

## Guidance

# G148 A4

# Management of noise due to public address systems

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## 1 Purpose

The purpose of this document is to provide guidance for Public Address (PA) noise management relating to Category 1 Standards for [1-142](#) 'Operational information systems' and [S1180](#) 'Standard for Rolling Stock'.

## 2 Scope

This guidance applies to all stakeholders involved in the specification, design, maintenance, installation and commissioning of PA system and noise complaint management.

This document should be referenced during all design and installation phases as well as maintenance and noise nuisance surveys following complaints regarding any LU PA system.

## 3 Guidance

### 3.1 General

- 3.1.1 PA systems should be designed, installed and operated to be compatible with requirements of relevant legislation including the Environment Protection Act 1990 (EPA) and (EA) Equality Act 2010.
- 3.1.2 All PA systems operated adjacent to residential properties should be configured and operated to minimise noise pollution whilst taking into account safety requirements.
- 3.1.3 Noise controls implemented should be documented and traceable to local /specific agreements. Deviations from these should be subject to an agreement from Public Address Noise Management Group (PANMG) and relevant standard holders.
- 3.1.4 Noise controls both technical and operational restrictions applied to sites at risk of noise complaints should be subject to risk-based assurance controls e.g. audit/ surveys to ensure effectiveness.
- 3.1.5 PA noise complaints should be managed and resolved in accordance with guidance and relevant processes provided in attachment 1 of this document.
- 3.1.6 Any conflicts that arise during the course of resolving a noise complaint should be referred to PANMG and relevant standard holders as required.
- 3.1.7 The Customer Services Centre (CSC) team dealing with PA noise complaints should hold central records for all PA noise complaints for a minimum of 3 years.
- 3.1.8 Detailed records of PAS (PA system) operation, including PA operating times, types and frequency of messages should be kept and updated as agreed by PANMG.

**Note 1:** This guidance focuses mainly on fixed PA systems e.g. stations /depots. Train PA complaints can be dealt with the similar noise management principles. Rolling stock engineers should be consulted for on-train PA volume problems /fixes.

## 3.2 Customer information (messaging) strategy

- 3.2.1 The types and number of PA messages broadcast to customers in trains or in station environments should conform with TfL S&SD directorate published standards and guidelines corrected for risk of noise complaints.
- 3.2.2 Factors for consideration used to develop LU PA operating guidelines should include (particularly for surface sites) the risk of PA noise nuisance complaints. Refer to attachment 2 to this guidance.
- 3.2.3 Where PA operating guidelines referred to in clause 3.2.2 are linked to line-based /site specific Customer Satisfaction Survey (CSS) scores, these may need to be reviewed depending on the effectiveness of noise controls used to prevent PA noise complaints.
- 3.2.4 Proposals to vary the PA element of the CSS should be submitted to PANMG for review.

## 3.3 Operational Practice - Stations

- 3.3.1 Station staff should be familiarised with site-specific restrictions that need to be observed to manage noise emissions at known / affected sites.
- 3.3.2 At noise sensitive sites all non-essential PA should be restricted after 2300 hours and before 0700 hours to minimise noise complaints. Refer to [S1311](#).
- 3.3.3 Where local conditions /risk assessment require more onerous restrictions these should be agreed by PANMG.
- 3.3.4 At noise sensitive sites except for emergencies, station and line control room staff should ensure all PA announcements (recorded or live) conform to any noise reduction measures documented and agreed between LU and the local council / residents.
- 3.3.5 For sites affected by or at risk from noise complaints, the reduction / deactivation of long-line PA should be considered.
- 3.3.6 At noise sensitive sites where 'Mind the gap' messages are used; these may need to be limited to on-train or at certain times only to manage noise nuisance.
- 3.3.7 Pre-announcement attention drawing chimes should be disabled to minimise noise nuisance.
- 3.3.8 Where possible fire alarm tests at noise sensitive sites should be scheduled to minimise noise nuisance to neighbours.

## 3.4 Operational practice - trains

- 3.4.1 Train operators should be familiarised with site-specific restrictions that need to be observed to manage noise emissions at known /affected sites.
- 3.4.2 Platform announcements (whether by a member of staff or an automated voice announcer) should be timed to avoid coinciding with a train entering or leaving the plat-form or whilst an announcement is being made on the train and the train doors are open.



3.4.3 Where possible duplication of train and station PA messages should be avoided.

3.4.4 Where practicable operational restrictions that apply to noise sensitive station platforms should be applied appropriately to trains stopping at these platforms.

### 3.5 Technical – system assurance

3.5.1 In the absence of more specific guidance it is recommended that the following criteria be used as the basis for design of PA systems adjacent to residential properties:

- a) for PA system upgrades the noise emissions from the upgraded system should be limited to a rating level, as defined in BS 4142:2014 equal to or better than the rating level of the previous PA system
- b) for new PA systems where previous noise emission data/rating level is not available then noise emissions should not exceed the ‘marginal significance’ rating level of +5dB above background noise levels as defined in BS 4142:2014
- c) in addition, LU has a statutory obligation to demonstrate that best practicable means has been adopted to minimise noise at all times. This should include both operational and technical strategies as defined in this guidance
- d) messaging and operational strategies to minimise noise nuisance are given in sections 3.2 and 3.3/3.4 respectively. The Technical (design / implementation) strategies are detailed in section 3.6.

3.5.2 For all noise sensitive station PA systems new or upgraded the project manager / engineer should produce a “Noise Study” report. This report should be compiled to take into account the following.

- a) noise measurements to conduct a BS 4142 noise complaints risk assessment:
  - i. background noise measured as  $L_{A90, T} \{PA \text{ OFF}\}$
  - ii. residual (ambient) noise measured as  $L_{Aeq, T} \{PA \text{ OFF}\}$
  - iii. specific noise measured as  $L_{Aeq, T} \{PA \text{ ON}\}$
  - iv. the average (A-weighted) acoustic transfer function between a given PA zone and the nearest noise receptor. (See also note 2; para. 3&4)
  - v. current profile of PA announcements (where applicable).

**Note 2:** (applicable to clause 3.5.2 a)

Readings i) and ii) should be taken at a position that is representative of the nearest / most sensitive noise receptor or ideally if opportunity permits at a defined noise receptor position.

Reading iii) needs to be taken simultaneously from two positions: in the PA zone and at the representative measurement position/ receptor

The *acoustic transfer function* characterises the attenuation loss between the PA zone and the noise receptor/ representative measurement position; taking into account distance, direction and contribution of reflections

The difference between the two simultaneous specific noise measurements provides an approximation of the acoustic transfer function between the specific PA zone and relevant (affected) noise receptor.

The duration T is given in BS 4142:2014 as 1 hour for daytime. In practice this can be difficult and shorter duration (5 – 15 minutes) may be more practicable.

The PA announcement profile referred to in 3.5.2 a) v) includes information details about PA operation i.e. Start and finish times for normal operation, message duration, frequency of messages per hour and message types being broadcast.

- b) noise readings listed in 3.5.2 a) should be taken at times such that the resultant BS 4142 assessment will highlight the worst-case impact of normal PA operation. This is likely to be earlier during the morning or later during the evening when the background noise measured as  $L_{A90, T}$  will be lower
  - c) for sites with a history of noise complaints and where the local council is involved in LU consultations; a detailed acoustic survey may be needed that includes the impact of tonality e.g. 1/3 octave-band analysis at the most sensitive noise receptor. See also BSEN ISO 18233 sections 5 & 6. The project manager should seek expert acoustics advice in this regard to confirm if such a survey is required
  - d) a site survey report with relevant photographs showing physical speaker layouts of PA zones in relation to adjacent noise receptors should be provided. The layouts should include speaker datasheets and positioning information. This report should include scaled OS drawings that highlight affected noise receptors.
- 3.5.3 The format and technical content of the report required in 3.5.2 should be compatible with guidance provided in BS 4142 and BS 7445 or the latest applicable standards.
- 3.5.4 Noise instrument specifications should conform to BSEN 61672 or later standards as they become available for use. In most cases for the purpose of LU records (unless specifically required or requested) a minimum noise instrument accuracy of class 2 is sufficient.
- 3.5.5 When responding to or investigating formal noise complaints made by the local council, or when readings are formally requested, class 1 accuracy is required.
- 3.5.6 External readings should be taken in the free field at least 3.5m from reflecting surfaces and between 1.2 – 1.5m above ground/ finished floor surface.
- 3.5.7 Where measurements cannot be made in the free field, readings should be taken 1-2m from the relevant facade or 0.5m in front of an open window. A similar method should be adopted for readings inside buildings above the ground floor.
- 3.5.8 For new PA systems the Project manager should ensure that the contractor supplying and installing the PA system provides system documentation including commissioning /maintenance manuals and as-built drawings. The documentation and drawings should include the latest configuration changes and system updates. See also section 3.6.

**Note 3:** See attachment 3 and BS 7445-2 / BS 4142 for further guidance on noise measurements and corrections for facade readings

### 3.6 The technical – design and system implementation

- 3.6.1 mandatory technical requirements applicable to PA and VA (Voice alarm) systems are given in LU standard 1-142. In respect of systems operated on surface sites and some sub-surface sites (where noise emissions could reach neighbouring properties), the system design should take into account the risk of noise complaints as evaluated in section 3.5 of this document.
- 3.6.2 Particular attention should be given to sites whose BS 4142 rating level excess (above background noise) is > 0dB. The design strategies deployed to reduce and manage noise emissions at these (moderate / high risk) sites need to be fully considered. To this end the Head of ICT Engineering and PANMG should be consulted.
- 3.6.3 The following are key references for the design and maintenance of PA-VA systems
- a) 1-142 (LU Standard)
  - b) BS 5839-8 (PA-VA)
  - c) BS EN 54
  - d) BS EN 60268
  - e) BS 6259:1997
- 3.6.4 Guidance regarding noise measurements and noise pollution levels should be sought from the latest version of the following standards / references:
- a) BS 4142
  - b) BS 18233
  - c) BS 7445
  - d) BSEN 61672
- 3.6.5 The Integrated PA system design should offer both operational and technical flexibility in providing audio customer information whilst enabling effective management of PA noise emissions. The inclusion of the following features should be considered:
- a) access to pre-recorded (read-only) digital message libraries with the option to add and overwrite user recorded message
  - b) ability to define complex message sequences using multiple libraries
  - c) ability to control (switch on/off) specific agreed (non-safety) messages
  - d) ability to control operating times for all key (non-safety) PA messages
  - e) use of appropriately installed directional speakers (at specific heights/ orientation)
  - f) use of switchable speaker circuits ( canopy / outside canopy)
  - g) use of speakers activated by the presence of customers on the relevant platform
  - h) use of ANS (ambient noise sensors) where applicable (see 3.6.11 and 3.6.12)
  - i) night volume control (Station PA)



- j) system memory of all user set configurations (controls / messages) including user id and time of configuration changes
  - k) integration of Station and Train PA systems.
- 3.6.6 The Integrated PA system GUI should always issue a warning prompt when any user initiated action will result in a permanent message deletion or system change.
- 3.6.7 The PA installer /maintainer as appropriate shall ensure in respect of the PA system:
- a) correctly set gain structure
  - b) appropriate signal limiting/ compression to control dynamic range / headroom
  - c) appropriate level of equalisation of specific frequencies to minimise noise spill
  - d) speaker are selected, positioned and screened to minimise noise spill.
- 3.6.8 The long-line PA where used needs to conform to 1-142 for message priority
- 3.6.9 Installed PA systems should be confirmed compliant in respect of noise emissions.
- 3.6.10 PA systems should incorporate dynamic ambient noise sensors (ANS) / controllers to regulate volume levels in environments with variable ambient noise. The signal to noise ratio (SNR) setting for the ANS should be guided by the “existing PA system” or “Noise Study” report described in section 3.5 of this document. PA systems on surface stations at risk of noise complaints should not be operated with a SNR of greater than 6dB.

Note 4: Where there is a moderate / high risk of noise complaints the PA system SNR may have to be set so that speech intelligibility is reduced when the ambient noise is higher. E.g. trains arriving, departing, standing in the platform or other external noises. The trade-off between SNR and speech intelligibility should be risk driven.

- 3.6.11 Standard “sample-hold” ANS microphones/controllers are unsuitable for surface sites with low and steady levels of ambient noise and should be avoided if there is any risk that ANS controlled PA announcements will cause noise nuisance.
- 3.6.12 At risk legacy PA systems having these types of ANS should be disabled and PA output SPL’s capped. The SPL ceiling can be empirically determined using measurements suggested in section 3.5.
- 3.6.13 If ANS are to be used in fluctuating noise environments these should be designed to track ambient noise dynamically.
- 3.6.14 New or upgraded train PA systems need to comply with the Rolling Stock standards [S1180](#) and [S2180](#).
- 3.6.15 For noise sensitive sites new or upgraded train PA system output levels based on train speed should be tested for noise nuisance using “train stationary” level with doors open.

- 3.6.16 For new systems except for emergencies (where autonomous operation is needed) there should be a level of integration between the station PA system and the arriving train PA system.
- 3.6.17 An appropriate open protocol data signalling system; wired or wireless could be used to “cue” and sequence the train / station PA messages system to enable control of PA messages to prevent overlapping of station / train broadcasts and priority conflicts.
- 3.7 Technical – system maintenance**
- 3.7.1 The PAS maintenance organisation should keep an accessible library of relevant documentation, drawings and asset records as listed in 3.7.2. This information should be kept up-to-date and managed to a standard compatible with BS EN ISO 9001 and BS ISO 15489-1.
- 3.7.2 The following guidance is the minimum PA system information that should be obtained and maintained:
- a) system operation manuals
  - b) system commissioning and testing manuals
  - c) system maintenance manuals as directed /required by LU
  - d) as-built drawings, wiring schedules and system schematics
  - e) speech intelligibility readings (STI/STIPA) for each PA zone
  - f) sound Pressure level (SPL) readings for each PA zone
  - g) BS4142:2014 noise assessments for stations at “marginal” risk or higher
  - h) internal /independent (relevant) noise investigations /reports as required
  - i) list of PA faults/ complaints responded to.
- 3.7.3 The maintenance organisation upon being informed of a PA noise complaint for a given station or train should conduct a survey to check/ test the following:
- a) the system is configured to the as-built system commissioning specification and this is compliant with current LU standards
  - b) the system has not developed any fault that is causing the noise problem
  - c) the user controlled settings and how many PA messages made per hour and if this conforms locally set schedule / local agreements as applicable
  - d) site and PA system information including measured noise emissions should be captured consistently in a survey form
  - e) completed survey forms with recommendations should be sent to PANMG.
- 3.7.4 The PAS maintenance organisation should keep records of attendance times, personnel and fault reports including work carried out, readings taken in respect of PAS faults.
- 3.7.5 PAS fault reports and readings should be consistent and follow a standard template.



- 3.7.6 PAS alterations in response to a given noise complaint should not affect its safety performance
- 3.7.7 PAS drawings / other records should be updated to reflect any alterations carried out in response to noise complaints.

## 4 Responsibilities

### 4.1 PANMG roles

Responsibilities can be assigned to the key roles identified in this guidance as follows:

- a) CPD- Head of ICT Engineering; to advise on and maintain the technical content of this guidance including the PA noise management process. Approve any necessary concessions to Category 1 technical standards to resolve noise complaints.
- b) HSE Environment advisor – to advise PANMG in respect of environmental noise guidelines / legislation and liaise with Local Council Environmental Health Officer. Maintain a list of formally issued noise abatement notices / complaints.
- c) PANMG – PA Noise Management Group, to convene at regular intervals to review PA noise complaints with the goal of speedy / consistent resolution and minimum loss (financial /reputational) to TfL/LU.
- d) AMS– Area Manager Stations - In conjunction with OLM (Operational Liaison Manager/OTM) conduct initial noise complaint investigation. Provide support to PANMG throughout complaint resolution as required including liaison with complainants / local council.
- e) OTM– Operational Task Manager – In conjunction with Area Manager Stations conduct initial noise complaint investigation. Provide support to PANMG throughout complaint resolution as required including liaison with complainants / local council.
- f) S&SD Customer Information Manager – To chair and manage PANMG meetings. Coordinate PANMG agreed actions/decisions in respect of noise complaints. Coordinate approvals of any necessary concessions to resolve particular noise complaints, both operational /customer –related and technical. Agree across PANMG members as required.
- g) APD Communications Support Manager – Provide technical support and resources to PANMG as necessary to resolve noise complaints.
- h) APD – Noise & Vibration team – Provide technical support to PANMG as when required to resolve particular complaints /technical issues.
- i) TLL Communications – Provide technical support and resources as necessary to PANMG as necessary to resolve noise complaints
- j) CPD HoE Rolling Stock / Project / Discipline Engineers – Provide technical support to PANMG as when required to resolve particular complaints /technical issues.

## 5 **Supporting information**

### 5.1 **Background**

5.1.1 PA systems are used on LU stations and trains to provide two primary functions:

- a) provide customers with routine (service status) information
- b) during emergencies provide safety information / alarms to manage the safe evacuation of customers/staff

5.1.2 Some customer information is considered safety-related information and LU is obliged to provide this at certain intervals. Further information in this regard is published in S&SD and operational security standards /guidance.

### 5.2 **Safety considerations**

5.2.1 Noise reduction measures identified as a result of guidance provided in this document should be fully assessed for impact to customer safety and service operations and be implemented accordingly

### 5.3 **Environmental considerations**

PA systems should be operated with the objective of remaining compliant with noise and other relevant legislation (EPA 1990) and industry good practice as defined in relevant BS EN standards and codes of practices.

### 5.4 **Customer considerations**

Accessibility and availability of clear and real-time customer information is a key part of TfL/LU customer satisfaction and network management strategies. These are subject to revision as the LU network grows and develops and technology improves.

6 Attachments

6.1 Attachment 1 – PA Noise Complaint Resolution Processes

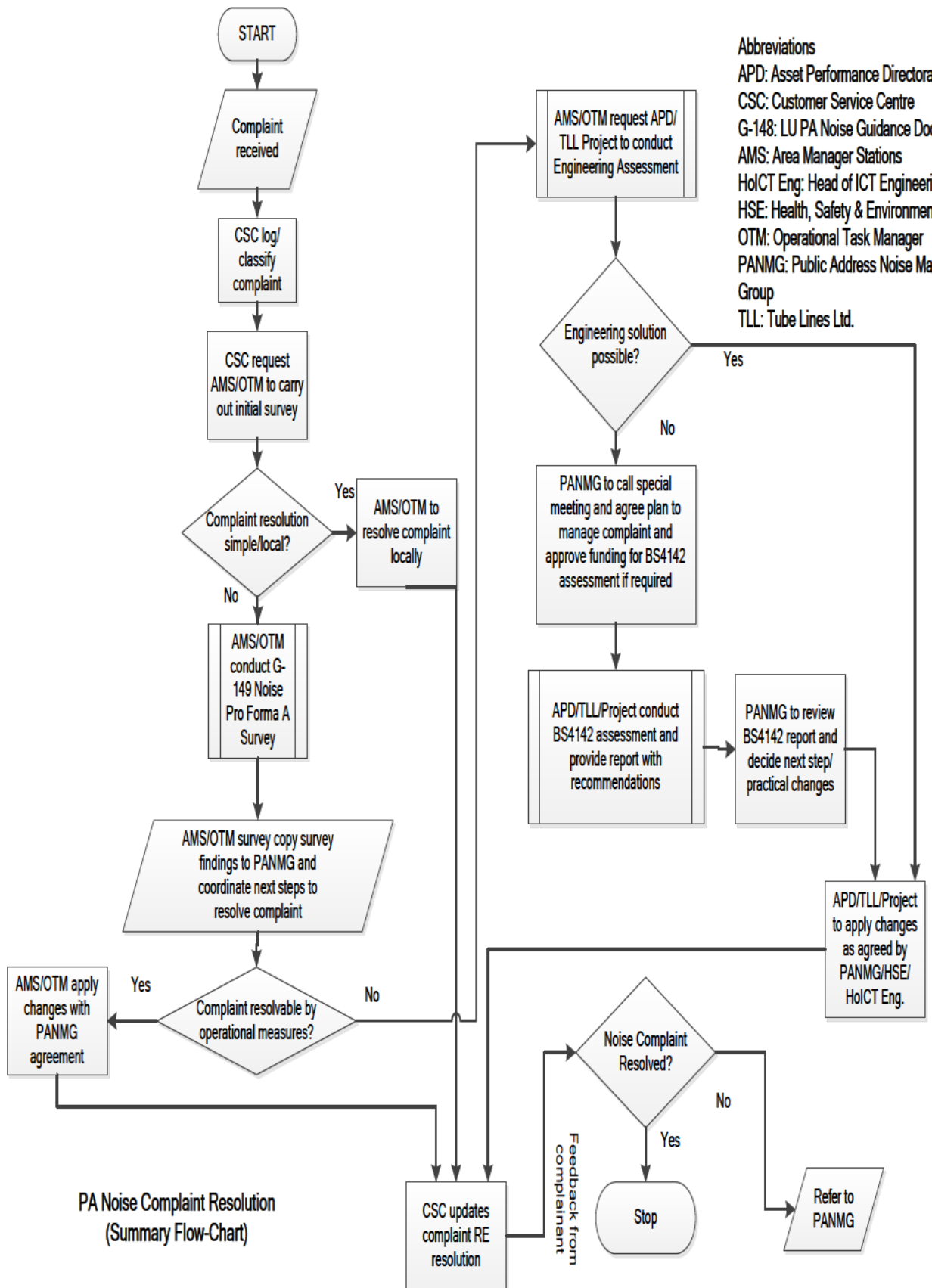
Activity Flow	Participants					INPUT	OUTPUT
	CSC	AMS/OTM	HSE	APD/TLL	HoE		
<b>Step 1.</b> Log customer complaint	R	C	I	I	I	A	PA Noise complaint received directly from neighbour. Customer or indirectly via 3 <sup>rd</sup> party
<b>Step 2.</b> Operational investigation –Area Manager Stations/OTM to conduct initial assessment of PA noise complaint and explore simple /local resolution if possible.	R	R	C	I	C	A	CSC create central record including details of complaint & complainant, send complaint details to Area Manager Stations/AMS/OTM including G-148 Pro forma A.
							Area Manager Stations/OTM receive details of complaint & complainant from CSC & Pro forma A
<b>Step 3.</b> CSC log Area Manager Stations/OTM recommendations / emails/ pro forma A #	R	R	C	I	C	A	Area Manager Stations/OTM provide (via email) recommendations based on survey. If applicable copy completed G-148 Pro forma A to CSC /APD/TLL
							CSC receive Area Manager Stations/OTM recommendations and completed Pro forma A where applicable
<b>Step 4.</b> Operational resolution – Area Manager Stations/OTM resolve complaint through operational measures; apply changes as necessary with any required concessions from S&SD/PANMG* RE: CSS Impact	R	R	C	I	I	A	Area Manager Stations/OTM action next steps to resolve noise complaint
							Area Manager Stations/OTM (operational) recommendations from G-148 Pro Forma A
<b>Step 5a.</b> Engineering investigation – APD/TLL review Area Manager Stations/OTM e-mail / Pro forma A and conduct technical survey/ suggesting possible options to resolve complaint with indicative costs for each	R	C	C	R	R	A	Area Manager Stations/OTM confirm to CSC that operational resolution has been implemented CSC consult with PANMG* prior to writing to complainant of implemented change CSC copy PANMG* all correspondence /feedback to and from complainant
							Area Manager Stations/OTM to request APD/TLL/projects to conduct technical survey (APD – may involve Noise & Vibration team – TLL may involve their PA contractors)
<b>Step 5b.</b> Engineering Resolution – following engineering /safety consultations & approvals: APD / TLL to resolve complaint in accordance with PANMG* agreed option.	R	R	C	C	C	A	APD/TLL Projects to send technical survey report to OTM /PANMG with recommendations and costs. Technical survey report can include pro forma B or G-148 compatible format report
							PANMG /OTM approval given to APD/TLL/projects carry out engineering resolution of complaints
<b>Step 5a.</b> PANMG to agree an appropriate plan to resolve complaint – Assign actions to specific roles with timescales and give approval to carry out a formal BS 4142 assessment at complainant's property.	R	R	R	R	R	A	APD/TLL/projects confirm to OTM that engineering resolution has been implemented. Area Manager Stations/OTM informs CSC who following PANMG consultation will write to complainant to advise on changes made keeping Area Manager Stations/OTM/PANMG* in circulation of all correspondence
							Escalated / High profile complaint received, where previous complaint resolutions have not worked. Local Council/ other senior figures (LU/TLL /political) seeking assurance that complaint will be resolved
<b>Step 5b.</b> APD / TLL or Relevant Project conduct BS4142 assessment	R	C	C	R	C	A	Plan to resolve complaint agreed by PANMG, BS 4142 assessment using class 1 test equipment approved. HSE/CSC gain permissions via Local council/ complainant(s) to conduct tests
							Request to conduct BS4142 assessment with details of complainant address and access time received from PANMG/CSC
<b>Step 6c.</b> PANMG hold special meeting to review BS4142 report conclusions to decide further measures to resolve complaint including next steps/ CSC correspondence	R	R	R	R	R	A	Relevant agency conducting BS4142 assessment provide approved report with conclusions
							PANMG members to read BS4142 report ahead of special meeting
<b>Step 7.</b> PANMG hold review meeting to assess effectiveness of PA noise reduction measures taken.	R	I	I	I	I	A	Clear decision from PANMG for next step(s) RE – resolution measures / CSC correspondence
							PANMG agreed actions completed, CSC have received feedback from complainant

\* refers PANMG Chairperson

# all CSC logs in respect of this guidance should be copied to the PANMG shared drive



**Abbreviations**  
 APD: Asset Performance Directorate  
 CSC: Customer Service Centre  
 G-148: LU PA Noise Guidance Document  
 AMS: Area Manager Stations  
 HoICT Eng: Head of ICT Engineering  
 HSE: Health, Safety & Environment Directorate  
 OTM: Operational Task Manager  
 PANMG: Public Address Noise Management Group  
 TLL: Tube Lines Ltd.



PA Noise Complaint Resolution  
 (Summary Flow-Chart)

## 6.2 PA noise complaint resolution processes – notes

- a) The PA complaints resolution process is designed to achieve a successful outcome to the majority of PA noise complaints. All complaints should be centrally logged with the Customer Service Centre (CSC) with all the relevant details of the complaint and complainant.
- b) The process initial activities enable the complaint to be investigated and validated. For confirmed complaints the process aims to coordinate a resolution that is consistent and delivered within TfL internal / published timescales.
- c) To this end the use of proforma's /emails and PANMG meeting minutes and CSC correspondence enables TfL / LU to demonstrate a verifiable audit trail should it be required in cases of unresolved /escalated complaints.
- d) Essentially three classes of complaints are covered;
  - I. complaints that can be easily resolved locally either through operational resolutions or in cases of exceptional / erroneous PA operation where a simple apology explaining the exceptional circumstances / error may be sufficient for resolution.
  - II. Complaints that require engineering intervention / testing to confirm a PA system fault / non-conformance (to LU standards) and ultimately clear the fault to resolve the problem /complaint.
  - III. Escalated / high profile complaints that will require careful attention to detail and management to ensure an outcome that is acceptable to the complainant and LU. These type of complaints may require more work to resolve for example a formal BS- 4142 assessment may become necessary to better understand the complainants perspective and PAS noise emissions at the complainants property.
- e) It is recommended that the initial (non-trivial) noise complaint investigation is recorded on "Pro-forma A". This e-form is available on-line (Intranet) and enables the capture of PA system and site specific information that will be useful for complaint resolution and will form part of the audit trail in demonstrating (when required) 'best practicable means'. The use of Pro forma A is not restricted to Area Manager Stations/ OTM's, it can be used by any investigators when conducting an initial investigation of a complaint.
- f) It is important to keep accurate notes of any statements made / meetings held in respect of high profile/escalated complaints. Hence the need for CSC to act as single point of contact for any external correspondence / liaison. All PANMG members have duty to ensure they share all relevant information with CSC / other PANMG members as applicable.

## 6.3 Attachment 2 – Design principles

### 6.3.1 Part A - Management of noise emissions

- 6.3.1.1 Noise emissions should be managed wherever possible primarily through PAS design. PAS should be energy efficient utilising the minimum energy to deliver intelligible broad-casts with the capability of adapting to ambient noise levels. In practice the avoidance of noise nuisance may require a trade-off between PAS performance and the risk of noise complaints.
- 6.3.1.2 Sound delivery should be via directional speakers installed to deliver PAS broadcasts in the relevant PA zones only with minimum noise spill to adjoining / neighbouring areas. Where the use of screens / barriers is being considered, specialist advice should be sought.
- 6.3.1.3 The dynamic range of the PAS should be automatically controlled so that repeated adjustments to volume are not needed for naturally softly spoken and loud announcers. Correctly set gain-structure and intelligent use of signal compression / limiting will be key in achieving this goal.
- 6.3.1.4 The clarity and intelligibility of noise emissions outside the PA zones and in particular at noise receptors can be reduced via graphic equalisers by limiting the energy in specific speech-band frequencies.
- 6.3.1.5 The PA system designers should be cognisant of the factors that could influence the propagation of PA noise emissions outside the intended PA broadcast zones:
- a) Speaker directivity  
Directional speakers should be used for noise sensitive sites as they will be more effective in confining the PA direct sound to a given broadcast zone. In particular frequencies centred on the 2kHz and 4 kHz octave bands which are important to speech intelligibility /clarity.
  - b) Speaker height and alignment  
Optimum height minimises the energy needed to deliver audible PA announcements. For alignment the speakers should be angled into the listening space to prevent direct sound reaching an adjacent noise receptor. The speaker height relative to noise receptors (neighbouring properties) may have an impact on PA broadcast propagation if influenced by local wind / temperature gradients.
  - c) Speaker positioning  
In some cases the positioning of speakers can be critical in avoiding noise complaints especially if a given speaker is causing a direct sound path to an adjacent noise receptor. Occasionally unintended sound focussing due to reflections can occur creating a seemingly amplified wavefront to be propagated in particular directions. This should be proved by noise measurements during investigations.
  - d) Wind and Temperature gradients  
Both wind and temperature gradients can cause sound refraction over a distance



- I. wind gradient – Sound propagation into a headwind can cause the wavefront to be bent upwards and by a similar analogy a sound wavefront with an assisting tail wind will be bent downward.
- II. temperature gradient – sound wavefronts will be refracted (bent) towards lower temperature zones. During daytime refraction is upwards and downwards at night.

### 6.3.2 Part B - BS 4142:1997 Assessment [Summary]

- 6.3.2.1 BS 4142:1997 was originally created to assess risk of complaints from industrial noise and not specifically the risk of PA noise complaints. It is however used by acoustic consultants and local councils when investigating noise complaints in general including speech /music related nuisance.
- 6.3.2.2 The standard when used properly (with appropriate measurement corrections and penalties) provides in most cases a reasonably accurate indication of the risk of complaints from PAS operation. See BS4142:1997 for the assessment details and correction methods.
- 6.3.2.3 The use of this standard in the assessment of noise complaints risk will be particularly useful at the design prior to the implementation stages of the PAS.
- 6.3.2.4 Typical corrections that apply for noise assessments in LU PA environments include:
- a) Specific (PA) noise correction  
This correction is needed if the residual (ambient) noise is high enough (i.e. within 10 dB of the specific noise level) to contaminate the specific noise reading. Where residual noise contamination is present Table 1 in BS 4142 provides approximate decibel values that can be subtracted from the combined residual /specific noise reading to give the actual specific noise level.
  - b) On-time correction  
This is needed if the specific noise (when operating) is not continuous (as will be the case for LU PA operation) and the message ON duration ( $T_o$ ) is less than the BS 4142 reference interval ( $T_r$ ) 1 hour. For specific noise measurements over period  $T_m$ , the corrected reading normalised to reference interval ( $T_r$ ) is given by;  
$$LA_{eq,Tr} = LA_{eq,Tm} + 10 \log T_o / T_r$$
  - c) Tonal (Acoustic feature correction)  
This is required for specific noise that contains distinguishable /attention attracting features and for PA systems add +5dB to specific noise reading.
  - d) Facade correction  
This is needed when measuring near large / significant reflectors (within 1-2m) and requires 3dB subtraction from the facade reading to estimate incident SPL.
- 6.3.2.5 For detailed / further guidance refer to section 3.5 of this guidance and the BS 4142 standard document which contains several worked examples of noise assessments.

## 6.4 Attachment 3 – Pro forma A



### ProformaA AMS/OTM-Noise complaint investigation and assessment

#### Introduction

The purpose of this pro forma is to assist Area Manager Stations (AMS), Operational Task Managers (OTM) or other LU staff involved in conducting a Public Address (PA) noise complaint investigation.

This pro forma enables the investigating team to capture / record a range of information about the PA system, its operational use and environmental impact to the station surrounding areas. Investigators can upload relevant photographs to help reinforce a particular point or issue highlighted in their report.

This form can be completed using Adobe reader 6.0.6 or later or Adobe Acrobat.

Investigators should read the "Points for consideration" on page 4 when conducting this assessment. Use page navigation buttons provided at the foot of each page to move around the form.

Once the form is completed it can be saved locally and sent as a pdf via email to [REDACTED]@tfl.gov.uk. Alternatively investigators can use the 'submit by Email' button located top right corner of this page; return only the Form (XML) data (including any uploaded site photographs). The CSC will receive the XML data and use it to reconstruct the original form. This will be stored as a record to aid current / future complaint resolution decisions.

When returning form data (via 'submit by Email' button) in this way please wait a few seconds as you may be prompted as to how you wish to send the data (desktop email or internet) choose desktop.

The pro forma can also be filled and printed (using print button) then manually faxed to the CSC on [REDACTED].

If you have any problems call CCO team

Phone: [REDACTED] (24 hours)

or email: [tfl.gov.uk/contact](mailto:tfl.gov.uk/contact)

**AMS/ OTM PA Noise Complaint Investigation**

Survey Date (DD/MM/YY)

**Site Specific details**

**Investigating Team Details**

LU/ TfL Station

Local Council

PAS Maintainer

<b>ROLE</b>	<input type="checkbox"/> AMS	Name	<input type="text"/>
	<input type="checkbox"/> OTM	Name	<input type="text"/>
	<input type="checkbox"/> Other	Name & Role	<input type="text"/>

PA Zone(s) affecting complainant

Neighbouring roads /properties

PA Operating times; Mon-Fri / Sat-Sun Bank Holidays

Complainant name & address

Weather conditions / ambient noise levels on day of Survey

Reported Complaint (Summary)

**PA announcements made at station**

**Frequency**

**Frequency**

<input type="checkbox"/> Service Status	Exp'ctd <input type="text"/>	Obs'vd <input type="text"/>
<input type="checkbox"/> Security	Exp'ctd <input type="text"/>	Obs'vd <input type="text"/>
<input type="checkbox"/> Train dest'n	Exp'ctd <input type="text"/>	Obs'vd <input type="text"/>

<input type="checkbox"/> Local DVA	Exp'ctd <input type="text"/>	Obs'vd <input type="text"/>
<input type="checkbox"/> Platf'm Safety	Exp'ctd <input type="text"/>	Obs'vd <input type="text"/>
<input type="checkbox"/> Long Line	Exp'ctd <input type="text"/>	Obs'vd <input type="text"/>

Other PA Specific Details

**Speakers Used at the Station**

**Systems Information / Functions Available**

		
<input type="checkbox"/> Horn (Bell)	<input type="checkbox"/> Re-entrant Horn	<input type="checkbox"/> Surface Mounted
		
<input type="checkbox"/> Bi-directional Horn	<input type="checkbox"/> Column	<input type="checkbox"/> Projector

<input type="checkbox"/> Digital Voice Announcer	<input type="checkbox"/> Train Mass Detectors
<input type="checkbox"/> Long Line PA	<input type="checkbox"/> PA Timer
<input type="checkbox"/> Mind the Gap	<input type="checkbox"/> Night Volume Control
<input type="checkbox"/> Ambient Noise Sensors	<input type="checkbox"/> SMS MICA
<input type="checkbox"/> Fire Panel PA Interface	<input type="checkbox"/> Radio Mics
<input type="checkbox"/> Switchable Speakerchain	<input type="checkbox"/> Stn announcement Points

State if any recent changes have been made to the PA System



**Listening Tests (Sample)**

Note 1. Message Intelligibility and Audibility (loudness) is graded from 1 to 5, where 1 is lowest and 5 is highest  
 Note 2. Listening tests conducted under 3 ambient noise conditions;  
 - Low (quietest - early AM/late PM operating times);  
 - Normal (during day between trains)  
 - Train berthed in platform

PA Zone under test		
Ambient Noise Conditions		
<input type="checkbox"/> Low noise/quiet	Intelligibility	<input type="text"/>
	Audibility	<input type="text"/>
<input type="checkbox"/> Normal (between trains)	Intelligibility	<input type="text"/>
	Audibility	<input type="text"/>
<input type="checkbox"/> Train berthed	Intelligibility	<input type="text"/>
	Audibility	<input type="text"/>

PA Zone under test		
Ambient Noise Conditions		
<input type="checkbox"/> Low noise/quiet	Intelligibility	<input type="text"/>
	Audibility	<input type="text"/>
<input type="checkbox"/> Normal (between trains)	Intelligibility	<input type="text"/>
	Audibility	<input type="text"/>
<input type="checkbox"/> Train berthed	Intelligibility	<input type="text"/>
	Audibility	<input type="text"/>

PA Zone under test		
Ambient Noise Conditions		
<input type="checkbox"/> Low noise/quiet	Intelligibility	<input type="text"/>
	Audibility	<input type="text"/>
<input type="checkbox"/> Normal (between trains)	Intelligibility	<input type="text"/>
	Audibility	<input type="text"/>
<input type="checkbox"/> Train berthed	Intelligibility	<input type="text"/>
	Audibility	<input type="text"/>

PA Zone under test		
Ambient Noise Conditions		
<input type="checkbox"/> Low noise/quiet	Intelligibility	<input type="text"/>
	Audibility	<input type="text"/>
<input type="checkbox"/> Normal (between trains)	Intelligibility	<input type="text"/>
	Audibility	<input type="text"/>
<input type="checkbox"/> Train berthed	Intelligibility	<input type="text"/>
	Audibility	<input type="text"/>

Position outside Station		
Ambient Noise Conditions		
<input type="checkbox"/> Low noise/quiet	Intelligibility	<input type="text"/>
	Audibility	<input type="text"/>
<input type="checkbox"/> Normal (between trains)	Intelligibility	<input type="text"/>
	Audibility	<input type="text"/>
<input type="checkbox"/> Train berthed	Intelligibility	<input type="text"/>
	Audibility	<input type="text"/>

Position outside Station		
Ambient Noise Conditions		
<input type="checkbox"/> Low noise/quiet	Intelligibility	<input type="text"/>
	Audibility	<input type="text"/>
<input type="checkbox"/> Normal (between trains)	Intelligibility	<input type="text"/>
	Audibility	<input type="text"/>
<input type="checkbox"/> Train berthed	Intelligibility	<input type="text"/>
	Audibility	<input type="text"/>

**Subjective Assessment of PA Announcements (Points for consideration)**

1. Investigators should first listen to the announcements in the PA zone(s) associated with the PA noise complaint. Clear and loud announcements may cause noise nuisance particularly during periods of low ambient noise (early am/ late pm).
2. Announcement levels in a given PA zone may appear to be normal for adequate intelligibility; however this does not necessarily mean the announcements will be inaudible at or near adjacent properties.
3. To determine the potential of external noise nuisance a visual inspection of the PA speakers in the affected and adjacent PA zones should be made to assess the types, heights and direction of speakers. Where neighbouring properties are immediately adjacent to the station PA zone, speakers should be directional, low-medium sensitivity, heights kept to the minimum 2.3m and angled into the listening area to optimise sound delivery.
4. A sample of announcements both live and recorded should be listened to in the station (PA zone) and at or near the complainant's property. The audibility should be scored subjectively 1 to 5 where 1 indicates messages are inaudible and 5 very loud. Message intelligibility should be similarly scored, such that 1 indicates messages are imperceptible and 5 indicating excellent clarity and intelligibility. The test should be repeated for a range of ambient noise conditions including
  - No trains (Earliest/latest agreed operating times for station)
  - Normal ambient noise (day time - interval between trains)
  - Train berthed in platform
5. Relevant photographs of the speaker installation/positioning in respect of adjoining /complainant's property should be taken to aid resolution decisions by the "PA Noise Complaints Resolution Meeting". If the latter is not possible the complainant's property should be indicated on a local ordnance survey map with respect to the station boundary/PA zone. This pro forma allows photographs to be uploaded into the form.

**Summary Report**

AMS/OTM Summary Report of Initial Noise Assessment & recommendations	
----------------------------------------------------------------------	--

**Photograph uploads - Station PA zones / External areas**  
**Max file size = 500kb for each photo**

Photograph 1

Location	<input style="width: 100%;" type="text"/>
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Photograph 2

Location	<input style="width: 100%;" type="text"/>
----------	-------------------------------------------

Photograph 3

Location	<input style="width: 100%;" type="text"/>
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Photograph 4

Location	<input style="width: 100%;" type="text"/>
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Photograph 5

Location	<input style="width: 100%;" type="text"/>
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Photograph 6

Location	<input style="width: 100%;" type="text"/>
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## 6.5 Attachment 4 – Pro forma B - (PA maintainer measurements template)

### 6.5.1 Background

- 6.5.1.1 Pro forma B will record the noise readings necessary to enable the PA maintainer to make a technical assessment of a given PA noise complaint.
- 6.5.1.2 Noise instruments (including sound level meters, microphones and calibrators) should be built and calibrated to BS EN 61672 and provide a minimum of class 2 accuracy. This will be sufficient for routine maintenance and initial technical assessments in response to PA noise complaints. Class 1 accuracy is necessary for formally requested measurements (e.g. by local council) to demonstrate best practicable means or compliance with a noise abatement.
- 6.5.1.3 Measurements should be conducted using an integrated sound level meter (SLM)
- 6.5.1.4 To ensure consistent readings and minimise reflections the SLM should be fitted with a suitable wind shield and mounted on a stable tripod 1.2 to 1.5 metres from the floor.
- 6.5.1.5 Readings should be taken in the free field wherever possible and at least 3.5m from the nearest reflecting surface. Specific noise readings contaminated by high residual noise levels should be discarded and re-measured
- 6.5.1.6 Façade level measurements should be appropriately corrected to obtain free field levels. See attachment 2 part B.
- 6.5.1.7 Total noise measurements containing the specific noise and residual noise should be level corrected where this does not exceed residual noise level alone by 10dB. The correction can be carried out using equation below or the SPL correction graphs shown in Fig. 1
- $$L_{\text{specific}} = 10 \log (10^{\text{total}/10} - 10^{\text{residual}/10}) \dots\dots\dots (1)$$
- 6.5.1.8 For convenience Fig.1 also enables addition of two incoherent SPL's
- 6.5.1.9 Time and character correction should be applied where appropriate and when conducting BS 4142 noise risk assessments. Guidance regarding these corrections is given in BS 4142 and attachment 2 part B of this guidance.
- 6.5.1.10 Sound level meters should be calibrated before and after the noise measurements. All instrumentation must be UKAS or NAMAS calibrated as a minimum every 2 years
- 6.5.1.11 Testers should be competent (i.e. LU accredited /licensed) to undertake environmental noise measurements
- 6.5.1.12 A recommended measurement template for Pro Forma B is suggested overleaf

**Pro Forma B – PA Noise Measurements Template**

Test Record 1 of.....

Site/ Station:

Date:

Sound Level Meter (SLM) details						
SLM model:	Asset ID:	Calibration date:	Microphone type:	Asset ID:	Calibration date:	
Manufacturer:	Serial No:	Recalibration date:	Manufacturer:	Serial No:	Recalibration date:	
SLM Calibration Details				Tester details		
Calibrator model:	Asset ID:	Calibration date:	Start Calibration level:	Tester name:	Tester grade / title	
	Serial No:	Recalibration date:	End Calibration level:			
SLM Settings						
Frequency Weighting:	Time Weighting:	Measurement function:	Measurement duration:	Noise parameter:	Tripod: Y / N Windshield: Y / N	
Noise Environment Description						
Weather conditions / Wind speed			Residual Noise sources		Specific Noise sources	

**PA Noise Measurements – TestRecord 2 of.....**

**Station:**

**Date:**

Measurement Details				
Reading Description	Measurement Location	Noise descriptor	SPL Value	Comment

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<b>Measurement Details</b>					
<b>Reading Description</b>	<b>Measurement Location</b>	<b>Noise descriptor</b>	<b>SPL Value</b>	<b>Comment</b>	

**Conclusions:**

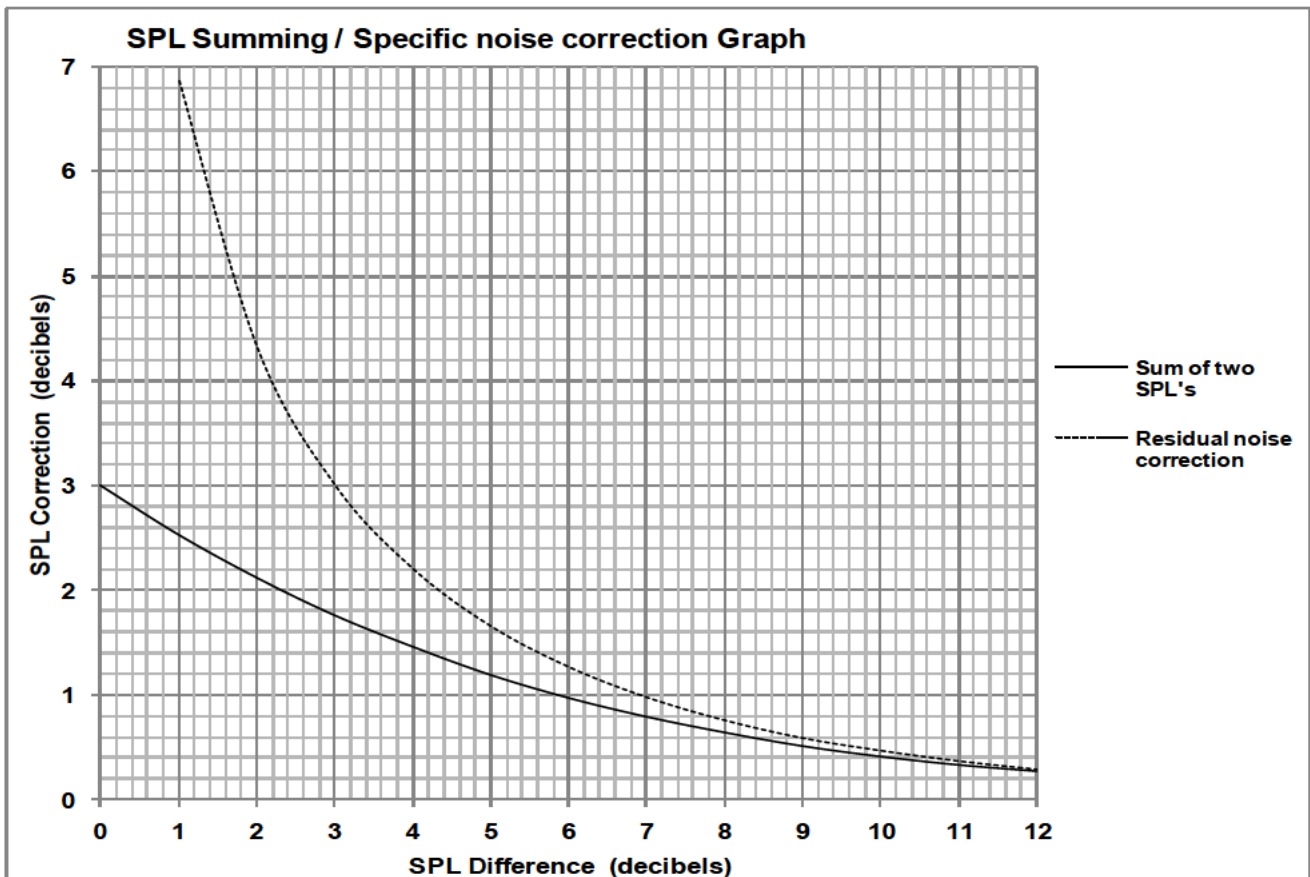


**Signature of Testers:**

**Date:**

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Using graph (Fig.1)

1. When adding two sound pressure levels, use the solid (sum of two SPL's) curve. Note the difference between the two SPL's and read off the SPL correction (y-axis) value. This needs to be added to the higher SPL to get the overall SPL sum.

E.g. The sum of two SPL's 65 dB and 70 dB can be estimated by adding the SPL correction value (1.2 dB) to 70 dB based on the 5dB difference. Thus  $65\text{dB} + 70\text{dB} \approx 71.2\text{ dB}$ .

2. For specific noise correction, use the broken (residual noise correction) curve. Note the difference between the specific noise and the residual noise and read off the SPL correction (y-axis) value. This needs to be subtracted from the combined (specific + residual) noise reading.

E.g. A residual noise reading of 50 dB is taken adjacent to a noise receptor with PA noise OFF. If this increases to 54 dB when the station PA is switched ON, then the actual specific (PA) noise level can be estimated by subtracting the SPL correction value (2.2 dB) from 54 dB based on 4dB the difference. Thus specific PA noise =  $54 - 2.2 \approx 51.8\text{ dB}$ .



7 **Person accountable for the document**

Name	Job title
Nicholas Ball	Principal Engineer, ICT Engineering

8 **Definitions**

Term	Definition	Source
Acoustic transfer function	the attenuation loss between the PA zone and the noise receptor or representative measurement position; taking into account distance, direction and contribution of reflections	a
Ambient noise Sensor	A device installed in the PA zone and used by the PA system to regulate volume levels in environments where the ambient noise is variable	a
Ambient noise	Totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far.	BS4142
BS 4142 Assessment	This is a noise complaints risk assessment originally designed for rating impact of industrial noise on and mixed residential & industrial areas but is often used by Local councils and there-fore LU when assessing noise complaints under EPA 1990	a
Background noise LA <sub>90,T</sub>	The A-weighted sound pressure level of the residual noise at the assessment position that is exceeded for 90 % of a given time interval, T, measured using time weighting, F, and quoted to the nearest whole number of decibels.	BS4142
Class 1 and 2 noise measurement	Noise measurement accuracy defined in BS EN 61672 Class 1 being more precise.	BS EN 61672
Residual noise	The ambient noise remaining at a given position in a given situation when the specific noise source is suppressed to a degree such that it does not contribute to the ambient noise.	BS4142
Specific noise source	The noise source under investigation for assessing the likelihood of complaints.	
Specific noise level	The equivalent continuous A-weighted sound pressure level at the	BS4142

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	assessment position produced by the specific noise source over a given reference time interval measured as $L_{Aeq,T_r}$	
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## 9 Abbreviations

Abbreviation	Definition	Source
ANS	Ambient Noise Sensor	a
APD	Asset Performance Directorate	a
CPD	Capital Programmes Directorate	a
CSS	Customer Satisfaction Survey	a
dB	Decibel	a
dB(A)	dB measurement normalised to the A-Weighting curve	a
DVA	Digital Voice Announcer	a
EA	Equality Act (2010)	
EPA	Environmental Protection Act 1990	a
OTM	Operational Task Manager	a
AMS	Area Manager Stations	a
GUI	Graphical User Interface	a
HSE	Health, Safety and Environment directorate	a
PA	Public Address	a
PANMG	Public Address Noise Management Group	a
PAS	Public Address System	a
S&SD	Strategy and Commercial Directorate	a
SNR	Signal to Noise Ratio	
SPL	Sound Pressure Level	a
STI	Speech Transmission Index	a
STIPA	Speech Transmission Index for PA systems	BSEN 60268-16
TLL	Tube Lines Ltd	a

## 10 References

List any LU, TfL Corporate or external documents that you have referred to.

Document no.	Title or URL
BS 4142:1997	Method for rating industrial noise affecting mixed residential and industrial areas,
BS EN 54	Fire Detection and Alarm Systems ( Relevant parts – 2/4/16/18/21/24/25)
BS 5839–8	Fire Detection and Fire Alarm Systems for Buildings – Code of practice for the design, installation, and servicing voice alarm systems.

BS 60268	Sound System Equipment
BS 6259:1997	Code of Practice for Design, planning, installation, testing and maintenance of sound systems
BS 60849	Sound Systems for Emergency Systems
BS 7445	Description and Measurement of Environmental Noise
BSEN 61672	Electroacoustics -Sound level meters — Part 1: Specifications
BS EN 60268-16	Sound System Equipment Part 16: Objective rating of speech intelligibility by speech transmission index
BSEN ISO 18233	Acoustics — Application of new measurement methods in building and room Acoustics
1-140	Telecommunications Philosophy and Principles
1-142	Operational Information Systems
1-145	Wired Communication Systems
G-148	Management of Noise due to Public Address Systems
1-312	Automated audio and visual information in public areas of stations and trains

11 **Document history**

Issue no.	Date	Changes	Author
R3	Sept 2007	Manual 5-01204-012 re formatted and re-numbered to G-148, no technical changes have been made to the content other than changing references to other Standards where their numbers have changed.	SQE
A1	Oct 2007	Authorised for use. Previous authorisation is valid	SQE
A2	April 2013	As per DRACCT No. 01855, rewrite of document taking into account revised LU / BS EN standards improved PAS technology and LU /TfL organisational changes and review comments	Naran Gorasia
A3	January 2015	Change made for FftFS – all references to Group Station Manager or GSM changed to Area Manager Stations or AMS  Note: the rest of the document was not reviewed or updated	Uzma Khan
A4	13/12/2016	General update and reformatted using the current template as per change No. 05088.	Steve Bayes