainants. The vast majority of the complainants (81.6%) self reported not suffering any hearing or psychological condition which could be affected by noise exposure.These results showthat profile of theaverage complainant to be a male or female of middle ageof healthy hearing sensitivity which owns his/her affected residency.

More than a quarter of the respondents (27.4%) expressed that would be happy to participate in semi-structured interviews and more than a third (33.9%) would be happy to volunteer to allow helicopter noise measurements to be taken at their home.Almost half of the respondents (49%) provided extra comments in the last free text box question. The vast majority of these comments expressed dissatisfaction, frustration and/or distress as a result of noise emission from the heliport operation.

A very small proportion of comments indicated overall satisfaction or no disturbance caused by the heliport noise emission..

Below is a sample of verbatim quotes provided in the free text box as given in the last section of the questionnaire. The quotes have been grouped by salient themes.

*“The noise can be deafening. You have to stop whatever you're doing until the helicopter passes especially when they fly too low, which is very often. I end up never using my balconyn as a result”.*

*“I cant now have the windows or doors open (which has been a nightmare with the recent hot weather) because of the noise making it impossible to hear the television or anything else”.*

*“..and we have to actually stop telephone conversations when the helicopters take off and land”*

*“…we find the noise stressful, as well as interfering with our daily activities (talking on the phone/working from home/watching TV etc)”.*

*“The noise is so loud that it cuts above conversations, TV, or any other noise. We have had to close our doors during the hot summer months on occasions in order to be in our home. Please help us!!”.*

*“I have noticed an increase in noise pollution from helicopters over the past year. It affects me and my husband every day…”*

*“I've noticed more activity over the years…”*

*“The frequency of helicopters flying past our house (particularly between Friday and Sunday) has got worse over the last 12 months.”*

*“more and more helicopters, more noise.. more pollution..”*

*“Noise and volume of traffic is out of control, the peaceful river residential area i brought into, is now a noisy polluted stressful location. ..sit by the river opposite the heliport try and have a conversation, its impossible, try and work from home impossible..”*

*“I am irritated by pilots keeping the engines running on the ground. The noise bounces off the flats opposite. Some pilots pass opposite my third floor flat. Others higher up.”*

From a content text analysis of the information collected in the free text box, it is clearly apparent that the operation of the heliport has adverselyaffected the quality of life and well-being of many local residents. Residents of the three boroughs were not offered the possibility to complaindirectlyto the researchers involved in the subjective survey. However, at least 26 unofficial and spontaneous complaints and reports have been received by the researchers via email complaining about the significant adverse impact on living conditions and well being caused by the heliport operation noise emissions. From a content text analysis and from the unofficial complaint emails received by the researchers, it appears that affected residents are not clear where or how best direct their formal complaints.

## Discussion

Some factors limited a desired higher participation rate. These included that the survey being opened for a short time, limited publicity provided by relevant boroughs, and the survey running during summer holiday session. This resulted in the virtual absence of K&C respondents..The demographic data of the sample provided evidence of the required diversity, relevance and validity of respondents.The proportion of adversely affected residents by noise emission from the heliport operation in those two boroughs was very high.The large majority of responses reporting extreme annoyance came from distances within the helicopter´s Air Traffic Zone (ATZ). This is the area covered by a circle centred on the Heliport with a radius of 1800m, one nautical mile. The majority of respondents (52.6%) who stated that live within 1600m of the heliport helicopters approaching or leaving routes felt highly annoyed by helicopter noise with windows open, while 4.4% of respondents expressed “not annoyed at all” or “very little annoyed”.

The reported level of annoyance caused by helicopter noise appeared higher than the level of annoyance attributed to noise measurements see section 4. However, it is important to note that many non-acoustical factors (such as location time of the day, socio economic factors) may influence when expressing attitudes and perception (annoyance/disturbance). To illustrate the issue it can be seen from Figure 2 how close the helicopters can fly to the residential dwellings.



Figure 2. Shows a helicopter approach to the heliport as photographed from Price’s Court

Qualitative results from a content text analysis of the information collected in the free text box appear consistent with quantitative results from relevant questions of the questionnaire. Those results clearlyreveal the important adverse effects created by the heliport operation noise emissions on the quality of life and well-being of many residents.

The main limitation of the subjective survey was the fact that responses were received only from residents who were aware of the online survey and decided to opt-in to participate. From responses obtained, it appears that many affected residents are not aware of the complaint systems available. That suggests that a more representative number of official complaints would be received if an effective and coordinated complaint handling system were in place.

The survey results suggest that despite implementing the specific recommendation of the 2006 GLA Study (London in a Spin)[2] to establish a formal complaint recording and monitoring scheme for the Heliport, there is a very significant local reservoir of complaints about helicopter noise that are currently not being recorded.

# Objective Survey

The objective survey section includes a literature review, a summary of relevant guidance and policy, description of the noise monitoring methodology used to indentify air movements, location descriptions, reports of measurements and an analytical assessment against applicable planning conditions, guidance, policy and standards concerning appropriate noise. The section concludes with a summary of day and night-time compliance.

## Relevant guidance and policy

Research into helicopter noise in the urban environment has been scant in comparison to fixed wing aircraft. A recent study didinclude improving the management of helicopter noise [14].There was no reference, except in one table, to rotary aircraft in the current UK Civil Aviation Authority New Airspace Change Policy document [15].

A review of the literature has found the following day and night-time potentially applicable national and international guidance, standards and policy documents:

1. ProPG: Guidance for Planning and Noise [16],
2. BS 8233:2014 - Guidance on sound insulation and noise reduction for buildings [17],
3. Aviation Framework Policy 2013 [18],
4. Planning condition set by Greater London Council[19]
5. British Standard BS4142:2014+A:2019 –Method for assessing and rating industry and commercial sound [20]. Please note this standard was used tentatively.

The criteria used in these documents will,where applicable, be applied in the assessment of the noise levels monitored inside and outside of the residential dwellings.

4.1.1 ProPG: Planning and Noise

In May 2017 a new planning guidance document entitled ProPG: Planning and Noise - Professional Practice Guidance for Planning and Noise [16]was jointly produced by the UK Institute of Acoustics (IOA), Association of Noise consultants (ANC) and Chartered Institute of Environmental Health (CIEH). The document provides guidance for sustainable housing development in regard to noise in the planning process through good acoustic design. It is based onthe latest information on criteria noise levels based on the dose-response principle of NOEL (No observable effect level), LOEL (Lowest observable effect level), and SOEL (Significant observable effect level) as introduced in Noise Policy Statement for England (NPSE) [21]. The primary method of assessing a location is by considering the health risks to the residents. This is accomplished through a table specifying day and night noise levels corresponding to health risk descriptors, see Table 1.

Table 1: ProPG Health Risk based onExternal Noise Levels (free field)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Negligible Risk** | **Low Risk** | **Medium Risk** | **High Risk** |
| LAeq, 16 h (07:00-23:00) | <50 dBA | >60 dBA | >65 dBA | >70 dBA |
| LAeq, 8 h (23:00-07:00) | <40 dBA | >50 dBA | >55 dBA | >60 dBA |

4.1.2 British Standard 8233:2014. Guidance on Sound Insulation and Noise Reduction for Building

Based on the World Health Organisation recommendations [22] BS8233:2014 specifies internal and external noise levels from air or structure borne sound both during the day and night, see Table 2.

Table 2: BS8233:2014 Recommended internal and external maximum noise levels

|  |  |  |  |
| --- | --- | --- | --- |
| **Activity** | **Location** | **LAeq, 16h**  **07:00-23:00** | **LAeq, 8 hr/ LAFmax**  **23:00-07:00** |
| Resting | Living Room | 35 dBA |  |
| Dining | Dining Area | 40 dBA |  |
| Sleeping/ Day time rest | Bedroom | 35 dBA | 30 dB / 45 dB |
| Amenity | External area | 50- 55dBA |  |

## 4.1.3 Aviation Policy Framework

In 2013, the UK Government’s Aviation Policy Framework was published [18]. It confirmed the three noise level thresholds used to define expected low, moderate and high annoyance to residents from aviation noise in terms of outdoor (free field) LAeq, 16 h (0700:2300), and corresponding entitlement to remedial measures, see Table 3.

Table 3:External (free field)noise levels from the Aviation noisewith corresponding entitlements

|  |  |  |  |
| --- | --- | --- | --- |
|  | Low Annoyance | Medium Annoyance | High Annoyance |
| Daytime LAeq, 16h (dB) | >57 | >63 | >69 |
| Entitlement | None | Sound Insulation | Moving Costs |

4.1.4 BS4142:2014 Method for rating and assessing industry and commercial sound

This British Standard is one of the UK’s most widely used standards for the assessment of environmental noise. "It employs outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident”.The standard considers relative levels rather than taking absolute noise criteria and makes use of penalties for tonality, impulsivity and intermittency of the specific noise source. The standard provides as a specific example of application of vehicles that are intrinsic part of the overall sound emanating from premises or processes, such as that from fork-lift trucks, or from train or ship movement on or around an industrial or commercial site.

It is unclear from the standard if the commercial operation of a heliport could be consideredwithin its scope of applicability. The standard takes the long term average noise level, LAeq,16hof the sound source under investigation and subtracts the long term background noise level LAf90,16hwithout the specific sound source present, called the Rated Level. The lower the Rated Level the less likelihood of adverse impact. For example: Rated Level of 10 indicates significant adverse comment likely, 5 adverse comment likely, 0 low impact likely.There are also penalties to be added to the Rated Levelfor the impact of tonality or impulsivity of the sound, see Table 4, as well for distinctive characteristic- a penalty of 5. This was the penalty used for this study based on multiple observations at the selected sites.

4.1.5 Greater London Council Criteria

The former Greater London Council (GLC) first imposed operational restrictions on heliports during the 1970s. At this time the GLCwasthe strategic planning authority for London and used agreements under what was then section 52 of the Town and Country Planning Act [23] as a means of controlling heliport activity at London Heliport. A part of these agreements includes the classification of helicopters by way of a two-list system. List A contained helicopter types that at the time were shown to be good noise performers and List B other types that were not able to demonstrate compliance with a specified noise limit value expressed in A-weighted decibels, Effective Perceived Noise Decibel, EPN dB.

The admission of a helicopter type into list A was dependent upon it being able to meet a noise emission standard of not exceeding 81 decibels EPN dB at a distance of 150m from its flight path. The standard methodology included a series of “flyover tests, departure and arrival flights” measurements. The principle of restricting operations at London’s heliports by means of a movement quota based upon the noise emissions of the helicopters was thus established over 40 years ago.This gave rise to the limitations of air movements for the heliports for rated and unrated helicopters. After 40 years, these restrictions remain current. By agreement of the London Heliport Consultative Group (LHCG) the exceedance criteria was replaced by anLAFmax=81 dB criterion for the restricted helicopter type [24].

## Noise monitoring Methodology

This section consists of the new measurementmethodology used to identify air movements, instrumentation used, and location chosen for the study. An environmental noise assessment for each location including an example of theproposed methodology completes the section.

### Measurement Setup and Processing

The measurement methodology had to be designed and developed specifically for the assessment of noise emissions from the operation of an urban located heliport. After preliminarysite visits, it was found that landing/ take-off occurred at aapproximate frequency of five minutes – particularly for tourists’ flights during the day. This frequency determined the duration of each measurement period. Relevant standards and guidance were used to select the most appropriate acoustic measurement parameters; LAeq, LA90 and LAFMax. Each standard had the same day and night durations (07:00-23:00) and (23:00-07:00), respectively which conveniently exactly matched the operating hours of the Heliport.

This longitundal study simultaneously measuredindoors and outdoors noise levels, in accordance to the standards and guidance including free field correction where appropriate. Each set of measurements at each monitoring site covered a period of at least 10 days, some up to 45 days. All instrumentation used was Class 1 (CEL 593, Norsonic Nor140 and NTi XL2 sound level meters [25]) set on 1.2m high tripods and calibrated using Class 1 calibrators[26]. Figure 3 shows examples of external measurement setups at three residences. Calibration occurred before and after each location visit, the visit being necessary to swap out the battery packs for the external sound level meters and/or to download the data.External measurements were taken on balconies, which were, then free field corrected. Internal measurements were only taken in unused rooms; some volunteers were excluded from the study because of this criterion. One other criteria was used in the participation selected, no pets

The raw data was post processed so that the LAeq,16 hours and LAeq, 8 hourscould be derived through logarithmic averaging to give the day and night value. These valueswere further averaged over the duration of the monitoring session, 10-45 days, to give an overall long-term value for day and night each monitoring site in the study. In addition, the highest of the daily noise levelswasalso reported.

Further data analysis was undertaken: firstly, by counting the number of times the maximum criterion, LAFMax was exceeded each day. The average number of daily exceedances was reported, as well as the greatest number of exceedances recorded during one particular day over the monitoring session.

Additional analysis was necessary to establish the external background noise level at each location. Normally achieved by removing or turning off the specific sound source, but in the case of helicopters this was not possible. However, helicopter movements were identified using the exceedance criteria. These 5-minute periods were excluded in the averaging of the LA90 to give the daily background level without the presence of a specific-type of sound source. No night value was derived, as the heliport did not operate at night.

Figure 3a.Shows calibration at Price’s Court. Figure 3b, Measurements at Queen’s Club Gardens

### Monitoring Sites, Locations with Dates

Working closely with LHCG, four monitoring sites (residences) were selected from twenty-five volunteers, so residents of all three boroughs were represented and one control dwelling was selected to represent a site distant from the heliport. Long term noise monitoring were undertaken at these sites in the three boroughs, 11th April 2017 to 1st September 2017, see Figure 4.

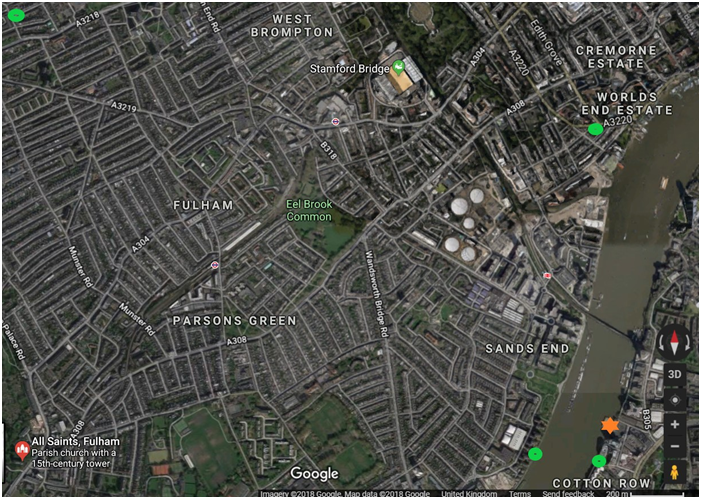


Figure 4. Google aerial photo showing in green four monitoring locations, in orange the Heliport

## Noise monitoring and assessment results

Noise monitoring and assessments for the following London borough sites are presented: Wandsworth, Hammersmith and Fulham, and Kensington and Chelsea, together with the monitoring results and assessment for the Control residence.

### Wandsworth

The monitoring location in Wandsworth was,Prices Court- a 2nd floor flat, 150m from the Heliport. Both internal and external noise levels were measured at the residence over a 45-day period between May-July 2017, see Table 4.

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Table 4. Prices Court Long Term Noise Monitoring Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Long Term Average Noise Level (LAeq, T)** | **Highest Daily Average Noise Level (LAeq, T)** | **Maximum number of Exceedances Per Day based on LAFMax>81 dB** | **Average number of Exceedances Per Day based on LAFmax>81 dB** |
| Day-Time  Internal Level  (0700-2300) | 56.9 | 63.1 | 45 | 11 |
| Day-Time  External Level  (0700-2300) | 64.2 | 66.0 | 55 | 36 |
| Night-time  External Level (2300-0700) | 51.4 | 57.0 | 4 | 1 |

The unexpected small difference in internal and external day long term averaged noise level was due to the unusually warm weather. The large balcony door being open for a large part of the day over the 45 days of monitoring in the summer of 2017, see Table 4. Table 4 also shows a very large number of exceedances with the worst day giving 55 exceedances with an average of 36 per day.

A BS4142 assessment was undertaken. The Rating Level is the difference between the long-term averaged daytime level, LAeq and the derived background LA90 level, 47.4 dBA, gave a value of 12.8dBA. However, the distinctive character of the sound needed to be considered, a correction factor based on subjective assessment of 5, giving a Rating Level of 17.8 dBA. This Rating Level was highly likely to result in significant adverse impact. If the measurements in table 4 were compared to BS8233:2014 both the internal and external levels were well in excess of the design criteria, see Tables 2 and 4. Finally, when the measurements are compared to the Aviation Framework Policy recommendations, the noise levels indicate medium levels of annoyance and that the dwelling would qualify for the installationof sound insulation.Turning to the GLC criteria it was found that on average 36 exceedances occurred per day, see Table 4, with the worst day recording 55 exceedances during the day. This compares to the night-time measurements were on average there was only one exceedance per night, and four on the worst day recorded. These results clearly indicate that the Heliport was the main source of daytime noise.

### Hammersmith and Fulham

The monitoring location in Hammersmith and Fulham was, Waterman’s Quay- a 3rd floor flat, 200m from the Heliport. This location was on the far side of the river Thames opposite from the Heliport. Measurement instrumentation was setup in a bedroom, window open, and on ariverside balcony over a 14-day period in July 2017, Table 5. Unfortunately, due to technical difficulties the external measurements were all invalid.

Table 5: Waterman’s Quay Long Term Noise Monitoring Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Long Term Average Noise Level (LAeq, T)** | **Highest Daily Average Noise Level (LAeq, T)** | **Maximum number of Exceedances Per Day based on LAFMax>81 dB** | **Average number of Exceedances Per Day based on LAFmax>81 dB** |
| Day-Time  Internal Level  (0700:2300) | 57.2 | 64.0 | 31 | 7 |

From Table 5 it was seen that the internal noise levels measured were in line with those taken on the other side of the river at Prices Court, as were the number of exceedances, Table 4. The long-term measurements werewell in excess of those given in BS 8233:2014 see Table 2. It was not possible to make any other assessments due to the lack of data.

### 4.3.3 Kensington and Chelsea

Themonitoring location in Kensington and Chelseawas , World’s End- an 8th floor flat, 1200m from the Heliport but located next to a major “A” road,Chelsea Embankment. Both internal, windows closed, and external noise levels were measured at the site over a 30-day periodin the living room and on a small river-facing balcony, see Table 6

Table 6. World’s End Long Term Noise Monitoring Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Long Term Average Noise Level ( LAeq, T)** | **Highest Daily Average Noise Level (LAeq, T)** | **Maximum number of Exceedances Per Day based on LAFMax>81 dB** | **Average number of Exceedances Per Day based on LAFmax>81 dB** |
| Day-Time  Internal Level (0700:2300) | 42.8 | 45.3 | 0 | 0 |
| Day-Time  External Level (0700:2300) | 63.2 | 65.2 | 121 | 33 |
| Night-time  External Level (0700:2300) | 60.4 | 62.5 | 4 | 4 |

From Table 6 the internal noise levels were in-line with the criteria used for an urban setting in BS8233:2014 see Table 2. The external noise levels both during the day and at night were well in excess of the BS8233:2014 criteria. The derived long-term background LA90noise level was found to be 57.0dBA. The BS4142 assessment could not be undertaken as there were more exceedances recorded than air movements possible, up to 121 in a day, hence helicopters could not be the primary sound source, although both the authors observed frequent flybys. The primary sound source at the residence was very likely to be road traffic from Chelsea Embankment. This was evidenced by the very high night-time averaged noise levels, 60.4 dBA just 2.8 dBA less than the day time values. Road traffic flows both day and night on the main east-west highway across central London, whereas helicopters fly only during the day except for emergency or military vehicles. This would also mean that the Aviation Framework Policy was not an appropriate assessment method based on the measurements.

4.3.4 Control Site

The control site was a terraced house in the borough of Hammersmith and Fulham near Queen’s Club Gardens in London, approximately 1800m from London Heliport. Internal and external noise levels were measured over 10 days during August 2017 in an unused living room, windows closed, and on a south facing balcony looking over a minor road. The nearest major road, A4, was 300m to the North, as was a train line. Table 7 presents the measurement results.

Table 7: Queen’s Club Gardens Long Term Noise Monitoring Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Long Term Average Noise Level (LAeq, T)** | **Highest Daily Average Noise Level (LAeq, T)** | **Maximum number of Exceedances Per Day based on LAFMax>81 dB** | **Average number of Exceedances Per Day based on LAFmax>81 dB** |
| Day-Time  Internal Level  (0700:2300) | 40.9 | 44.8 | 0 | 0 |
| Day-Time  External Level (0700:2300) | 52.1 | 53.3 | 2 | 0 |
| Night-time  External Level (2300:0700) | 47.6 | 50.8 | 4 | 1 |

This residence was located far from the Heliport in a residential area in West London. As such, the daytime levels were marginally higher than those given in BS 8233:2014 for an urban residence, 40.9 dBA with closed windows, but in line with the criterion for amenity space, 52.1 dBA, see Table 7. The derived long-term LA90background noise level was 40.8 dBA. This quiet residence did have a small number of exceedances most likely to be due to emergency vehicles. This could be inferred from the relatively small difference between the external long-term averaged day and night noise levels, 4.5 dBA, indicating a primary sound source active both day and night, most likely the A4 arterial road. A train line runs paralle l to the arterial road but does not run 1am to 5am.This would also mean that the Aviation Framework Policy was not an appropriate assessment method based on the measurements and similarly for the GLC and BS4142 assessments.

4.4. Noise Assessment

It should be noted that all four standards and guidance documents were in broad agreement, Section 4.1, regarding absolute noise levels in and around domestic dwellings. The remaining standard, BS4142, used a comparative assessment and as such gives no absolute noise levels or criteria.

When comparing the results from each site a consistent picture begins to form for the internal measurements. The internal noise measurements along the river near the Heliport, Price’s Court and Waterman’s Quay, were very similar, 56.9 dBA and 57.2 dBA, when the windows were open. The internal noise levels away from the Heliport, World’s End and Queen’s Club Gardens, were also similar 42.8 dBA and 40.9 dBA both with closed windows.A difference between open and closed windows is commonly given as 15 dB, which is in broad agreement with the measurements. Analysing the number of exceedances measured indoors, it was clearly seen that residences with open windows near the Heliport, Price’s Court and Waterman’s Quay, had 45 and 31, on the worst day, 11 and 7, on average, respectively. There were zero exceedances at residences far from the Heliport although these did have closed windows.

Studying the external noise levels a different picture appears, for residences nearroads there was only a small difference between the day and night noise levels, World’s End 63.2 dBA and 60.4 dBA giving a 2.8 dB difference, where as Queen’s Club 52.1 dBA and 47.6 dBA giving a 4.5 dBA difference. This result agrees with previous London based long-term measurements. For example the sighting of rooftop urban wind turbines in London [27]. This study found less arterial road traffic, A2, flowing faster gives a similar average noise level as daytime traffic moving slowly [27]. However, by the river near the Heliport Price’s Court away from any roads the daytime noise level was 64.2 dBA and the night 51.4 dBA giving a difference of 12.8 dBA, indicating there was a primary sound source that operated during the day but not the night, the Heliport.

With only one dataset for externally measured exceedance near to the Heliport, Price’s Court, reported another independent dataset was required to make a comparison to validate the measurement methodology. Fortunately, the Civil Aviation Authority logs all air movements, so the week of the Silverstone Grand Prix was taken as the datum, see Figure 5.

Figure 5. Number of exceedances compared to number of movements: Price’s Court, 10-18 July 2017

Figure 5 shows the relationship between the number of exceedances recorded at Price’s Court and the air movements as logged by the CAA between 10-18th July 2017. Excellent agreement was found for the day of the British Grand Prix, 16th July 2017, see Figure 5.It should be noted thattourist flights normally dominate the number of air movements, however during the Grand Prix a significant proportion of flights were much larger types of helicopters [28].

To provide further evidence to support the exceedance criteria, the Price’s Court datawas extrapolated to cover the entire quarter, giving a predicted 3,276 exceedances. In the same quarter, the Civil Aviation Authority (CAA) recorded 3,788 air movements of which 228 were byemergency or military helicopters [28]. This leaves 3,560 CAA logged air movements from the Heliport,a 7.9% misreporting rate for the developed measurement methodology, thus further verifying the results. The Price’s Court results demonstrated an extremely high number of exceedances from Heliport flights to the nearest residence, with a predicted 86.5% of all flights breaking the GLC criteria, when only 12.5% of commercial movements are of an unrestricted category of helicopter (1500 unrestricted movements of the allowed 12,000 air movements allowed). This result could be used to justify only allowing 1,500 movements, the unrestricted number, from the Heliport.

1. **Discussion**

Long-term measurements were undertaken over the months, April to September 2017, at multiple sites across West London both near and at a distance from London Heliport, whilst at the same time an on-line questionnaire was used to survey the local residents concerning sound emissions from Heliport operations. Five current standards and guidance documentswere used in the assessment of the measured environmental noise. It should be noted that two of these documents, BS8233 and ProPG, were written solely for the purposes of design and planning and not to retrospectively evaluate environment noise. However, Wandsworth Council – one of the borough’s involved in the study was considering planning applications near to the Heliport hence the inclusion of these assessment documents. Table 8 summarises the daytime assessments based on the measurements.

Table 8. Summary of effect and compliance with relevant guidance, standards and policy (Daytime)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **ProPG Health Risk** | **BS4142**  **Assessment** | **BS8233 criteria**  **(internal/external)** | **Aviation Policy**  **Annoyance** | **GLC Local**  **Planning Condition** |
| Wandsworth Price’s Court | Low/Medium | High Adverse  Impact | Exceeded /  Exceeded | Medium | Regularly Exceeded |
| Kensington and ChelseaWorld’s End | Low | Non Identifiable Source | Exceeded /  Exceeded | Non Identifiable Source | Non Identifiable Source |
| Hammersmith & Fulham Waterman’s Quay | Missing Data | Missing Data | Exceeded/  Missing Data | Missing Data | Regularly Exceeded |
| Control- Queen’s Club Hammersmith & Fulham | Negligible | Non Identifiable Source | Compliant  Compliant | None | Compliant |

It can be seen from Table 8 for the daytime summary that homes near the Heliport, Price’s Court and Waterman’s Quay were non-compliant with all the standards, guidance and policy documents, based on the available data. The Control residence measurements were all compliant with the same assessment documents. Away from the Heliport but along the river the noise assessments were inconclusive due to a lack of a known sound sourcebut found to be high. Nextto consider werethe night-time assessments by way of comparison, as shown in Table 9.

Table 9. Summary of effect and compliance with relevant guidance, standards and policy (Night-time)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **ProPG**  **Health Risk** | **BS4142**  **Assessment** | **BS8233 criteria**  **(external)** | | **Aviation Policy**  **Annoyance** | **GLC Local**  **Planning Condition** |
| Wandsworth Price’s Court | Negligible/ Low | Non Identifiable Source | | Compliant | N/A | N/A |
| Kensington and Chelsea World’s End | Medium | Non Identifiable Source | | Non-Compliant | N/A | N/A |
| Hammersmith & Fulham Waterman’s Quay | Missing Data | Missing Data | | Missing Data | N/A | N/A |
| Control- Queen’s Club Hammersmith & Fulham | Negligible | Non Identifiable Source | | Compliant | N/A | N/A |

It can be seen from Table 9 the night-time summary that two of the standards and guidance documents were not relevant as they only cover day time measurements, Aviation Policy and GLC planning condition. However, the three remaining documents were valid although the Waterman’s Quay data was missing. This left three sites, two of these were not near major roads and were negligible or low risk and compliant to the relevant criteria, the remaining site – World’s End situated close to a major road was a medium risk and non-compliant with the BS8233 criteria. This indicates that at night traffic on major roads was the primary sound source, and thus non-identifiable as a specific noise source. This led to the BS4142 assessment being dismissed as an evaluation tool for the night-time condition.

By comparing and contrasting night and day assessment results,a picture could be formed of environmental noise in West London. Major roads were found to be the main noise source except if the residencewas along the river near, in which case the sound environment was quiet at night.

A weaknesses identified in this research is the lack of identification of individual types of helicopters –this was due to the automated data collection methodology necessitated by the length of the study. The data collected could be used to help in the development and validation of the NORAH helicopter prediction model [11], as this model requires a large proven independent dataset.

By comparing the objective and subjective survey results there was very strong evidence of noise annoyance from heliport operations. For instance 95% of the 1570 respondents stating that flybys were much louder than the background noise, this agreed with the daytime BS4142 noise assessment for the residences close to the Heliport on the river, 17.8 dB compared to 20 dB the value general taken as being equivalent to a much louder sound. This would indicate that the vast majority of the respondents lived close to the Heliport along the river. In addition, 85% of respondents were highly annoyed when the windows were open almost exactly matching the percentage of flights in exceedance of the GLC criteria over a similar period, 86.5%.

The was also a near even split between respondents to the survey between Wandsworth and Hammersmith and Fulham boroughs reflecting the high internal noise measurements found in the corresponding sites along the river. This indicates that residents of these boroughs were the most concerned about air movements from the Heliport. By way of contrast, there was a small number, 39 respondents from Kensington and Chelsea, again agreeing with the conclusion of the objective assessment.

# Conclusions

This was the first time environmental noise monitoring consisted of geographically spread locations taking detailed temporal measurements both inside and outside domestic properties had been undertaken both close to and away from an urban located heliport. Objective and subjective methods were combined in the assessment of the environmental noise across three London boroughs adjacent to London Heliport. A new measurement methodology was designed and tested to establish if helicopter movement could be identified from their noise emissions.

It was found daytime noise criteria were breached or exceeded multiple times at nearby residences. The measurement methodology identified a predicted 86.5% of air movements at a residence near to the heliport according to CAA records. Good agreement was found between the subjective attitude survey and the measured noise levels.

The subjective survey in the form of an online survey questionnaire was developed to collect perceptions and attitudes of local residents on the noise emissions from London heliport operation. A total of 1570 questionnaires were received the majority of respondents reported to feel extremely annoyed or disturbed by helicopter noise with windows open or closed. Noise emissions from the heliport operation cause adverse impact on quality or life and well-being of a large majority of respondents.The level of annoyance caused by helicopter noise reported by respondents appeared higher than the level of annoyance attributed to noise measurements at monitoring sites.

1. **Recommendations**

When the original planning enforcement conditions were set, the Heliport was located in an industry complex, where there were only a few noise sensitive locations. In addition, other commercial heliports were in operation in London.Now there are hundreds, if not thousands, of sensitive receptors (residents) living near the heliport and along the heliport flight path in newly built residential properties, such as Imperial Wharf. As such, it is recommended that Local Planning services review the current operation of London Heliport “Vertical Gateway to London”. The incorporation of helicopter noise and its impact in future aviation guidance and policy as well as the promotion of research in this field will be a major contributor in the improvement of the health and well being of thousand of urban residents living near urban heliports.

The authors would strongly recommend that that all planning applications strictly adhere to the design guidance given in BS8233:2014 and WHO guidance. The creation of a dedicated helicopter noise prediction model that is able to identify the number of residents affected by heliport operations, which will help policy makers make informed planning decisions and flight policy.

Finally, it was highly recommended by the authors that the Heliport Noise Complaint System, currently logged by phone by the Heliport, be modernised so that complaint handling becomes an accurate, reliable and effective instrument in understanding the noise impact on local residents from the heliport operation.

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