USING PLANNING CONDITIONS TO IMPROVE INDOOR ENVIRONMENTAL QUALITY (IEQ) OF NEW RESIDENTIAL DEVELOPMENTS

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1 INTRODUCTION

The interdependence of provisions for acoustics, indoor air quality (ventilation) and controlling overheating is an important consideration when designing a building to provide suitable indoor environmental quality (IEQ). The ProPG: Planning and Noise, identifies the need to consider these individual qualities within an integrated assessment. The Association of Noise Consultants has produced supporting guidance on how to assess these interactions in the Acoustics, Ventilation and Overheating Guide ("AVO Guide").

Where residential developments rely on opening windows to mitigate overheating, there can be a compromise between allowing excessive noise ingress with windows open, or excessive temperatures with windows closed. The paper includes a review of recent planning applications which highlights the need for consistency between the noise and overheating assessments regarding the assumptions of window operation and it proposes how conditions could be used to produce aligned noise and overheating assessments.

There are no mandatory limits for mechanical ventilation noise in the UK Building Regulations. However, noise can be a significant constraint to the use of the ventilation systems, as occupants turn off noisy equipment. Without adequate ventilation in modern airtight dwellings, air quality can have a significantly adverse effect on the health of the occupants. This paper includes a review of available research on noise limits from mechanical services and discusses how the limits proposed within the AVO Guide could be applied to planning conditions.

2 PLANNING CONDITIONS

The Town and Country Planning Act 1990 (the Act) empowers LPAs to "*grant planning permission, either unconditionally or subject to such conditions as they think fit*"[1].

The NPPF[2] requires LPAs to consider if developments could be made acceptable through the use of planning conditions but they should only be imposed when they are:

- necessary;
- relevant to planning;
- relevant to the development to be permitted;
- enforceable;
- precise; and
- reasonable in all other respects..

These requirements are known as the 'six tests' and they must be satisfied each time a decision to grant planning permission subject to conditions is made[3].

A paper at the 2015 IOA Conference[4] looked at the implications on lawfulness of planning conditions relating to environmental noise following recent changes to the national planning system, and it covered each of the tests in detail.

This paper will concentrate on why the conditions are necessary and will discuss precision and enforcement of the conditions.

2.1 The need for planning conditions to control noise ingress

Ideally the control of noise ingress would be a matter for building control as it impacts on the health and safety of occupants. The most recent attempt to introduce noise ingress control into the Building Regulations was the Part E[5] consultation[6] in 2001; this identified the link between ventilation and noise ingress and felt a better integrated approach would occur if all requirements were controlled within the building regulation regime and could form part of an integrated system with Approved Document F[7] for ventilation and Approved Document L[8] for control of overheating.

The requirements to control noise ingress were not adopted following that consultation process and the reasons are not known to the authors. It therefore continues to be the role of the planning process to control noise ingress.

2.2 What level of detail can be expected with a planning application?

The RIBA Plan of Work 2013[9] organises the process of briefing, designing, constructing, maintaining, operating and using building projects into a number of key stages, numbered from 0 through to 7. The key design stages are:

RIBA Stage 2 Concept Design
RIBA Stage 3 Developed Design
RIBA Stage 4 Technical Design

Within the document it suggests that *'Planning applications are typically made using the Stage 3 Output*' and that during Stage 3 the core objectives are to *'prepare the developed design, including coordinated and updated proposals for structural design, building services systems, outline specifications, cost information and project strategies..'*

If the planning applications are submitted with the Stage 3 information it would be reasonable to expect the noise assessment, ventilation strategy, overheating assessment and air quality assessments to be based a coordinated ventilation strategy and associated assumptions.

3 BUILDING REGULATIONS

A planning condition is unlikely to be valid if its requirements are already covered under the Building Regulations.

3.1 Approved Document E – Resistance to the passage of sound

Approved Document E provides minimum standards of sound insulation between different parts of a building and adjoining buildings. It does not provide limits for indoor ambient noise levels;
however, it does have some influence on the indoor environmental quality as disturbance from adjoining building occupants will affect the comfort of the internal environment.

The sound insulation values provide reasonable resistance to sound from other parts of the same building however the standard is only required to be met with windows closed. The sound insulation between dwellings could be less when windows or other ventilation systems are open for both dwellings.

3.2 Approved Document F – Ventilation

Approved Document F states:
The noise caused by ventilation systems is not controlled under the Building Regulations. and

Ventilation may also provide a means to control thermal comfort but this is not controlled under the building regulations.

It does provide some advisory information on noise and suggests that to ensure good acoustic conditions, the noise levels within living rooms and bedrooms should not exceed 30dB $L_{Aeq,T}$.

When considering purge ventilation, the document says there may be practical difficulties in meeting the required window opening for purge ventilation rates if people were exposed to excessive noise form outside. It doesn't define what it considers excessive noise.

The AVO Guide[10] describes the Part F ventilation systems which are commonly encountered within dwellings.

3.3 Approved Document L1A – Conservation of fuel and power

A requirement of Approved Document L1A is that reasonable provision should be made to limit solar gains. Solar gains are beneficial in the heating season as a means of offsetting heating demand but can contribute to overheating in the summer months.

The Building Regulations requires a risk of overheating to be established using a standard assessment procedure, SAP (ref), and it says that a '*reasonable provision would be achieved if the SAP assessment indicates that the dwelling will not have a high risk of high internal temperatures*.'

The recently published CIBSE Guidance TM60 Good practice in the design of homes[11] comments that SAP cannot realistically predict overheating risk and more robust checks using dynamic thermal modelling are necessary to ascertain the risk of a design overheating.

4 PLANNING GUIDANCE

4.1 Planning Practice Guidance on Noise (PPG(N))

The web based planning practice guidance for Noise[12] provides a noise exposure hierarchy, based on likely average response and part of this has been reproduced in Table 4.1.

Table 4-1: Planning practice guidance on noise

Lowest Observed Adverse Effect Level			
Perception	Examples of Outcome	Increasing effect level	Action
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g…; 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...	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	Significant Observed Adverse Effect	Avoid

	sleep, premature awakening and difficulty in getting back to sleep.		
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

The draft AVO Guide comments that *although for both LOAEL and SOAEL, the word 'level' is used, this does not mean that the impact can only be described as a single noise level. It could also include factors such as the number of times the noise impact occurs, the duration of the impact, and the time of day the impact occurs. Thus, depending on the circumstance, the noise impact could be managed by reducing how often it occurs rather than just reducing the level of impact when it does occur.*

This is particularly relevant when assessing noise levels with windows open, as the LOAEL and SOAEL are likely to be significantly higher levels than when the windows are closed, due to the temporary requirement to open the windows and the occupants control of the environment.

4.2 ProPG: Planning and Noise

The ProPG: Planning & Noise[13] was published in 2017 and it provides guidance on the best practice approach for assessing noise impact at new residential developments. It includes several paragraphs which introduce the need for an integrated assessment of noise in conjunction with the ventilation and overheating requirements.

The relevant sections include:

Para. 2.34 *Where internal target noise levels can only be practically achieved with windows closed… special care must be taken to design the accommodation so that it provides good standards of acoustics, ventilation and thermal comfort*

Para. 2.36 *.. consider the potential noise impact during the overheating condition*

Para 2.38 *Where mechanical services are used as part of the ventilation or thermal comfort strategy for the scheme, the impact of noise generated by these systems on occupants should be assessed.*

5 BS 8233

BS 8233:2014 Guidance on sound insulation and noise reduction for buildings[14] provides guideline values, reproduced in Table 5.1, for internal noise levels within living rooms and bedrooms and is usually referenced in planning conditions.

Table 5-1: Noise Indoor ambient noise Table 4 from BS 8233

Location	07:00 to 23:00	23:00 to 07:00
Living Room	35 dB $L_{Aeq,16hr}$	
Dining Room	40 dB $L_{Aeq,16hr}$	
Bedroom	35 dB $L_{Aeq,16hr}$	30 dB $L_{Aeq,8hr}$

The notes below the table in BS 8233 are important and the note relevant to ventilation and overheating requirements are:

Note 5 *If relying on closed windows to meet the guide values, there needs to be an appropriate alternative ventilation that does not compromise the façade insualtion or resulting noise level. If applicable, any room should have adequate ventilation (eg trickle ventiltors should be open) during assessment.*

The notes suggest where closed windows are required to meet the guide values then appropriate alternative ventilation is required. It doesn't define '*appropriate alternative ventilation'*.

6 NOISE AND OVERHEATING

6.1 Review of recent planning applications

To establish if there is a need to include planning conditions that address both overheating and noise a review of 160 recent planning applications for major developments within Greater London local authorities was undertaken.

As the developments are major developments they must include an energy statement with the planning application and this should include an overheating assessment in accordance with section 5.9 of the London Plan[15].

To manage the number of applications to be reviewed, it was decided that they should meet the following criteria:

- they were submitted between January 2014 and December 2017;
- they received full planning permission; and
- the application included more than 100 dwellings.

The applications for Harrow, Havering, Hounslow and Hillingdon were not included as they did not list their applications chronologically and they could not be sorted by date within the database. Although applications for Waltham Forest were identified, they were not reviewed as the planning portal did not identify the title of the summitted supporting documents for each application.

From the remaining 28 planning authorities, a total of 160 applications met the criteria for review. Not all applications included a noise assessment or overheating assessment. In some instances, the energy statement was included but didn't cover overheating. The assessment of overheating varied from full dynamic thermal modelling through to a paragraph in the energy statement commenting on the risks of overheating.

Out of the 160 planning applications reviewed:

- 152 applications included a noise assessment;
- 130 applications included an overheating assessment; and
- 122 applications included both a noise assessment and overheating assessment.

The noise assessments and overheating assessments were reviewed against a set of questions, with simple yes / no answers. The questions and findings for the noise assessment review are shown in Table 6-1.

Table 6-1: Noise assessment review

	Questions for the noise assessments	Answer Yes	%
1	Does it discuss ventilation requirements	143	94 %
2	Does it discuss the need to control overheating	23	15 %
3	Are windows assumed closed for the assessment	146	96 %

4	Do any facades require higher specification glazing	131	86 %
5	Are mechanical services noise level limits proposed	7	5 %

Although a high proportion of noise assessments consider the impact of a trickle vent, there is very little consideration of the ventilation strategy and the provisions required for trickle vents if using System 1, for example.

From the review of the noise assessments it is evident that the industry standard approach to producing a noise assessment is to predict the internal levels with the windows closed (96 %), but to also include any façade ventilators. The vast majority of noise assessments discuss ventilation (94 %), but it was quite rare for the assessment to discuss overheating (15 %). Very few included proposed noise level limits for mechanical ventilation systems (7 %).

In most assessments (86 %) at least one façade was exposed to noise levels which resulted in glazing or ventilation specifications being proposed which were greater than the 'standard' systems. This is perhaps not surprising for large applications in London, which often have little separation from transportation noise sources.

For the overheating assessment the questions and outcome of the review are shown in Table 6-2.

Table 6-2: Overheating assessment review

	Question for overheating assessments	Answer Yes	%
1	Does it discuss noise as a constraint for opening windows	30	23 %
2	Does it assume open windows for all or part of the time	119	92 %

The review of the overheating assessments indicates that the majority (92 %) of assessments assume windows are openable for all or part of the time. Just 23 % of the assessments made any comments regarding noise levels and the constraints that noise may impose on the strategy for reducing overheating.

Out of the 30 applications which did mention external noise levels in the overheating assessment a summary of the different approaches to address the noise are shown in Table 6-3. The most common approach was to increase the mechanical ventilation rates to reduce the requirement to open windows whereas only one application proposed the use of attenuated vents.

Some applications assumed rooms were unoccupied when being ventilated, some stated that acceptable internal ambient noise levels would be achieved with open windows and some applications suggested further design development to establish a solution.

Table 6-3: Proposals where noise was discussed in the overheating assessment

Mechanical ventilation without cooling	11
Mechanical ventilation to reduce need for open windows	4
Cooling / Air Conditioning	3
Considered noise level suitable for open windows	2
Proposed alternative indoor ambient noise levels	1
Assumes open windows when rooms are unoccupied	4
Attenuated vents / Acoustic louvres	1
No alternative proposed, required design development	4

The main purpose of the review was to compare the assumptions of the noise and overheating assessments in relation to openable windows. For the 122 applications which included a noise and overheating assessment we determined if the noise assessment assumed closed windows, while the overheating assessment for the same building application assumed open windows, and the results are shown in Table 6-4.

Table 6-4: Noise and Overheating assessments

	Question for applications with noise and overheating assessments	Answer Yes	%
1	Does the noise assessment assume closed windows and the overheating assessment assume openable windows	104	85 %

The majority of the planning applications have a situation where the noise assessment assumes closed windows, and the overheating assessment assumes windows are open (85 %). The review does not establish the duration that any of the windows would need to open, or what are the predicted internal levels with the windows open, it does however highlight the need for consistency of the assumptions applied for the assessments.

This research demonstrates that it is necessary for noise and overheating to be considered in an integrated way as part of the planning process. If the application does not adequately address these issues in a detailed and co-ordinated method, then planning conditions would be necessary.

6.2 Proposed approach to updating conditions for noise ingress

Most noise ingress planning conditions refer to BS 8233 and the current industry approach is to demonstrate the indoor ambient noise levels can be met with the windows closed and trickle vents open.

To align with the ProPG guidance, the noise assessment should also consider the methods of ventilation and controlling overheating and should assess the indoor ambient noise levels with windows open. The draft AVO Guide provides a method of assessing noise levels for different ventilation and overheating conditions and can be referenced to add precision to the conditions.

The AVO Guide includes the details which you should include within the noise assessment. For the higher risk noise sites these include:

- Statement of overheating criteria being applied;
- Descriptions of the provisions for meeting the stated overheating criteria. This should include, where relevant, the area of façade opening;
- Details of the likely internal ambient noise levels for the overheating condition and the method used to predict these;
- An estimate of how frequently and for what duration the overheating condition applies;
- The proposed noise levels of any mechanical services used to control overheating; and
- Assessment of likely impact on occupants

The assessment needs to ensure that the assumptions for the noise and overheating assessment are consistent with regards to the opening of windows

The enforcement of the conditions could require details of the sound insulation scheme and overheating assessments to be submitted and approved, or additionally testing of the noise levels could be undertaken prior to occupation. Testing of noise ingress levels for residential projects is rarely undertaken and there can be practical problems of establishing the appropriate external environment during the construction phases, however it is commonly carried out for hotels and schools which can face the same practical issues and should be considered.

7 NOISE FROM MECHANICAL VENTILATION

7.1 Current research

A detailed review of noise from domestic ventilation systems has been documented in the paper 'How loud is too loud? Noise from domestic mechanical ventilation systems' [16].

It concludes *that many residents in parts of Europe and beyond are dissatisfied with their ventilation systems due to the noise. This dissatisfaction causes them to reduce or disable entirely the operation of those ventilation systems. This represents a potential health hazard in modern air-tight homes, as infiltration cannot be relied upon to achieve adequate IAQ. Excessive noise levels and unacceptable quality of noise are separately reported as issues leading to interference with ventilation systems.*

The particular characteristics of ventilation system noise that cause occupants to interfere with the operation of their systems are not well researched; there is little evidence in the literature about people's tolerance to noise from their own ventilation systems. Research is urgently needed to identify a suitable metric for ventilation system noise, and determine appropriate guideline values for different rooms. The Swedish and COST Action TU 0901 acoustic classification schemes emphasise the value of noise levels well below 30 dB(A).

In the interim, the highest limit that may be proposed for mechanical services noise in bedrooms should prevent total noise levels (from internal and external sources) exceeding 30 dB(A), to avoid adverse effects on sleep; a limit for mechanical services noise alone of 28 dB(A) may achieve this, without being too onerous. The literature suggests that a more prudent limit for mechanical services around 24 dB(A) is more likely to be required to prevent an adverse reaction from most occupants while falling asleep, noting that 20 % of Finnish respondents found this too noisy. This may be an unnecessarily onerous target, depending on the characteristics of the noise. There is insufficient evidence to propose limits in living spaces and bathrooms without suitable research.

The effectiveness of ventilation systems in the UK has been investigated by the Zero Carbon Hub[17], which found that the majority of ventilation systems were operating at less than half the required ventilation rates and that nearly all the occupants of the survey had turned off their ventilation systems at night due to the noise.

The National House Building Council (NHBC) has also observed poor practice in mechanical ventilation. Their Technical Extra report[18] follows investigations at over 200 sites, looking at six key areas of design and drawings, installation, ducting, air transfer, testing and commissioning, and handover to the homeowner. The report details significant findings of non-compliance, repeating many of the findings of the ZCH report.

This demonstrates why it is necessary for noise from mechanical ventilation to be suitably controlled. It is not currently controlled by the Building Regulations and can therefore be controlled through the use of suitable planning conditions. Testing on completion, by competent engineers, is necessary to ensure that the required ventilation designs are achieved.

7.2 Draft AVO Guide recommendations for mechanical services

The draft AVO Guide provides guidance on mechanical services noise levels for systems which provide year round ventilation (whole house and moisture extraction) in addition to systems which are sized to provide ventilation which is to control overheating.

The proposed levels within the AVO Guide are based on current UK guidance from the Building Regulations, CIBSE[19] and BRE / CIRIA[20] documents.

7.3 Proposed approach for planning conditions for mechanical services

It is currently unusual for planning noise assessments to include a discussion of mechanical ventilation noise, however as the ProPG: Planning and Noise document states that mechanical services noise should be assessed, it is reasonable to expect proposed noise levels from the mechanical ventilation to now be included within a planning noise assessment.

If noise limits are proposed within a planning report, they can be compared to the recommended levels from the AVO Guide and a condition could be included for the systems to be tested prior to occupation, to demonstrate compliance.

If the noise assessment does not include an assessment of mechanical services noise, the condition could refer to the noise limits included in the AVO Guide along with the requirements for testing. The proposed noise level limits for different ventilation conditions in the AVO Guide would give precision to the condition and the requirements for testing prior to occupation would make the condition enforceable.

Noise limits in different rooms should be included for the whole dwelling ventilation condition, extract ventilation condition and where appropriate, the overheating ventilation conditions.

Where the ventilation system is used for the control of overheating, the overheating assessment would need to be provided, which should follow the methodology of CIBSE TM59[21] and should include the ventilation rates required to control overheating, so the noise levels can be measured at the required rates.

The measurement of the noise levels at a given ventilation rate will require engineers who are competent at undertaking airflow measurements and noise level measurements.

8 AIR QUALITY CONSIDERATIONS

A review of the air quality assessments was not undertaken as part of this research however the air quality assessment must also be co-ordinated with the noise and overheating assessments.

For some developments the external air quality can already exceed the recommended air quality limits for Nitrogen Dioxide (NO_2) and Particulate Matter (PM_{10}). In these instances, the mitigation options are usually to include mechanical ventilation with the air inlet located on a less polluted façade, or to use filters within the mechanical ventilation system.

In these instances, the need to open windows to control overheating must also be considered and noise limits for the mechanical ventilation systems should be specified to reduce the risk that occupants turn systems down (or off) until they can tolerate the noise.

9 CONCLUSIONS

A review of recent planning applications has highlighted that the majority of assessments of noise and overheating have conflicting assumptions regarding open windows, with the noise assessment assuming they are closed and the overheating assessment assuming they are open.

Planning noise assessments and conditions must be used to ensure a co-ordinated ventilation strategy is adopted for new dwellings which considers noise levels, overheating and air quality. The assessment methodology proposed in the AVO Guide gives a precise approach to assessments and pre-occupation testing can ensure enforcement of such conditions.

Evidence suggest that ventilation systems in new houses fail to deliver sufficient ventilation and the noise levels of the system play an important role in occupant behaviour when operating the ventilation systems.

Noise assessments should include noise levels from mechanical services and planning conditions should be used to ensure that the required levels are met prior to occupation.

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