# Goodwood Noise Study

## Analysis of evidence, findings & conclusions

**An assessment of motor circuit and**

**general aviation noise**

**Criteria evaluation for future development**

**for**

## Chichester District Council

Provided by

MAS Environmental Ltd.,

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## 1.0 Executive Summary - Main findings and conclusions

**1.1** This study has found:

- The need for and continuance of the 400m buffer zone identified in the Local Plan is robust and supported by the science. Within this zone, there should be a general presumption against noise-sensitive development.
- The potential for significant adverse impacts to affect noise-sensitive development extends significantly beyond the 400 metre buffer set out in current policy. The study has found that it would be a reasonable precautionary starting point for any proposals for noise-sensitive development within the wider vicinity of the site (and potentially extending up to 800 metre) to be informed by a noise impact assessment. However, the final decision on seeking a noise impact assessment should be made having regard to the particular circumstances of the site, the nature of the development proposals and the wider findings of this study. Such an approach could perhaps be referenced in the Local Plan.
- The study provides guidance on potential decibel criteria which could be applied where noise-sensitive development is proposed beyond the buffer zone. This includes that any noise impact assessment to be provided should take an LAeq(15 minute) level of 42dB not to be exceeded, and an LAmax(f) of 46dB not to be exceeded more than five times in any 5 minute period. These relate to emissions of noise from any Category event at Goodwood MC other than Category 1. Exceedance may not necessarily preclude development depending on the frequency and duration of impact as well as presence of quieter outdoor areas that are afforded additional noise reduction with any proposed residential development.
- Beyond the 400m buffer zone, variations in impact due to meteorological and topographical effects vary to a greater extent such that impact is

clearly reduced but the full extent of impact would require a case by case assessment.

- Evidence based research was released in October 2018 by the WHO. This reflects increased adverse impact in terms of health related effects from aviation noise than previously considered likely. Development in any locality where the Goodwood general aviation noise exceeds 45dB LAeq(16 hour) requires individual assessment.

**1.2** This study has been delayed to take account and reflect the emergence of new guidelines from the World Health Organisation (WHO) October 2018. There has also been a new National Planning Policy Framework released in July 2018. Two underlying principles of the NPPF2018 are to ensure good quality of living within new residential development and also any land use conflicts do not constrain or lead to the demise of existing commercial land uses. The WHO have clarified the inapplicability of their guideline values to neighbourhood sources such as motor sport and also the need for stricter criteria for aviation noise, compared to that advised in their previous guidance.

**1.3** There is also a new approach in the National Planning Policy Framework (NPPF) based on the "agent of change" principle where a new development, in this case, new housing rendering the locality more sensitive to noise intrusion, should be responsible for addressing or mitigating the impact. In effect developers need to address these issues arising from in the insertion of their development. In this case the open and airborne nature of the noise sources which impact a widespread area renders mitigation at receiver locations impractical. This policy approach supports the existing approach of a buffer zone in this case.

**1.4** It is concluded that new noise-sensitive development within the buffer zone is likely to be subject to unacceptable adverse noise. This also applies to varying degrees in the immediate area beyond the buffer zone in cases where the houses are not designed and afforded noise protection to reduce any noise impact affecting occupants. In turn it is concluded such development in this buffer zone and potentially in the area immediately outside it could potentially conflict with the Goodwood site along with restricting development in relation to aviation uses and flight pathways. Furthermore

it is considered that such development could constrain and significantly affect the existing commercial activities.

**1.5** **Risks arising due to new residential development subject to commercial noise.** Permitting noise-sensitive development within the buffer zone or in areas beyond where decibel levels exceed the short term noise criteria and maximum noise criteria set out in this study places residential amenity at risk from the existing commercial development with potential action for statutory or civil nuisance.

**1.6** It is important to recognise the senior courts have consistently confirmed the criteria for nuisance relates to the materiality of the impact as judged by normal reasonable people and in cases noise / decibel levels could effectively be immeasurable as an average and still constitute a nuisance, where those sounds are incongruous and / or alien in the sound environment. It depends on the nature and character of the noise in particular and not their level.

**1.7** Detailed analysis and review undertaken in this study and regard to recent guidance from the WHO, confirms that control is needed to protect any noise sensitive development within a significant distance of the Goodwood circuit and airfield and is also needed to protect the existing commercial use of motor sport and general aviation. This is best achieved through consideration of a combination of measures which are recommended including:

a. Continuance of the 400m buffer zone of a presumption against noise-sensitive development in order to protect the quality of life of people and the existing commercial uses in accordance with national policy. Outside of the 400 metre buffer zone, a precautionary approach is recommended for noise-sensitive development within the wider vicinity of Goodwood (potentially extending up to 800 metres) where a noise impact assessment should be required as a necessity should generally be expected to demonstrate the criteria in this report for the motor sport and general aviation are not exceeded.

b. Guidance on potential decibel criteria which could be applied where noise-sensitive development is proposed. This includes application of short term

LAeq(15 minute) levels for the assessment of noise-sensitive development where these levels are not expected to be exceeded due to the motor sport (other than Category 1 events) or when combined in such a period with aircraft activity. It is concluded there should not be expected an exceedance of 42dB LAeq(15 minute). Separately aircraft activity noise should not be expected to exceed 45dB LAeq(12 hour) for the daytime.

c. Additional application of maximum noise control per event / occurrence of a burst of intrusive noise from the motor sport are appropriate and follow principles set out in the WHO guidance. It is also common practice. It is concluded there should not be more than five separate exceedances of 46dB LAmax(f) during any 5 minute period.

d. The controls above should operate concurrently and independently in relation to all motor sport event types except Category 1 days where higher noise is likely accepted due to their limited number. Thus exceeding any one of the controls during any single period (not an arithmetic average of periods as applied by some acousticians) other than in a de-minimus way, would indicate unacceptable development.

**1.8** There is no neat formula to take account of the character of motor sport noise combined with its frequency and duration of impact, especially when experienced against the background of significant light aircraft activity. Guidance, experience and wider practice indicate it relates to the dominance of those sources of noise, based on their character content and how frequently they cause intrusion. In turn that relates to the level of masking noise present and the particular motor sport noise arising. Whilst some are more intrusive than others and more readily interrupt due to the more stark characteristics arising, it is primarily a matter of the noise character being present that draws attention whilst in and around the home and how regularly that interruption arises.

**1.9** Where the motor sport noise emerges typically 10dB above masking background sound it will clearly be dominant, distinctive and intrusive. The levels reflected in this study derive therefore from the combination of background sound levels experienced

as well as the character in the noise, the cumulative effect of the aviation noise and the application of similar levels and principles at other UK sites.

**1.10** In relation to controls at other sites, the study indicates controls at residential property applying short term LAeq values typically averaged over 10 minutes to an hour of 40-45dBA and maximum noise limits (LAmax(f)) of 43-55dBA are used. In some cases higher values have been applied either to permit a limited number of days where higher noise is allowed or because limits are applied at the motor sport venue which translate to these lower values in the community. Levels recommended for this site are consistent with controls applied in other cases.

**1.11** In principle, acceptability of future development should first and foremost be based on continuance of the science and evidence based 400m buffer zone as already applied. This relates well to adverse community response and exceedance of the levels identified. However, it is recommended a precautionary approach beyond 400 metres be extended, not as a buffer zone excluding development, but as an area where there should be a general expectation that a noise impact assessment should ordinarily be sought. However, the final decision on seeking a noise impact assessment should be made having regard to the particular circumstances of the site, the nature of the development proposals and the wider findings of this study. The noise impact assessment should inform the development proposals by applying and comparing the decibel criteria as set out in this study, subject to any mitigation effects and the resulting noise. Where these are not met there would need to be special planning grounds warranting acceptance of higher noise in the balance. A particular concern is the risks to the commercial operations from increased adversely affected populations.

**1.12** Any developer would generally be expected to demonstrate the short term LAeq and LAmax(f) criteria of 42dB LAeq(15 minutes) and 5 exceedances of 46dB LAmax(f) during any 5 minute period, respectively for motor sport noise from Goodwood and at the proposed development in free field conditions is not expected to be exceeded. In addition the aviation noise should not exceed 45dB LAeq(12 hour) also in free field conditions. These levels would apply under most circumstances to development beyond the buffer zone but recognising there are atypical weather and activity

exceptions that may lead to exceptional cases of exceedance which would not preclude development on their own. This provides an important secondary layer of evidence based protection that the quality of life of future residents is reasonably secured and importantly, any action whether civil or statutory by any affected resident should not result in the future constraint or demise of the commercial operations at Goodwood, an internationally recognised facility.

**1.13** It should be noted the criteria set here are designed in relation to planning provisions, to protect future residents from unreasonable and excessive noise, thereby maintaining quality of living as well as protecting the commercial operations from other civil and statutory controls relating to quiet enjoyment of dwellings. It is not a criterion defining nuisance which is more complex than these decibel criteria and beyond just the decibel values applied.

**1.14** The general aviation noise impact adds cumulatively to the motor sport impact introduces a further layer of complexity to any assessment. As a minimum outcome its occurrence indicates stricter control over noise / greater exclusion is needed and any question of uncertainty over the nature and character of the motor sport is negated. This added feature indicates potentially stricter criteria than recommended here but on balance it is considered those proposed are appropriate. It permits some adverse impact but is expected to fall short of that which is intolerable for most people. This is especially the case as the general aviation activity is well below its full potential and consideration needs to be given to the future level of impact that is likely / perceivable.

**1.15** The evidence and analysis reveals the 400m buffer zone is robust and supported by different evidential elements including the complaint based evidence generated within the community as well as noise level measurements. There is no basis to reject the complaints based approach that provides a barometer of affected residential opinion in this case and is a test of the normal reasonable person. This in turn is supported by controls applied at other sites where complaints arose and is also supported by findings of the courts and at planning inquiries. The rationale to the 400m buffer zone is discussed in more detail in this summary.

**1.16** Historical arguments presented in support of development within the buffer zone were based on incorrect application of noise principles and guidance. Any sensible interpretation of the guidance and the science should reflect this problem.

**1.17** The criteria developed at other sites in the UK within similar localities indicate a transferable form of controls of the same order of magnitude as applied in this case and that have been tested and found to be robust. Development within 400m generally cannot meet the criteria recommended here and consistent with controls adopted generally. There is also a sound basis for indicating the buffer zone could be extended further but this is not necessary with the additional controls discussed.

**1.18** An area of radius from the 400m buffer zone, potentially extending to 800m from the circuit identifies where detailed review and analysis of the noise impact and therefore the acceptability of any development that is sensitive to noise, could justify careful scrutiny in relation to the impact from motor sport and general aviation noise if a precautionary approach was adopted by the Council. A noise impact assessment could reasonably be sought as a general starting point in such a wider area including having regard to the criteria set out in this study.

**1.19** As in all aspects of development, there may be exceptions to the buffer zone where it can be demonstrated land use conflicts will not arise. This would need to address the noise criteria identified above and demonstrate how quality of life and absence of constraint on the commercial operations is achievable. Such circumstances are considered likely to be exceptionally rare. An example might be residential occupation tied to a commercial operation such as for security or animal welfare needs but would need to incorporate protection of amenity in any event.

**1.20** How we derive noise criteria for this type of activity? In terms of noise there are basically two fundamentally different types of noise, divided by the way they impact and affect humans. They impact differently and so are assessed differently.

**1.21** There are generally more benign anonymous types of noise which are often 24/7 such as road traffic noise for which we have guidance on their health effects. Our unconscious mind increasingly ignores these sources over time and impact is more a factor of overall loudness and sound energy. Then we have noise which exhibits

special characteristics which increasingly draws our attention over time. It is not normally 24/7 but can be. Importantly it continues to draw our attention and in many cases we sensitise to it, leading to increased impact over time. This effect can take months and sometimes years to occur.

**1.22** This sensitisation arises more often when the noise occurs frequently enough and is clearly audible for significant periods. Classic examples of this type of noise include modern music bass beat, industrial noises which involve crashes and bangs etc., shooting noise, skate parks and other forms of recreation including motor sport noise. There are acoustic characteristics such as tonality and impulsivity and non-acoustic characteristics such as speech (foul language), expectation of necessary noise, elements imparting adverse attitude to sufferers (ones suggesting the noise producer does not care) and ones which reflect issues such as an inability to prevent the intrusion or escape from it.

**1.23** In the case of motor sport there are a wide range of attention grabbing characteristics including multiple changing tones, rapid changes in energy level, low frequency content, roars and screeches that can be trigger responses of expectation of a crash, short bursts and also secondary features such as tannoy.

**1.24** We tolerate a lot more of the former benign sources of noise such as road transport but not the latter which leads to complex human responses. These complexities commonly prevent the development of guideline values such as with motor sport. We have a lot of motor sport guidance but it does not set levels.

**1.25** As there is guidance for the anonymous benign types of noise like road traffic, and explanations of the limitations on those guidelines are not always obvious, there appears to be widespread misuse of the decibel values contained with them. It is common to see claims they apply to all community noise sources, a claim the WHO have now made clear is incorrect. These claims may arise out of ignorance of the limitations within the guidance, the lack of psycho-acoustic understanding by the acousticians, because the acoustician does not accept the principles of how noise impacts or potentially because such interpretations substantially benefit developer clients who are seeking positive support for their proposal.

**1.26** In various cases the courts have analysed such misuse of guidance and rejected it. Examples include the High Court case of Bontoft Taylor and Others versus East Lindsey DC, Lawrence and others versus Fen Tigers (a motor sport case in the High Court) and the Lydden Hill circuit where such misuse of WHO guideline values was rejected. Another example is the case of Elvington verses York city Council.

**1.27** There has been argument the Goodwood circuit motor sport noise lacks the special characteristics rendering this noise source more intrusive. This is rejected as clearly not correct. Character includes:

- Intermittent impact
- Identifiable source / causer
- Rapid acceleration and deceleration events leading to sudden changes in level and character
- Directionality of the noise and unconscious identification of it in the brain.

**1.28** **Mitigation at receiver locations**. It is important to recognise the effects of trying to mitigate against sources of the types of noise arising in this case at receiver locations is not only impractical but would lead to substandard housing. Substandard housing would arise as external amenity areas would have to be avoided because they are adversely impacted. The loss of their amenity would be actionable. Internal dwelling rooms would require protection meaning reliance on mechanical ventilation and removal of permitted development rights including the use of openable windows, loft and conservatory extensions. This is impractical to control within the planning system.

**1.29** In view of the ways this noise permeates and penetrates dwellings and residential areas, mitigation options are extremely limited and / or impractical. They are further limited as the noise intrudes according to the degree of masking noise present in the environment which in turn is limited by the sound character of the area.

**1.30** Thus it can be concluded motor sport noise is of a type and character far more intrusive than the more benign forms of noise as addressed in the WHO Noise Guidelines for Europe 2018. This type of noise is specifically excluded from the WHO Guidelines and cannot be assessed through comparison with them other than in terms

of some of the general concepts such as noise containing dominant low frequency content is accepted as more intrusive.

**1.31** The general advice from the WHO is for this type of noise with character and of short duration (not 24/7) to be assessed in terms of its maximum level (LAmax(f)). The WHO has clarified the inapplicability of its guideline values to this type of neighbourhood noise.

**1.32** The WHO is clear that current methods of assessment should be applied to motor sport and similar neighbourhood sources of noise. For the control of most motor sport noise in the UK, criteria has developed in terms of short term average sound energy levels (LAeq), commonly related to its emergence above background sound (masking) levels. In some cases controls based on LAmax(f) are applied and this has significant scientific merit and follows general principles identified by the WHO for event noise. These both follow the science of noise. Typically controls are based on 5-15 minute average levels but in cases are up to an hourly average.

**1.33** The audible peaks of noise from the Goodwood site for Category 3 type events and that occur regularly define the intrusion with typically two peaks a minute and at times this is more frequent. There are also typically 30-35 peaks every 15 minutes of activity (excluding Category 1 and 2 events where impact is greater).

**1.34** In the case of aircraft noise the WHO criteria for adverse effects has now been significantly lowered, indicating adverse effects of aircraft movements are greater than previously thought. This is also now an evidence based criterion rather than opinion based. Controls are based on the Lden index which is a long term average where evening and night time noise are weighted to reflect increased intrusiveness.

**1.35** Different types of noise impact upon us in different ways and this needs to be reflected in the application of guidance and controls in this case. Our research shows many reports supporting development nearby motor sport venues and light aircraft activity rely on criteria inapplicable to these types of noise, including long term averages. Thus they apply criteria typically limited to steady continuous, anonymous transport noise sources that relate to adverse health effects arising due to the noise level rather than the noise character. Such misapplication permits higher noise levels

and increased residential development than the science indicates is appropriate. Alternatively it provides a means of arguing the noise is not as intrusive as otherwise indicated. The outcome is that this approach, where more lenient criteria is applied, leads to land use conflict and ultimately the noise producer is subjected to greater constraint as well as potentially costly litigation.

**1.36** Assessment of sources of noise that intrude because of their special character require analysis of the following features on a case by case basis and cannot be determined simply by their decibel level. The decibel levels proposed in this study derive from an analysis of many factors. Some relate to the decibel but not the long term decibel dose. The matters affecting impact discussed below and marked with an asterisk do not relate to decibel dose arising from the activities, however they are objective criteria to these circumstances. They may have elements measurable using decibels but they do not relate to a dose response and thus depend on the context within which they occur. It can be seen they are extensive:

i. The character of the noise and any special characteristics which attract attention or prevent habituation to the noise along with how these vary from event to event.* All characteristics have varying effects to different degrees.

ii. The duration of the noise at particular times, for example when trying to relax or study and especially of particular periods of noise emission events occurring during national holidays, evenings, night time and weekends.*

iii. Times of occurrence of the noise both in relation to what normal domestic activities would be occurring at that time and reasonable expectation which differs on different days and different times of the day.* For those at work weekends are perhaps more important but for those retired any day of the week can be of equal concern.

iv. The message imparted by the noise. This is the message to the recipients and how this relates to expectation. For example, whether the noise produces are considerate of resident's needs. Thus if they did not expect to hear this noise and what is in effect commercialisation / industrialisation of their sound environment, it will have a greater adverse effect.* This can also relate to association with the

noise. Thus if a characteristic is present which previously led to adverse impact it will trigger a message of expected disruption.

v. Loudness of the noise. This relates to the degree of masking noise present at any particular time, its spectral content and variation of that noise and spectral content over time.* Whilst these factors can be described using decibels they do not relate to the "A" weighted decibel level received as an absolute value.

vi. Variation in the noise over time. The extent to which the noise rises and falls in level and the suddenness of those changes.*

vii. Content (spectrum of the noise). This changes human response and also it changes the level of attenuation of that noise over distance, into and around buildings. Low frequency noise is less attenuated and thus becomes increasingly dominant over distance and when going inside buildings.* As above whilst these factors can be described using decibels they do not relate to the "A" weighted decibel level received as an absolute value but are normally relative to the existing sound environment.

viii. What is interrupted - social factors.* Impact upon sleep has greater significance than impact upon relaxation but that is not a concern in this case. In this instance it relates to disruption of weekends for many and daytime. In turn this is of greater significance than noise during domestic chores such as cleaning.

ix. Regularity including the regularity of specific features in the noise.* This includes the knowledge that when noise stops it will likely start again in a short period.

x. Respite from the noise and the length / duration of respite.* This is a major feature. Motor sport sites which only disrupt a few known days a year are far more tolerable than impact from sites which can have activities occurring on most days even when much quieter or less intrusive. It is the lack of escape from the noise on any day that will have a draining effect on the tolerability of communities.

xi. Character of the area including character of the sound environment. This relates much to expectation but also masking noise. To a limited extent this can relate to decibel level as a feature of the character of the area but the decibel level remains

just one characteristic of an area.* This character of this area is of open rural spaces.

xii. Human annoyance caused. The emotional response of different people will vary.*

xiii. Effect upon human requirements for rest, sleep, relaxation, communication, social activities etc. This would relate not just to fundamental needs such as rest and relaxation but issues such as the ability to use the home for social gathering without disruption. Whilst this aspect is interrelated to many other factors listed here, physical needs will vary to emotional needs and thus it is not limited to annoyance or social factors alone.*

xiv. How easily the noise intrusion is avoided by those causing the noise and the recipient. If recipients cannot escape the noise inside their home or use areas of the garden without excessive exposure it becomes an added factor. Similarly if they cannot ventilate in a normal way by opening windows without excess exposure it is an added objective element and possibly a secondary health impact.* In relation to those causing the noise, in this case it effectively arises from entertainment and people enjoying themselves. Most people will recognise this as important but not when at the expense of their ability to escape from such impacts in their home where they have a high expectation of freedom from intrusion.

xv. Cumulative impact of intrusions, different noises and different events whether from one site or many.* In decibel terms this would need to relate to total noise dose and not just the dose from one site or activity and having regard to their different noise characteristics. It would also depend whether some of the noise tended to mask the intrusive elements or exacerbate them. In this case we have both light aircraft and motor sport noise which do not serve to mask the other but cumulatively impact. In terms of the motor sport there is the added factor of different types of intrusion due to the different nature of the activity.

xvi. The necessity of the noise and its direct relationship to the needs of society. This partly overlaps with points above except the message imparted can be much wider.*

xvii. Whether the noise is wanted, liked or disliked by the recipient (for example – most like to hear songbirds as a reminder of nature but not sounds that are alien to a natural environment).*

xviii. Whether the noise is identifiable or anonymous and non-descript. Thus where association in the mind is created with disturbance and those disturbing elements are readily identifiable on a subconscious level, intrusiveness is recognisably increased. This is a major element of attention grabbing characteristics in this case. This is why much guidance based on transport noise sources is not applicable to what we term neighbour and neighbourhood noise. In this case the bursts of noise, rapid acceleration and deceleration, distinctive elements of engine turbo chargers and similar features render the noise attention grabbing on an unconscious level.*

xix. Whether expected or unexpected. In this case the long existence of the site is an established feature for the existing population, which nevertheless complain indicating it remains unacceptable. However, any newly introduced residential community, especially if located nearer, whilst expected to know of the presence of the motor racing and aircraft activity, they cannot appreciate the manner of impact they will experience unless previously living near similar activities at similar levels of frequency and duration. Until residents live with an activity on a day to day basis they cannot appreciate the effects upon them of the frequency and duration of impacts, the times they occur and the manner it impacts upon the use of the home. In summary new residential populations do not have experience to understand the impact they will receive and therefore do not expect it.*

xx. Any visual impact associated with the noise. This is a reduced factor in this case except in relation to the aircraft.*

xxi. The predictability of impact and ability to plan for and work around any intrusion. This is a significant factor in this case as impact arises most days from time to time to varying degrees. Whilst major events can be planned for, this requires constant or regular calendar watching and planning which is an added intrusion.*

xxii. Decibel level. This can be an absolute level of the noise in some cases but more commonly is relative to other decibel levels in the environment that may serve to partially mask the intruding source of noise. In other word how dominant and distinctive is it and how well is it masked. This will in part depend on other environmental factors such as wind speed and direction and thus will differ day to day even for the same type and intensity of activity. The important element is the actual decibel level at any moment in time and not its average value. This does indicate loudness but once the noise is dominant and in relative terms loud, it matters little its added degree of loudness unless exceptionally loud such that closing windows does not provide respite.

**1.37** Limitations on the decibel level. It can be seen from the above factors that decibel level is just one factor which influences acceptability amongst many others. Once the noise is dominant or regularly audible as a significant feature then it becomes a factor of frequency and duration, times it occurs and what it affects as well as whether it can easily be escaped. Although many of the other elements can be measured using decibel levels, they are not specifically determined in terms of relevance and intrusiveness by their decibel level. It is concluded the decibel criteria that is available for controlling motor sport noise cannot fully take into account all the factors as to how this noise impacts upon residential locations.

**1.38** **Relationship of buffer zone and decibel level.** The effect of the buffer zone is to secure a combination of features helping avoid land use conflict due to the noise. Some of these are discussed below.

**1.39** a. Sound energy loss with distance. The increased distance equates to a reduction which for a point source is of approximately 6 decibels every doubling of distance. Thus at 400m the noise is of the order 6dB lower than at 200m from the track and 12dB lower than locations 100m from the track. In turn this means for those times where the intruding noise emerges 10dB above background sound levels at 200m distance and so is loud and dominant, for the same background sound levels it emerges only 4dB at 400m and will be significantly more masked and less noticeable. The outcome is that the buffer zone significantly decreases the frequency and duration when the motor sport noise is dominant and intrusive.

**1.40** b. Effect of wind and meteorology. It is recognised that as distance increases so does the effect of meteorology and especially wind direction on noise levels. At distances of 400-600m, when upwind of a ground based noise source such as motor sport, there is significant sound shadow typically reducing noise levels about 10dB, even with moderate and light winds. When downwind sound levels are increased typically of the order of 2dB giving a difference of the order of 12dB, the same as quadrupling the distance. In some atmospheric conditions this downwind level is increased another 2-4dB. Thus when downwind noise levels typically increase 2dB and in some very limited circumstance this could be higher but upwind reductions are much greater and of the order of 10dB at this distance. Where closer to the site the wind and meteorological effects are increasingly reduced.

**1.41** c. The buffer zone is of sufficient distance to ensure wind and meteorological effects provide significant benefit. The effect is to reduce the frequency and duration of adverse impact as a feature of their regularity of occurrence. Build within the buffer zone and this feature is significantly reduced.

**1.42** d. Near ground effects. The primary problems of noise impact during the day are upon ground floor rooms. The closer to the ground a receiver is located the greater the effects of sound reduction due to a combination of multiple screening features at the ground and sound waves interacting with the ground (especially when the ground is soft) and their energy being absorbed. Topography will limit ground effects in some locations and enhance them in others but the 400m buffer zone ensures a useful ground effect contribution.

**1.43** The effects of these features are a wider spread and stepwise change where all effects can combine leading to increasingly greater periods of quiet enjoyment of dwellings. Thus it is not just reduced noise reflective of distance increase but a combination of effects reducing noise. This is not assisted much beyond 400-600m but at these distances the diversity of effects of meteorology and ground result in a stepwise lowering of incidence of adverse noise in this area.

**1.44** The response of the WHO to the assessment of noise impact and the limited utility of decibel levels is encapsulated in advice from the WHO that only 1/3rd of noise nuisance relates to the decibel level with 2/3rd relating to non-acoustic factors. This

aspect is also supported by other guidance. For example in the UK we have general noise guidance produced by the Institute of Environmental Management and Assessment (IEMA) who produced guidelines in 2014 for Environmental Noise Impact assessment. It states: "the noise impact and the consequential effect can only rarely be properly determined solely by the simple numerical difference in the value of the particular noise indicator".

**1.45** Effect of aircraft noise on the motor sport impact and the buffer zone. The aircraft movements are significant in relation to this airfield but are not at its full potential. Assessment of development needs to consider future impact and this indicates the need for stricter criteria and not any lessening.

**1.46** Emerging evidence including in the new WHO Noise Guidelines 2018 reveals aircraft noise is recognised as significantly more intrusive than previously thought. Whilst the WHO looks at this in terms of health effects, overall it reflects that historically decibel limits for this form of noise were set too high.

**1.47** General Aviation and in particular propeller aircraft are recognised as more intrusive than equivalent long haul jet airliner traffic in terms of their decibel level. This is likely a factor of the increased attention grabbing nature of general aviation. In turn this indicates stricter constraint maybe argued than currently applied. However, the current approach is considered reasonably effective as a protective policy. It does mean development immediately outside the buffer zone also requires careful consideration in the future in relation to aviation noise also. The WHO 2018 identifies that for average noise exposure, they strongly recommend reducing noise levels produced by aircraft below 45 dB Lden, as aircraft noise above this level is associated with adverse health effects. Lden is a long term average of daytime, evening and night time noise with decibel penalties applied to the evening and night time noise. In this case impact is mainly a daytime issue and the value is arguably directly applicable to the daytime average level.

**1.48** In addition to the decibel level, the frequency and duration of movements is an important aspect as to, when, how often and how repetitively adverse disturbance occurs. In the case of general aviation we are considering more frequent movements of less sound energy than for jet planes. This can increase adverse impact.

**1.49** In summary the aviation activity adds significantly to the impact indicating strong grounds for stricter criteria in terms of overall noise impact. On balance it is considered this should remain as currently set but any development would also need to consider the extent of aircraft noise levels and aircraft movement activity levels in addition to assessing the motor circuit noise. This would include the area immediately outside the buffer zone as such development may also constrain future development of the aviation activity. The difference with the aviation noise is its dependence on take off direction and flight path which is influenced by wind direction. There is also a lack of ground effects due to the height of the source above the ground.

**1.50** Cases argued for development within the buffer zone. Erroneous arguments have been made for residential development within the buffer zone based on inappropriate assessment of noise. This includes miss-application of guidance which relates / is limited to benign anonymous sources of noise, disregard for the attention grabbing character of this noise, not considering moment by moment noise change through averaging nor identifying the degree of dominance of the character in the noise. There is also a failure to consider the cumulative effects of the aviation and motor sport noise together as well as excluding the noisiest events. I understand 5 Category 1 events and 110 Category 2 events have been ignored in some historical analysis. This is a substantial element in any noise impact and required to be evaluated as indicated in the recommended criteria in this study. Such exclusion does not correlate with human perception where we are sensitised by the noisiest events leading to a desire for respite including complete freedom from the noise even on quieter days. These quieter days still draw attention and unconsciously trigger emotional and stress related responses.

**1.51** There has also been reliance on average aviation noise contours. This form of analysis is only a small part of the consideration of aviation noise and misses a number of key modifiers including the shorter averaging time of activity at this site, a more diverse mix of plane types used, exclusion of over-flights and the emerging guidance limits are set too high.

**1.52** Arguments for development within the buffer zone not only wrongly evaluate impact but fail to look at the cumulative effect of motor sport and aviation which is individually excessive but in combination is clearly much worse.

**1.53** Assessment in support of development is typically based on windows being kept closed. This in itself provides evidence of unacceptable impact and would be classed as a material interference with use and enjoyment of property supporting a case of nuisance. Furthermore keeping windows closed exacerbates problems such as the build up of internal pollutants, C02 build up, condensation and dampness issues as well as loss of connection with the external environment. The latter is also important in relation to family life for hearing children in the garden etc. a need of responsible parents. Recent planning inquiry decisions have supported the importance of having openable windows.

**1.54** In a planning sense it is impractical to prevent openable windows, for example through the removal of permitted development rights as residents will resort to opening doors and circumventing the controls.

**1.55** Modelling of motor sport noise. MAS Environmental have gained considerable expertise in this and written our own modelling software, which served to expose limitations. It can be useful as an indicative tool of change in some circumstances. In summary the modelling of decibel levels is a crude tool that has very limited accuracy, especially for sources such as general aviation and motor sport noise. It can help comparing one scenario with another, for example the effect of adding a barrier but is relatively inaccurate at predicting actual resulting noise levels. The standard most commonly used, ISO9613-2 recognises the limitations and uncertainty and is itself dated (1996).

**1.56** A range of factors indicate a need to consider lowering limits. These include:

a) The character of the area where this noise is incongruous.
b) Impact at weekends when less impact is expected.
c) Loudness in relative terms as background sound masking levels are generally low.
d) The nature of the message imparted. This is not essential noise but derives from leisure activity (entertainment at the expense of peaceful enjoyment of the home).
e) The variability and unpredictability of impact.
f) Lack of respite where most days can be adversely impacted by noise. However little it reminds and triggers hormone responses of adverse memories relating to days when impact was worse.
g) Inability to avoid the noise in the home. In some cases parts of the home may be screened and experience less noise but overall the home environment is widely impacted.
h) Cumulative effects of motor sport and aircraft noise leads to the need to reduce overall exposure.
i) Whilst new residents may have some expectation of intrusion, unless they previously lived in a similar impacted environment they cannot appreciate and expect the continuum of impact and heightened sensitivity that would arise along with other aspects how the noise intrudes in practice that are not foreseen without prior experience. Simply put they have no experience with which to relate to especially long term effects and sensitisation over time.
j) This problem of noise impact is not resolved by moving inside a dwelling as both the source and background masking noise are reduced by doing this and except where it is taken below limits of audibility, it continues to draw attention when inside houses.

**1.57** It is concluded:

**1.58** The noise from the motor circuit activity should be regarded as creating an unnatural sound environment within the buffer zone and unlike that which would be expected in a predominantly residential area located on the urban / rural fringes of Chichester.

Having regard to the locality it is considered that this would be unexpected by new residents moving to such an area.

**1.59** Incidence (frequency and duration) are much higher when within about 400-600 metres as it benefits much less from wind direction, other meteorological and ground effects.

**1.60** The primary control based on experience of complaints and predicted and measured noise levels is the continuance of a 400m buffer zone. This zone is based on sound science and consideration of the planning balance.

**1.61** The noise impact continues outside of this 400m buffer zone and any future noise-sensitive development within the wider vicinity of the site needs careful planning to take account of the noise impact that will be experienced including from increased activity within permitted limits. Such detailed assessment comparing and contrasting the criteria set out in this study could potentially extend up to a distance of about 800m. In this area analysis is likely to be needed to evaluate whether the decibel criteria set out above is met. However, it is not recommended development is precluded in this zone but assessment of the noise is required to enable consideration of the appropriate siting of development and applying the planning balance, reflect the reduced incidence of impact arising the further away development arises. It will therefore be subject to factors such as frequency and duration of impact that reduce the further away you go.

**1.62** The criteria of acceptability for noise-sensitive development recommended by MAS as a result of this study in order to avoid significant adverse impact from motor circuit noise, whether inside or outside the buffer zone would be an LAmax(f) value of 46dB, not to be exceeded more than 5 times in any five minute period and a second and separate control mechanism of a short term LAeq of 15 minutes of 42dB, not to be exceeded other than on a de-minimus basis. At the same time aviation noise as a 12 hour average LAeq should not exceed 45dB. All control mechanisms would operate separately. Where noise exposure is above this and outside the buffer zone, residential development would not be considered suitable without consideration of the frequency and duration of impact along with any additional mitigation and planning benefits derived.

**1.63** As most winds have a southerly or westerly component this would indicate some capacity to develop to the south and west provided it was not within the buffer zone and was subject to an appropriate analysis of the frequency and duration that the decibel criteria are exceeded. It is recommended that for successful development the incidence of exceedance would need to be a small minority of events not exceeding 20 days a year. This reflects the principle that some periods of higher noise intrusion are considered tolerable provided they are few in number.

**1.64** The decibel controls applied in this study turn out to be of the same order of magnitude found applied at other motor sport circuits and thus are generally in agreement with the approach to control applied more widely across the UK and reflective of similar levels of adverse noise exposure. Adopting such an approach is not only consistent with our findings as to the onset of adverse impact but controls applied by others.

**1.65** For aerodrome activity this study is unable to conclude the threshold at which this operation becomes of significant annoyance but conclude it is lower than previous guideline levels for aviation and is expected to be below a daytime average of 45dB LAeq(12 hour), possibly nearer 40dBA. As an interim measure a value of 45dB LAeq(12 hour) is recommended as it is unknown as to the extent research also reflects general aviation impact and what the difference is between that and jet aviation impact. This reflects recent guidance from the WHO derived from evidence of health effects from aviation noise.

**1.66** The combined effect of aviation and motor sport indicate the need for stricter noise criteria than found at other sites across the UK. However, in the planning balance the 400m buffer zone and the assessment of aviation remain separate but in the knowledge there is an indication of the need for stricter criteria and not its relaxation. This also means the controls are conservative.

**1.67** Assessment of impact beyond the 400m buffer zone should be assessed based on a range of factors and not just the average noise level which can underplay the impact from noise but any housing design need to provide maximum protection through measures such as single aspect housing. Whilst not a desired form it is an important consideration in both the protection of residential amenity and protecting against

constraint of the commercial activities but needs assessing on a case by case basis. Further, it is a fundamental aspect of English planning guidance that noise should not be considered in isolation. The aerodrome activity is considered an exacerbating factor in terms of noise when considered cumulatively alongside motor circuit noise.

**1.68** In accordance with the discussions and evidence considered in this study, adverse impact does not simply relate to absolute decibel levels but the periods of audible intrusive noise that impact precisely because it is not masked and contains attention grabbing character. The decibel controls derived are designed to reflect this factor.

**1.69** It is a fundamental aspect of noise assessment in accordance with English planning guidance which itself follows general principles of noise impact that there is not a simple relationship between noise levels and the impact on those affected and that other factors such as the intrusive and attention grabbing characteristics of a source of noise are given sufficient weight to reflect the added intrusiveness. The controls derived in this case, including the 400m buffer zone reflect an analysis of these factors and go further into considering the frequency and duration of impact that is not often adequately considered.

**1.70** The pragmatic buffer zone of 400m has considerable noise impact and planning merit but is not the point at which adverse impact is no longer excessive. It reflects an area where adverse impact is clearly excessive but beyond that there is scope to consider development on a case by case and merit based approach. The wider potential adverse impact indicates a doubling of the buffer zone where noise is a material consideration. Beyond 800m there is still some adverse impact but its reduced frequency and duration is not considered to likely amount to a bar to development.

**1.71** The operations from GMC and GA occur regularly meaning any adverse impact would be frequent, except when adequately reduced by wind direction or topographical and other meteorological effects.

**1.72** The race circuit is permitted to host a range of track days in excess of 245 days a year with the airfield also permitted to operate 7 days a week. These features support the use of short term decibel based criteria that is already adjusted to reflect the character of the noise sources as applied in this report as an additional measure to the

400m buffer zone. However, the most critical and readily recognised control to maintain is the 400m buffer zone.

**1.73** There would be a need to also consider internal as well as external noise impact, (with windows open) in locations where noise levels are likely to exceed the decibel criteria identified here when outside the buffer zone.

**1.74** Assessment of noise in the planning sense needs and does recognise that impacts on existing commercial operators are legitimate planning considerations when taking into account any residential development nearby. Not only would noise impact on future housing affecting quality of life but it would also risk the viability of GMC in particular through the potential for enforcement action and civil controls which could threaten the demise of the motor circuit as well inhibiting its ability to develop in continuance of its business by having unreasonable restrictions placed upon it because of changes in nearby land uses. Restrictions and constraints caused by new residential development do not manifest themselves only in the form of a risk of enforcement action but there is clear evidence in terms of the viability of investment for expansion etc. as it is recognised investors become increasingly cautious.

**1.75** The analysis provided in the reports of acousticians in support of development do not assist assessment of acceptability of the buffer zone as their assessment relies on inappropriate criteria.

**1.76** In the study we have reviewed measures suggested by others for mitigation to protect future occupiers from noise but they rely on residents actively closing windows which fail for the reasons explained in this summary. Closing windows in itself is a well recognised coping mechanism in response to adverse noise and therefore not acceptable and providing evidence in support of nuisance.

**1.77** The continuance of the buffer zone is commended and supported as a pragmatic and appropriate control. Secondary decibel controls have been derived from this study. They reinforce the appropriateness of the 400m buffer zone and support the need a range of controls operating simultaneously but each as an individual measure of clear unacceptability. Conversely meeting the criteria does not equate to acceptable noise but likely tolerable intrusion.

## 2.0 Introduction

**2.1** MAS Environmental Ltd ("MAS") have been appointed by Chichester District Council (CDC) to undertake a study of the impact of motor sport and aviation noise upon potential development in the locality of Goodwood Motor Circuit and Airfield. In particular they sought us to investigate the suitability of maintaining the existing approach set out in paragraph 12.50 of the adopted Local Plan which identifies a buffer zone that effectively restricts residential development within 400m of the boundary of the site.

**2.2** The main findings and conclusions of this study are set out in the Executive Summary.

**2.3** The setting of this buffer has come under scrutiny and challenge and it has been argued that there is no robust or credible evidence to retain CDC's current Local Plan requirements that housing development should not be within 400m of the Goodwood boundary.

**2.4** Challenge has mainly been based on an argument that regular noise impact below about 55dBA as a long term average decibel level would not cause significant observed adverse impact. This appears to be based on arguments that World Heath Organisation guidelines as adopted in BS8233 2014 indicate there is not significant adverse impact from noise below this level.

**2.5** It is to be noted at the outset that arguments formulated on this basis are rejected as contrary to the science, contrary to the guidelines from which support is sought and contradicted by the courts that have looked at such arguments historically. However, the critical analysis in this report is not the invalidity of arguments supporting development but whether the 400m buffer zone is robust and if there is any additional considerations to take into consideration.

**2.6** It is noted in the Inspector's report on the examination into the Chichester Local Plan[1] (May 2015) that the Council's approach to the matter is sound. This report outlined

[1] Chichester District Council Inspector's Report on the Chichester Local Plan: Key Policies 2014-2029 - http://www.chichester.gov.uk/article/24684/New-Local-Plan-2014---2029---latest-update

that the setting of the precautionary buffer had been based on the Council's own experience of receiving complaints, as well as the need to allow space for any attenuation measures that may be necessary but that limited development within this buffer is not precluded.

**2.7** It is also of note that planning guidance on noise emphasises the responses arising from the imposition of noise on a community such as complaining and modification of lifestyle and therefore agrees with an approach based on complaints assessment.

**2.8** A starting question is why are community members in a locality complaining if the noise is currently acceptable? Vexatious complaints and those due to hyper-sensitivity are factors to consider but absent evidence of those elements complaints cannot be ignored. There is an assumption complaints arise from normal reasonable people with the community. A check arises where independently officers of the authority either are able to corroborate or undermine those complaints.

**2.9** The Council is reviewing its Local Plan in accordance with the commitment set out in the adopted Local Plan to have completed such a review by 2020 including a Housing and Economic Land Availability Assessment (HELAA) to identify and assess sites that may have potential to accommodate future housing and economic development.

**2.10** The HELAA confirms that sites are being actively promoted for development within the vicinity of Goodwood Motor Circuit and Airfield.

**2.11** A further important planning consideration is the protection of existing commercial and business operations and the protection of their future expansion. Recent changes to national planning policy have introduced an "agent of change" approach where those seeking to change the character of an area and introduce development which places existing development at risk, need to adequately mitigate against the harm to existing development. In the case of many commercial operations which emit noise, the risk is from nuisance action where the defence of being established before the new development is not an established defence in the locality.

**2.12** It is through the promotion of sites for development within the vicinity of the site that the feasibility of the 400m buffer zone has been challenged with arguments that development can be achieved closer to Goodwood by the setting of noise criteria

within which residential development will be acceptable / can be made acceptable. As discussed, the noise criteria argued by some is based on generalised criteria but for noise classed as anonymous and benign in nature.

**2.13** Classification of noise into two basic types is explained in this study which in summary are those with special characteristics and those considered of a benign and anonymous[2] type. Where intrusion relates to their attention grabbing features which unconsciously grab an individual's attention thereby disrupting activity they are classed as containing "special characteristics"[3]. These sources impact, amongst other things subject to their frequency and duration and the times at which the impact occurs.

**2.14** Concerns have been raised by officers of CDC that the noise criteria proposed by developers may not be suitable for assessing the impact from motor circuit and general aviation activities occurring at the Goodwood site since it is based on levels for noise from steady, continuous and anonymous sources, as discussed which are generally classed as "anonymous" sources. It is already identified above that such arguments are supported and the approach adopted in order to support those arguments is erroneous. This is part of a wider problem, highlighted in particular by MAS Environmental in national research reported internationally[4]. In addition the arguments applying higher decibel limits derives from "critical health effect" based criteria for anonymous noise sources.

**2.15** It is of note in the new WHO noise guidelines published 10th October 2018 that application of their health effect guideline values to neighbourhood sources of noise other than those identified in the guidelines is incorrect. Furthermore the principles on which they are based means it is clear they are not transferable to other types of noise.

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[2] "Anonymous" refers to sources which do not continuously grab attention and are not associated with a specific site or community activity. The main example is of transport noise sources. These do not impart a message of concern and progressively we habituate them.

[3] Attention grabbing "special characteristics" include acoustic features such as impulse and tonality and non-acoustic features such as voices, sudden change / rises in level, low frequency content and distinctive features.

[4] See MAS paper to Internoise 2017 in appendix XXXX

**2.16** A map of the locality is presented at Figure 1 below, upon which 2 lines have been drawn to note separation distances at 200m and 400m from the edge of the motor circuit track.

**2.17** This study also considers the case for a wider review area additional scrutiny should be considered before any residential development is viewed acceptable.

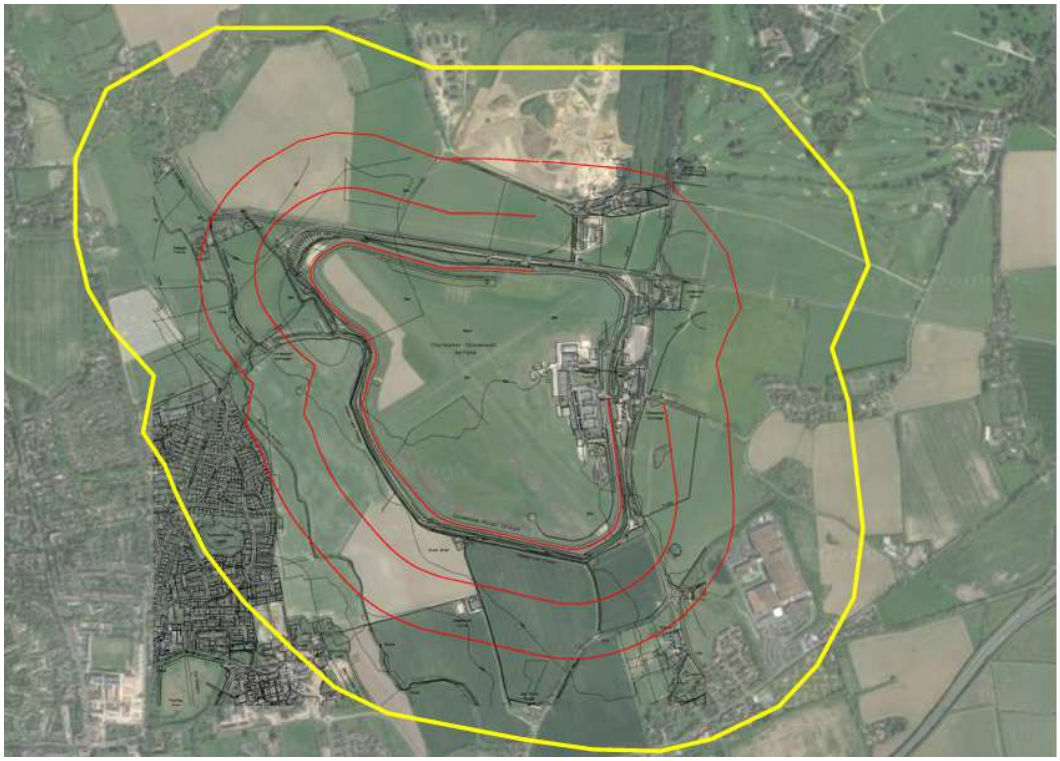

**Figure 1** – Map of locality noting separation distances as 200 and 400m buffer from Goodwood shown in red and the area for greater scrutiny up to 800 metres shown in yellow.

**2.18** In order to appropriately weight the arguments and best approach to acceptable residential development MAS has been given the following objectives:

- Critique existing arguments being promoted by acousticians for developers (which argue for acceptability based on comparing site noise levels with guidance linked to benign anonymous source of noise (generally considered steady and continuous) for residential development within a 400m buffer zone;
- Evaluate the strength of arguments and reasons when to refuse development within the buffer zone or outside of it;

- Consider the appropriateness of prohibiting residential development within 400m due to adverse noise impact concerns arising from the Goodwood motor circuit (GMC) and Goodwood airfield (GA). Determine whether the evidence supports such an exclusion of development and;
- Review whether assessment should be based on decibel criteria in addition to or substitution of the buffer zone.

**2.19** These objectives and the competing evidence are addressed in the following chapters of this study

**2.20** The approach of MAS to the objectives in this study is first and foremost to independently and critically review whether there is a need for protection of the Goodwood site having regard to the nature and character of the noise emissions, their frequency and duration of impact and any other factors that are relevant. The primary question is, where there is a need for the protection of the site's activities, as here, how this is best applied / determined.

**2.21** A further question for MAS is whether the current approach excessively sterilises land unnecessarily.

**2.22** It is also necessary to assess this matter in the context of current national and local planning policy which includes the protection of existing commercial operations and which in this case is a nationally recognised facility.

**2.23** As discussed in October 2018 the WHO released new environmental noise guidelines and these help provide some clarity on the separation of guideline values between those sources we habituate to and those with special characteristics that we sensitise to, advising the use of existing procedures and criteria for such sources as motor sport. The relevance of these new guidelines to arguments on acceptability requires consideration and impacts upon our assessment of aircraft noise proposing stricter criteria. This study is based on a combination of extensive experience of impact form motor sport venues and aircraft activity and measurements at this site compared to criteria of acceptability.

## 3.0 Goodwood – A brief background and preliminary analysis of 400m buffer

**3.1** Goodwood motor circuit (GMC) is a 2.4 mile circuit located on the fringes of Chichester and forms part of the Goodwood estate. Its history as a motor circuit dates from 1948 to 1966 when competitive racing took place. Prior to this the circuit originally functioned as the perimeter track to RAF Westhampnett which operated during the 2nd World War and which now currently operates as Goodwood Aerodrome (GA).

**3.2** Over the intervening years GMC has continued to operate as a testing and track day venue along with some specific events. Competitive racing was reintroduced in 1998 but is limited to just a handful of days but nevertheless contribute to the overall impact, diminishing the number of days where high noise is generally tolerated by a community. Track day and testing events allow for high speed driving to take place on the circuit which are limited in number and are subject to imposed controls in terms of noise limits.

**3.3** Motor sporting activities at Goodwood are organised by category which identify the number of days per annum and the maximum noise limit allowable. This has been authorised under the approval WH/13/00108/FUL, summarised in Table 1, below.

| Category | Description | Trackside noise limit | Days per annum | Hours of use |
|---|---|---|---|---|
| Category 1 | High speed driving and racing | No limit | 5 | 10 hours (08:00 – 20:00) Mon to Sun |
| Category 2 | High speed driving | $L_{Aeq,30min}$ 82 dB | 110 | 7 hours (09:00 – 17:00) Mon to Sat |
| Category 3 | High speed driving | $L_{Aeq,30min}$ 78 dB | 130 | 7 hours (09:00 – 17:00) Mon to Sat |
| Category 4 | Road speed driving | $L_{Aeq,5min}$ 70 dB | 71 | 7 hours (09:00 – 17:00) Mon to Sat |
| Silent | No motor vehicles | No limit | 49 | Any time – Mon to Sun |

**Table 1** – Summary of categories for motor sporting activities at Goodwood circuit

**3.4** To place this in perspective, at a distance of 400m the Category 2 controls approximate to those applied by the courts and planning authorities in other cases including in the case of Mildenhall[5]. Similar controls arise across the UK at a number of motor sport sites. A compounding factor in this case is the occurrence of general aviation noise intrusion from the same locality.

**3.5** General aviation activities from GA allow for flights for the public transport of passengers and for flying instruction. The aerodrome is an all grass operating environment with 3 runways each with 2 modes of operation (06/24, 10/28, 14/32)[6] and a heliport. The aerodrome operates under a section 52 agreement (Town and Planning Act) implemented under planning approval WH/22/86. This restricts movements and maximum permitted weights and operating times / days[7]. GA also has noise preferential routes to avoid over-flying of noise sensitive areas.

**3.6** The maximum number of movements[8] permitted annually is 70,000 of which no more than 30,000 shall be touch and go[9] by fixed wing aircraft, and not more than 10,000 shall be helicopter movements (of which no more than 4,000 shall be circuits[10]). Opening hours during the summer are from 09:00 – 18:00. Flying outside of these hours is permitted subject to prior arrangement but night flying does not take place as there is no lighting provision on any of the runways. Flight data from 2017 notes that activity from GA is well below permitted numbers with the total number of movements just below 27,000. It is therefore to be recognised this could increase up to double and impact needs to be assessed having regard to this potential, especially when considering national planning policy and the risks of development restricting current business growth opportunities.

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[5] Lawrence and another v Fen Tigers and another 2011 as upheld in the Supreme Court in 2014.

[6] These relate to the angle in degrees of the direction of the runway so 06/24 is 60 degrees from north i.e. easterly and 240 degrees from north i.e. south-westerly.

[7] Goodwood Aerodrome - Section 52 Agreement between Goodwood Aerodrome and Chichester County Council - https://www.goodwood.com/estate/aerodrome/noise-management/aerodrome-consultative-committee/section-52-agreement/

[8] Take off or landing

[9] Practice or simulated landing where the aircraft merely touches the ground during landing and ascends again.

[10] These are training exercises similar to touch and go and involve a short circuit starting with take off and then landing. It effectively is akin to movements in succession or close after each other.

**3.7** Presented at Figure 2 below is a plan summarising the layout of GMC and GA. The circuit only operates in a clockwise direction and each turn is named after the area it is nearby.

**3.8** In many cases relating to other sites a number of days of higher noise are permitted based on different formula. However, in many cases less days at this level are permitted and there is not an easy way of directly comparing. In this case there is the combined impact of the aviation. On balance criteria at other sites and the added general aviation indicate stricter criteria might otherwise be applied to the protection of residential property. In summary residential development at 400m indicates dwellings will be subjected to excess noise from the motor sport activity and excess noise when GA and motor sport are considered in combination. However assessed it indicates excess noise arising when closer than this.

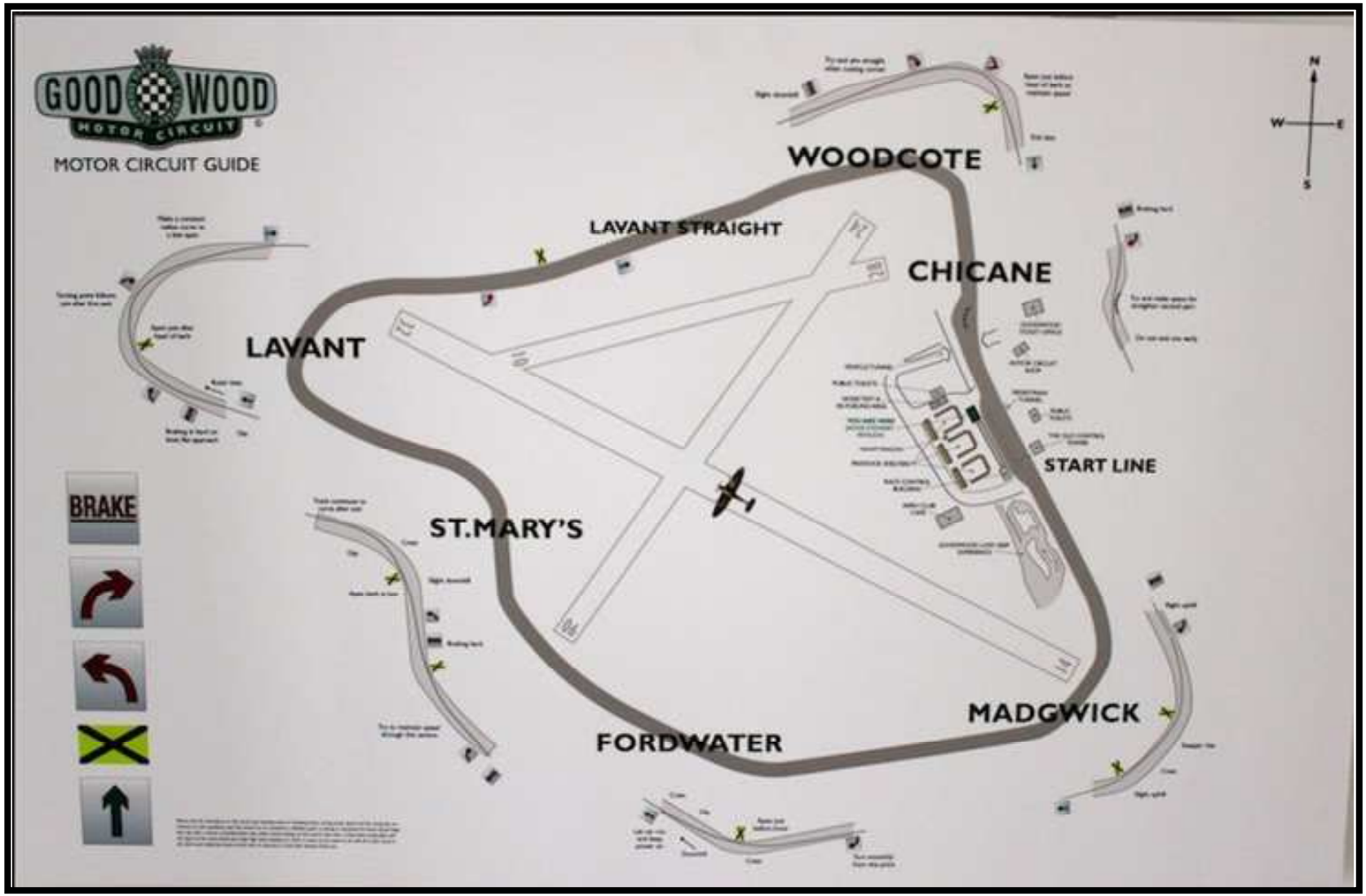


**Figure 2 – General layout of GMC and GA**

## 4.0 Policy and guidance relevant to the assessment of noise in the context of the operational activities of Goodwood Motor Circuit and Airfield

**4.1** In terms of assessing the impact of noise there are no European or national noise limits to be met for environmental acceptability. These could not exist in any event as control needs to consider local circumstances and the individual effects arising in this locality.

**4.2** At a national level policy related to noise impact of this type is virtually absent[11] of any decibel based guidance and assesses impact based on the significance of the effects on a community and recognising that the onset of significant impact can be different for different sources of noise and different localities. What is recognised in the guidance are coping strategies arising from a source of noise such as closing windows. A long recognised coping strategy for a minority of the population is to complain about the noise. It is estimated 5-20% of a population will complain when noise is adverse. In the case of Goodwood there are significant community complaints.

**4.3** Wider sources of guidance, such as British Standards or industry codes of practice / guidance exist and do provide some contextual decibel related guidance but is specific to certain sources of noise under very specific criteria. This does not include noise arising from motor sport and is limited for general aviation.

**4.4** New guidance for aviation overall contained in the WHO guidelines 2018 indicates decibel controls of the order of 10dB lower than historically applied in the UK, reducing from 55dB LAeq(long term) to 45dB LAeq(long term)[12]. This is evidence based guidance looking at adverse health effects. The relationship for general aviation compared to long haul jet based air travel is not clear in these lowered limits but has long been considered more intrusive. This may be reflected in the lowering of limits. In any event, emerging criteria are necessarily stricter than previously applied / considered appropriate.

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[11] The current exception is Minerals Planning Guidance but even in that case levels are subject to various caveats.
[12] Criteria are evolving from a 16 hour daily value and separate night time value to a night time and Lden (daytime and penalised evening and night time value). The daytime value equates to the Lden value.

**4.5** The boundary between acceptable and unacceptable environmental impact in any particular locality from general aviation is clearly lower than previously considered in national and international guidance. This indicates a tightening of controls / exclusion is indicated by emerging guidance. The new WHO environmental noise guidelines have also identified the inappropriateness and inability to readily combine noise of different types and compare their impact against a composite / cumulative impact value. The most that can be drawn from this is the need to reduce decibel limits where there is cumulative impact from differing noise sources but by unknown amounts.

**4.6** It is to be understood that the assessment of noise will vary from site to site and will depend upon a range of factors such as the character of the source(s) under consideration and how it presents in the environment. In planning terms acceptability due to noise impact should not be considered in isolation and where relevant be considered alongside economic, social and policy factors. In this case residential development can lead to complaints about noise which in the case of the motor sport activity, could lead to its demise through any nuisance complaints. At decibel levels above about 40-45dBA being exceeded as a short term average level on a regular basis, the risk of successful nuisance action significantly increases.

**4.7** One purpose of this section is to consider the range of available policy and guidance to aid consideration / development of criteria for environmental acceptability in this case beginning with national policy as the appropriate starting point for assessment. This national government policy on noise is helpful in relation to planning considerations but separate criteria are applicable to nuisance evaluation. The risk of potential additional constraints or even the demise of the existing motor sport use of the site relates primarily to these latter criteria. In turn this is less related to decibel levels and more to the nature and character of the noise intrusion.

**4.8** **Noise Policy Statement for England (March 2010) (NPSE)[13].** The concepts of the NPSE centre largely on the balance between noise impact and sustainable development. A fundamental principle of the NPSE is that noise should not be considered in isolation, and that it should be considered alongside economic and social benefits. The vision for the NPSE is two-fold based on the protection of health which may arise from exposure to noise and effects on quality of life which is often categorised in terms of annoyance.

**4.9** The NPSE identifies that where national policy is relevant it should apply to all types of noise (except for occupational noise) and broadly separates noise into 3 categories:

- Environmental noise which includes noise from transportation sources
- Neighbour noise which includes noise from inside and outside peoples homes; and
- Neighbourhood noise which includes noise arising from within the community such as industrial and entertainment premises, trade and business premises, construction sites and noise in the street.

**4.10** It is clear that in this case the sources of noise fall within the "Neighbourhood noise" category.

**4.11** The NPSE sets three levels of significance in relation to noise impact as the no observed effect level (NOEL), lowest observed adverse effect level (LOAEL) and, the significant observed adverse effect level (SOAEL). The NOEL and LOAEL are established concepts developed from toxicology currently being applied to noise impacts by the WHO. They relate to critical health issues and not amenity or quality of life issues and there is concern these concepts cannot mirror how noise intrudes in practice. The WHO are considering health effects of noise for which a relationship with toxicological effect identifiers can be seen. The NPSE has extended these concepts to include the SOAEL but there is no basis in science which supports this concept.

[13] Great Britain. Department for Environment and Rural Affairs (DEFRA) (2010) *Noise Policy Statement for England.* London: TSO

**4.12** There is therefore no clear quantitative description to accompany these effect levels and whilst some qualitative description is provided the judgement is both objective and subjective and excluding any decibel based guidance. Crucially the NPSE recognises that it is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations and this is likely to be different for different sources, for different receptors and at different times. This is considered to be deliberate as many sources of noise cannot be judged reasonably by their decibel level. The most studied field in terms of health effects relates to transport noise and the lack of any defined levels or continuing reducing levels, even for this most common environmental type of noise helpfully confirms the relevance of many wider issues than decibel dose.

**4.13** The NPSE sets aims which in brief amount to:

- Avoiding significant adverse impacts
- Mitigating and minimising noise impact
- Improvement of health and quality of life by effective noise management and control.

**4.14** **National Planning Policy Framework (July 2018) (NPPF)[14].** The NPPF introduces general concepts of sustainability, balance of needs with minimisation of noise impact and refusal of planning permission only as a last resort where adverse impacts can not be resolved through mitigation, condition or compensation. It was revised July 2018.

**4.15** Critically the Framework recognises the importance of minimising noise impact, protecting existing development, protecting quality of life and has introduced the concept of "agent of change" where those introducing change warranting new protections / mitigation need to implement it. It follows where adequate mitigation cannot be achieved and the existing development is placed at risk (including its expansion), the proposed development is unlikely unacceptable.

[14] Great Britain. Department for Communities and Local Government (2018) *National Planning Policy Framework*. London: TSO.

**4.16** Technical guidance to the NPPF has been withdrawn and replaced with the noise Planning Practice Guidance (PPG). This is similarly vague in terms of decibel levels controls and emphasises the outcome of impact in practical terms such as the coping strategies that derive from it, for example, having to keep windows closed.

**4.17** In summary the main NPPF principles relevant to this case include:

- Avoiding noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;
- Mitigating to reduce to a minimum other adverse impact on health and quality of life arising from noise from new development, including through the use of conditions;
- Recognising that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established; and
- Placing emphasis on the developer to mitigate any noise impact.

**4.18** **Planning Practice Guidance (PPG)**[15]**.** Government planning guidance revised in 2014 and in part again in 2018, replaces previous noise guidance that set noise impact acceptability, which in many cases used decibel level values. The PPG has removed guideline decibel values in favour of an assessment of impacts / outcomes and their significance. This broadens the noise impact assessment approach to include, for example, consideration of impact in context of the source within the character of the area, expectations, necessity and wider human perceptions. Other relevant factors include combinations of influencing factors that affect impact such as the combined GA and motor sport in this case and the potential for noise mitigation. It also recognises the decibel level is a minority consideration.

**4.19** Whilst decibel criteria is a limited part of a wider picture of control, existing controls for motor sport noise are based on short term decibel levels looking at maximum

[15] Great Britain. Department for Communities and Local Government (2012) *Planning Practice Guidance*. London: TSO. Available from: http://planningguidance.planningportal.gov.uk/

noise levels and 5-60 minute LAeq (average) levels. These relate to the audibility and attention grabbing character of the noise that relate to the levels of background masking sound and the frequency and duration of intrusive events as well as the times at which they occur. For example in relation to the last point there is greater expectation of freedom from noise during the evenings and at weekends.

**4.20** It is noted in the PPG that local authorities' decision taking should take account of the acoustics environment and in doing so consider:

- Whether or not a significant adverse effect is occurring or likely to occur
- Whether or not an adverse effect is occurring or likely to occur
- Whether or not a good standard of amenity can be achieved

**4.21** Mitigation of the adverse effects of noise is a specific consideration of the PPG, listing four main types of mitigation:

- Engineering – reducing or containing the noise
- Layout – reducing noise by distance, orientation, screening
- using planning conditions / obligations – limiting activity & times
- mitigation protecting certain areas or buildings

**4.22** The PPG notes that there may be additional considerations that reduce the impact of noise on residential development. This includes whether there is a relatively quiet façade, if there are relatively quiet amenity spaces and whether there are other amenity spaces, for example public parks and gardens, that may be used as an accessible amenity space.

**4.23** The PPG summarises how the effects of noise might be determined and this is reproduced in Table 2 below. Although noted as influencers of impact, this is not an exhaustive list and there is no guidance on how effect levels might be swayed by the character of the noise, character of the area without the noise, frequency and duration of impact or time of day of impact etc.

| Perception | Examples of Outcomes | Increasing Effect Level | Action |
|---|---|---|---|
| **Not noticeable** | No Effect | No Observed Effect | No specific measures required |
| **Noticeable and not intrusive** | Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life. | No Observed Adverse Effect | No specific measures required |
| Lowest Observed Adverse Effect Level | | | |
| **Noticeable and intrusive** | Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life. | Observed Adverse Effect | Mitigate and reduce to a minimum |
| Significant Observed Adverse Effect Level | | | |
| **Noticeable and disruptive** | The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area. | Significant Observed Adverse Effect | Avoid |
| **Noticeable and very disruptive** | Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory | Unacceptable Adverse Effect | Prevent |

**Table 2: PPG effect levels**

**4.24** **World Health Organisation Guidance[16].** The World Health Organisation (WHO) has published guidance which recommends criteria to be met for specific environments (indoors and outdoors) in order to avoid exposing people to levels of community noise which may impact health, impair development or result in annoyance. "Annoyance" is used as a health effect term by the WHO and not in the sense of its general lay meaning. The WHO have recently revised their guidelines based on evidence rather than expert opinion. As part of the process they have confirmed and clarified the limitations of how their guidelines apply. The new WHO guidelines clarify they are limited to road, rail, aircraft and wind farm noise. They also relate to leisure noise but in relation to person exposure (hearing damage) to the noise from a health perspective and not in relation to impact ]upon communities within their home due to loss of amenity. The relevant criteria outlined by the WHO for consideration of impact due to noise during the daytime is summarised in Table 3, below.

| **Specific Environment** | **Critical health effect(s)** | **$L_{Aeq}$ dB / $L_{den}$** | **Time base (hours)** |
|---|---|---|---|
| Impact upon a dwelling at the worst façade (façade level) – WHO 2018 | Highly annoyed 10% of community for aircraft noise<br><br>Increased Ischemic hearth disease risk | 45<br><br>52.6 | Annual $L_{den}$ |
| Dwelling, indoors<br>WHO 1999 | Speech intelligibility and moderate annoyance, daytime for steady continuous / anonymous noise | 35 | 16 hours day |
| All WHO | Motor sport noise<br>*No criteria is identified for this type of noise internally or externally but use of LAmax(f) is promoted for each occurrence of noise. The resulting level would depend on its emergence above masking levels and character which in turn affects sensitisation.* | LAmax(f) per noise event / occurrence | 42dB at night internally |

[16] World Health Organisation (1999) *Guidelines for community noise*. Geneva: WHO now superseded or complimented in part by the *WHO Noise Guidelines for the European Region 2018*.

**Table 3 – Guidelines for community noise**

**4.25** It is important to recognise the WHO values are façade levels and therefore include reflected noise from the façade of the dwelling under consideration. This element and the wider miss-application of the WHO guideline values has been considered in a number of cases including Roper v Tussauds 2006 (aka Alton Towers) and Lawrence and another v Fen Tigers 2011 (aka Coventry v Lawrence determined in the Supreme Court in 2014). This point and the miss-application of these guidelines to wider noise sources was confirmed as incorrect by the courts and is now clearly confirmed by the WHO in their 2018 guidelines.

**4.26** The stated aims of the NPSE, NPPF and NPPG are to avoid significant adverse effects on health and quality of life due to noise and to mitigate and reduce to a minimum any other adverse impacts caused by noise. Historical WHO criteria has been commonly misused to argue it provides suitable criteria to avoid adverse impact but is now confirmed as incorrect. In any event the historical WHO guideline values from 1999 were based on consideration of steady, continuous (and benign) sources of noise, such as transportation sources and focussed solely on critical health effects which result in physiological and / or psychological change and not well-being, quality of life or amenity loss. They also related to total energy dose and not one specific source of noise or site of emissions. The 2018 WHO guidelines have provided significant clarity, confirming their inapplicability to sources such as motor sport.

**4.27** The WHO 2018 guidelines do indicate stricter criteria are required for sources that grab attention due to their special characteristics than the sources of noise covered by their guidelines. Furthermore they promote use of LAmax(f) as an index for the assessment of individual noise events and also the application of existing assessment methods.

**4.28** Existing assessment methods in relation to motor sport noise include use of short term LAeq values over periods of 5-60 minutes and typically 5-15 minutes along with the use of LAmax(f). Both of these are based on the extent they are masked or dominant and grab attention.

**4.29** However, in the case of aviation noise the new WHO guidelines show a significant tightening of decibel level controls is recommended because adverse impacts have been under-estimated. Most assessment data relates to large international airports and further uncertainty arises as generally study shows general aviation is more intrusive than long haul jet aircraft flights. On balance the evidence indicates GA noise levels probably need to be lower for equal impact than for jet transport around major airports but in any event stricter criteria is required and levels should not exceed 45dB as a daytime (12 hour day) average.

**4.30** It is to be acknowledged that the annoyance response to noise is also affected by several other factors both acoustic and non-acoustic. Within guidelines issued in 1995[17] and on which their main Community Noise Guidelines 1999 were formulated, the WHO identify that annoyance response can be affected by certain features of sound. These are mainly features that attract attention, rendering the sound more discernible and include the relative frequency, variation in levels with time, sound quality, content, tonality, impulsivity and regularity. These features often specifically identify the sound to the listener and allow it to be distinguished from the residual background noise. Critically they grab attention and thus continue to have significant adverse effects as a result of their character content more than their sound energy level. This is the second type of noise, those with attention grabbing special characteristics.

**4.31** The steady, continuous, anonymous sounds such as distant road traffic noise, are generally considered easy to acclimatise to and habituation can arise relatively quickly whereas sounds that have an identifiable source, impart a particular message, are variable, unpredictable and have specific identifiable characteristics such as a hum or drone and are more annoying at lower levels than steady continuous sounds that do not import a message to the unconscious listener of concern. Furthermore, contrary to acclimatisation it is natural in many cases to sensitise increasing their adverse effect over time.

[17] World Health Organisation (1999) *Community noise*. Geneva: WHO

**4.32** With non-acoustic factors the WHO have identified that only one third of noise annoyance can be accounted for by exposure to varying sound level and that whilst sound can be measured, the actual extent of noise nuisance cannot be measured in this way. Annoyance reactions are sensitive to many non-acoustic factors of a social, psychological, or economic nature and there are considerable differences in individual reactions to the same noise such that non-acoustic factors have a greater effect than sound level.

**4.33** In the case of aircraft noise significant non-acoustic effects include fear of crashing and loss of privacy (especially for helicopters) and small aircraft at lower height. It is also noted in measurements of over-flying aircraft that the noise level modulates due to atmospheric effects and this pulsing / modulating effect may also increase intrusiveness as it draws attention to the noise.[18]

**4.34** The effects of noise character and different effects of the two main types or categories of noise are addressed in detail in the appendix.

**4.35** **Guidance on sound insulation and noise reduction for buildings (BS8233:2014) (BS8233).**[19] BS8233 provides guidance on acceptable levels of internal noise for a narrow range of noise sources that are generally steady (and benign) external sources. It applies primarily where existing noise sensitive buildings are affected by new anonymous noise sources such as transport or where new noise sensitive development is to be located close to existing environmental noise sources other than commercial, industrial and neighbour sources. In some of these latter types of noise the reader of the standard is directed to the use of BS4142[20]. Put another way the standard recognises its limited utility for "Neighbourhood" noise with character.

**4.36** BS8233: 2014 provides detail on planning and design of buildings, insulation and also reference noise source levels. It gives recommended indoor ambient noise criteria with the caveat that it is applied to steady, anonymous noise sources such as road

[18] This may be a major factor why aircraft noise intrudes more as this modulation will draw attention.
[19] British Standards Institution (2014) *BS8223:2014: Guidance on sound insulation and noise reduction for buildings*. London: BSI.
[20] See BS8233: 2014 section 6.5.2

traffic noise that are not associated with any specific site or property. This is logical as it is modelled on the WHO criteria that are confirmed as limited in its application.

**4.37** For dwellings, internal ambient noise levels for noise sources without specific character should meet the following criteria:

| Activity | Location | 07:00 to 23:00 | 23:00 to 07:00 |
|---|---|---|---|
| Resting | Living room | 35 dB $L_{Aeq,16hour}$ | — |
| Dining | Dining room/area | 40 dB $L_{Aeq,16hour}$ | — |
| Sleeping (daytime resting) | Bedroom | 35 dB $L_{Aeq,16hour}$ | 30 dB $L_{Aeq,8hour}$ |

**Table 4 BS8233 indoor ambient noise levels for dwellings**

**4.38** External amenity areas, such as public parks and gardens, should aim to minimise external noise and not exceed 50-55dB LAeq. It is noted in the Standard that these values may not be achievable in some areas and that dwellings should be 'designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited'. It is considered the principle applied is that where the need for housing outweighs other planning considerations then a small increase in noise exposure may be permissible to help meet that need. This guidance is derived prior to current understanding as determined from the WHO 2018 guidance which now substantially undermines such arguments or views.

**4.39** In any event the scope of BS8233 is limited to consideration of anonymous sources of noise and cannot address psychological factors. It is plainly not a suitable standard for considering the acceptability of impact from motor sport or general aviation noise.

**4.40** The use of BS8233 guideline values or what are effectively the same (now historical) WHO criteria that are specifically applied to road traffic noise, for the sources of noise identified in this case with high character content would mislead and serve to significantly understate impact.

**4.41** **Methods for rating industrial and commercial sound (BS4142:2014)[21].** Whilst noise from motor sport and general aviation activities are outside the scope of this standard,

[21] British Standards Institution (2014) BS4142:2014; Methods for rating and assessing industrial and commercial sound

BS4142 does outline a form of assessment for determining the likelihood of an adverse impact by recognising and emphasising the relevance of certain acoustic features such as tonality, impulsivity or intermittency when assessing the likely effect of sound on people.

**4.42** The approach advocated in BS4142 is based on predicting the likelihood of an adverse impact on people (who may be inside or outside a dwelling) after decibel penalties are applied to the specific noise under consideration, and the degree to which it exceeds the background masking sound levels.

**4.43** BS4142 is adopting long established principles where the intrusiveness of noise from certain types of site related activity and which contain certain forms of character relates to its emergence above the masking levels of background sound and impacts subject to how those characteristics such as tonality, impulsivity, distinctiveness and intermittency attract attention and in so doing disrupt. In effect BS4142 serves to endorse the difference in impact on people and their assessment from more benign and anonymous sources of noise and those related to specific sites and which contain specific attention grabbing character.

**4.44** It is understandable that the specific criteria of acceptability in BS4142 cannot apply to motor sport or general aviation as acceptability of both are affected by non-acoustic factors which research on the use of BS4142 cannot address. The inference is that BS4142 is liable to understate the impact.

**4.45** It is instructive that research[22] by MAS Environmental comparing equal sound energy levels (45dB LAeq) of road traffic noise, music noise venue breakout, metals recycling noise, motor sport noise and wind farm noise results in conflicting results with different people placing different as that causing worst impact. Generally the music noise breakout was worst but this is a night time noise source. Metals recycling and motor sport noise were similarly rated as virtually equally intrusive.

**4.46** Notwithstanding the above both motor sport and general aviation are regarded as activities that contain special acoustic characteristics that increase their intrusiveness.

[22] Currently in progress for future publication.

**4.47** **ProPG: Planning & Noise[23].** This non-governmental guidance has recently been published as professional practice guidance. The guidance was developed for the consideration of new residential development that will be exposed predominantly to airborne noise from transport sources. Other sources of noise including industrial, commercial and entertainment are considered to be outside of the scope of the guidance. The limitation in the scope of the ProPG serves to highlight how such sources of noise require different assessment criteria.

**4.48** The suggested approach of the guidance is based upon an initial site risk assessment of an empty, unoccupied and unmitigated site. The guidance does not set limits for NOAEL, LOAEL or SOAEL, but suggests ranges where increasing noise levels may help identify whether the noise risk at a site is low, medium or high. The theory is that the greater the risk the greater the challenge in mitigating the impact and that it might be possible to introduce noise mitigation measures to a site rendering it acceptable for development based upon the principle of good acoustic design (which should be considered at an early stage of the development process).

**4.49** For internal and external spaces the noise level guidelines are reproduced from BS8233:2014 which in turn derive from the WHO guidelines of 1999 as target values or the onset point of adverse health effects (although the guidance does outline situations where relaxation of these guidelines may be applied) hence another reason why the scope of this guidance is restricted to transportation noise sources. However the principle of risk assessment to consider the viability of land in local plan development could be transferable to other sites which are impacted by non transport sources albeit the criteria adopted cannot.

**4.50** It is important to note the ProPG criteria ignored important guidance contained in the WHO 2009 night Noise guidelines. Furthermore, it has also been superseded by the WHO 2018 revised guidelines. The critical element of the ProPG is its recognition the

[23] ProPG: Planning & Noise [2017]. Professional Practice Guidance on Planning & Noise – New Residential Development.

criteria for the transport sources is not applicable to sources with special character such as industrial noise.

**4.51** Unfortunately the ProPG guidance relates to maximum noise guidelines that reflect WHO advice in 1999 and not that which emerged in 2009 for night noise. This is not explained in those guidelines. However, this site does not involve night time noise and thus that particular lacuna in the ProPG would not impact.

**4.52** **Environmental Protection Act 1990.** Legislation regarding the control of nuisance level noise can be found in the Environmental Protection Act 1990, which defines statutory nuisance at Section 79(1)(g) as "noise emitted from premises so as to be prejudicial to health or a nuisance". Action for nuisance would be available against operators of commercial premises but excludes aircraft activity other than from model aircraft. The prejudicial to health limb would include impacts upon public health (threat of disease, conditions and similar health effects) and the nuisance limb follows the principles of civil nuisance, for example intolerable, unreasonable impacts that affect comfort and convenience leading to a material interference with use and enjoyment of property. In simple terms it relates to loss of quiet enjoyment.

**4.53** Civil nuisance can be public or private. A public nuisance typically concerns indiscriminate impact on the wider community, whereas a private nuisance concerns individual property. It is important to recognise that decisions in nuisance derive entirely from separate law to the Town and Country Planning Acts with different aims and objectives. I also understand the courts consider planning permissions have extremely limited relevance to nuisance decisions other than marginally, for example the hours of operation of a site.

**4.54** As a general principle it has long been recognised that planning controls should intend to be more exacting than nuisance and would aim to avoid circumstances where nuisance arises. It is also to be recognised that planning approvals assume reasonable use of sites / activities. National planning guidance seeks to minimise impacts and it follows this differs to nuisance where material interference with use and enjoyment of property must arise. Furthermore the planning controls are proactive intending to avoid land use conflicts that might be defined in nuisance terms.

**4.55** The potential demise or significant constraint of the motor sport activity is however, likely as a result of a complaint of nuisance.

**4.56** The test of nuisance is an objective one of the ordinary reasonable person, and nuisance by noise usually arises when activities interfere with a neighbours comfort and convenience in the enjoyment of their land (which would include quality of life). Where people are complaining, *prima facie* it is indicative they are materially adversely affected and unless they are abnormally sensitive, unreasonable members of society, a finding of nuisance is likely. Put another way the complaints of nuisance indicate current noise levels are excessive and approaching nuisance levels. To permit more affected residents would move the situation closer to one of nuisance.

**4.57** Whether or not noise is actionable in nuisance is matter of degree and depends on circumstances such as how loud the noise is, the type and character of the noise, duration and frequency. It follows that assessment of nuisance requires consideration of a range of factors and should not focus solely on the decibel level. The benchmark for nuisance could not be based on whether a source of noise was measured above or below the WHO guidelines, especially now with clear clarification by the WHO such use would be inappropriate and misleading.

**4.58** Assessment of impact on the use and enjoyment of premises can relate both to human responses such as annoyance and irritation but also their coping strategies and how they try to adapt to the noise. This can relate to changes in behaviour such as complaining, avoiding the use of specific parts of the property, or having to mask the noise in some way (e.g. playing music). Evidently some of the coping strategies considered under nuisance are directly comparable with the outcomes detailed in the PPG.

**4.59** The assessment of nuisance has been guided by case law and considers both subjective and objective judgements. Nuisance can generally be considered a set of circumstances or state of affairs where there are periods of intrusive noise, which is unreasonable and excessive to the extent they affect the use of enjoyment of a property in a material way. The following factors are commonly considered can influence the assessment of nuisance:

- Character of both the noise and of the area
- Duration
- Time of occurrence
- Loudness
- Message imparted by the noise
- Variation in noise over time
- Spectral content
- Regularity / predictability of the noise
- Respite from the noise, length / duration of respite
- How easily the noise can be avoided
- Cumulative impact of noise intrusions
- Decibel level of the noise
- The necessity of the noise in relation to greater society

**4.60** Action taken in respect of statutory nuisance can also be based on the likelihood of occurrence, for example where a new housing development is being built close to an existing commercial / industrial occupier. Whilst the housing is not yet occupied it is likely that future residential occupiers would be unduly impacted by noise[24].

**4.61** In summary, criteria for nuisance differs to planning and relates to typical responses of people. Where complaints arise it is reasonable to conclude nuisance action may arise and this would likely lead to the constraint and possible total demise of the commercial activity. In particular it may also lead to prevention of any future expansion or variation. This is contrary to the national planning policies and the wider principle of avoiding land use conflicts. As a general rule planning decisions should not

[24] This aspect is now complicated as in Coventry V Lawrence 2014 the Supreme Court redefined the rules on "coming to a nuisance" and effectively identified there is potentially a defence when this arises. The difficulty and unknown factor is how far this principle impacts the application of statutory nuisance provisions. It is unlikely to affect matters considered prejudicial to health. Furthermore it is at most a possible defence and cannot be given weight where there is existing housing.

lead to a risk of nuisance action which would be obligatory upon the local authority where they are satisfied a nuisance exists and regardless of the merits.

**4.62** It is also a fundamental principle of the NPPF, NPSE and PPG that noise should not be considered in isolation, and that it should be considered alongside economic and social benefits. Where an adverse noise impact due to motor sport related activities is identified, not only would this have an environmental impact, economic and social impacts would need to be considered due to potential enforcement action that could place unreasonable restrictions / prohibitions on an existing business. Thus the potential demise of an existing business, its restriction or curtailment in terms of future development are therefore relevant planning considerations.

**4.63** Therefore in the wider sense of current planning policy, impact from motor sport noise should be considered not just in terms of the planning principles and the balance of needs such as housing and economics but by having specific regard to the principles of nuisance and what the outcome would be in terms of the commercial operations. Impact is not just in relation to the motor sport activity but also aviation. For example future development plans such as hard surfacing any of the runways would require planning permission and would be dependant on noise impact.

**4.64** **Guidance specific to general aviation activity.** There are numerous documents related to aviation noise assessment and general planning guidance, but the majority of these documents are typically associated with larger, commercially operating airports. This is similarly the case with the latest WHO 2018 noise guidelines for the European Region. There is limited guidance related to noise from general aviation.

**4.65** For example the Aviation Policy Framework (APF - March 2013)[25] states that the Government "will continue to treat the 57 dB $L_{Aeq,16h}$ contour as the average level of daytime aircraft noise marking the approximate onset of significant community annoyance". Not only does the WHO indicate substantially lower levels should be considered (45dB $L_{den}$), but it likely relates more to the assessment of larger

[25] Secretary of State for Transport [March 2013] – Aviation Policy Framework

commercial airports because of the requirement for the major UK noise-designated airports to produce such decibel contours.

**4.66** In addition the standard approach for assessment of aviation noise is to assess this decibel level based on the average number of movements in a 16 hour day across the 92 days of summer (16th June to 15th September) and does not reflect the hours of movements at Goodwood Aerodrome which are known to occur within a shorter timeframe.

**4.67** The APF identifies that whilst noise exposure contours are a well established measure of annoyance for large jet aircraft and are useful to show historic trends in total noise around airports, it is recognised that people do not experience noise in an averaged manner and that the value of the $L_{Aeq}$ indicator does not necessarily reflect all aspects of the perception of aircraft noise. The critical aspect of this is the substantial reduction to an $L_{den}$ value of 45dB as the point at which there is a significant percentage of highly annoyed people.

**4.68** It is recommended that average noise contours should not be the only measure used when airports seek to explain how locations under flight paths are affected by aircraft noise, especially in relation to GA. Airport operators are encouraged to develop measures in consultation with their consultative committees and local communities that better reflect how aircraft noise is experienced in different localities[26]. An important aspect of this is the number of movements and the time they dominate the sound environment.

**4.69** A survey of noise attitudes CAP 1506 (February 2017)[27], recognises that residents will struggle to understand what a 57 dB $L_{Aeq,16h}$ (now 45dB $L_{den}$) contour actually means in terms of noise impact on the ground and that there is merit in considering greater use of supplemental indicators, such as the number of events above a specific $L_{AMAX(f)}$ value to help communicate noise to communities more effectively.

[26] For example recently in the case of Rochester Airport a Government EIA scoping assessment identified the need to review aircraft movements and periods of respite between these and not just the decibels levels.
[27] Civil Aviation Authority [2017] – Survey of noise attitudes 2014: Aircraft CAP 1506

**4.70** This survey also detailed that the same percentage of respondents said to be highly annoyed at an $L_{Aeq,16H}$ 57 dB based on a government study from 1982 were now found to be affected at a lower level of 54 dB. This indicates a further lowering in tolerance of noise due to exposure of commercial aviation activity and it is instructive that based on evidence the WHO have reduced this to a long term average of 45dB $L_{den}$.

**4.71** The stepwise reduction in aircraft noise levels recognised by the WHO in 2018 is a major concern and indicative that previous assessment criteria has permitted dramatically excess noise.

**4.72** Guidance which considers annoyance from general aviation can be found in an Institute of Sound and Vibration study of General and Business Aviation (GABA)[28] which correlated noise level and annoyance from general aviation at levels 5 dB lower than for commercial aviation. However, with the dramatically lowered criteria for general jet based aviation it is unclear how much lower levels should be set. As a precautionary approach it is likely a value of 45dB $L_{den}$ should be applied and likely the differential previously considered is reduced.

**4.73** The reasons why annoyance thresholds towards general aviation are normally considered lower can be speculated on a number of principles including lower background levels, different (and shorter) hours of operation, tonal characteristics of light aircraft and human response to the difference between noise considered as caused through necessity of society and that based by those simply enjoying a recreational activity which can create an adverse message of disregard of the needs of others in return for the flyers individual personal pleasure.

**4.74** Notwithstanding the differences between jet transport aviation and GA, the stepwise reduction in acceptability criteria for aviation generally indicates it is unsafe to continue to speculate there is a difference of 5dBA and as an interim measure the same criteria should be applied to both forms of aviation.

[28] Department of Transport [1988]. A study of annoyance due to general and business and aviation noise

**4.75** Most people are prepared to tolerate a degree of noise until their loss is greater than they expect to suffer. The distinct character of the noise generated by general aviation compared to commercial aviation readily triggers attention and leads to differentiation between the reasons for the noise. It also appears the character of the noise is more readily discerned and so likely to trigger human attention and interfere with activities at lower decibel levels.

**4.76** **Findings from emerging evidence on aircraft noise.** In summary, the evidential relationship identified by the WHO of 45dB $L_{den}$ (this equates to a 12 hour daytime LAeq value of the same) with significant adverse impact in a community from aviation noise indicates the increased impact in the area of Goodwood is a greater trigger of unacceptable overall noise than previously thought and that the aviation contribution is substantial. In turn this indicates more detailed consideration of noise impact over a much wider area depending on flight paths but also more stringent motor sport noise decibel criteria may be appropriate than the currently considered value of 50dBA for GA.

**4.77** The WHO 2018 guidance indicates a stricter criteria of at least 5dBA. This accords with the decibel criteria considered in this study for motor sport noise as well as GA noise (as discussed in more detail below), this indicates short term LAeq controls of the order of 40-45dBA. When considering this relates to 5 days of uncontrolled noise and a further 110 days of Category 2 days, it indicates levels of not more than 42dB LAeq(15 minutes) as a free field value are appropriate as a control mechanism. The effect of the aircraft noise is to support an argument further reduction is required but on the current evidence of cumulative impact from GA and motor sport, this cannot be sustained.

**4.78** As distance from a source of noise increase the difference between the average level and maximum noise (LAmax(f)) diminishes. At 400m a difference of 4dB is not unexpected although at times it may be greater. However, peaks of noise in excess of 44dBA would indicate adverse intrusion that should not be regularly repeated. Exceedance of this value on more than 5 times in a 5 minute period provides a reasonable measure where some odd excess happenings can potentially be tolerated

but where this happens with high regularity the intrusiveness will be increased substantially.

**4.79** Comparing Goodwood to other similar rural areas and the criteria applied to other motor sport venues around the UK indicates LAmax(f) controls around 45-50dB are appropriate and a short period LAeq of 40-45dB is also appropriate. Exceedance of this criteria beyond 400m is to be avoided with a balance being applied in the form of the following criteria which would apply in combination and potentially along with other criteria:

a) limited frequency of occurrence arising due to the distance and directional effects of the most common weather conditions,

b) Duration of impact arising due to the combination of weather, direction and topographical features as well as elevated local masking noise levels such as raised background adjacent a road.

c) Provision of noise escape, for example flats with protected external areas.

d) Quiet and protected facades where main daytime living rooms are screened from the source noise.

e) External screening of patios and garden space areas due to build features such as pitched roof garages and side extensions.

f) Internal design features which reduce noise such as single aspect housing.

g) Reduced impact from general aviation flight paths due to location.

**4.80** It is important to note these criteria should not include reliance on mechanical ventilation not least as occupants would be entitled to rely on natural ventilation and complain that loss of that facility is a material interference with their use and enjoyment of their property.

## 5.0 Critique of noise impact assessments relating to Goodwood Motor Circuit and Goodwood Airfield

**5.1** A number of site specific acoustic assessments have been prepared in support of development within the 400m buffer zone, which have considered the suitability of land both within and abutting the 400m buffer around the Goodwood motor circuit (GMC) and Goodwood aerodrome (GA). These assessments have argued that residential development should take place within the 400m buffer imposed by Chichester District Council by challenging that there is no robust or credible evidence to support the Council's case that the noise from the above sites precludes residential development.

**5.2** A key objective of this independent study is to consider and review the noise criteria adopted by acousticians used to argue in support of development within the 400m buffer zone. A critique of those acoustic assessments undertaken to date is covered in this section of the study.

**5.3** Information provided by Chichester District Council identifies that a number of acoustic assessments have been undertaken, in particular by Cole Jarman (CJ). Their main body of work and upon which subsequent reports have been based is report reference 12-3750 which was originally completed in 2013.

**5.4** Subsequent reports which have investigated the suitability of land abutting and / or just inside the 400m buffer and dated as recently as 2016 provide no evidence to confirm if original monitoring results are still valid. However, the primary issue is the concepts and criteria of assessment of acceptability applied.

**5.5** With regard to the CJ reports their proposed criteria for environmental acceptability for development proposals near to GMC and GA are:

- 55 dB $L_{Aeq,30min}$ as an upper limit for Goodwood Motor Circuit noise emissions in isolation[29] (except Category 1 events)
- 52 dB $L_{Aeq,16h}$ or less as an aim for General Aviation noise[21]

[29] Not cumulatively with all other community noise.

- 55 dB $L_{Aeq,16h}$ or less as an aim for total noise levels (GA and motor sport combined).
- 35 dB $L_{Aeq,16H}$ during the day for internal noise level assuming windows open.

**5.6** These criteria can be summarised as adopting WHO criteria for steady, continuous anonymous noise sources that were formerly recommended by the WHO as the onset point of serious community annoyance for such sources of noise. As already identified such application of this criteria to the motor sport and GA noise:

i. Is contrary to the guidance provided by the WHO in relation to how their guidance can be used, both generally in those documents and specifically in correspondence when they have been asked;

ii. Is contrary to the interpretation of the courts as to the applicability of such criteria to motor sport noise in other cases;

iii. Is contrary to long established criteria developed at other sites;

iv. Is contrary to the science of acoustics and in particular how noise with special character intrudes differently to that of a more benign nature;

v. Is contrary to the guidance as emerging from the WHO on the application of their guidance;

vi. Is contrary to the caveats within BS8233: 2014 that adopts and applies the WHO criteria to some sources of noise;

vii. Is contrary to the most recent 2018 guidance on aviation noise that now recognises much more stringent criteria are needed to protect communities.

**5.7** Arguing the WHO benign, anonymous type noise based criteria are acceptable to noise outside of their scope and description of applicability does enable arguments that greater levels of intrusive noise are acceptable. In turn this supports arguments in support of residential development where it would otherwise be refused. Whilst there may be acoustic engineers who genuinely consider such criteria can legitimately

be applied, any detailed or forensic analysis reveals this is a miss-application of the science. In the case of CJ they have been involved in cases where such criteria have been rejected and thus must be aware of the limitations on the use of such guidance.[30]

**5.8** In summary the criteria originally proposed by CJ in 2013 was developed from what is a misinterpretation of guidance based on WHO Guidelines, PPG24 (revoked) and BS 8233:1999 (superseded by BS 8233:2014). Furthermore their free field value of 55dB used ignored façade reflections and thus even when seeking to apply the transport noise criteria, up to 3dB should be deducted from the criteria to reflect the effect of dwelling facades. The 2018 WHO guidelines clarify the values apply to the worst affected façade.

**5.9** Motor sport (and also general aerodrome activity) is regarded as irregular / intermittent and tonal and therefore does not fit with the scope of guidance used to assess benign sources in any event. In summary the approach adopted by CJ allows more noise as it relates to generally benign 24/7 sources of environmental noise and not less frequent / intermittent neighbourhood sources that attract attention due to the character of the noise and the unconscious message it imparts.

**5.10** As advised the WHO has confirmed in correspondence on motor sport noise in cases MAS have been involved that its guideline values are not applicable. In terms of the former planning policy document PPG24 and its Noise Exposure Categories (NEC), the document clearly identified that criteria only applied to transport noise. Such arguments were extensively explored in the High court case of Lawrence and another v Fen Tigers 2011 and was rejected as it was in other cases considered by the courts.

**5.11** Misuse arises over an NEC category that includes some industrial noise where it does not dominate. Historically this has been misapplied to use it for non transport noise sources but is still contrary to the specific guidance contained within PPG24.

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[30] Some acoustic engineers have argued reference in BS4142 examples that relate to commercial noise to BS8233 implies such an approach. Careful analysis reveals there is an absence for any such support in that document and careful review reveals it provides no more support than an argument the broad advice in BS8233 may assist in some cases where commercial noise falls within the descriptors applicable to anonymous, benign sources.

**5.12** In justifying their proposed environmental criteria CJ acknowledge that motor racing does not normally share the characteristics associated with an anonymous constant source of noise (on which WHO, PPG24, BS8233 are based) but argue that in the case of Goodwood the character of the noise is often closer to road traffic noise than high level motor racing noise, except in the case of Category 1 events.

**5.13** Contrary to the assertions, there is only limited evidence presented in their survey work which can potentially support this point or is sufficient to overcome the effects of character content which draws attention and it is undermined by our own survey work that identifies significant attention grabbing character.

**5.14** In terms of current policy the criteria set by CJ does not have due regard to guidance contained in the NPSE. As discussed the NPSE introduces the principle of toxicology to determine NOEL and LOAEL and has extended these principles to introduce the concept of SOAEL. Toxicology is the science and study of how poisons affect organisms and uses information from medicine, pathology, chemistry, epidemiology and statistics and therefore is considered to be directed at assessing impacts on health rather than quality of life / annoyance. Regardless it is not addressed.

**5.15** The limitations of the toxicological model are not explained within the NPSE. It is understood that the NOEL and LOAEL are taken from the WHO Noise Night Guidelines (WHO NNG) 2009[31] which considers the $L_{night}$ noise descriptor as average noise levels over a year. This is also largely based on the study of health impacts due to sources such as transportation noise which are regarded as generally benign and anonymous, devoid of tonality, impulsivity and other attention drawing features. Simply put the transference of these principles to noise annoyance is not demonstrated.

**5.16** Whilst it may be considered reasonably appropriate to apply the principles of toxicology in the NPSE strictly to sources of noise identified in the WHO research, the same cannot be considered for heterogenic sources of neighbourhood noise as there is greater uncertainty because of the limited evidence / research regarding onset levels for adverse effects on health or quality of life. This is now effectively confirmed

[31] World Health Organisation [2009] Noise Night Guidelines for Europe

by the WHO where they have recognised that existing methods of assessment should be used for neighbourhood sources of noise not covered by their guidelines and these primarily relate to short term average and maximum noise levels.

**5.17** The limitations of the guidance applied by CJ are clear and contrary to the use they have applied to them. This is now further demonstrated in the WHO 2018 guidelines.

**5.18** Whilst there is only limited research and guidance regarding acceptable noise levels for motor sport this does not justify use of inappropriate guidance in the absence of something else, especially where this allows more noise and it is recognised the character within the motor sport and GA would result in stricter criteria. Furthermore, there is a long evidential history of controls over motor sport noise applied generally in the UK but which have not entirely eliminated land use conflicts indicating at best a precautionary approach is needed whereby existing controls may provide adequate protection but equally may permit excessive noise in some cases.

**5.19** **Audible comparisons.** To highlight the difference in character between road traffic noise and motor sport activity from GMC a website link is being developed which is to be online before the end of 2018 that will allow the reader to compare recordings of both and which are normalised to the same decibel level. Separate research work involving subjecting local authority enforcement officers to varying sources of noise reveals clear recognition of the greater intrusiveness of motor sport noise than road traffic noise.

**5.20** The samples were recorded at similar distances from the source, approximately 220 – 230m. Sample 1 is a recording of road traffic activity measured near to the A43 dual carriageway in Northamptonshire. Sample 2 is a recording of a Category 2 day during monitoring of track activities at Goodwood. The reader will therefore be able to judge the differences in the character and nature of the noise themselves.

**5.21** **Detail of the CJ monitoring.** Referring to the CJ survey methodology, monitoring was set up to measure continuous 1 minute periods. This is not considered to be an appropriate interval of measurement as this will have concealed the pattern of variation over time. Temporal measurements are needed typically 10 times a second to reflect how the noise changes moment by moment.

**5.22** Noise impact occurs on a moment by moment basis and character such as sudden rise or fall in noise is not defined by the average level during any minute. The numerical data presented in the CJ reports for motor sport activity lacks any description of the acoustic environment or explanation regarding the variation across different measured $L_{Aeq,30min}$ periods. It fails therefore to define or identify the effects of character in the noise, the sources contributing and how these factors affect impact.

**5.23** MAS's own experience of monitoring around GMC noted that events of motor circuit activity occurred as crescendo events of hard acceleration / exhaust noise as cars passed by on the circuit or accelerated into the distance. There were clear attention grabbing characteristics that were repeated and this source of noise should not remotely be described as benign anonymous and continuous.

**5.24** There are also directional effects which mean there is significant change in level depending where an observer is located. To emphasise how the interval of measurement used by CJ is inappropriate and how this has concealed the character of noise of motor sport at GMC a comparison of the same period of measurement data is presented below at Figure 3.

**5.25** Figure 3 is a sample time history where motor circuit activity has been analysed at 100ms intervals which demonstrate that it occurs as steep fluctuations that peaked significantly above ambient / average levels.

**5.26** The blue arrow on the graph has been drawn to help demonstrate the large changes in level moment by moment based on an approximate doubling of loudness with a 10dBA increase in noise levels. It is clear that motor circuit activity not only doubles in loudness but quadruples in some cases and therefore leads to stepwise significant attention drawing changes. This is relevant to explaining why motor circuit activity was noticeable in the local environment as opposed to presenting results as averages from which such notice-ability could not be determined.

**5.27** To further demonstrate how the use of 1 minute average values visually suppress the nature of motor circuit activity within the data these have been superimposed onto Figure 3. It is clear that such intervals diminish the true nature of motor circuit activity by hiding those discrete events of crescendo that represent the moment by moment

variation in levels that describe the noise environment and grab attention. If activity were to be viewed based on 1 minute averages then and only then could a miss-description of the noise as steady arise.

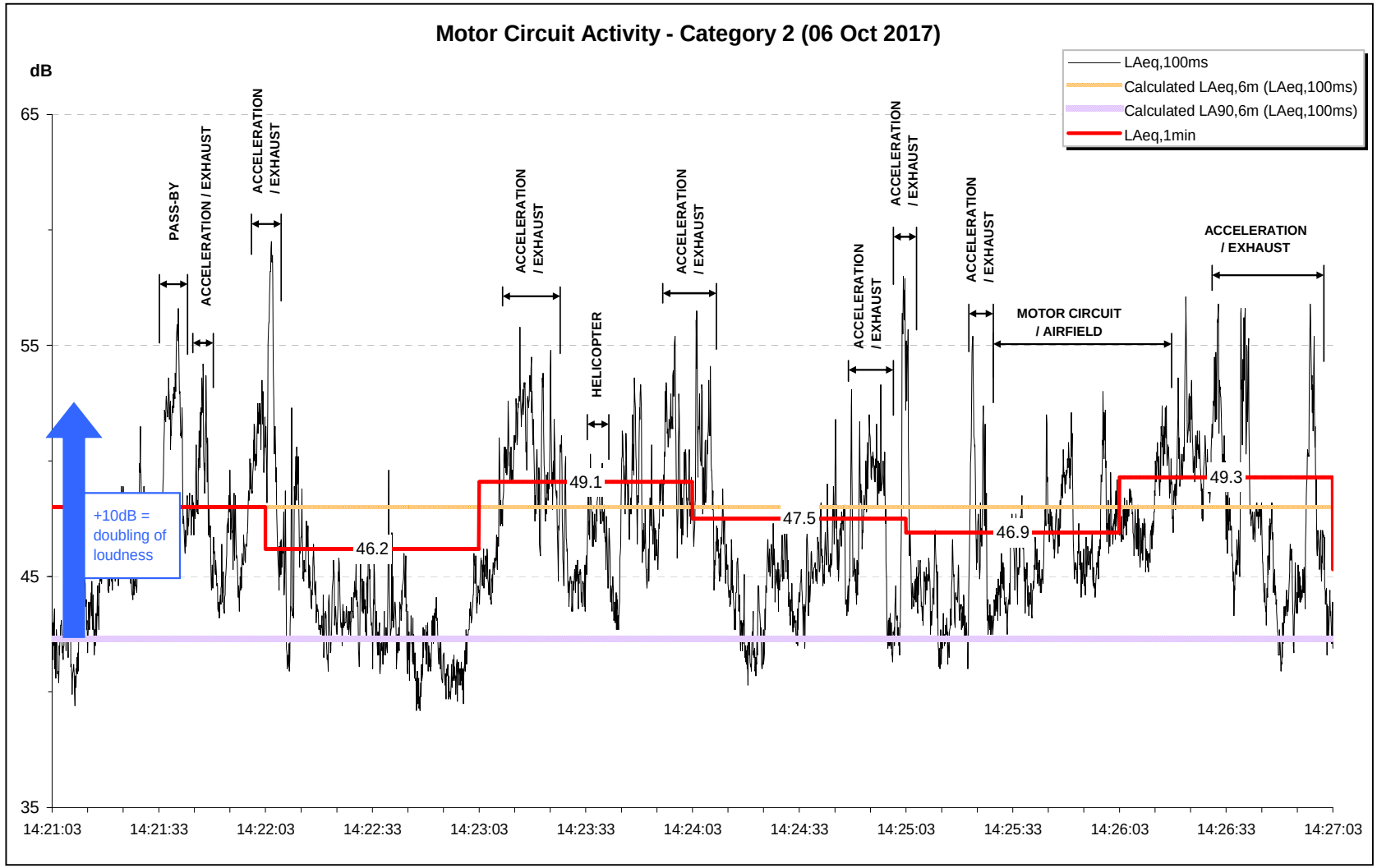



**Figure 3 – Sample time history to describe motor circuit activity when analysed as $L_{Aeq}$ 100m/s when measured at a distance of approximately 515m from GMC (and upon which $L_{Aeq}$ 1 minute has been superimposed)**

**5.28** The use of direct observation and audio recording to describe the acoustic environment by CJ in their reports has been very limited. The evidence disagrees with the view of CJ that motor circuit activity at GMC is comparable / similar to that of distant road traffic noise. More recent field observations by MAS at distances / locations similar to that of the CJ study identified the noise from GMC is not comparable to the character of distant road traffic noise because of the tonal sounds associated with high speed driving, quite often involving high end performance vehicles. The bursts and acceleration, engine / exhaust sounds and sudden rises and falls in noise all differentiate the noise and result in clearly different attention grabbing character as can be seen in Figure 3 above.

**5.29** In their study CJ explain that audio recordings were only triggered whenever the Sound Pressure Level (SPL) at the measurement position (CJ1 – CJ3) exceeded a preset level of 70 dB(A). These monitoring positions were noted as being located 360 and 435m from GMC.

**5.30** It was identified by MAS that when monitoring at distances of approximately 220m from Goodwood that events in excess of 70 dB(A) were rarely attributed to motor circuit activity and were typically associated with other events such as aircraft flyovers. Therefore it is considered that any audio recordings made by CJ would not have been triggered to capture specific events of motor circuit activity which would have been necessary to have verified events recorded by a sound level meter.

**5.31** In summary the CJ survey would not have captured audio information on noise character and any post analysis would be incapable of determining the differences. In any event experience of motor sport noise at community locations at a number of sites around the UK readily reveals significantly different character and the idea they are similar is contrary to both logic and experience.

**5.32** When assessing the noise potential from GMC it is considered that the CJ study should have included the potential noise impact from all categories of events, not least as it is the entire set of circumstances that lead to community reaction. As noted in their report, CJ exclude Category 1 events as atypical of site activity, but there is limited

justification for doing so and even a small number of high noise events could significantly contribute to an overall adverse situation.

**5.33** The requirement of planning policy is that noise needs to be considered when new developments would be sensitive to the prevailing environment, and should consider the cumulative impact. Whilst Category 1 days may be limited to 5 days per calendar year, this forms part of the overall operation of the GMC site which can operate up to a total of 316 days per year (110 Category 2 days; 130 Category 3 days; and 71 Category 4 days) in combination with the general aviation activity.

**5.34** All events contribute and the Category 1 days probably result in the greatest intrusion that reduces tolerability to the more regular noise as a result. This is a normal human response.

**5.35** There is no reason to consider residents would disregard or ignore the substantial noise contribution on the Category 1 days. Their overall tolerance relates to the total noise impact and the higher noise on these days will likely lead to more extreme coping strategies which in turn add to the experience and memory of residents of their sound environment.

**5.36** The inclusion of Category 1 events in the overall assessment is considered highly relevant and especially since the environmental criteria suggested in the CJ study is not regarded as remotely suitable for demonstrating acceptability. For example, because of the character of noise associated with motor sport it may be the case that an adverse impact occurs when category 2 events are running. Unlike category 2 events, the noise levels from a category 1 event are unrestricted. Although being limited to just 5 days per year, these events operate at substantially higher levels of noise. Assuming category 2 events are regarded as significant and unacceptable intrusion, the addition of 3 consecutive days of motor racing (i.e. the Goodwood Revival) could be seen by residents as the tipping point for a case of severe unacceptable impact and intolerable intrusion, depending on what is impacted.

**5.37** Figure 3 places this in perspective where average levels were of the order of 48dB LAeq. This is at the upper end of controls applied at other venues and exceeds the

criteria applied to abate nuisance in the case of Lawrence and another v Fen Tigers 2011. In that case 12 there were 12 weekends where a level up to 55dBA was permitted and all remaining daytime periods levels were required to fall below 45dB LAeq(15 minutes). In the case of Goodwood 110 Category 2 days are permitted and if Figure 3 values were applicable to all, this would indicate substantial exceedance of what was considered a nuisance in the case of Lawrence and Fen Tigers.

**5.38** Whilst GMC only currently use 3 of their 5 days permitted for category 1 events, this would in theory further increase the numbers of days to which residents are exposed to unacceptable noise when combined with the 110 category 2 event days that are permitted. Therefore category 1 events should have formed part of overall cumulative impact assessment and be identified in terms of their significant contribution due to the increased impact on those days and the lack of respite.

**5.39** In any event, analysis is required as to why it might be considered that development around Goodwood can tolerate more noise than that around Mildenhall. The latter often continued into the evenings where a lower limit applied and the former experiences substantially more aviation noise.

**5.40** **Aerodrome activity**. For general aviation the proposed CJ criteria were developed from guidance contained in the General and Business Aviation (GABA) noise study, referenced earlier in this report. As identified, guidance from the WHO 2018 now appears to supersede this indicating stricter control is needed to protect communities.

**5.41** The aviation policy framework suggests that average noise contours should not be the only indicator of noise effects at locations under and around flight paths and that people do not experience noise in an averaged manner. It is well recognised the value of the $L_{Aeq}$ indicator does not necessarily reflect all aspects of perception of aircraft noise.

**5.42** General aviation noise should be considered differently to that of Commercial / Transport aviation in a number of respects. This would include the frequency and duration of aircraft movements, the typical respite time between those movements and how they are distributed day to day, especially during main leisure periods such as

weekends when residents expect greater freedom from such noise sources. In spite of the aviation policy framework having been published when the CJ study was originally conducted the suggestions for alternative criteria for assessment have not been included. The use of alternative criteria was similarly identified in other cases where CJ have been involved including Rochester airport. In that case the number of intruding events of take off and landing were considered important and required analysis.

**5.43** Assessment of impact has largely been based on contour modelling by CJ and which contains a number of flawed assumptions. Impact assessment has been based on assumed modelling of movements to generate daytime $L_{Aeq,16h}$ contours (07:00 – 23:00) but actual operational hours for Goodwood Aerodrome (GA) are known to be shorter than this. Guidance from the WHO on aviation noise splits the day up into a daytime 12 hour period, evening 4 hour period and night time 8 hour period. Decibel penalties are applied during the evening and night time periods. The outcome is that daytime is assessed on the basis of a 12 hour average and not 16 hours.

**5.44** Through liaison with the control tower at GA MAS understands that the majority of movements occur during manned hours with the main thrust of aerodrome activity taking place over a 9 hour period between 09:00 – 18:00. Based on a 16 hour assessment this would therefore include averaging across hours where little or no flight activity is taking place giving the impression of lower sound energy levels across the site than occur for the main period of activity. At best a 12 hour value should be used and most appropriately a 9 hour average.

**5.45** Adoption of a 12 hour LAeq value would permit direct comparison with the WHO Guidelines 2018.

**5.46** The aircraft types included in the modelling exercise also do not consider the variety of aircraft flying from the aerodrome. Modelling inputs were based on just 3 different light aircraft whereas GA has confirmed a more diverse mix of aircraft visiting and departing the site. For example there is regular seasonal activity due to the Boutlbee Flight Academy which operates Spitfires, Mustangs and Harvards from April to October. It has been suggested locally that these are some of the noisiest and most

noticeable aircraft which operate from the aerodrome. Field observations by MAS also noted a number of light aircraft including bi-planes which produced a noticeable tonal sound during take-off compared with other light aircraft.

**5.47** The effect levels for general aviation noise recommended by CJ are not considered appropriate for this site. For general aviation CJ set the range for the Lowest observed effect level (LOAEL) at 52 – 61 dB based on an $L_{Aeq,16H}$. This range combines guidance contained in the Aviation policy framework (APF) and the now withdrawn noise exposure categories (NEC) in PPG24. For the onset of significant community annoyance the APF set the limit $L_{Aeq,16H}$ 57 dB. A level of 52 dB is achieved by applying the 5 dB penalty identified in the GABA report to account for greater sensitivity due to general aviation noise. The upper limit for the LOAEL derived at by CJ is based on NEC B as found in the former PPG24 guidance to which a similar correction is applied, i.e. 66 – 5 = 61 dB. CJ justify this range on the basis that $L_{Aeq,16H}$ 57 dB (for commercial aviation) only 25% of the population would find noise to be unacceptable. However CJ have not to sought to justify the proportion of persons in the context of noise policy or why it is considered acceptable to adversely affect such a high number of people.

**5.48** Whilst CJ consider 25%[32] to represent a low number of persons annoyed, in a development of 100 properties this would result in 25 considering their quality of life to be significantly adversely affected by noise and / or adverse health effects and problems such as impact upon cognitive learning to arise. On this basis it would appear to be quite a substantial amount of homes affected and that the significance of impact should be set at 52 dB especially when CJ suggest a more relaxed criteria of 55 dB when combining the effects of general aviation and motor circuit activity by increasing the value to 55 dB.

**5.49** These criteria as adopted by CJ are placed in perspective by the evidence based emergent guidance from the WHO which identified Ischemic heart disease problems

[32] It is instructive to realise that the WHO criteria for steady continuous benign type road traffic noise which was set at 55dBA and now an Lden of 53dB is derived from a small percentage of the population being adversely affected and there is no basis for concluding the appropriate population percentage cut off point is higher for aviation type noise in any event.

at 52dB and high annoyance at 45dB. In turn these indicate the need to tighten the applicable criteria to protect against adverse health, learning and annoyance effects. In summary the criteria of acceptability should not be relaxed as indicated by CJ but tightened, as strongly indicated by the emerging evidence of the WHO.

**5.50** The modelling of general aviation by CJ also assumes the activity around GA follows the noise routings for arrivals and departures and circuit patterns generally defined in published patterns. It has been MAS's experience that the land south of Goodwood was regularly subject to over-flights by light aircraft. As these aircraft were not following any published circuit patterns additional and potentially significant events of aviation activity in the area argued suitable for development has been missed by the modelling study.

**5.51** **General Considerations of proposed criteria of developers with the Buffer Zone.** To account for cumulative impact CJ set a consolidated total noise level of $L_{Aeq,16h}$ 55 dB. This is clearly inappropriate even for noise that is wholly benign and anonymous but it does not reflect local activities arising from GMC or GA and the character and nature of their noise and is devoid of any merit.

**5.52** In addition for the majority of the year GMC cannot operate the motor circuit for more than 7 hours a day, and neither does GA operate over a 16 hour day. The criteria set by CJ has been derived based on inappropriate guidance but which is now superseded and indicated as excessive for the benign anonymous types of sources it relates to.

**5.53** Furthermore the application of a consolidated total noise level which is higher than the noise level for general aviation alone, as applicable at the time it was proposed is illogical and inappropriate however considered.

**5.54** Historically the criteria set by CJ for general aviation was $_{LAeq,16h}$ 52 dB, which had some argument or merit before the evidence based guidance of the WHO 2018, when combined with motor sport activity this was clearly unreasonable and inappropriate. The WHO have helped confirm such cumulative approaches to different sources of noise fails and thus not only is a level of $LAeq_{,16h}$ 55 dB wholly excessive, its derivation runs contrary to guidance and the science.

**5.55** Whilst the assessment period for GMC is set over 30 minutes, where 2 sources of noise of a similar level are combined this serves to increase the overall noise levels but they are assessed differently due tot heir character effects. In theory to avoid exposing residents to more noise when combining sources a lower level should have been set when considering that both sources of noise will be present at the same time.

**5.56** The disparity now arising with the recent WHO guidelines for aviation of a daytime level of 45dB LAeq(12 hour) and use of existing methods for motor sport indicating levels of the order of 40-45dBA as a short term LAeq and adjusting for the differences between short term and longer term averaging, indicates criteria typically 10-16dB stricter than applied by CJ is warranted.

**5.57** Finally the combined noise level for GMC and GA ignore other noise contributions in the environment which should be considered in any total noise dose criteria as well as reflected noise from dwelling facades as discussed above. This is now difficult to reconcile having regard to the advice of the WHO over difficulties looking at cumulative impact.

**5.58** Considering the internal noise levels recommended by CJ this is $L_{Aeq,16H}$ 35 dB during the day, this relates primarily to external criteria and again anonymous, continuous steady sources of noise based on guidance contained in WHO 1999 and BS8233: 2014. As above it does not relate to the character of noise that is associated with either GMC or GA activity and as such are equally inappropriate.

**5.59** The internal value of 35dB relates significantly to speech interference criteria during daytime periods where a signal to noise ratio of 15dBA is desired. This would require speech at levels of 50dBA. However, the GMC and GA noise is variable and thus peaks of noise could impact any continuum of communication such as listening to the radio, TV or general conversation. More importantly it will be audible and commonly dominant and therefore continue to grab attention. This internal level concept works reasonably for steady continuous anonymous benign noise but not that with attention grabbing character.

**5.60** In any event, with regard to the criteria suggested for the external environment by CJ, to meet and maintain the recommended internal limits, windows would need to remain closed (assuming a reduction 15 dB for a partially open window from a façade value). This would not be considered an acceptable expectation given the locality which is a semi-rural area on the outer fringes of Chichester rather than a busy urban centre as there is an increased desire for connection with the external sound environment, especially in the case of families and children playing in gardens. In any event even in an urban or industrial area, residents often desire open windows for ventilation and summertime cooling and loss of this would be an element of material interference with use and nuisance.

**5.61** It is also considered that gardens and outdoor spaces would be an intrinsic part of the development and future occupiers would expect to enjoy these spaces as such.

**5.62** In assessing the locality and apart from reliance on inappropriate guidelines, CJ have failed to consider factors such as the potential for nuisance and the risk of action being taken against a commercial operator that would arise from such a determination. Powers to serve a Community Protection Notice under the ABCP Act 2014 could extend the risk of curtailment of their business operations beyond those of nuisance controls.

**5.63** In any event the concept that future residents would be required to experience unreasonable and excessive noise is viewed a material noise consideration warranting refusal of any consent. Assessing noise in this case based on guidance related to anonymous noise sources has inappropriately considered the prevailing environment, the character contained within the noise and a raft of factors unrelated to the average decibel level. Furthermore those guidelines have now been updated indicating the need for more stringent control and not relaxation upon which they rely.

**5.64** Whilst it is ultimately for the courts to decide the potential for any nuisance action this can risk the viability of a business and potentially lead to its demise. A key requirement of the NPPF is that noise should not be considered in isolation and should also account for social and economic factors.

**5.65** In summary the criteria argued in support of development within 400m of Goodwood is flawed and does not require relaxation as suggested by CJ but significant tightening. This indicates the validity of the 400m buffer zone and the need to consider very carefully any noise sensitive development in a further area of the order of 800m from Goodwood. This is not indicating exclusion of development at these further distances but the need to appropriately balance need versus impact on a case by case basis, assurance that noise is fully assessed against appropriate criteria as identified in this report also careful consideration of noise mitigation and balancing factors, such as quieter areas.

## 6.0 Methodology used in this noise study

**6.1** Referring back to the objectives of this study the role of MAS has been to independently advise and report on the following :

- To evaluate and determine the appropriateness of the 400m buffer zone currently adopted around Goodwood.
- To review any additional decibel criteria potentially applicable where evidence indicates land use conflicts.
- To critique existing arguments being promoted by developers (which argue for acceptability based on comparing site noise levels with guidance linked to inappropriate types of noise) for residential development within a 400m buffer zone;
- Where supporting the 400m buffer zone to provide robust arguments (and justification for reasons to refuse development within the buffer zone, where justified) that support maintaining a 400 metre buffer within which residential development is prohibited due noise concerns arising from the Goodwood motor circuit (GMC) and Goodwood airfield (GA), provided the analysis of evidence supports this and;

**6.2** The inappropriate criteria for environmental acceptability recommended by Cole Jarman (CJ) have been discussed in the previous section and dismissed on a wide range of grounds but primarily relating to the incorrect application of guidance outside its context and contrary to the science. It is demonstrated that their recommendations based on guidance contained in WHO / BS8233 / PPG24 (revoked) are not appropriate for residential development and contradict the guidance itself as well as the findings in a number of cases where examination of the criteria has led to its rejection when forensically considered.

**6.3** This case relates to both an environmental source of noise in the form of the general aviation but which might also be considered a neighbourhood source and also what is clearly a neighbourhood source of noise in the form of the motor sport which is

considered vastly different in character to those where guidance for benign anonymous sources might be applicable. Furthermore such guidance was revised as recently as October 2018 clarifying the inappropriateness of using it for commercial sources and lowering levels necessary to protect communities from aviation noise.

**6.4** In terms of the gathering of evidence to address the arguments and criteria for or against maintaining the 400m buffer, MAS proposed objective and subjective listening exercises supported by environmental measurement to correlate the environmental noise conditions encountered with impact upon the community and its correlation with commonly adopted guideline values in such circumstances as arising elsewhere.

**6.5** Originally this was to be addressed by monitoring across one day of each of the main categories of motor circuit activity, i.e. Category 1, 2 and 3, as well as a day to observe and monitor general aviation. Monitoring data would be used to develop noise modelling to predict off-site noise levels from GMC to account for a wider geographical area.

**6.6** Actual monitoring covered 5 days which included one Category 1 day, 3 Category 2 days, and 1 Category 3 day. A critical element of this is was to ensure significant attended monitoring in order to relate sound level measurements with observations on noise character. A further day was set aside to monitor general aviation noise but due to inclement weather conditions this was encompassed within the 5 days of motor circuit activity observations. A summary of these monitoring activities is discussed in further detail below.

**6.7** The critical element is whether there is a progressive change in terms of likely noise acceptability as you move outside the 400m buffer zone or alternatively are levels acceptable within this distance. Simple analysis ignoring factors such as atmospheric absorption and near ground screening features indicated at 400 metres levels are expected to be of the order 44dB LAeq as a short term average value (5-15 minutes) and this is close to the limits set at numerous other sites for this type and level of activity. However, some measurements indicate higher levels and potentially the need for close analysis of development over a wider area. At 515 metres levels of about 48dBA were recorded as short term averages indicating in very basis terms this

would reduce to 44dBA at 800m. In effect, subject to wind direction, short term average decibel levels (5-15 minutes) due to GMC noise and within 400m of Goodwood are expected to exceed 40-45dBA on a regular basis indicating clear unacceptability in planning terms and significant adverse impact upon quality of life for this source in isolation.

**6.8** Goodwood Motor Circuit (GMC)

**6.9** Monitoring of motor circuit activity combined attended and unattended measurement which covered a number of trackside locations around GMC and on land that encompassed the motor circuit sweeping along its southern and western boundary. The area of study is described in further detail at Figure 4, below. Monitoring incorporated continuous audio recordings with measurement intervals set as continuous 100m/s periods and data sorted in 15 minutes periods of activity.

**6.10** Most commonly there is a westerly or southerly wind component but for significant periods it can be northerly and easterly. Furthermore when easterly winds occur they can persist for a period of weeks. This would lead to sustained adverse impact when downwind. The effect though is that to the south and west adverse impact will more commonly be reduced by upwind conditions, effects which increase with increasing distance. This distance effect indicates at about 400m away, levels are excessive when in neutral or downwind conditions and marginally acceptable when upwind for the 110 Category 2 event days. At greater distance, wind direction, noise source direction and other meteorological effects have a greater impact on noise levels leading to diversity in the extent of impact.

**6.11** Upward refraction and sound shadow near the ground will also occur to some degree on hot and blustery days such that again at increasing distances beyond 400m the predictability of impact occurrence is unclear but will be reduced. This all supports exclusion with 400m and careful and detailed consideration of short time noise levels and their frequency and duration of occurrence beyond that, especially in terms of the short duration LAeq and LAmax(f) levels.

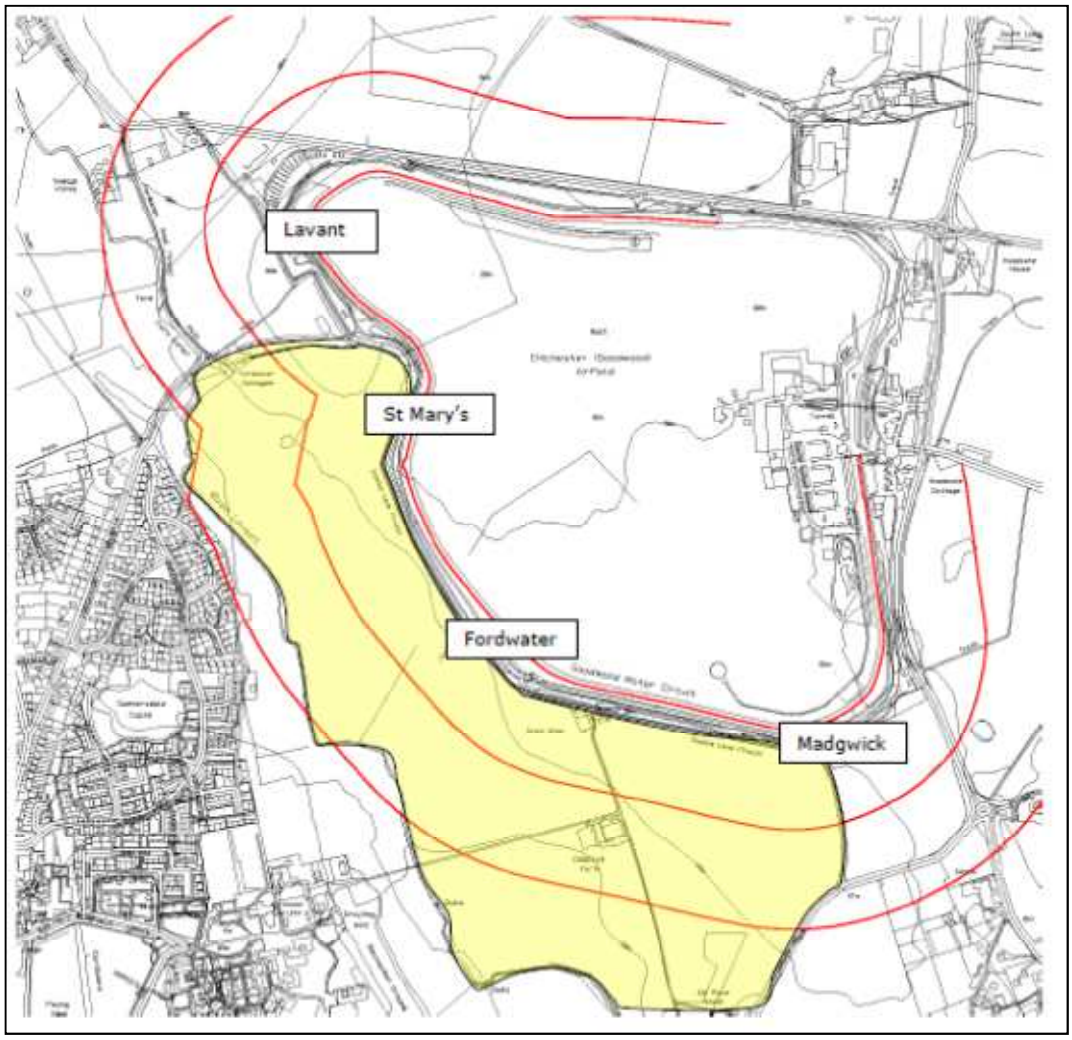



**Figure 4 - Area of study (shaded yellow) adjacent to Goodwood motor circuit**

**6.12** Trackside monitoring was conducted close to the circuit from the grass embankments that surround it. Typical separation distances were between 10 – 15m, although this could extend up to 30m around the turns. The purpose of trackside monitoring was to obtain measurements of circuit activity close up for modelling impacts off-site. This helped increase understanding of motor circuit activity and factors that would affect off-site noise levels such as the variety of cars on the circuit, how they sounded in terms of character, the number of cars which may be allowed onto a circuit during a session and the number of laps that could be completed within a session or certain time period.

**6.13** It was also identified that motor circuit activity across a day would be sub-divided into more discrete periods of high speed driving of 15 minute sessions. Between these sessions, periods of respite could occur and were dependant upon how active the circuit was on a specific day. This was influenced by numbers of cars and drivers using the circuit.

**6.14** For example, on a Category 2 private hire day there were 7 cars and 9 drivers in attendance. Periods of respite between sessions were noted to be longer due to factors such as changing over of cars / drivers or the issuing of warnings for driving style or too much noise. In contrast the following Category 2 day had shorter respite periods as there were 39 cars and 64 drivers in attendance. As one session exited the track the next session would be lined up and ready to go. Based on the observations made it was considered that assessment over a 15 minute period would more likely reflect how the circuit operated and the relationship between impact upon the community and any noise measurements. Short time periods typically of about 15 minutes are commonly used as an averaging period for any derived decibel controls at many motor sport venues and is considered the best applicable for this site.

**6.15** The main thrust of the assessment covered the area of land that was presented at Figure 1 (shaded blue) but can be applied more widely around the site. Monitoring in this location utilised fixed unattended measurement and snapshot measurement from a number of points around the site. A more detailed description of the 5 days of monitoring are summarised below.

**6.16** **9th September 2017.** Goodwood Revival (Category 1) – A three day major annual event involving cars primarily from 1948 – 1956, where there are no noise restrictions and racing and high speed driving is permitted. Fixed unattended monitoring (F1) was set up adjacent to the permanent monitoring station operated by GMC that is in compliance with their noise management plan. Portable spot measurements were undertaken north-east (downwind) near Westerton (P1) and a location south of Madgwick and Fordwater (P2) at respective distances of 480 and 260m from the nearest part of the circuit. These monitoring locations are detailed in Figure 5, below.

In turn this would enable comparison with GMC trackside measurements as well as predicted levels in the community.

**6.17** Weather conditions on the day were generally dry until 15:30 due to the onset of heavy rain which had been forecast as thunderstorms. Monitoring was concluded at this point due to the continuing forecast which predicted further rain. Rain had also occurred the previous day which left grassed areas damp underfoot. Wind conditions were checked using the BBC website and compared with information provided by GA. Both identified prevailing Westerly winds and during the morning this was measured by GA at a speed of 7 mph and 17 mph during the afternoon.

**6.18** Attended measurements were made downwind (P1) and crosswind (P2). During measurement wind was noted as gusting whereas during the afternoon this became a more sustained and a noticeable feature during measurement. It is important to recognise that where continuous high quality audio is used and moment by moment measurements the actual effect of wind noise over the microphone assembly can be determined as it shows up in the traces and can be checked via the audio.


**Figure 5 – Goodwood Revival monitoring locations (Cat 1) 9th September 2017**

**6.19** **28th September 2017.** Private track day (Category 3). A private hire day where high speed driving is permitted and noise restrictions are in place and limited to $L_{Aeq,30min}$ 78dB and a drive by limit of $L_{Amax(f)}$ of 96dB. Cars in operation on the circuit were a fleet of BMWs owned and operated by GMC. Fixed unattended monitoring (F1) was located south of GMC at a distance of approximately 220m. Snapshot attended measurements were conducted from multiple locations which included trackside (P1) and tracing the southern edge of GMC from the Madgwick to Lavant turn (P2 – P7). These monitoring locations are detailed in Figure 6 below.

**6.20** Weather conditions on the day were noted to be dry. Whilst there had been rainfall the previous day / night the motor circuit was drying out such that this did not generate any moisture, spray or increased tyre noise. Wind conditions recorded by GA were West North Westerly during the morning changing to a South Westerly in the

afternoon with wind speeds measured at 10 mph. All measurements were made at cross wind locations. Subjectively wind influence was not regarded as significant during the morning's monitoring activities but was considered a noticeable influence during spot measurements made closer to GMC due to the rustling of leaves on trees that surrounded the circuit.

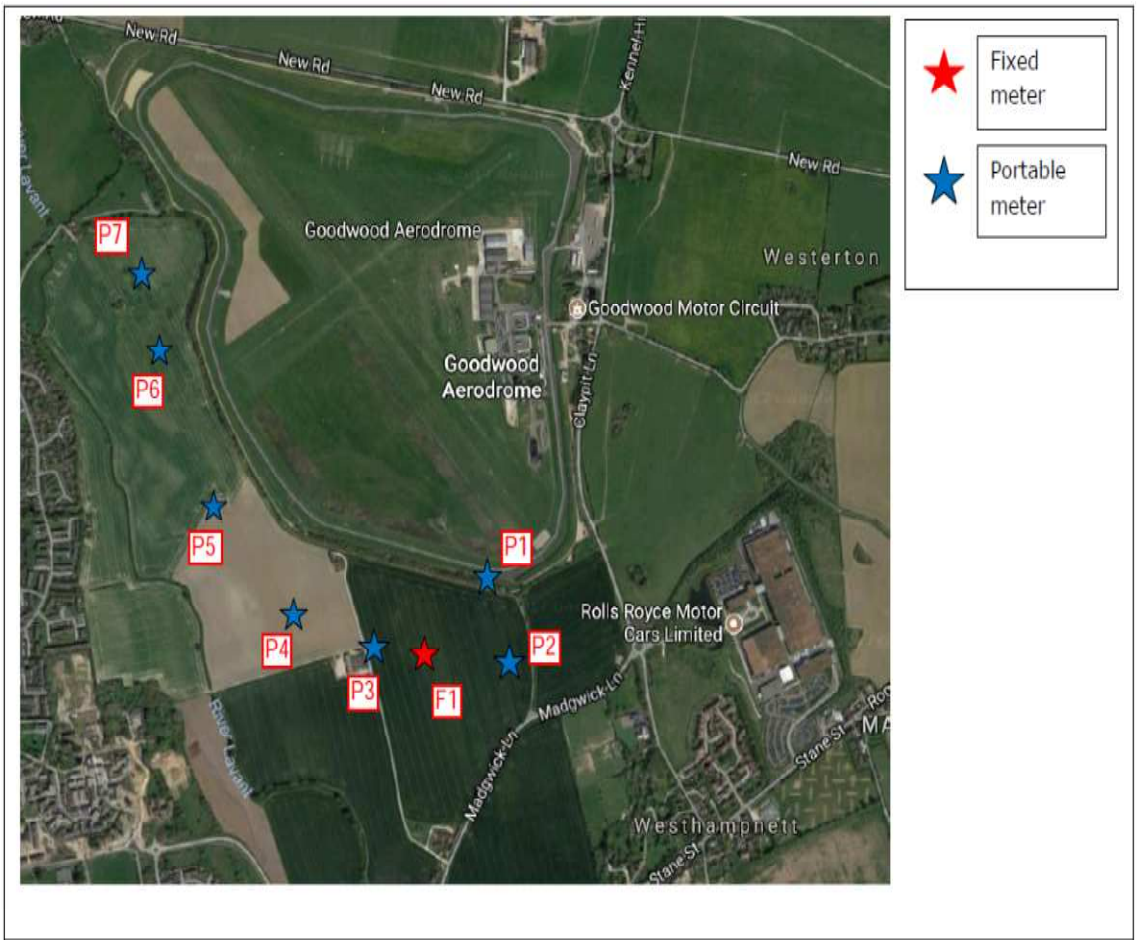



**Figure 6 – Private hire day monitoring locations (Cat 3) 28th September 2017**

6.21 **29th September 2017.** Private track day (Category 2). A private hire day where high speed driving is permitted with noise restrictions in place limited to $L_{Aeq,30min}$ 82dB and a drive by limit of $L_{Amax(f)}$ 101dB. Cars on the circuit were privately owned which included a mix of Porsche, Mercedes, BMW M3 and a Ford GT40. Portable attended measurements were undertaken at trackside locations around GMC. These monitoring locations are summarised in Figure 7 below.

**6.22** Weather conditions on the day were generally noted as dry with one or two short periods of light drizzle. Despite some rainfall overnight the motor circuit was in use under drying conditions and a process which was being accelerated by circuit activity. Wind activity data obtained from GA noted wind direction as Westerly in the morning and West South Westerly in the afternoon. Wind speeds were recorded as 12 mph in the morning and 8 mph in the afternoon and were noted as quite windy due to the amount of rustling of leaves on the trees that surrounded the motor circuit. However as monitoring took place close to the circuit edge this was not considered of such volume as to mask or influence measurement of circuit activity.

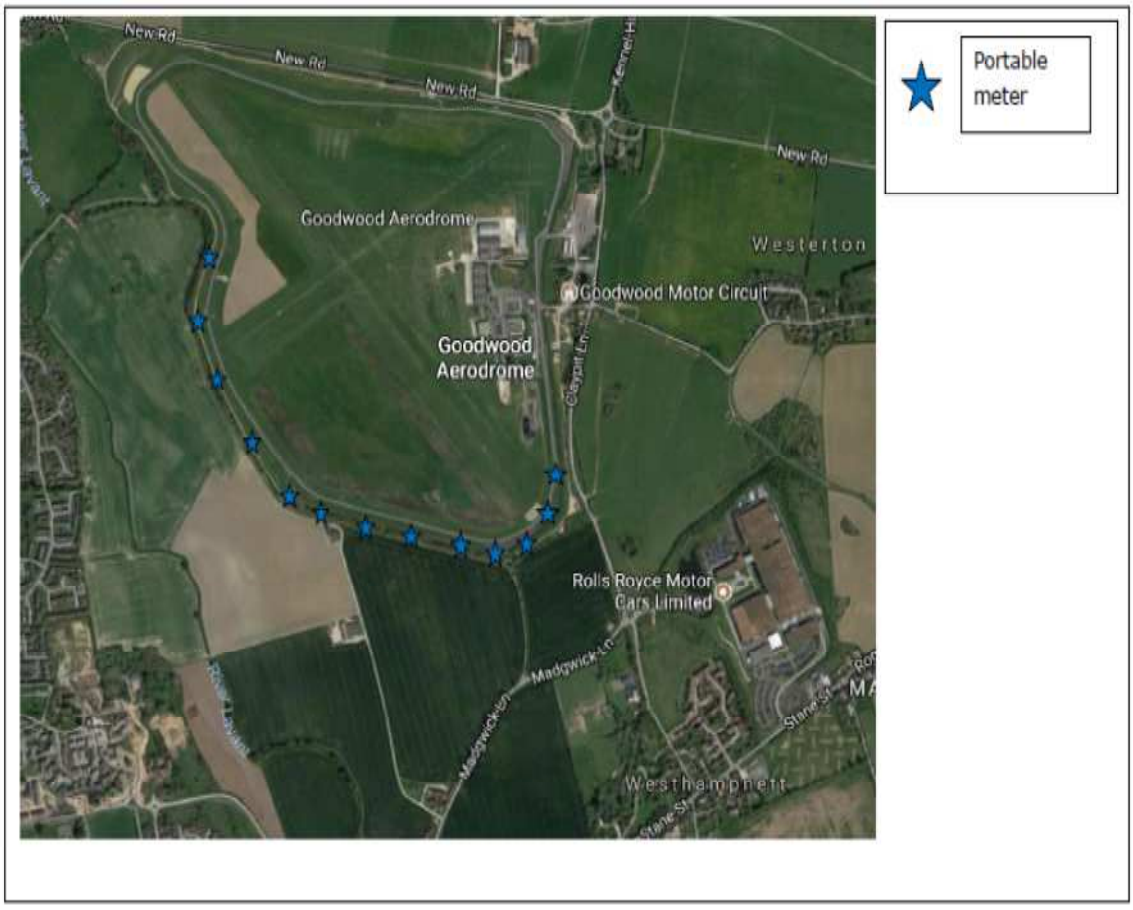



**Figure 7 – Private hire day monitoring locations (Cat 2) 29th September 2017**

**6.23** **30th September 2017.** Harwoods track day (Category 2 day) – A track day with a mix of cars privately owned and supplied by a local retailer of prestige cars, Harwoods. High speed driving is permitted and noise restrictions are in place, limited to $L_{Aeq,30min}$ 82dB

and a drive by limit of $L_{Amax(f)}$ 101dB. Cars on the circuit were noted to include Aston Martin, Ferrari, Porsche and Audi. Fixed unattended monitoring was located along the Madgwick straight (F1) during the morning session and on the inside of the Madgwick bend (F2) during the afternoon session. Portable attended monitoring was undertaken south (P1 – P4) and east (P5 and downwind) of GMC at respective distances of 220m and 160m. These monitoring locations are summarised in Figure 8, below.

**6.24** Weather conditions during the morning were noted to be under drying conditions following rainfall which had occurred overnight. Measurements made at snapshot locations noted the ground to be damp underfoot but not saturated as needed to generate increased tyre noise. Further rainfall was recorded in the afternoon and measurements were paused due to some short periods of moderate / heavy rainfall. Wind direction recorded by GA was Westerly during the morning and South Westerly during the afternoon. Measurements made at P1 – P4 were under crosswind conditions and downwind at P5. At P5 the pick in local road traffic noise (Chichester by-pass) was considered to be a noticeable contributor when making measurements at this location. Wind speed recorded by GA for the day was 6 mph, but notes made of wind conditions perceived this as being stronger and at times affecting measurement due to wind across the microphone. Tyre noise was not a significant factor with exhaust / engine noise being the primary factors.

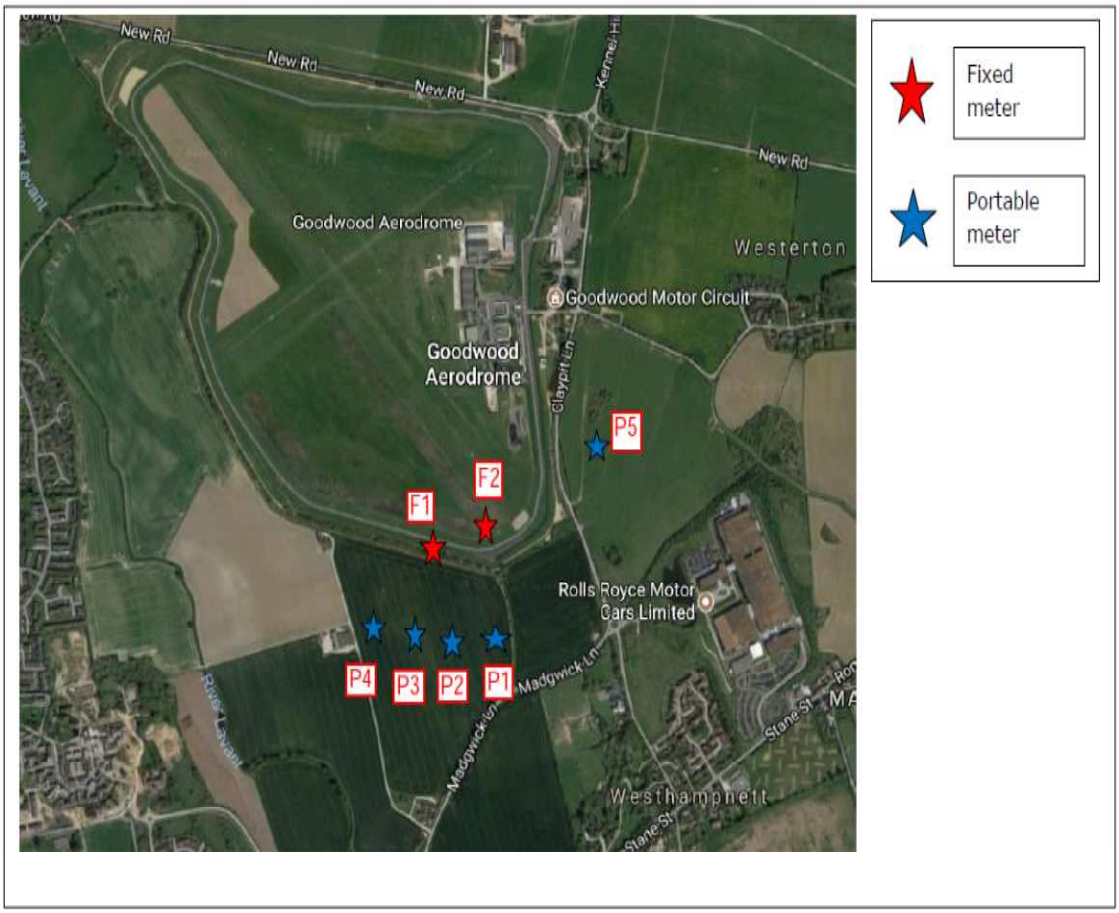



**Figure 8 – Harwoods track day monitoring locations (Cat 2) 30th September 2017**

**6.25** **6th October 2017.** Porsche Club (Category 2 day) – A track day of high speed driving for Porsche owners. As with monitoring of other Category 2 day's, noise restrictions applied, limited to $L_{Aeq,30min}$ 82dB and a drive by limit of $L_{Amax(f)}$ 101dB. Fixed unattended monitoring (F1) was located south (downwind) of GMC approximately 260m from the circuit during the morning session. This was repositioned during the afternoon session approximately 230m from the circuit and near to a bridleway (F2) which runs north to south and is accessed from Madgwick Lane. Portable attended monitoring included trackside measurements at the Fordwater turn (P1) and between the St Marys and Lavant turns (unlabelled) during the morning session. During the afternoon session portable monitoring covered a number of locations south of GMC (P2 – P8). These monitoring locations are summarised in Figure 9 below.

**6.26** Weather conditions during the day were noted as dry. Conditions noted on the BBC website recorded a north-north-westerly wind direction with wind speeds of 9 – 10

mph, whereas GA had recorded wind speeds of 6 mph (also in a NNW direction). Subjectively this was reported as a noticeable and steady breeze in the morning but as the day progressed wind speeds dropped as conditions became warm and sunny. Due to prevailing wind directions measurements made at F1, F2, P2 – P4 were regarded as being downwind GMC with other monitoring locations at crosswind positions.

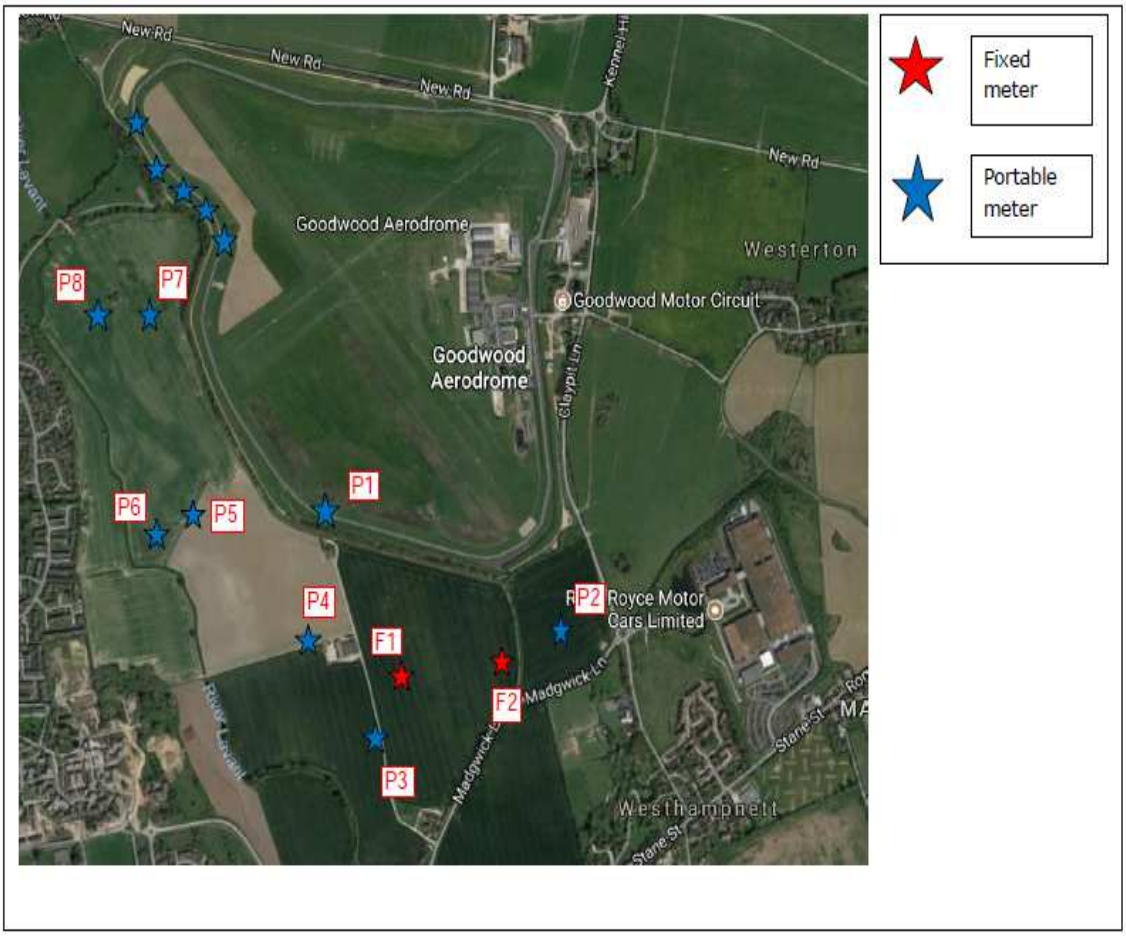



**Figure 9 – Porsche club monitoring locations (Cat 2) 6th October 2017**

**6.27** Goodwood Airfield (GA)

**6.28** Assessment of general aviation activities had the potential to be affected by a wide number of variables. This included the level of activity, weather conditions and mode of operation. As GA operate with 3 runways, each with 2 modes of operation (06/24, 10/28 and 14/32) there was the potential for no aerodrome activity near the study area. It was understood that take-off and landing would be into the direction of the prevailing wind and that whilst runway operation mode could be predicted by the

local weather forecast, control tower advice on such methods was precautionary as local topography could also be a factor affecting wind direction.

**6.29** Monitoring of GA was combined with measurements of motor circuit activity and limited to considering impact at the location where the meter was positioned. Therefore to widen the impact assessment this also considered activity data provided by GA to analyse the hours of operation, numbers of flights and periods of respite between events. Due to runway 14/32 having been out of commission for drainage works this year, analysis was based on GA data for July 2016 and covering a summer month when activity would be at its peak.

**6.30** Activities from helicopters at GA were most apparent when monitoring on the motor circuit from trackside locations. South of GMC / GA helicopter events were quite sporadic. Whilst an active part of the aerodrome the heliport was located toward the north end of the site and further away from potential residential development. As only runway 14/32 operated during site visits, aircraft circuit patterns had to follow the northern circuit and therefore flying away from the assessment areas. In turn this indicates impact would increase under other circumstances.

## 7.0 Findings in relation to monitoring and observations

**7.1** Goodwood motor circuit (GMC)

**7.2** This section sets out the key findings from the detailed analysis of the data and observations and in particular their relevance and consequences in relation to development proposals within the buffer zone. There is of necessity detailed analysis of data and its correlation with human response mechanisms and the observed outcomes.

**7.3** **9th September 2017 (Category 1).** When monitoring from location P1 and P2 (as described in Figure 5) motor racing from the Goodwood Revival was very apparent and dominant in the environment due to clear attention grabbing characteristics from acceleration and exhaust noise.

**7.4** Although not forming part of the study area, monitoring from location P1 was intended to account for prevailing wind direction on the day for the purpose of calibrating and validating noise prediction modelling. By monitoring downwind this also took account of the relevant clauses contained in BS7445-1:2003 and BS4142:2014 which detail that measurement should be undertaken in conditions which represent the most stable sound propagation conditions (a positive wind component from source to measurement position) and that most calculation models refer to neutral or favourable sound propagation conditions as other propagation conditions are more difficult to predict. Although BS7445-1:2003 details that it may be possible for measurement made over a range of meteorological conditions to determine a sound pressure level equivalent to that obtained under specific conditions it does not detail how. Of the limited guidance available BS 8233:2014 suggests for distances of 500m to 1000m this ranges from increasing the level by typically 2 dB downwind to reducing it by typically 10 dB upwind.

**7.5** Figure 10, below describes the environment which captured the final 5 minutes of the Barry Sheene memorial trophy. This was taken from location P2 and demonstrates how dominant in the environment motor circuit activity was by noting the transition in site levels from race activity to ambient. Despite some windy conditions during

measurement of racing activities the difference between source and background sound energy for the period are regarded as significant (20 dB(A)) and therefore insignificantly affected. The wind direction meant that at location P2 this was not representative of a measurement made downwind, but crosswind from the motor circuit.

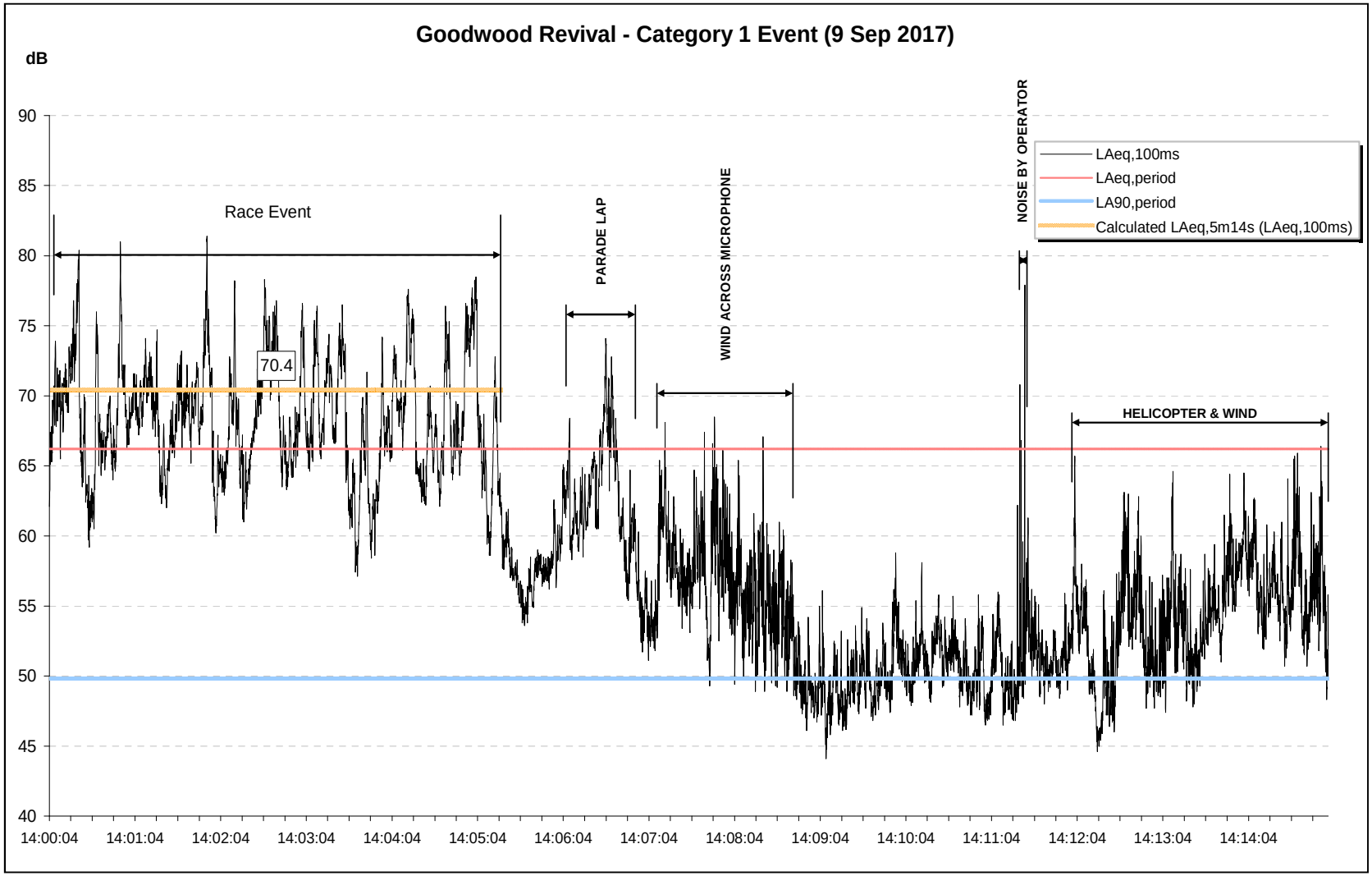



**Figure 10** – Time history of Goodwood Revival at monitoring location P2 – Barry Sheene memorial trophy.

**7.6** To further describe how prominent in the environment motor racing was Figure 11 below compares simultaneous measurements made by the trackside and P2 meters during the St Mary's trophy. Activity levels on the time history describes regular events that measured well in excess of 100dB(A) during pass-by events. Off site this translated to a source of noise that was clearly audible and dominant in the environment due to attention grabbing events of motor racing (exhaust and acceleration). The average for the period was measured as an $L_{Aeq,15m}$ 65dB with many discrete events in the potential community locations that peaked above 70dB(A).

**7.7** Average levels during racing were clearly of the order of 20dBA above background sound levels on this windy day indicating typically a fourfold increase in loudness with variations during racing from below 60dBA to more than 80dBA. Thus the sound energy level was varying substantially, it was much louder than the background sound environment and included significant features which also grab attention. Absent circuit noise, levels dropped substantially revealing a different sound environment.

**7.8** Variations from near trackside to potential community locations were of the order of 30dBA on this occasion as an average but this differential varies from location to location and is not fixed. It also varied moment to moment. Whilst some peaks off site corresponded with peaks trackside this was not always the case indicating multiple points along the circuit affect the level of sound emission experience off the circuit with no clear pattern due to so many variables.

**7.9** Independent observations confirmed whilst the loudness of the intruding noise was a significant factor so too was the particular characteristics exhibited along with their continuum, frequency and duration.

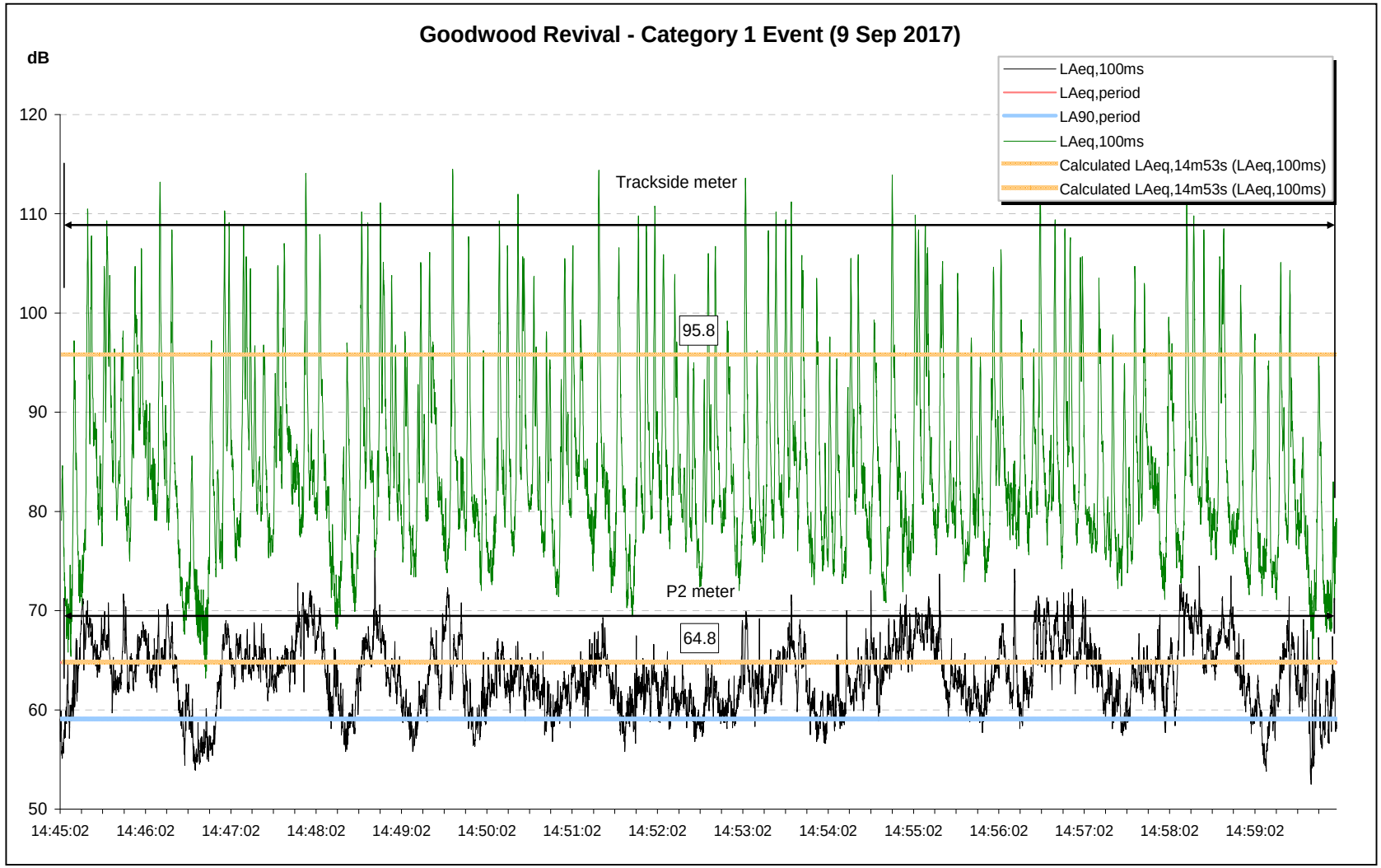



Figure 11 – Time history of simultaneous measurement comparing fixed meter (F1) and portable meter (P2) – St Mary's cup

**7.10** **28th September 2017 (Category 3).** Monitoring of motor circuit activity focused on measurement around the south of Goodwood (as described in Figure 6). This included a fixed monitoring position 220m from the edge of the circuit near the Madgwick straight and a number of snapshot measurements which covered a wider area between the Madgwick and St Mary's turns.

**7.11** Observations made from measurement positions during the morning's activities identified that motor circuit activity could be clearly distinguished in the local environment because it contained some notes of character due to exhaust / acceleration. Not all of the 11 cars available for use on the circuit that day produced such notes and earlier trackside observations had identified some cars as producing relatively nondescript notes of exhaust / acceleration. Despite being audible the subjective opinion of motor circuit activity in the local environment was one that was not too objectionable when considered as an event in isolation rather than cumulatively contributing to a wider range of periods of impact.

**7.12** During the afternoon and around measurement positions P4 – P7 motor circuit activities were felt to have been subdued by other factors present in the local environment. This was associated with changing weather which had led to increasingly windy conditions (because of leaf rustle on trees that surrounded Goodwood) and also nearby construction activity which drew the attention away from motor circuit activity.

**7.13** A sample of measurement data from the fixed meter location (F1) is presented at Figure 12 below. A period of activity has been isolated on the time history which represents motor circuit activity. Calculating average levels for this period motor circuit activity was measured as $L_{Aeq,8min}$ 44 dB. A simple comparison based on an emergence above background sound levels for the period equated to a level of difference of just 4 dB(A), e.g. 44 – 40 = 4. If one were to rate impact in this way with an adjustment for noise character, this would be considered to fall somewhere between an adverse impact and significant adverse impact unless sufficiently infrequent. Observationally the frequency, duration and level of the noise was considered low in impact terms when considered as an event in isolation.

**7.14** However, as can be noted in the time history, motor circuit activity arose as more discrete irregular events that peaked noticeably above background sound levels across the period. Averaging levels is considered to under-represent the noise potential since it includes periods between peaks where no circuit activity is present. An average does not describe how noise changes moment by moment and why it has the potential to be considered intrusive because of the events that peak above the background by significantly greater margins and which have periods of dominance and periods when they draw attention. The intermittency of attention drawing periods and unpredictable absence adds to intrusiveness.

**7.15** Analysis also identifies an element of tonality within the sound environment due to motor circuit activity. This adds to attention grabbing features. Reporting activity based on a simple $LAeq_{,T}$ does not take account of attention grabbing features such as tonality, variations or intermittency as well as non-acoustic descriptors.

**7.16** In many cases penalties can be used to help explain the annoyance potential of a noise by applying a penalty rating (as of the same type adopted and described in BS4142:2014). Rating noise and applying contextual elements is a common adjustment to address attention grabbing character and BS4142: 2014 provides an example where this is done but would not be applied direct to motor sport noise. To help with describing the tonal nature of motor circuit activity the time history presented at Figure 12 is reproduced in Figure 13 which is superimposed with an additional time history covering the 160 Hz 1/3 octave band (low frequency noise).

**7.17** This also emphasises why average levels likely or commonly under represent how annoying or intrusive motor circuit activity can be. At similar decibel levels different sounds can have a very different impact which is related to its character. It is the presence of features which can cause one sound to stand out more than the other which demonstrates the inability of the sound energy level to depict impact, a factor long recognised, for example by the WHO and the courts and as discussed in the appendix. At 160 Hz, a low frequency contribution the peaks in circuit activity are significantly more pronounced than if viewed on a simple A weighted scale.

**7.18** At 400m this would equate to borderline acceptable noise for this Category 3 event.

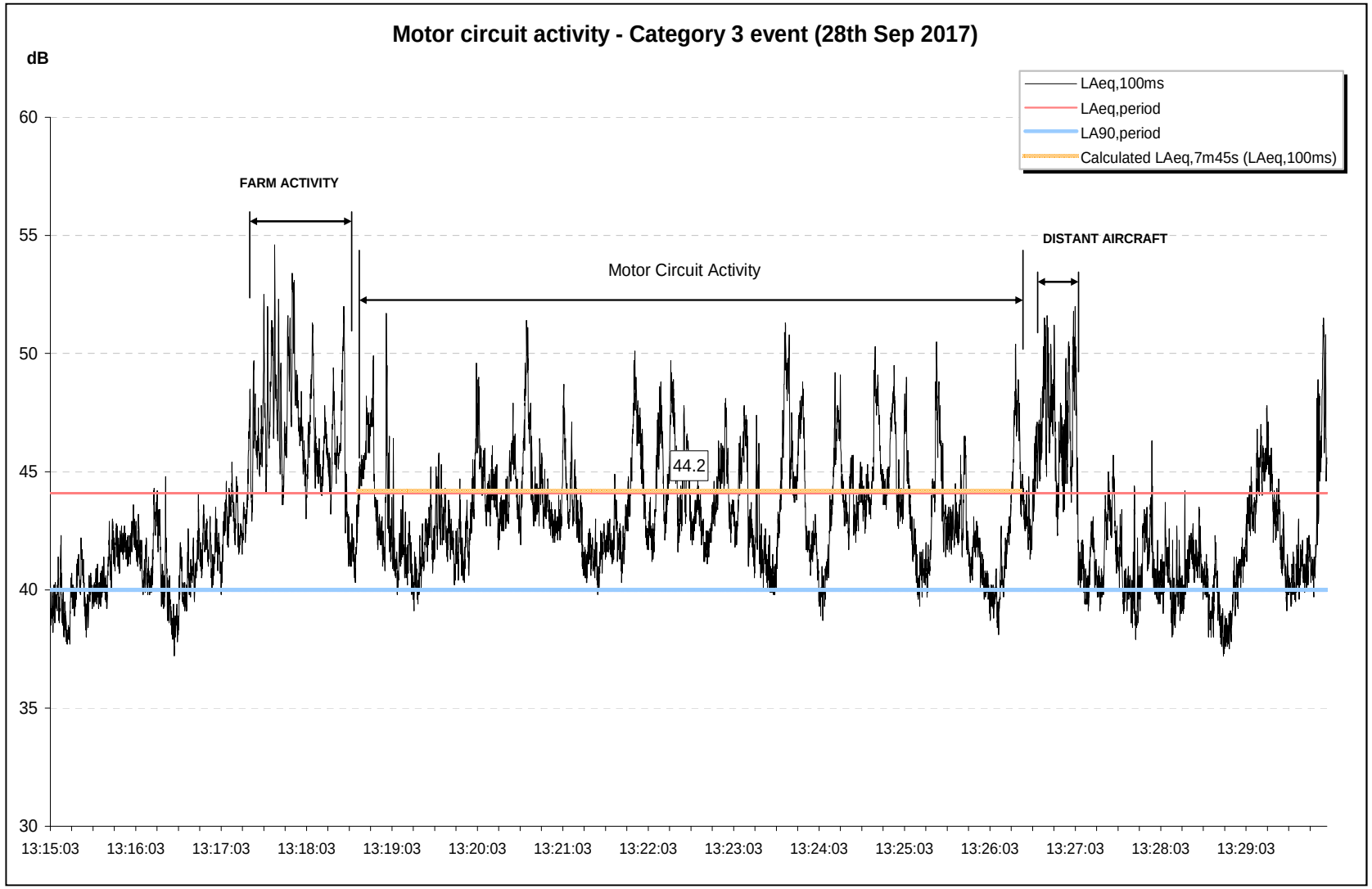



**Figure 12 – Time history of motor circuit activity at meter location F1**

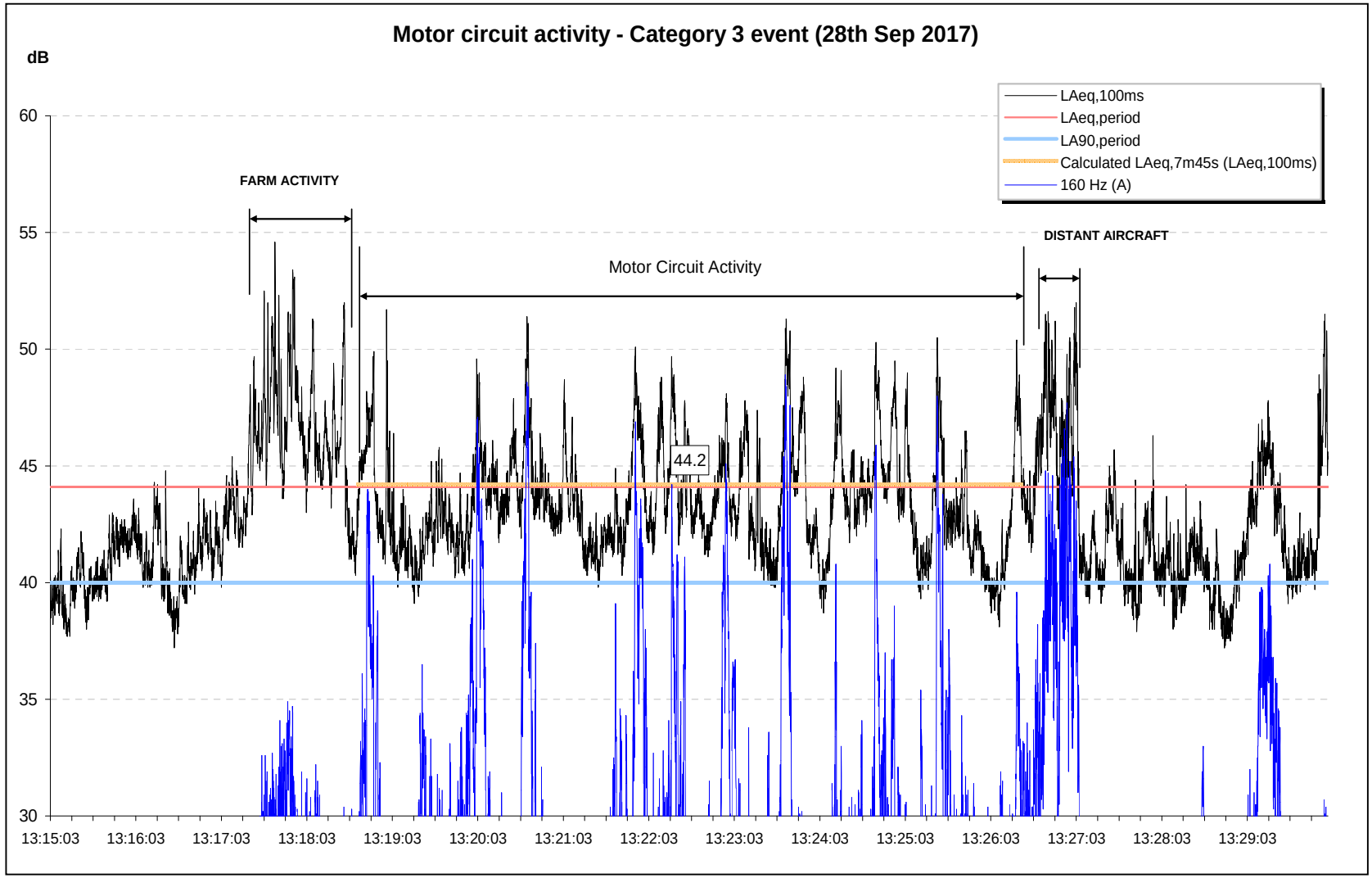



**Figure 13 – Time history of motor circuit activity at meter location F1 with superimposed 160 Hz time history**

**7.19** **29th September 2017 (Category 2).** Measurement of motor circuit activity on this occasion focused on trackside locations to compile data that could be considered for modelling the off-site impacts by accounting for the fact that at different points on the circuit a car would produce variable levels of sound.

**7.20** Compared with trackside observations made the previous day, all cars on the circuit produced their own distinctive and noticeable exhaust / acceleration note. Whilst the day's activities did not include off-site observations the step-up in sound levels was apparent and the change in character equally apparent.

**7.21** A particular observation point that arose during trackside measurements was that it was also not the loudest car (highest decibel level) on the circuit that produced some of the most distinctive sounds of character and thus were less intrusive than those with more distinct character and lower sound energy, as a result.

**7.22** Environmental scrutineering forms showing static or drive-by noise levels of individual vehicles, maintained by GMC as part of their noise management plan, recorded a Ford GT40 as the 5th loudest vehicle when based on the $LA_{max}$ drive-by measurements. However on circuit this car produced a very distinctive exhaust note that was apparent when stood some 300m away from the measurement position, rendering it more intrusive that other louder vehicles. This exhaust note occurred as the car turned into a corner so that the exhaust faced towards the measurement point. This also demonstrates the importance of directionality effects.

**7.23** What this is intended to highlight is, given the above separation distance, events such as these would likely be clearly audible off-site because cars turn into Fordwater so their exhaust would be facing south towards a proposed development and which is proposed for development within the 400m buffer at the point where there is a significant rise in sound emissions and increased attention grabbing character. An example of this sound is to be provided on a web link. Thus elements of the sound environment were depicted by short highly noticeable burst of noise which drew attention disproportionate to the average decibel level.

**7.24 30th September 2017 (Category 2).**

**7.25** Monitoring of motor circuit activity on this occasion combined fixed unattended measurements at the trackside and simultaneous attended snapshot measurements made off-site (as detailed in Figure 8).

**7.26** Despite at times there being variable windy conditions observed, motor circuit activity was regarded as a dominant and an objectionable source of noise in the environment which was characterised by intermittent and irregular events of acceleration and exhaust related noise emissions. Measurements made at locations P1 – P4 covered a period of approximately 45 minutes during which motor circuit activity was present throughout. The area was also noted to be impacted by general aviation activity arising from take-off from GA runaway 06 and light aircraft generally over-flying the area.

**7.27** Motor circuit activity measured at location P1 is summarised by way of this example graph in the time history at Figure 14 below. This has been labelled to note events of motor circuit activity (MCA) and light aircraft (LA). A period of respite has also been included on the graph which is assumed to be a period of transition between one session ending at approximately 11:05 and the next starting at approximately 11:13. This is identifiable because of the events that peak on the time history that are due to motor circuit activity.

A period of motor circuit activity from location P1 is also presented at Figure 15 to describe in greater detail how levels were continuously changing with time and that events that led to significant peaks above the prevailing background conditions were associated with events of pass-by and acceleration into the distance by vehicles using GMC. It is clear how the motor sport and aircraft activity stand out as distinct events that regularly punctuate the sound environment with much increased levels of sound energy rising typically 15-17dBA above the prevailing ambient levels. This cannot even remotely be described as similar to road traffic noise as proposed by some. They are clearly intrusive and dominant periods of activity, regardless of the attention grabbing features that cannot be seen in the graphs. Pass-by labels on the graph refer to vehicles using GMC.

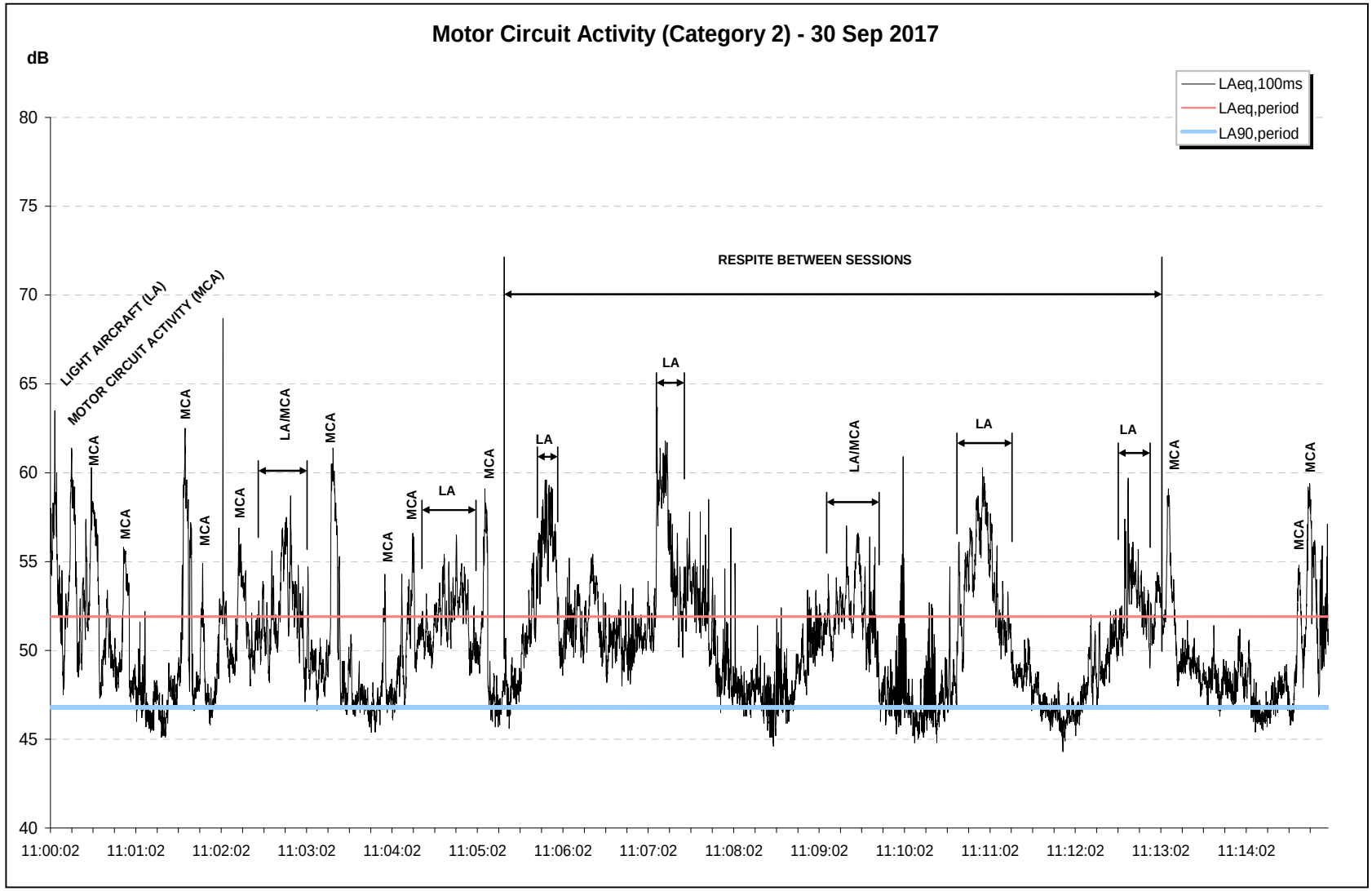



**Figure 14 - Time history of motor circuit activity at meter location P1**

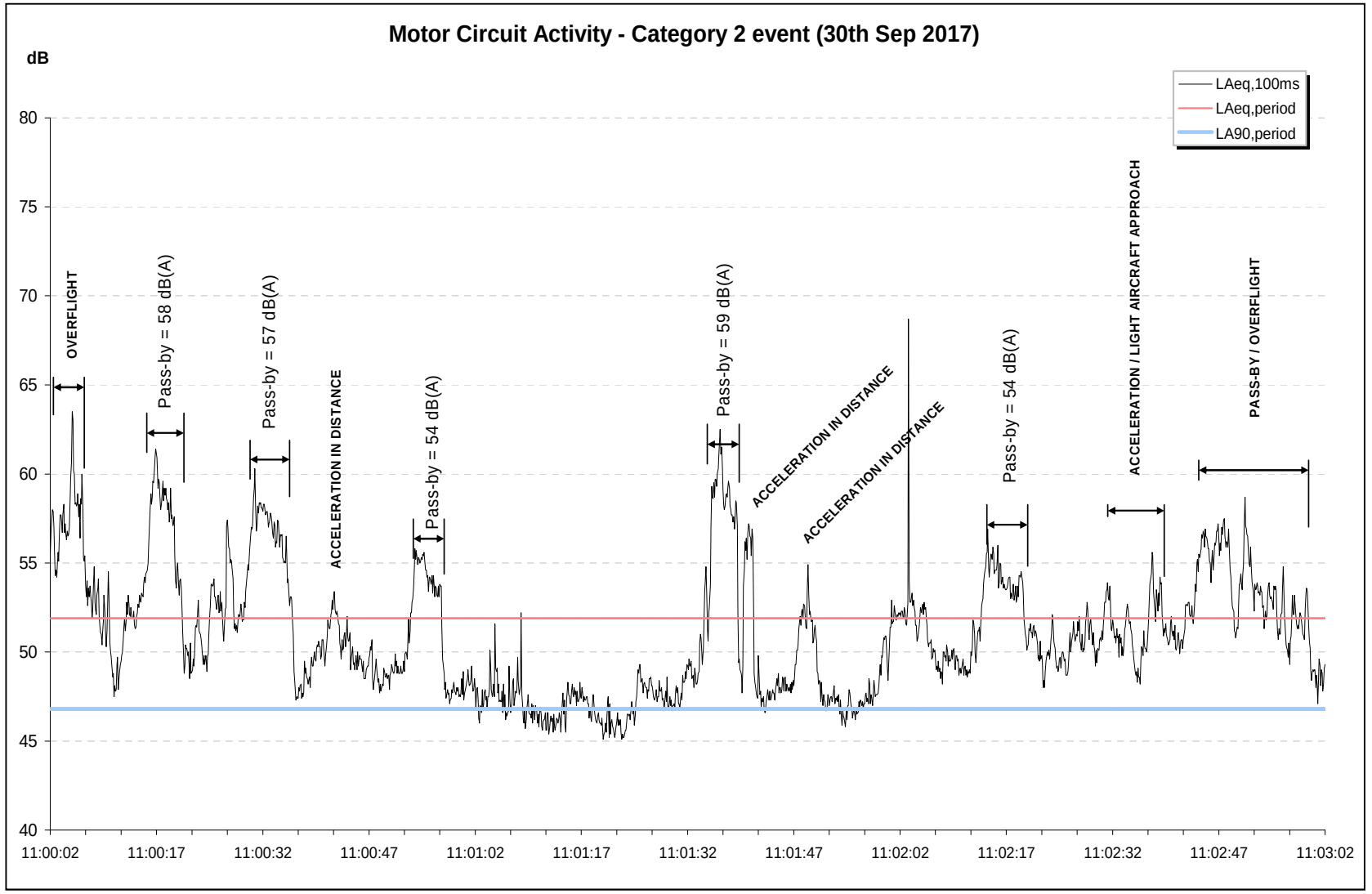



**Figure 15 – Time history of motor circuit activity at meter location P1 which specifies average pass-by values for specific events**

**7.28** The events shown in Figures 14-15 translate to levels of the order of 45-46dBA as short term averages at the boundary of the 400m buffer zone and up to 10dB higher for some peaks and most peaks about 4-8dB higher.

**7.29** Presented at Figure 16 is a time history for measurements made of motor circuit activity at meter location P3. As with measurements at location P1, motor circuit activity is characterised by events of pass-by (and one of distant exhaust noise) that rise sharply and significantly above the background.

**7.30** Comparing Figures 14, 15 and 16 it can be seen all locations are impacted by dominant GA and GMC noise but to varying sound energy levels and the impact is highly variable. Whilst a different impact at each location arises the noise is dominant for periods at all three and its attention grabbing features stand out in stark contrast at all the locations. It is these repetitive event noise occurrences that require limiting to ensure levels are not unacceptable.

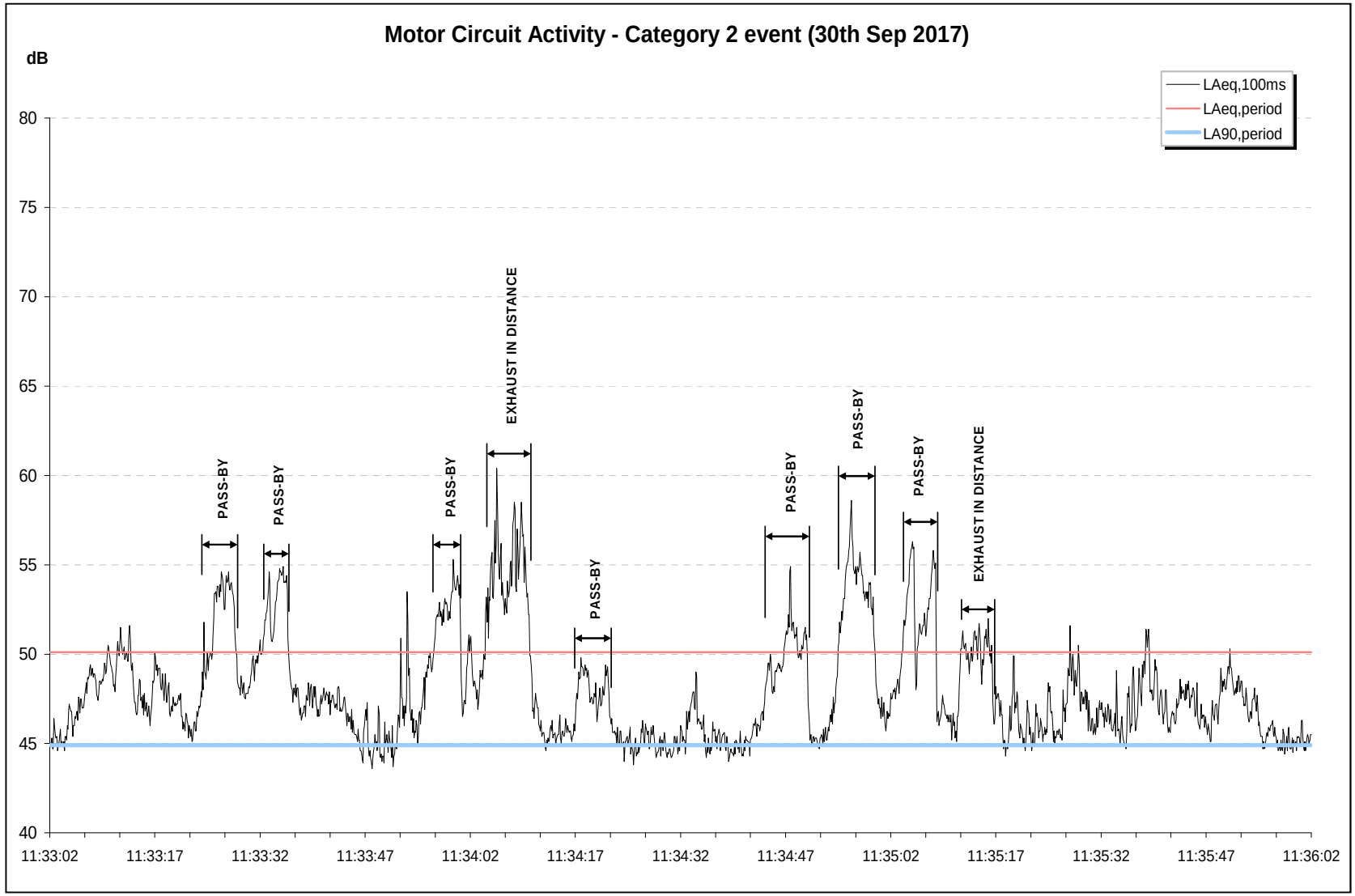



**Figure 16 – Time history of motor circuit activity at meter location P3**

**7.31** Due to the fluctuating nature of motor circuit activity, assessing this based on long term average levels would not be considered to appropriately represent its impact within the environment. Even short term averages, adjusted for character can understate impact and what is required is a mix of controls including those of the maximum noise generated.

**7.32** Whilst it might be possible to try to apply a penalty to reflect character content, there is not a neat formula for considering the various characteristics and what weight to apply to each. Experience indicates that the standard using penalties to rate commercial noise, BS4142:2014 can understate impact from motor sport noise and it is noted that the standard is caveated to ensure its direct application to motor sport noise is not applied as a measure of acceptability. It is still feasible to compare and contrast an equivalent level of industrial or commercial noise with such character to compare acceptability, especially where the motor sport noise is a common feature but in essence the presence of these characteristics serves to warn of the inadequacy of the average decibel level.

**7.33** In order to provide some indication of levels for motor circuit activity at locations P1 – P4, and because track activity run as 15 minute sessions it appears logical to present data in 15 minute periods as these shorter periods arguably better reflect the way noise from this site would most likely intrude.

**7.34** However, measurements made at P1 – P4 were not undertaken over a long enough interval to be able to cover a full 15 minute session and merely reflect the variability experienced. Simultaneous trackside measurement had been undertaken and showed the number of events within a 15 minute session could be used to estimate a period average based on sound exposure levels (SEL)[33].

**7.35** Figures 15 and 16 above are reproduced below as Figures 17 and 18 but which is superimposed with simultaneous measurement data from location F1. This identified that not all the events measured by the trackside meter were registered by the

[33] Equates sound energy of a pass-by event into 1 second.

attended meter off-site and some site activity is either masked or differentially attenuated over distance. This may be a factor of directionality and relative distance to sources. Based on the information contained in Figures 17 and 18 it has been approximated that 6 – 7 events of vehicle pass-by typically occurred within a period of 3 minutes (ignoring the exhaust in distance events) for this type of activity. Factoring this up to a 15 minute session indicates peaks of noise due to vehicle pass by would total 30 – 35 such events. These peaks need control, where they regularly occur at an excessive level. In terms of development it is important to ensure there is not a regular exceedance of particular levels on a repeated short term basis.

**7.36** SELs were calculated from a number of pass-by events and the average value used to estimate the $L_{Aeq,15min}$ for a session. Based on this approach the $L_{Aeq,15min}$ was estimated as 49dB. Compared with the average levels for events of pass-by which ranged from 54 – 59dB(A) this again highlights why reporting motor circuit activity in an average manner can underplay the significance of events at the moment they occur and which relates more to their impact.

**7.37** In summary, during such events there are approximately two events every minute lasting somewhere of the order of 10 seconds, when including the rise and fall of noticeable intrusion. In turn this means approximately 20 seconds respite before the intrusive noise recurs. Such a period is too short to fully adjust and return thoughts to some other activity before being disrupted again. Thus repeated disruption is expected at these levels. Reducing these of the order of 6dB on the basis of an approximate doubling of distance and some atmospheric absorption and screening feature / ground effects places resulting levels at the edge of the 400m buffer zone in the region of 43dB LAeq (15 minutes) with maximum levels 48-53dBA. The peaks are identifiably excessive indicating beyond this boundary there is a need to have limited intrusive events, dependent on other influencing factors which lead to less regularity of intrusion at greater distance.

**7.38** As with the observations made regarding measurement data obtained on the Category 3 day, motor circuit activity was found to emit noticeable tonal character. Whereas measurement data from the Category 3 showed a consistently repeating tone at 160 Hz, tones were produced across of range of lower frequencies for this day including

160, 200, 250 and 315 Hz. In some cases tones were specific to a specific car on the circuit or would present as a shifting tone when changing gears. These features add to the intrusiveness of the cars and confirm the importance of controls as reflected at other sites that have been developed to reflect a suitable balance.

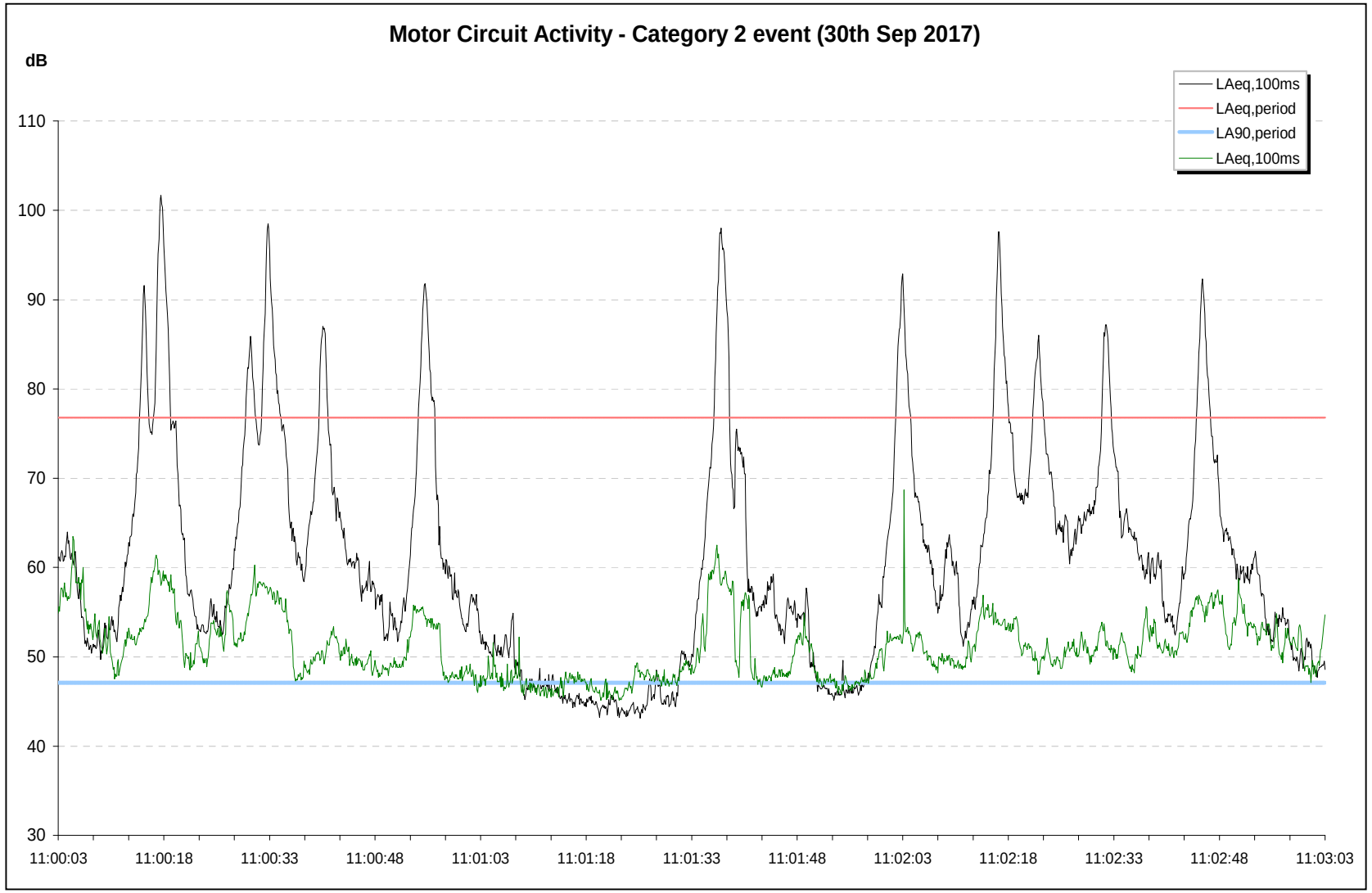
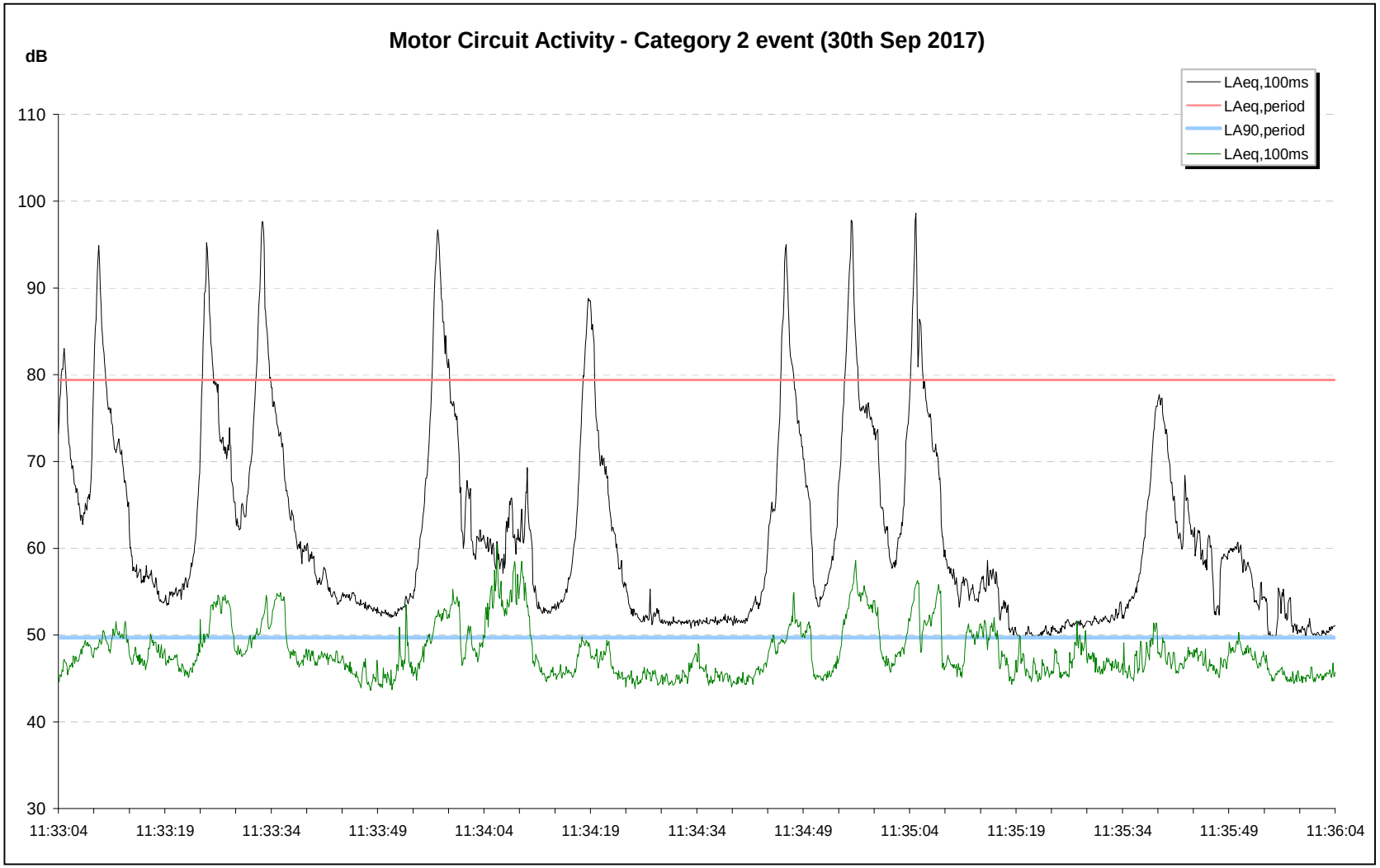



**Figure 17 – Simultaneous trackside and P1 meter time history**




**7.39**

**Figure 18 - Simultaneous trackside and P3 meter time history**

**7.40** **6th October 2017 (Category 2).** Measurement of motor circuit activity on this occasion combined fixed unattended monitoring and snapshot attended measurements at a number of locations near Goodwood (as summarised in Figure 10). This also included simultaneous trackside measurement and in particular trackside measurement near the Lavant and St Mary's turns undertaken to complete earlier monitoring of cars when at different points on the circuit.

**7.41** Observations made of motor circuit activity were such that these events were regarded as some of the most of noticeable of all the days when monitoring took place. Due to a north-north-westerly wind, measurements made at location F1, F2 and P2 - P4 were regarded as downwind of the circuit and this was felt to have been a factor in motor circuit activity being experienced as the most prominent at these locations. In particular intrusion by events of distant exhaust seemed to occur more frequently at these locations, because cars on the circuit turning into Fordwater were positioned so that their exhaust faced towards these points.

**7.42** However, even at locations that were not downwind (in particular P5 – P8) snapshot observations of motor circuit activity were noted to be a prominent source of neighbourhood noise throughout the day. In addition to motor circuit activity many positions were found also to be impacted by general aviation activity relating to GA. On the day of monitoring, runway 32 was in operation meaning that planes were taking off in a North Westerly direction and moving away from the measurement positions. Despite this, groundside and runway activity led to a number of clearly noticeable events in the locality.

**7.43** Featured at Figures 19 and 20 below are periods of motor circuit activity measured from location F1, during the morning session. On both time histories motor circuit activity is characterised by recurring sharp peaks which corresponded with exhaust / acceleration notes. Based on a simple average for both of these periods of motor circuit activity this has been calculated as an $L_{Aeq,10min}$ 52dB. This is considered to under-represent the potential impact at this receiver location (as has already been discussed in this chapter) because motor circuit activity is not a steady sound and many of the peak events occur well above this average attention grabbing level and

disturbing activity each time. It is these peaks that are considered to define the intrusiveness of the motor circuit activity.

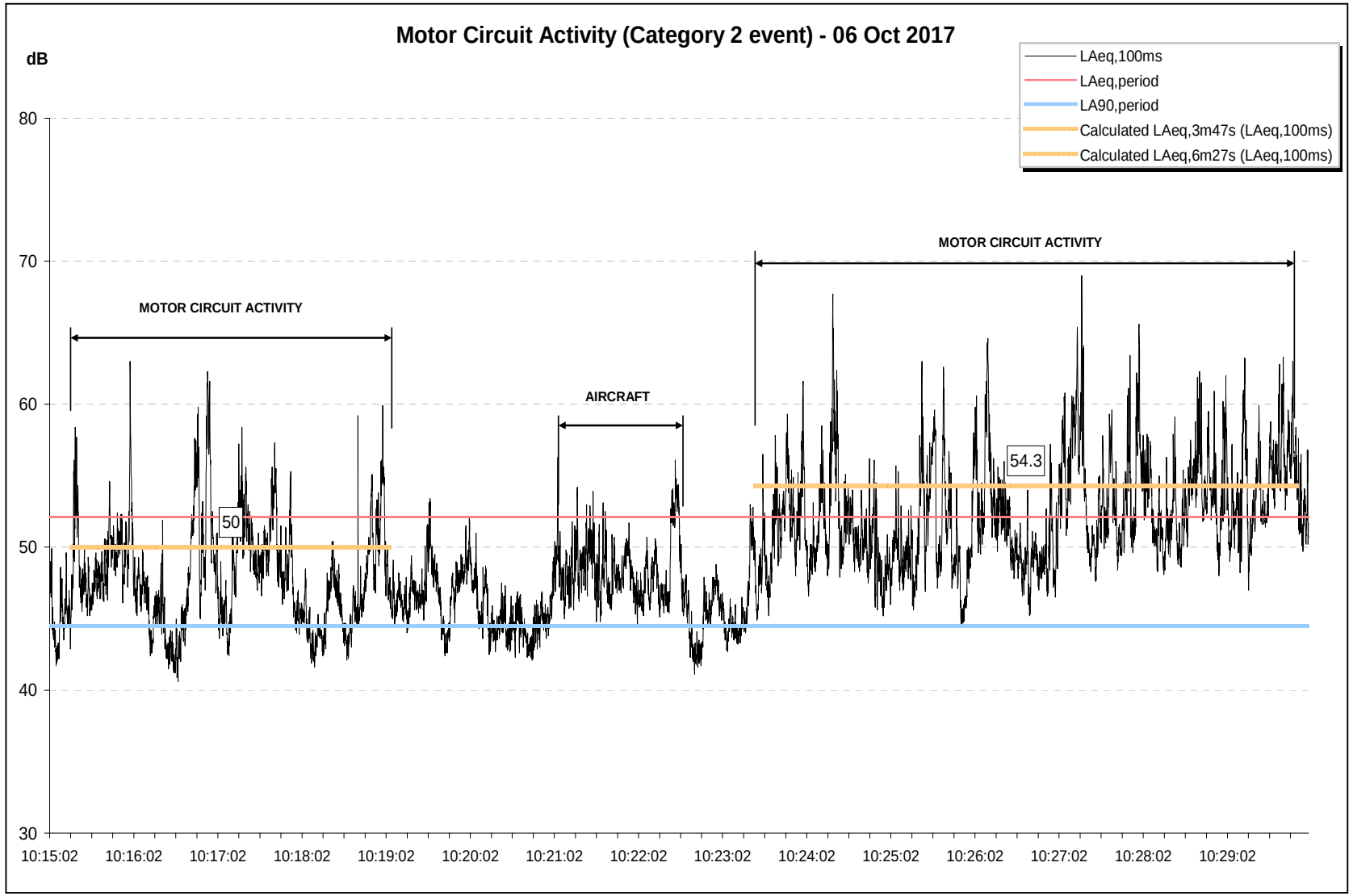



**Figure 19 – Time history of motor circuit activity at location F1 (10:15 – 10:30)**

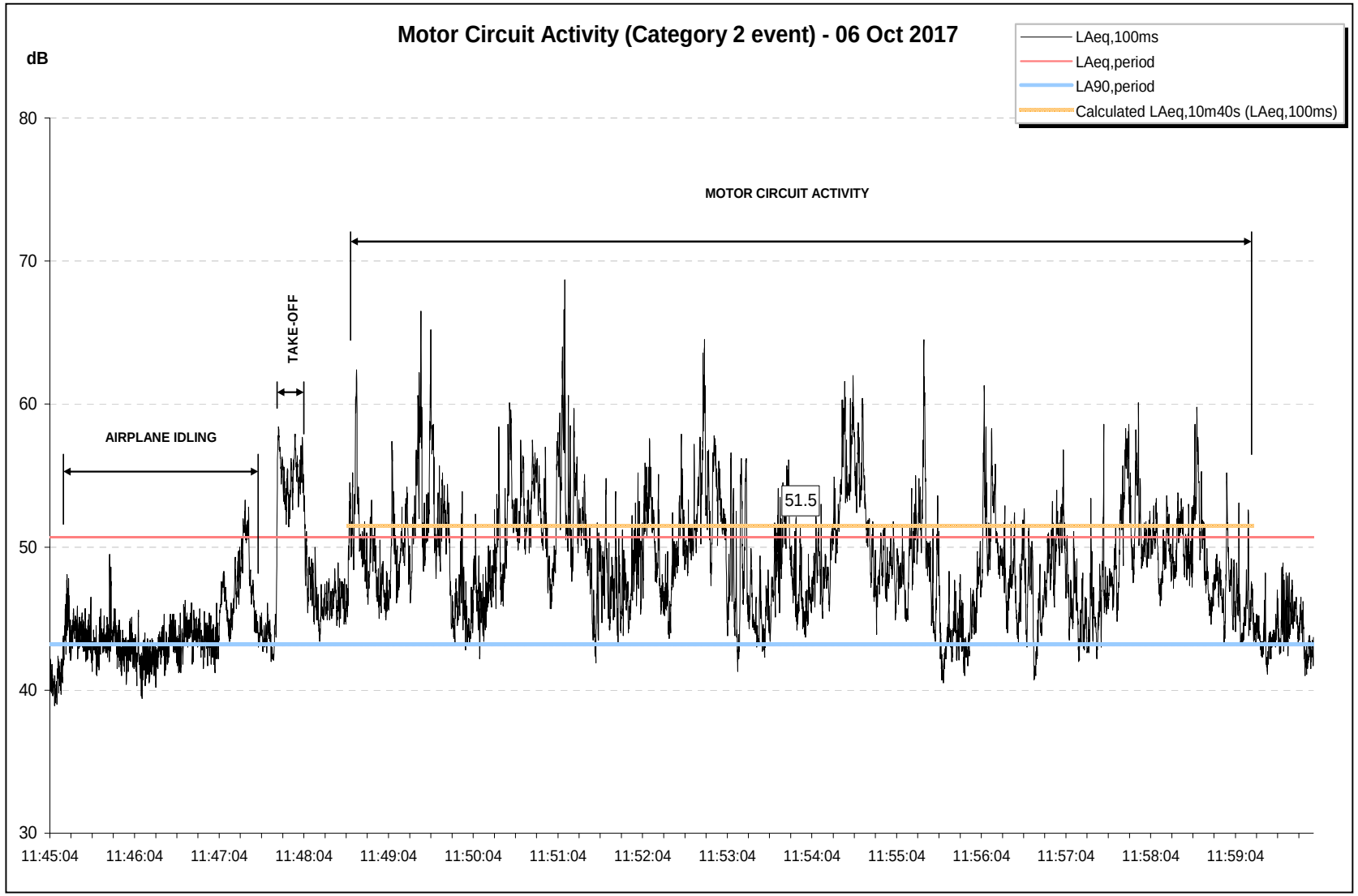



**Figure 20 – Time history of motor circuit activity at location F1 (10:45 – 12:00)**

**7.44** As above measurements and activity outcomes need to be translated to their impact at the 400m buffer zone where they remain clearly excessive.

**7.45** For the afternoon session the fixed meter F1 was relocated to a new position, F2. The intention was to note how an area of the site would be impacted near to the runway as planes came into land (on runway 32) and whilst the circuit was in operation. However it was identified that this element of the aerodrome activity generated very little noise due to the prominence of groundside activity and events of take-off that drew the attention as well as prominent and noticeable events of motor circuit activity also being recorded.

**7.46** Presented at Figure 21 is a time history which describes the local environment due to events of motor circuit and aerodrome activity at location F2. It can be noted that at location F2 the activity due to motor circuit activity is comparable to the events measured at location F1, i.e. noticeable bursts / peaks of activity. The event recorded at the start of this record has been identified as aerodrome activity. This has been likened to an aircraft sitting on a runway revving to build up power for take-off followed by a rapid level increase as the plane takes-off.

**7.47** Based on a simple period average, which excludes most of the aerodrome activity, motor circuit activity has been calculated as producing an $L_{Aeq,10min}$ 53dB value at this location.

**7.48** In addition to Figure 21 a further period of measurement activity is presented at Figure 22. This time history identifies the aerodrome activity to be more prominent during the measurement period which also obscured some of the motor circuit activity. A simple period average which accounts just for motor circuit activity (absent aerodrome activity contribution) was calculated as $L_{Aeq,5min}$ 54dB when rounded to the nearest decibel.

**7.49** As previously identified these levels translate to exceedance of 40-45dBA at the boundary of the 400m buffer zone and indicating unacceptable noise at such distances.

All the measurements indicate especially that Category 1 and 2 events result in excessive noise up to and exceeding the boundary of the 400m buffer zone.

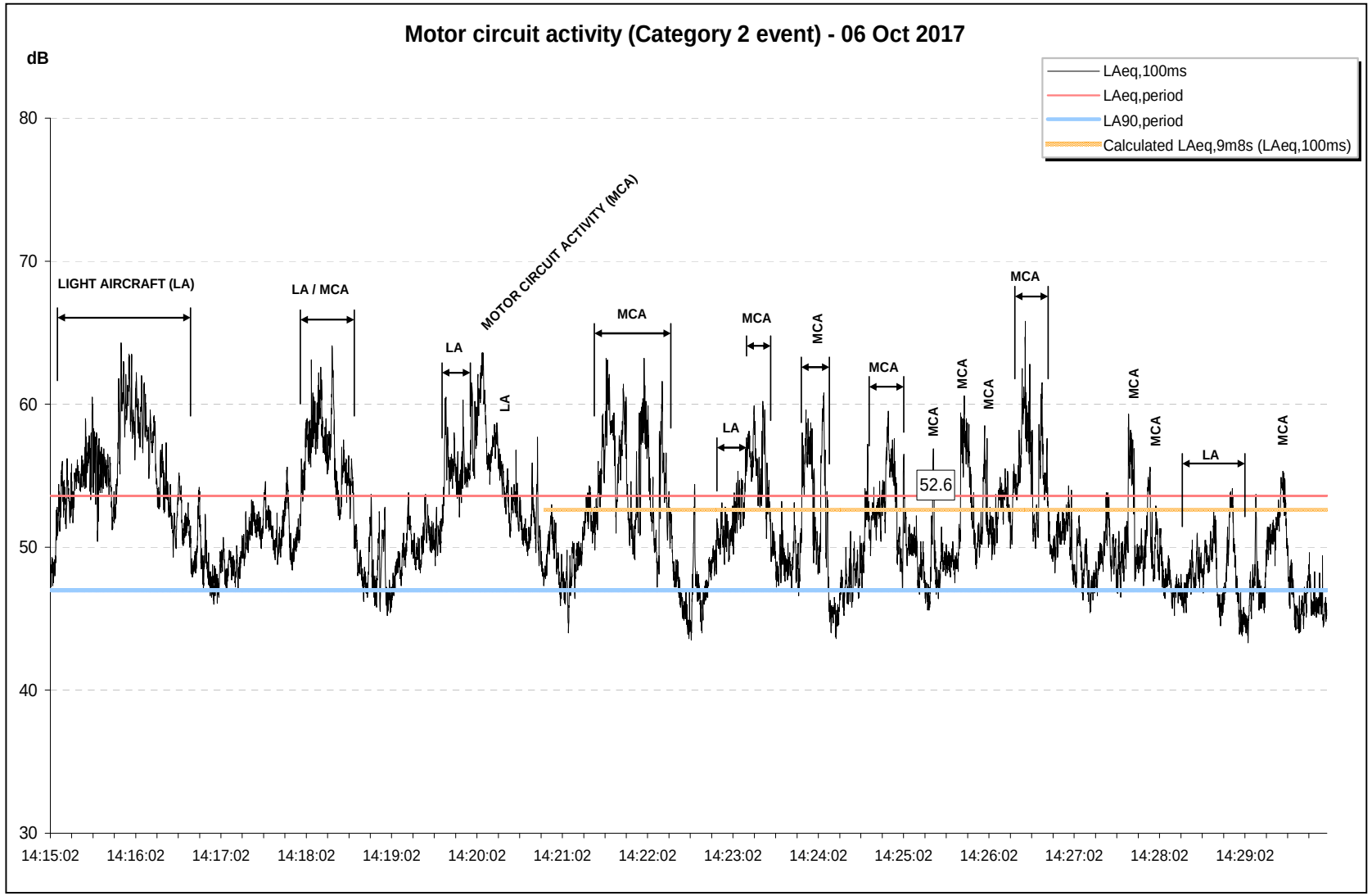



**Figure 21 – Time history of motor circuit activity at location F2 (14:15 – 14:30)**

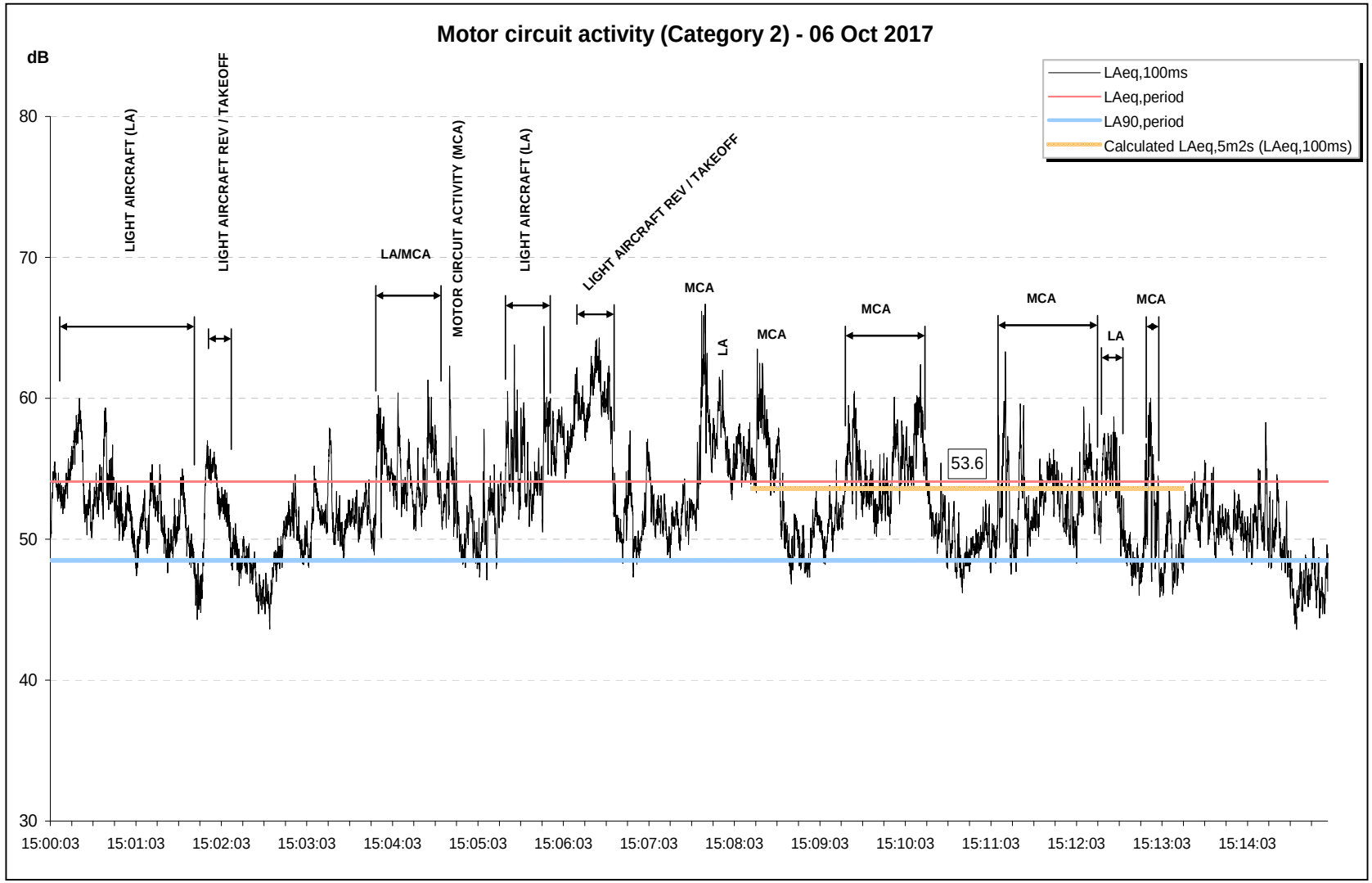



**Figure 22 – Time history of motor circuit activity at location F2 (15:00 – 15:15)**

**7.50** Referring to the snapshot measurements conducted the purpose of these was to seek to characterise noise levels impacting across a wider part of the study area. At location P3 which was approximately 500m from the boundary of Goodwood events of acceleration / exhaust from cars on the circuit were noted as clearly audible and distinguishable events that drew attention. The monitoring during this snapshot is presented below at Figure 23. At this distance levels are indicated as excessive for the 6 minute period but are closer to the limits that might achieve acceptability based on diversity and other features designed to improve the sound environment. As before this supports the 400m buffer zone and the concept that beyond this careful noise impact assessment based on design, layout and frequency and duration of impact would dictate acceptability.

**7.51** The measurement of the motor circuit activity is noted to be consistent with measurement from other days with events of cars on the circuit characterised by sharp distinctive peaks of noise emerging above background sound levels. This and other time histories help with explaining the attention grabbing nature of motor circuit activity, because of the manner in which it is perceived. Motor circuit activity was recorded in notes made when events took place. These notes identified irregular and intermittent events which stood out because of these characteristics but also because of the distinctive character and nature of sound produced by many of the cars on the circuit.

**7.52** Assessing motor circuit activity as a simple average for the period of measurement this was calculated as $L_{Aeq,6min}$ 48dB. It follows this average cannot depict the degree of intrusion arising as the average sound energy level cannot address the variations in the noise, the rate of rise and fall in levels, the tonal content and how this changes, the identifiable features which attract attention, how much these sounds emerge above and differ in content from background sound levels and their dominance, nor the effect of regular ongoing occurrences of similar noise. However, they do allow comparability and indicate any new development should not be subject to such levels and character of noise. In turn this indicates that outside the buffer zone there is still a need for noise assessment and its mitigation as far as is reasonably practicable.

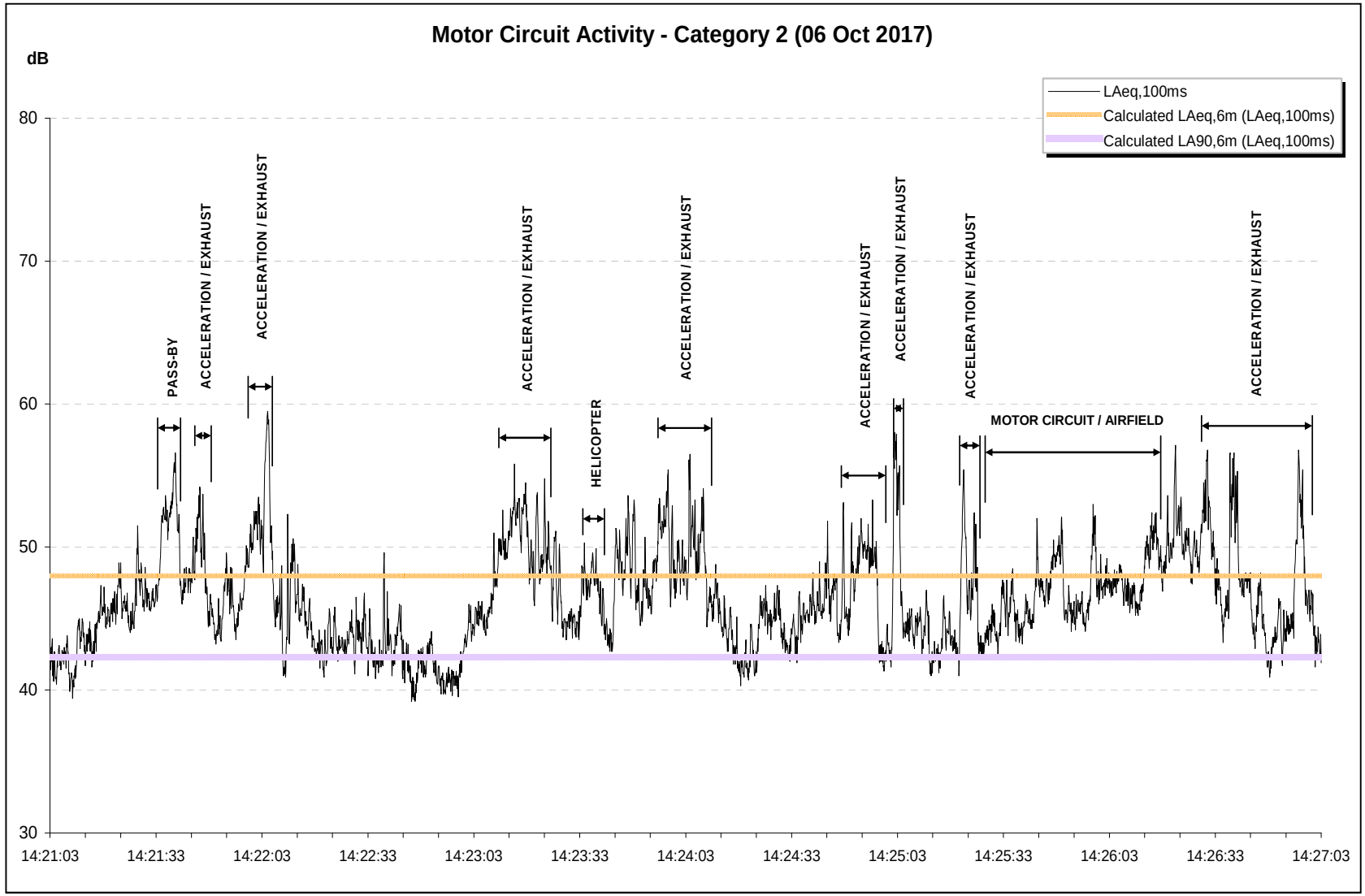



**Figure 23 – Time history of motor circuit activity at location P3**

**7.53** At P4 it was felt that an insufficient amount of time was spent at this measurement position to obtain meaningful determination of the motor circuit activity. This had included changing position slightly to address the issue that motor circuit activity appeared subdued at this location which was initially thought to be due to the position of the meter relative to the angle of the circuit (i.e. slightly out of the shadow of Fordwater that exhaust events were not as prominent). However when post processing the data for this location, aerodrome activity arising from groundside (planes accelerating) and take-off events stood out as having been very identifiable and likely to have masked motor circuit activity.

**7.54** An unexpected outcome of monitoring was the sudden and significant crescendos in noise due to acceleration (light aircraft) that was recorded at this location and noted to be very prominent. The time history for this period is presented at Figure 24 which describes those events measured in further detail. Despite the impression of subdued motor circuit activity at this location, the time history in Figure 24 identifies that motor circuit activity produced some of the loudest events (with peaks in excess of 70 dB(A) at one point) as well as highlighting the bursts of acceleration from aerodrome activity which impacted quite significantly on the ambient environment.

**7.55** Despite motor circuit activity in the main having been obscured by aerodrome activity, for the handful of events observed these were regarded as audible and noticeable events that added to the impact overall in a significant manner.

**7.56** The period shown in figure 24 also serves to demonstrate the cumulative impact factor and difficulty in determining adverse impact due solely to a single source. In the circumstances it is reasonable to conclude both as similarly significant contributors to adverse impact. This is supported by the WHO 2018 guidelines that identify aircraft noise as significantly more harmful as historically thought.

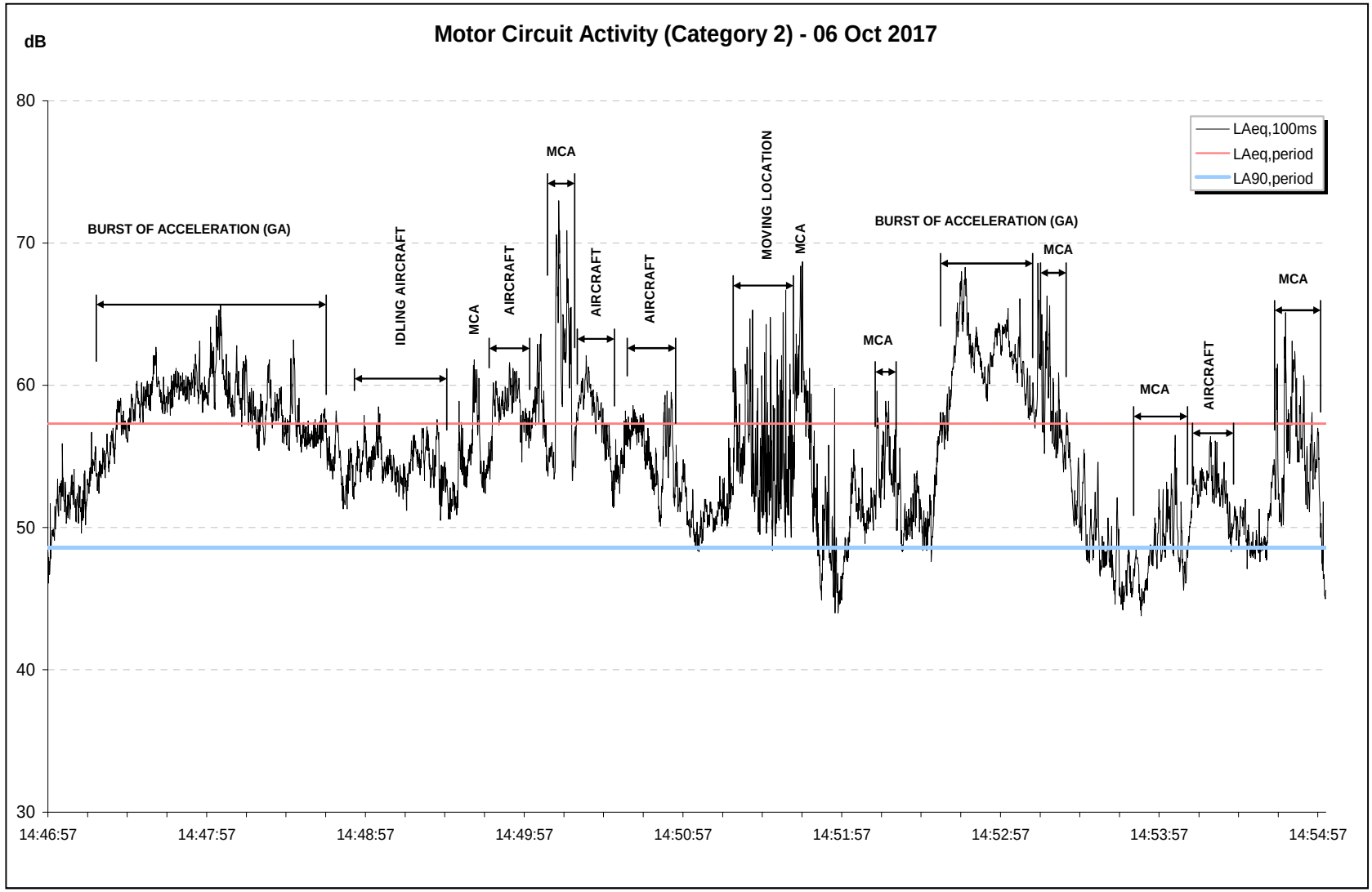



**Figure 24 – Time history of motor circuit activity measured at location P4**

**7.57** At location P5 the area was noted to be impacted by motor circuit activity and aviation activity due to one event of take-off and over-flights. Motor circuit activity was regarded as clearly audible at this location and could be distinguished by irregular and intermittent events of acceleration / exhaust. This has been detailed in Figure 25 below.

**7.58** A 2nd measurement was also undertaken nearby next to the river Lavant (P6) to consider a location set slightly further back from the Goodwood site and at the extent that development would be possible on this part of the site when applying the 400m buffer zone. At this position events of acceleration / exhaust were logged as being clear, noticeable and adding to adverse impact. It was noted that cars could be heard as they approached and accelerated through the St Mary's turn. However as with snapshot measurements, observations made at P4 of aviation activity were noted to impact the location and obscure some motor circuit activity. This has been detailed at Figure 26 below.

**7.59** For both locations P5 and P6 levels calculated for motor circuit activity have been based on shortened periods absent of any influence of general aviation. Over an approximate period of 3 minutes average levels for motor circuit activity were measured at $L_{Aeq,3min}$ 49 and 46 dB respectively. As previously identified, these levels represent excessive and borderline excessive noise respectively. As before this supports the 400m buffer zone and the need for assessment in the adjacent area if development was to be considered there.

**7.60** The findings on the buffer zone are logical as there is not a simple transmission for unacceptable to acceptable but there does appear to be consistent support that development within 400m is unacceptable and beyond that additional analysis is required applying short term decibel criteria and appropriate mitigation that affords protection and respite from intrusion.

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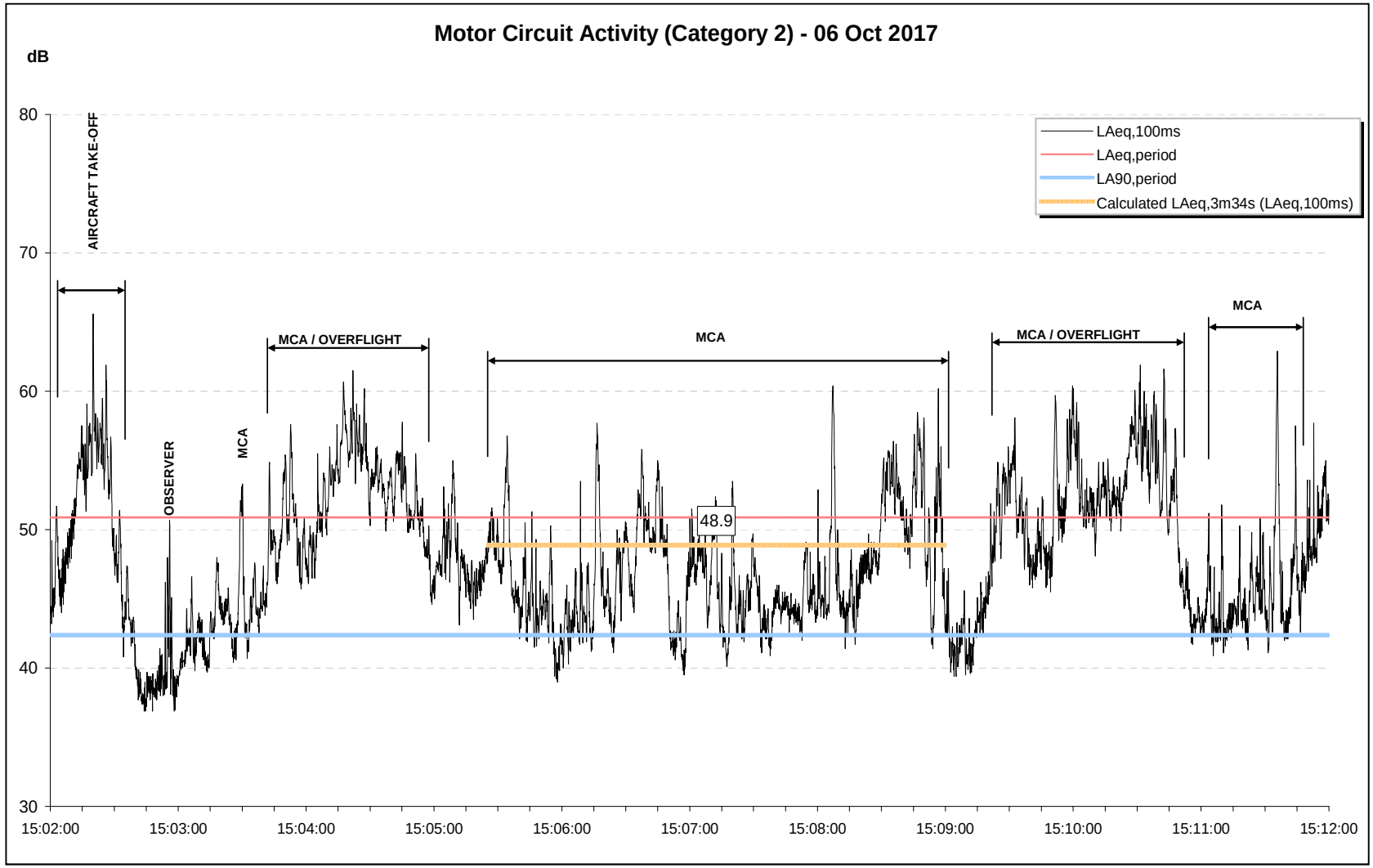


**Figure 25 – Time history of motor circuit activity measured at location P5**

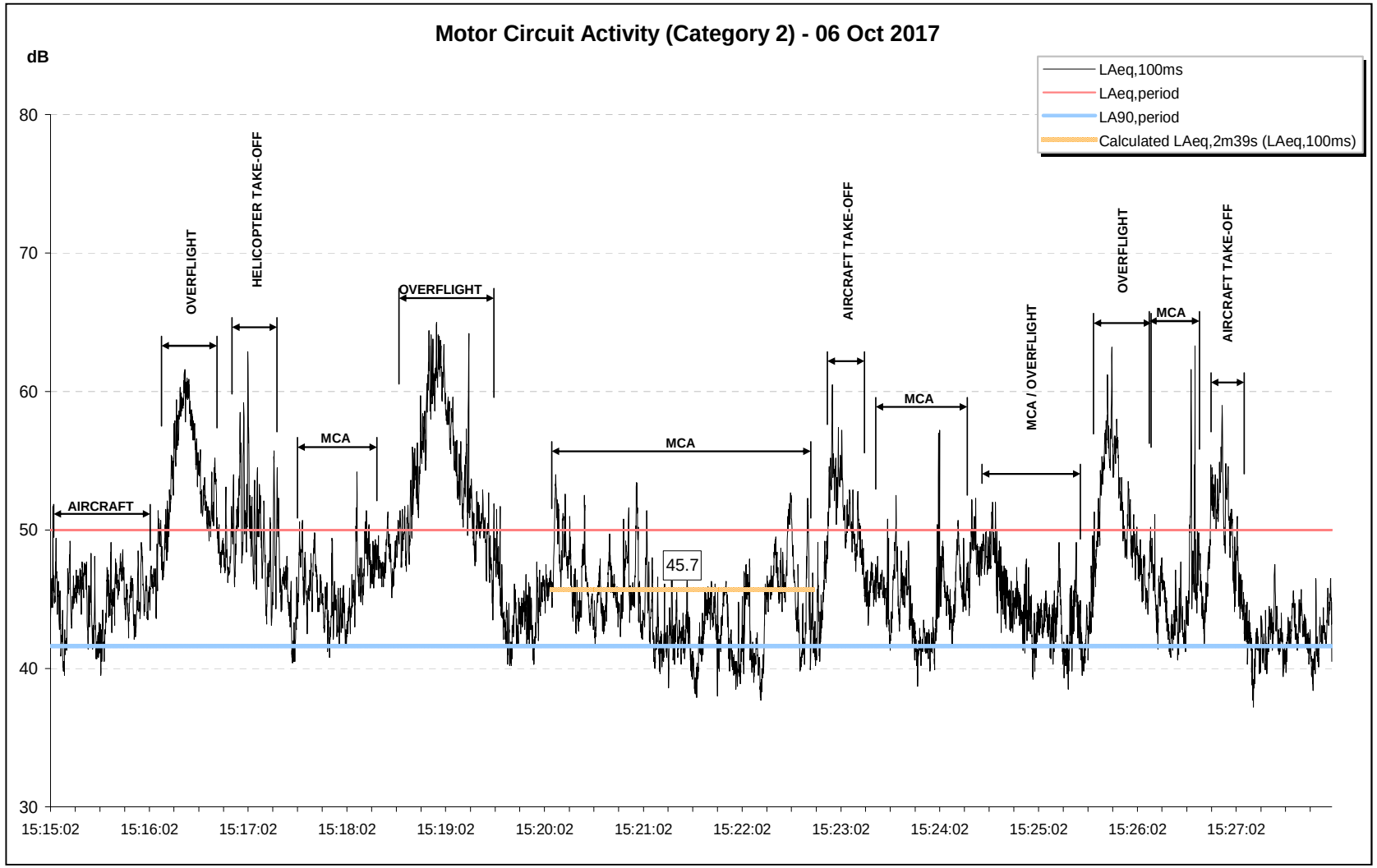


**Figure 26 – Time history of motor circuit activity measured at location P6**

**7.61** At locations P7 and P8 this accounted for locations where the level of assessment had been limited to just the earlier snapshot measurements as made on the 28th September. Due to the proximity of these locations near to the end of runway 32 notable and significant events of take-off were captured at both these positions and were attributed to the activities of the Boutlbee flying academy's Spitfire and Havard planes.

**7.62** At location P7 motor circuit activity was audible and very noticeable due to the irregular peak events of exhaust and acceleration. This position was quite close to the circuit at approximately 180m at the nearest point, but due to the location it was also subject to secondary intrusive events as cars passed from St Mary's corner through to Lavant further up the circuit (see figure 10).

**7.63** The snapshot at location P8 was undertaken to consider conditions at a location set further back from the circuit and with regard to the extent of the 400m buffer. This was undertaken at approximately 290m from the circuit facing towards the St Mary's turn. Circuit activity was clearly audible at this location due to events of exhaust / acceleration noise. The site was also noted to be impacted by aerodrome activity due to events of take-off and over-flight.

**7.64** Presented at Figures 27 and 28 is the time history for measurements made at P7 and P8. Due to the presence of aviation activity, motor circuit activity has been calculated absent any influence from this. At location P7 the average was derived as an $L_{Aeq,4min}$ 50dB and at location P8 $L_{Aeq,3min}$ 44dB. This is again consistent and supportive of the 400m buffer zone.

**7.65** All the levels of average motor sport noise reported here indicate events or periods of activity which are clearly audible, commonly dominant and adding to intrusion. There is not a cut off of impact at 50 or 55 dB(A) or even 47 and 52 dB(A) when adjusting WHO / BS8233 criteria for facade reflection effects, i.e. less 3 dB(A). The evidence is patently clear adverse impact occurs at levels significantly below this as identified by the emergence of the noise above masking levels. It is consistent with levels applied at other sites in the region and 40-45dBA.

**7.66** In accordance with the discussions and evidence in this report, adverse impact does not relate to absolute decibel levels but the periods of audible intrusive noise that impacts precisely because it is not masked and contains attention grabbing character. This is confirmed by comprehensive observations at various locations. In particular it is clear the impact noise experienced is unlike that of road traffic noise and such comparisons are not appropriate.

**7.67** When noise emissions and observed effects of the noise are compared to decibel levels, they concur with adverse impacts typically arising in the region of 40-45dBA as a short term average and maximum noise levels typically being 3-8dBA higher. The evidence is clear that once as close as 400m there is significant and sufficient adverse effects to clearly exclude further residential development. At distances of 400m to 800m there is reducing impact but a need to consider the nature and extent of remaining impact and the mitigation provided before acceptability could be determined.

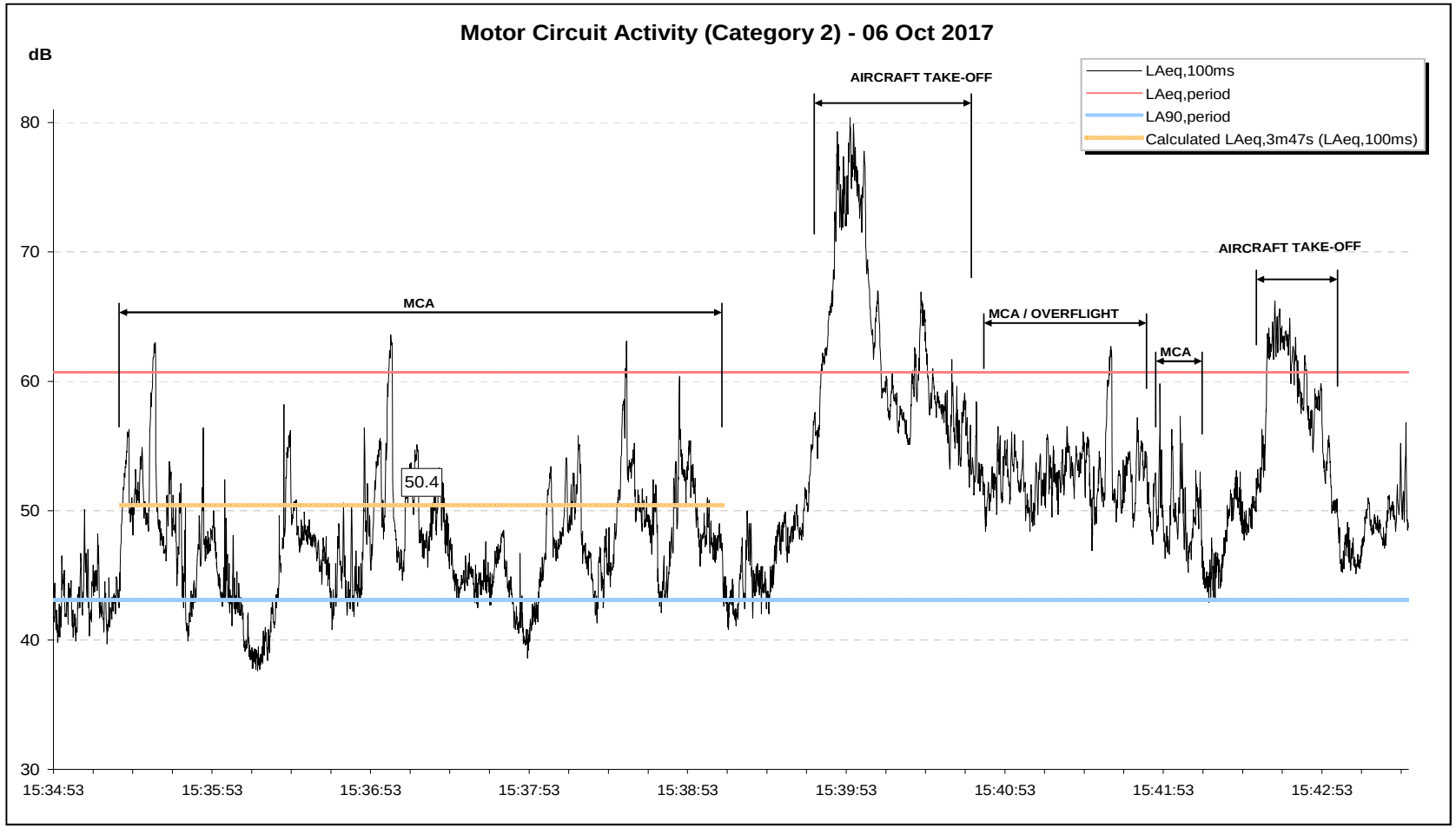


**Figure 27 – Time history of motor circuit activity (MCA) measured at location P7**

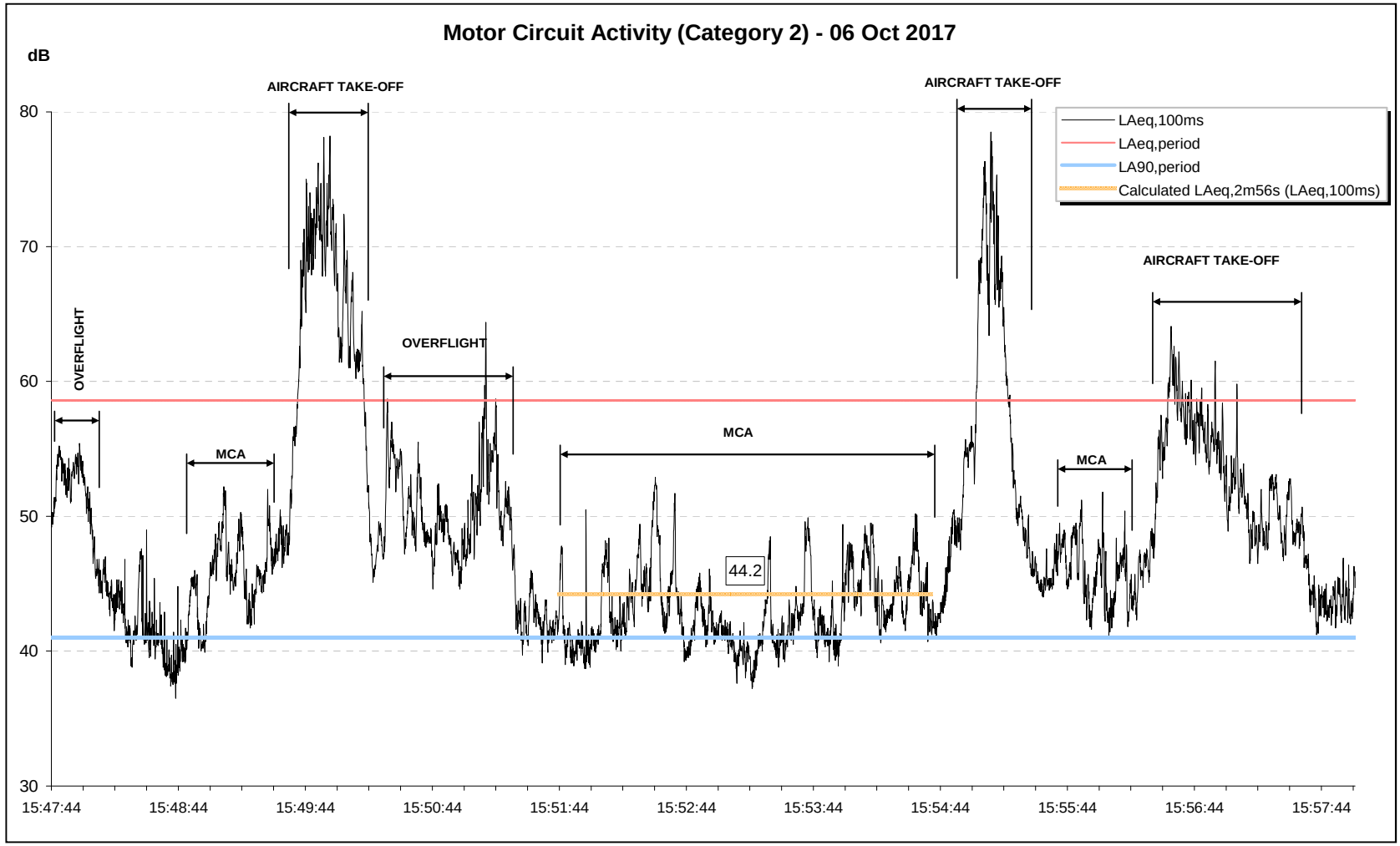


**Figure 28 – Time history for motor circuit activity (MCA) measured at location P8**

**7.68 Prediction and modelling of motor sport noise.**

**7.69** As an element of the study it was intended to consider the impact of motor circuit activity across the evaluation area through the use of noise modelling using the ISO9613-2 platform. All modelling has limitations but the variables identified in the case of motor sport noise prevent a simple determination of levels over distance. As a result, whilst there is clear evidence of excess noise up to 400m, beyond that distance individual case by case evaluation is needed.

**7.70** Modelling was validated using measurements made on the 6th October which included simultaneous measurement at the trackside and downwind of motor circuit activity off the site. However it was found that the attempt to model the site using ISO9613-2 was inconclusive because the actual measured levels demonstrated that at similar distances from the trackside the software modelled very different levels for the same activity. This is a factor with motor sport noise propagation and meteorological effects not unexpected and recognised in ISO9613-2 as a limitation.

**7.71** This difference in levels at similar distances meant that the calculations using attenuation due to distance, and other distance based factors that ISO 9613 is based on, were insufficient at predicting the levels in this case. The most likely reason for this difference in levels was due to the directivity of the sources (car exhaust is very directional) as well as meteorological variances and from this it was not possible to accurately model this site using ISO9613-2 to further advise on the buffer zone.

**7.72** Whilst CadnaA using ISO9613-2 allowed for the motor circuit to be plotted as a point or line source (assuming moving points over time) the directivity of either of these options could not be calculated accurately and therefore could not be included in the model. To be clear directionality can be modelled but as a continuously varying source adequate accuracy is not achieved. Other issues include environmental factors including wind direction and atmospheric refraction that affect the levels at different locations. These cannot be modelled as a moment by moment change.

**7.73** Noise mapping can be a useful tool for comparing simple and hypothetical situations, for example the inclusion of a barrier when dealing with a single noise event or a consistent source. When dealing with complex soundscapes as is the case here, with

multiple moving, inconsistent and highly directional sources of noise over long periods, accurate noise mapping becomes very difficult if not impossible to achieve. This exercise demonstrated it was the use of the actual measured levels that are most effective to confidently determine exposure and areas where noise is unacceptable. This exercise had two purposes therefore, to evaluate the likely effectiveness of modelling noise impact for this site and determine the range of differences between actual measured values and predicted values.

**7.74** The outcome is a conclusion such modelling has substantial uncertainty and is not an acceptable procedure to determine the acceptability of impact within any location.

**7.75** To highlight the disparity that arose between modelling and monitoring, the modelled impacts from motor circuit activity across the study area are presented at Figure 29 below. Values were based on $L_{Aeq,15min}$ with the predicted levels specified at distances of 200 and 400m from the circuit. Disparity was most notable around positions P5 – P8 and by having regard to measurements made at these locations. At P5 and P6 measured values (based over a 3 minute average) were 49 and 46 dB(A) compared with modelled values of 58 and 54 dB(A) respectively. A similar level of disparity arose at locations P7 and P8 where the average for motor circuit activity was measured at 50 and 44 dB(A) but modelling predictions also suggested much higher values of approximately 57 and 53 dB(A). The reasons for these differences are alluded to above and in the event of longer term averaging an entirely different relationship would be expected such it is unsafe to draw any conclusions of impact.

**7.76** The modelling cannot address locations affected by higher noise due to the directionality of the noise sources and common meteorological effects that are stated as outside the modelling parameters. As a general rule, greater attenuation arises when moving to distances of 400m away from the circuit than indicated by ISO9613-2. This is also why outside of the 400m area individual comparison with parameters is needed on a case by case basis that reflect measured levels under downwind conditions and specific meteorological conditions that do not produce spurious results. An example would be a very hot cloudless day that leads to upward refraction and sound shadow.

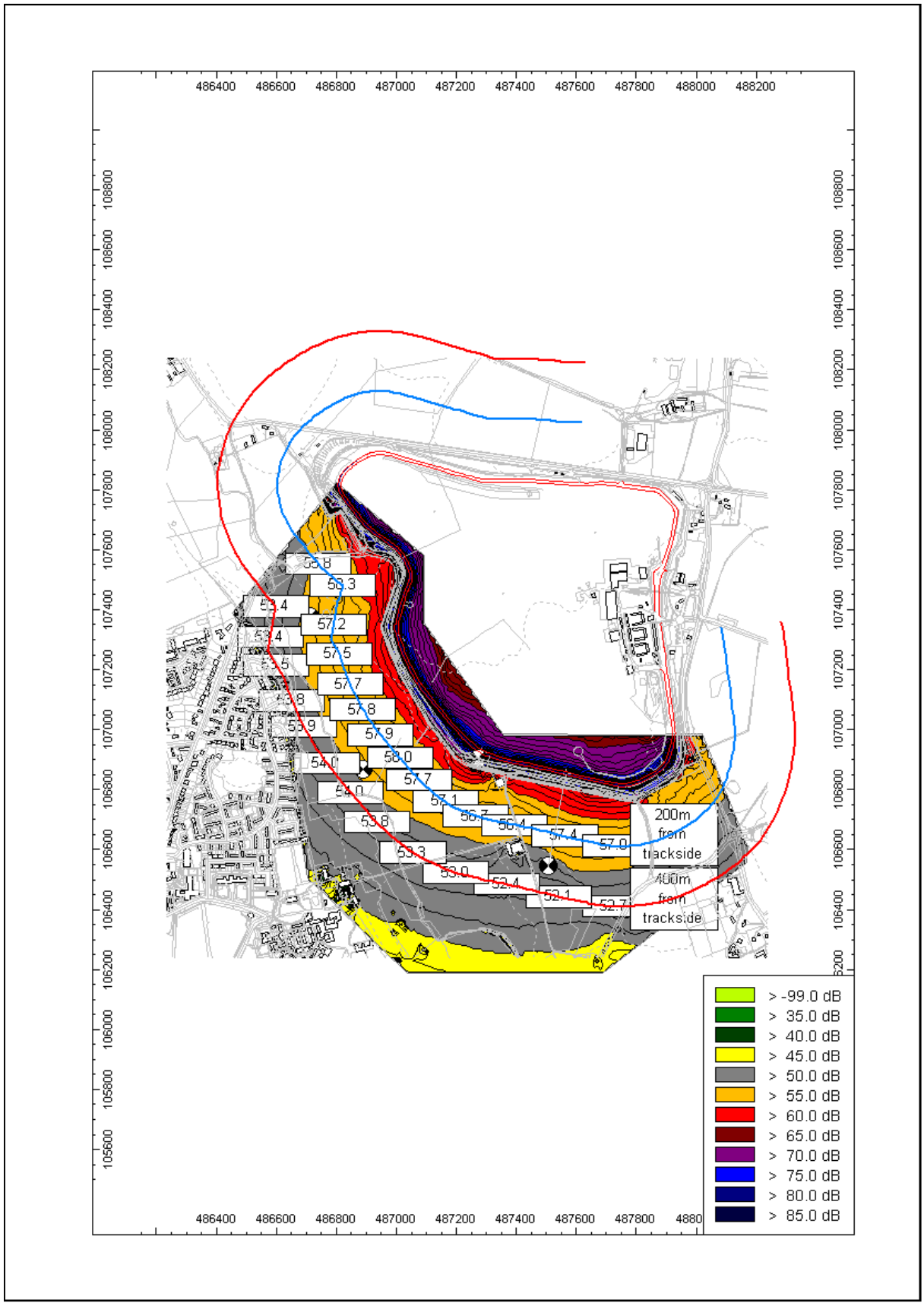


**Figure 29 – Modelling of predicted motor circuit impacts**

**7.77** Goodwood Aerodrome

**7.78** Over the 5 days during which assessment of activities took place, aviation activity was observed on 3 of these days. Aviation activity was heavily restricted during the Goodwood Revival on the 9th September. On the 29th September there were no flights due to windy conditions. When site assessments were made only runway 14 or 32 were in use.

**7.79** Assessment of general aviation focused on monitoring data from the fixed continuous meter positioned at location F1 (as noted in Figure 7) on the 28th September, subjective and objective observations made on the 28th, 30th September and 6th October and aviation activity data provided by Goodwood Aerodrome (GA).

**7.80** Whilst events of aviation activity were monitored on the 30th September and 6th October, it was considered that monitoring data from the 28th September provided the most consistent account of aviation activity by being based at a fixed single location. Measurement on the 30th September was limited to roaming snapshot measurements from multiple locations which mainly captured events of over-flight. It did confirm the range of variation in aircraft noise at different locations and that this is a significant contributor to overall noise impact. Measurements on the 6th October also made use of roaming snapshot locations at a range of places across the study site and whilst this also included monitoring from a fixed location this was located at the opposite end of runway 32 which was in use that day. As such the decibel results are considered conservative.

**7.81** It was established during assessment visits and as expected that take-off events were most distinguishable when measuring near to the end of the runway in use. For example measurements made at location F1 which was 400m from the end of the runway (as noted in Figure 7) clearly captured the events of take-off from runway 14.

**7.82** However, on the day observations were made when runway 32 was in use general aviation activities were still found to be audible, clearly distinguishable and adding to intrusion at a number of monitoring positions that were not close to the end of the runway. These observations noted distinctive events of groundside activity which were assumed to be aircraft accelerating (for take-off) followed by the event of take-

off itself. During observations the prevailing wind direction was recorded as north-north-westerly and it is assumed that some locations were being impacted to a greater extent because they were located downwind of the runway on that day.

**7.83** It is important to recognise that normal assessment of noise is based on its impact downwind as this is the most stable transmission state and thus can provide comparability. Downwind assessment also meets the requirements of environmental noise measurements as defined by BS7445-1:2003, the main standard for determining how and where to record environmental sound.

**7.84** There is a matter of some uncertainty however, as runway 32 was only observed in operation on one day such that comparisons could not be made under different wind conditions but what this did highlight is the potential for certain parts of the evaluation area to be impacted cumulatively by aerodrome and motor circuit activity when runway 14 or 32 is in use.

**7.85** Observations made of general aviation found this to be made up of clearly audible, distinguishable and intermittent events linked to the activities of aircraft taking off and over-flights of the evaluation area. For clarification, over-flights were determined to be events where light aircraft were noted to over fly the evaluation area but were not following any designated circuit patterns. Events of aircraft coming into land were not considered to impact the area in quite the same way although when observations were made of this activity this was at a time when the motor circuit and other general aviation activities were prevalent, i.e. these had the effect of masking landings.

**7.86** During observation and attended measurement a diverse mix of light aircraft were noted taking off from GA and more varied than the 3 light aircraft specified in the Cole Jarman (CJ) modelling study. Observations noted a mix of both modern and older aircraft, such as those flown by Boutlbee Academy (Spitfire and Harvard) and biplanes. Some aircraft were also noted to produce very distinguishable (attention grabbing) high pitched tones during take-off. All these factors require consideration and will weight any assessment of impact.

**7.87** For the monitoring that was undertaken on the 28th September this recorded a number of events of take-off and over-flight. This was correlated with information

provided by GA which recorded a total of 19 take-offs between 12:30 and 16:30. Although the measurement activities ceased at 15:00 and did not cover the full day of aerodrome activity, events of take-off and over-flight were isolated from the time history by reviewing audio recordings and the GA departure information. In addition to the 19 reported departures a further 7 events of over-flight were identified. A sample of aerodrome activity which highlights an event of take-off and over-flight activity is presented at Figure 30, below.

**7.88** It is also important to recognise that helicopter activity is generally accepted as more intrusive but has not been considered in any detail in this case due to the wealth of information that there is already significant adverse impact when within 400m of GA or GMC and that this does not cease when moving further away but diminishes, in some cases more rapid than others.

**7.89** However, this is a further reason for individual assessment for any development within a wider area of 800m.

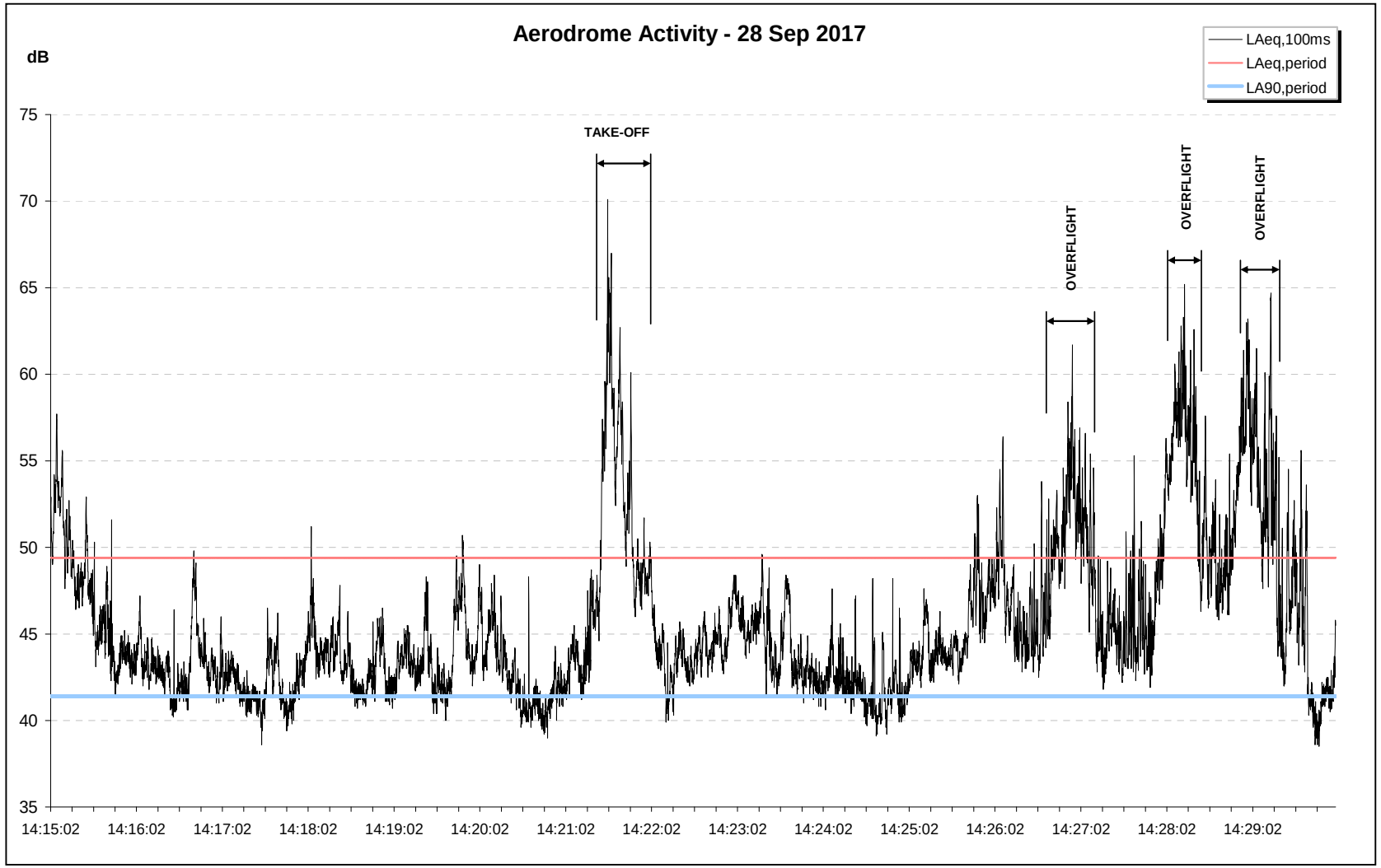


**Figure 30 – Aerodrome activity measured from location F1 (28th September)**

**7.90** In considering the impact from general aviation sound exposure levels (SEL) have also been calculated for different events of take-off and over-flight measured on the 28th September to estimate the $L_{Aeq,T}$ for the 4 hours that aerodrome activity was present. This estimated noise levels of $L_{Aeq,4H}$ 49dB which is now above the suggested criteria for the onset of significant annoyance of $L_{den}$ 45dB as defined by WHO 2018. Furthermore if the 4 hours of aerodrome activity were to be adjusted to be representative of a 16 hour day this would reduce levels at the receiver to $L_{den}$ 44 dB suggesting a no observed adverse effect despite it being clear that activity had occurred over a much shorter period and there were clearly periods of intrusion and adverse effect. In any event this impact cannot be viewed in isolation as it does not happen in isolation.

**7.91** With comparison to the 28th September observations made on the 30th September, when runway 14 was again in use, identified this as being a more active day. Data provided by GA recorded 52 departures between 09:00 – 16:00. Whilst the roaming snapshot measurements only recorded one event of take-off, 11 events of over-flight were logged within the 45 minute period that these measurements were taking place. It is also to be recognised that there is a potential for much greater GA activity in accordance with what is permitted should the business need arise.

**7.92** Based on the 52 events of departure and hours of activity (09:00 – 16:00) the noise impact at location F1 was estimated using the SELs from events of take-off and over-flight derived from activity on the 28th September 2017. The total number of over-flights for this period is not known but has been estimated at 50 events simply on the assumption that activity continued at a steady level for the day and the events that were observed. Assuming an SEL of 72 dB for take-off (based on the lowest SEL value calculated) and 74 dB for over-flights the estimated impact at location F1 was $L_{Aeq,7H}$ 50dB.

**7.93** However by substituting the lowest SEL value calculated for take-off with one of highest values which was 77 dB (and assuming all events of take-off are of the same level) this resulted in an $L_{Aeq,7H}$ 52dB, exceeding the suggested level of onset for significant annoyance by the WHO 2018. Estimating impact in this way highlights the uncertainty because there are many unknown factors. For example whilst over-flights

occur above the evaluation area, the number of such events is not known or recorded but nevertheless a relevant factor in considering impact. Similarly events of take-off assume the same SEL for all departures as the data available has not been so detailed as to note take-off by aircraft type and to which a specific SEL could be applied. This also indicates reliance cannot be placed on the average contour method where employed in this case.

**7.94** **Flight data 2016.** Aside from the monitoring of general aviation activity, impact was considered in the wider context by scrutinising flight data obtained from GA for 2016. Flight activity for the month of July (representing a summer month when activity would be at its peak) was broken down to investigate hours of operation, numbers of take-offs (including touch and go) and periods of respite between events. This has ignored the runway mode of operation assuming the same mode of operation all day, every day. This has only accounted for movements made by fixed wing aircraft since helicopter activity was rarely observed in the evaluation area. It is assumed that this was the case because helicopters would be operating away from the evaluation area along the northern circuit pattern due to runway 14/32 being in operation.

**7.95** This method of assessment identified that departures occurred over an average day of 9 hours. The shortest and longest recorded days ranged from 2.5 hours through to 12.5 hours. The average period of respite between departures was calculated as every 11 minutes and which ranged from 5 minutes to 36 minutes as the shortest and longest average periods of respite. For the whole month it was identified that on 18 days the average respite period was 10 minutes or less. Departure numbers were quite varied with the lowest number of recorded departures in one day being as low as 5 but the highest 153. As a daily / monthly average the number of departures totalled 69 per day but as a daily / weekly average this ranged from 60 – 100 departures per day. This summary is presented below at Table 5.

**7.96** Compared with observations made during the survey, in terms of sound energy levels, this is clearly greater and indicates a serious risk of understating impact.

**Table 5 – Breakdown of departure data**

| Date | Time of 1st Flight | Time of last flight | Day length | Shortest respite (mins) | Longest respite (mins) | Av respite (mins) | No of flights |
|---|---|---|---|---|---|---|---|
| 01/07/2016 | 10:19 | 17:01 | 06:42 | 00:04 | 01:17 | 00:20 | 21 |
| 02/07/16 (sat) | 08:28 | 15:54 | 07:26 | 00:01 | 00:52 | 00:10 | 45 |
| 03/07/2016 | 07:10 | 16:45 | 09:35 | 00:01 | 00:55 | 00:11 | 68 |
| 04/07/2016 | 07:56 | 14:57 | 07:01 | 00:00 | 00:56 | 00:16 | 37 |
| 05/07/2016 | 08:17 | 16:54 | 08:37 | 00:01 | 00:37 | 00:08 | 69 |
| 06/07/2016 | 08:35 | 17:16 | 08:41 | 00:00 | 00:36 | 00:08 | 83 |
| 07/07/2016 | 06:29 | 16:34 | 10:05 | 00:01 | 01:36 | 00:09 | 78 |
| 08/07/2016 | 08:00 | 16:57 | 08:57 | 00:00 | 01:02 | 00:10 | 45 |
| 09/07/16 (sat) | 08:26 | 17:01 | 08:35 | 00:01 | 00:55 | 00:11 | 54 |
| 10/07/2016 | 14:27 | 16:54 | 02:27 | 00:07 | 01:00 | 00:36 | 5 |
| 11/07/2016 | 08:37 | 18:00 | 09:23 | 00:00 | 01:11 | 00:29 | 21 |
| 12/07/2016 | 08:03 | 16:45 | 08:42 | 00:00 | 00:54 | 00:14 | 49 |
| 13/07/2016 | 08:32 | 16:38 | 08:06 | 00:01 | 00:26 | 00:11 | 58 |
| 14/07/2016 | 07:38 | 17:30 | 09:52 | 00:00 | 01:01 | 00:06 | 107 |
| 15/07/2016 | 08:35 | 18:05 | 09:30 | 00:00 | 01:06 | 00:08 | 91 |
| 16/07/16 (sat) | 08:26 | 19:00 | 10:34 | 00:01 | 01:05 | 00:08 | 90 |
| 17/07/2016 | 07:40 | 18:00 | 10:20 | 00:00 | 01:42 | 00:10 | 69 |
| 18/07/2016 | 08:48 | 17:25 | 08:37 | 00:01 | 00:35 | 00:08 | 74 |
| 19/07/2016 | 07:19 | 20:00 | 12:41 | 00:01 | 01:00 | 00:07 | 117 |
| 20/07/2016 | 07:09 | 17:30 | 10:21 | 00:00 | 01:44 | 00:08 | 79 |
| 21/07/2016 | 08:41 | 17:11 | 08:30 | 00:00 | 00:23 | 00:06 | 107 |
| 22/07/2016 | 08:35 | 17:33 | 08:58 | 00:00 | 00:53 | 00:07 | 102 |
| 23/07/16 (sat) | 08:32 | 17:08 | 08:36 | 00:00 | 00:27 | 00:05 | 153 |
| 24/07/2016 | 07:40 | 16:24 | 08:44 | 00:01 | 01:11 | 00:13 | 41 |
| 25/07/2016 | 08:36 | 19:20 | 10:44 | 00:00 | 01:20 | 00:12 | 67 |
| 26/07/2016 | 08:30 | 17:31 | 09:01 | 00:01 | 00:28 | 00:08 | 76 |
| 27/07/2016 | 09:21 | 18:30 | 09:09 | 00:00 | 01:56 | 00:14 | 47 |
| 28/07/2016 | 08:28 | 17:45 | 09:17 | 00:00 | 01:50 | 00:16 | 47 |
| 29/07/2016 | 08:05 | 17:11 | 09:06 | 00:01 | 00:59 | 00:09 | 87 |
| 30/07/16 (sat) | 07:47 | 18:00 | 10:13 | 00:01 | 01:34 | 00:13 | 54 |
| 31/07/2016 | 07:18 | 17:00 | 09:42 | 00:00 | 01:13 | 00:08 | 98 |

**7.97** Based on a more detailed scrutiny of activity using first and last flights this identified that take-offs before 09:00 and after 17:00 tended to be sporadic events and typically the main reason for the longest period of respite. Flight activity from the aerodrome was identified as being the most intensive between the hours of 09:00 – 17:00 which is summarised in Figure 31, below. Interestingly 09:00 – 17:00 also represents a period of 8 hours which amounts to half the suggested interval of assessment of 16 hours for general aviation. Since it would appear that GA seems to operate over a much more compact time frame, it follows that the impact from general aviation should be based on a shorter averaging period. This is also consistent with the WHO approach now adopted. In particular these relate more to the periods of motor sport use and general use of amenity by residents.

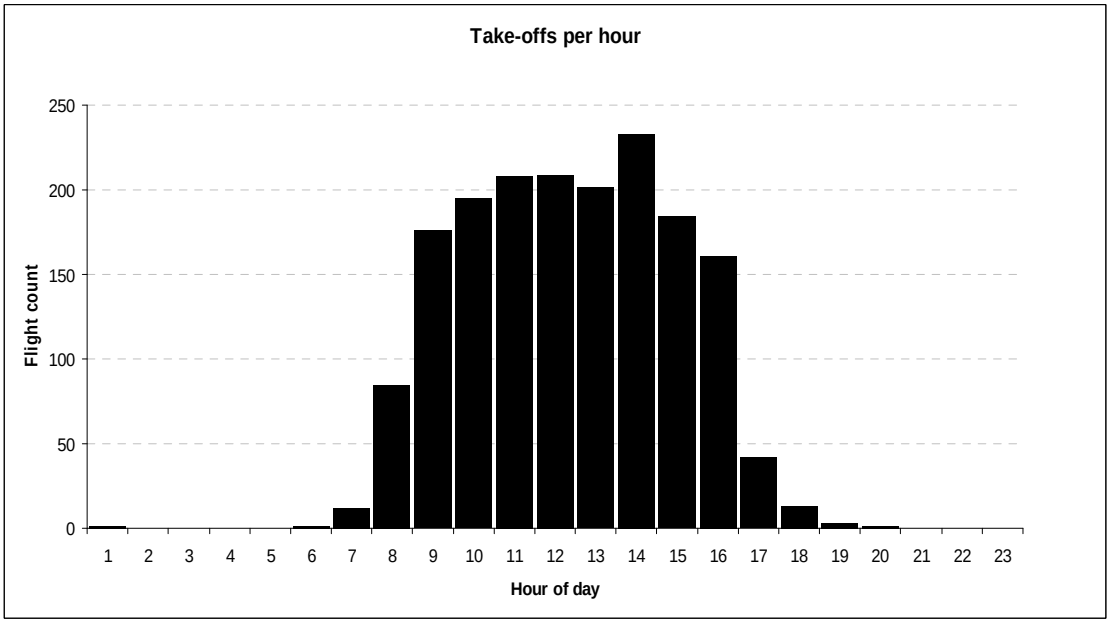


**Figure 31 – Take-offs per hour (July 2016)**

**7.98** With consideration to how greater numbers of take-off events might impact neighbouring land, the data obtained from GA has been used to estimate site levels at location F1 using the activity data for Saturday 16th July 2016.

**7.99** A weekend day was selected to reflect a period of greater potential annoyance due to interference with leisure activities. This has not covered the busiest weekend day but one that falls within the range of the daily / weekly average number of flights. On this

day 90 events of take-off were recorded between 08:30 – 19:00 (a total period of 10.5 hours).

**7.100** To account for the most intense period of aerodrome activity impact has been estimated over an 8 hour period (09:00 – 17:00) and the whole day (08:30 – 19:00). By removing the period before 09:00 and after 17:00 the total number of departures decreases from 90 to 84. Assuming an SEL of 72 dB for an event of take-off the period average for 8 hours and 10.5 hours yielded the same result, 46 dB(A). If averaged as a 16 hour day this resulted in a slight decrease to 44 dB(A). These values are consistent with significant annoyance in a population due to the aviation noise.

**7.101** Even by halving the averaging period there appears to be little difference in overall levels as there would be an expected reduction of 3 dB(A) as with flights occur over a wider range of hours.

**7.102** However if general aviation noise were simply reported on the basis of a 16 hour average this provides no other information about its potential impact. By scrutinising data in more detail this has identified that flight activity from GA is consolidated into a much more intense period of activity and whilst this does not result in a dramatic rise in decibel levels, despite halving the averaging period, it does identify that over a period of 8 hours a potential residential receptor is calculated to be impacted by aerodrome activity every 5 minutes with each event typically lasting for 26 seconds in duration.

**7.103** The above estimation of site level is also unable to account for the variable noise level created by different aircraft taking off from GA. This is described below in Figure 32, which details 2 events of take-off that occurred in close proximity. It is clear from the data presented on the time history that these events would be regarded as loud and dominant in the environment, based upon the degree by which they exceeded the ambient noise levels whilst also detailing that one event was significantly louder than the other. Whilst departure numbers out of GA were known the type of aircraft and corresponding noise level were not

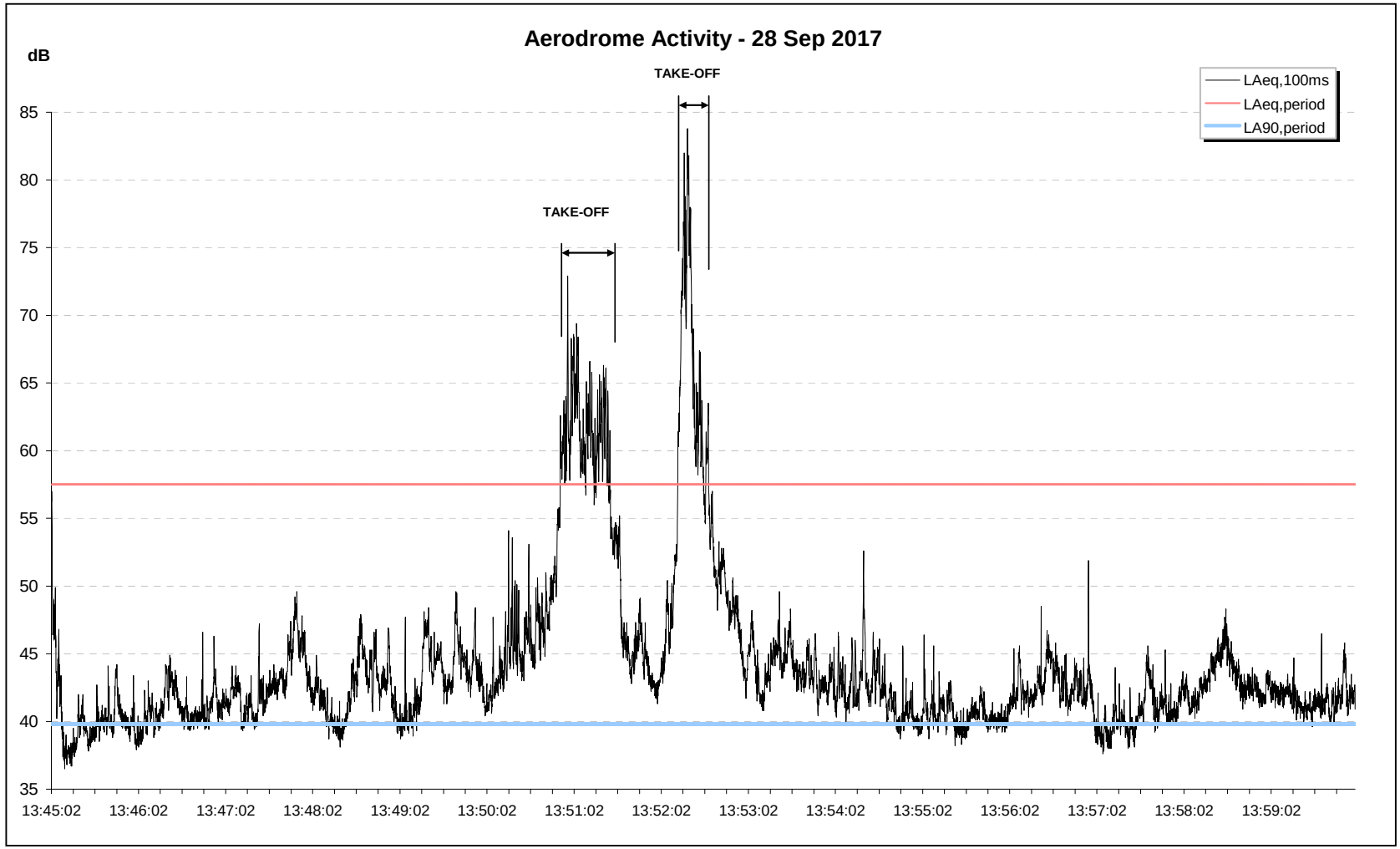


**Figure 32 - Aerodrome activity measured from location F1 (28th September)**

**7.104** What Figure 32 also highlights is that by reporting noise in an average manner the significance of high noise events such as these are hidden. Whilst it is likely that a low number of such events are unlikely to draw an adverse reaction this will not remain the same as the frequency of events increases or when combined to look at cumulative impact from aircraft and motor sport activity.

**7.105** The estimates of impact calculated above are also unable to account for over-flights unrelated to GA which occurred over land south of Goodwood and which appeared to be a significant contributor to activity at this location. There is also the matter that GA is currently operating well under the capacity of its local agreement, which permits a maximum of 70,000 movements per year. The reported average for 2016 was circa 27,000. It is understood that activity numbers at GA have been decreasing as found with many general aviation aerodromes but that is not to say this trend could not be reversed.

**7.106** The consequence of these calculations and activity determines that there remain significant aircraft events that contribute to any impact upon residential use of the land. This relates to the number, intensity, frequency, duration and attention grabbing character of such events as well as their individual dominance / loudness. Not acoustic factors also include visual impact and feelings such as of loss of privacy. This is not determined by its average sound energy level, averaged over a 16 hour day on the same basis a 24/7 or 16/7 activity would affect residential areas.

# 8.0 Acceptability criteria for residential development around Goodwood

**8.1** In line with national policy and guidance noise is relevant to planning in particular when new development would be sensitive to the prevailing acoustic environment or when preparing local or neighbourhood plans. It is also much wider than this.

**8.2** Along with the NPSE this requires identifying whether the overall effect of the noise exposure is or would be above or below the significant observed adverse effect level (SOAEL) and the lowest observed adverse effect level (LOAEL) for the given situation. An added factor is the effect on the existing commercial development of new residential development where it could lead to the constraint or demise of existing noisy activity. Finally, following the new NPPF the effect of the "agent of change" introduces the question whether the development proposed can adequately mitigate impact from existing noisy development.

**8.3** For noise due to motor sport or general aviation there is very limited evidence or guidance which helps to define where the LOAEL or SOAEL lies for either of these activities other than existing assessment methods as identified by the WHO.

**8.4** Both the NSPE and NPPG are absent of any specific and objective noise based levels that defines them and this is correct as the variables mean every case differs. Whilst NPSE does recognise that SOAEL will be different for different receptors at different times it recognises that further research is need to understand what may constitute an adverse impact in specific cases. What is clear and re-iterated by the way the planning guidance is developed is that acceptability criteria is much wider than the decibel level and needs to consider the effects of noise.

**8.5** In this case the evidence of historical complaints, observations of activity at the Goodwood site, application of the science of noise masking and dominance plus attention grabbing character and comparison with existing evolved controls at other sites all indicate that at distances closer than 400m intrusion is clearly unacceptable. Moving further away form this distance the variables increase substantially indicating assessment on a case by case basis but applying the decibel principles derived in this study.

**8.6** The lack of decibel guidance regarding motor sport noise has been acknowledged professionally[34] and unlike other noisy activities such as pop concerts, air travel and industrial noise there is limited available specific technical guidance to assist circuit operators, decision makers and members of neighbouring communities. However despite this lack of guidance current planning policy for identifying if noise is a material factor requires that the degree of the adverse impact must be identified and whether or not a site can be made acceptable in planning terms (such as through mitigation measures) falls primarily back to the frequency and duration of attention grabbing noise in the environment as a result of the source.

**8.7** Where evidence has emerged of potential NOAELs and LOAELs these are largely based on the study of health impacts due to sources such as transportation noise which are regarded as generally benign and anonymous, devoid of tonality, impulsivity, intermittency and other attention drawing features.

**8.8** Whilst it may be considered reasonably appropriate to apply the principles of toxicology in the NPSE strictly to sources of noise identified in the WHO research, the same cannot be considered for heterogenic sources of neighbourhood noise (such as motor sport or general aviation) as there is greater uncertainty because of the limited evidence / research regarding onset levels for adverse effects on health, well-being or quality of life.

**8.9** Absent of any specific limits or guidance it is the opinion of MAS and following experience and the advice of the WHO that existing assessment methods have the greatest benefit, including complaint generating criteria and factors which affect the intrusiveness of noise, especially special characteristics. In this case a buffer zone of 400m evolved and was specifically supported in the local plan process. This is based on both the science in relation to distance, angles of observation, wind direction and other meteorological and topographical effects.

**8.10** Measurement evidence strongly supports the 400m buffer zone but further indicates excess noise can arise beyond this. Following normal planning principles this then

[34] Noise Bulletin [May 2010] – Experts tackle motor sport noise

leads to a process of assessing the extent and frequency of impact beyond that zone along with any mitigation achievable through design and layout.

**8.11** It is clear that in almost all cases land within the current 400m buffer around Goodwood motor circuit (GMC) would unlikely be capable of rendering suitable for development due to the identified exceedance of acceptability criteria when so close to the noise sources and the reduced variation that increases over larger distances.

**8.12** This finding has been determined based on objective and subjective observations combined with measurements of motor circuit activity which has identified this source as being audible and distinguishable in the environment because of the attention grabbing characteristics associated with events of exhaust and acceleration, emergence above background sound levels and its dominance during the peaks of noise. Comparison with acceptability criteria developed in a large range of other sites and cases corroborates these findings and indicates that an area beyond the 400m buffer zone needs careful consideration also.

**8.13** These findings are compounded by recent evidence based research published by the WHO during October 2018 indicating the aviation noise must be considered likely to cause community annoyance at much lower levels than previously considered likely and which arises simultaneously to the motor sport noise. Furthermore, because of the characteristics in the motor sport noise that grabs attention and disrupt at relatively low decibel levels, observations made when motor circuit activity was taking place demonstrated this noise would be regarded as objectionable to any normal reasonable potential future occupier within the 400m zone and exceeded acceptability criteria by a clear margin. Moving outside this zone though there were reductions in noise indicating greater scope for development but considered on a case by case basis.

**8.14** Situations where motor circuit activity was not regarded as objectionable during observations related to the Category 3 track day usage. Whilst there was some distinguishable character from certain cars on the circuit during these periods this was not identified to be such a dominant feature in the local environment when considered in isolation. However if considered cumulatively with other track day events and the totality of noise impact this would be regarded an exacerbating factor indicating stricter criteria.

**8.15** In comparison the observations made during Category 2 track days consistently identified that cars on the circuit were a dominant feature because of the sound energy peaks in the region of 5-20dBA above ambient levels, associated with exhaust and pass-by noise. There was a combination therefore of increased average noise when assessed over a 15 minute period and bursts of higher noise.

**8.16** Attempting to suggest or set limits for the NOAEL, LOAEL or SOAEL with regard to an individual category of an event day or totally, especially aviation and motor sport combined is with substantial difficulty. It is also contrary to the advice of the WHO who has identified the difficulties in cumulative impact assessment from the sources of more benign anonymous noise they have considered in their 2018 guidelines.

**8.17** The WHO do advise the use of currently developed methods and this has considerable merit as it relates to the historical wealth built up over time of what controlling limits work. These indicate short term LAeq values, repeated LAmax(f) values and in the case of Goodwood a buffer zone. Furthermore the short term LAeq and LAmax(f) criteria strongly support the imposition of the buffer zone as recognising a boundary where the noise is clearly unacceptable. Conversely this does not mean outside this zone it is acceptable but the variables indicate increasingly development is likely as you progress further away than 400m, especially where there is scope through design and layout to maximise mitigation, for example by protecting immediate garden areas and daytime living and dining rooms.

**8.18** From the information made available by GMC comparison is made of drive-by noise levels from cars on different Category 3 track days and this is presented below in Table 6. This compares drive-by noise levels of the cars on circuit during observations made on the 28th September with cars in use on other Category 3 days. DB1 and DB2 relate to two different drive-by levels recorded.

| Category 3 Comparisons | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Car | DB1 | DB2 | Car | DB1 | DB2 | Car | DB1 | DB2 |
| Mini Cooper | 80 | 79 | Bentley Flying Spur | 90 | 89 | Skoda Octavia | 84 | 85 |
| Mini | 81 | 80 | BMW i80 | 90 | 89 | Ariel atom | 86 | 87 |
| i8 | 86 | 85 | Ferrari California | 91 | 90 | McClaren 575s | 90 | 91 |
| Alpina | 87 | 86 | Nissan GTR | 93 | 91 | Ferrari F430 Spyder | 92 | 91 |
| BMW M3 | 86 | 88 | Lambo Gallardo | 93 | 92 | Aston Martin DB9 | 92 | 93 |
| BMW M2 | 87 | 88 | Ferrari 458 | 93 | 92 | Nissan GTR | 93 | 92 |
| BMW M5 | 89 | 90 | Porsche GT3 | 98 | 93 | Audi R8 | 93 | 94 |
| BMW M4 | 90 | 91 | Audi R8 Spider | 94 | 94 | Lambo Gallardo | 93 | 91 |
| BMW M6 | 90 | 92 | McClaren 575s | 96 | 94 | Porshce 911 | 94 | 93 |

**Table 6 – Category 3 comparisons**

**8.19** What Table 6 highlights is that in terms of their drive-by levels the fleet of BMW vehicles used during the private track day were some of the quietest. Whilst it has already been considered in this study that it is not always the loudest car that produces the most noticeable noise, the types of cars listed on other category 3 days are noticeably if not up to twice as loud as some of the fleet of BMW cars.

**8.20** Many of these cars can also be identified as high end or prestige vehicles that compare with the type of car that attended the Category 2 day, which were identified as cars producing a distinctive character of sound. For example the BMW M3 produced 86-88dBA but the Porche GT3 produced 93-98dBA and the McClaren 575s 94-96dBA. The Mini-Cooper was 79-80dBA which is approaching a four fold difference in loudness compared to the McClaren. A 10 decibel increase is considered typically a doubling of loudness and a 3dBA increase doubling of the sound energy.

**8.21** With regard to the noise exposure hierarchy used in the PPG and based upon the experience of observing motor circuit activity it is considered that significant and excessive strategies would need to be adopted by residents to cope with and try to block out the noise from motor circuit activity when within the buffer zone. It is considered that motor circuit activity would affect both the internal and external environment of dwellings and given the semi rural location on the fringes of Chichester, would become and be regarded as an incongruous noise if residential development were to be established.

**8.22** As development moves further away this would lessen, in cases dramatically but is dependant on many variables and requires individual case by case assessment against appropriate short term LAeq and LAmax(f) criteria.

**8.23** Within such a locality it would be reasonable to expect residents to be able to open doors and windows for ventilation, thermal comfort and maintaining a connection with the outside environment as part of normal living. However the presence of motor circuit activity would likely lead to noise causing a material change in behaviour by having to keep doors / windows shut most of the time as well as strategies to shut out or mask noise, e.g. playing a radio. This could also lead to the avoidance of using certain activities or rooms during periods of intrusion. As GMC may operate up to a

maximum 245 days a year for Category 1 -3 days only, the potential for intrusion is substantial and clearly material.

**8.24** In an environment where residential development is proposed next to a commercial neighbour of this type, providing alternative means of ventilation or requiring windows to be kept shut would be regarded as unacceptable mitigation since this would interfere with reasonable user rights and enjoyment of property and increasing the potential for a nuisance action to succeed. Increasing the dwelling number within such proximity must be expected to seriously exacerbate arguments of nuisance and their likely success. Permitting such dwellings must significantly constrain the commercial uses and potentially lead tot heir complete demise.

**8.25** It is also considered that the presence of motor circuit activity would seriously impact on the use of any outdoor spaces attached to homes as it would be wholly dominant, distinctive, loud, draw attention and incongruous. Again referring to the local environment which sits on the rural fringes of Chichester and a locality where nature was in abundance, it would be considered that any outdoor amenity space e.g. gardens, would be an intrinsic part of development and by changing the character of the area motor circuit activity would be incongruous to a residential occupation.

**8.26** Whilst the PPG appears to place a lesser emphasis on the protection of garden spaces any relaxation that may be applied to acoustic quality of such spaces (and where determined necessary and desirable) should only be suggested in circumstances where the prevailing noise arises from road transport sources that are not actionable and impact significantly less as they do not constantly draw attention. It is considered habituation to road traffic noise is expected but not motor sport noise where sensitisation would be a normal human response.

**8.27** In the case of a commercial neighbour there would be very little scope to relax the acoustic standards of an environment and in doing this it would expose these spaces to higher levels of motor circuit activity therefore interfering with reasonable expectation, use and enjoyment.

**8.28** With regard to the Goodwood motor circuit being a commercial operator it would not just be the impact upon potential future occupiers that local plan development would

need to consider. The NPPF recognises that occupiers wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established. Thus as a matter of national planning policy the planning authority will need to consider any restrictions or potential demise of the commercial activities by any planning decision which they have and which continues as a primary matter of importance.

**8.29** It is important to recognise that both GMC and GA are placed at risk by permitting residential development within a buffer zone recognised as experiencing excessive noise impact as future development of the air activity is also at risk, for example any future development such as a solid rather than grass runway.

**8.30** Placing housing close to the motor circuit would create a land use conflict with the potential for nuisance action which could risk the demise of the business and a negative economic outcome in the future. This is based on noise levels within the 400m buffer zone recognised as exceeding levels found to cause nuisance at other sites within the UK of similar locality and circumstances.

**8.31** It is important to recognise that decisions in nuisance derive entirely from separate law to planning considerations with different aims and objective. Permitting housing in relatively close proximity to the Goodwood operations could enable nuisance action whether statutory or private to curtail the current operations and impact upon the business. The position over "coming to a nuisance" is complicated since the Supreme Court case of Coventry v Lawrence 2014 (aka Lawrence and another v Fen Tigers 2011 in the High Court) but at best may permit them to argue they have a defence of the GMC noise as was at the time of development. It is at best a possible argument based on the merits of the case but has not thus far been applied to statutory nuisance or in any other case I am aware of with success. The expected outcome is, therefore of constraint and potential demise.

**8.32** Disregarding major strategic cases such as the HS2 rail proposals, it is understood the courts consider planning permissions do not generally affect a decision in nuisance other than perhaps marginally, for example hours of operation of a site. As a general principle it has long been recognised that planning controls should intend to be more exacting than nuisance and would aim to avoid circumstances where nuisance arises.

**8.33** It is also to be recognised that planning approvals assume reasonable use of sites / activities. National planning guidance seeks to minimise impacts and it follows this differs to nuisance where material interference with use and enjoyment of property must generally arise. Furthermore the planning controls are proactive intending to avoid land use conflicts that might be defined in nuisance terms.

**8.34** There are many examples of action taken in respect of other motor sporting venues across the UK that can assist with suggesting decibel criteria to determine if land would be suitable for development and where conflict is expected to arise. These levels are already exceeded in this case at the boundary of the buffer zone.

**8.35** Controls which have developed at other sites have set a threshold of acceptability by approaching the matter based on one or a combination of noise levels and restricting the number of days of adverse impact or with a few exceptions for higher noise. A summary of community noise limits set at some stage at other motor circuits (and based on previous work compiled by MAS) is detailed below. Whilst some development at sites such as Rockingham has revised limits, the principles for setting the limits below remain valid.

**8.36** The purpose of this is to consider and compare situations where a decibel limit is applied in the community and if so what limit. In some cases limits apply only in relation to some of the activity permitted. It is noteworthy that controls relate to short average periods of noise intrusion such as may be experienced over a race or short term activity. This reflects human response to noise which is based on the moment by moment intrusion experienced. Alternatively controls relate to a maximum level of noise not to be exceeded.

**Palmer Promosport – Thurleigh Beds**

- 45dB $L_{Aeq}$ Mon-Fri (40dB 17:30-20:00) at residential locations.
- Maximum level on the boundary[35] of the site - 65dB $L_{Amax}$ 08:00- 17:30 (55dB 17:30 – 20:00).

[35] This is not the level in the community which is much lower.

- There are trackside levels as well which serve as a secondary raft of controls. These are short term LAeq levels set out in planning related controls. These levels are exceeded within the 400m buffer zone applied to Goodwood.
- Other controls i.e. Hours etc.

**Mallory Park – Hinkley and Bosworth**

- 45dB $L_{Aeq,10min}$ at two fixed locations between the racetrack and dwellings.
- 55dB $L_{Amax}$ at the two fixed locations at dwellings.
- Saturdays generally prohibited.
- NOTE: Now superseded as the operating company went into liquidation. These levels are exceeded within the 400m buffer zone.

**Yorkshire Dales Autograss Club**

- Maximum of 13 days a year. Racing shall not start before 11am and must finish by 6pm.
- Other controls TBC.

**Red Lodge Karting, Cambridgeshire**

- Community limit of 42 – 46dB $LA_{eq,5min}$ at the boundary of residential property, depending on the time and type of vehicle operated.
- Note this is adjacent a very busy dual carriageway (A11). The levels are exceeded when within the 400m buffer zone.

**Rockingham Motor Speedway – Northamptonshire**

- Community limit 47dB $L_{Aeq}$ during the day at the boundary of any residential property.
- Four unsilenced event a year (i.e. Formula 1).
- Potential changes & other controls TBC on request. This level is also exceeded within the buffer zone for significant areas and especially when downwind.

**Castle Coombe**

- 10 days of what is described as "Open tyre testing and racing school activities" restricted to Thursdays.
- 10 days of Classic and Historic Use.
- 12 Race Days.
- 206 Days for use by road standard vehicles.
- There are different vehicle noise limits on each. There are no community levels.
- A second noise abatement notice for statutory nuisance was served in January 2005 that introduced vehicle noise controls on the race days. This notice was upheld on appeal.
- Other controls TBC on request.

**Castle Donnington**

- Maximum noise level on non race days to exceed the community ambient level by not more than 5dB - Equates to $L_{Amax(f)}$ of 45dB in the community. The background noise level was 37dB. Control arose from Noise Abatement Notice.
- 40 race days a year permitted with unsilenced vehicles limited by planning decision and Abatement Notice.
- 2 days a week where vehicle testing allowed – Details can be confirmed
- Weekends protected except race days.
- Other Controls TBC on request. The limits based on maximum noise are exceeded within the 400m buffer zone in this case.

**Elvington Airfield near York**

- Crown Court appeal against an Abatement notice led to a Notice in simple terms i.e. Abate the Nuisance. Any Formula 1 testing was held to be a nuisance

and other activities were considered acceptable if they were similar to a former "Selby" agreement.

- Selby Agreement
    - No weekday evening use
    - No activity at all on the last two weekends of a month i.e. a maximum of 28 weekends a year.
    - Use by the MOD effectively meant no weekday use as well.
    - Remainder TBC on request.

**Lydden Hill Motor Racing Circuit**

- Total 52 days of use permitted following planning appeal in 1986. Limits based on hourly LAeq in an abatement Notice upheld in 2016 with an uncontrolled event, 55dBA for 26 events and 50dBA for the remainder.
- Other controls are provided not in terms of decibel levels.
- Note: Many more days are permitted in the case of Goodwood and thus the limits are exceeded in this case within the 400m Buffer Zone. In many locations and cases the 55dBA limit is at times exceeded as is the 50dBA level.

**Tattershall Go-Kart Circuit**

- 44dB $L_{Aeq,1H}$ at 300m in any direction from the track.
- Public Address inaudible 300m from the track.
- Note these controls are not unlike the 400m buffer zone in this case as the limits would be exceeded at Goodwood within 400m.

**Bruntingthorpe Proving Ground**

- Community limit of 40dB $L_{Aeq,10min}$ applied to certain activities including karting that required planning permission. Note this limit was proposed by me and agreed with the appellant's acoustic consultant at a Planning Inquiry. Other controls can be confirmed on request but mainly fall under the 28 day exclusion for temporary activities.

**Mildenhall Stadium**

Controls applied by the High Court in 2011 and upheld by the Supreme Court in 2014.

- 45dB LAeq(15 minutes) falling to 38dBA(15 minutes) after 20:00 hours.
- 55dB LAeq(15 minutes) on a total of 12 weekends (24 days).

Note the main 45dB LAeq limit is clearly exceeded within the 400m buffer zone applied at Goodwood. It is exceeded in locations outside this area but needs to be considered in the context of the locality and the frequency and duration and impact.

**Croft Circuits**

Limits set by the Court of Appeal based on a decision in the High Court.

- 40 event days only to exceed a level of 40dB LAeq(1 hour) per annum based on 70dBA trackside.

  This is exceeded within the buffer zone at Goodwood. It would also be exceeded outside of this area potentially up to about 800m and therefore warrants further consideration.

**Summary on limits of acceptability in the community and their assessment**

It can be seen that there are a range of short term noise limits applied at circuits and motor sports facilities with some common themes and levels of acceptability. These vary from time to time but generally:

- Short term average decibel limits ($L_{Aeq}$ 10minutes – 1hour) of 40 – 47dB applied and in the main 40-45dBA.
- Limit on events exceeding these short term average levels between 10 – 40 days.
- Sometimes maximum noise limits applied of 45 – 55dB $L_{Amax(f)}$ in community locations.

- Average noise limits based on the principles of noise emerging above masking background noise, a set of principles adopted in BS4142. This was especially recognised in the Fen Tigers case i.e. that noise emerging 10dBA above background masking noise levels was clearly much louder and it was these events that were intrusive and warranted control, based on background masking levels.

**8.37** Based on the above summary of available evidence from other motor circuits this identifies that where a level has been set in the community this has been at relatively low levels and relates to relatively short periods of time to reflect the impact at the time as the noise emerges above background sound levels.

**8.38** Reproduced at Table 7 below are noise levels from measurements made during the assessment of site activities from GMC. A column has also been added to this table which describes the range across which the peaks of motor circuit activity were measured. For ease of reference the approximate locations of each measurement position are summarised at Figure 33 below.

**8.39** Despite the different averaging periods at different monitoring locations there is generally a good degree of consistency and the results in table 7 show that most measurements of motor circuit activity within the 400m buffer zone were above the range of the limits of community acceptability that have been reported and / or applied for other circuits. A similar outcome was also noted with peak events (maximum noise), the only exception being measurements made on the Category 3 day (28th September 2017).

**8.40** Based on the observations made alongside measurements during Category 2 events, motor circuit activity at all monitoring locations was regarded as clearly distinguishable and as containing clear attention grabbing events (bursts) of exhaust and pass-by (acceleration and deceleration). Despite the similarity between some of the average levels derived during the Category 3 event day when compared against some of the Category 2 measurements, what sets the Category 2 monitoring apart was the degree to which the noise from these Category 2 events were more prominent and noticeable in the local environment due to the louder peaks and specific character contained within it.

**8.41** Based on the experience of monitoring motor circuit activity from GMC and its regularity it is suggested that the criteria for environmental acceptability should be based on meeting a short term LAeq value reflective of current practice and also use of an $L_{AMAX(f)}$ value, also reflective of current practice. Where these are exceeded residential development would not be considered suitable unless there was sufficient mitigation including quiet areas, protected facades etc., or lack of frequency of impact at these unacceptable levels. In turn this identifies the need for the 400m buffer zone within which these levels are clearly and excessively exceeded and a further zone beyond that where careful consideration of any development is needed following a detailed noise assessment based on the principles of the short term noise criteria considered here.

**8.42** The context of this approach is also that such noise impact does not occur once but is a repeated factor enabling consideration of repeat maximum noise events.

**8.43** Due to the assessment area also being impacted by general aviation activity these other events in the local environment make it difficult to avoid averaging over a 15 minute period without there being GA noise included. This is a complication but not insurmountable. However, the use of the LAmax(f) criteria adds clarity.

| Date | Category | Location | Approximate distance from GMC (metres) | Level dB(A) - SEL | Averaging Period (minutes) | $L_{AMAX}$ Range |
|---|---|---|---|---|---|---|
| 9th Sep 2017 | 1 | A | 260 | 70 | 5 | 70 - 81 |
| 9th Sep 2017 | 1 | A | 260 | 65 | 15 | 63 - 74 |
| 28th Sep 2017 | 3 | A | 220 | 44 | 8 | 45 - 52 |
| 30th Sep 2017 | 2 | B | 220 | 49 | 15* | 54 - 64 |
| 30th Sep 2017 | 2 | A | 220 | 49 | 15* | 49 - 59 |
| 6th Oct 2017 | 2 | C | 260 | 52 | 10 | 52 - 69 |
| 6th Oct 2017 | 2 | B | 230 | 53 | 9 | 53 - 64 |
| 6th Oct 2017 | 2 | B | 230 | 54 | 5 | 53 - 66 |
| 6th Oct 2017 | 2 | D | 500 | 48 | 6 | 51 - 59 |
| 6th Oct 2017 | 2 | E | 250 | 49 | 3 | 47 - 60 |
| 6th Oct 2017 | 2 | F | 350 | 46 | 3 | 46 - 61 |
| 6th Oct 2017 | 2 | G | 180 | 50 | 4 | 53 - 64 |
| 6th Oct 2017 | 2 | H | 290 | 44 | 3 | 45 - 57 |

**Table 7 – Summary of measurement data of Goodwood Motor Circuit (*calculated based sound exposure level where average noise is determined by the emerging bursts of noise in isolation)**


**Figure 33 – Monitoring locations specified in Table 7**

**8.44** The evidence is clear that the levels experienced at the monitoring locations and now expressed in terms of LAmax(f) in Table 7 above were periods of noise considered unacceptable and which would lead to adverse community reaction. They exceed the SOAEL but by an indeterminable element as we are unable to differentiate the point where the noise becomes acceptable. However, there were a couple of borderline scenarios objectively assessed with levels of 44dB LAmax(f) and this serves to potentially define a boundary, along with limits developed at other sites where it may move towards acceptable subject to regularity.

**8.45** When considering the points from the PPG discussed above at paragraph 4.20, at a distance of 400m from the Goodwood circuit and disregarding the GA impact, significant adverse impact is identified and occurring. The question of a good standard of amenity relates to the frequency and duration of the impact currently experienced at these distances.

**8.46** At greater distances than 400m there can remain significant adverse impact but less frequently due to the diversity caused by weather effects which lead to greater variation at larger distances than this. At 400-600m there is a wind direction reduction when upwind of the order of minus 10dB and +2dB when downwind. At these distances cross-wind effects are considered likely to be relatively neutral. Meteorological variables increase significantly at greater distances leading to less certainty over the most distance effects.

**8.47** Notwithstanding the increased variations in decibel level beyond the 400m buffer zone, the guidance notes that "there is not a simple relationship between noise levels and the impact on those affected" and outlines a range of factors that should be considered when assessing noise impact. These include:

a) The source of noise and absolute level together with time of day it occurs (and that it may be more noticeable where background levels are lower)

b) For non-continuous sources of noise, the number of events and the frequency and pattern of the occurrence of noise

c) Spectral content and the general character of the noise

d) The cumulative impact of noise from more than one source

**8.48** All of the above factors are increasingly variable at greater distances such that as distance increases the acceptability of noise impact in any location will depend on a more complex assessment of meteorological, existing background sound, distance effects and other noise source variables. These factors indicate a simple buffer is no longer practicable increasingly beyond about 400m but decibel criteria can still indicate acceptability based on frequency and duration of impact along with masking noise levels, quiet spaces and part of dwellings etc.

**8.49** In summary therefore in terms of suggesting the level for environmental acceptability this has considered measurements across the evaluation area having regard to the current restrictions that limit development within 400m of GMC. The closest receptors to the 400m boundary can be identified as location F and H which was measured at approximately 350m and 290m from GMC circuit edge at the approximate nearest point. With reference the range of values specified in Table 7 it is suggested that the LAmax(f) criteria assists and a regular exceedance of a value of $L_{AMAX(f)}$ 46 dB (free field) indicates unacceptable impact is likely. Similarly slightly lower shot term LAeq criteria are relevant as an assessment tool along with the 400m buffer zone within which levels are clearly excessive.

**8.50** In addition, applying the developed principles applied at other circuits as recommended by the WHO, the science that impact relates to the audibility and emergence of attention grabbing noise above masking background sound levels and the frequency and duration of the levels of excess impact, this leads to 3 criteria of unacceptability as follows:

a. Development within the 400m buffer zone where it is clearly indicated levels exceed common criteria of unacceptability and found to cause nuisance in other similar localities in the UK.

b. Development where noise levels exceed either 42dB LAeq(15 minutes)[36] as a free field value, other than rarely and noise has not been mitigated to

[36] The range of criteria indicating unacceptability was from 40-45dBA and in one case 47dBA but generally related to emergence of a dominant noise which in this case occurs at relatively low levels. Furthermore this is not a

provide noise protected facades and external areas through the layout and design of buildings along with features which provide respite and protection from excess noise such as screening. This excludes mechanical ventilation permitting windows to be kept closed as this is still a material loss of rights of enjoyment.

c. Development where LAmax(f) levels from GMC regularly exceed 46dB (more than 5 times in any 5 minutes) as a free field value, other than rarely and also subject to the mitigation considered in b) above.

d. The decibel controls need to be considered as part of any noise impact assessment in a zone extending up to 800m from the GMC site.

e. The criteria also reflect the added intrusion of general and other aviation noise which requires additional and separate assessment and should not exceed 45dB LAeq(12 hours) i.e. 07:00-19:00 hours as a free field value[37] other than exceptionally without mitigation creating protected spaces.

**8.51** The controls above relate to Category 2 and 3 events but not Category 1 events. In terms of LAeq levels there is some argument that values of 45dB LAeq would be acceptable on a small number of occasions in addition to Category 1 days but that this should not be more than arising on a few days a year and would need to be considered on an individual case by case basis outside the 400m buffer zone. Typically 5 days. Similarly arguments arise in relation to the LAmax where levels up to 55dB LAmax(f) may be considered for a small number of days to reflect atypical circumstances. These recommendations are not transferred to the main findings and conclusions as they would require individual analysis and assessment as to the circumstances of development.

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nuisance control but under the T&CPAs. The balance therefore is at the lower end but with flexibility based on a case by case assessment.

[37] Note WHO guidelines are façade levels and theoretically these may be higher than free field values for the same source but generally aircraft noise as a source above is not so readily assessed through an assumed reflection factor of 3dB. Furthermore, in free field conditions there is potentially greater ground reflection. In the absence of clarity a free field value is adopted.

**8.52** It can be seen that all the periods of noise from Category 2 and 1 events exceed the criteria within the buffer zone and will do at is boundary, with one exception which is due to the transmission conditions. It also indicates significant mitigation is needed to reach an acceptable environment for Category 1 and 2 events. In view of the separation distance and physical limitations on any site, this does not appear practical and the 400m buffer zone is an important and beneficial control over development.

**8.53** Beyond 400m it is necessary to demonstrate the frequency and duration of exceedance of the above decibel criteria coupled with any balance of mitigation through design and layout producing benefits such as the main daytime living rooms being protected by buildings as well as the main near dwelling garden space leading to a case by case decision basis looking at the merits of each.

**8.54** Beyond 800m the frequency and duration of adverse impact is likely too infrequent to be of concern but within this noise impact assessment of the GA and separately GMC is required, comparing the LAmax(f) and LAeq values considered within these conclusions.

**8.55** What the study has not suggested is the level at which NOAEL, LOAEL or SOAEL would be achieved but that they are below the short term LAeq and LAmax(f) criteria suggested in this report.

**8.56** This criteria is developed without the effect of general aviation that is additional and separate as identified above.

**8.57** Criteria of acceptability for general aviation

**8.58** As with motor sport there is limited guidance which defines the level of acceptability for general aviation noise but this is recently modified by the WHO Noise Guidelines 2018. Historically higher levels of the order of 50-52dBA as a daytime average may have been argued relevant but the evidence based criteria issued by the WHO indicated Ischemic heard disease issues at levels of 52dBA as an $L_{den}$ façade level and 45dB $L_{den}$, equivalent as a 12 hour average value of 45dB as a point of onset of serious community annoyance. This is also a façade level.

**8.59** These new evidence based findings undermine previous approaches and arguments, they add significant clarity as to how level are derived but do not differentiate general aviation from jet transport aircraft. As a result it is unsafe at the current time to apply stricter criteria to GA but equally inappropriate to permit greater levels than 45dB LAeq(12 hour) i.e. daytime level.

# Appendix A

## Fundamentals of noise assessment and application of guidance.

**PART I**

It is commonly necessary to go into this issue of an acoustician's evidence on noise acceptability which is commonly based on the principle that noise below an absolute decibel level is acceptable regardless of its character content. Furthermore the derived absolute levels are in relative terms high and formulated on the same parameters as health effects from road traffic noise.

This is perceived as a growing problem within the profession which I and others have researched and reported upon, in my case in an international paper presented to Internoise 2017. I suggest that once the primary principles that are long established are recognised, the application of guidance and its usefulness becomes significantly easier.

The discussion here about noise disregards workplace noise exposure which arguably falls into a third category.

Further general discussion on the assessment of sound and noise is provided in the following part 2 of this document.

**Noise impact versus acoustics.** There is a substantial difference between noise impact and acoustics / sound level measurements which derive from different psycho-acoustical effects. In essence and in order to simplify issues, there are two main types of noise impact upon communities and which are conventionally split under three headings. These headings do not replicate their differences in terms of impact / effect. The three headings used are as follows:

Environmental noise which effectively refers to transport sources

Neighbourhood noise which mainly relates to commercial sources within communities and

Neighbour noise which relates to matters such as domestic noise, dog barking and similar.

**Main types of noise.** Whilst these categories have their uses, there remain two main types or classifications of noise in an environment, those which we call "anonymous"[38], benign noise or lacking attention grabbing content, which we generally tend to habituate to over time such as with distant or almost continuous road traffic and those with special characteristics which intrude and impact mainly due to those characteristics and to which we commonly sensitise over time.

Those with special characteristics are normally but not exclusively associated with Neighbour and Neighbourhood noise. There are of course exceptions and sources which may exhibit elements of both which is why sometimes, in context, exceptions to general principles of assessment may apply.

Road transport noise is generally 24/7/365 and we have a lot of research such as WHO Community Noise guidelines and Night Noise Guidance for Europe that can show onset points of "critical health effects" where physiological and psychological changes can be determined to the point we now estimate deaths where noise is a contributory factor. These "critical health effect" values are more or less replicated in BS8233 and its guidance limited to this type of noise.

Where BS8233: 2014 discusses relaxing levels it relates to accepting a larger portion of the population experiencing increased critical health effects which may be a balance needed in some cases where housing is a critical requirement. BS8233: 2014 is clearly caveated in various places, identifying it does not apply to noise with special character.

**Noise with special characteristics**. The second type of noise is that which grabs attention unconsciously and so disrupts activities and to which we generally sensitise. The range of special characteristics is considerable and unlike the "anonymous" noise we cannot relate their effects to the sound energy dose. Even in the case of "anonymous" noise, guidance identifies circumstances and elements which cause increased sensitivity and impact. A common example is the presence of low frequency noise where lower guideline values are

[38] We generally class it as anonymous as we do not relate to it a particular site or neighbour activity and in the mind its messages are progressively ignored over time to the point we can often become unaware of it until there is some change drawing our attention. This is a normal natural process.

recommended. The guidance does not say how much lower as our understanding remains too limited.

Special characteristics can be acoustic such as tonality and non-acoustic such as insults or foul language. This is why the WHO state[39]:

"Whilst sound can be measured with the help of acoustical instruments such as sound level meters, the actual extent of noise nuisance cannot be measured in this way. One of the negative noise effects is annoyance. Large-scale population studies show that only one third of noise annoyance can be accounted for through exposure to varying sound levels. Non-acoustical factors, including personal factors such as noise sensitivity, and social factors, can have as much effect as the sound level."

What distinguishes the two types of noise generally is that one type is progressively ignored by unconscious brain processes (you habituate to it) and the other increasingly draws attention (you sensitise to it) where mental processes are disrupted. Exceptionally loud anonymous noises do differ as the brain processes loudness separately and there will also be physiological responses and not just those related to memory. As discussed above further analysis of this is provided in Part II below.

In effect it is normal for some noises to intrude simply because they trigger unconscious reaction and acceptability becomes an issue of their frequency, duration, times they occur, what they disrupt, where and the materiality of their effects. Loss of sleep inside a bedroom is clearly more important than intrusion at the end of a garden only.

In other cases, mainly rail and road transport, we are progressively less affected consciously over time but may recognise experience of lower quality sleep etc. without realising one of the reasons for that is the noise climate. Another common factor is having to keep windows closed due to noise leading to increased C02 that also reduces sleep quality or causes tiredness and dreariness during the day. This is why an effective and quiet form of mechanical ventilation is essential but cannot address the problems from GA and motor sport noise.

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[39] Technical Annex, Noise and Health – Local authorities, health and environment 2000

Possibly one of the biggest issues in noise assessment at present, both in the UK and internationally is assessing impact of noise with special characteristics using guidelines and principles directed at “anonymous” noise. This is commonly the case with motor sport and similar sources which emit a significant range of varying noise characteristics some of which are significantly varied and commonly draw attention.

Furthermore there is no scientific basis or standard acoustic principle for adjusting a health related sound energy level of “anonymous” noise such as applying a penalty to guideline values of “anonymous” noise to reflect the impact of the noise exhibiting those special characteristics. This is due to the wide variables and the fact commonly it relates to the extent it unconsciously disrupts mental processes which is not the same as sound energy level that is processed by different neurons in the brain. The penalty ignores the fundamental principle, does the noise still grab attention and thereby disrupt sleep, rest, relaxation and cognitive tasks etc.? They relate to how well the brain perceives the noise. This is why BS4142:2014 relates the penalties in a formula based on how the intrusive noise emerges above background sound masking levels and not to an absolute level. BS4142 is addressing character in noise over a short period precisely because the effect of attention drawing character is a moment by moment effect.

It is instructive that BS4142 looks at noise over an hour during the day and 15 minutes at night whereas BS8233 and WHO values are based on long term exposure, effectively over a year.

Interestingly in cases of high concentration i.e. enhanced mental processing such as when at work, there is less capacity for attention grabbing and disruption but this does not apply to mental tasks involving less effort such as trying to relax.

General “anonymous” noise guidance or guideline values as found in the WHO Community Noise Guidelines 1999, The WHO Night Noise Guidelines for Europe 2009 and in BS8233: 2014 but are clearly caveated to avoid such problems, despite which they are commonly and widely misapplied as my 2017 research found and as commonly found with motor sport noise.

**Exceptions.** It is logical that many sources of noise will fall between the two main types of noise identified here and potentially contain elements of both. However, if there is attention

grabbing characteristics these will generally dictate response, subject to the frequency and duration of those characteristics and what they disturb.

Similarly, broadband, steady continuous anonymous noise can sometimes intrude where it is incongruous or alien in the sound environment experienced. It might be considered the difference is a special character in the context of that case. Conversely some forms of music and rhythmical or natural sound can be relaxing and / or mask unacceptable noise. The motion of sea waves is one recognised as possibly achieving this and classical music as it has a slower rhythm and less beats etc. Sounds from young children playing are pleasant or relaxing for some and intruding for others. However, these masking sounds only tend to work when controlled by the person impacted as lack of control is a significant non-acoustic factor in terms of noise intrusion.

It is for these reasons BS8233: 2014 directs the reader to using BS4142: 2014 for industrial noise and in BS4142: 2014 there are worked examples where reference is made in a couple of narrowly construed circumstances where BS8233: 2014 might assist. It does not promote the guideline values in BS8233 but recognises there might be circumstances where lack of special characteristics means wider health principles for "anonymous" noise may help formulate a limit due to the benign, anonymous nature of the intruding noise. I consider no more weight can be given to it than that.

Another problem is a commonly held false belief internal sound environments do not drop much below about 30dBA at night and rarely below 20dBA. This is simply wrong and commonly dictated by measurements using instruments incapable of measuring sufficiently low. For example we now routinely use specialised low noise floor microphones when measuring internally and obtain levels as low as the noise floor of the instrument which is less than 10dBA. In urban areas we are recoding values typically 10-15dBA. Thus an intruding noise of 20-30dBA could be twice to four times louder than any masking noise present and wholly dominate the internal sound environment changing it to an alien one.

**Using incorrect guidance but that permits more noise.** The primary problem is that guidance for "anonymous" types of noise permits substantially more noise than that for noise with special characteristics and as a result can potentially permit development the specific guidance or absence of guidance but application of standard principles such as how well it is masked, would prevent.

In nuisance cases the special characteristics would be assessed using the basic principles relating to attention grabbing as discussed above. Planning guidance also now widely adopts these principles by focussing on coping strategies adopted by people, i.e. how they modify their lifestyle.

Disregarding these important factors and using “anonymous” noise guideline values for noise with special characteristics as is now commonly applied understates impact.

In terms of nuisance the following criteria are of significance. It can be seen the decibel level is only one and acoustic factors a limited element:

character - both of the noise and of the area

duration

time of occurrence

loudness

message imparted by the noise

variation in noise over time

spectral content of the noise

frequency of occurrence

regularity / predictability of the noise

respite from the noise, length / duration of respite

how easily the noise can be avoided

impact of the noise on basic needs such as sleep and communication

cumulative impact of noise intrusions (different noise sources from single or multiple sites)

the necessity of the noise also in relation to greater society

decibel level of the noise

visual or other impacts associated with the noise

## Part II - Assessment of sound and noise

Human hearing has been referred to as "the sentinel of senses".[40] Its capacity to respond to information and changes to that information in light, dark, consciousness and sleep is incredibly sophisticated.[40] As noted by Jones et al (2010) it appears that human hearing is obligatory, we cannot help but hear, attend to (specifically or inadvertently) and respond to our aural environment.40 It is a fundamental human response and dates back to our evolutionary past when certain sounds would have had significant meaning. Many of these basic responses remain engrained and are even exploited, for example in music and film, to elicit emotional response.[41]

Our environment is made up of many different natural and man made sounds. Human responses to sound combine both physiological responses, i.e. a response to the disturbance of a sound wave moving through the air and through our auditory pathways, and psychological responses. Psychological responses can be influenced by physiological responses, how these responses are processed by the brain and many other subjective factors including non acoustic factors such as attitudes to the sound source.

The difference between sound and noise is dependent on a number of subjective, personal and situational variables. Subjective responses may be acoustic and non acoustic and can depend on factors such as age, absolute decibel level, character of the sound, time of the day at which the sound occurs, personal attitudes to the sound and historical experiences, the attitudes of those generating the sound, character of the area etc. As defined by others, "sound can be measured by a sound level meter or other measuring system. Noise is related to a human response and is routinely described as unwanted sound, or sound that is considered undesirable or disruptive".[42]

The distinction between sound and noise at an individual level is subjective. Just as there are different preferences for musical taste the judgement of sound versus noise can vary widely

[40] Davis H. Preface. In Stevens SS, Warshofsky F, ed. (1970) Sound and hearing. Netherlands: Time Life Books. Cited in Jones DM, Hughes, RW, Macken WJ. (2010). Auditory distraction and serial memory: The avoidable and the ineluctable. Noise Health. 12:201-209.

[41] For example the lack of wildlife sounds and silence in woodland scenes to indicate danger or the Jaws theme, a low frequency sound increasing in pace and getting louder indicating advancing danger.

[42] British Standards Institution (2014) *BS4142:2014: Methods for rating and assessing industrial and commercial sound*. London: BSI.

from person to person. This includes differences both in sounds that are considered pleasant and unpleasant but also individual sensitivities to noise, i.e. hearing thresholds.[43]

The assessment of whether sound is noise and whether that noise is unreasonable is not always simple but most people will commonly recognise levels and types of noise they find unpleasant and that materially affect the use of property especially in relation to rest and relaxation.

There are certain features of sound that are generally considered to increase annoyance and reduce tolerance and thus can be treated as exacerbating factors. These are mainly features that attract attention, rendering the sound more discernible and include impulsivity, tonality and intermittency. Steady, continuous, anonymous[44] sounds, for example distant road traffic noise, are generally considered easy to acclimatise to and habituation can arise relatively quickly. Sounds that have an identifiable source, impart a particular message, are variable, unpredictable and have specific identifiable characteristics such as a hum or drone are more annoying at lower sound levels than steady continuous sounds and typically spark adverse reaction and ongoing complaints without acclimatisation. In many cases increased sensitivity to the sound source can arise and it is generally accepted that this aspect of sensitisation is a normal and typical response.

Our brains are constantly analysing and interpreting our sensory environment. As noted in Baars & Gage (2010) "The central role of the auditory perception system is to extract information from the listening environment in order to determine what is happening around us".[45] Attention can be drawn to sounds voluntarily or involuntarily. It is often involuntary attention that can cause annoyance as this disturbs other tasks to which we are trying to direct our attention. On hearing a loud or unexpected sound we become instantly alert, entering a state of heightened arousal in assessing what the noise was, where it came from.

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[43] With regards to nuisance assessment it is generally accepted that those who are hypersensitive to noise are not protected.

[44] Not triggering a response relationship for example to a particular event or location such as would arise with a neighbour's dog.

[45] Baars, B. & Gage, N.M. (2010). *Cognition, Brain and Consciousness: Introduction to Cognitive Neuroscience.* 2nd ed. Oxford: Elsevier.

This is also true when there are changes in our auditory environment that perhaps are unexpected or cannot be easily explained. The effect is described by Baars (1997) in relation to the Orientating Response (OR):[46]

Suppose you hear the sound of a refrigerator pump – a series of noise bursts of a certain duration, spectral distribution, onset, offset envelope, location in space, cycle time, and so on. If the sound is not painfully loud, people will tend to lose awareness of it rather quickly, but they will tend to be conscious of the noise again as soon as any parameter of the sound changes: The noise can become louder or softer, the time between the noise bursts can change, the intensity envelope can change, or the noise bursts can just stop. Any of these changes will trigger a new OR, just as we may become aware of the noisy refrigerator as soon as the noise stops. [47]

Theories relating to our expectations of sound and how we react to and perceive events that do not correlate with our previous experiences have been much discussed in relation to our perception of music. The same basic principles can be applied more generically to noise and sound. Constant sound with little change to volume, pitch / frequency or character will be easily accustomed to and requires little cognitive appraisal or attention. Negative responses are more likely to be associated with unexpected changes in loudness, frequency content and more generally by sounds not behaving in a predictable manner. Furthermore, our previous associations and memory of sound will influence and guide future reactions and interpretations. For example, one night of disrupted sleep due to an irritating mechanical hum may elicit an early adverse response to any future occurrences of the hum compared to the first experience due to the pre existing associations with sleep disturbance. Much of this again relates to the character of the noise and the interpretation of any message imparted by the noise in assessment of noise impact.

Restful and relaxing environments are typically those with a lack of attention drawing characteristics and with positive associations. For example, music labelled as 'relaxing' typically has a slow tempo, with predictable, consonant harmony and minimal melodic,

[46] The orientating response, or orientating reflex, is a response to a change in an organism's environment usually elicited by novel stimuli.
[47] Baars, J. B. (1997) Contrastive phenomology, in: Block, N.J. Flanagan, O. and Güzeldere, G. (eds) The nature of consciousness, philosophical debates. Massachusetts: MIT, p. 191

dynamic and harmonic variation. In seeking rest and relaxation we are therefore typically searching for 'quiet'. This can have several relevant meanings with respect to noise and sound as described in Andringa and Lanser (2013). [48] Firstly and most simply it can refer to a lack of (or little) noise / sound. Secondly, 'quiet' can also refer to a lack of activity or disturbance, for example the relaxing music with minimal changes in melody / harmony or one simple noise source as opposed to multiple different noise sources. Finally 'quiet' can refer to mind states that are not disturbed or interrupted, i.e. a lack of attention drawing character such as the constant, broadband noise from a fan compared to a mobile phone with a melodic ring tone that keeps ringing.48 Thus, consideration of sound and noise is not simply limited to level (decibel level / loudness) but specific features of the noise / sound and how they interact with and influence our environment.

The human hearing mechanism is incredibly sophisticated, perceiving sounds from around 0-130 decibels (dB) over a range of 20 cycles a second (Hz) - 20kHz. The human ear can adjust to and be startled by very quiet sounds especially when there is little or no other sound, for example a twig breaking in the countryside at night time and at the other extreme can perform temporary threshold shifts to adjust the auditory threshold and protect itself from very high and / or sudden exposure to sound (for example a loud rock concert). The human ear is more sensitive to certain frequencies, typically between 1kHz and 4kHz (approximately the top two octaves on a piano) as this is an important part of the range of speech. However, when a sound is dominated by lower frequency content, typically below around 200-250Hz, it is also recognised as more intrusive than noise that has a more 'balanced' spectrum and so warrants special attention.[49] The A weighting decibel scale (dB(A)) is used to adjust the absolute sound levels measured to reflect the approximate sensitivities of the

[48] Andringa, T.C., & Lanser, J.J.L, (2013). How Pleasant Sounds Promote and Annoying Sounds Impede Health: A Cognitive Approach. *International Journal of Environmental Research and Public Health*. 10 pp 1439-1461

[49] See Leventhall H G. Low frequency noise and annoyance. Noise Health 2004;6:59-72. A balanced spectrum has an accepted fall off in noise level per octave. In an office an acceptable fall of per octave was found to be 5dB / octave. Where there is an excess of low frequency noise this is typically perceived as a 'rumble'. The difference between C weighted and A weighted levels (see glossary for definitions) has also been found to indicate dominance of low frequency noise. If the difference between C weighted and A weighted values is greater than around 20dB then there is a potential for a low frequency problem. Caution should be exercised in low noise environments.

human ear, though it is recognised it cannot reflect all elements of the noisiness and intrusiveness of a sound, especially low frequency sounds.

Sound is most commonly measured in decibels, though there are other means for assessing sound, for example using loudness scales. Some common sound sources and approximate decibel levels are given below. A change of 3dB(A), in a sound without other change in its content, is just noticeable to most people in an environmental location and an increase of 10dB(A) in the sound level is typically perceived to be twice as loud.

Some examples of typical decibel levels measured by MAS are given in table 2 below as a guide. However, it is noted that these are decibel levels alone and do not include a description or penalty for character or context of the noise which in reality would contribute to its acceptability / unacceptability.

Table 8: Typical short term decibel levels for common sources of noise[50]

| | |
|---|---|
| Amplified music in bar | 96dB LAeq,T |
| Road traffic - busy dual carriage way, approximately 20m from centre of carriageway | 73dB LAeq,T |
| Light aircraft flying directly overhead | 70dB LAeq,T |
| Restaurant extract fan at 1m | 68dB LAeq,T |
| Skate park average sound level at 6m | 61dB LAeq,T |
| Mixed residential and industrial area, evening ambient sound level (external) | 55dB LAeq,T |
| Open plan office average daytime sound levels | 50dB LAeq,T |
| Urban residential ambient sound level, night time (external) | 35dB LAeq,T |

[50] Significant variation can arise, for example, music levels in a bar may drop typically to around 80-85dB(A) in cases and external levels will depend on context and time of day.

| | |
|---|---|
| Rural night time ambient sound level (external) | 25-30dB LAeq,T |
| Noise in flat from neighbour's TV located in flat directly above. Clearly audible though content (words) not discernible (internal) | 23dB LAeq,T |
| Inside remote rural bedroom, night time (window partly open) ambient sound level | 12dB LAeq,T |

Whilst research in to threshold levels for sounds with specific attention drawing characteristics is limited, for example the onset point of annoyance in a given set of circumstances, some basic sound level thresholds have been found for steady continuous sources such as road traffic noise and relating to the onset of critical health effects. A long term steady level of noise of approximately 42dB(A) outside a window from transport sources at night is recognised as the point above which there are increasing adverse sleep effects. [51] An impulsive / peak noise of 35dB inside is recognised as likely to cause some sleep disturbance and a maximum level internally of 42dB(A) is recognised as commonly leading to awakenings when there is repeated incidence, especially during periods of lighter sleep. These threshold levels are based on research into sources of noise typically considered benign (e.g. road traffic noise) and it follows that there will be sleep disturbance effects, such as lower quality sleep, at some intermediary level where the noise contains specific character.[52]

Further information on the measurement of sound, definitions, terms and commonly used parameters for measuring sound can be found in the glossary in appendix A.

[51] This is an Lnight,outside value. See: World Health Organisation (2009) *Night noise guidelines for Europe*. Geneva: WHO.

[52] It is noted that sleep criteria, and indeed many other threshold levels of acceptability, have often been based on transportation sources and it follows that sounds that do not have the same benign, steady, anonymous character are likely to disrupt sleep at lower levels. This is likely a combination of lack of habituation to sounds that are not steady, anonymous etc, to which a listener might actually become more sensitised, and due to attention grabbing characteristics that are not always recognised in traffic noise. For example it is commonly accepted that audible music bass beats at night in a dwelling are unacceptable and likely to disrupt sleep, regardless of level.

**Annoyance.** The WHO use the word "annoyance" to describe a wide range of human responses which go beyond the lay use of this word. The relationship between noise and annoyance is well summarised by Guski et al (1999).[53] The paper describes a number of definitions of annoyance, influenced by a number of variables:

Annoyance as emotion, i.e. an affective process related to the sound source for example fear of plane crashes.

Annoyance as disturbance, intrusion and disruption of day to day activities such as speech communication. This latter is most often related to nuisance, noise having a material effect on the use and enjoyment of amenity.

Annoyance as attitude, most people will have an opinion of a noise source as either good or bad even if they have no personal experience of the source.

Annoyance as knowledge, judgements of a sound source in a given situation will be influenced by prior knowledge of that sound source, for example the detrimental effects of aircraft noise on learning.

Annoyance as a result of rational decisions, i.e. making an annoyance decision based on a combination of factors and balancing these factors, for example the level of noise and exposure time of noise, historical exposure to the noise, the actions of those responsible for the noise.

In reality, annoyance is likely to be influenced by all of the above factors and by acoustic and non acoustic factors. Guski et al (1999) found that annoyance was mainly a result of "(1) immediate behavioural noise effects aspects like Disturbance and Interfering with intended activities, and (2) evaluative aspects like Nuisance, Unpleasantness and Getting on one's nerves". Guski et al (1999) define annoyance as "a psychological concept which describes a relation between an acoustic situation and a person who is forced by noise to do things he/she does not want to do, who cognitively and emotionally evaluates this situation and feels partly helpless".

[53] Guski, R., Felscher-Suhr, U. & Schuemer, R. (1999). The Concept of Noise Annoyance: How International Experts See It. *Journal of Sound and Vibration*. 223(4) pp 513-527

These definitions go a long way towards identifying why noise can be highly intrusive and annoying even at lower decibel levels. By interfering or disrupting activities in the home (by attracting attention away from the intended activity) and because of variable and intrusive (tonal, impulsive etc.) noise characteristics (typically evaluated as unpleasant noise characteristics).

The assessment of noise impact and annoyance is often related to decibel levels and whilst this offers an easy approach to assessment it often oversimplifies the judgements and interacting factors that occur in reality. The WHO (2000) [54] state:

"Whilst sound can be measured with the help of acoustical instruments such as sound level meters, the actual extent of noise nuisance cannot be measured in this way. One of the negative noise effects is annoyance. Large-scale population studies show that only one third of noise annoyance can be accounted for through exposure to varying sound levels. Non-acoustical factors, including personal factors such as noise sensitivity, and social factors, can have as much effect as the sound level."

[54] Technical Annex, Noise and Health – Local authorities, health and environment 2000

## Appendix B – Glossary of Terms

*This glossary is harmonised with relevant British and ISO standards which are referenced. Some definitions vary slightly due to updates since written and with other noise guidance documents.*

**A-Weighting** - This is a function which attempts to simulate the characteristics of human hearing at lower levels. Hence a dB(A) reading is an estimate of what we actually hear for quieter sounds whereas dB(LIN), {dB(C) on simpler instruments}, is an objective reading of what is actually physically present. However, for louder and low frequency sounds dB(C) correlates better to the human ear.

Note, dB(A) has been proven not to be so effective in weighting for human hearing at low frequencies.

**Acoustic environment** – Sound at the receiver from all sounds as modified by the environment. The acoustic environment can be the actual environment or simulated, outdoors or inside, as experienced or in memory. [ref BS ISO 12913-1 2014]

**Ambient sound** – Totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far. The ambient sound comprises the residual sound and the specific sound when present. [ref BS4142 2014]

**Ambient sound level (La = LAeq,T)** – Equivalent continuous A-weighted sound pressure level of the totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far at the assessment location over a given time interval, T. [ref BS4142 2014]

**Attenuation** – The loss in energy level of the sound usually used in relation to the loss due to sound passing through a structure or enclosure.

**Background sound level (LA90,T)** – The A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest number of decibels. It is the underlying level of noise in the absence of the source and normally excludes most short duration noises

(depending on time interval relative to the presence of source noise) (see **Residual sound level**). [ref BS4142 2014]

**Note:** Many other guidelines and documents reference background noise level. There is a general move to sound level.

**Background sound level ("influenced")** - In many situations the background sound level can be measured either when the source or premises from which sound emanates, or is associated with, is not operating. Alternatively the intermittency of the source means that it does not have any appreciable effect on the background level, which is a statistical level based mainly on sound that continues with limited breaks. Where this is not the case the measured sound level will be increased and thus influenced.

**Background sound level ("uninfluenced")** - This refers to any measurement of the background sound level that has not been increased due to noise associated with the source.

**Broadband Noise** – This is noise covering the whole of the audible frequency range. Compare to narrow band noise which is noise made up of only a very narrow band of frequencies. It will normally exhibit tonality.

**Character (of the noise)** - Noise character refers to specific features of a noise or sound that render it more intrusive and / or more likely to attract a listeners attention. Noise character can refer to distinguishable or discrete continuous tones (for example hums, whines, hissing or screeching), distinct impulsivity (bangs, clatters, thumps, clicks, pulses) or any other irregularity that attracts attention or makes the noise readily distinctive in relation to the pre-existing acoustic environment.

**Context** - This includes the interrelationships between person and activity and place, in space and time. The context may influence the soundscape through auditory sensation, interpretation of auditory sensation and the responses to the acoustic environment (see **Soundscape**). Context is also objectively measured using weightings for character and emergence of the sound above the background sound environment (loudness and relative character).

**C-Weighting** – see **A-Weighting** above.

**Decibel (dB)** - A unit or level, derived from the logarithm of the ratio between the value of a noise energy quantity and a reference value. For sound pressure level the reference

quantity is 20µPa, the threshold of normal hearing is in the region of 0 dB and 140 dB is the threshold of pain / instantaneous damage. A change of 1 dB of the same sound is only perceptible under special conditions.

**dB(A): (see A-Weighting)** - This is decibels measured on a sound level meter weighted by a scale which is designed to reflect the weighting placed on noise by the human ear. A noise meter incorporates a frequency weighting device to create this differentiation. The dB(A) scale is now widely accepted. Measurements in dB(A) broadly agree with people's assessment of loudness for broadband noise. A change of 3 dB(A) of the same sound is the minimum perceptible under normal conditions, and a change of 10 dB(A) corresponds roughly to halving or doubling the loudness of a sound. The background sound level in a living room may be about 30 dB(A); normal conversation about 60 dB(A) at 1 metre; heavy road traffic about 80 dB(A) at 10 metres; the level near a pneumatic drill about 100 dB(A).

**dB(Z):** The Z-weighting is a flat frequency response of 10Hz to 20kHz ±1.5dB. This response replaces the older "Linear" or "Unweighted" responses as these did not define the frequency range over which the meter would be linear.

**DnT,w:** See weighted level difference.

**Equivalent continuous A-weighted sound pressure level (LAeq,T)** - The sound level of a notionally steady sound having the same energy as a fluctuating sound over a specified measurement period. LAeq is used to describe many types of noise and can be measured directly with an integrating sound level meter. It is obtained by continuously integrating ('adding up the energy of') a fluctuating sound signal and dividing by the elapsed time, to give the true mathematical average of any time varying signal. An LAeq reading must always be related to a measurement time interval and should not be read as an instantaneous value of sound pressure.

**Façade level** - Sound pressure level 1m in front of the façade. Façade level measurements are typically argued 1 to 2dB higher than corresponding free-field measurements because of the reflection from the façade in BS8233 2014 and 2-3dB in many other standards and guidance documents giving a range of 1-3dB.

**FFT (Fast Fourier transform) Analysis** – A method using digital signal processing to produce very rapid narrowband frequency analysis of acoustic signals. It can be used to equate audible sounds into decibel levels and / or enable a range of analysis of temporal sounds.

**Filtering - Octaves & 1/3 Octaves** - In general most noise is broad band i.e. it contains energy in virtually all the frequencies across the audio range in different combinations so that it has certain recognisable characteristics. To determine the frequencies at which most of the energy is concentrated, a sound signal is filtered into bands, commonly octave and 1/3 octave bands. Information from such filtering is widely used for diagnostic work and to determine noise control measures. (see **Octave band 1/1** and **Octave band 1/3**)

**Free-field level** - Sound pressure level away from reflecting surfaces. These are typically measurements made between 1.2 to 1.5m above the ground and at least 3.5m away from other reflecting surfaces. To minimize the effect of reflections the measuring position has to be at least 3.5m to the side of the reflecting surface (not 3.5m from the reflecting surface in the direction of the source). [ref BS8233 2014]

**Frequency** – This is the number of air vibrations or pressure fluctuations per second. The unit is the hertz (Hz).

**Hertz (Hz)** – See **Frequency** above.

**Impulsivity** - Used to describe an acoustic feature of single or repeated sound events of short duration such as a bang, shot or sudden impact of metal on metal etc. It is generally assessed subjectively as perceived by the listener and demonstrates rapid onset in the change in sound level and overall change in sound level. [ref BS4142 2014]

**Lnight,outside** - The long term equivalent outdoor A weighted sound pressure level established over a period of a year during night time hours (8 hours, typically 23:00 - 07:00). The Lnight,outside is a key parameter of the WHO 2009 Night Noise guidelines which was taken from the Environmental Noise Directive and is typically taken at the facade without reflections (free field level) rather than the facade level given for night time noise disturbance in the WHO 1999 guidelines. It is normally measured / calculated at a height of 4m.

**Logarithmic** – A scale where the exponent indicating the power to which a fixed number, the base, must be raised to produce a given number. The base used in acoustics is 10. Thus the

logarithm of 10 = 1, the logarithm of 100 = 2 and the logarithm of 1000 = 3. In terms of sound energy, an increase of 10 decibels equates to a 10 fold increase. The human ear is sensitive to a very wide range of sound pressure levels (intensities). Measuring human response to sound with a linear scale would not be practical as the scale would be too large and hence a logarithmic scale, in the form of decibels, is used.

**Loudness** – An observer's auditory impression of the strength of a sound. It is a subjective effect which is a function of the ear and brain as well as the amplitude and frequency of the sound. Whilst loudness is a subjective perception, a value can be attributed to loudness, which is typically measured in phons. Loudness is related to sound intensity and takes account of the sensitivity of the human to ear to certain frequencies.

**Low frequency noise** – This is normally considered to be noise ranging from 20 Hertz (pressure fluctuations per second) to 200-250 Hertz, depending on the reference. In music it is the bass region as opposed to alto and soprano.

**Masking** – The process by which the threshold of hearing of one sound is raised due to the presence of another.

**Maximum (A weighted) sound level (LAmax)** - The highest value A-weighted sound level with a specified time weighting that occurs during a given event. The time weighting (see below) used (F or S) should be stated. All measurements were 'fast' in this survey. [ref BS5228-1 2009+A1 201455]

**Measurement time interval (Tm)** - Total time over which measurements are taken. [ref BS4142 2014]

**Meter response and time weightings** - Most practical sound sources cause fluctuating readings. If the level fluctuates too rapidly, an analogue pointer may move so erratically that it will not be possible to obtain a meaningful reading, or with impulsive sound the meter may not respond quickly enough to obtain an authentic reading. Sound level meters are therefore provided with a variable time response control with settings:-

[55] This edition of BS5228-1 2009 includes updates from February 2014.

**'S' Slow** - Meter response is over damped with a time constant of approx 1 second or 1000ms. The setting tends to average out fluctuations in the readings.

**'F' Fast** - Permits the instrument to follow and indicate levels that do not fluctuate too rapidly; the time constant response is 125ms.

**'I' Impulse** - Uses a special electrical circuit with a time constant of about 35ms (of the same order as the response time of the human ear) to permit a very rapid response for investigating very sudden, short duration, impulsive sounds. This setting incorporates a detector which in effect stores the signal for sufficient time to allow it to be displayed. Also a slow decay rate is incorporated with time response of approx 1500ms to allow more easy reading of the maximum value as the indicator moves back relatively slowly.

**'P' Peak** - Higher grade meters often incorporate this setting which enables the absolute peak (as opposed to the rms) value of an impulsive waveform to be measured. A time constant of the order of 20 - 50 micro seconds is now involved to permit the following of very sharp impulsive events. Evidently electrical signal storage is also required to permit the meter to register the peak of such very fast events.

**Noise** - Sound perceived by the receiver to be unwanted.

**Octave band 1/1 (single)** - Band of frequencies in which the upper limit of the band is twice the frequency of the lower limit. [ref BS4142 2014]

**Octave band 1/3 (third) -** Band of frequencies in which the upper limit of the band is 21/3 times the frequency of the lower limit. [ref BS4142 2014]

**Percentile level (LAN,T)** - A-weighted sound pressure level obtained using time-weighting "F" which is exceeded for N% of a specified time interval. Typically the percentile level can be changed on modern sound level meters e.g. LA90,T, LA10,T, LA50,T etc. [ref BS8233 2014].

**LA90,T**: The A-weighted sound pressure level exceeded for 90% of the specified measurement time interval. It is a statistical measurement. In BS4142 2014 (and generally) it is used to describe the background sound level. Thus for a measurement time interval of 1 minute it would equate to the quietest 6 seconds of

sound. For a measurement time interval of one hour it would be the quietest sound for 10% of the time (or 6 minutes). If a machine runs continuously without a reduction in sound for 54 minutes and then stops it would represent the quietest 6 minutes of sound but if run for 55 minutes it would represent the quietest period of machine sound.

**LA10,T:** The A-weighted sound pressure level exceeded for 10% of the time. It represents the highest sound pressure levels within any measurement time interval. The LA10,18hour is typically used as a measure of road traffic noise.

**Pitch** – Frequency is an objective measure whereas the term pitch is subjective and although mainly dependent on frequency, is also affected by intensity. See also **Tonality**.

**Rating level (LAr,Tr)** – The specific sound level of a source plus any adjustment (penalty or weighting) for the characteristic features of the sound. It is used in BS4142 2014 for rating and assessing industrial and commercial sound. [ref BS4142 2014 and BS7445-1 2003 for tonal character and impulsiveness of sound]

**Receiver** - Person or group of persons who are or who are expected to be exposed to environmental noise.

**Reference time interval (Tr)** - Specific interval over which the specific sound is determined. For BS4142 2014 this is 1 hour during the day from 0700 to 2300hrs and a shorter period of 15 min at night from 2300 to 0700hrs. [ref BS4142 2014]

**Residual sound level** - Equivalent continuous A-weighted sound pressure level of the residual sound at the assessment location over a given time interval, T. [ref BS4142 2014]

**Rw** - See Sound reduction index.

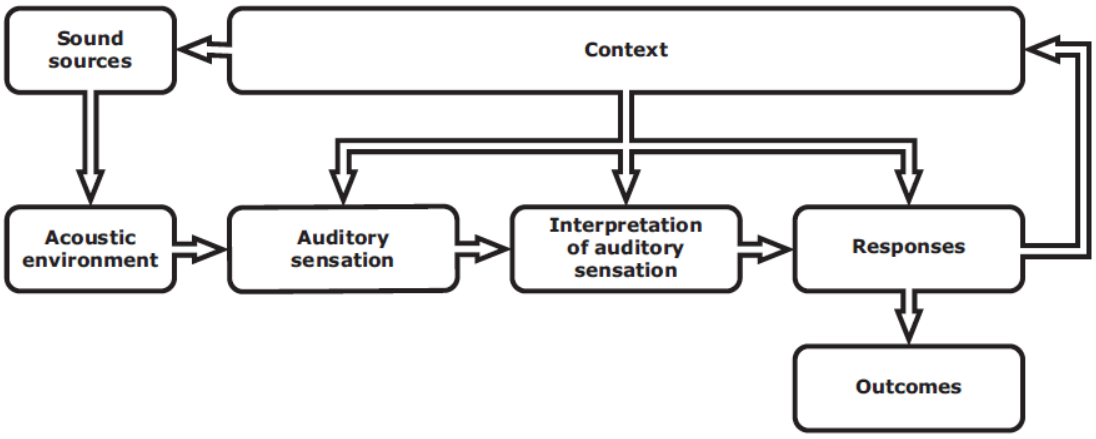
**Sound power level** - Sound power is a measure of the flow of sound energy with reference to a unit of time measured in watts (W). The sound power level is an expression of this energy in a logarithmic scale. The sound power level, unlike the sound pressure level, is independent of room or environmental effects and distance.

**Sound pressure level** - Sound pressure is measured in pascals (Pa) and is created by fluctuations in air caused by sound. The sound pressure level is an expression of this

pressure in decibels. The sound pressure level is variable depending on distance from the source and the interaction of the source with the environment (e.g. reflections).

**Soundscape** – The acoustic environment as perceived or experienced and/or understood by a person or people, in context (see 'acoustic environment' and 'context'). Figure 1 illustrates that soundscape is people's perceptions or experiences and/or understanding of an acoustic environment. The measurement, assessment or evaluation of soundscape is through the human perception of the acoustic environment.

Figure A1 - Elements in the perceptual construct of soundscape




[ref BS ISO 12913-1 2014]

**Sound reduction index, R, Rw, Rw + Ctr** - a level that describes the sound reducing properties of a building element or partition. The weighted sound reduction index (Rw) is a laboratory measurement undertaken in accordance with ISO 717 and provides a standardised value, using a reference curve, which allows comparison between different building elements using the Rw value. The addition of the "Ctr" term, i.e. Rw + Ctr, provides an additional weighting which allows for sound sources with lower frequency spectral dominance.

**Specific sound level (Ls = LAeq,Tr)** - The equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given time interval, T. [ref BS4142 2014]

**Tonality** – Tonal sound gives a definite pitch sensation. It usually occurs where the sound energy in a narrow range of frequencies is greater than those either side of that narrow

range. It will appear as a peak on a graph of sound energy shown in decibels versus the audible spectrum. It can often be shown by comparing adjoining octave band (1/3) spectra. A formal definition of tonality varies between standards. Where one 1/3rd octave band is more than 5dB above those either side, the noise contains a tone or alternatively as assessed by narrow band analysis. [ref BS7445-2 1991 / ISO1996-2 1987]. In BS4142 2014 the level differences between adjacent 1/3rd octave bands that identify a tone are:

15dB in the lower frequencies (25Hz - 125Hz)

8dB in the mid frequencies (160Hz - 400Hz)

5dB in the higher frequencies (500Hz - 1000Hz)

**Weighted level difference Dw, DnTw, DnTw + Ctr** - The weighted level difference gives a single number value for the airborne sound insulation performance of building elements or partitions etc. As with the sound reduction index, the DnTw is a standardised weighted level difference, standardised to a reverberation time of 0.5 seconds, and allows comparison of different building elements. The addition of the "Ctr" term, i.e. DnT,w + Ctr, provides an additional weighting which allows for sound sources with lower frequency spectral dominance.