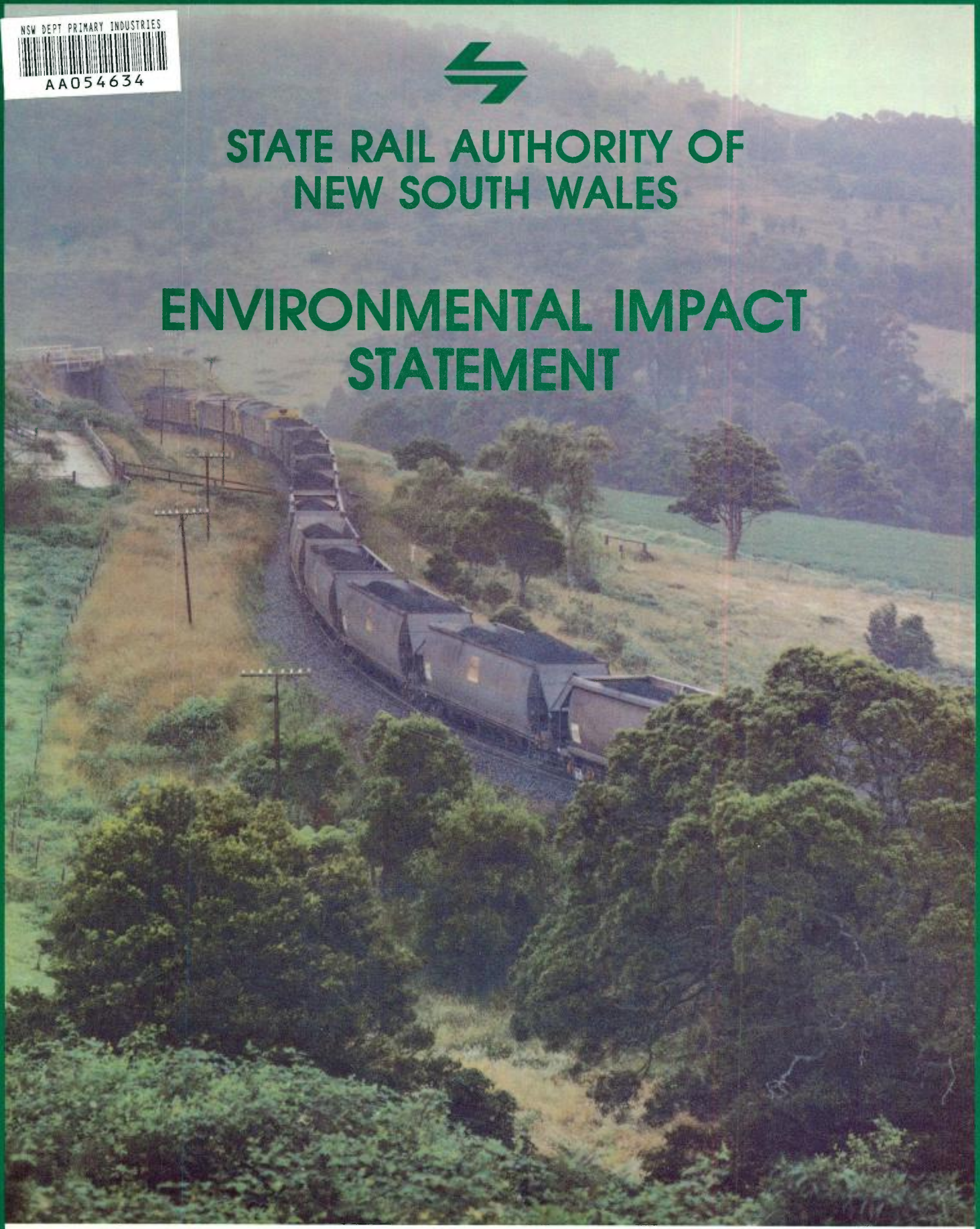
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STATE RAIL AUTHORITY OF NEW SOUTH WALES

ENVIRONMENTAL IMPACT STATEMENT



MALDON-DOMBARTON-PORT KEMBLA RAILWAY

SUPPLEMENTARY REPORT – NOISE CONTROL STUDY

VOLUME IV

EIS 209

is A Challis and Associates Pty Ltd

OCTOBER 1983

NOTHING IN THIS VOL FOR DMR ASSESSMENT.

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1. INTRODUCTION

This Acoustical Environmental Assessment examines the acoustical impact associated with the construction of a new rail-line extending from Maldon to Dombarton and through Farmborough Heights and Unanderra to the coal loader at Port Kembla. This document is intended to form a supplement (as Volume 4) to the overall environmental impact statement prepared by Dames & Moore, which was released for public review on the 5th October, 1983

The report evaluates the existing acoustical environment during both the day and night time at a number of carefully selected monitoring positions adjacent to the proposed route. It compares the measured results with a series of criteria which have been proposed both overseas and in Australia for determining the acoustical adequacy of rail operations.

A series of detailed proposals for treatment of the noise generators at source, in the path and at the perceiver as well as possible treatment to the rolling stock are presented for consideration, to minimise the noise annoyance of the operational system.

Volume III of the E.I.S. incorporates, on page H14, a tentative figure for L_{eqA24} which was provided by us to Dames & Moore.(1) That preliminary figure was based on the mistaken belief that all 54 trains which might use the line each day and they would be hauled by three diesel electric locomotives. Updated information has shown this to be incorrect, as less than one third of the trains will be diesel electric when the line is used to maximum capacity.

2. DESCRIPTION OF THE PROPOSED RAIL-LINE

The proposed railway will link the Main Southern Line and the Moss Vale - Unanderra Railway from Maldon to Dombarton below the Illawarra Escarpment. This line will be a single track line incorporating four passing loops. There is no provision for duplication of the line at this stage.

The total route comprises 9.5 km new construction between the Main Southern Line to Wilton, 25.7 km new construction between Wilton to Dombarton and duplication of the existing railway tracks between Dombarton and Port Kembla.

The selected route will leave the Main Southern Line near Maldon and will cross the Nepean River north of the new Maldon road bridge. The line will traverse what is generally open grazing country for approximately 9 km between the Nepean River and Wilton. This portion of the route crosses under the South Western Freeway (F5) and Wilton Road (Trunk Road 95).

At Wilton the line will enter the Metropolitan Water Sewerage and Drainage Board's Metropolitan Catchment Area,which is uninhabited, passing to the south of Thorntons Hill and crossing the Cordeaux River approximately 23 km south of the junction of the Cordeaux and Avon Rivers.

Within the Metropolitan Catchment Area the route generally follows a southerly direction by following the existing alignment of fire roads numbered 6A and 6B. This portion of the route will represent about one half of the total length of the line between Maldon and Dombarton. It generally follows the ridge line which separates the Cordeaux River and Avon River catchment areas. Significant lengths of line will be located in an already cleared corridor, occupied by the fire roads, all of which is readily accessible by road.

The only residential areas affected are those adjacent to the township of Wilton and in the area from Dombarton to Unanderra, where the new line will run parallel with the existing Port Kembla to Moss Vale line.

3. ACOUSTICAL CRITERIA FOR COMMUNITY NOISE ASSESSMENT

3.1 Impact of Noise on People

The way in which people perceive loudness or noisiness of any given sound depends on a number of measurable and descriptive physical characteristics or parameters of the sound. These parameters are :

(a) Sound intensity - where in general, a 10 decibel increase in intensity may be considered as an approximate doubling of the perceived loudness or the noisiness of a sound.

(b) Frequency content - where sounds with concentrations of energy between 2,000 Hertz and 8,000 Hertz are perceived as being more noisy than sounds with equal sound pressure level with dominant energy outside this range of frequencies.

(c) Modulation of the sound - where modulation is defined as cyclical changes in sound pressure level. Sounds that are rhythmically varying in level, or increasing in level, are judged to be somewhat louder and more obtrusive and disturbing than those which are decreasing in level.

(d) Impulsiveness of the sound - or rapid rates of increase of sound pressure level. Impulsive sounds are sounds which exhibit high peaks of energy starting and stopping very abruptly. Such sounds are perceived to be more noisy and far more disturbing than constant sounds with the same peak level.

The task of quantifying the environmental impact of noise associated with any noise source generally requires the application of a suitable statistical methodology. This approach is necessary because individual human response to noise is subject to considerable natural variability. Over the past 25 years researchers have identified many of the diverse factors which contribute to the variation in individual's reactions to intrusive noise.

Knowledge of the existence of these variables gives some understanding as to why it is not readily possible to state simply that "a given noise level from a given noise source will elicit a particular community reaction or have a particular environmental impact". In order to do this it is normally necessary to know how much each of the variables referred to in the above set of parameters contributes to the human reaction to noise. Research in psycho-acoustics has revealed that an individual's attitude, beliefs and values may greatly influence the degree to which a person considers a given sound annoying. The aggregate emotional response of an individual has been found to depend on:

(a) Feelings about the necessity or preventability of the noise. If people feel that their needs and concerns are being ignored, they are more likely to feel hostility towards the noise. This feeling of being alienated or of being ignored or mistreated, is the root of many human annoyance reactions. If people feel that those creating the noise care about their welfare and are doing what they can to mitigate the noise, they are usually more tolerant and are willing and able to accommodate higher noise levels.

(b) Judgements of the importance and of the value of the primary function of the activity which is producing the noise.

(c) Activity at the time an individual hears a noise and the disturbance experienced as a result of the noise intrusion. An individual's sleep, rest and relaxation have been found to be more easily disrupted by noise than are his communication and entertainment activities.

(d) Attitude about environment. The existence of undesirable features in a person's residential environment will influence the way in which he reacts to a particular intrusion. People living in better or more affluent residential areas are less tolerant of intrusive noises within their areas than are people living in poorer or less affluent residential areas.

(e) General sensitivity to noise. People vary in their ability to hear sound, their physiological predisposition to noise and their emotional experience of annoyance to a given noise.

(f) Beliefs concerning the effects of the noise on their health. If the listener feels that there is a possible risk to his health from the noise level, he is more likely to respond adversely.

(g) Feeling of fear associated with the noise. For instance, the extent to which an individual fears physical harm from the source of the noise will affect his attitude toward the noise.

A number of physical factors have also been identified by researchers as relevant parameters influencing the way in which an individual may react to a noise. These other factors include:

(a) Type of neighbourhood.

Instances of annoyance, disturbances and complaint associated with a particular noise exposure will be greatest in rural areas, followed by suburban and urban residential areas, and then commercial and industrial areas in decreasing order. The type of neighbourhood in which one lives may actually be associated with one's expectations regarding noise.

People expect rural neighbourhoods to be quieter than cities. Consequently, a given noise exposure may produce greater negative reaction in an area where the people have purchased their houses in the belief that the area was a quiet one with little or no vehicular traffic.

The converse is also true in areas or locations where the property owner has purchased his land or building in the full knowledge that some degree of intrusive noise level is likely to be perceived. Thus people purchasing land or homes adjacent to an existing railway line must reasonably expect some acoustical penalty which is offset in part by the lower purchase price which would be expected as a result of the proximity of the property to the railway line.

(b) Time of day.

A number of studies have clearly shown that noise intrusions are considered more annoying in the early evening and much greater late at night than during the daytime.

(c) Season.

Noise is considered more disturbing in the summer than it is in winter. This is understandable since windows and doors are likely to be open in the summer in Australia to assist ventilation and many recreational activities take place out of doors.

(d) Predictability of the noise.

Research has revealed that individuals exposed to unpredictable noise have a lower noise tolerance than those exposed to predictable noise. Thus, for example trains, buses, a neighbour regularly coming home late at night and a garbage truck in the early morning all constitute predictable noises. Studies conducted in Europe and our own studies in Australia have confirmed that, following a period of habituation, the majority of the people living adjacent to railway stations and railway lines are generally unaware of and are usually unconcerned about the noise from trains.

(e) Control over the noise source.

A person who has no control over the noise source will be more annoyed than one who is able to exercise even limited degrees of control over the source.

(f) Length of time an individual is exposed to a noise.

There is some evidence supporting the argument that annoyance resulting from some classifications of external noise will decrease with continued exposure. Extremely high level noise sources will under some circumstances result in an overall increase in annoyance the longer one is exposed.

In this particular situation (with exposure to trains), the degree of preconditioning as a result of prior exposure is reasonably well documented. Only very high noise levels from trains tend to negate the effects of continuing exposure to trains.

(g) Habituation to Noise

The habituation to a sound source from a public service, statutory authority or community service, which is regarded as essential by members of the community or society, is less likely to cause annoyance per se and is usually assigned a special rating or dispensation in the mind of the perceiver.

3.2 Assessment of Noise Impact

Studies to determine the "noisiness" of sound extend back historically to the first work of Fletcher and Munson at the Bell telephone laboratories in the early 1920's. It is not particularly well known that their initial work involved simultaneous objective and subjective assessments of traffic and train noise in the New York area. The equipment that they used was archaic by present day standards, but nonetheless provided them and indirectly us, with data on methodologies, but little by way of useful results (2).

Schultz and Kryter have indicated that in many noise control problems it is not how loud a sound is that concerns us most, but rather how noisy and unwanted it is. Inherent in this statement is the assumption that loudness and noisiness are two distinguishable, although related, manifestations of human response to noise.

Kryter's findings(3) were chiefly the outcome of a series of laboratory investigations of subjective response to aircraft noises. In these studies, ratings based on jury judgments of propeller and jet aircraft noises were compared with ratings based upon computed loudness levels. The comparisons indicated that the computed loudness consistently underestimated the noisiness or unwantedness of jet aircraft noise.

The determination of 'perceived noise decibels' is a relatively complex measurement to perform and normally requires either microprocessor controlled intrumentation or a computer controlled third octave band analysis system for the complete and accurate assessment. Whilst simple measurements utilising "D" curves on sound level meters are sometimes utilised, these are not regarded by most experts as being completely accurate and appropriate. For this reason A-weighted sound level measurements have tended to retain their position as the appropriate measurement quantity.

Schultz' findings(4) were an extension of the original work by Kryter in the early 60's and add the results of extensive studies on the subjective responses of both American and European communities to all forms of traffic and industrial noise sources.

3.3 Additional Noise Measurement Methodology Section

There have been a wide range of other units for the determination for community noise impact. These include amongst others the equivalent A-weighted sound level abbreviated to L_{eq}, the noise and number index abbreviated to NNI, day-night average L_{DN} and Community Noise Equivalent Level abbreviated to CNEL. Of these criteria L_{eq} is the most popular descriptor for determining short term (10 minutes to 1 hour) and medium term (1 hour to 12 hours) A-weighted noise impact level.

The L_{DN} criteria has been the most popular descriptor for use in the United States for traffic noise studies over a 24 hour period. NNI and CNEL have been primarily utilised for aircraft noise studies in the United Kingdom and have not been favoured as a universal parameter in other countries.

Noise rating numbers are the most popular criteria for evaluating frequency or tonally dominant noise sources of either an industrial nature or from traffic. Studies of ground borne sound radiation from railway lines and many major studies of airborne railway noise have been evaluated in terms of the noise rating number criteria.

4. OBJECTIVE CRITERIA FOR COMMUNITY NOISE ASSESSMENT

4.1 National Standards for Community Noise Assessment

The release of the British Standard BS4142 (1967) "Method of Rating Industrial Noises Affecting Mixed Residential and Industrial Areas" provided the first national standard which other nations were able to use as a model for producing their own community noise standards. In particular, the International Standards Organisation Standard R1996 (1971) "Assessment of Noise with Respect to Community Response - 1st Edition" and Australian Standard AS 1055 - 1973 "Noise Assessment in Residential Areas" drew extensively on the British document and its principles in producing their respective documents.

4.2 Australian Standard 1055 - 1973

Committee AK5 of the Standards Association of Australia produced over a period of 3 years from 1970 to 1973 the first Australian Standard for Noise Assessment in Residential Areas. The document contained a number of obvious deficiencies, the most important of which related to extracts from the British Standard for which the derivation sources could not be confirmed. The document had other technical and legal deficiencies which resulted in complaints concerning its suitability for generalised community noise assessments.

4.3 Australian Standard 1055 - 1978

The Australian Standard was redrafted in 1976 - 1978 and the resulting document contained significant extracts from the original standard together with major changes in text, whose purpose was primarily intended to assist the planner and health surveyor. Regrettably, the Australian Standard provides documentary clauses which were aimed primarily at assessing industrial noise sources rather than transportation noise, so that it is not strictly applicable to this study.

4.4 Australian Standard 2107 - 1977

Australian Standard 2107 - 1977 Ambient Sound Levels for Areas of Occupancy Within Buildings has been prepared to provide design criteria for the conditions affecting the acoustical environment within a wide range of commercial and residential situations. The descriptor utilised for the noise measurement assessment is dB(A). The purpose of this standard is to specify desirable background noise levels (primarily in terms of an (A) weighted L_{90} value) for internal airconditioning and external machinery related noise sources, as opposed to external traffic noise or other intrusive noise sources. In the normal application of this standard, it would be anticipated that other external and internal intrusive noise sources would be present. These would be expected to elevate the 'foreground noise' to significantly higher sound levels over and above the background noise level.

4.5 Provisional Statistical Criteria for Rating the Acceptability of Community Noise

In 1970, the US Housing and Urban Development commissioned the firm of Bolt Beranek and Newman to develop a technical programme for noise abatement with suitable methodology and appropriate criteria. The team leader, Ted Schultz, developed a radical new approach through the introduction of statistical criteria in which the (A) weighted 'noise exceedance levels', together with the equivalent sound level, were presented in terms of 4 criteria zones of designated acceptability superimposed on a graph of statistical noise exceedance values.

The 4 designated zones were respectively classified as "clearly acceptable", "normally acceptable", "normally unacceptable" and "clearly unacceptable".(5)

The advantage of presenting community noise measurements, or forecasts, in terms of such criteria, is the ease with which one can visually compare an existing, future or offending acoustical environment with the designated criteria. Such reference criteria may then include either the prior or existing noise environment, local or regional regulatory criteria or even two differing sets of forecast conditions which may then be inter-compared.

The only significant disadvantage with Schultz's noise exceedance graphs was that their derivation and intended usage related primarily to day-time conditions.

Being aware of the limitations of such criteria, we extended the data to include a set of provisional night-time criteria, derived after approximatey 14 years experience in statistical community noise assessments. Those criteria have been utilised in a large number of major community studies and have been documented in a paper presented in the United States of America in 1982.(6)

The major advantage of statistical noise analysis and the associated statistical noise criteria is their inherent objective allowance for transitory or intermittent noise sources, as typified by trains operating in the urban environment. The major outcome of the noise exceedance graphs is their confirmation of the acceptability of an environmental noise level in terms of day-time, and night-time, criteria. Our studies have confirmed that the acceptable equivalent noise level for day-time (L_{eq}) (7am - 6pm) is 62 - 64 dB(A) whilst the acceptable equivalent noise level for night-time (10pm - 6am) is 53 - 55 dB(A). The criteria for the intermediate time zones of evening (6pm - 10pm) and early morning (6am - 7am) fall between these two criteria and are typically 57 - 58 dB(A). These figures should not be taken as "black and white" and absolute divisions, but rather as "grey" areas dependent upon a wide range of factors relating to those determinants discussed in Section 3.1.

5. OTHER RELATED STUDIES ON TRAFFIC NOISE

5.1 The Wilson Report

The best known of all community noise assessments is that produced by the Wilson committee (7) assessing the problems of noise in United Kingdom in the early 60's. Their report provided the first significant synthesised objective and subjective assessment of community noise in the broadest sense. Prior to the 1960's there were few if any major studies of noise annoyance in residential areas. The data that the Wilson report provided is not necessarily directly applicable in Australia, where the weather conditions are greatly different and social and economic factors tend to differ markedly from the English model.

The most important conclusion of the Wilson Report was the highlighting of the extent to which small sections of the community can be adversely affected by transportation noise, particularly when that noise is at high levels as is typically experienced by people residing adjacent to airports and by those people living in the immediate vicinity of motorways, highways, main roads and railroads.

5.2 The ISVR Railway Noise Surveys

Whilst the Wilson report makes reference to the problem of train noise in the United Kingdom, the comments and conclusions that they draw are of necessity qualified by the committee's knowledge that train noise is classified as being treated as a statutory authority for the purpose of the Noise Assessment Act (U.K.) of 1960. It had to await further and subsequent studies to specifically address the issue of train noise.

The most significant of these studies is that produced by Walker and Fields (8) at the University of Southampton's Institute of Sound and Vibration. Whilst our copy of their report was a preliminary document it nonetheless showed clearly that the marginal criteria level at which community annoyance from train noise would be acceptable, would occur at an L_{eq} level of approximately 55-60 dB(A). They commented that in the "real world" represented by their noise survey, there would not be significant bends in the curvature of the subjective acceptability graph relating the percentage of the population annoyed versus the equivalent noise level.

Put another way, they acknowledged that, irrespective of level, a certain percentage of the population will complain of annoyance. This correlates well with our own studies of noise from both trains and entertainment which have shown clearly that typically up to 5% of the sample population questioned in a properly conducted survey will complain of annoyance purely because they are able to "hear the offending sound".

For this reason, the point at which the "average man" would define the threshold of annoyance occurs when the curve, relating percent annoyed against noise level, flattens out.

In their summary, Walker and Fields state that within the L_{eq} range 45-80dB(A), annoyance increases steadily with noise level. Their curve, however, shows that a figure of approximately 55 dB(A) L_{eq} constitutes the practical limit below which there is no significant decrease in the number of people annoyed for a small differential change in sound level.

5.3 Canadian Studies

Whilst Canada has produced a wealth of research reports on environmental criteria, most of these, on examination, have proven to devote their attention to noise sources which exclude trains. One exception to this is the report of May (9) dealing with criteria and limits for wayside noise from trains.

This scholarly treatus prepared on behalf of the Ministry of Transportation and Communications shows convincingly that the L_{DN} value for acceptable community noise impact should ideally not exceed 55dB(A) and preferably the L_{eqA24} should not exceed a value of 55dB(A). The relationship between L_{DN} and L_{eq} is a function of the number of trains in the period 10pm to 7am relative to the period 7am to 10pm, but for simplification, can be treated for an urban rail situation as corresponding approximately to -3dB(A). Thus, we may presume that May believes that an L_{eq} value of 55dB(A) is unlikely to result in significant community annoyance in Canada.

5.4 Japanese Studies

In Japan noise regulations have not been imposed on the Railways but railside acoustic barriers have been installed in many parts of the country, particularly in densely populated areas to minimise the noise of rail/wheel interaction which constitutes the most significant noise source for medium to high speed trains. Japanese environmental standards (10) for noise for the Shinkansen Bullet Train are based on three category areas described under classifications of AA, A and B. AA areas are those which require particular quiet and are typically hospital zones. A areas are primarily residential, whilst B areas are those in which substantial numbers of residences are located amongst shops and factories. The table below presents the desired dB(A) L_{50} levels.

Noise level exceeded 50% of the time in dB(A)

Category of Area	Division of Hours		
	Daytime	Morning & Evening	Night Time
	Not more than	Not more than	Not more than
AA	45	40	35
A	50	45	40
B	60	55	50

Surveys conducted by the Japanese National Railways on the 8 year old Tokaido line and the 4 month old Sanyo line reported by Remington and Nimura (11) show clearly that the acceptability point in terms of L_{eq} dB(A) values are subject to the degree of habituation following the commencement of operation of the railway line. Thus the "neutral point" in the plotted results of peak A weighted level in terms of the mean annoyance score is typically 8 dB(A) lower on the Sanyo line than on the Tokaido line. If we presume that the difference between the peak level (L_1) and the L_{eq} value is at least 8 to 10 decibels, then the mean annoyance score for the Sanyo line 4 months after commencement of operation would be between 52 and 54 dB(A).

5.5 New Zealand Studies

The New Zealand Board of Health (12) has proposed simple criteria for minimisation of community annoyance in terms of peak external noise levels measured from railway rolling stock, particularly locomotives, when operating in the open country-side at full power. Apart from the Silver Fern, there are few important mainline trains left in New Zealand, and the suburban rolling stock in Auckland and Wellington are now more than 50 years old. The procurement criteria for new rolling stock would result in equivalent noise levels of less than 55 dB(A).

5.6 Scandinavian Studies

Noise studies in Norway and Sweden detailed in (13) highlight that a significant proportion of the population is disturbed by noise from railroads, with the majority of these being in the urban areas close to existing above ground suburban rail lines. As a result of these studies, the Swedish National Railways are constructing the majority of new railway lines below ground and introducing cost-effective rail vibration isolation systems.

5.7 American Studies

There have been more studies relating to the mechanism and criteria of train noise in the United States of America than in all the other nations put together. The most significant researchers in this area have been the Stanford Research Institute, Wiley Laboratories, Wilson Ihrig & Associates, and Bolt Beranek and Newman. Their research work, together with other associated studies, have primarily been funded by the U.S. Department of Transportation. Many of the studies have been devoted to planning for new rapid-transit rail systems mooted in the early 60's and 70's to solve the transportation problems of the major American cities.

5.8 Summary

While the above studies primarily relate to the assessment of the acoustical impact of suburban and mass transit rail systems, the information provided by them has specific relevance in this report as all of those studies have aimed at providing criteria for "acceptable" community noise impact.

The primary criteria that have been developed from the aggregate of the research projects is the achievement of an L_{DN} equal to 55 dB(A) as the preferred urban acoustical criteria.

By contrast the typical values of equivalent noise experienced by residents living adjacent to "active" railway lines in most countries in the world have been conservatively estimated to range between L_{eqA24} values of 55 and 75 dB(A). Walker and Fields have stated that in the United Kingdom more than 200,000 people are currently exposed to values of 65 dB(A) or higher.

Other countries including most European countries, U.S.S.R. and Japan would have segments of the populations exposed to equally high levels of railway noise.

In Sydney there have been conservative estimates of more than 12,000 people with L_{eqA24} exposures from trains of greater than 55 dB(A).

6. CURRENT OVERSEAS NOISE CONTROL PRACTICE

Current overseas practice for control of train noise can be subdivided into two different approaches. The first approach relates to the specification of maximum noise levels to be produced by the trains themselves. The second approach relates to better design of rolling stock, railway lines, and the introduction of effective airborne and groundborne noise and vibration barriers.

One of the more important of the former approaches is the promulgation of the Railroad Noise Emission Standards released by the United States E.P.A. on July 3rd, 1974 under part 201 (14). In Section (8) of that document entitled Health & Welfare Impact, the Standard tacitly states that L_{DN} values of greater than 55dB(A) will have an adverse effect on health and welfare. This is reiterated in the section titled Pre-emption, where the document recommends that local and state guidelines for property development set a level of 55dB(A) L_{DN} at the property line.

By contrast most other nations which have imposed criteria on railway systems have done so in the form of a maximum noise emission standard at a predetermined distance from the railway line. The typical levels recommended are 93dB(A) maximum at 28' metres and 73dB(A) at idle (15). These levels have been specified to take into account the noise emission characteristics of diesel electric locomotives rather than electric trains, and it is apparent that most international authorities do not attempt to regulate urban train noise in the same way that they regulate inter-urban diesel or electric train noise emmissions.

Local Ordinances in the U.S.A., Europe and Japan have been utilised as a means of minimising train noise.

In most of these situations, the local Authorities have realised their inability to make significant changes to the rolling stock and have consequently devoted their efforts and attention to modifying the noise path from rolling stock to points of possible complaint.

Attempts to control noise from trains have been generally unsuccessful apart from the rail grinding techniques utilised in the U.S.A., Sweden, Germany, Switzerland and France. Additional research work devoted to improving wheel designs developed in the U.S.A. and Germany have been moderately successful, whilst the rail barrier techniques developed in Japan, Holland, Germany and Australia (16) have proven to be very successful.

In the United Kingdom there has been a growing realisation that as a result of more than 200,000 people currently being exposed to equivalent noise levels of greater than 65 dB(A), as a result of train noise, (17) it is important for British Rail to take stock of the situation and implement slow but gradual noise abatement procedures. The British Rail planning personnel have sponsored or rendered direct assistance to the most important of the recent studies. Whilst they have not openly promoted standards of acceptability, we have been advised that any new urban rail lines are tentatively planned on the basis of a normalised L_{eq} value of 55dB(A) at the nearest residential boundary.

In the United States whilst the E.P.A. introduced the Railroad Noise Emission Standards in 1975 with an effective date of September 31st, 1976, little change took place in the intervening period. The new BART system in San Francisco and the new METRO system in Washington are the only new railway systems to be constructed in America since that time. The external vibration levels and to a lesser extent the external noise levels from both of these systems are significantly better than those produced by any other railway system in the U.S.A.

More recently the E.P.A.'s charter for implementing this particular standard was withdrawn by the Reagan administration, as they regarded the cost and consequent benefits of Federally funded acoustically treated railway systems as being disproportionate.

In Australia there have been no documented attempts to impose criteria or noise emission standards on railway authorities. The only exceptions to this rule of which we are aware, are primarily associated with the construction work on new Railway lines, noise emission from Way and Works Branch maintenance depots and railway car cleaning facilities.

7. PARAMETERS OF RAILWAY NOISE AND POSSIBLE IMPROVEMENTS

Railway noise is determined by three groups of parameters which are respectively:

those related to emission of noise source (train motive source, train rolling stock, extent of traffic and condition of track);

those associated with the transmission or propagation path which are determined by the topography between rail track and perceiver;

and those associated with the perceiver.

Noise abatement measures can be applied to each of the three groups. Whilst the most desirable and effective noise abatement procedure is generally by the reduction of the noise generated by the source, this is relatively difficult to achieve with railway rolling stock. Different problems face the locomotive and railcar fabricators, the State Rail Authority, the Government and the operating personnel. There are also other relevant factors which have an effect on the acoustical problem, including speed, safety and economics.

7.1 Noise Source

Railway noise is generated by a complex system of interacting noise sources. Each passing train either comprises one or more locomotives hauling a row of railcars or is a self powered multiple unit passenger train, comprising a series of coaches, some of which contain power units, operated jointly from the front driving cab.

The primary noise sources on any train are normally the power units and the wheel/rail interactions respectively. A railway train may be considered to be equivalent to a line of point sources at regular spacings, together with a series of other sources formed by the engine(s) (locomotive (s) or power units).

At a specified distance from the track, the engines may also be regarded as point sources. When in close proximity to the track, one is readily able to observe the different sources passing by. At some distance, typified by a physical spacing dimension greater than 1/3 the length of the train, the noise of the different wheels will amalgamate, forming an incoherent line source of finite length.

We describe the source as being "incoherent" since as it is built up of separate point sources whose noise emission is not harmonically related nor do they act in phase. The noise emission of the engine decreases faster with distance than the combined group of wheel/rail noise sources and, generally at low engine power settings, it will not protrude above the wheel's rolling noise. Finally at a great distance, relative to the length of the train, the passing train will appear to act as a single point source.

The maximum noise level emitted by a single train depends on the engine type (diesel, electric), the kind of train (passenger, freight) and also the speed (fig. 7.1). When annoyance by railway traffic is being investigated the noise exposure may be considered over a relatively long time period, e.g. by using the equivalent sound level L_{eq}. This parameter is determined by the length and the number of trains passing during a specific analysis period.

Special noise sources are created by rail joints, points, sharp curves, whistles and brakes. Railway stations, shunting yards, sub-ways and elevated steel or concrete rail structures, are sources of noise which warrant particular attention.

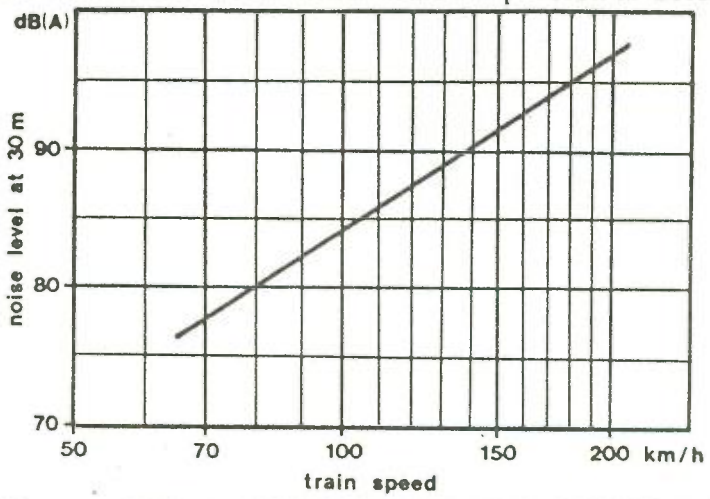


Fig. 7.1 Peak A-weighted train noise level as a function of train speed for a 4-car multiple unit at 30 m.

Noise reductions at the source are difficult to achieve because even though most of the noise producing elements are in the hands of the State Rail Authority, the reduction of engine noise, the construction and maintenance of railway vehicles and tracks, is complicated by the extent of existing equipment whose usage is not necessarily restricted to only one section of line.

7.1.1 Engine

Whilst the principal motive systems on this line will be electric the existing railway traffic on the Moss Vale line, which uses diesel-electric or diesel powered units, will continue to operate after the construction of the Maldon-Dombarton-Port Kembla Railway.

In diesel-electric traction a diesel engine drives an electric generator producing the energy required for the traction motors. Speed is regulated with the electric motors and the diesel engine has a limited number of throttle settings (8 or less) to regulate the required power e.g. when accelerating or climbing a grade.

The noise emission of traction units is determined by the type of engine, the type of exhaust silencer (if fitted to the locomotive) and speed or throttle setting. Most diesel electric locomotives utilise a turbo-blower for increased engine efficiency and these normally result in significant attenuation of the engine exhaust noise levels. Many locomotive manufacturers do not fit large or even effective supplementary exhaust silencers after the Turbo blower in order to keep down weight and in the belief that such silencers are not required.

When a high motive power is required, e.g. during acceleration or on steep climbs (fig. 7.2), a relatively high noise level is emitted, although train speed may be low.

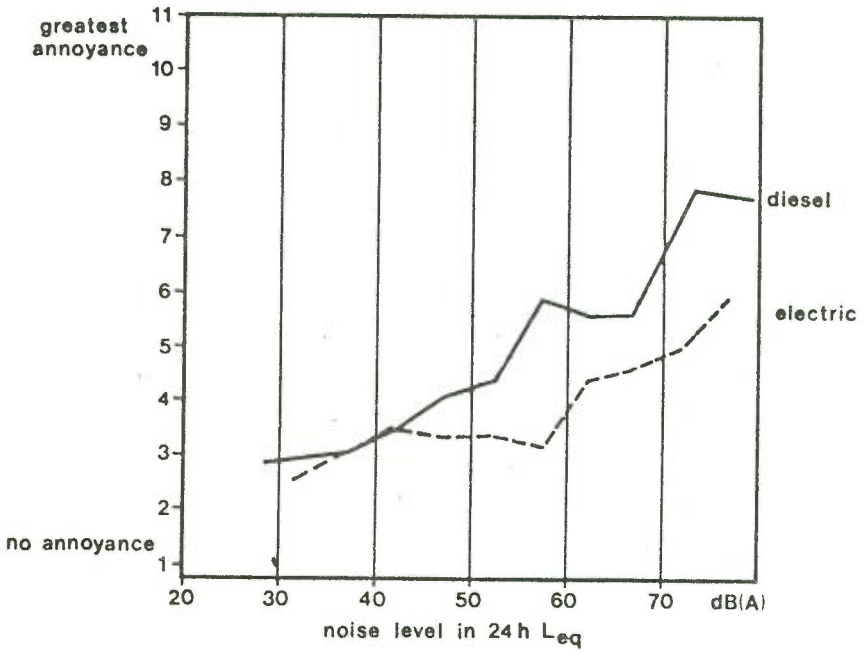


Fig. 7.2 The effect of traction type on annoyance

Diesel locomotives generate high noise levels at high throttle settings, and they also cause a higher level of annoyance than that predicted by the measured peak sound level. This is due to the presence of strong low-frequency tonal components in the engine exhaust noise spectrum.

At some distance from the track however and particularly at low throttle settings (constant speed, level track), the diesel engine noise will not always protrude above the rolling noise. The noise of electric locomotives and from self powered railcars will not usually exceed the rolling noise of a normal railcar, so acoustically they may be generally considered as being equivalent to railcars. It is not always easy to predict the annoyance produced by passing trains owing to differences in construction and traction systems and the deficiencies in the available sound ratings and criteria in common usage.

While engine noise on moving trains intrudes only at short distances or during acceleration, the noise of stationary trains is dominated by the idling engine, although other sources such as cooling systems, air-conditioning systems etc. may also contribute to their impact.

The most important noise sources on a locomotive or traction unit are the cooling air inlets, the engine exhaust and the panel vibration of the locomotive body. The problems of wheel/rail interaction is discussed in more detail below. These sources are sometimes treated by using appropriate inlet - and exhaust silencers or even by improving the internal insulation and the extent of panel damping of the locomotive body walls.

7.1.2 Ancillary Equipment

Ancilliary equipment such as compressors, generators, oil and water cooling fans for engine-cooling and airconditioning systems also constitute important noise sources. Normally they are more important on stationary trains. Improvements or reduction of noise from these items may be achieved by appropriate acoustical treatment or by providing shielding in those places where trains frequently have to wait. These locations are principally stations and passing sidings. When these are situated near dwellings they normally cause additional annoyance in the neighbourhood.

7.1.3 Wheel/Rail Noise

The most important noise source on tracked transport systems is that created by the wheel/rail interaction. This noise is a combination of three special noise sources: roar, squeal and impact noise.

7.1.3.1 Roar Noise

Roar noise is caused mainly by small scale roughness on the surfaces of both the rails and wheels, although other parameters might have some influence in the generation process. Rails may develop corrugations on their surface, with depths as great as 0.3mm and with a regular spacing ranging between 30 to 60mm. A train travelling on 'corrugated rails' may generate a typical howl-tone at a speed-dependent frequency.

The most peculiar aspect of this phenomenon is that the same rails when installed in other situations do not necessarily show any tendency to generate corrugations, to any measurable degree.

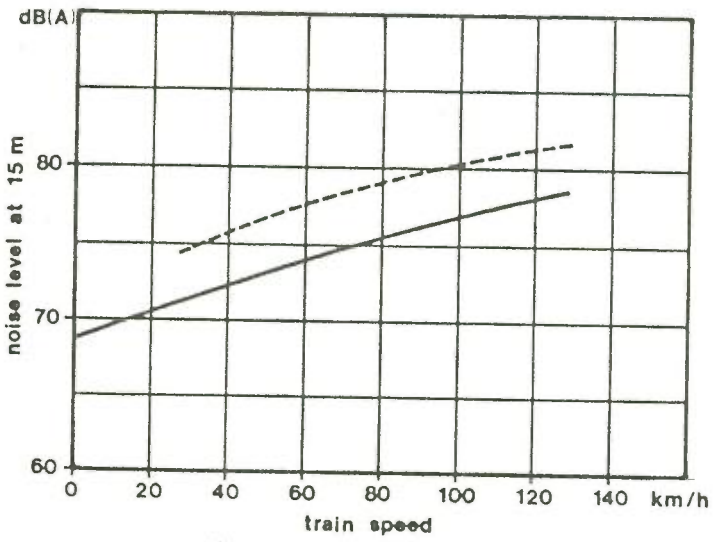


Fig. 7.3 Effect of rail surface roughness on wayside noise (—— relatively smooth rails, -- rough rails)

The most efficient measure for the reduction of roar noise is achieved through the regular grinding of the rail surface by means of special grinding trains. Truing of the wheels may also give some reduction, especially with tread braked railcars. Substitution of tread brakes by disk brakes will prevent the roughening of the wheels. More significantly the use of disc brakes will partially screen the noise radiated by the wheels, further reducing the emitted noise level. However, tread brakes may have a more positive influence on the impact noise emitted by railcars (see paragraph 7.1.3.3.).

7.1.3.2 Squeal Noise

On sharp curves trains may generate high levels of squeal noise which is probably caused by the "crabbing of the wheels" across the top of the rails . This noise can be reduced by several measures. The noise level depends on the curvature of the track, the distance between two axles on a bogie and on the vehicle speed.

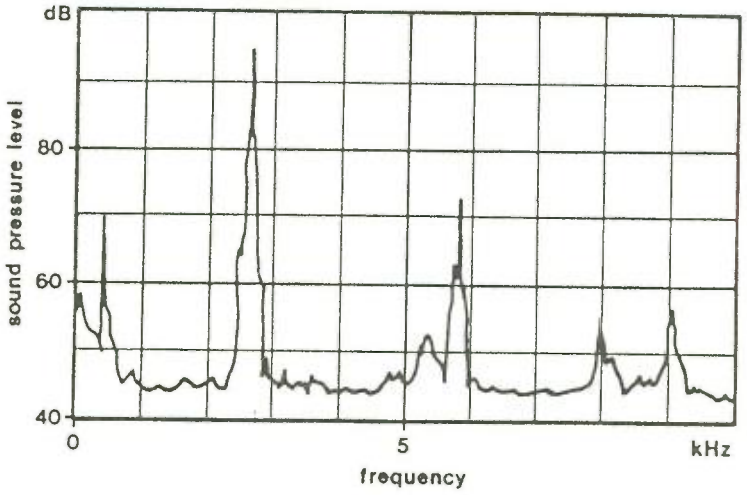


Fig. 7.4. Squeal spectrum from coal train car on a curve with approximate radius 250m

The axle distance is a fixed datum, but vehicle speed may be restricted in sharp curves and, when planning a new route, the curvature of the tracks can be limited.

7.1.3.3. Impact Noise

The third component in rolling noise is firstly generated by the impact of wheel and rail at rail joints and secondly by wheel flats. The successive pass-by of the different wheels of a train over a joint between two rails produces the typical "Clickety Clack" - noise of a passing train. The level of the emitted noise is determined solely by the height difference between the two rails and not by the width of the gap. This noise level increases with increasing vehicle speed up to a "critical train speed". Above this speed the intensity of the impact noise still increases with speed in the "step-up" direction, but is generally independent of speed in the "step-down" direction. This phenomena is caused by the separation of the wheel from the rail when encountering a discontinuity.

In the past rail joints were sometimes made oblique so that the transition of a wheel from one rail to the other was achieved more smoothly. Nowadays rail joints are more frequently welded, resulting in a recorded decrease in the level of impact noise of up to 10 dB(A).

Resiliently mounted wheels and to a lesser extent damped wheels, may decrease the impact noise as well. Up till now experimentally damped rails did not show any marked improvement.

The most obvious and simple measures to reduce impact noise are achieved by good and consistent maintenance of the rails (to avoid height differences) and the replacement of bolted rail joints by welded joints, particularly in noise sensitive areas.

Impact noise is also generated also by wheel flats that are created when a wheel "locks up" during braking. If wheel flats have developed they can be removed by truing the wheels. Conventional railway tread brakes have a positive influence on impact noise, as they 'wear off occasional wheel flats and act as self correcting elements in the operational rail system.

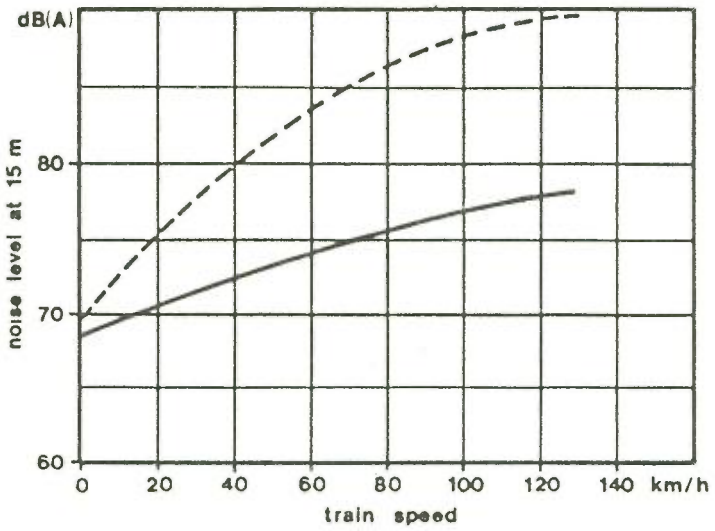


Fig. 7.5. Effect of wheel flats on wayside noise.

These are the three mechanisms that generate the rolling noise of a passing train. The emitted sound level depends on train speed and is determined by type of train, wheels and rails, and by their condition (corrugations, wheel flats and jointing system). A passing train not only emits noise, but it may also generate significant vibration at the wheel/rail interface. This vibration is also transferred from the rail through the rail fasteners, ties and ballast to the substructure (ground, rock earth bank, elevated structure or tunnel).

The properties of these intermediate elements in the transmission path influence the noise emission, because the vibrating sub-structure also usually radiates some of the noise. The use of resilient rail fasteners and ties on ballast reduces the vibration transmission. Concrete sleepers exhibit as much as 2 dB(A) reduction when compared with wooden sleepers. The ballast itself is also an effective sound and vibration absorber.

There are a number of questions remaining as to which part of the wheel/rail system radiates the most noise. The relative contributions of wheel and rail are not however completely understood.

The knowledge of the actual source position is important, particularly when the choice of noise abatement techniques is being considered. In particular the options of damped rails or damped wheels, car skirts that screen the wheels or low barriers along the rails are to a large extent dependent on that knowledge. The source height is also an important factor in the calculation of screening effects.

7.1.4. Other Noise Sources

Another source of impact noise is at track turnouts and diamond crossings where a higher level impact sound is generated. This noise may be reduced by careful construction and good maintenance procedures.

Another problem is brake squeal. This noise is caused by the brake shoes which generate high level modal vibrations in the wheels. Acoustical wayside barriers are particularly effective in controlling the radiation of such noise to locations adjacent to curves.

At some locations along a railway an audible warning is required, so that passing trains sound their whistles or horns. This high level and/or high pitched sound may cause very significant annoyance. If such a "whistle zone" is situated near residential areas, either special instructions are required to minimise annoyance or else barriers can be built along the track to shield some of the noise from the neighbourhood.

7.1.5. Total Noise Profile of a Passing Train

The noise of a passing train is generated mainly by the traction system and the wheel/rail interaction. Very close to the track aerodynamic noise may also have some influence, e.g. the shock wave driven forward by the front of high speed trains.

If a train has a locomotive the noise profile will essentially show a relatively fast increase (depending on speed and distance) up to the noise level of the locomotive, a slight decrease when the coaches or wagons pass-by and finally a decrease to the ambient noise level.

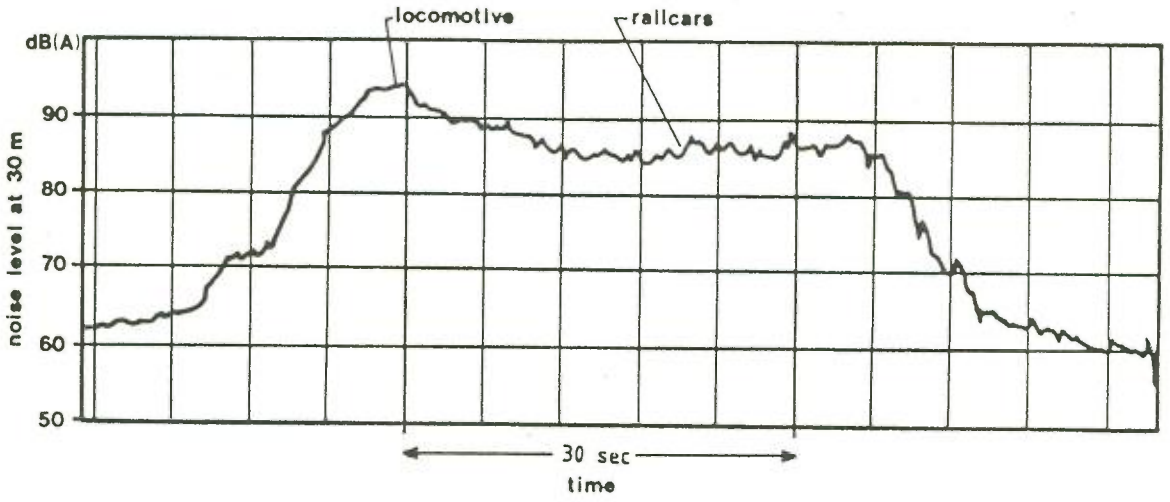


Fig. 7.6. Noise profile of a passing locomotive-hauled coal train at 30 m travelling at 50 km/h

The small peak occurring at the front of the train is determined by the type of locomotive and the distance from the track. The noise of diesel-electric locomotives may protrude markedly above the rolling noise at a short distance to the track. By contrast the noise of electric locomotives will, in most cases, be drowned by the wheel/rail noise. Multiple units may be regarded as simple coaches. Our measurements have shown that wheel/rail noise tends to dominate the A-weighted level at distances greater than about 20 m, even with diesel-electric traction.

Several models have already been developed to predict the shape of the noise profile of a passing train, and they all showed a common feature namely : the lack of profile symmetry. The noise level rises faster at the front and decreases much slower than predicted at the end of a passing train. This is caused mainly by the air flow around the train yielding an effect similar to the bending of sound waves by a wind velocity gradient.

The air speed relative to the (moving) train is practically zero at the car body walls and increases with increasing distance from the train. A similar air speed gradient occurs in the wake of the train. Thus the emitted sound rays are bent towards the rear of the train.

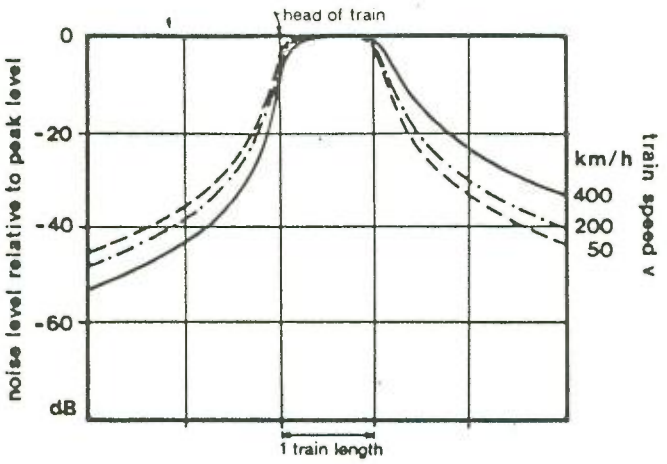


Fig. 7.7. Normalised noise profiles at a distance of 0.125 train lengths from the track at three train speeds

The sound waves propagating forward are refracted away from the train, those travelling rearward are bent backwards to the train. The noise is thus attenuated at the front and amplified at the rear of a passing train, the magnitude of the effect being entirely speed dependent.

Taking into account all these aspects the noise profile of a passing train may be predicted fairly accurately. For the prediction of annoyance however either L_{eq} or the maximum A-weighted pass-by noise level are commonly used as descriptors. These may be derived from the noise profile models and the absolute level emitted by the train. The energy equivalent noise level L_{eq} for a specified period of time depends on speed, train length, number of passing trains in that period and distance.

By contrast the maximum sound level depends only on speed and distance. Some corrections have to be applied for the type of train (freight, passenger, ...), occasionally for the locomotive (diesel, electric, ...), usually for the rail joints (bolted or welded) and possibly for some constructional details (type of brakes, type of wheels, car skirts, ...). But normally the traffic along a railway is composed of different train types so that some of these factors will not markedly influence the L_{eq}.

7.1.6. Overbridges

Rail overbridges are a source of noise, the extent of which depends primarily on their form of construction.' The noisiest constructions are light steel bridges, the quietest are normally heavy and massive concrete bridges.

The general principle is that a passing train generates vibration in the rails which is transferred to the rail fasteners and then through the construction, which starts to vibrate and to radiate audible noise. Depending on the material and the type of construction as well as on the mass and the available damping, the noise level near an elevated railway may be up to 30 dB(A) higher than near a railway track at grade.

Rails are frequently fixed directly to the construction, without ties or ballast, so that vibrations are transferred to the structure without any appreciable damping. Ties and ballast have a double effect for they act as dampers and also increase the mass of the structure. They cannot be used however on every structure. Concrete bridges or bridges with at least a closed deck may easily support the ballast, steel girder bridges generally however have no supporting structure for it. In such cases the rail fasteners may be mounted resiliently so as to attenuate the vibration transfer. The mass, type of construction and material used for an elevated structure are equally important. A bridge with large undamped radiating surfaces (steel plates, footway, sidewalls ...) will generate a high noise level.

8. ASSESSMENT OF EXISTING ENVIRONMENT

8.1 Area of Interest

Background Noise measurements were performed in the following areas at the specific positions listed:

Mount St. Thomas - Designated as Area A

Position No. A1 - outside 226 Gladstone Avenue 30 metres from the centreline of existing track.

Position No. A2 - at rear of 141 Gladstone Avenue, (Last house near Ocean Street), 10m from centreline of existing track.

Position No. A3 - outside 143 Gladstone Avenue, near Taronga Avenue, at side of house, 20 metres from centreline of existing track.

Position No. A4 - The Avenue, directly opposite RAAF closed compound (Between Television and Taronga Avenues).

Unanderra - Designated as Area B

Position No. B1 - Rear of vacant lot at 61 O'Donnell Drive 10 metres from centreline of existing track.

Position No. B2 - Old Five Island Road, first house near Railway Line, 40 metres to centreline of existing track.

Position No. B3 - O'Neill Street, next to only residence, 50 metres from centreline of existing track.

Position No. B4 - Second Avenue, at residence half way along the Street, 50 metres from centreline of existing track.

Position No. B5 - Second Avenue outside DMKT Transport.

Position No. B6 - Third Avenue, outside only residence.

Unanderra - Designated as Area B (Cont)

Position No. B7 - on Princes Highway, near Unanderra Station, 20 metres from centreline of existing track.

Position No. B8 - computational position, on Princess Highway at rear of Unanderra Shopping Centre (two residences behind shops).

Position No. B9 - outside 191 Princess Highway, on side of house level with rear facade.

Position No. B10 - vacant lot beside 34 Thornbury Avenue, level with rear of adjacent house.

Position No. B11 - 93 Farmborough Avenue, at rear of property.

Position No. B12 - computational position, on Jenkins Street.

Position No. B13 - vacant lot at 183 Farmborough Road, near Crest Street, level with rear facade of adjacent houses.

Position No. B14 - Corner of Roberts Street and Farmborough Road.

Farmborough Heights - Designated as Area C

Position No. C1 - computational position. At rear of Hamilton Residence, 23 Bristal Lane.

Position No. C2 - rear of 41 Fairloch Avenue (off Bardess Crescent), 10 metres from centreline of existing track.

Position No. C3 - at bridge on Bardess Crescent, 10 metres from centreline of existing track.

Position No. C4 - 55 Fairloch Avenue (MWSDB pumping station site), level with rear facade of nearest house.

Farmborough Heights - Designated as Area C (Cont)

Position No. C5 - outside 93 Fairloch Avenue, level with rear facade on concrete platform.

Position No. C6 - at rear of 106 Farmborough Road.

Position No. C7 - at rear of Van der Haar residence, off Farmborough Road

Position No. C8 - 309 Farmborough Road.

Dombarton - Designated as Area D

Position No. D1 - at nearest residence of three railway cottages at rail loop.

Position No. D2 - at Arnold residence.

Position No. D3 - at Williams' residence.

Wilton - Designated as Area E

Position No. E1 - at corner of Wilton Road and Trunk Road, 100m from residence on Lot No. 18.

Position No. E2 - outside Mr. Tim Blair's Residence at Condle Park.

Position No. E2A - 500m away from Mr. Tim Blair's Residence on Wilton Road.

Position No. E3 - Weston Road, 20m from F5 Highway at entrance to residence.

8.2 Noise Sensitive Areas

There are several types of land uses in the areas of interest all of which, in varying degrees, may be regarded as "noise sensitive". These are as follows, in descending order of sensitivity :

(i) Residential - these include all the residential properties overlooking the railway line. Such areas are sensitive to noise for 24 hours a day.

(ii) Community - these include schools and churches. These designated areas are only normally sensitive to noise in the daytime or evening.

(iii) Recreational - these include parks and reserves. Passive recreation areas are often more sensitive than active areas, but normally only on a daytime basis.

The emphasis in this study has been placed on residential areas, with no specific emphasis being placed on community areas.

8.3 Measurement Positions

The measurement positions were selected in consultation with the officers of the State Pollution Control Commission. The sites were selected on the basis of their being representative of the likely acoustical impact from the proposed line. The actual positions of these houses is shown on Appendix No. 1.1, 1.2, 6.1, 6.2, 19.1 and 19.2. All measurement sites were selected so as to be free of nearby reflecting surfaces, obstructions and spurious local noise sources such as large stands of trees, transformers, sprinklers and domestic air-conditioners. At each location the microphone was positioned 1.5 metres above the ground on a tri-pod with windscreen fitted.

8.4 Time Periods for Monitoring

The time for the measurements were arranged where possible to incorporate passing trains on the existing Moss Vale line and were arranged to incorporate typical mean minimum background noise levels at night time or very early in the morning.

Measurements were performed on weekends to typify minimum traffic levels, which in Farmborough Heights, Dombarton and Wilton tend to be extremely low.

8.5 Data Recorded

8.5.1 Statistical Data

The data was recorded in the form of statistical exceedance levels over a ten minute sample period, and each location was monitored once in each of the four time periods nominated above. The statistical exceedance level is the noise level in decibels (A) scale, (dB(A)), referred to the standard reference level of 20 micropascals, exceeded for a given percentage of the sample period e.g. L_{10} is the level exceeded for 10% of the sample period, L_{90} is the level exceeded for 90% of the sample period and L_{eq} is the equivalent continuous noise level. The following exceedance levels were recorded :

L_{max}, $L_{0.1}$, L_1, L_2, L_5, L_{10}, L_{20}, L_{50}, L_{90}, L_{99}, L_{min}, L_{eq}

The analyser was set to the "Fast" response.

Where possible the nearest noise sources influencing the measurement were identified and noted, whilst general or unidentifiable noises were described in terms of the direction from which the sound appeared to be coming.

The total (non-directional) traffic flows were recorded simultaneously with each acoustical sample. Trucks over 2 tonnes nominal (that is with double rear wheels) were recorded separately.

Other noise sources considered likely to influence the measurements were also noted, for example, trains, jet aircraft, light aircraft, domestic noise, animals, insects, leaves rustling, etc.

Wind speed and direction were measured during each sample, and the mean peak gusts recorded. If wind speeds exceeded 13kph, the measurements were aborted, except on some occasions where the gusts were infrequent, or it was considered that the overall results would not be significantly degraded (for example if that site was already subject to high noise levels).

These results are presented graphically in Appendix Nos. 1 to 35.

8.5.2 Spectral Data

The spectrum of the night time mean minimum background noise (L_{90}) was measured at each location. The measurements were recorded as the mean minimum pointer deflections using a sound level meter set to the "Fast" response on an octave band basis generally over the frequency range 31.5 Hz to 8 kHz. The results are presented graphically as insets on the statistical noise graphs in Appendix Nos. 1 - 35.

8.6 Equipment

8.6.1 Statistical Measurements

Community Noise Analysers	Genrad type 1945 S/Nos 212, 370 Bruel & Kjaer Type 4426
Microphones	Genrad type 1971-9605 S/N 8013 Bruel & Kjaer Type 4161 S/N 407529
Level Recorders	Linear Type 143
Windscreen	Bruel & Kjaer type UA0207
Reference sources	Bruel & Kjaer type 4230

The above equipment has been calibrated in our laboratory for linearity of digital readout, accuracy of statistical computation and frequency response.

8.6.2 Spectral Measurements

Sound Level Meter	Bruel & Kjaer type 2215
Microphone	Bruel & Kjaer type 4165
Windscreen	Bruel & Kjaer type UA0237
Reference Source	Bruel & Kjaer type 4230

All of the above equipment has been calibrated in our laboratory for compliance with the relevant Australian Standards.

8.6.3 Annotation of Noise Exceedance Graphs

The following abbreviations have been used to designate the various identifiable noise sources noted on the noise exceedance graphs and level recordings;

B. Birds	Dr. Door	L. Light Plane
C. Cars	Ind. Industry	MB Motor Bike
D. Dogs	K. Children	R. Rustling Leaves
		T. Trucks

9. COMMENTS ON THE MEASUREMENTS

9.1 Electric & Diesel Electric Locomotive Characteristics

Our measurements have shown that the acoustical characteristics of Electric and Diesel electric trains are markedly different.

Two electric traction units of the 86 class under specified load on an up grade produces peak A-weighted levels of 83 dB(A) at 30 metres from track centre line and two 81 class diesel electric locomotives produces 92 dB(A) under similar loading conditions.

On down hill runs with regenerative braking two 86 class locomotives produces 81 dB(A) whilst under dynamic braking conditions whilst two 81 class locomotives produces 89 dB(A) at the same measurement position.

From these figures it is obvious that the electric locomotives are much quieter than the diesel-electric locomotives under conditions of maximum load. More significantly, however, the electric locomotive is even more quiet under low load conditions both when under way or when stationary. Whilst an electric locomotive produces almost negligible noise when stationary, by contrast an 81 class diesel electric locomotive under idling conditions produces 76 dB(A) when measured at 30 metres from the centre line of the track.

It is because of these significant differences in sound emission that the government has decided to electrify the rail line between Port Kembla and Maldon as this is one of the most practical and effective ways to minimise the acoustical impact of the proposed line.

9.2 Expected Train Movements

During the first few years of operation of the proposed line in the pre 1990 period we have been advised that it is unlikely the total daily movements will exceed 11 trains in each direction (7 electric and 4 diesel electric). Although this corresponds to nearly 4 times the present number of trains on the line, the resulting increase in the values of L_{eqA24} will be only approximately 3 dB(A). The reasons for this small increment is associated with the relative noise emission from diesel electric locomotives when compared to the noise produced by electric locomotives.

In simple terms the equivalent noise impact of the 7 trains hauled by electric locomotives is nearly equal to the equivalent noise produced by one train hauled by diesel electric locomotives. As a consequence the equivalent noise level in the pre 1990 period is unlikely to rise by more than 3 dB(A) at any of the primary monitoring locations in the areas of Mount St. Thomas, Unanderra, Farmborough Heights or Dombarton.

By contrast, in the post 1990 period with maximum line usage there will be up to a 7 dB(A) increase in the value of the equivalent noise level.

9.3 Equivalent Noise Levels from Proposed Line

The reference distance used for the analyses undertaken for this assessment is a point 30 metres from the centre of the track on level grade. Our assessment has shown that this distance (30 metres) is generally representative of the nearest houses to the line, although there is one house approximately 17 metres from the line at Mount St. Thomas and a small number of partially screened houses which are closer at Farmborough Heights. At a distance of 30 metres the present normalised value of L_{eqA24} is 55 dB(A). In the period between 1986 and 1990 that value would rise to 58 dB(A) and in the period following maximum line usage (54 movements/day) that figure would rise to 62 dB(A).

9.4 Assessment of Present Acoustical Impact

The present acoustical impact of train noise and other sources of noise emission in each of the areas does not currently result in a significant loss of acoustical amenity.

A small number of the homes in the Mount St. Thomas area (Area A) and the Unanderra area (Area B) are exposed to railway noise whose levels could be regarded as marginal and it could be expected that their occupants might be disturbed by railway noise.

The most important acoustical descriptors used by us in the appendices are the short term values of Equivalent noise (L_{eq}) and the values of mean peak noise (L_{10}) or higher. These values are generally dominated by noise sources which are not trains. These may be compared with the values computed for Daily Equivalent noise (L_{eqA24}) presented below. Those values indicate the relative changes in acoustical environment that have been computed at each measurement location in the absence of the recommended acoustical treatment (See Section 11).

9.5 Acoustical Impact at Measurement Locations

In order to quantify the noise levels at various points within the area of interest, we have computed the existing equivalent noise levels due to train movements as well as future noise levels in terms of L_{eqA24} values. These are set out hereunder for present levels (designated as "Present"), the forcast levels during the period when the line is operating with only 7 electric and 4 diesel electric trains (designated as "1990 levels") and forecast levels at maximum line capacity (designated as "Maximum Levels"). The levels presented hereunder are on the basis of no acoustical treatment as covered by the recommendations in Section 11 below. (See Appendices 1.1, 6.1, 6.2, 19.1, 27.1 and 31.1 for location of these positions)

Measurement Position dB(A)	Present Levels dB(A)	Pre 1990 Levels dB(A)	Maximum Levels
A_1	55	58	62
A_2	59.5	62	66
A_3	58	61	65
A_4	35	40	44
B_1	63.5	66	70
B_2	53	57	60
B_3	52	55	59
B_4	52	55	59
B_5	52	55	59
B_6	52	55	59
B_7	58.5	61.5	65
B_8	58.5	61.5	65
B_9	58.5	61.5	65
B_{10}	55	58	62
B_{11}	49	52	56
B_{12}	46	50	53.5
B_{13}	45	49	52.5
B_{14}	42	45	48.5

Measurement Position	Present Levels dB(A)	Pre 1990 Levels dB(A)	Maximum Levels dB(A)
C_1	50	53	57
C_2	63.5	66	70
C_3	60.5	63	67
C_4	60	62.5	66.5
C_5	46	50	53.5
C_6	38	42	45
C_7	35	39	42
C_8	30	33	38
D_1	52	55	59.5
D_2	41	45	48.5
D_3	40	44	47.5
E_1	--	28	32
E_2	--	33	38
E_{2A}	--	40	44
E_3	--	40	44

9.6 Noise Impact at Wilton Area

The noise impact in the Wilton Area has been substantially reduced as a result of the route chosen for the rail line. As the route taken for the train is typically 400 metres to 1300 metres distance from the nearest houses the level of impact can be regarded as being completely acceptable from an acoustical and environment standpoint.

10. CONSTRUCTION NOISE

10.1 General

The construction of the proposed railway line will involve five (5) basic phases which are outlined hereunder :

10.2 Surveying the Route of the Line

The surveying work for the proposed railway line has been partially completed by making use of aerial photography which will be supplemented by the detailed track surveys nearing completion. Whilst the presence of surveyors has already created some intrusion for a small number of residents living adjacent to the line, particularly in the Dombarton area, by and large, the likelihood of further intrusion to meet the surveyors' requirements may be regarded as being generally inconsequential.

10.3 Civil Works

The most significant phase of the proposed construction programme for the railway line will be created as a result of the civil works. This work will take place in the period 0700 hours to 1700 hours Monday to Friday and will give rise to considerable noise primarily as a result of the operation of excavation equipment which will include the following:

(i) Large tracked bulldozers in the D8 to D10 class

(ii) Wheel loaders in the 980 to 990 class

(iii) Backhoes and smaller motorised equipment

(iv) Large trucks with tare capacities in the range 15-30 tonnes

(v) Air compressors with capacities ranging up to $30m^3$/min.

(vi) Bucket shovels with capacities of up to $2m^3$

(vii) Limited blasting in areas where line drilling and ripping are not feasable

All of the above equipment and associated operations, with the exception of blasting, will give rise to noise levels at the nearest residential locations as high as 82 dB(A) for periods ranging between hours and days. The length of this phase of the construction activities can not be readily estimated until such time as the final definitive design is completed.

10.4 Track Laying

The track laying phase will involve the provision of ballasting, the laying and alignment of the sleepers and rails and the possible provision of the foundations for the acoustical barriers discussed in 9.6 below. This work will give rise to noise levels as high as 75 dB(A) at the nearest residences. The period of such noise is unlikely to exceed more than 8 days at any specific location (excluding the provision of wayside barrier foundations).

The time required for provision of wayside barrier footings will be determined by the type of barrier design finally chosen, if and when used, as well as the stability of the embankment or track bed associated with each specific location.

10.5 Provision of Electrical Supplies and Signalling Systems

The electric power reticulation system will take the form of a power line over each of the tracks, supported by steel stanchions located on both sides of the double track system. These will require reinforced concrete footings whose preparation and construction will be the most significant phase in which the noise will be generated. The peak noise levels of noise associated with this phase are unlikely to exceed 70 dB(A) at the nearest residences.

The installation of the stanchions and the stringing of the electrical cabling will not be a significant source of noise annoyance. This phase should give rise to noise levels of less than 70 dB(A) at the nearest residences for periods of less than a few days duration.

The installation of the signalling equipment is not a noise intensive phase and should not give rise to significant annoyance at the nearest residences.

10.6 Construction of acoustical barrier systems or other ameliorative work

The construction of an acoustical barrier system if and where used will not be a phase which will give rise to significant noise annoyance. The elements used in the barrier wall would be primarily prefabricated off-site and as such will only involve the drilling of a limited number of holes in panelling system components and the application and installation of the sub-elements required. This work will be partially self screening and where ever possible will be carried out so as to maximise the self screening capabilities of the work involved.

The maximum noise level expected from the construction of the acoustical barriers should be less than 65 dB(A) at the nearest residences.

11. RECOMMENDATIONS FOR CONTROLLING THE MAGNITUDE OF NOISE IMPACT

11.1 General

The noise amelioration treatment has been based on the proposed maximum number of 54 movements per day. Of those trains, 36 would be coal trains hauled by 86 Class electric locomotives whilst a maximum of 18 coal trains would be hauled by 81 Class (or equal) diesel electric locomotives. Our acoustical analysis indicates that the L_{eqA24} at the worst affected house adjacent to the proposed line (in the Mount St. Thomas Area) in the absence of specific acoustical treatment is likely to be 66 dB(A).

(NB: This figure of 66 dB(A) is lower than the previous tentative figure of 77dB(A) which we provided to Dames & Moore and which is quoted on page H14 of Volume III of the E.I.S. (1). That tentative figure was based on all diesel electric locomotives and a much closer distance than occurs in the real situation.)

The 30 worst affected residences adjacent to the proposed line would be exposed to a L_{eqA24} of 62 - 66 dB(A) in the absence of any specific acoustical treatment.

To reduce the elevated noise levels to an "acceptable" level at the residences adjacent to the proposed rail-line there are only a limited number of avenues available to achieve an effective noise reduction.

The order of ranking that must be considered to reduce the impact has to take into account a number of conflicting requirements, the most important of which include the :

- cost of implementation
- practicality from a maintenance and operational standpoint
- extent to which other unacceptable environmental impacts are created
- feasibility in terms of development of current technology where cost is not an over riding factor

If we critically examine these criteria in terms of the three (3) groups of parameters by which engineering and architectural noise control may be achieved we find that in broad terms the railway noise may be ameliorated through :

(i) Limitation of noise emission from the source (including the locomotives, rolling stock noise, the number of train movements, the condition of track and even the speed of the individual trains.

(ii) Limitation of noise emission through controlling the transmission or propagation between the rolling stock or track and point of perception. This will obviously include the nature of the topography, the extent to which man made or natural barriers are interposed to diminish the effective sound propagation.

(iii) Limitation of noise intrusion at the point of perception, primarily through architectural treatment to residences or other measures by which the most adversely affected residences are technically or satisfactorily dealt with.

11.2 Assessment of Options

If we examine each of these options in turn the following noise control procedures at the source must be considered.

(i) The limitation of noise emission from the diesel electric, electric or diesel locomotive and power units that will be used on the line. From a theoretical standpoint sound level reductions of up to 6 dB(A) are capable of being achieved in diesel electric locomotives in which the primary engine exhaust attenuation is provided only by the turbo-charger without incorporating supplementary exhaust silencers. This option is particularly effective as silencers with this order of performance would effectively reduce the L_{eqA24} more dramatically than any other form of engineering noise control.

The electric locomotives are significantly quieter than comparable diesel electric locomotives. They are 9 dB(A) quieter on maximum up grades at maximum throttle settings. They are 8 dB(A) quieter than the comparable diesel electric locomotives on down grades with maximum regenerative versus dynamic braking.

(ii) The limitation of noise emission from horns from locomotives and self powered rail cars passing through the residential areas. This problem which has plagued railway authorities the world over, is not a particularly easy one to resolve as the majority of drivers have developed "safe habits" which lead to the utilisation of their warning signals as a natural reflex when in doubt as to the possible action or presence of a person, animal or another train on the line.

Our analysis of noise impact of the proposed railway line has been based on the utilisation of automatic centralised train control signalling - "C.T.C." signalling - and no railway level crossings within the residential area bounded by Dombarton in the west and the Princes Highway at Unanderra in the east.

(iii) The limitation of noise emission through the utilisation of fully welded rails to remove the impact noise as each individual wheel passes over the joints between each section of the rail. The State Rail Authority has already accepted the need for the introduction of this step and this will thus produce an effective noise reduction compared with the alternative.

(iv) The limitation of noise emission through the use of surface rail grinding on the sections of rail adjacent to the affected houses in the Unanderra, Farmborough Heights and Dombarton areas. This pre-operation treatment of the rails followed by periodic routine regrinding will ensure a significant reduction of wheel-rail noise which is most probably the second most significant source of noise created by long trains of the type under consideration.

(v) The limitation of noise emission through the development and introduction of new brake shoes and/or improved railway wheels in order to reduce the impact of brake screech on the down line trains approaching Unanderra.

The problem with this approach towards minimising wheel noise is that the technology has not yet been adequately developed overseas.

(vi) The limitation of noise emission through the addition of acoustical shrouds on the sides of the rolling stock. This approach offers reasonably effective attenuation to reduce the level of noise emission created by both rail/wheel and brake to wheel contacts.

One problem with such an approach is that there is no guarantee that any piece of rolling stock so treated would return to this line and consequently the cost of fitting out all of the rolling stock likely to use the line would be prohibitive. More significantly the acoustical shrouds have a proven impracticality which manifests itself in the difficulty to both undertake routine inspections of the equipment and perform maintenance on that equipment.

(vii) The limitation of noise emission through improvements and/or modifications to couplings interconnecting locomotives and wagons. This approach could provide small but worthwhile improvements in the level of noise emission but ranks so low compared with the other dominant sources that the funds required cannot be reasonably allocated until such time as the more important sources are dealt with.

11.3 Control of Noise Emission in the Path

One of the most obvious means of reducing the noise emission is to locate the railway tracks to a position as remote as possible from the nearest houses.

This approach is not an option when the track runs between houses rather than on one side. Where the track is located with houses only on one side, as typified by the Farmborough Heights area, the new track has been located on the southern side of the of the existing line which is the more remote location.

One of the most practical approaches available for train noise emission control is to introduce wayside acoustical barriers in those areas where residences are located in close proximity to the line. Our analysis reveals that with acoustical wayside barriers, whose effective height is between 2 and 2.2 metres, the value of L_{eqA24} at the most adversely affected house can be reduced to 57.5 dB(A) (in the absence of any other form of engineering noise control). The mean value of L_{eqA24} at the 30 worst effected houses can be reduced to 57.5 dB(A). In order to provide effective attenuation to locomotive exhaust noise these wayside barriers would need to be more than 3 metres high. We believe that structures with such a height would be difficult to construct, extremely expensive and create extreme maintenance difficulties.

Extensive research work has been carried out on such barriers in other countries where similar barriers are now generally installed on most new railway lines passing through residential areas, particularly where there is no history of previous exposure.

The State Rail Authority has previously commissioned research work for a suitable barrier system to be utilised on the Eastern Suburbs Railway in the Woollahra cutting in order to reduce the noise of rail wheel interaction from high speed electric trains down to an acceptable level.

Obviously the primary attribute of railway wayside acoustical barriers is that, within limits, the higher the barrier the more effective it becomes from a noise attenuation standpoint. Conversely the higher the barrier, the more unacceptable it becomes from a visual obscuration standpoint. Obviously where the barrier takes the form of a cutting with the train being depressed below the normal line of sight such a barrier does not constitute a problem. When the rail line is located above the level of the surrounding country side and the acoustical barrier obstructs the vision of the vista beyond, then the height of the barrier assumes a significant environmental relevance competing directly with the acoustical requirements in terms of its acceptability rating.

In the case of Farmborough Heights and to a lesser extent at Unanderra, the vistas to the south and east respectively could reasonably be regarded as being more important to some of the residents than the acoustical impact created by the trains on the proposed rail line.

Because of this, it becomes particularly important to ensure that the height of the barrier is limited in order to achieve the optimum compromise between height and acoustical efficacy so that the two conflicting requirements are adequately catered for.

The design of the wayside rail barriers is generally based on the use of two different principles. The first requirement is that the surface mass of the barrier be sufficiently high to ensure that the component sound energy passing through the barrier is adequately attenuated, when compared with the sound energy passing over the barrier. A typical surface mass thus lies in the range 4 - 8kg/m^2.

The second requirement is that the inner surface should incorporate a suitable absorptive treatment. This is applied in order to reduce the amount of energy passing over the barrier and simultaneously to control the sound reverberation that would occur between the barrier and the side of the locomotive or wagon passing the face of the barrier.

One of the most suitable materials used in the construction of wayside barrier wall structure is galvanised steel. When this material is supplemented by a suitable perforated inner facing containing either fibreglass or rockwool absorptive media, then a very effective acoustical system can be provided.

Two problems need to be highlighted which affect the practicality of such barriers. The first is associated with the stability of the surface of the rail bed or shoulder of the rail bed where such a barrier would be located, particularly in the presence of high winds. The second is associated with the need for access for rail track maintenance personnel. This is because of the constraints that such barriers produce in the ability to exit from the rail track in the presence of an oncoming train.

The first problem has been carefully assessed and could be overcome by a number of possible means. These options include utilising a series of extended strengthened rail sleepers, which are themselves suitably stabilised and retained by the ballast below. These then simultaneously provide the supporting elements to which the wayside rail barrier may be bolted. Further options include the provision of a concrete track bed or concrete wayside kerbing system or the utilisation of holes into which the barrier posts may be inserted and bolted. The technicalities of such a system are neither an environmental issue nor a primary design problem at this point of time.

The second problem associated with wayside barriers is the restriction it places on people who have strayed onto the line or people working on the line. In the first instance the wayside barriers reduce the likelihood of people straying onto the line. In the second instance it is readily possible to incorporate a series of acoustically treated entrances and exits through which normal ingress and egress can be provided.

The precise position of the barrier relative to the line is of considerable importance. This is determined by the need to be as close to the gauge line as possible in the interests of acoustical efficacy (2.5 metres from centre line of track). It should also be as far from the gauge line as possible in the interests of safety for both the trains and ways and works personnel who periodically need to maintain the track (preferably greater than 2.8 metres). Our analysis has been based on the barrier being located at 2.8 metres.

Other forms of wayside barriers which have been considered include the acoustical treatment which we recommend be applied to the vertical faces of the railway cuttings. This is only important where the cuttings are located in the residential areas such as Farmborough Heights or where the depth of the cuttings are relatively shallow.

The treatment of the cuttings is only required to achieve comparable acoustical performance with the steel barriers located on elevated sections of the track. Specific solutions to this problem have been developed which would utilise modular acoustical absorption units with adequate durability and longevity.

11.4 Control of Noise Emission at the Perceiver

The control of noise emission at the point of perception is relatively straight forward from a technical standpoint in those situations where the perceiver is inside and far more complex where the perceiver is located out of doors.

Specific acoustical treatment in the form of special glazing, silenced ventilation or air-conditioning systems and acoustical zoning of residences so that bedrooms are located on the far side of the residences. The State Pollution Control Commission recently organised a competition in conjunction with Norbrick in which thirty entries were received for house designs to specifically achieve that aim. Whilst innovative designs of that type are suitable for new houses, they are generally inappropriate for existing houses. For this reason and because of the physical and subjective constraints produced by special glazing and similar treatment, many people are adversely disposed towards their incorporation in existing houses.

Whilst some countries have introduced compensation of houses where new transportation systems result in noise levels above a predetermined limit, this approach has not previously been mooted in Australia where there is a general reluctance on the part of authorities to provide compensation for environmental effects from transportation systems or community services which adversely affect one small section of the community.

11.5 Formal Recommendations

A critical appraisal of the above analyses reveals that the most practical options available for noise reduction in order of their feasible ranking are :

(i) The provision of fully welded rails on concrete sleepers.

(ii) The use of ground rail which will reduce rail/wheel noise sources by as much as 6 dB(A).

(iii) The maximum use of electric locomotives in lieu of diesel electric traction units for hauling trains on the line.

(iv) The provision of wayside acoustical barriers with effective heights ranging between 2.0 and 2.2 metres and incorporating absorptive facings on the track side. which will reduce the L_{eqA24} at the most adversely affected houses to a figure typically below 61.5 dB(A).

(v) The incorporation of engine exhaust silencers providing a 4-6 dB(A) attenuation in Diesel Electric locomotives

12. CONCLUSION

The State Rail Authority has committed itself to underake the recommendations relating to the use of continuous welded rail and the maximum possible use of the electric locomotives in lieu of diesel electric locomotives on the new line. The expected impact of these two steps has been documented in section 9.5 above for both the proposed pre 1990 and post 1990 operating conditions.

At the reference distance of 30 metres from the line, which is representative of the most adversely affected houses, this will result in equivalent A-weighted noise levels (L_{eqA24}) of 58.2 dB(A) pre 1990 and 62 dB(A) post 1990. These figures may be compared with the existing impact of rail traffic for which an approximate figure of 55 dB(A) has been computed.

The actual position of the new track in the Farmborough Heights area is currently being reviewed in order to determine the inter-relationship between the recommended acoustical configuration and the equally important geotechnical requirements for the line.

For this reason, whilst it is a primary aim to locate the new line on the southern side of the existing line, it may prove essential to locate the new line on the northern side at a limited number of locations.

It is our belief that, in the most critical areas of Farmborough Heights, the recommended configuration will be implemented with the new line being located on the southern side of the existing rail line.

It is clear that whilst the second of the recommendations presented in section 11.5 is based on the availability of suitable rail grinding equipment, the implementation of that specific recommendaton will only result in a further 0.5 to 1 decibel improvement in the value of the equivalent noise level (L_{eqA24}).

The State Rail Authority has stated that they do not intend to instal an acoustical wayside Barrier System nor do they intend to undertake modifications to Diesel electric locomotives. The resulting noise levels adjacent to the line are thus unlikely to be lower than those presented in section 9.5 for the nominated times and specified monitoring locations

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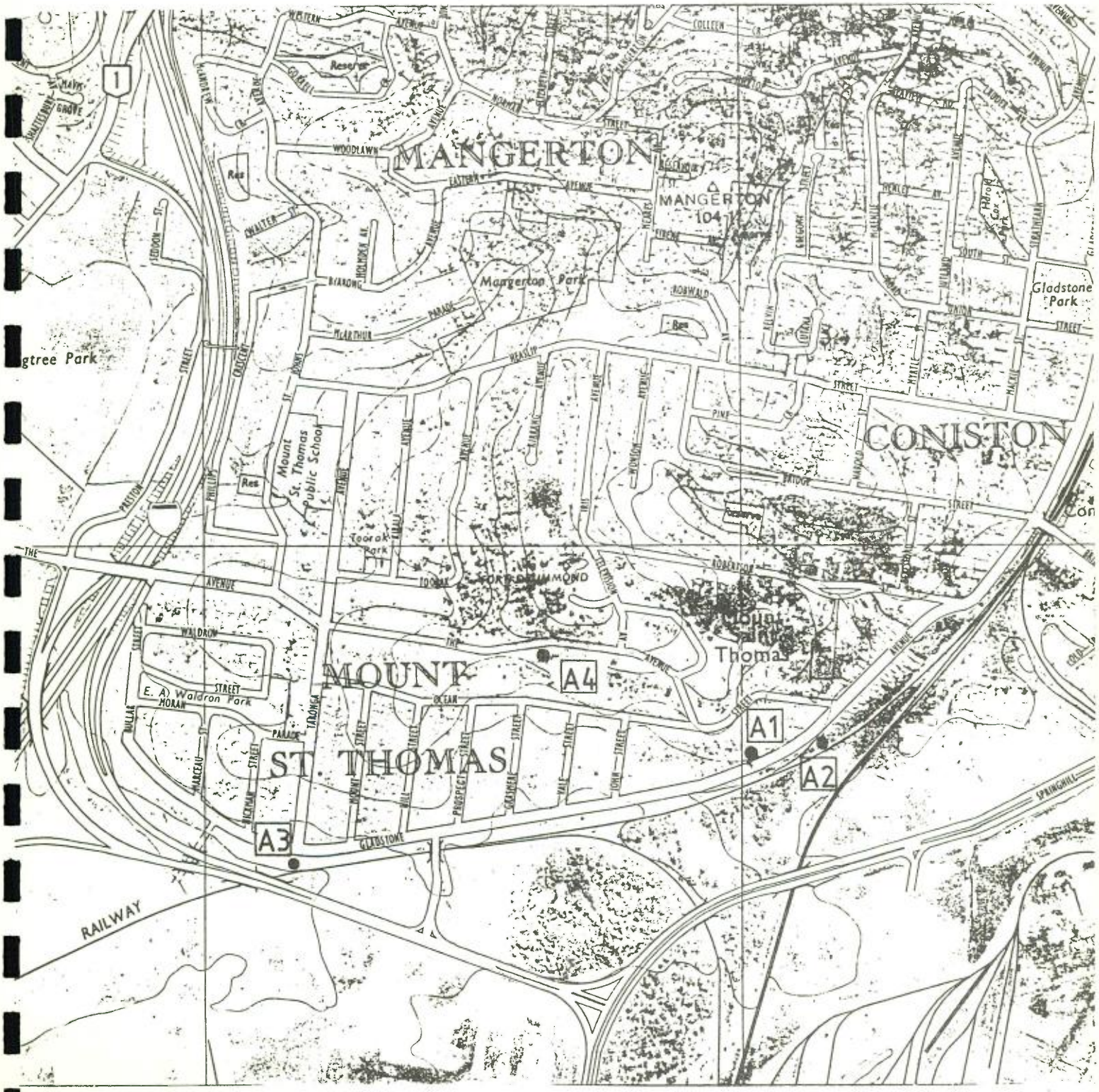
17. Walker J.G. and Fields J.M., Ibid

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Report No: 4500-3-83
Appendix No: 1.1

LOCATION PLAN
SHOWING MEASUREMENT POSITIONS
MOUNT ST. THOMAS AREA



DESCRIPTION OF MEASUREMENT POSITIONS

MOUNT ST. THOMAS
(Designated as Area 'A')

POSITION No: A1

Outside 226 Gladstone Avenue, 30m from the centreline of existing track

POSITION No: A2

At rear of 141 Gladstone Avenue, (Last house near Ocean Street), 10m from centreline of existing track

POSITION No: A3

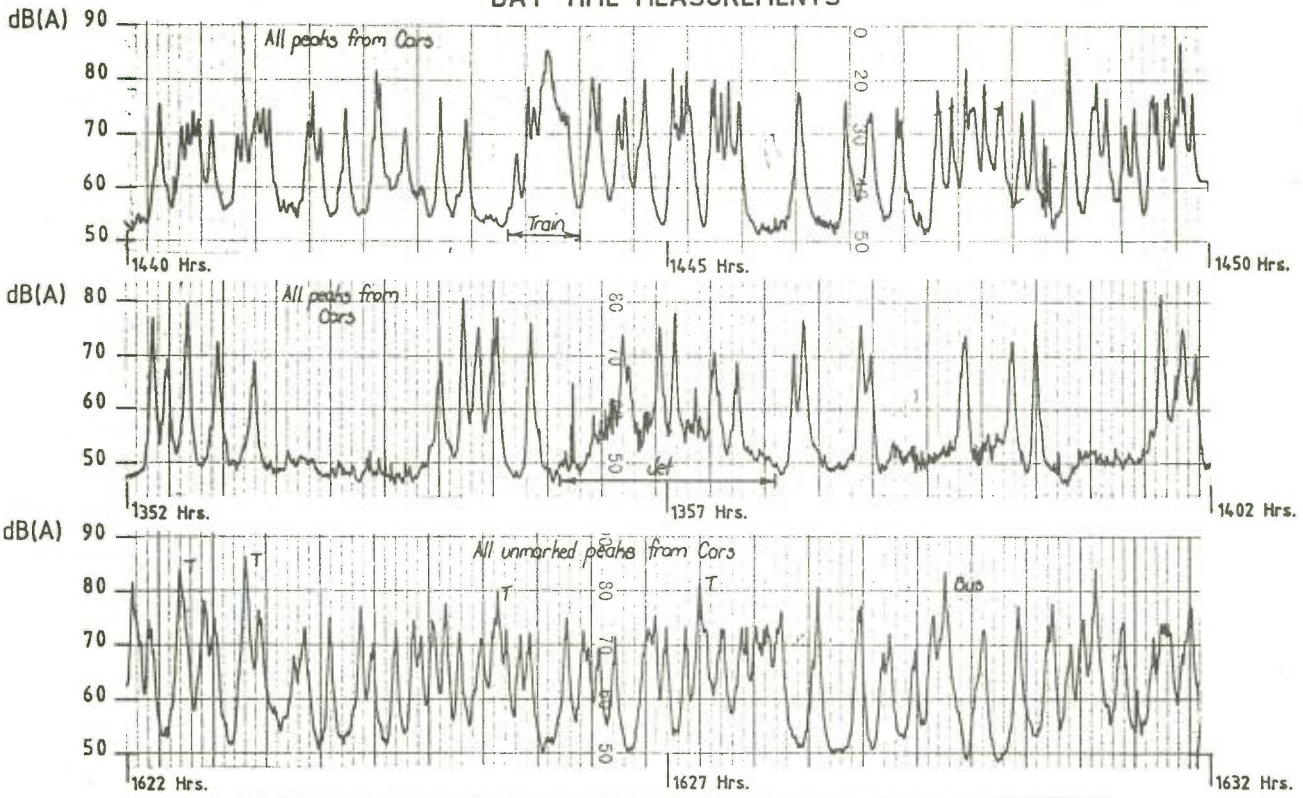
Outside 143 Gladstone Avenue, near Taronga Avenue, at side of house, 20m from centreline of existing track

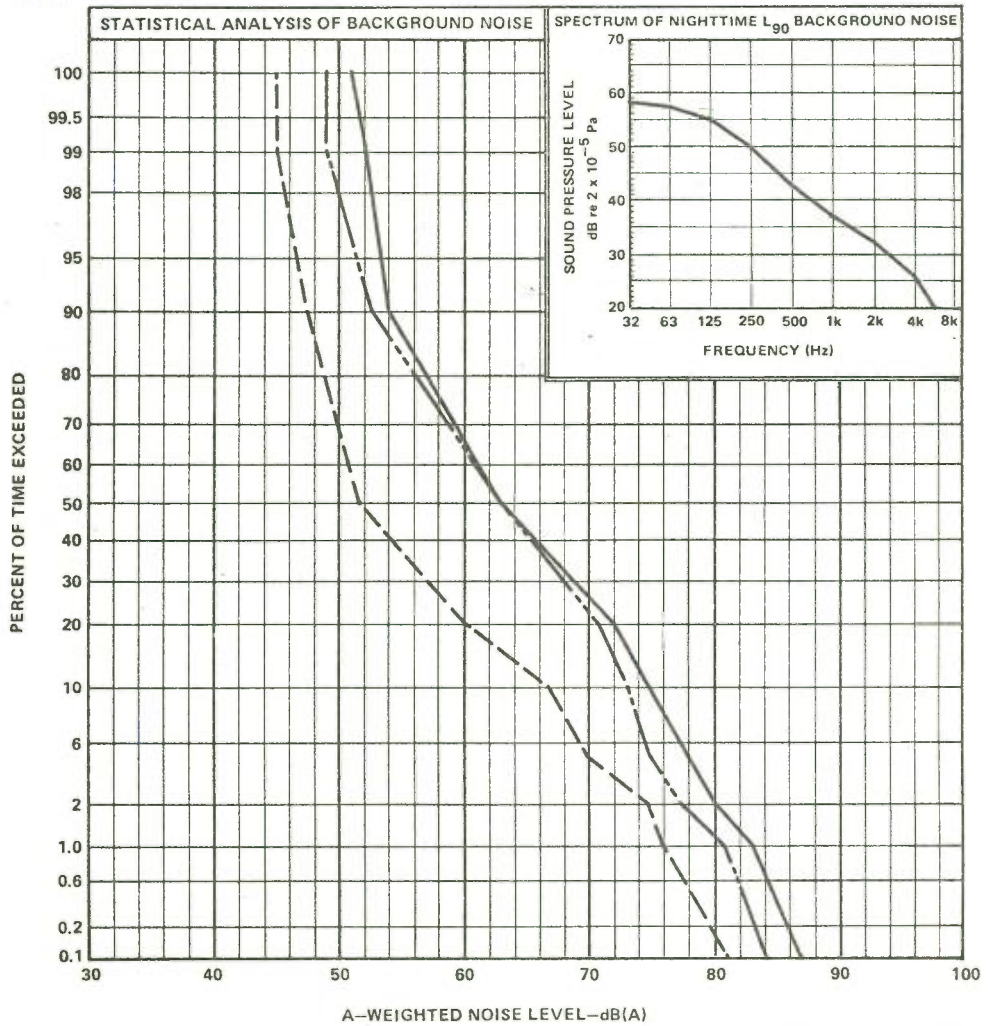
POSITION No: A4

The Avenue, directly opposite RAAF closed compound (Between Television & Taronga Avenues)

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Appendix No: 2.1

AMBIENT SOUND LEVELS
POSITION A1, MOUNT ST. THOMAS AREA
DAY TIME MEASUREMENTS





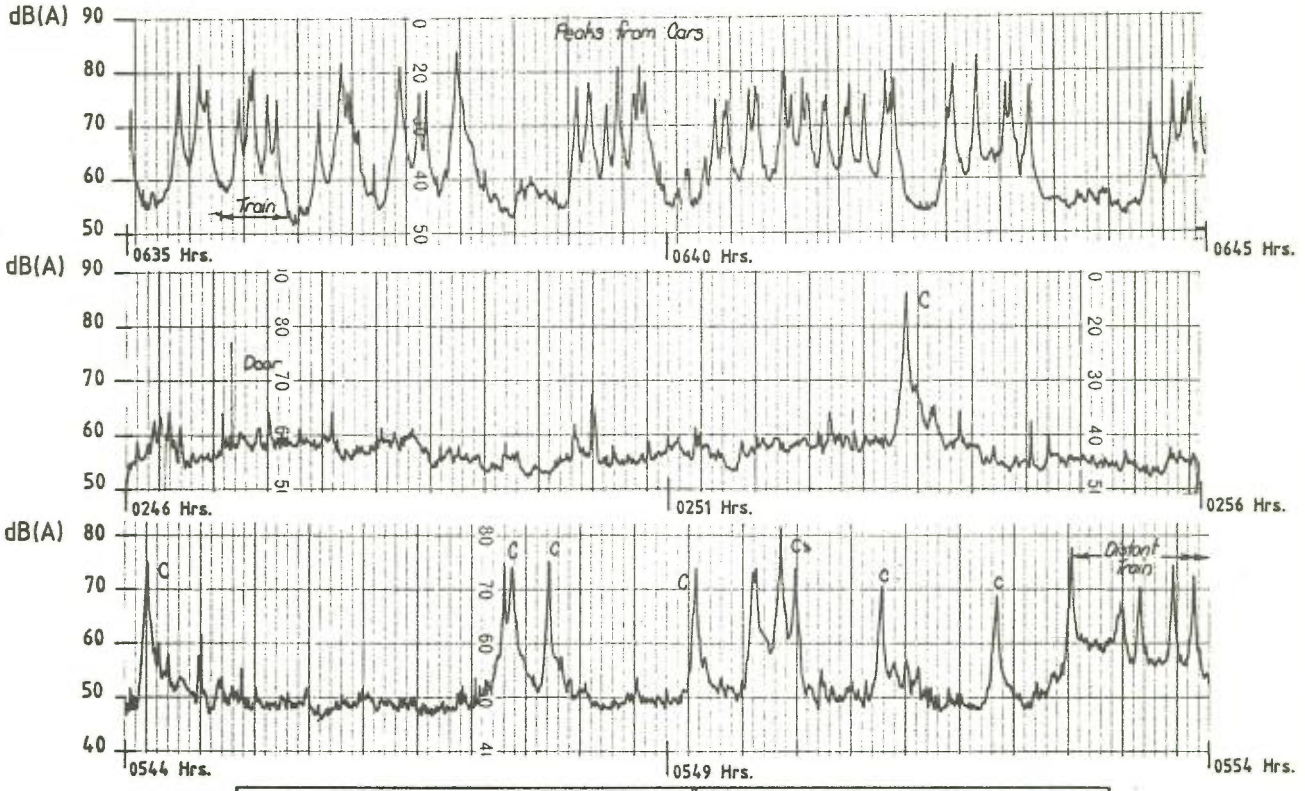
Leq 72 ———— 1440-1450 Hrs., Thurs. 8/9/83 :- ONE 7 CAR PASSENGER TRAIN FROM SOUTH ON MAIN SOUTHERN LINE

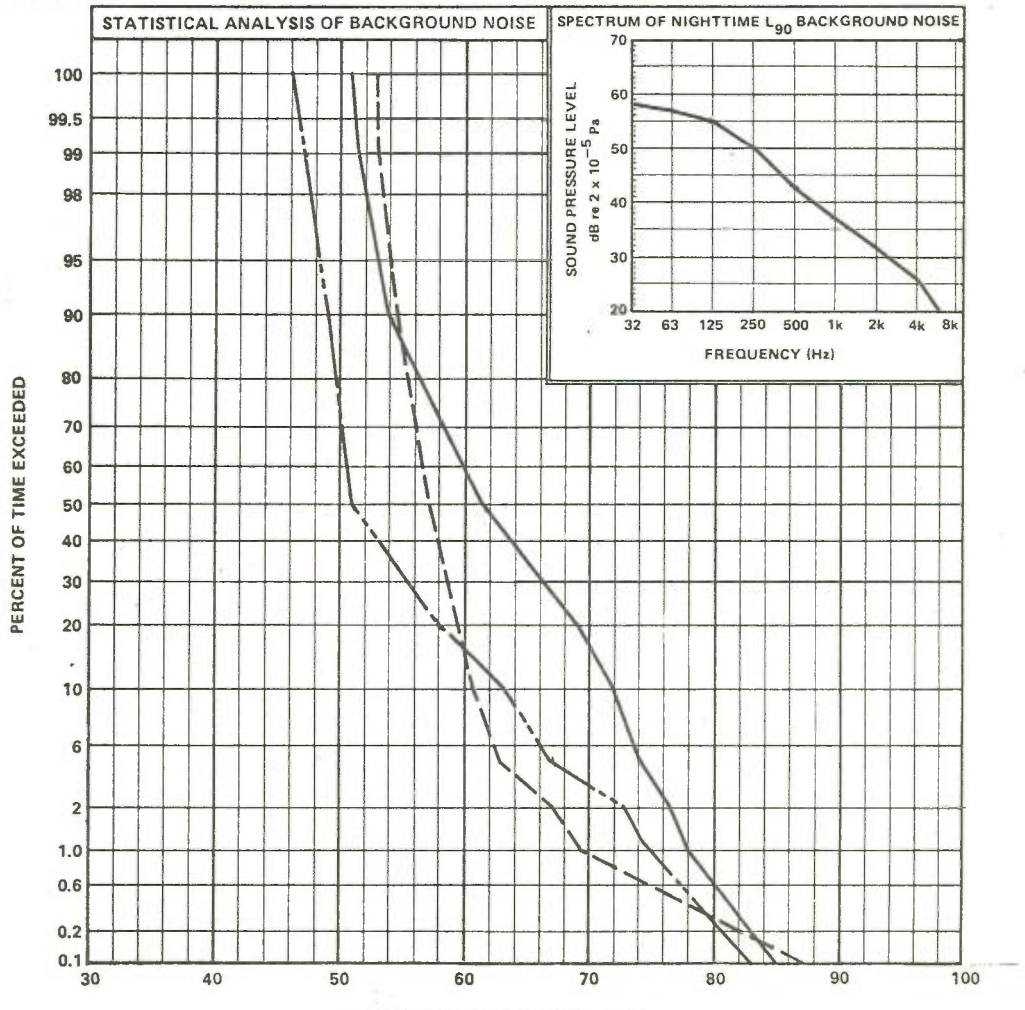
Leq 63.4 — — — — 1352-1402 Hrs., Sun, 18/9/83:- 1 JET. HEAVY TRAFFIC.

Leq 69.2 —— -- —— 1622-1632 Hrs. Mon. 19/9/83:- BUS. HEAVY TRAFFIC.

Report No: 4500-3-83
Appendix No: 2.2

AMBIENT SOUND LEVELS
POSITION A1, MOUNT ST. THOMAS AREA
NIGHT TIME MEASUREMENTS



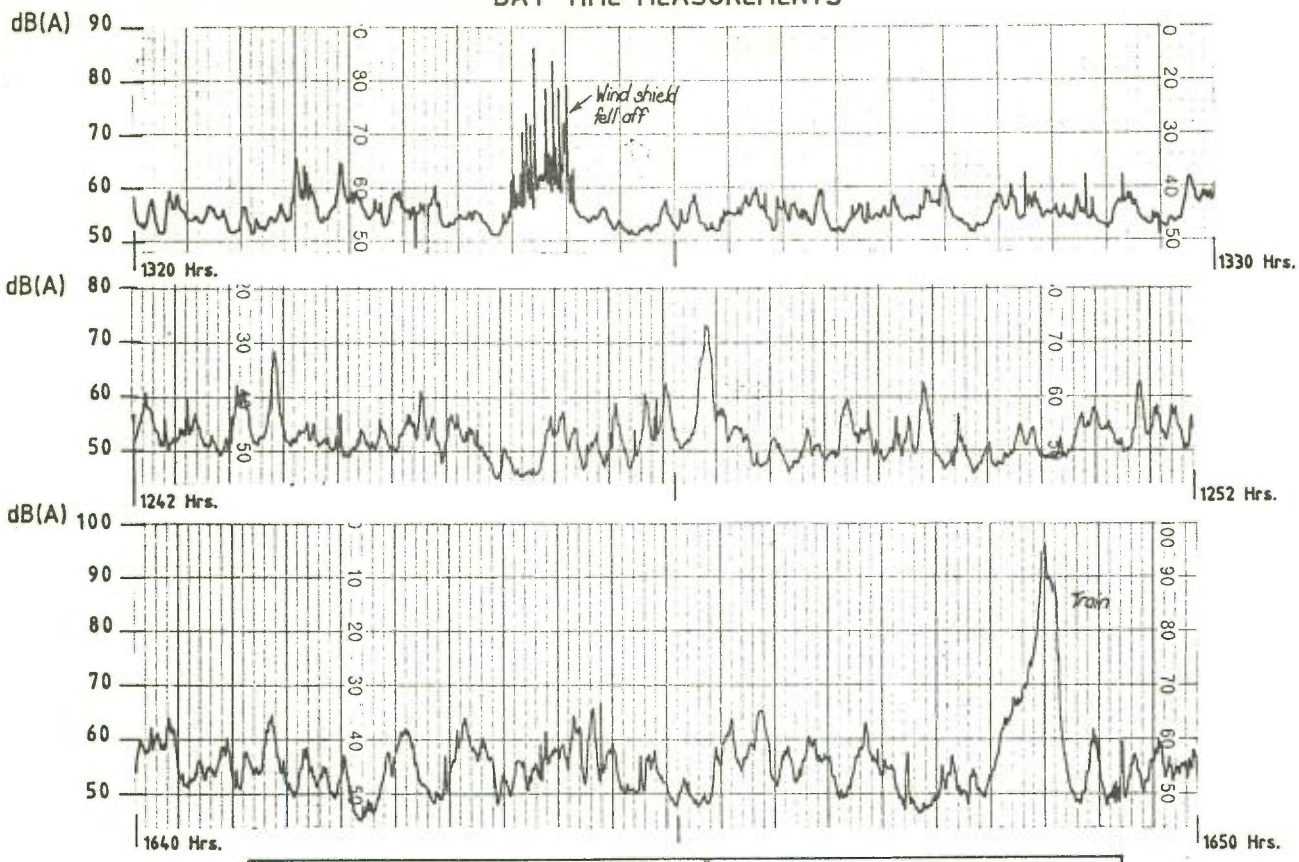


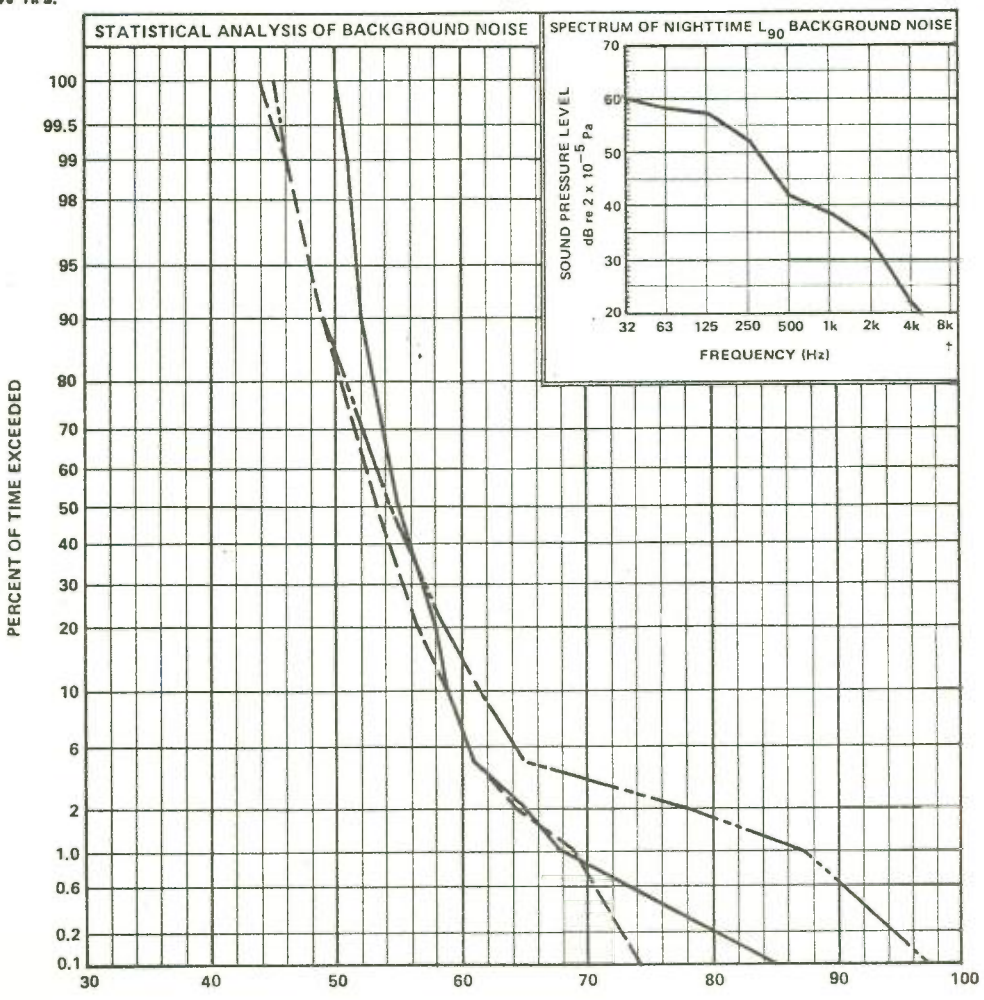
Leq 67.4 ———— 0635-0645 Hrs., Tues. 20/9/83 :- ONE, 4 CAR PASSENGER TRAIN FROM SOUTH ON MAIN SOUTHERN LINE

Leq 62.5 — — — — 0246-0256 Hrs., Wed. 21/9/83 :- CAR. DOOR.

Leq 63.5 ——— 0544-0554 Hrs., Wed. 21/9/83 :- DISTANT TRAIN (NOT VISIBLE)

AMBIENT SOUND LEVELS
POSITION A2, MOUNT ST. THOMAS AREA
DAY TIME MEASUREMENTS





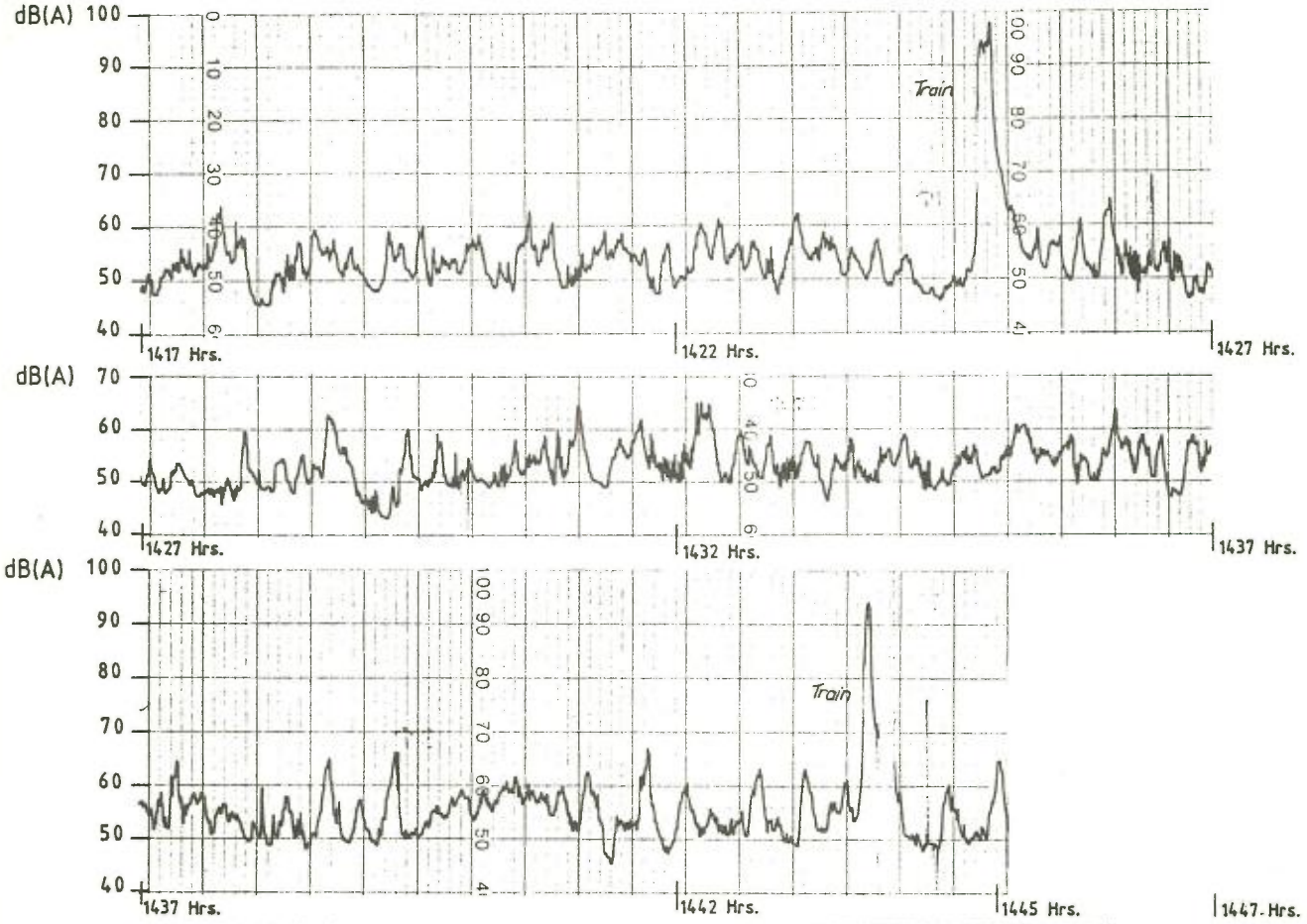
Leq 62 ———— 1320-1330 Hrs., Wed. 7/9/83:- MEDIUM TO HEAVY TRAFFIC. DISTANT INDUSTRIAL NOISE (BANGS)

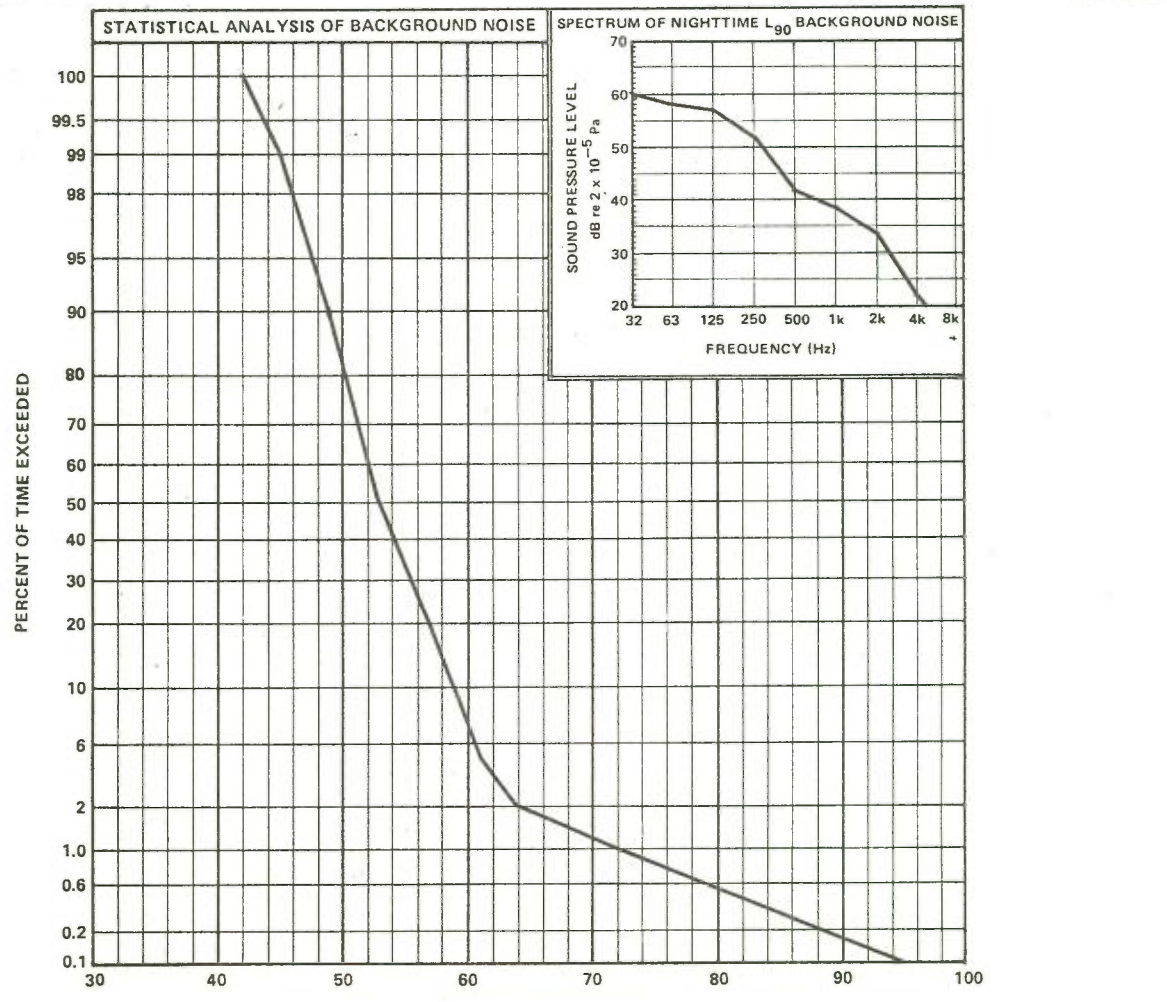
Leq 57.6 — — — — 1242-1252 Hrs., Frid. 16/9/83: -

Leq 72.9 ——- -—— 1640-1650 Hrs., Mon. 19/9/83:- ONE, 2 LOCOS, 4 CAR TRAIN TRAVELLING SOUTH ON MAIN SOUTHERN LINE

Report No: 4500-3-83
Appendix No: 3.2

AMBIENT SOUND LEVELS
POSITION A2, MOUNT ST. THOMAS AREA
DAY TIME MEASUREMENTS



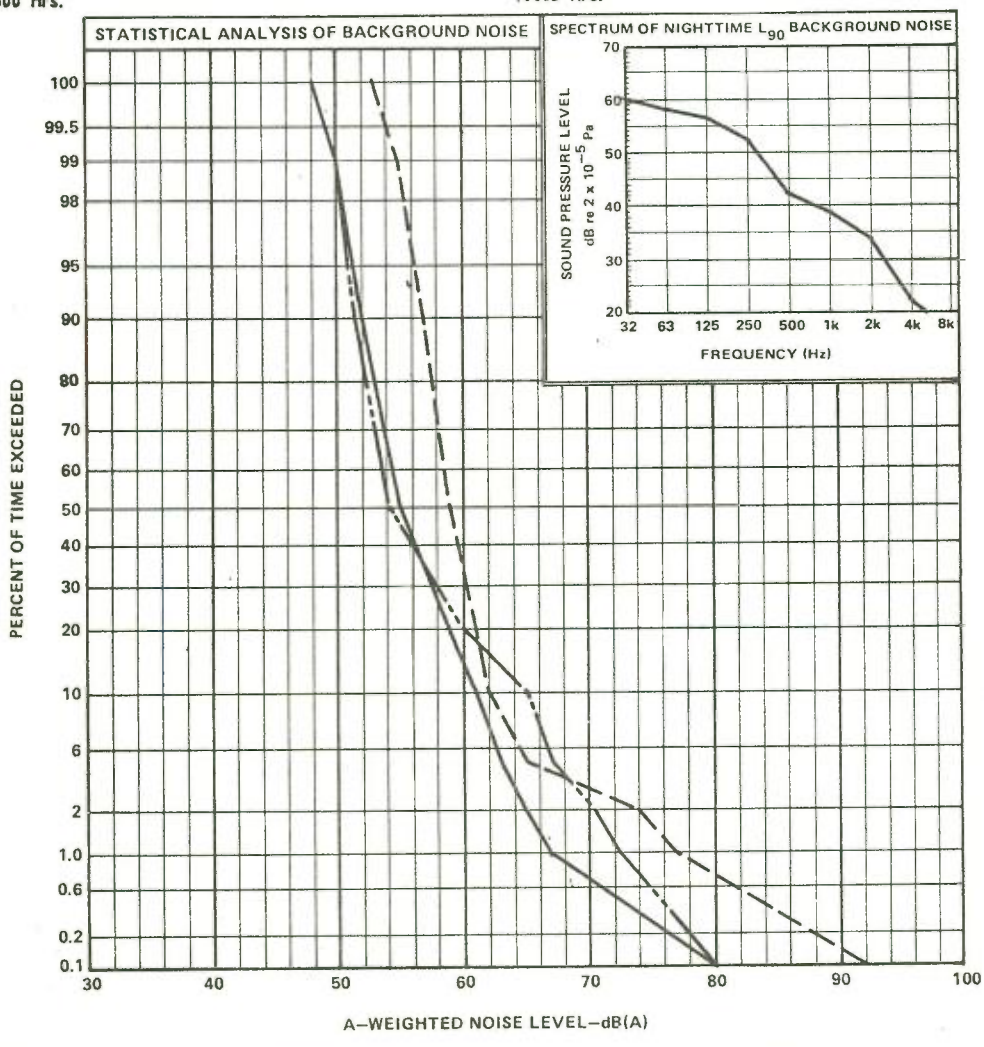


Leq 72 ———— 1417-1447 Hrs., Tues. 13/9/83:- ONE 7 CAR TRAIN FROM SOUTH, ONE 3 CAR TRAIN FROM SOUTH ON MAIN SOUTERN LINE

Report No: 4500-3-83
Appendix No: 3.3

AMBIENT SOUND LEVELS
POSITION A2, MOUNT ST. THOMAS AREA
NIGHT TIME MEASUREMENTS





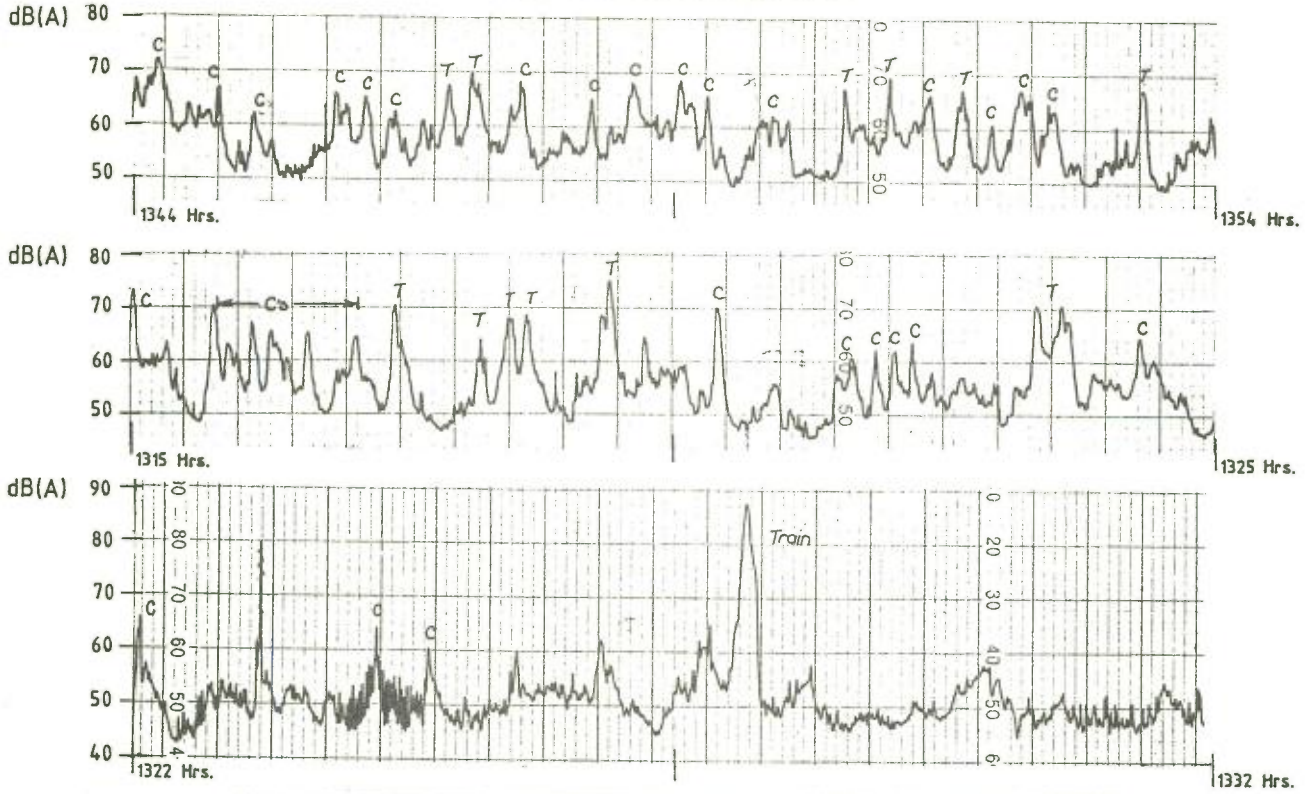
Leq 61.6 _____ 0653-0703 Hrs., Tues. 20/9/83 :- PASSENGER TRAIN IN DISTANCE

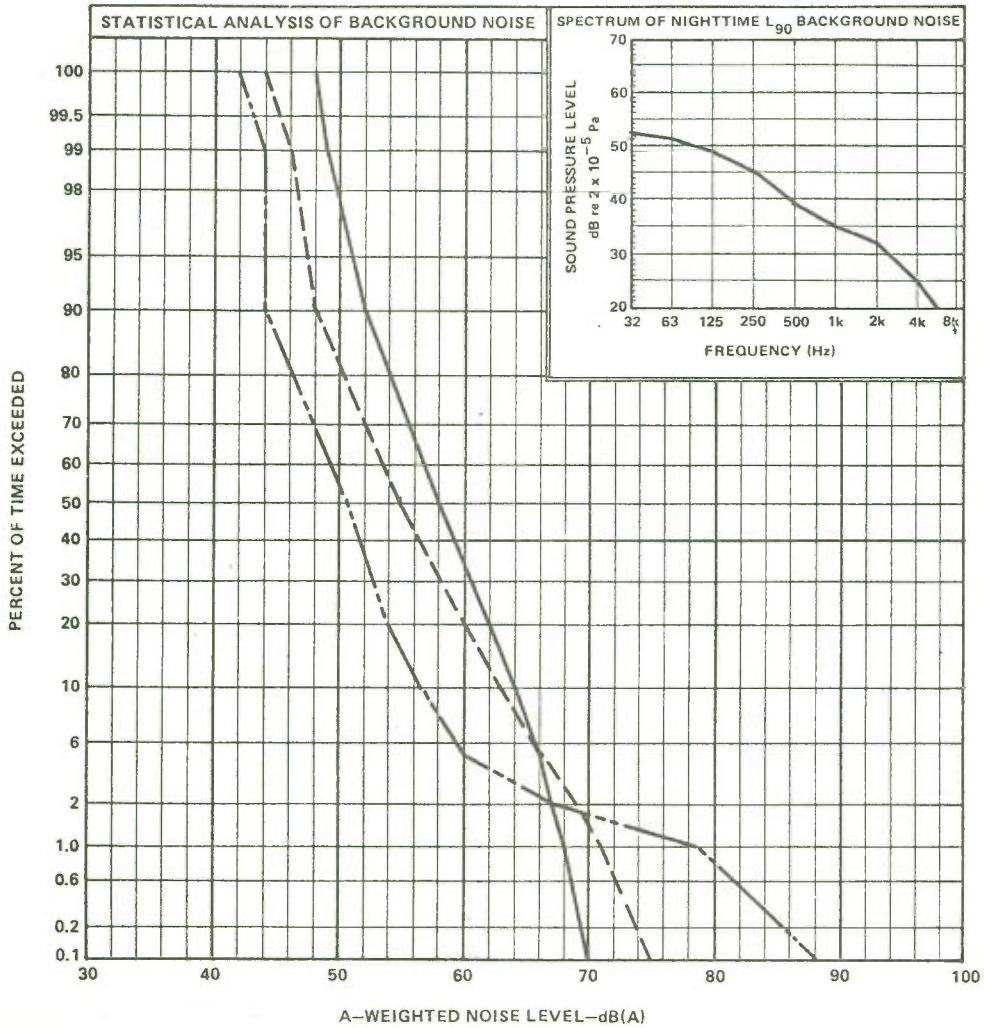
Leq 66.8 _ _ _ _ 0301-0311 Hrs., Wed. 21/9/83 :- CAR. HOOTER.

Leq 61.2 _____ 0600-0610 Hrs., Wed. 21/9/83 :- MEDIUM TRAFFIC.

Report No: 4500-3-83
Appendix No: 4.1

AMBIENT SOUND LEVELS
POSITION A3, MOUNT ST. THOMAS AREA
DAY TIME MEASUREMENTS





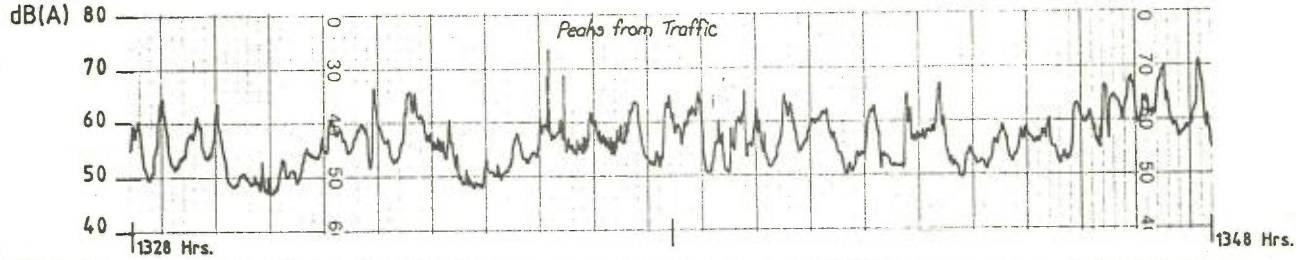
Leq 71 ———— 1344-1354 Hrs, Wed. 7/9/83:- MEDIUM TRAFFIC

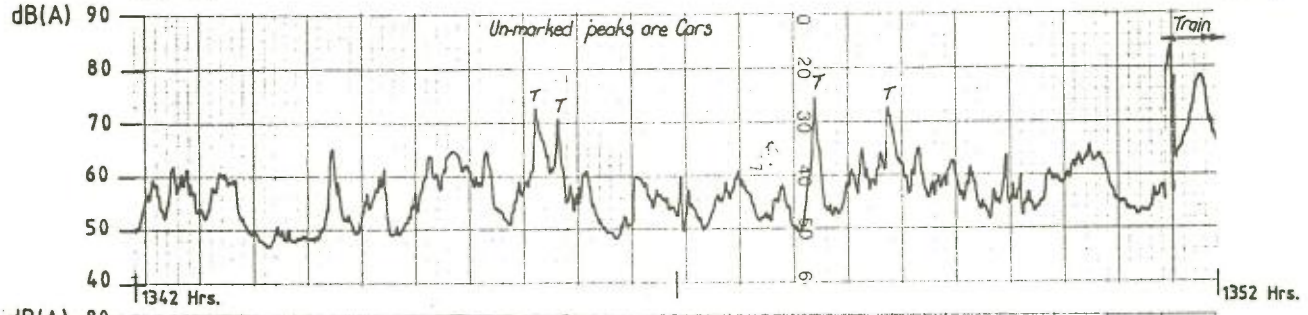
Leq 60 — — — — 1315-1325 Hrs, Tues. 13/9/83:- MEDIUM TRAFFIC.

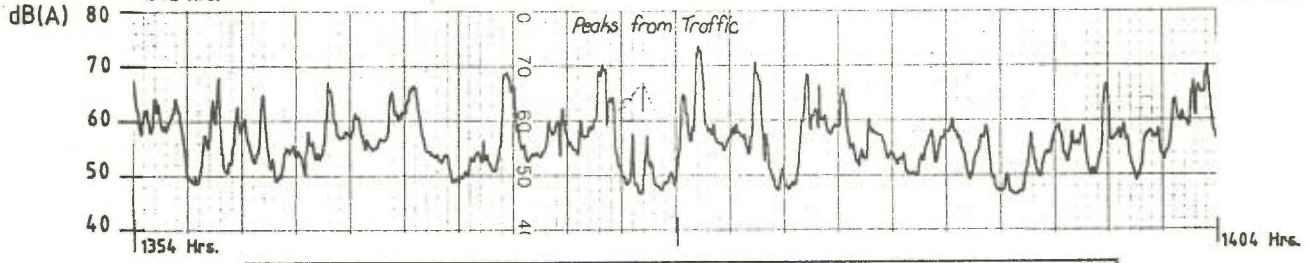
Leq 65.8 ——·—— 1322-1332 Hrs, Sun. 18/9/83:- PASSENGER TRAIN TO SOUTH- 1 LOCO & 3 CARRIAGES

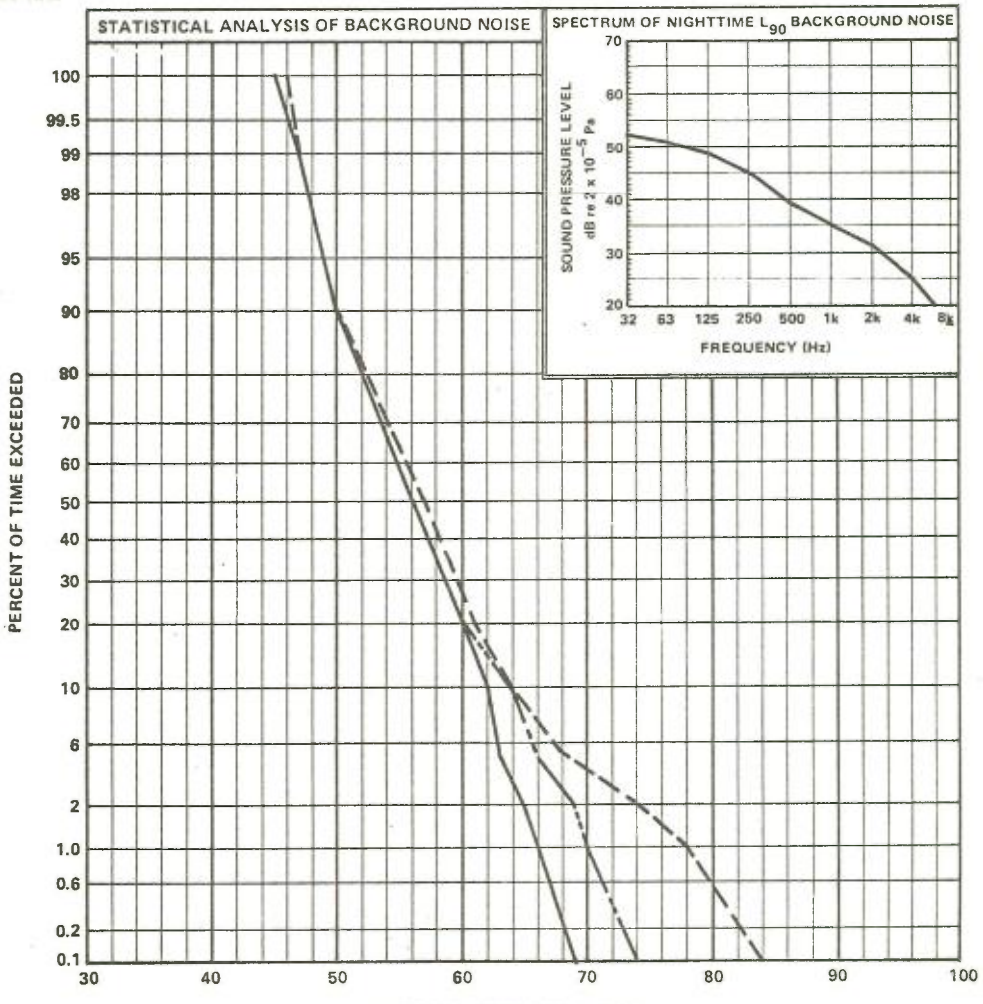
AMBIENT SOUND LEVELS
POSITION A3, MOUNT ST. THOMAS AREA
DAY TIME MEASUREMENTS

Report No: 4500-3-83
Appendix No: 4.2









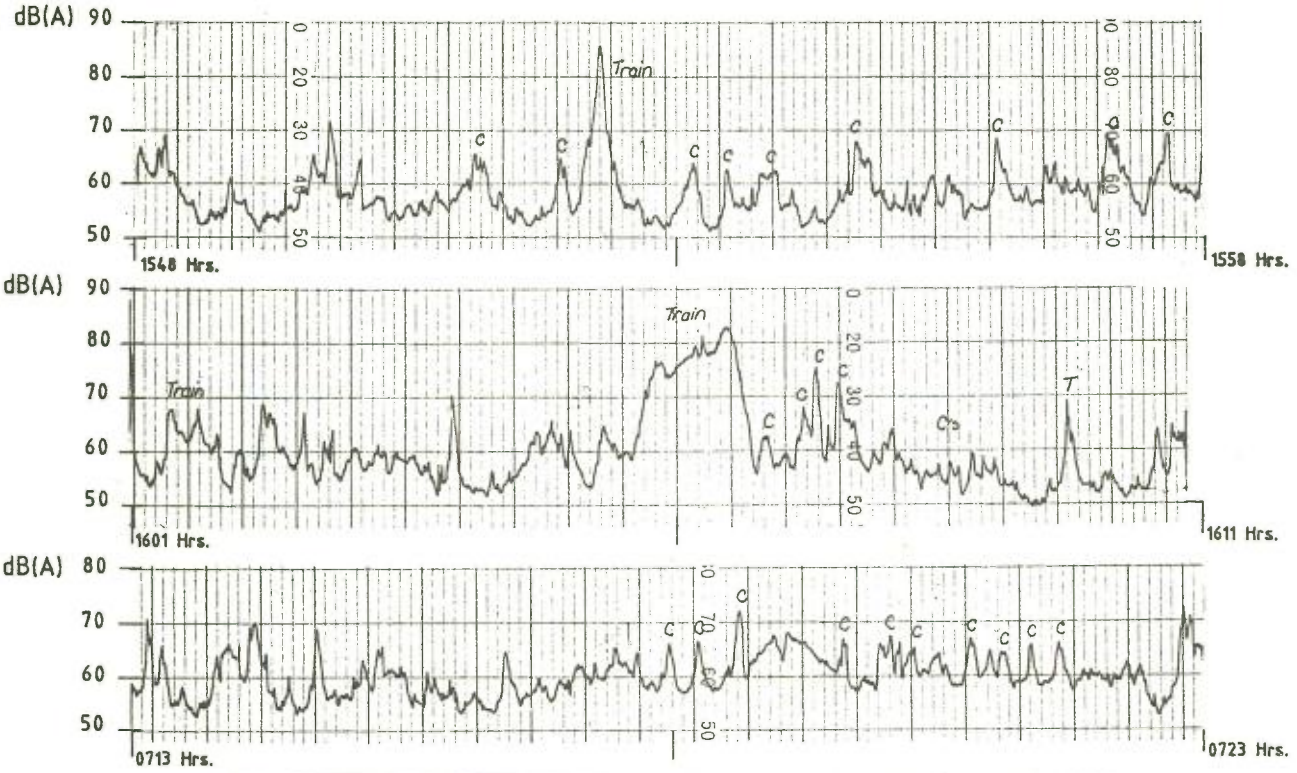
Leq 58 ———— 1328-1338 Hrs., Tues, 13/9/83:- DISTANT TRAFFIC

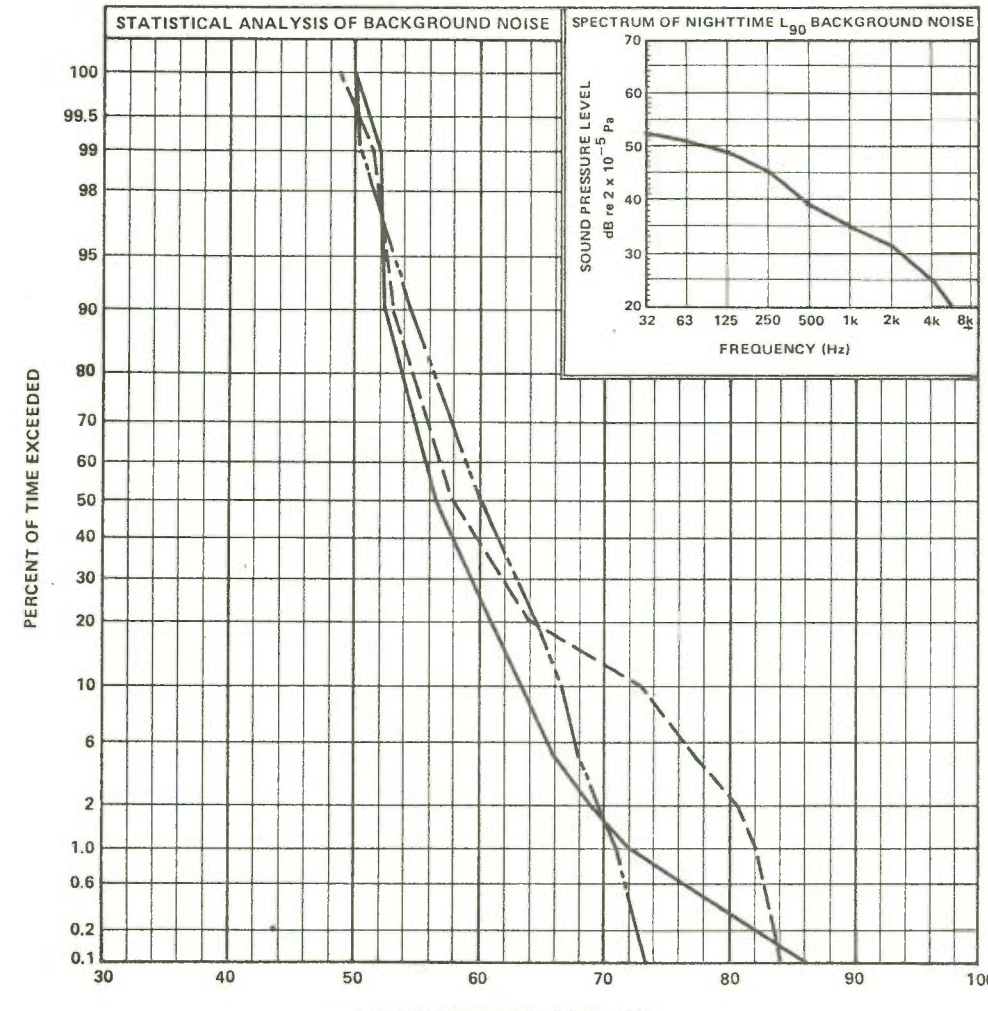
Leq 65 — — — — 1342-1352 Hrs., Tues. 13/9/83:- ONE 3 CAR GOODS TRAIN TRAVELLING SOUTH

Leq 60 ——·—— 1354-1404 Hrs., Tues. 13/9/83:- MEDIUM TRAFFIC.

Report No: 4500-3-83
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AMBIENT SOUND LEVELS
POSITION A3, MOUNT ST. THOMAS AREA
DAY TIME MEASUREMENTS





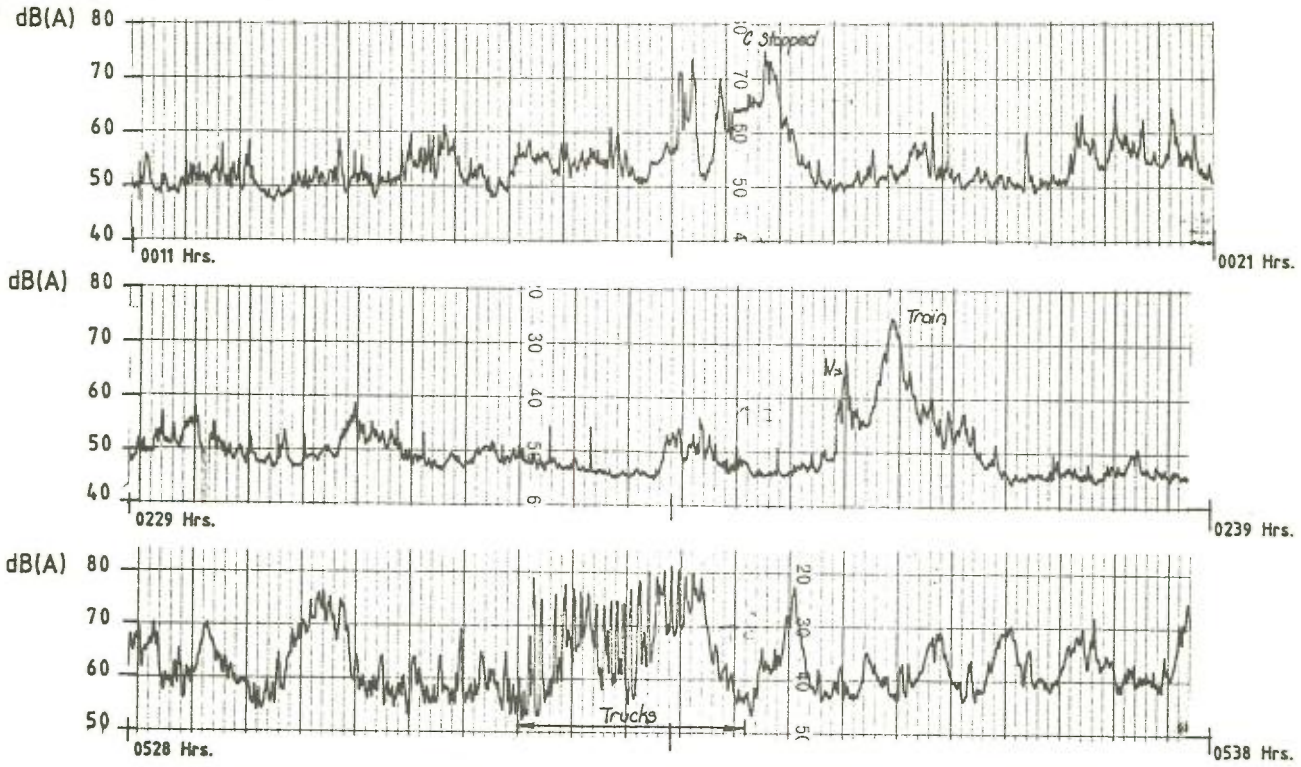
Leq 63.9 _____ 1548-1558 Hrs., Mon. 19/9/83:- ONE, 2 CAR PASSENGER TRAIN FROM SOUTH ON MAIN SOUTHERN LINE. MEDIUM TRAFFIC

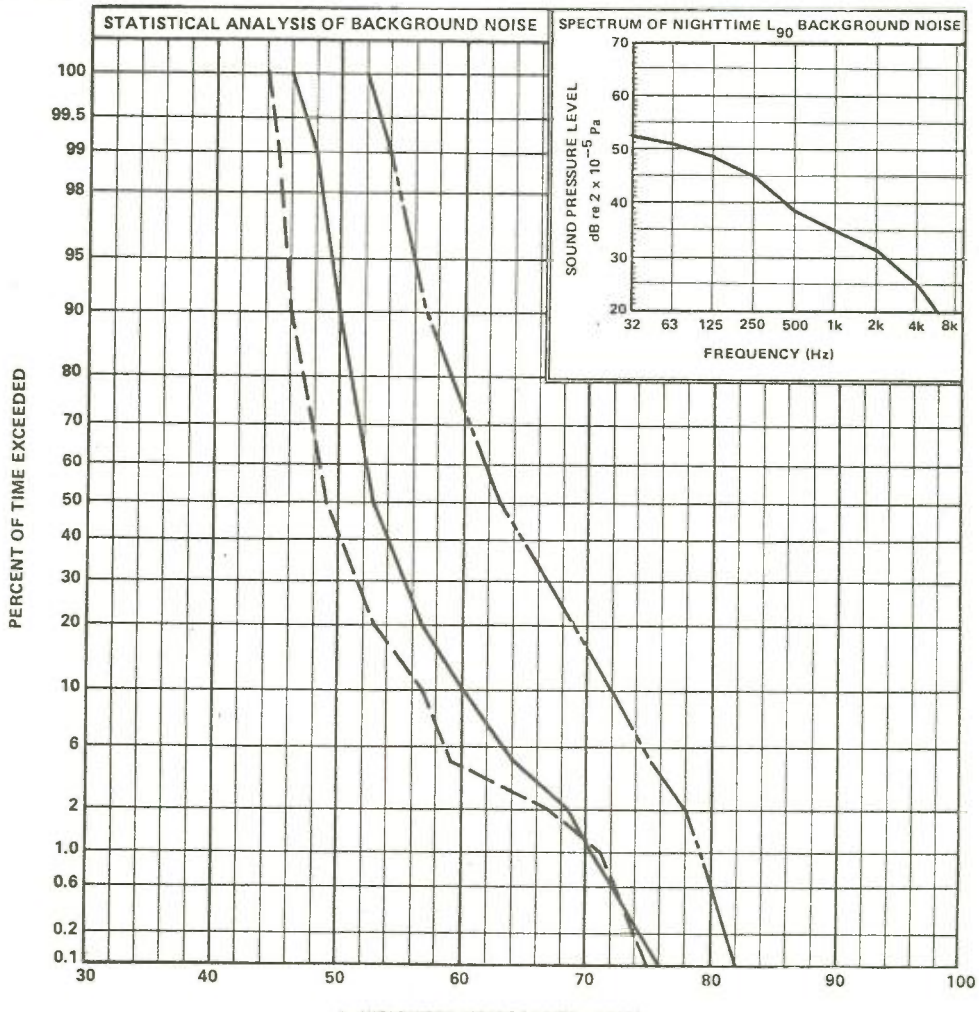
Leq 70.1 _ _ _ _ _ 1601-1611 Hrs., Mon. 19/9/83:- ONE, 2 LOCOS, 28 CAR, 1 CABOOSE GOODS TRAIN TRAVELLING SOUTH. ONE 6 CAR PASSENGER TRAIN TRAVELLING SOUTH.

Leq 63.5 _____ _ _ _____ 0713-0723 Hrs., Tues. 20/9/83:- MEDIUM TRAFFIC.

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AMBIENT SOUND LEVELS
POSITION A3, MOUNT ST. THOMAS AREA
NIGHT TIME MEASUREMENTS





Leq 62.2 _____ 0011-0021 Hrs., Tues. 20/9/83:- TRAFFIC ON HIGHWAY & GLADSTONE RD.
WIND: 20 kph

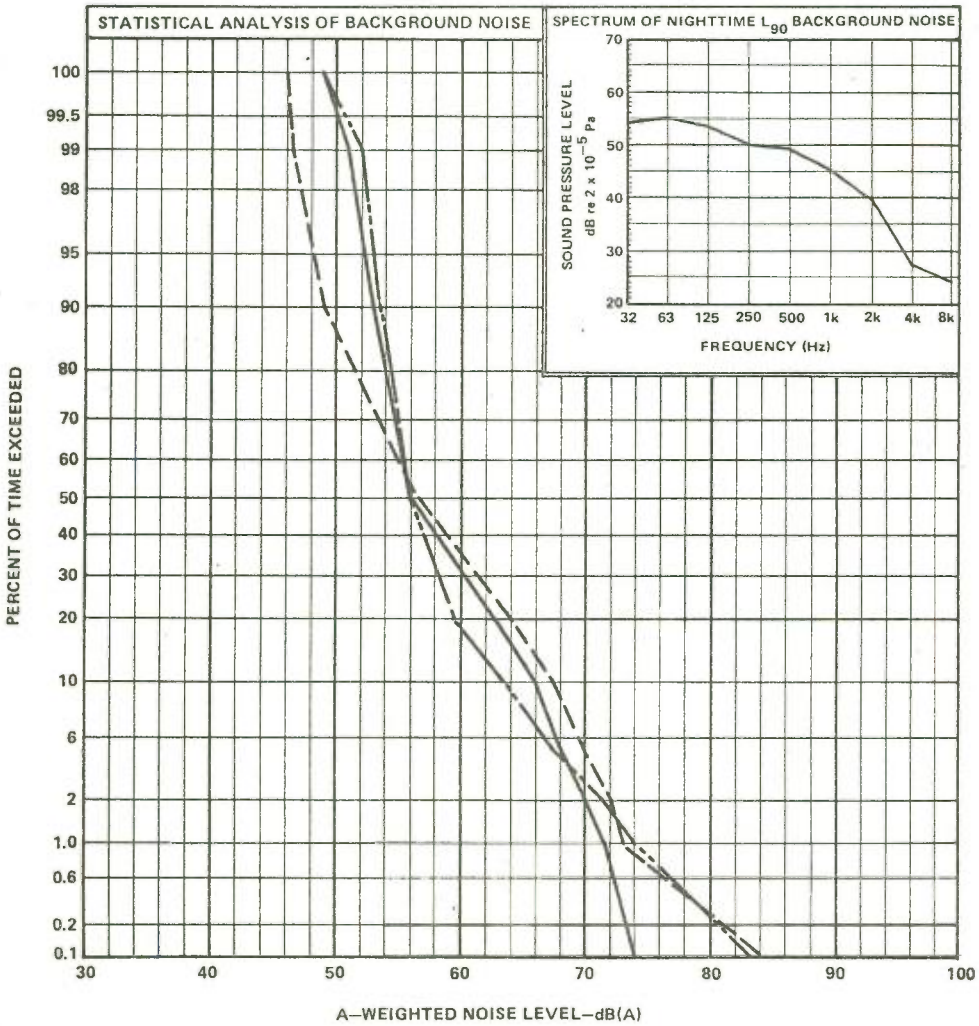
Leq 57.6 _ _ _ _ _ 0229-0239 Hrs., Wed., 21/9/83:- TRAIN.

Leq 68.5 _____ 0528-0538 Hrs., Wed. 21/9/83:- TRUCK. TRAFFIC.

AMBIENT SOUND LEVELS
POSITION A4, MOUNT ST. THOMAS AREA
DAY TIME MEASUREMENTS

Report No: 4500-3-83
Appendix No: 5.1



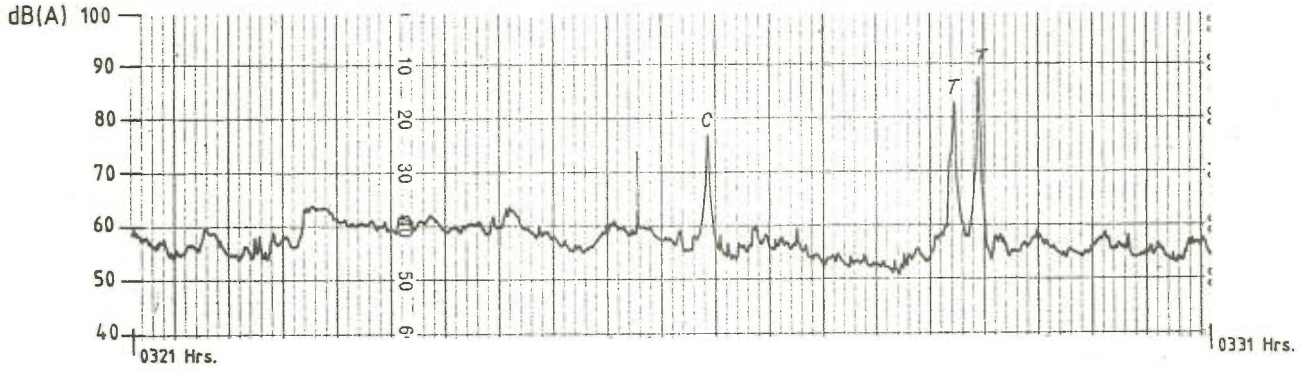


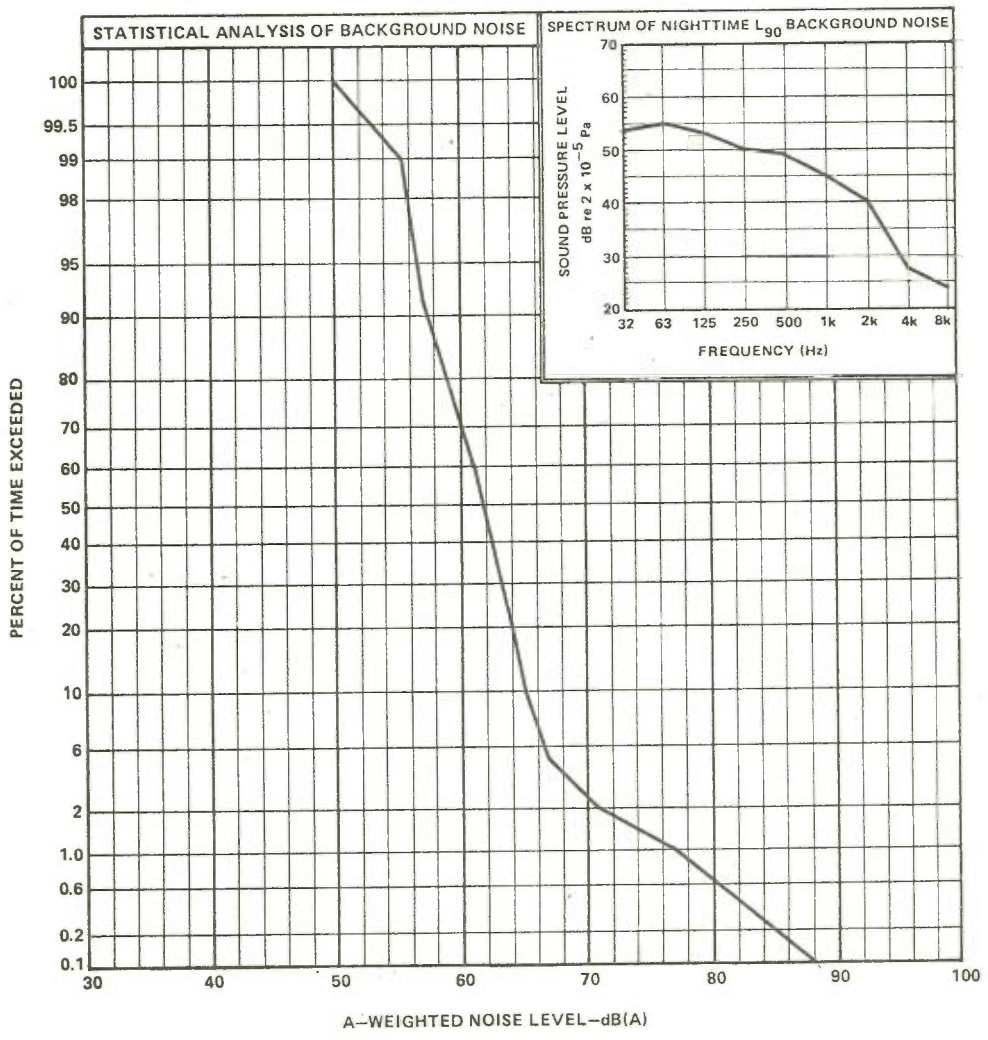
Leq 62.2 _____ 1221-1231 Hrs, Fri. 16/9/83:- MEDIUM TRAFFIC, DISTANT INDUSTRY

Leq 64.7 _ _ _ _ 1221-1231 Hrs, Mon. 19/9/83:- HEAVY TRAFFIC

Leq 64.3 _____ 0735-0745 Hrs, Tues, 20/8/83:- MEDIUM TRAFFIC, PASSENGER TRAIN TO SOUTH 1 LOCO & 3 CARRIAGES

AMBIENT SOUND LEVELS
POSITION A4, MOUNT ST. THOMAS AREA
NIGHT TIME MEASUREMENTS

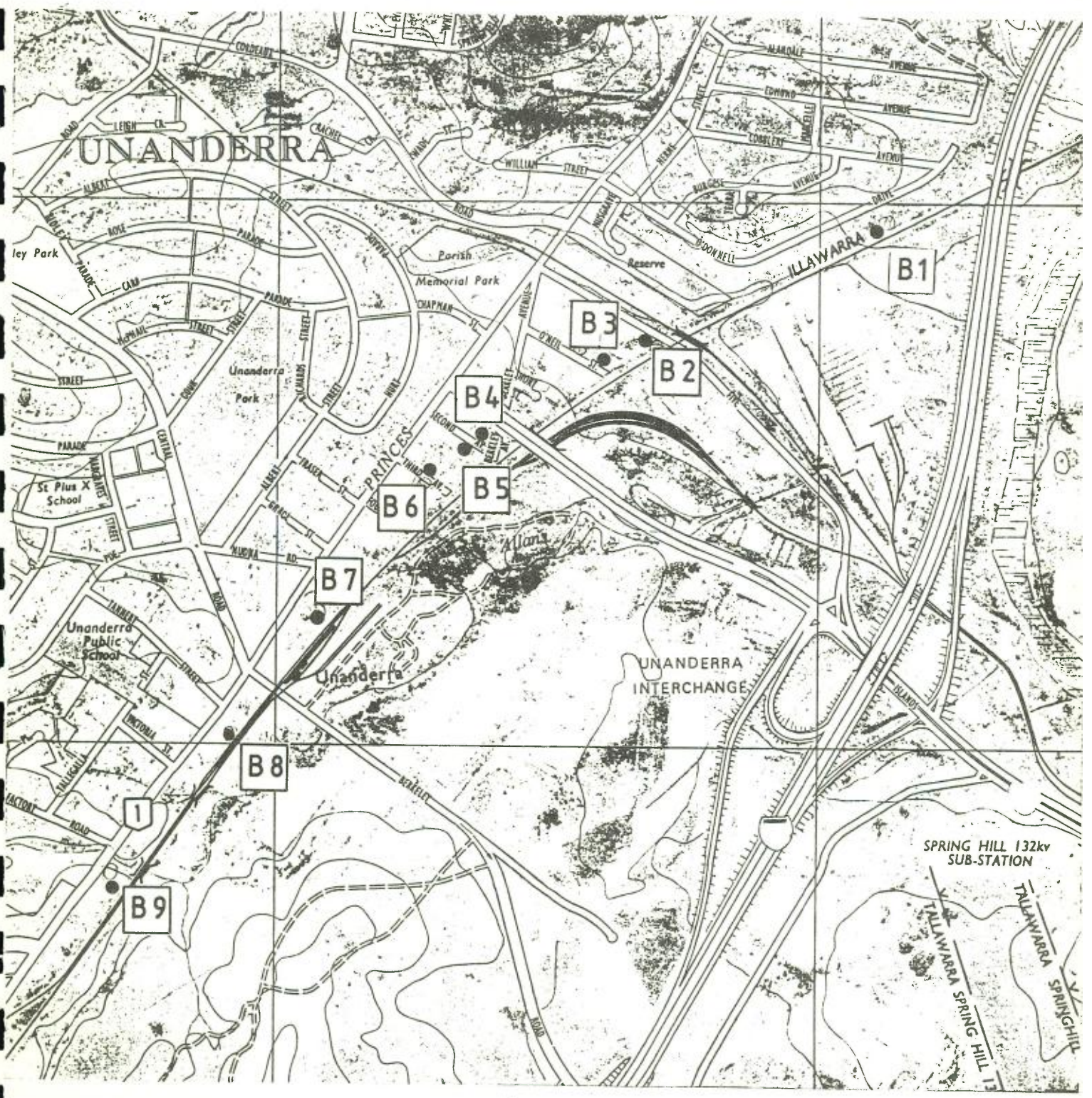




Leq 66.9 _____ 0321-0331 Hrs, Wed. 21/9/83:-

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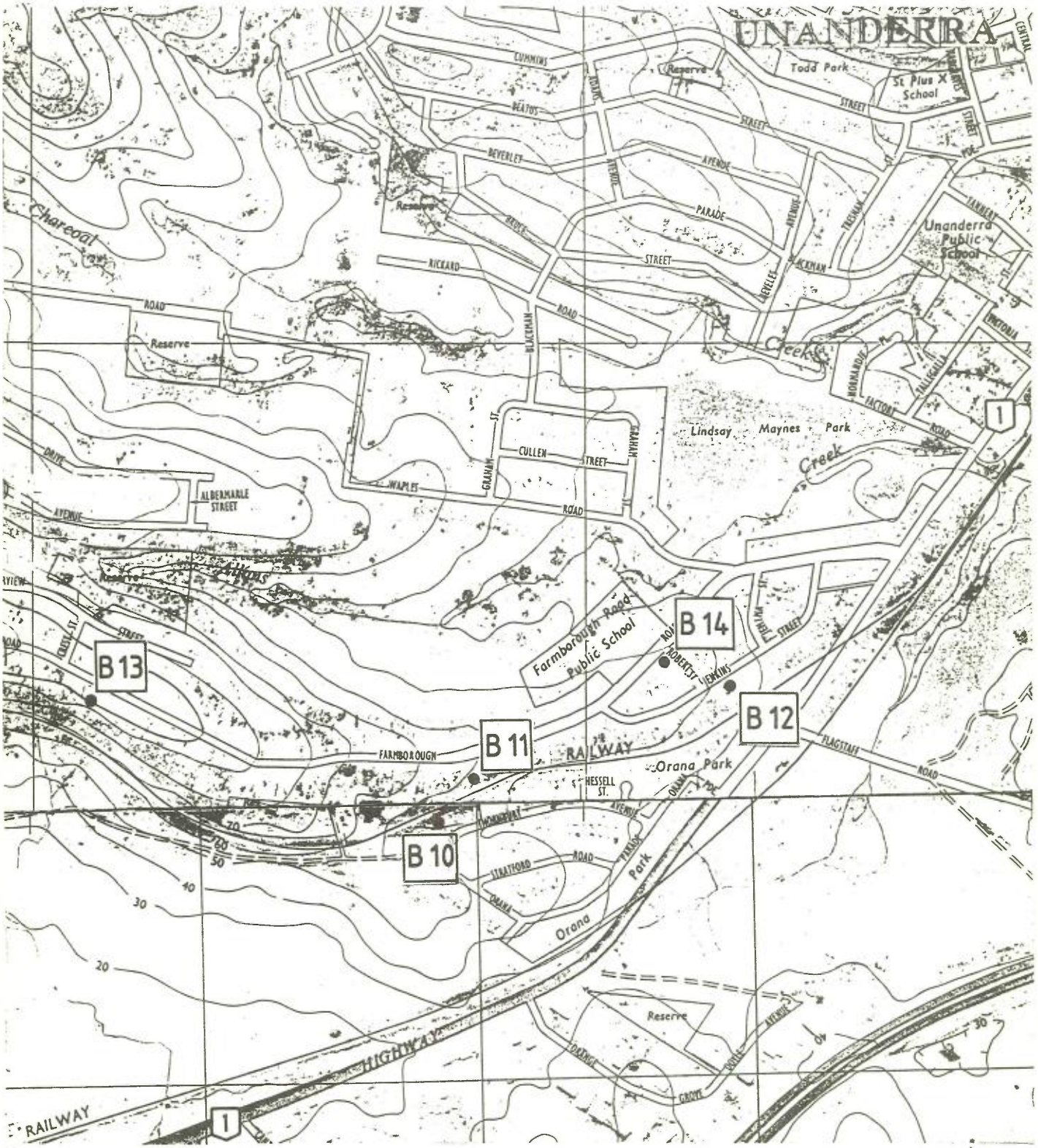
LOCATION PLAN
SHOWING MEASUREMENT POSITIONS
UNANDERRA AREA



Scale: 1÷10 000mm

Report No: 4500-3-83
Appendix No: 6.2

LOCATION PLAN
SHOWING MEASUREMENT POSITIONS
UNANDERRA AREA



Scale: 1÷10 000mm

DESCRIPTION OF MEASUREMENT POSITIONS

UNANDERRA
(Designated as Area 'B')

POSITION No: B1

Rear of vacant lot at 61 O'Donnell Drive, 10m from centreline of existing track

POSITION No: B2

Old Five Island Road, first house near Railway Line, 40m to centreline of existing track

POSITION No: B3

O'Neill Street, next to only residence, 50m from centreline of existing track

POSITION No: B4

Second Avenue, at residence half way along the Street, 50m from centreline of existing track

POSITION No: B5

Second Avenue, outside DMKT Transport

POSITION No: B6

Third Avenue, outside only residence

POSITION No: B7

On Princess Highway, near Unanderra Station, 20m from centreline of nearest existing track

POSITION No: B8

Computational position, On Princess Highway at rear of Unanderra Shopping Centre (two residences behind shops)

POSITION No: B9

Outside 191 Princess Highway, on side of house level with rear facade

POSITION No: B10

Vacant lot beside 34 Thornbury Avenue, level with rear of adjacent house

POSITION No: B11

93 Farmborough Avenue, at rear of property

POSITION No: B12

Computational Position, on Jenkins Street

POSITION No: B13

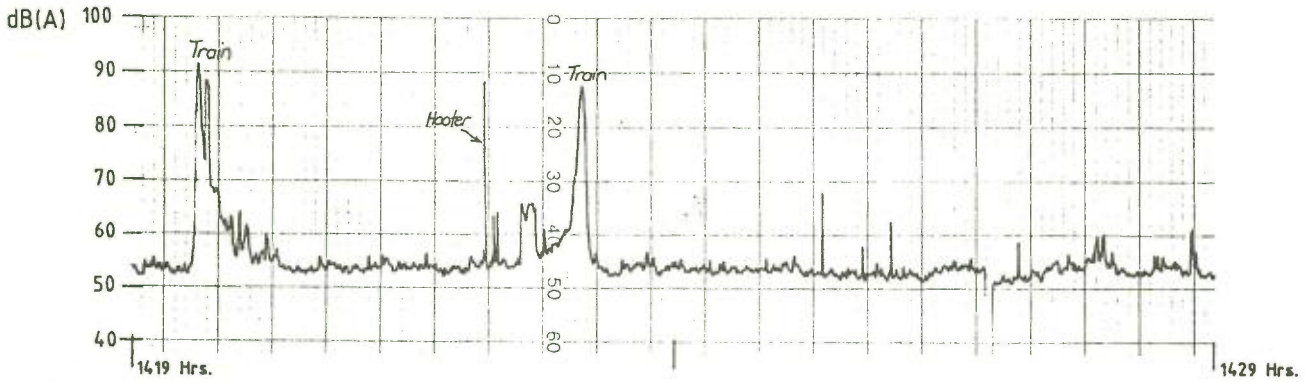
Vacant lot at 183 Farmborough Road, near Crest Street, level with rear facade of adjacent houses

POSITION No: B14

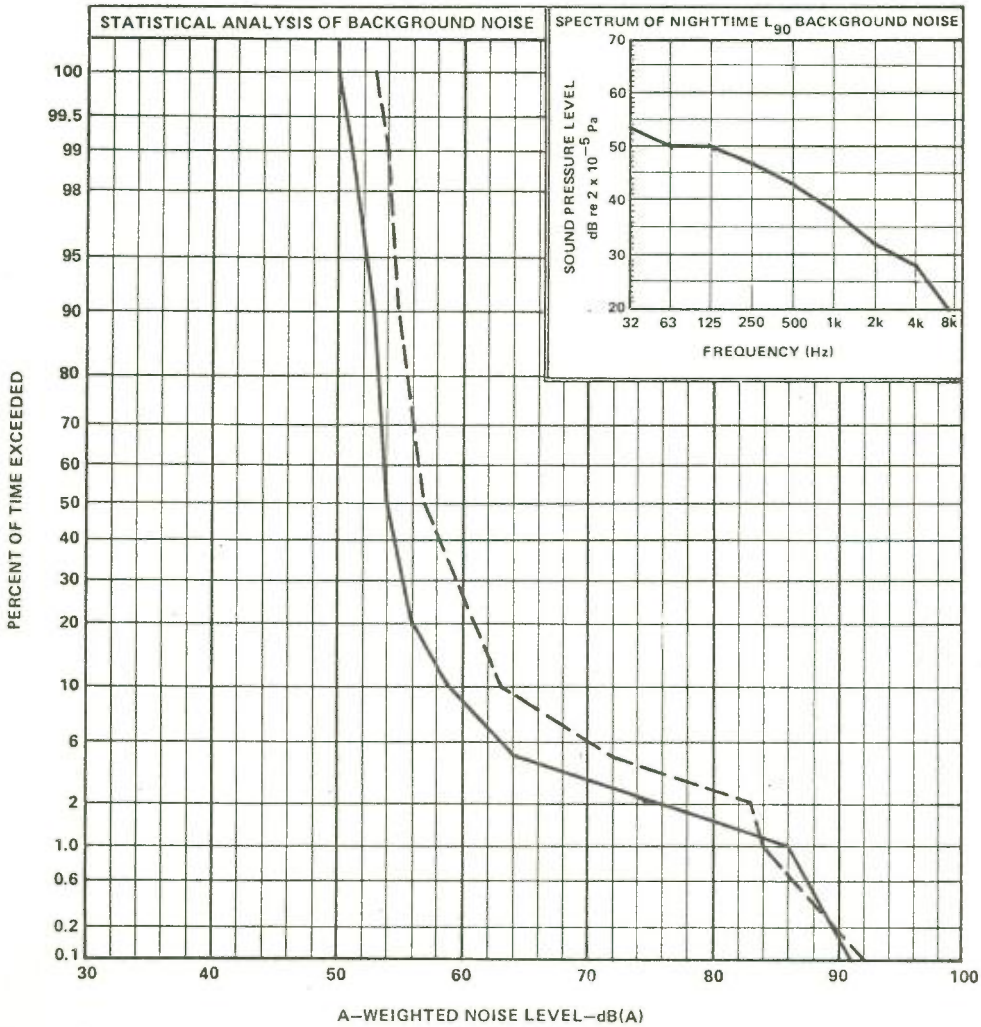
Corner of Roberts Street & Farmborough Road

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Appendix No: 7.1

AMBIENT SOUND LEVELS
POSITION B1 , UNANDERRA AREA
DAY TIME MEASUREMENTS







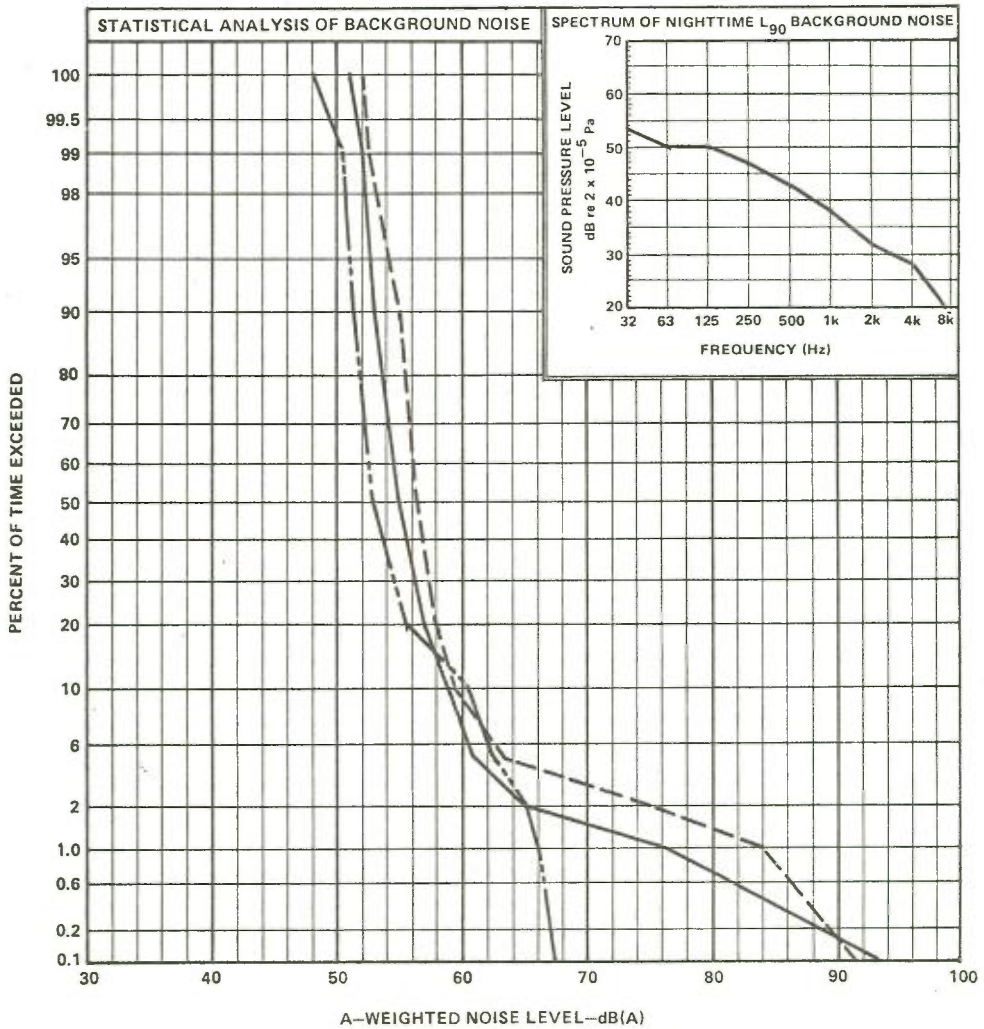
Leq 76 ———— 1419-1429 Hrs, Wed. 7/9/83:- LIGHT TRAFFIC, 2 DIESEL LOCOS & COBOOSE HOOTER, INDUSTRIAL (COMSTEEL). PASSENGER TRAIN ON SOUTH LINE

Leq 72 — — — — 1247-1257 Hrs, Tues. 13/9/83"- 1 PASSENGER TRAIN FROM SOUTH - 1 LOCO & 6 CARRIAGES, 1 GOODS TRAIN FROM SOUTH - 1 LOCO, 16 WAGONS & 1 CABOOSE.

Report No: 4500-3-83
Appendix No: 7.2

AMBIENT SOUND LEVELS
POSITION B1 , UNANDERRA AREA
DAY TIME MEASUREMENTS





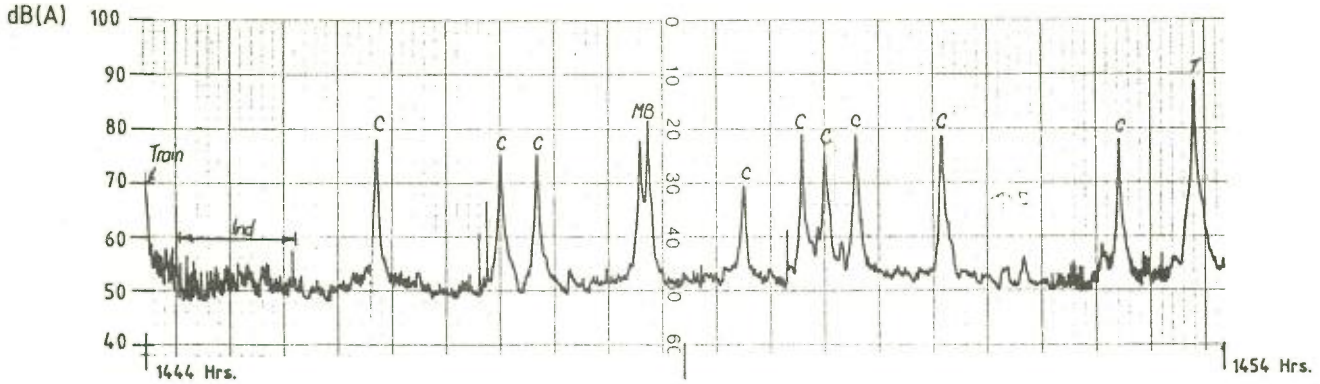
Leq 69.1 ———— 1726-1736 Hrs, Mon. 19/9/83:- PASSENGER TRAIN FROM SOUTH - 1 LOCO & 4 CARRIAGES

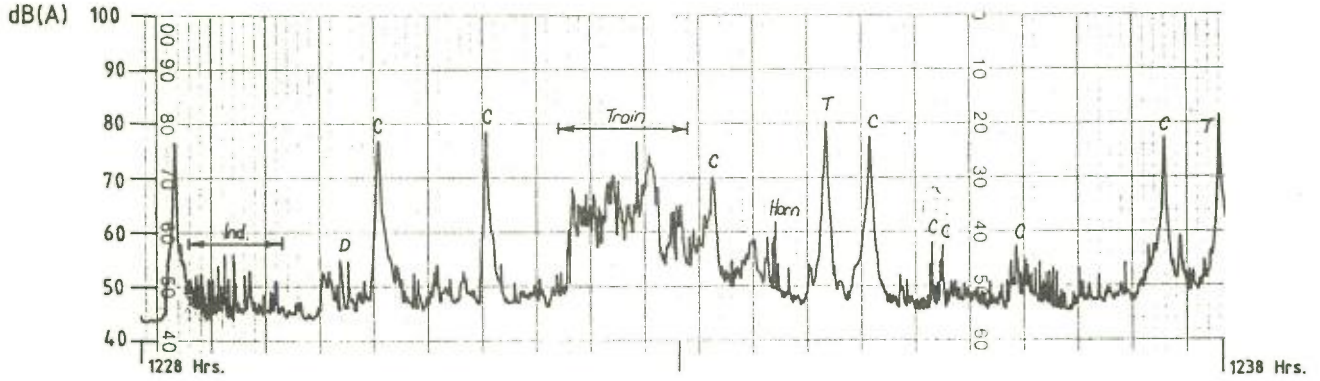
Leq 68.9 — — — — 1738-1748 Hrs, Mon. 19/9/83:- PASSENGER TRAIN TO SOUTH

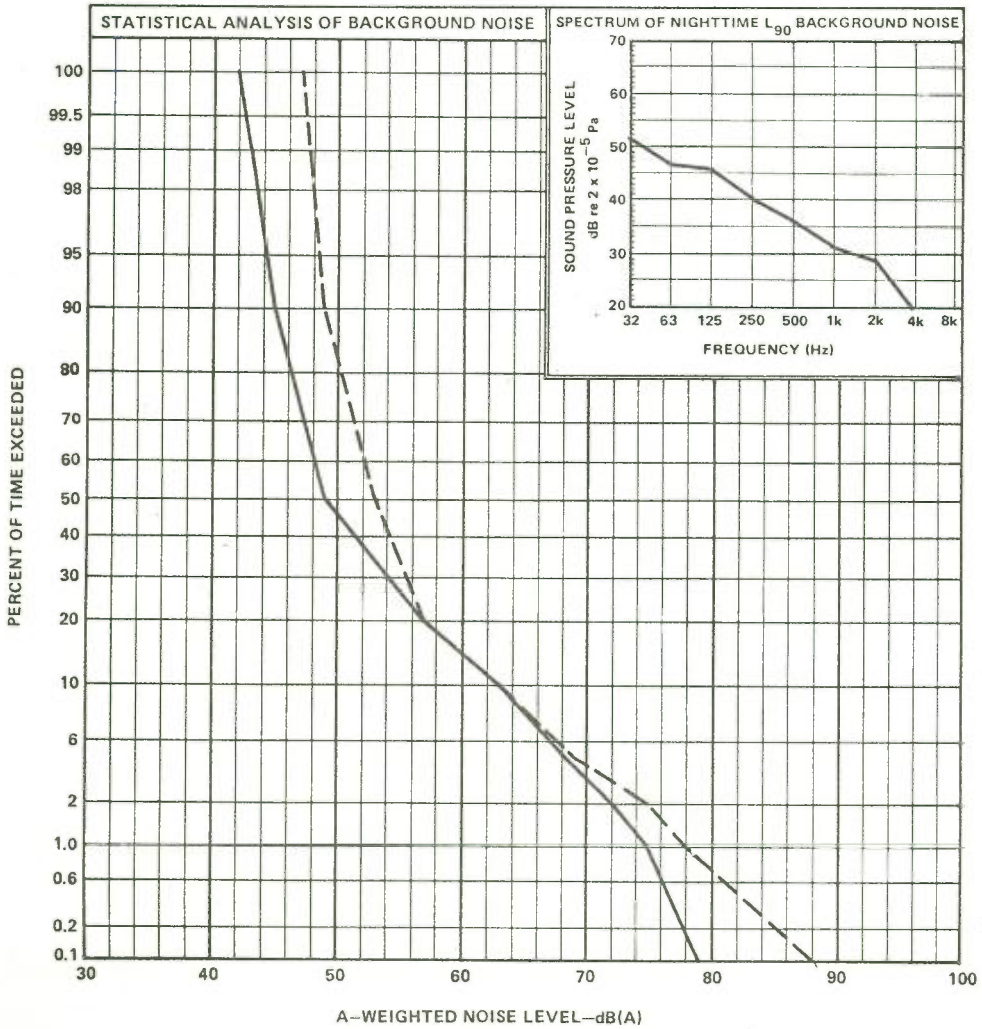
Leq 61.1 ——·—— 1108-1118 Hrs, Tues. 20/9/83:- TRUCK, STEAD INDUSTRY, ('COMSTEEL')

AMBIENT SOUND LEVELS
POSITION B2 , UNANDERRA AREA
DAY TIME MEASUREMENTS

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Appendix No: 8.1





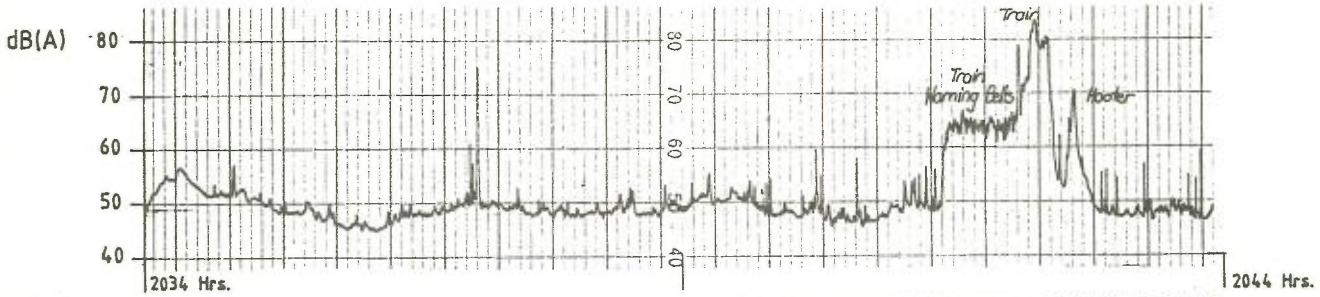


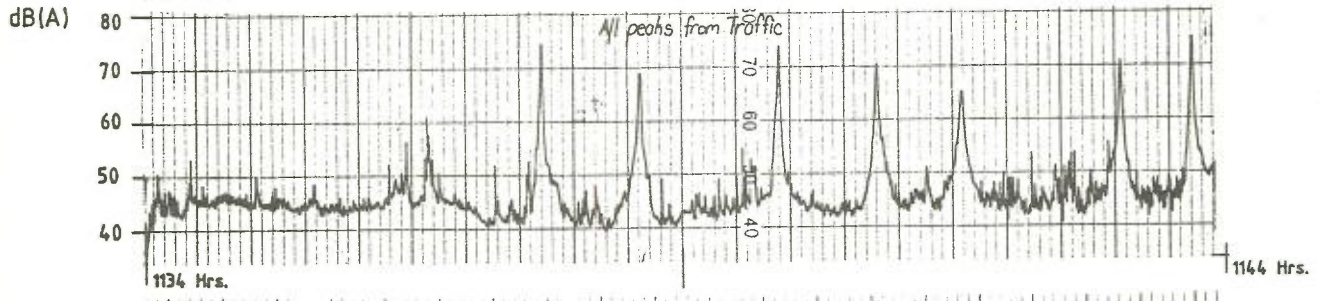
Leq 62 ———— 1444-1454 Hrs, 7/9/83:- BANGING, PASSENGER TRAIN ON SOUTH LINE, BELLS, DISTANT TRAFFIC

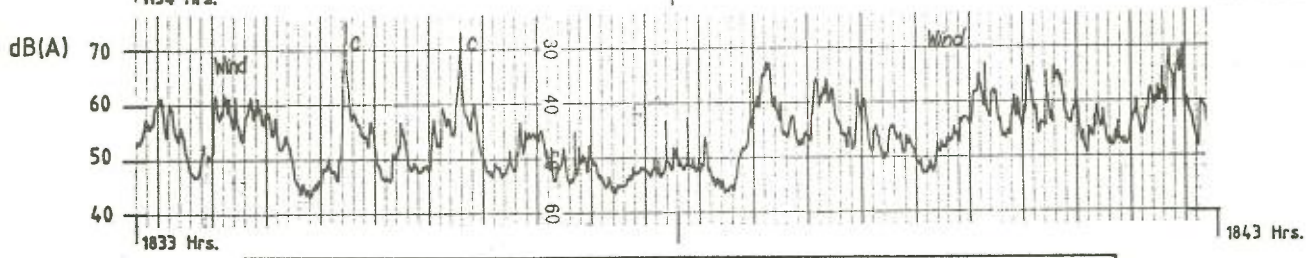
Leq 65 — — — — 1228-1238 Hrs, Tues. 13/9/83:- TRAIN, TRAFFIC, INDUSTRIAL, DOG

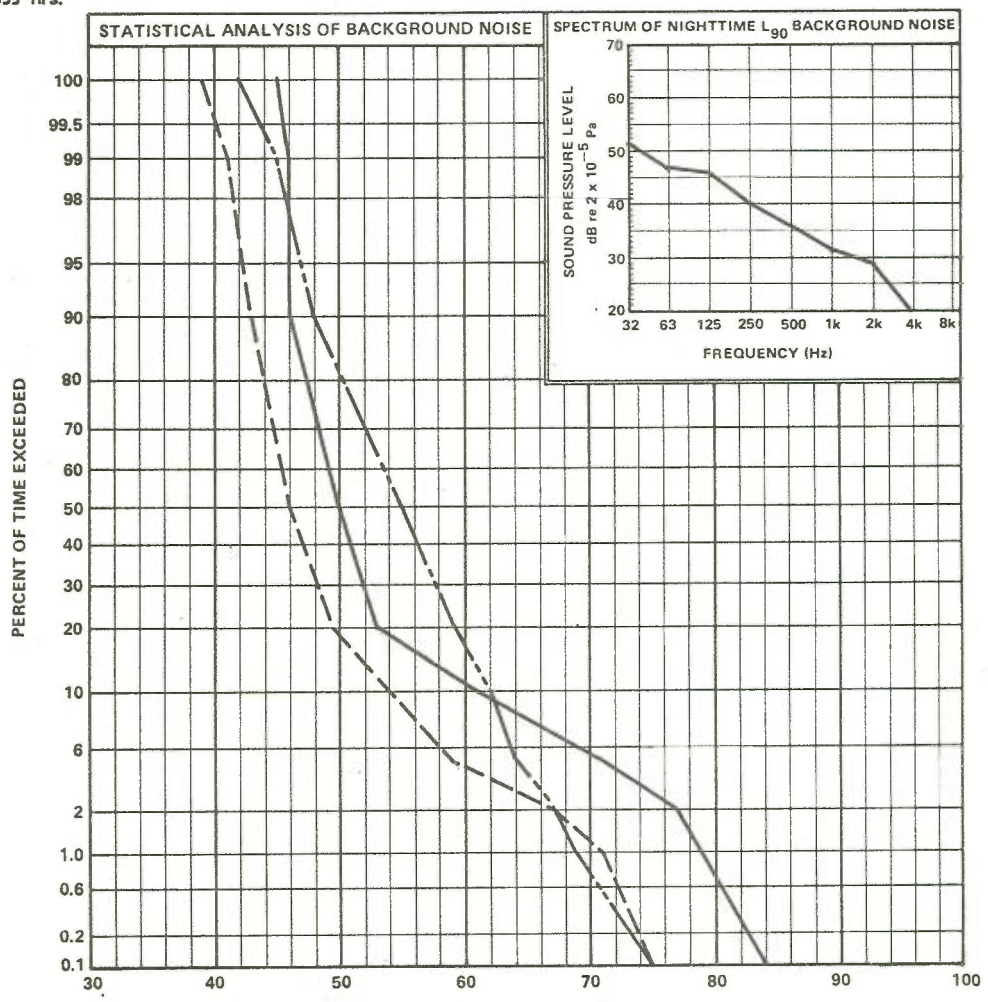
AMBIENT SOUND LEVELS
POSITION B2 , UNANDERRA AREA
DAY TIME MEASUREMENTS

Report No: 4500-3-83
Appendix No: 8.2







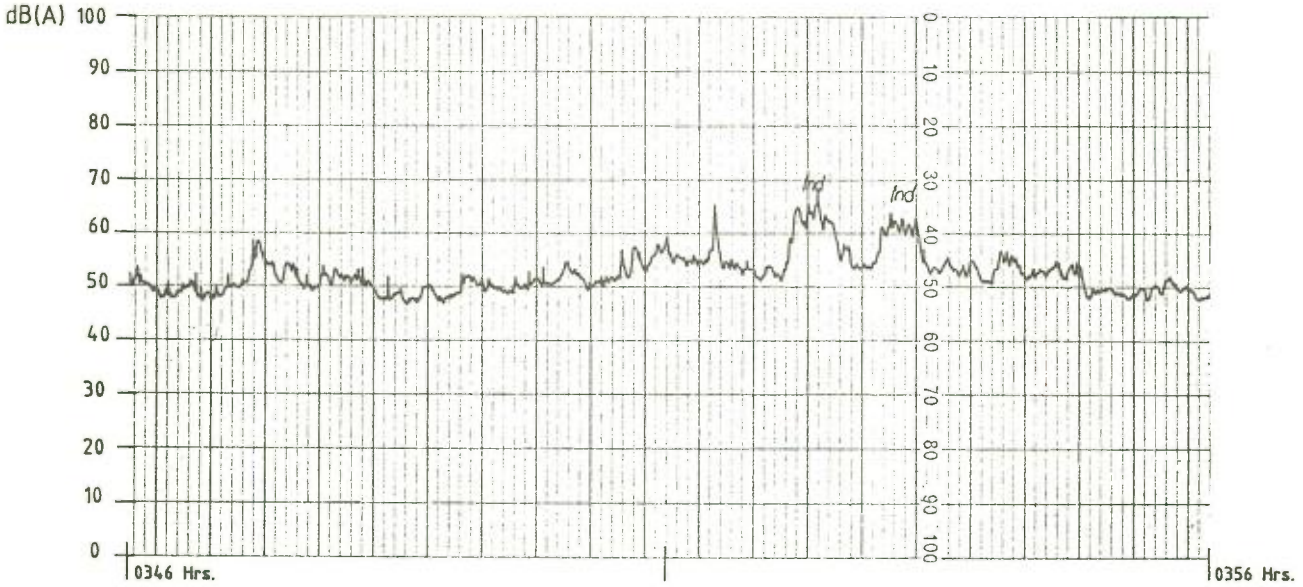


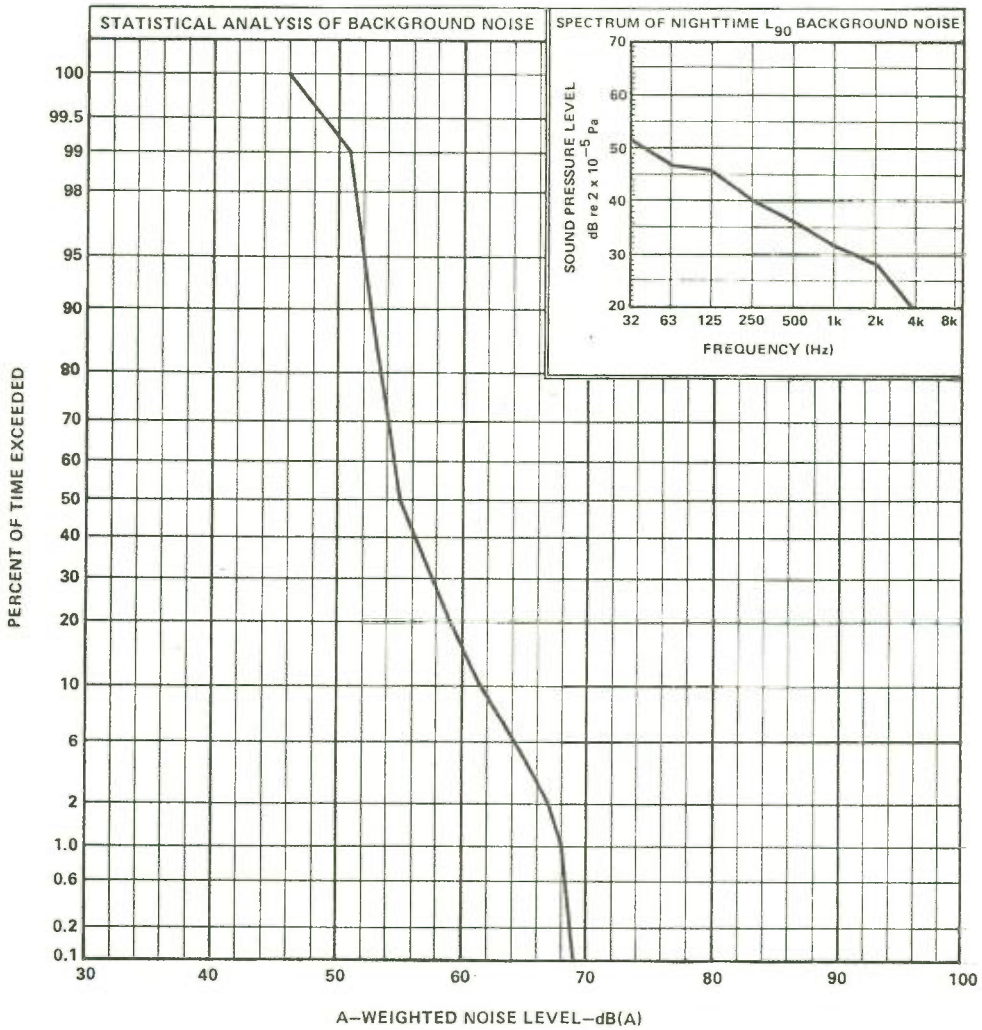
Leq 65.3 ———— 2034-2044 Hrs, Mon. 19/9/83:- PASSENGER TRAIN FROM SOUTH - 1 LOCO & 7 WAGONS

Leq 61.1 —— —— 1134-1144 Hrs, Tues. 20/9/83:- NOISE FROM SMALL INDUSTRIES

Leq 61.8 —— -- —— 1833-1843 Hrs, Tues. 20/9/83:- HIGH WINDS

AMBIENT SOUND LEVELS
POSITION B 2, UNANDERRA AREA
NIGHT TIME MEASUREMENT

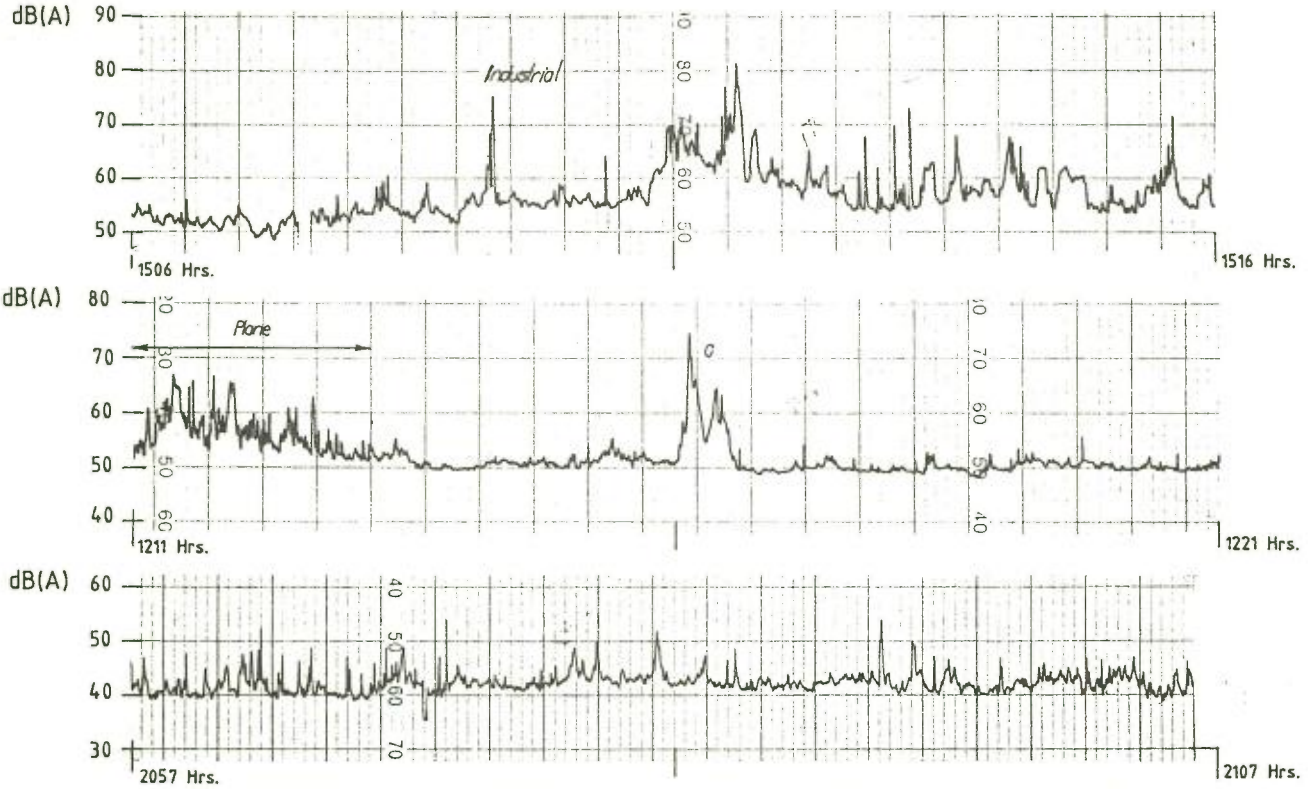


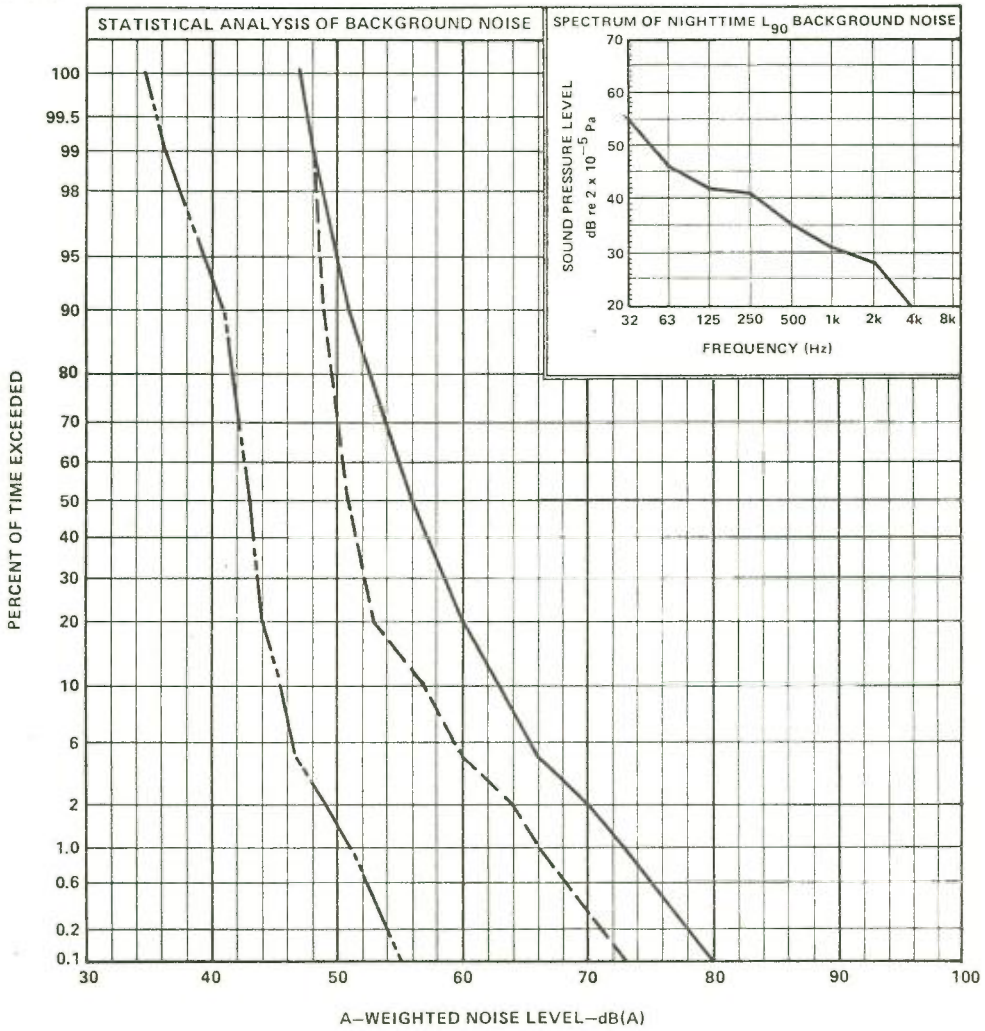


Leq 58.5 _____ 0346-0356 Hrs, Wed. 21/9/83:- INDUSTRIAL NOISE

AMBIENT SOUND LEVELS
POSITION B3 , UNANDERRA AREA
DAY TIME MEASUREMENTS

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Appendix No: 9.1





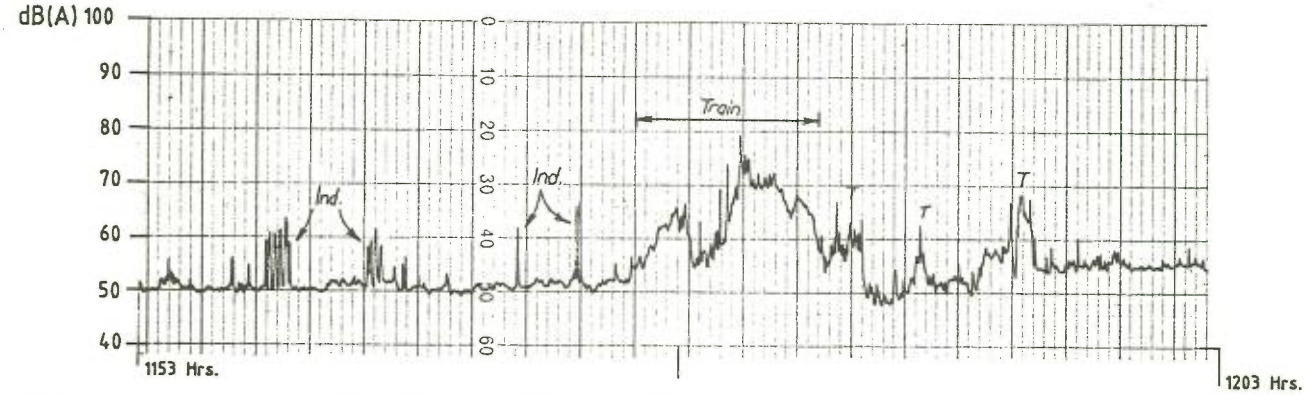
Leq 62 ———— 1506-1516 Hrs, Wed. 7/9/83:- INDUSTRY, TRAFFIC,

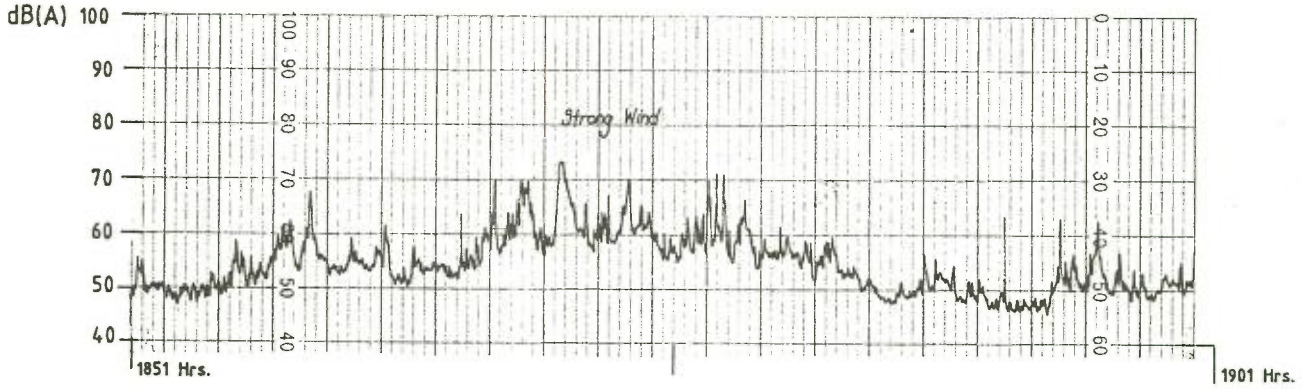
Leq 65 — — — — 1506-1516 Hrs, Tues. 13/9/83:- LIGHT PLANE

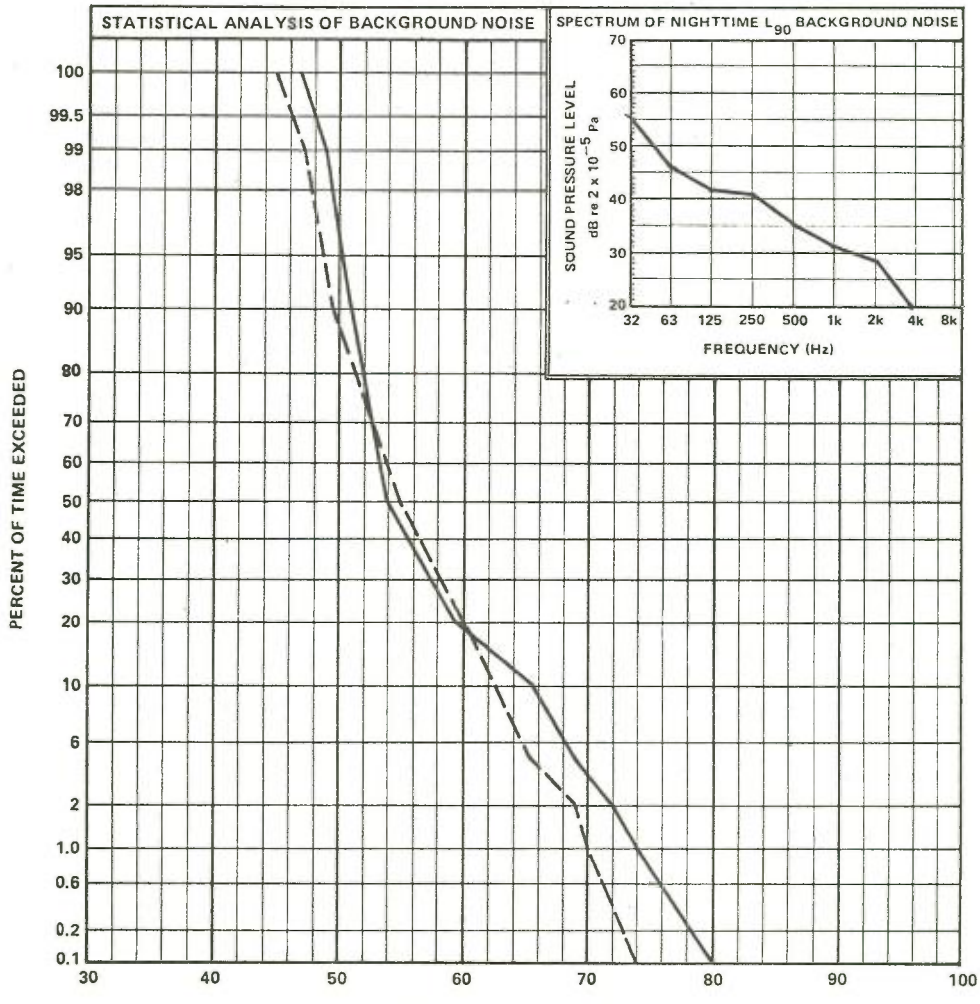
Leq 59.5 ——— 2057-2107 Hrs, Mon. 19/9/83:-

AMBIENT SOUND LEVELS
POSITION B3 , UNANDERRA AREA
DAY TIME MEASUREMENTS

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Appendix No: 9.2



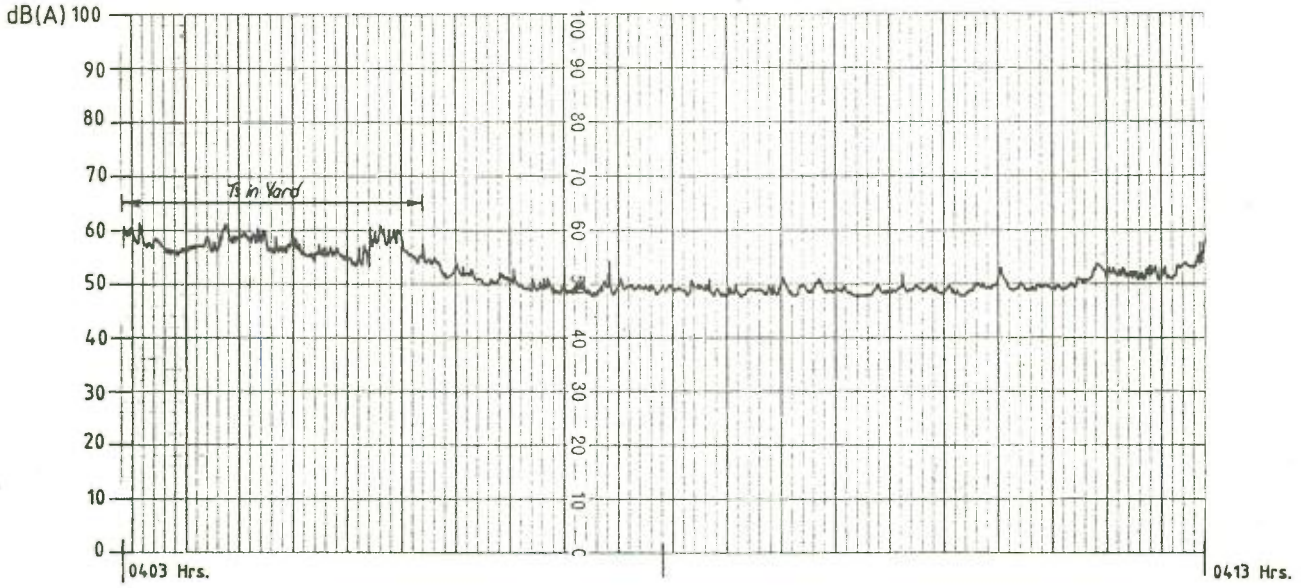


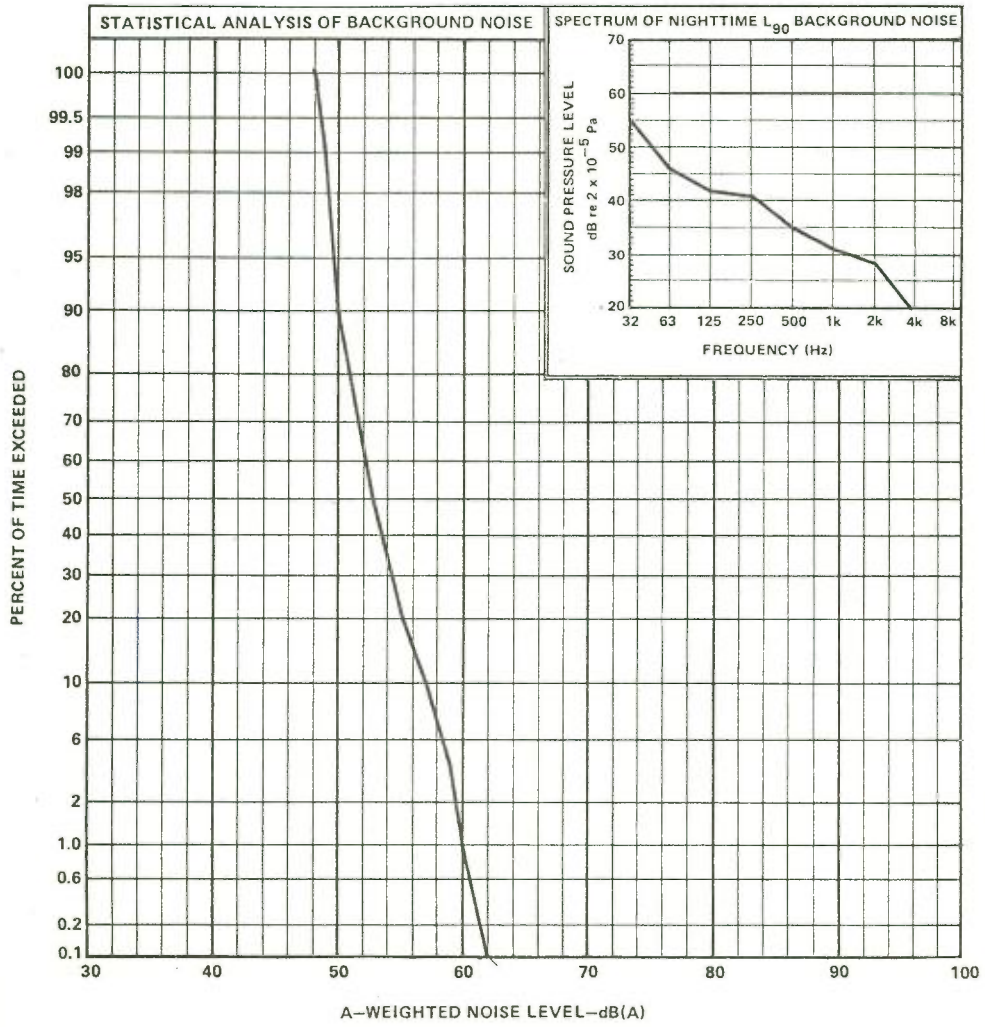


Leq 63.8 ———— 1153-1203 Hrs, Tues. 20/9/83:- GOODS TRAIN (NOT VISIBLE), TRUCK, INDUSTRIAL, HOOTERS

Leq 59.5 — — — — 1851-1901 Hrs, Tues. 20/9/83:- STRONG WIND.

AMBIENT SOUND LEVELS
POSITION B3., UNANDERRA AREA
NIGHT TIME MEASUREMENTS

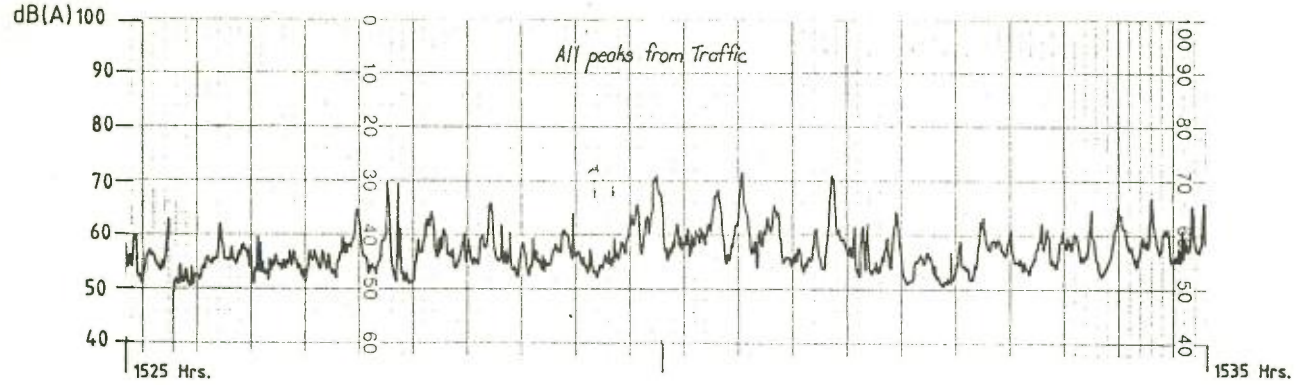


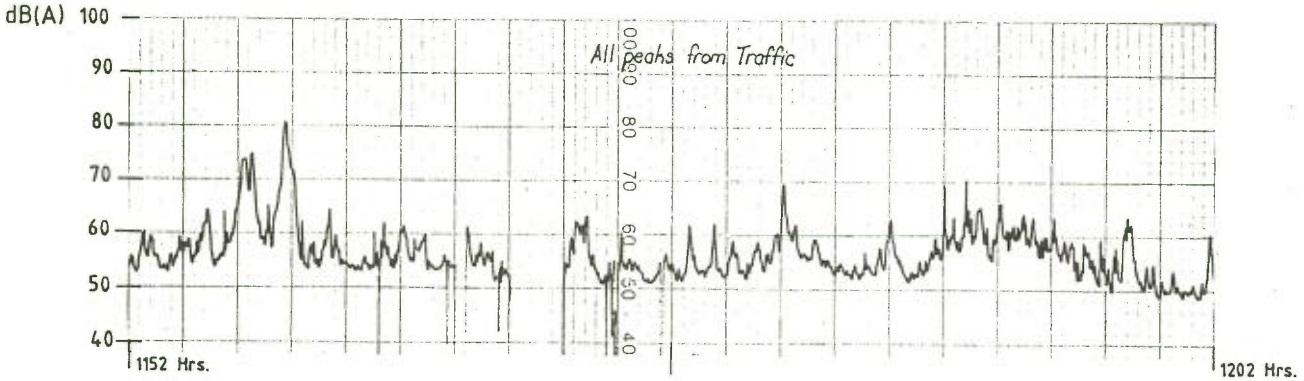


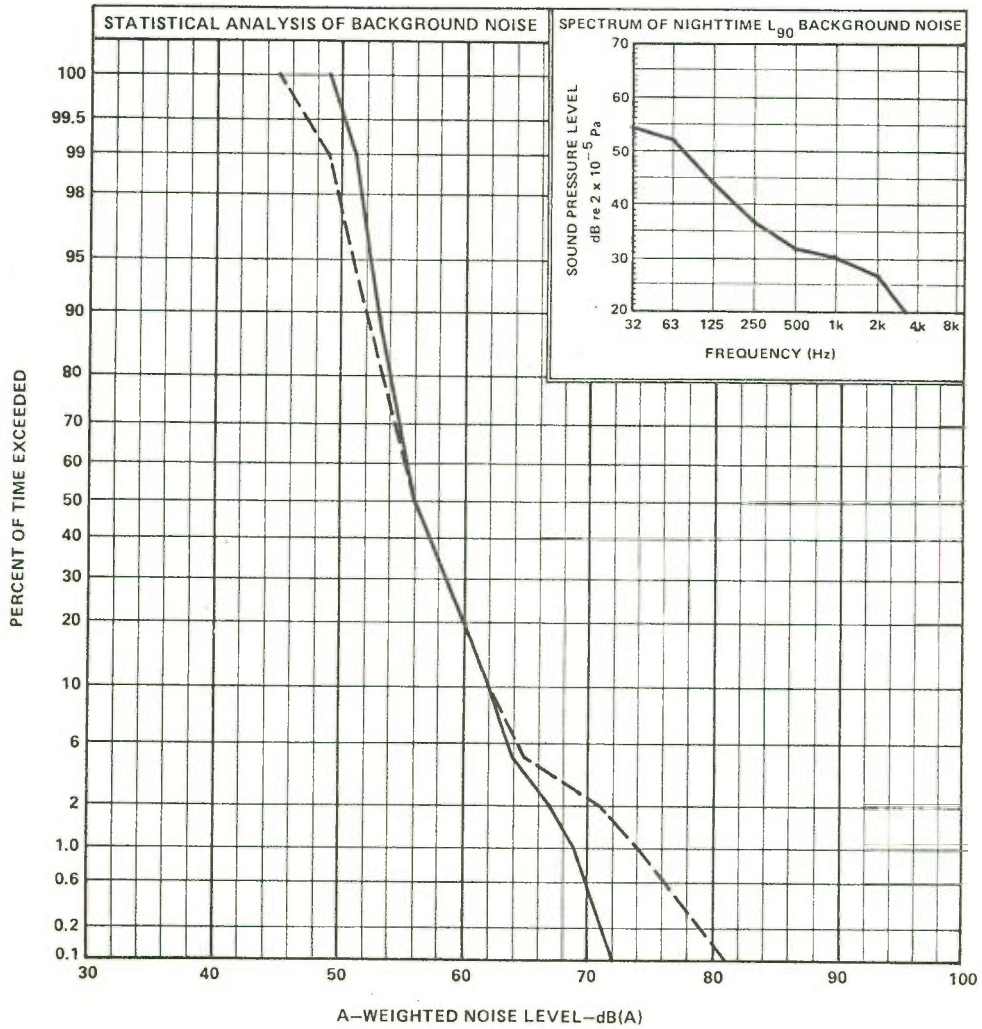
Leq 56 ———— 0403-0413 Hrs, Wed. 21/9/83:- TRUCKS IN YARD

AMBIENT SOUND LEVELS
POSITION B4 , UNANDERRA AREA
DAY TIME MEASUREMENTS

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Appendix No: 10.1





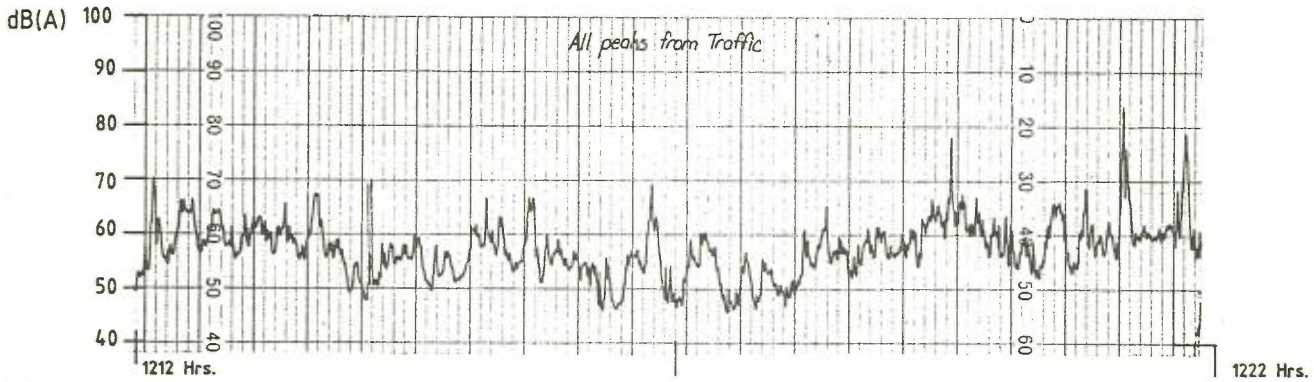


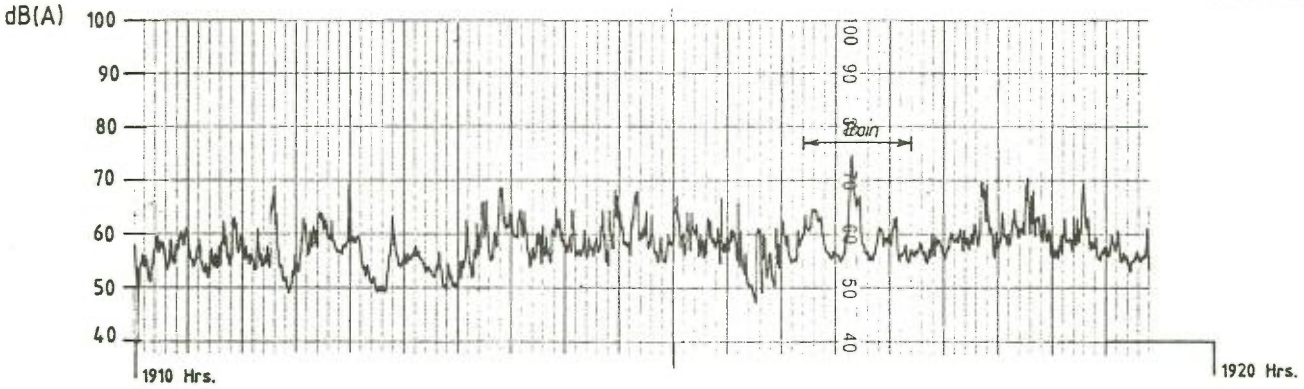
Leq 59 ———— 1525-1535 Hrs, Wed. 7/9/83:- HEAVY TRAFFIC

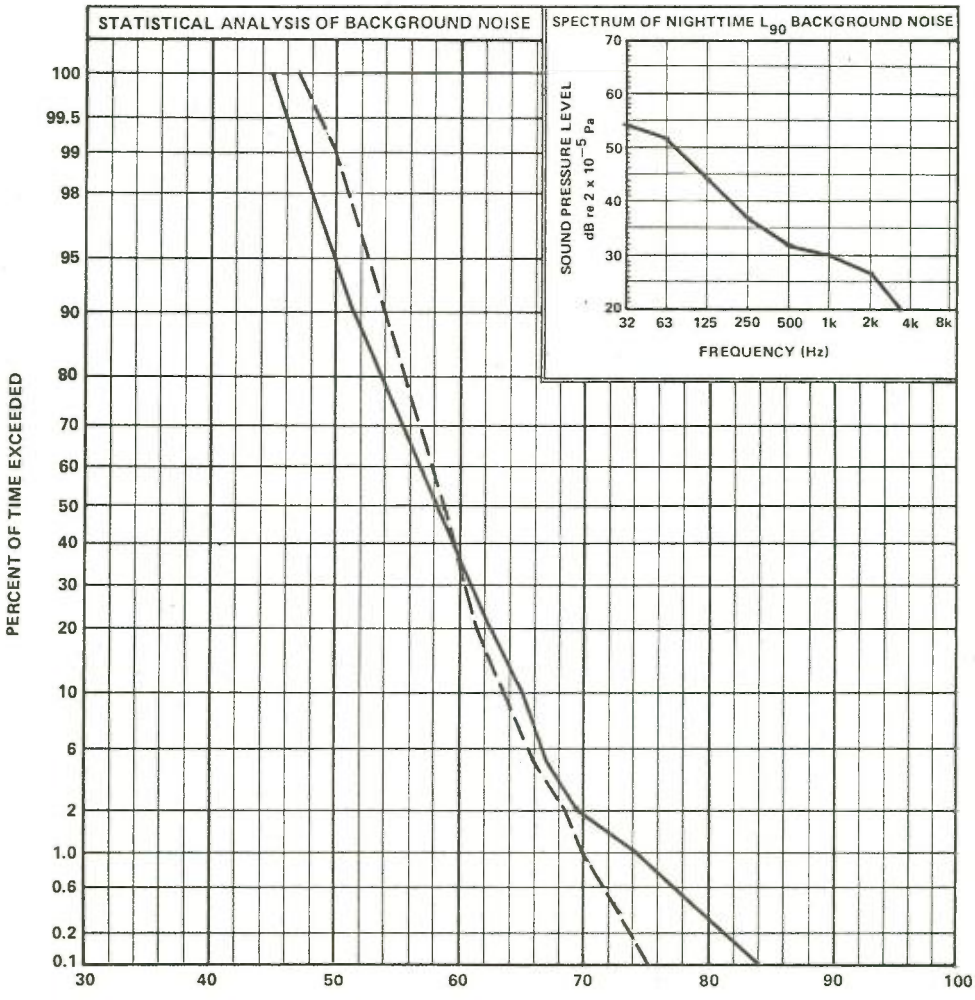
Leq 62 — — — — — 1152-1202 Hrs, Tues. 13/9/83:- TRAFFIC ON HIGHWAY

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Appendix No: 10.2

AMBIENT SOUND LEVELS
POSITION B4 , UNANDERRA AREA
DAY TIME MEASUREMENTS





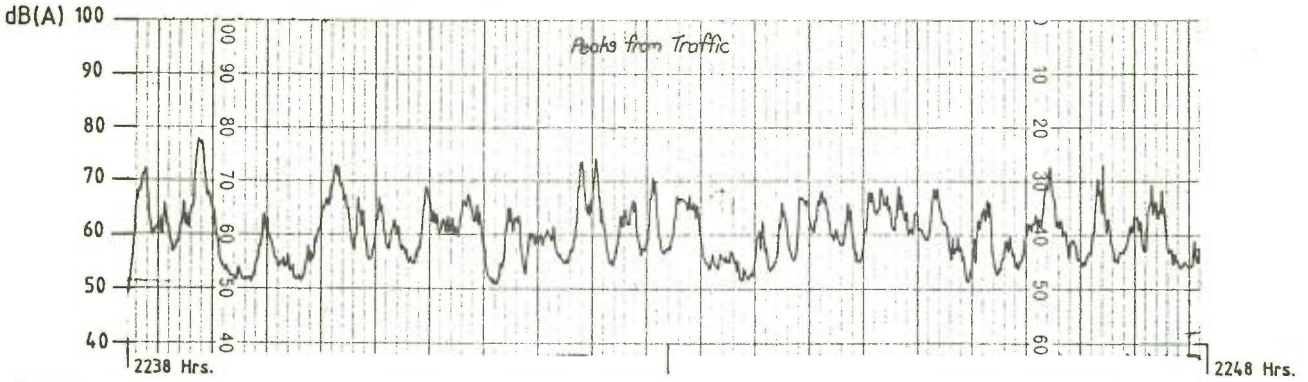


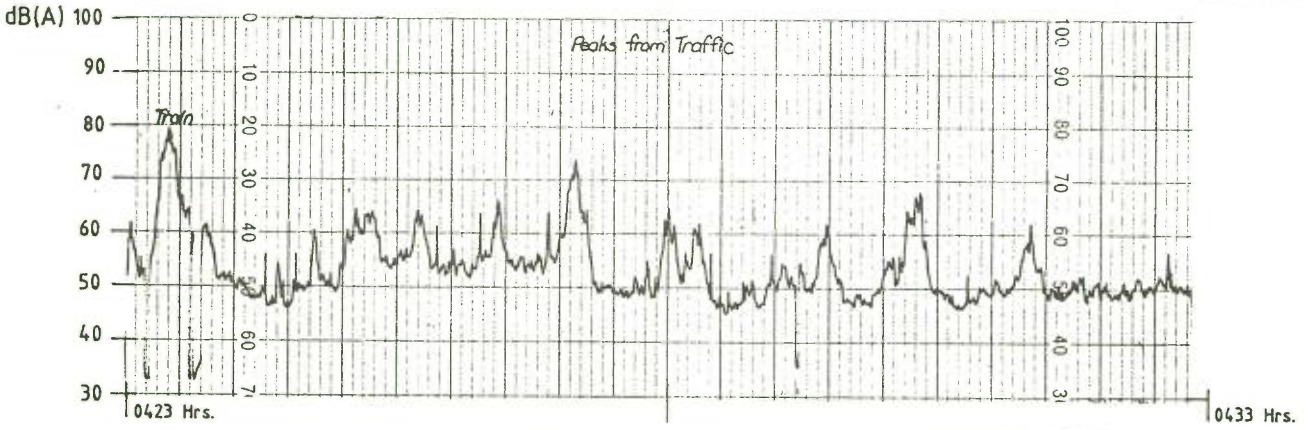
Leq 63.9 ———— 1212-1222 Hrs, Tues. 20/9/83:- TRAFFIC, INDUSTRIAL

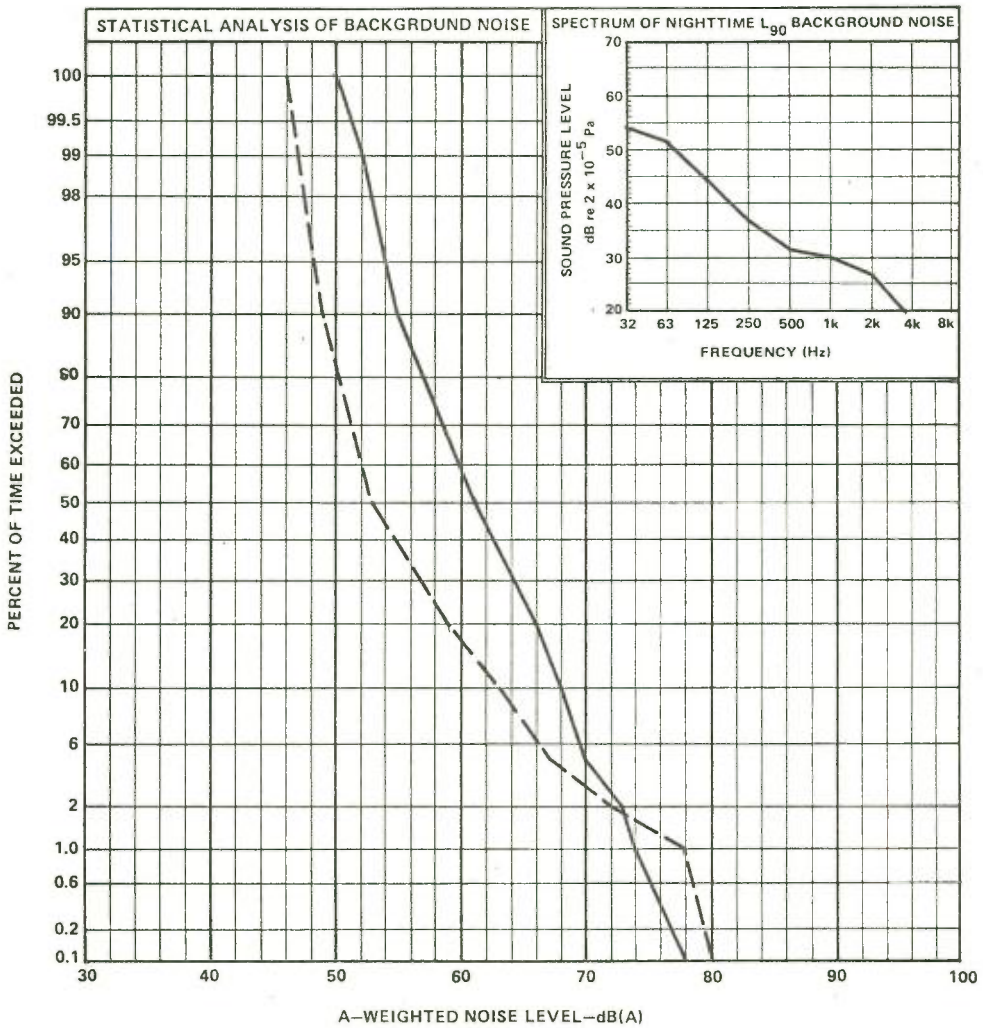
Leq 60.7 — — — — 1910-1920 Hrs, Tues. 20/9/83:- PASSENGER TRAIN FROM SOUTH
1 LOCO & 4 CARRIAGES

AMBIENT SOUND LEVELS
POSITION B4 , UNANDERRA AREA
NIGHT TIME MEASUREMENTS

Report No: 4500-3-83
Appendix No: 10.3







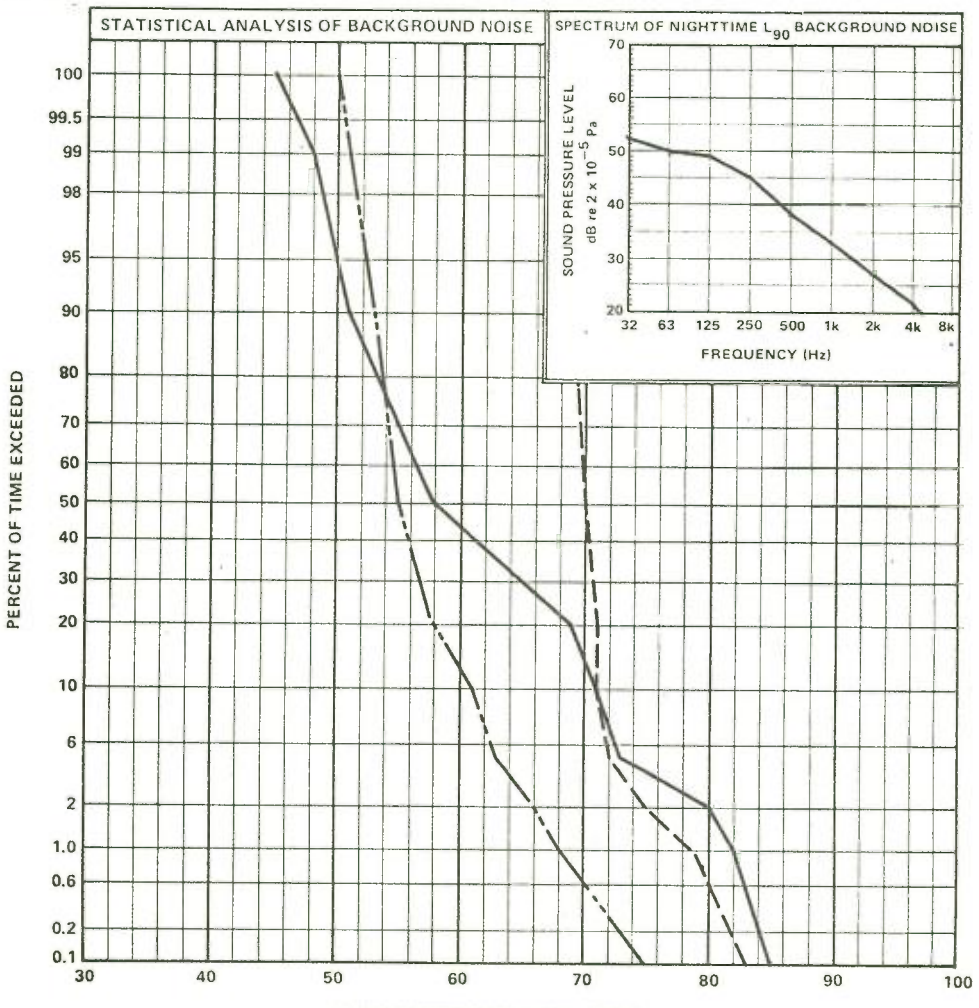
Leq 65.8 ———— 2238-2248 Hrs, Mon. 19/9/83:- HEAVY TRAFFIC

Leq 64 — — — — 0423-0433 Hrs. Wed. 21/9/83:- PASSENGER TRAIN FROM SOUTH WITH 1 LOCO & 3 CARRIAGES, MEDIUM TRAFFIC.

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Appendix No: 11.1

AMBIENT SOUND LEVELS
POSITION B7 , UNANDERRA AREA
DAY TIME MEASUREMENTS





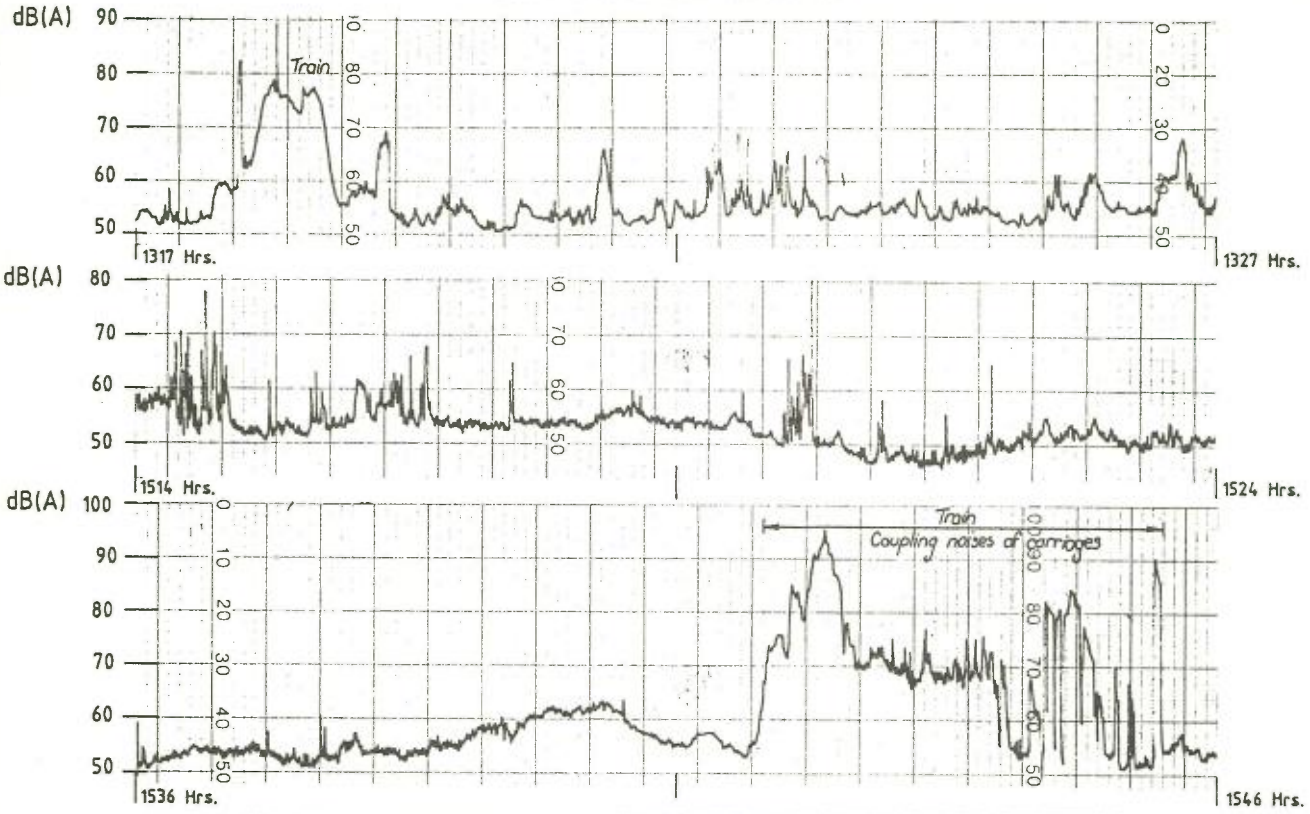
Leq 69 ———— 1550-1600 Hrs, Wed. 7/9/83:- HEAVY TRAFFIC, GOODS TRAIN ON MOSS VALE LINE, 2 LOCOS IDLING

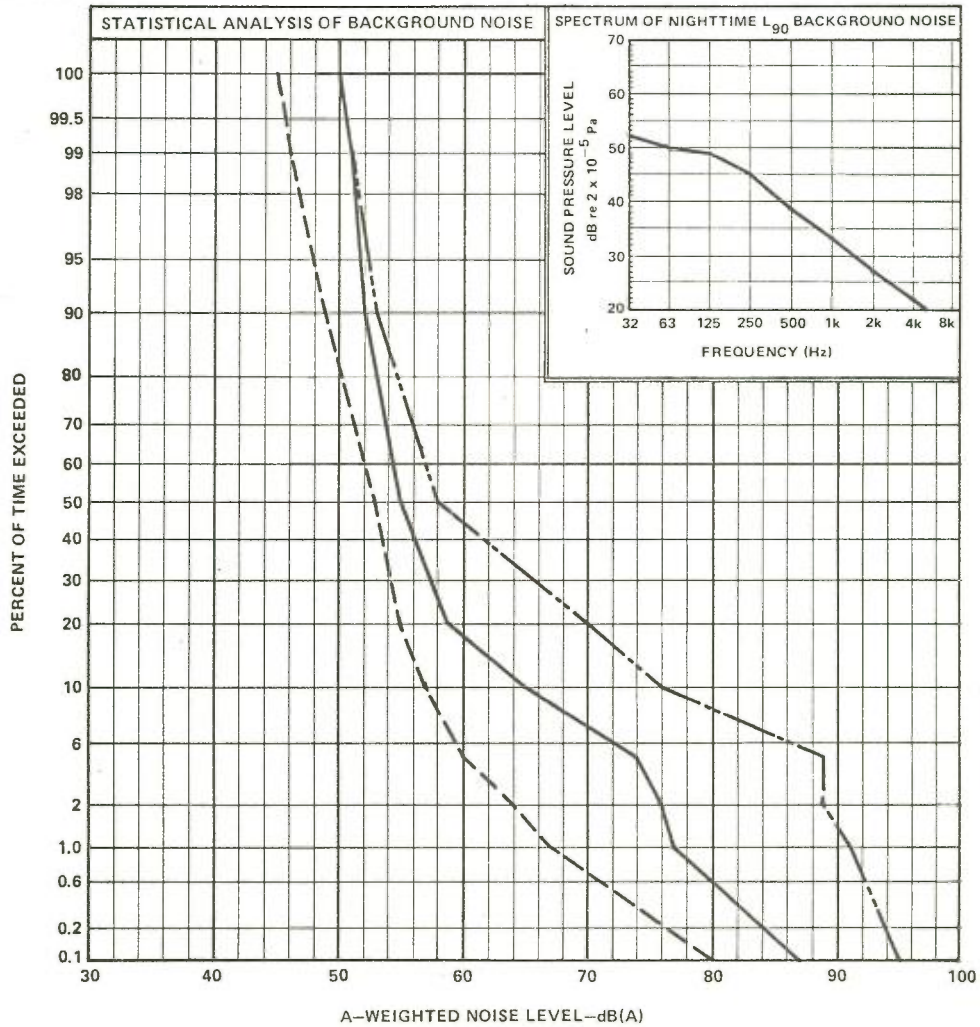
Leq 71 — — — — 1604-1600 Hrs, Wed. 7/9/83:- 2 LOCOS IDLING, PASSENGER TRAIN FROM SOUTH, PASSENGER TRAIN FROM NORTH

Leq 43 ———·——— 1304-1314 Hrs, 8/9/83:- HEAVY TRAFFIC ON PRINCESS HIGHWAY

AMBIENT SOUND LEVELS
POSITION B7 , UNANDERRA AREA
DAY TIME MEASUREMENTS

Report No: 4500-3-83
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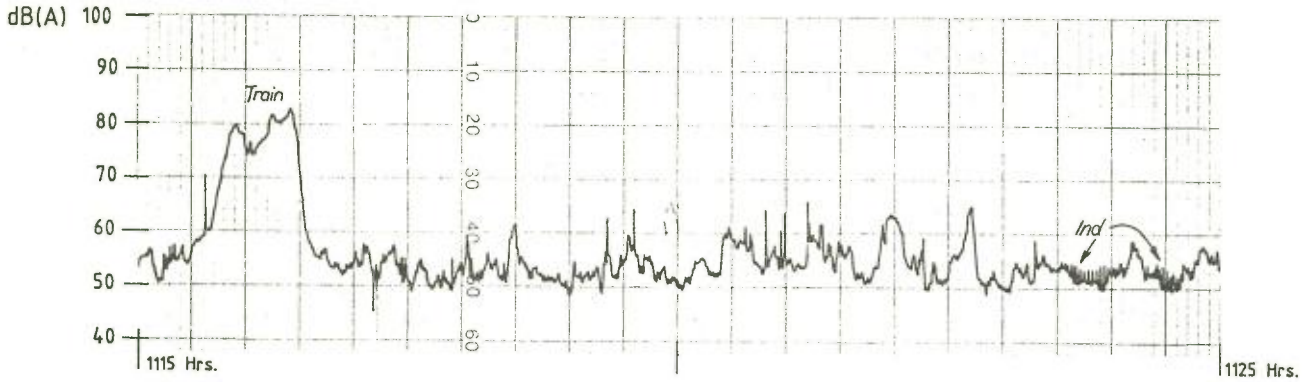
Leq 74 ———— 1317-1327 Hrs, Thur. 8/9/83:- SOUTH COAST LINE GOODS TRAIN TO NOWRA 3 LOCOS, 19 WAGONS & CABOOSE

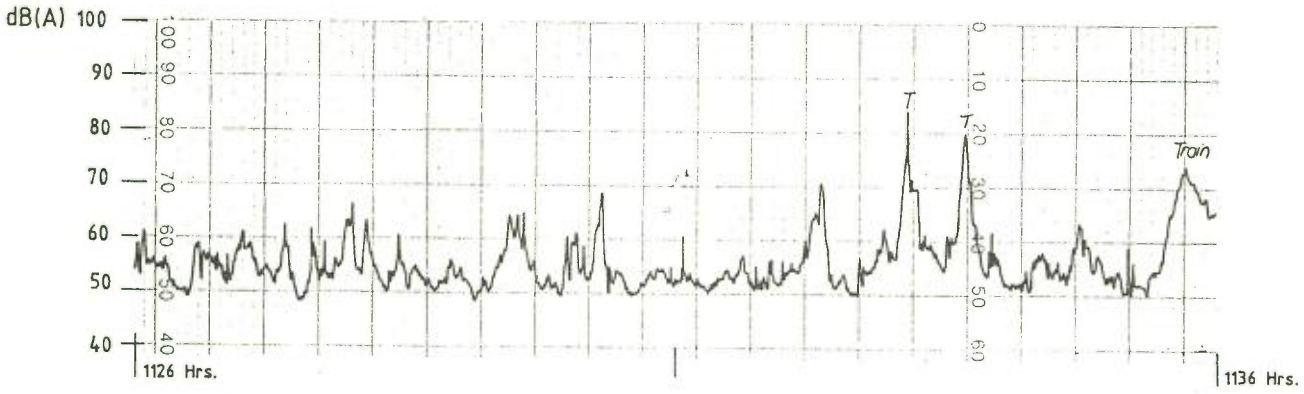
Leq 60 — — — — 1514-1524 Hrs, Thur, 8/9/83:-

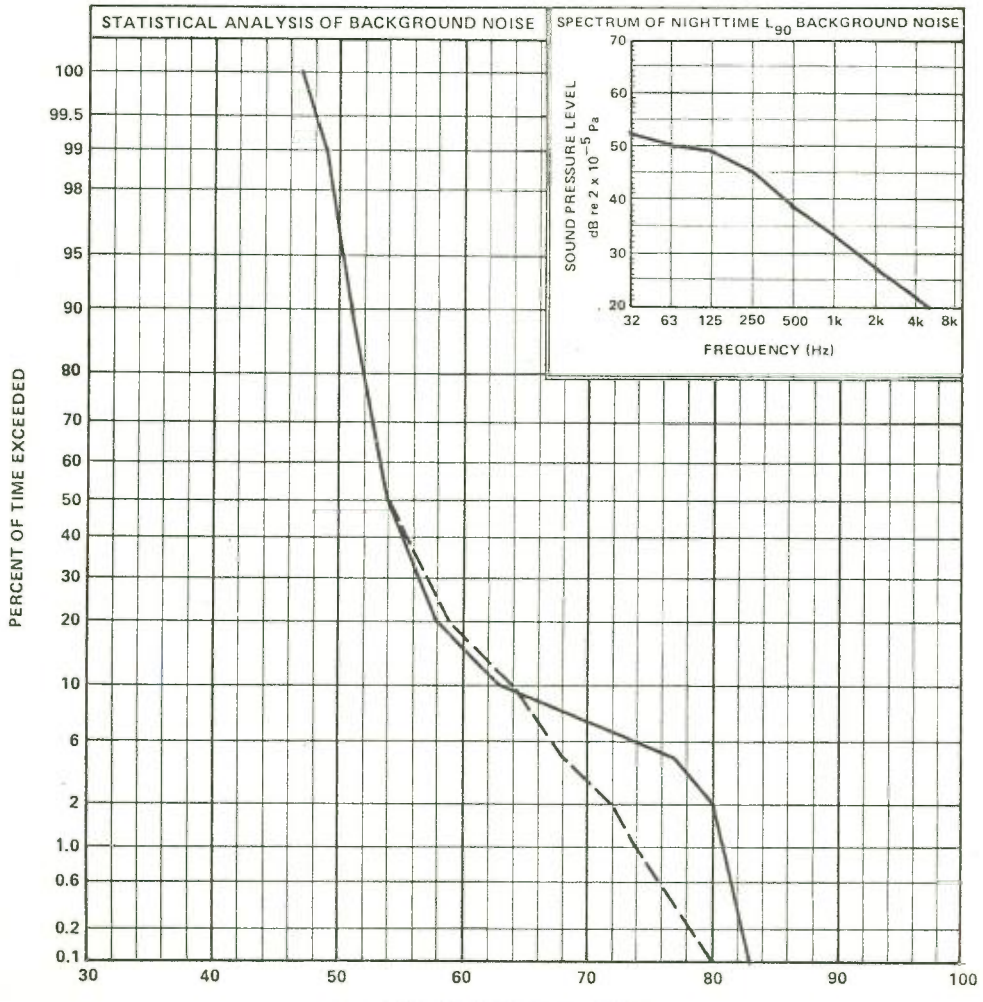
Leq 77 ——--—— 1536-1546 Hrs, Thur. 8/9/83:- GOODS TRAIN FROM MOSS VALE- 2 LOCOS & 28 WAGONS

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AMBIENT SOUND LEVELS
POSITION B7 , UNANDERRA AREA
DAY TIME MEASUREMENTS





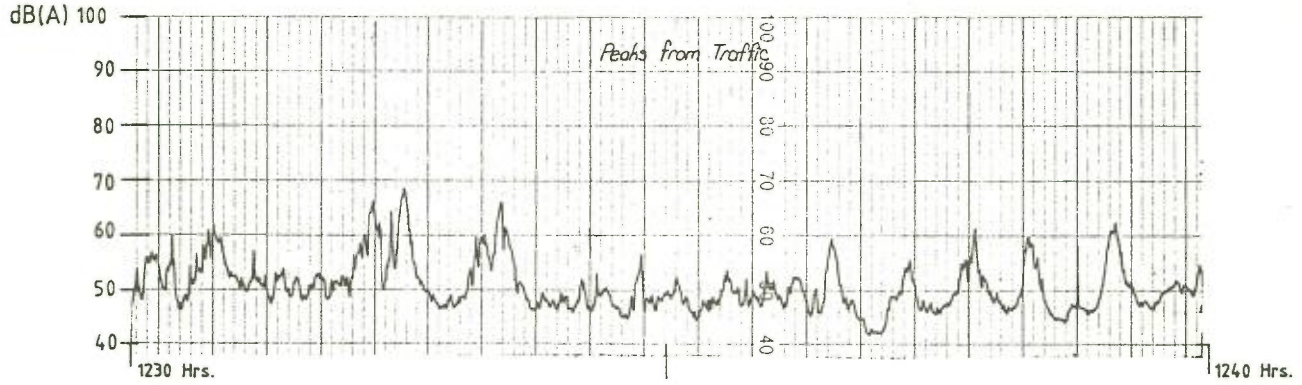


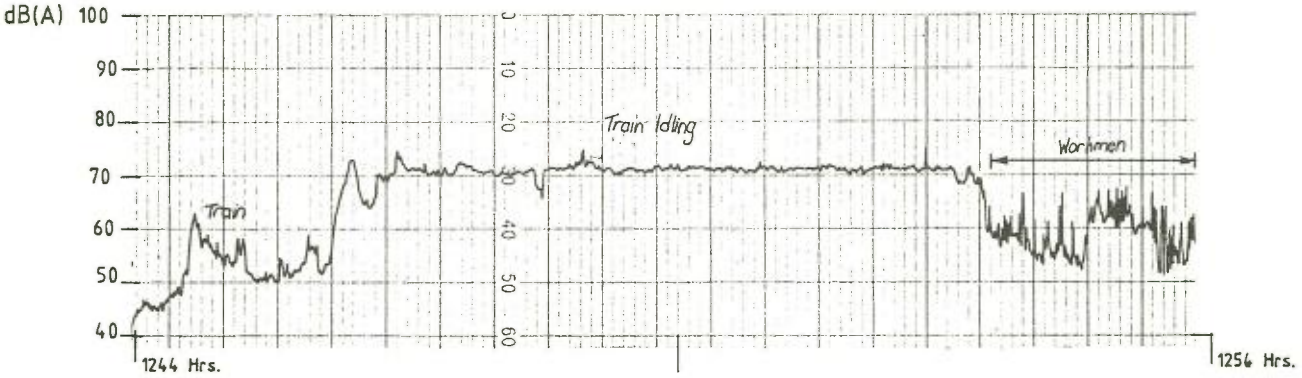
Leq 68 ———— 1115-1125 Hrs, Tues. 13/9/83:- GOODS TRAIN TO DAPTO - 3 LOCOS, 20 WAGONS & CABOOSE

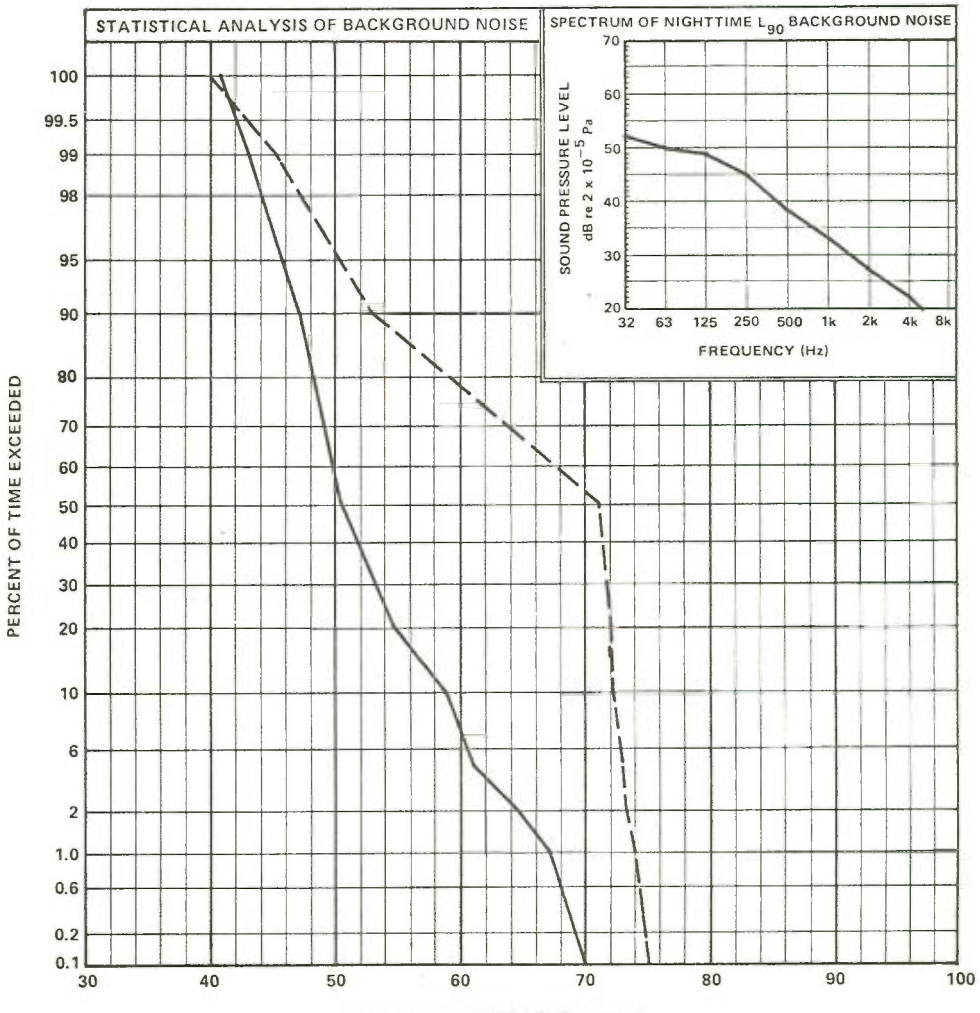
Leq 62 — — — — 1126-1136 Hrs, Tues. 13/9/83:- PASSENGER TRAIN TO DAPTO - 1 LOCO & 7 CARRIAGES

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Appendix No: 11.4

AMBIENT SOUND LEVELS
POSITION B7, UNANDERRA AREA
DAY TIME MEASUREMENTS



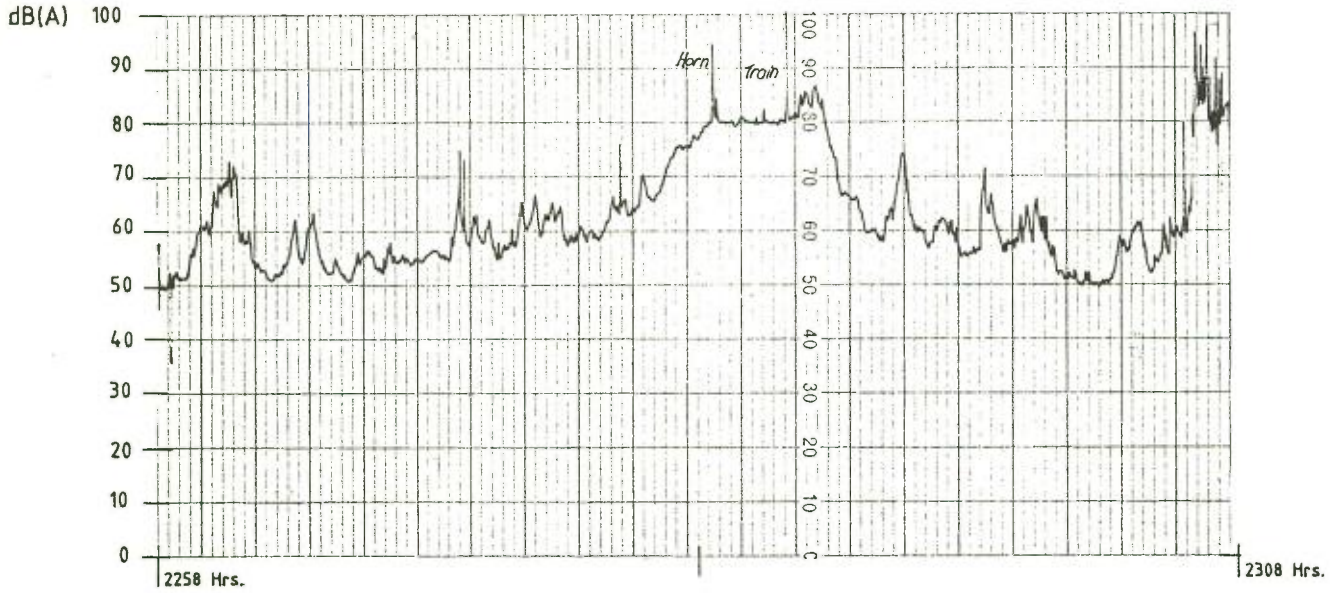


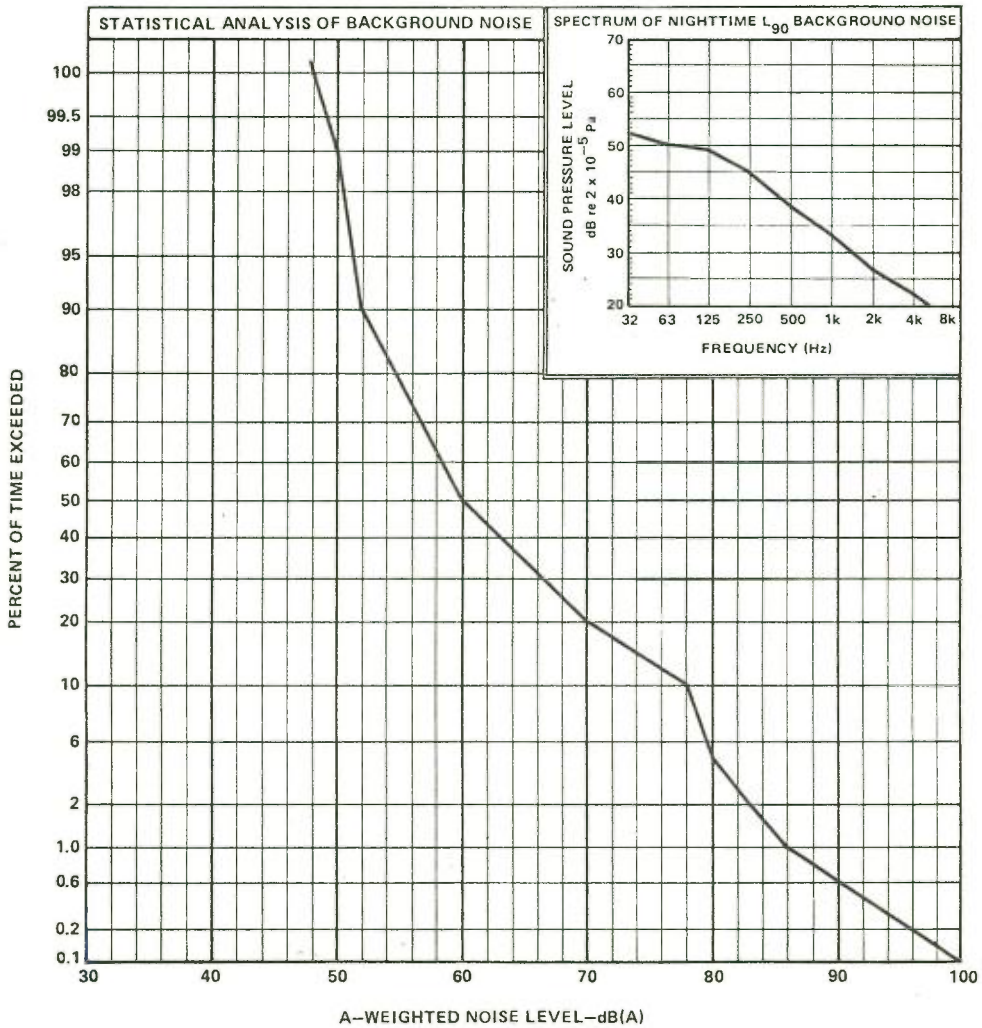


Leq 60.7 ———— 1230-1240 Hrs, Tues. 20/9/83:- MEDIUM TRAFFIC

Leq 69.7 ——--—— 1244-1254 Hrs, Tues. 20/9/83:- PASSENGER TRAIN TO SOUTH, PASSENGER TRAIN FROM SOUTH, WORKMEN

AMBIENT SOUND LEVELS
POSITION B7 , UNANDERRA AREA
NIGHT TIME MEASUREMENTS



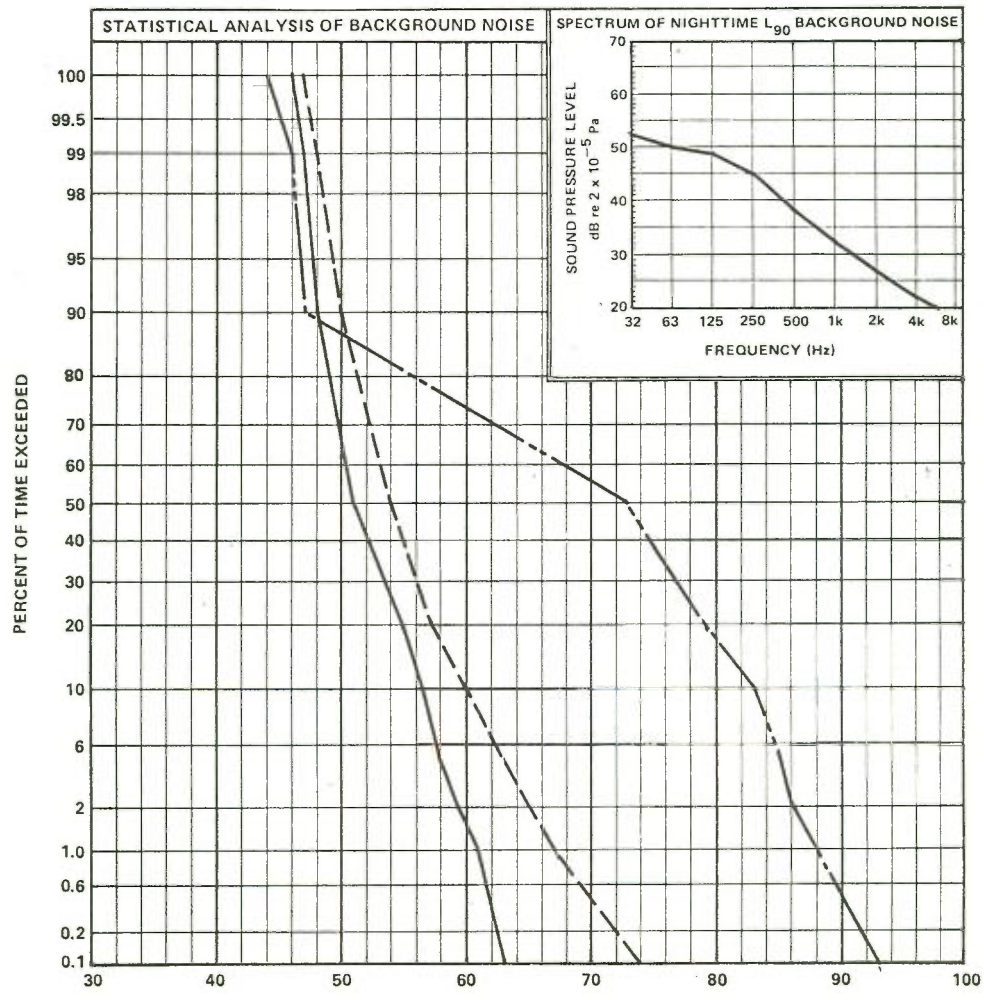


Leq 75.1 _____ 2258-2308 Hrs, Mon. 19/9/83:- TRAIN

AMBIENT SOUND LEVELS
POSITION B7 , UNANDERRA AREA
DAY TIME MEASUREMENTS

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Appendix No: 11.6





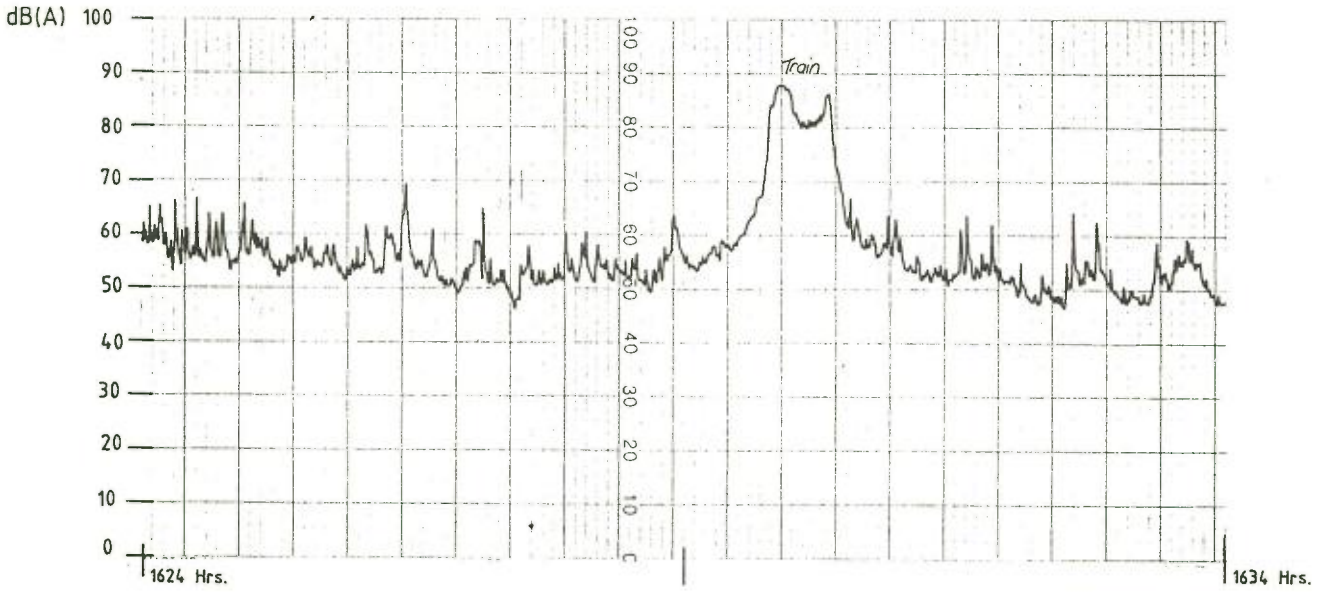
Leq 53.7 ———— 0132-0142 Hrs, Wed. 21/9/83:- MEDIUM TRAFFIC

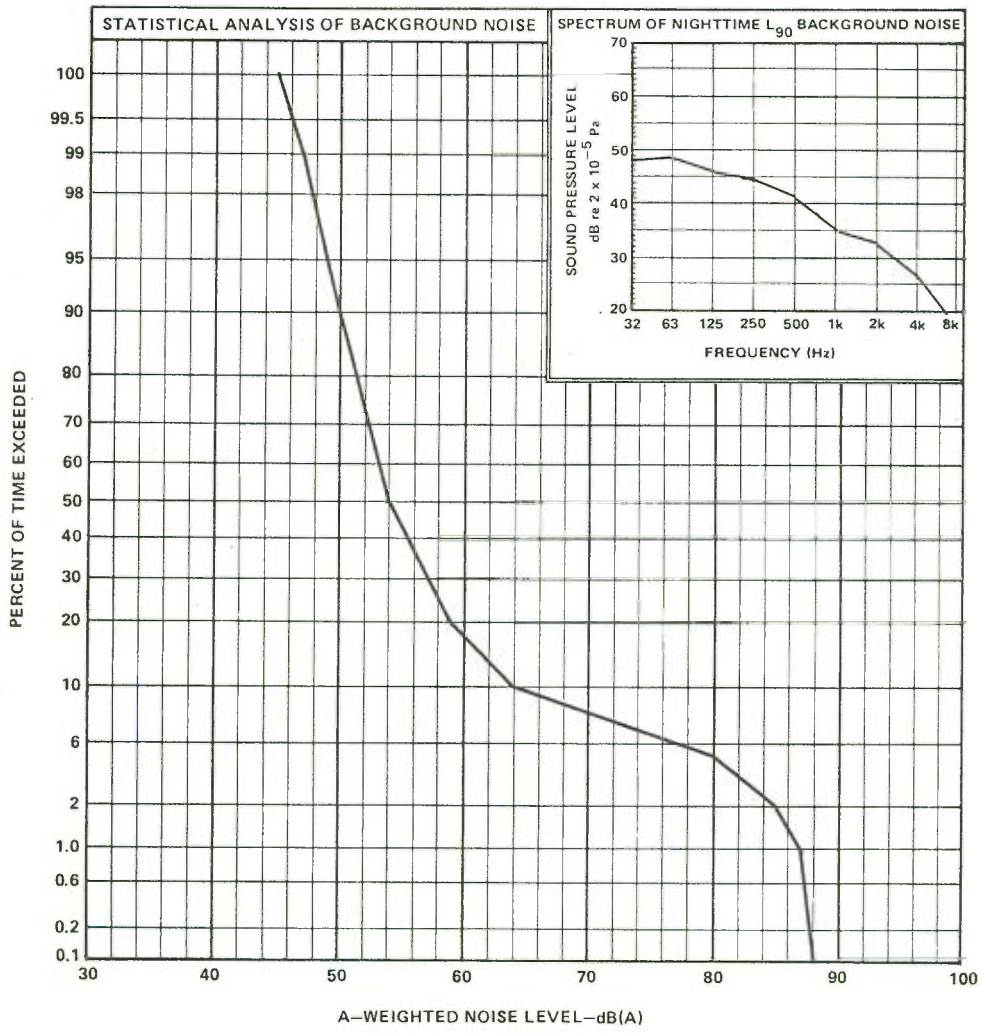
Leq 57.6 — — — — 0439-0449 Hrs, Wed, 21/9/83:- MEDIUM TRAFFIC

Leq 78.3 —— -- —— 0452-0502 Hrs, Wed. 21/9/83:- GOODS TRAIN IDLING IN STATION & GOODS TRAIN TO SOUTH

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Appendix No: 12

AMBIENT SOUND LEVELS
POSITION B8 , UNANDERRA AREA
DAY TIME MEASUREMENTS

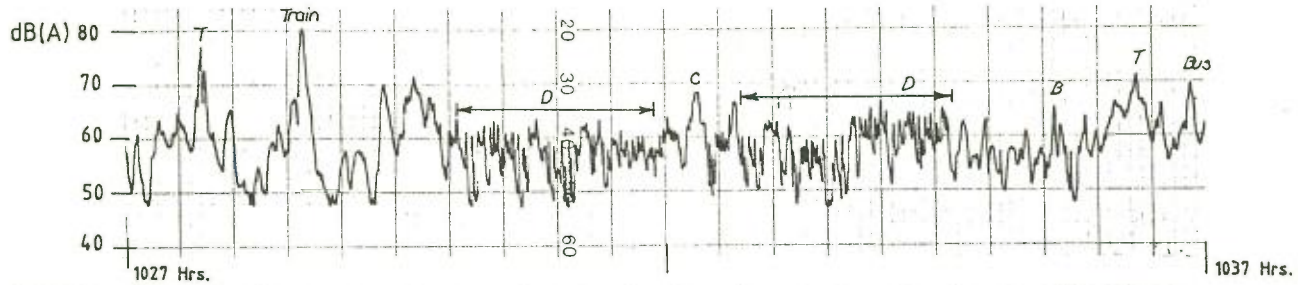


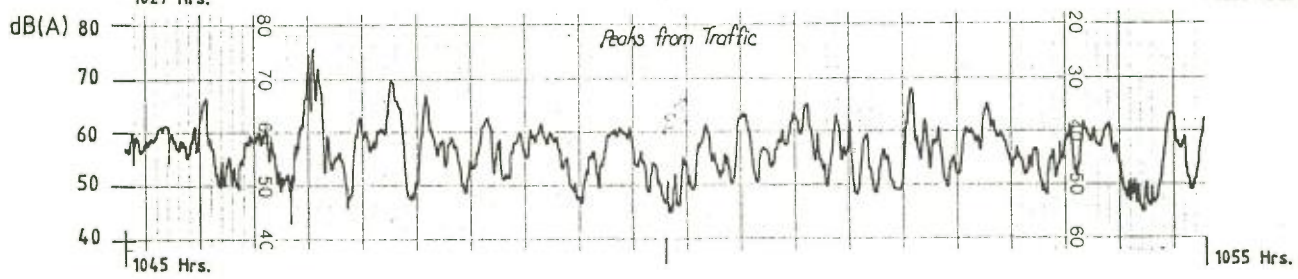


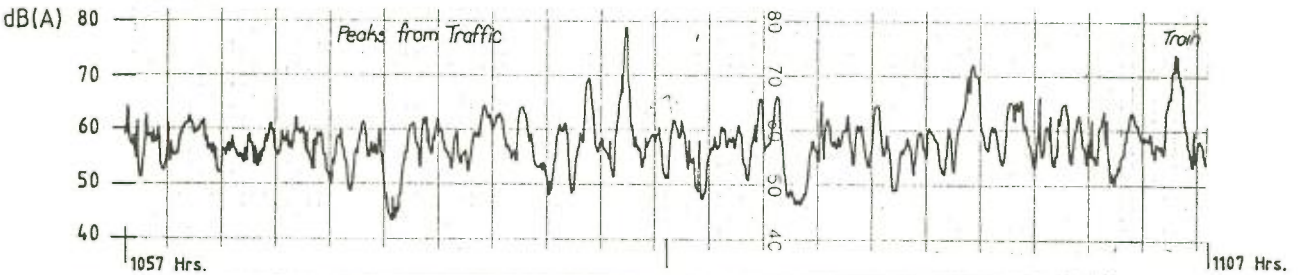
Leq 72 ———— 1624-1634 Hrs, Wed. 7/9/83:- GOODS TRAIN ON SOUTH LINE

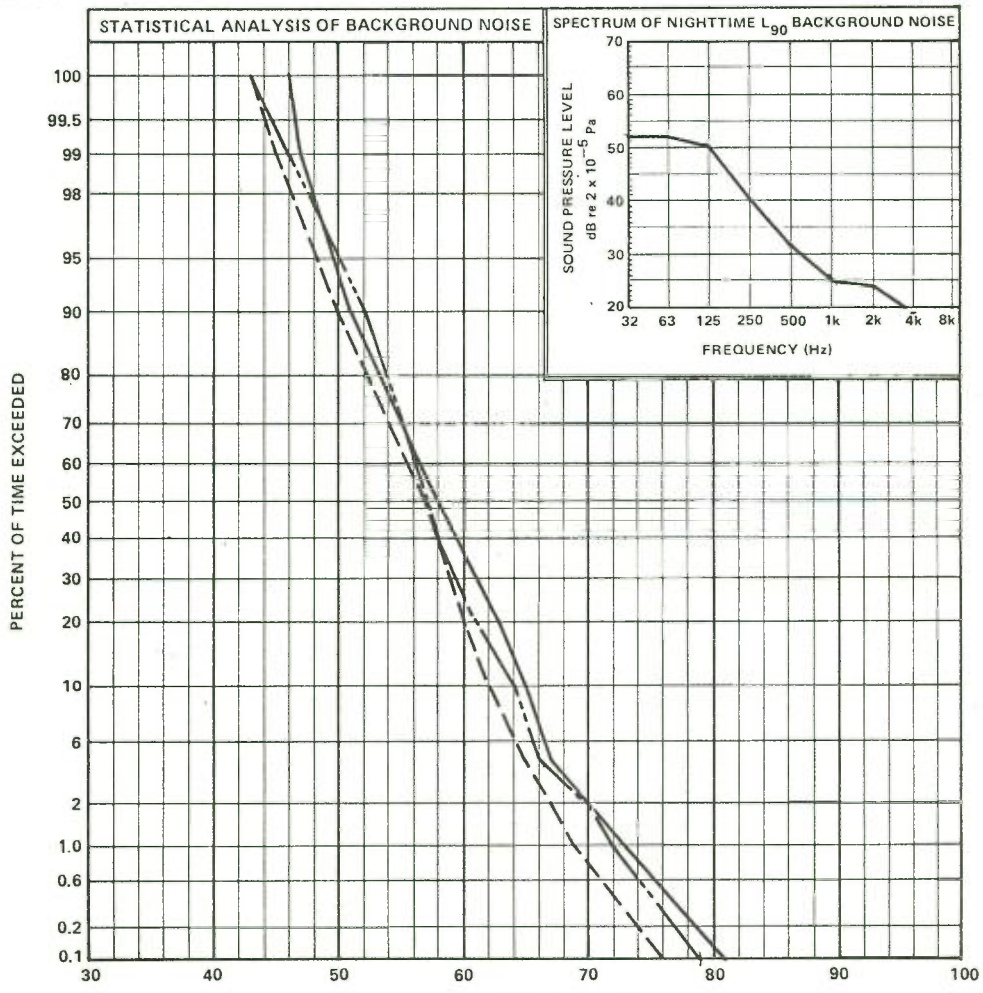
AMBIENT SOUND LEVELS
POSITION B9 , UNANDERRA AREA
DAY TIME MEASUREMENTS

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Appendix No: 13.1









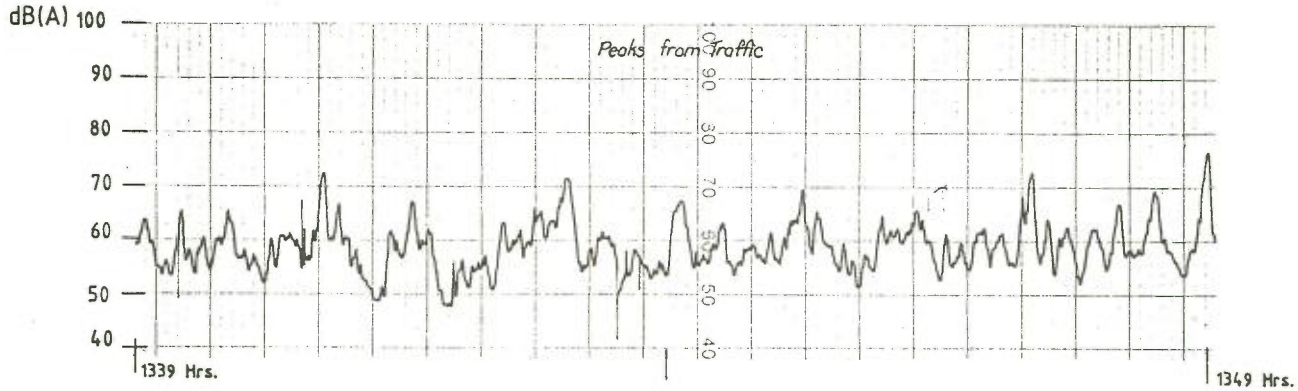
Leq 63 ———— 1027-1037 Hrs, Tues. 13/9/83:- PASSENGER TRAIN FROM SOUTH WITH 2 CARRIAGES, DOGS, TRUCKS, BUS

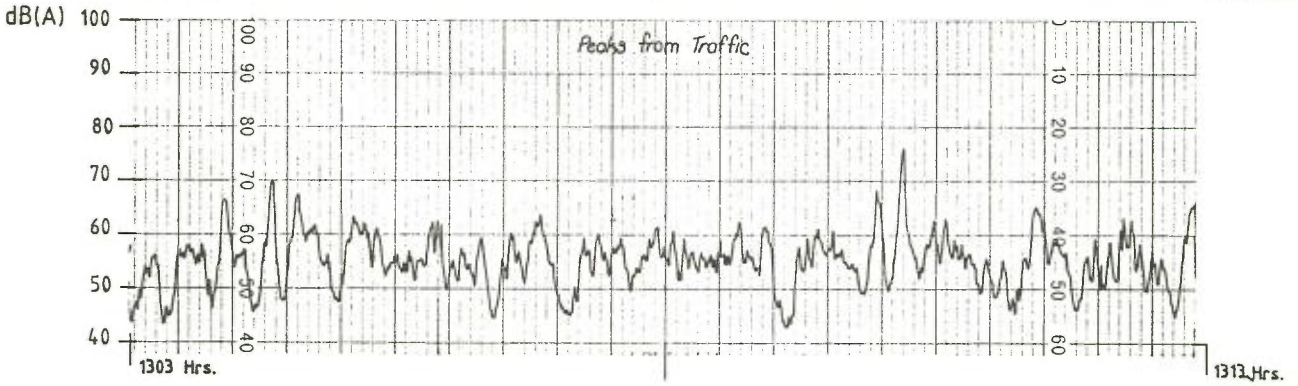
Leq 60 — — — — 1045-1055 Hrs, Tues. 13/9/83:- HEAVY TRAFFIC

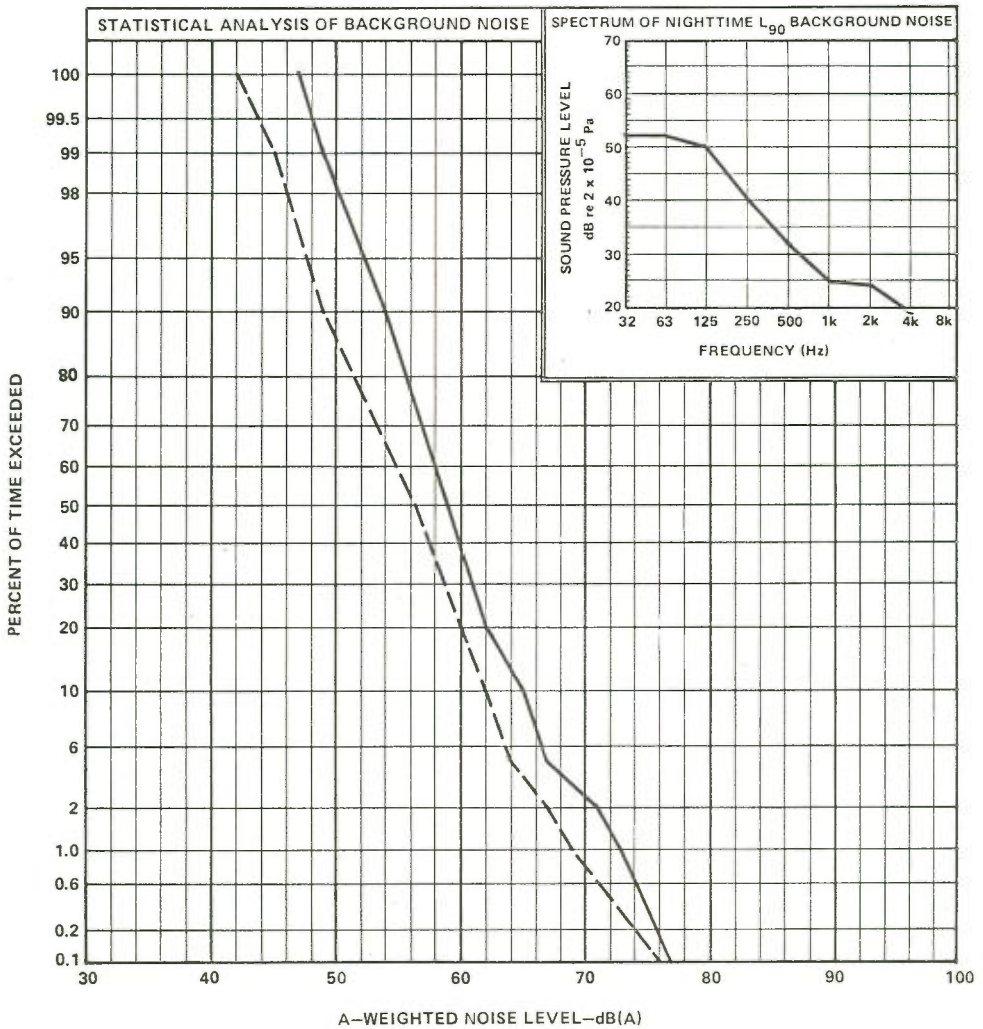
Leq 62 ——·—— 1057-1107 Hrs, Tues. 13/9/83:- TRAIN FROM SOUTH WITH 2 CARRIAGES TRAFFIC

AMBIENT SOUND LEVELS
POSITION B9 , UNANDERRA AREA
DAY TIME MEASUREMENTS

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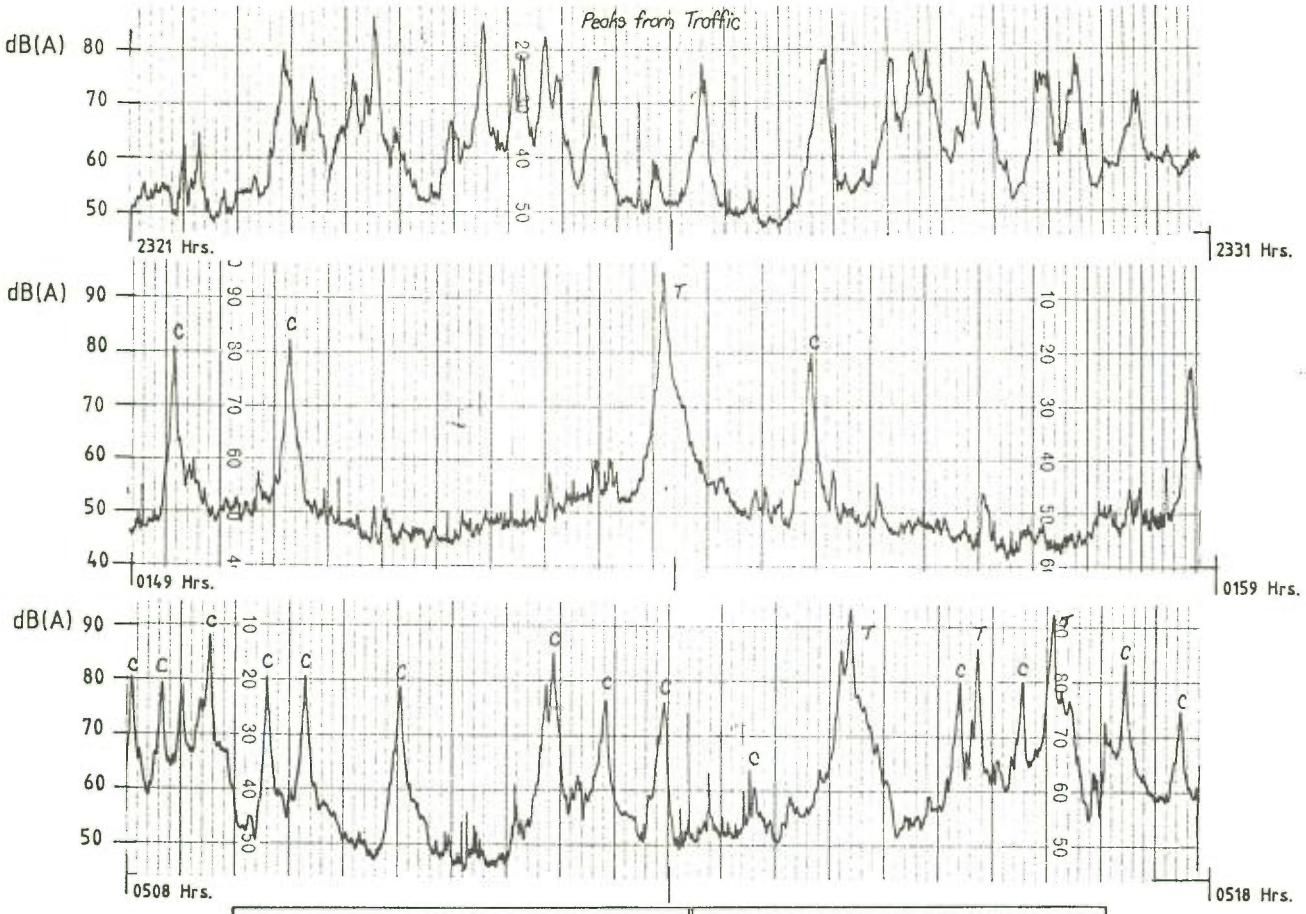


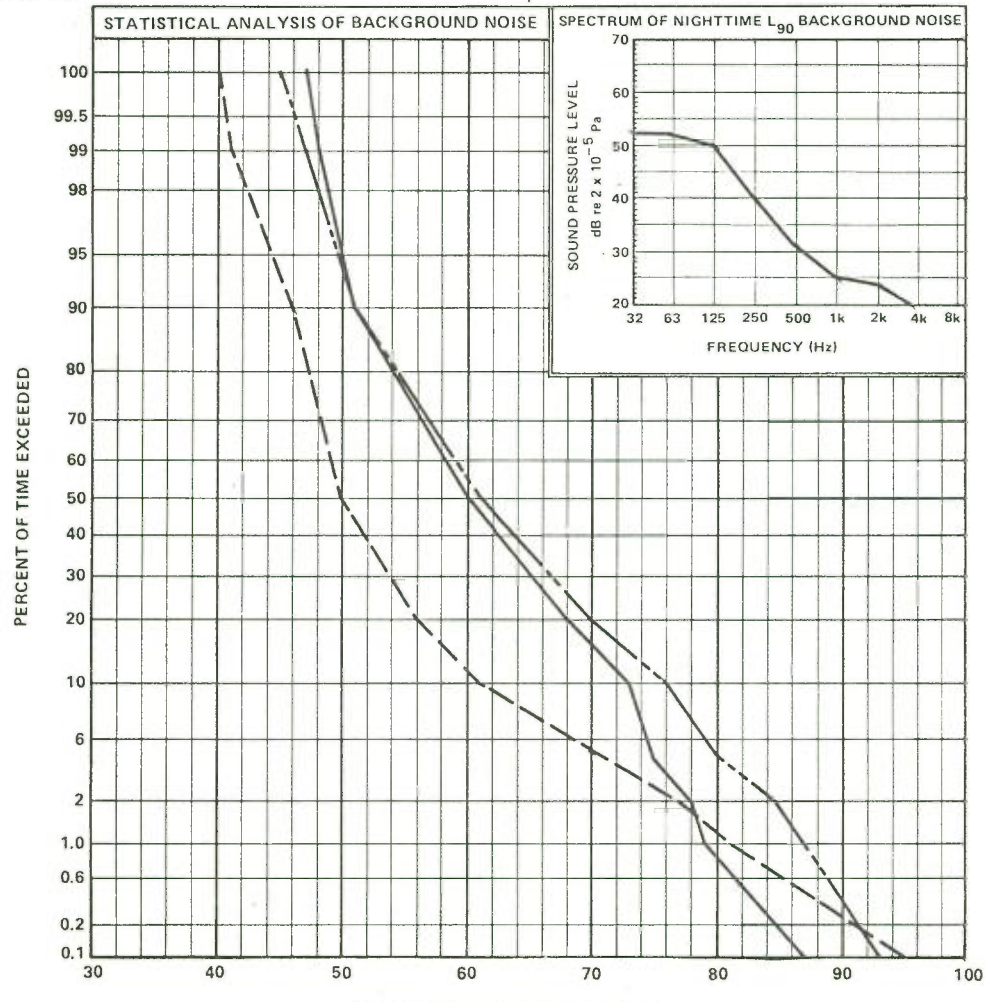
Leq 62 ———— 1339-1349 Hrs, Thur. 8/9/83:- TRAFFIC

Leq 62.3 — — — — 1303-1313 Hrs. Tue. 20/9/83:- TRAFFIC

AMBIENT SOUND LEVELS
POSITION B9 , UNANDERRA AREA
NIGHT TIME MEASUREMENTS

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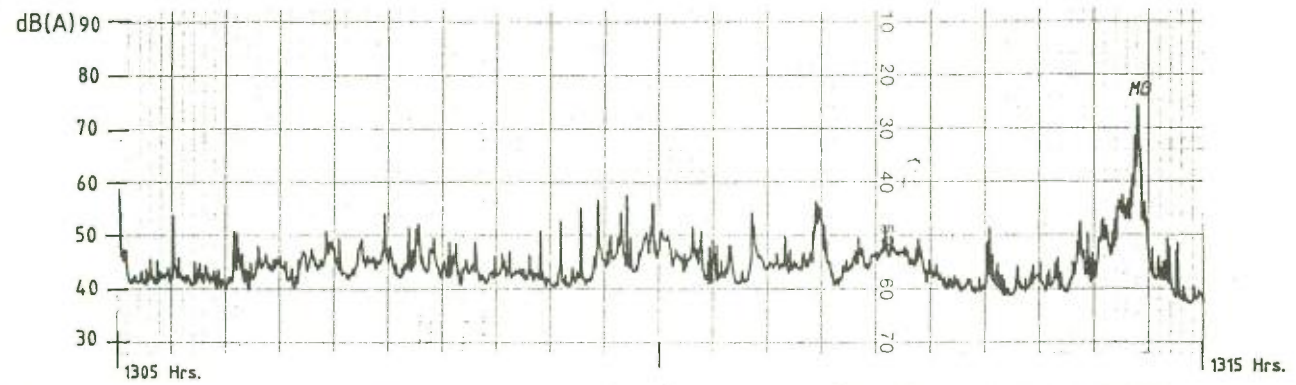
Leq 68.6 ———— 2321-2331 Hrs, Mon. 19/9/83:- MEDIUM TRAFFIC

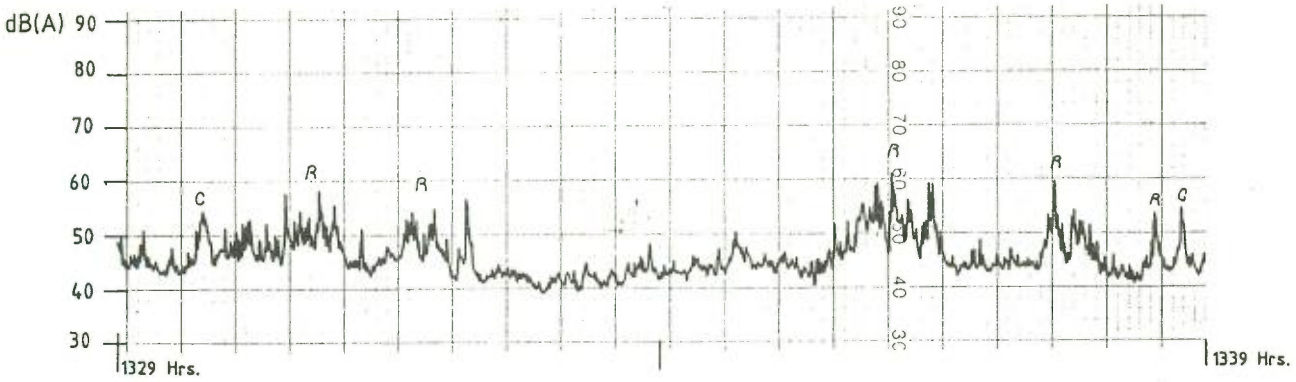
Leq 70.4 — — — — 0149-0159 Hrs, Wed. 21/9/83:- TRUCK, CARS

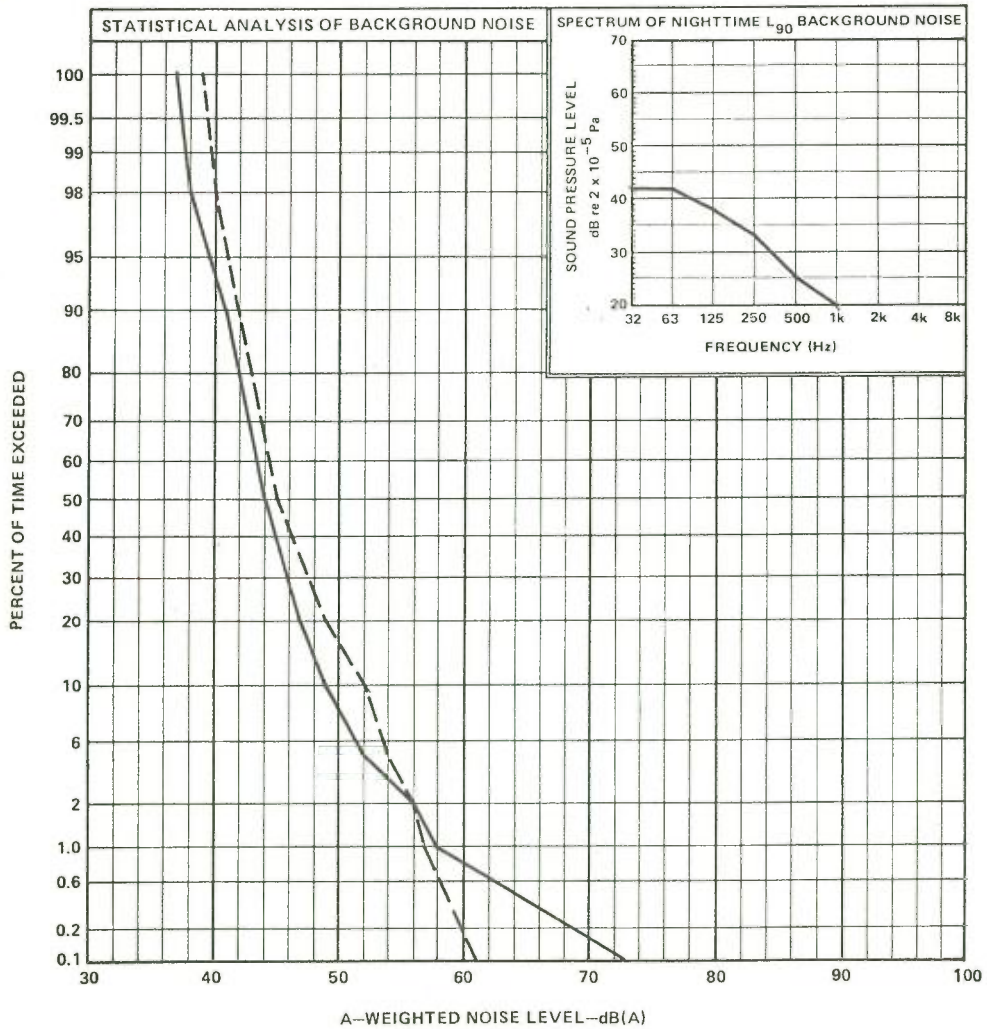
Leq 74 ——·—— 0508-0518 Hrs, Wed. 21/9/83:- MEDIUM TRAFFIC

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AMBIENT SOUND LEVELS
POSITION B10, UNANDERRA AREA
DAY TIME MEASUREMENTS





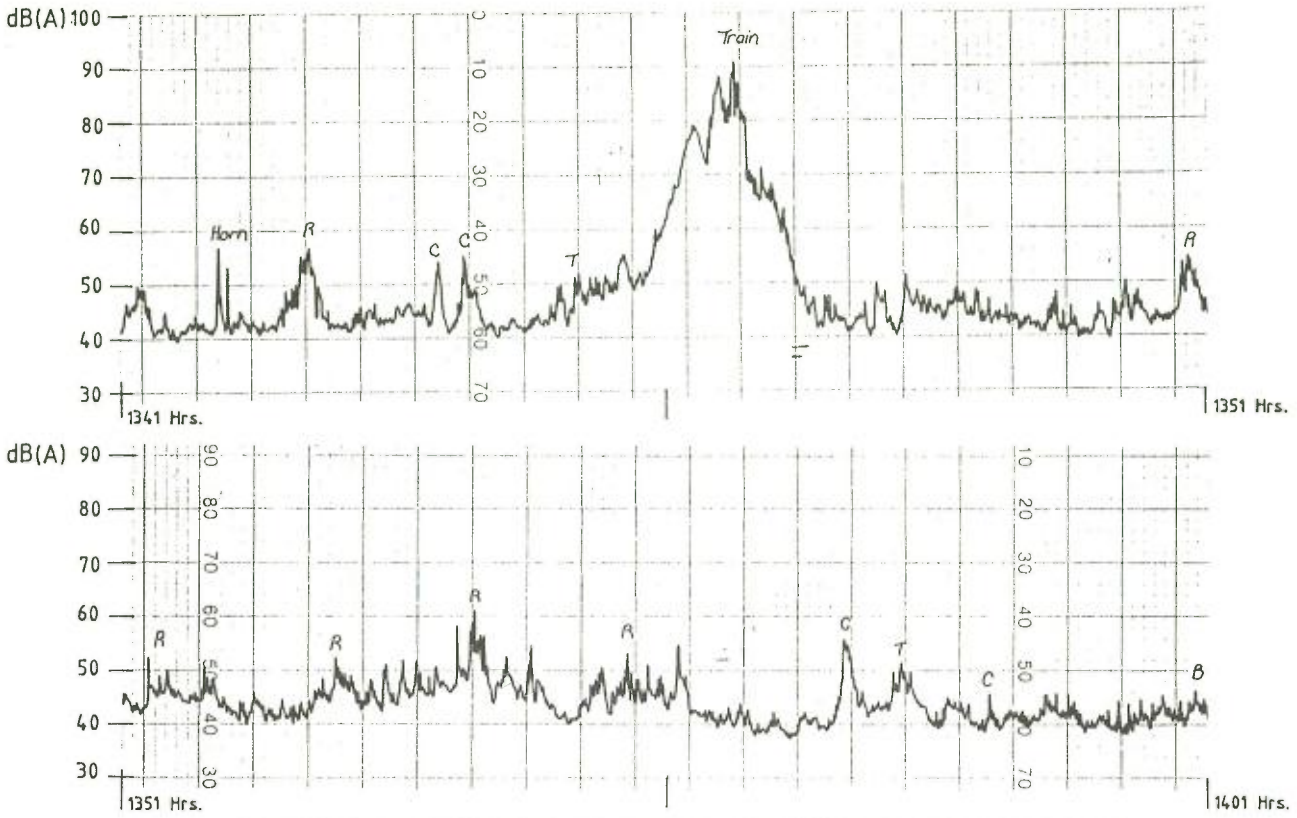


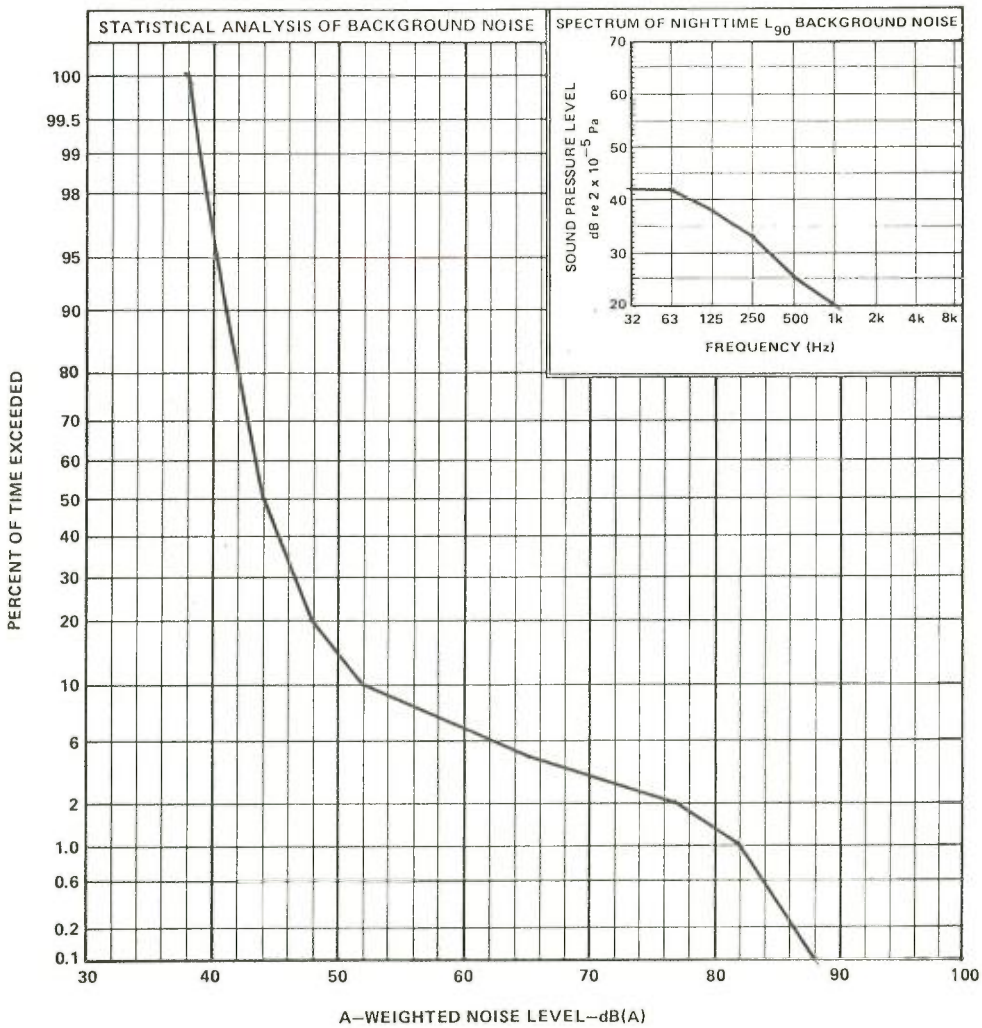
Leq 50 ———— 1305-1315 Hrs, Wed. 7/9/83:- 1 CAR, 1 BIKE, DISTANT TRAFFIC, WIND 10km/hr, RUSTLING LEAVES, BIRDS, DOG, HAMMERING

Leq 48 — — — — 1329-1339 Hrs, Wed. 7/9/83:- 2 CARS, DISTANT TRAFFIC, WIND 10-20 km/hr RUSTLING LEAVES, BIRDS, DOG

AMBIENT SOUND LEVELS
POSITION B10, UNANDERRA AREA
NIGHT TIME MEASUREMENTS

Report No: 4500-3-83
Appendix No: 14.2

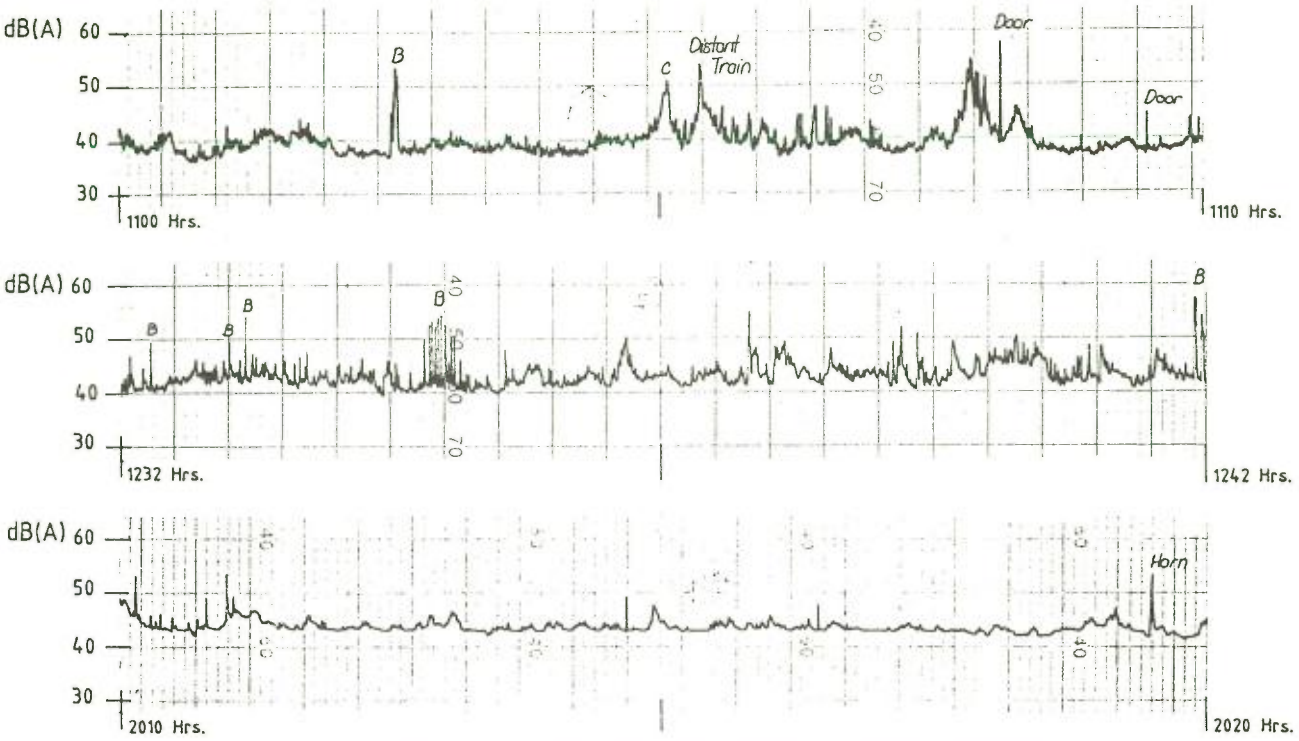


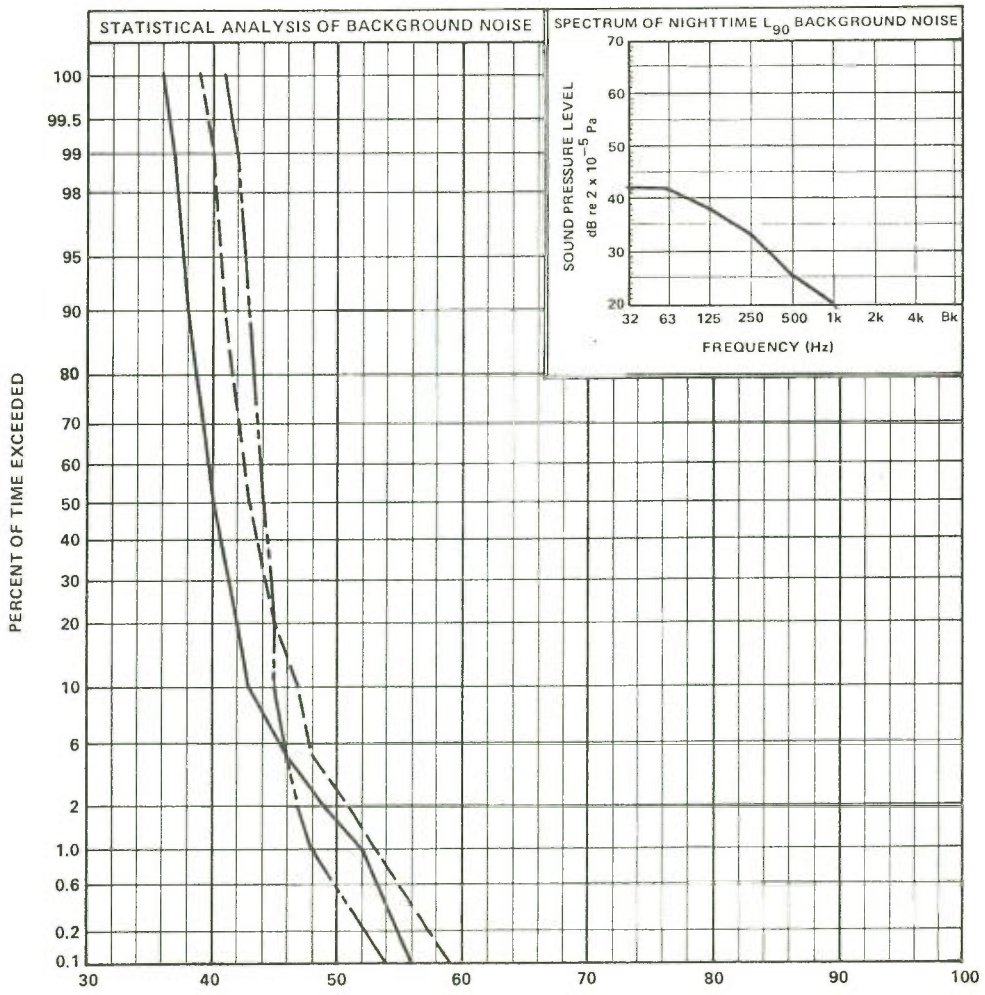


Leq 67 ——— 1341-1401 Hrs., Wed. 7/9/83:- TRAIN WITH 2 LOCOS & 19 CARRIAGES, 2 CARS, WIND 10-20 km/hr, RUSTLING LEAVES, BIRDS, HORN

AMBIENT SOUND LEVELS
POSITION B10, UNANDERRA AREA
DAY TIME MEASUREMENTS

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Appendix No: 14.3





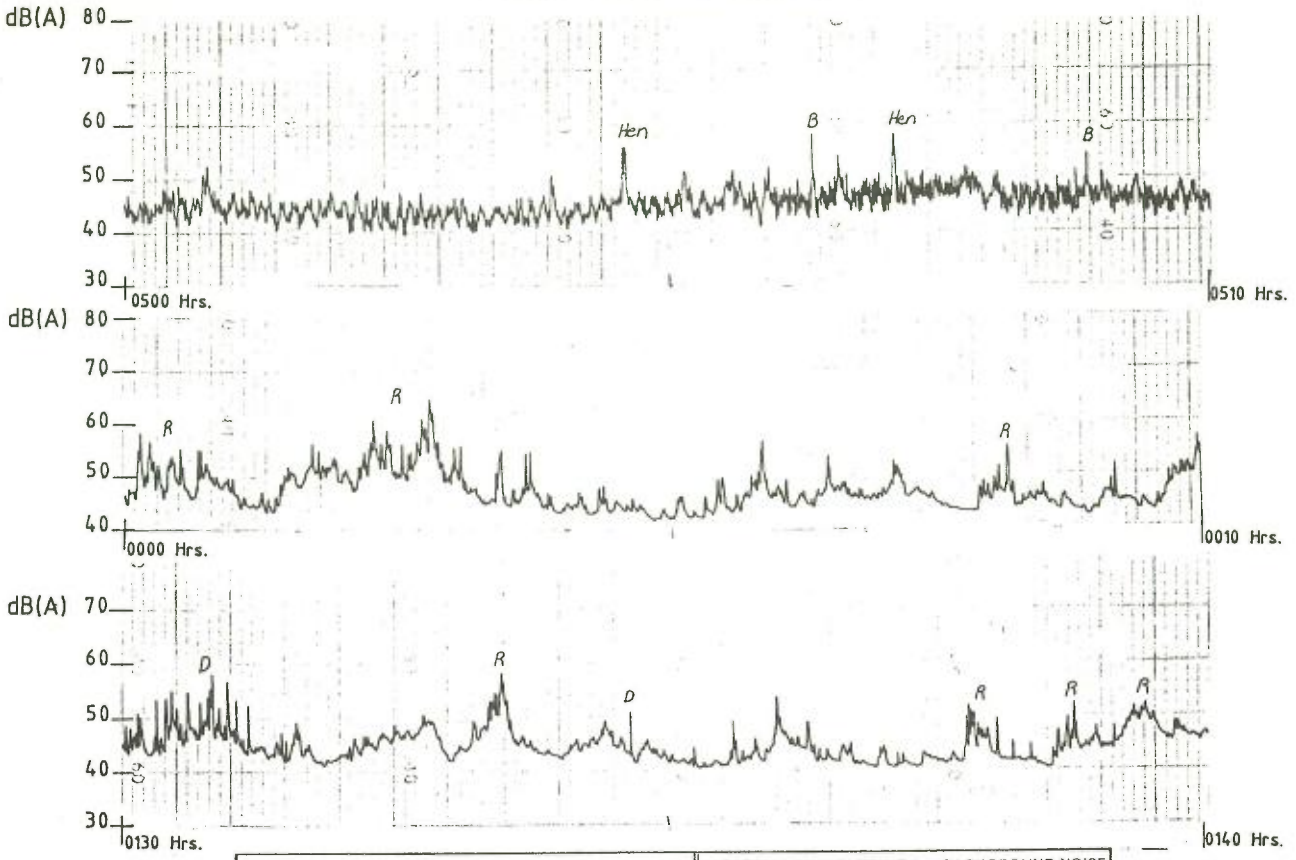
Leq 42 ———— 1100-1110 Hrs, Tues. 13/9/83:- 1 CAR, BIRDS, DOOR, DISTANT TRAIN

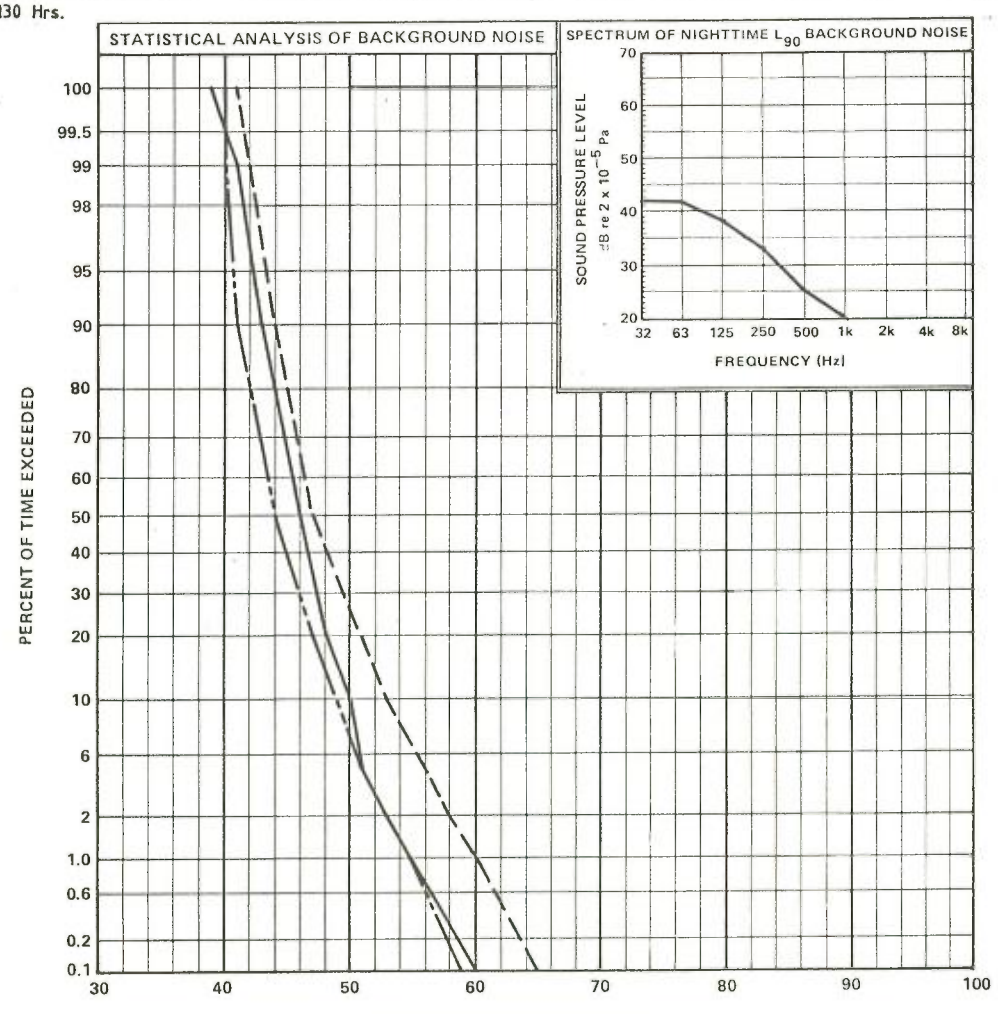
Leq 45 — — — — 1232-1242 Hrs, Sun. 18/9/83:- DISTANT TRAFFIC, 2 KNOTS WIND, RUSTLING LEAVES, BIRDS, DOG

Leq 44 ——- —— 2010-2020 Hrs, Sun, 18/9/83:- DISTANT TRAFFIC, HORN

AMBIENT SOUND LEVELS
POSITION B10, UNANDERRA AREA
NIGHT TIME MEASUREMENTS

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Appendix No: 14.4





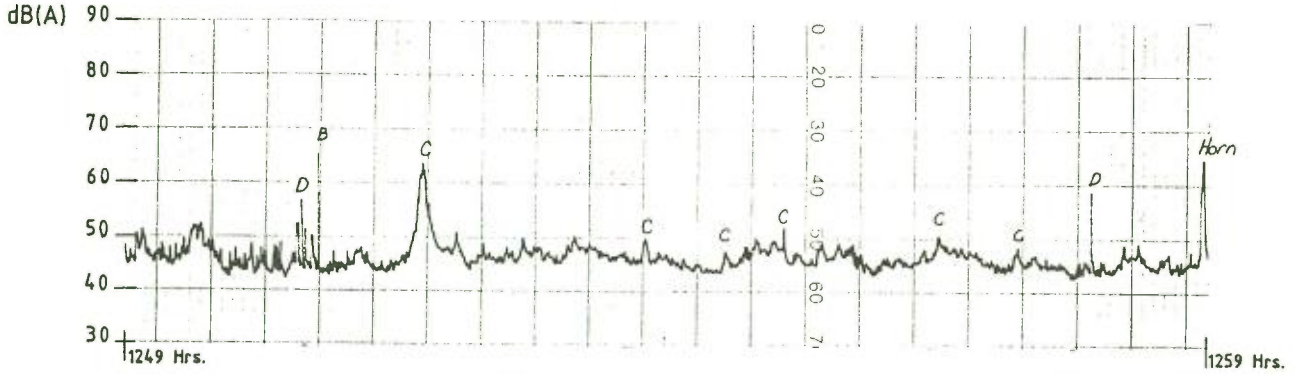
Leq 47 ———— 0500-0510 Hrs., Mon. 19/9/83:- BIRDS, HEN

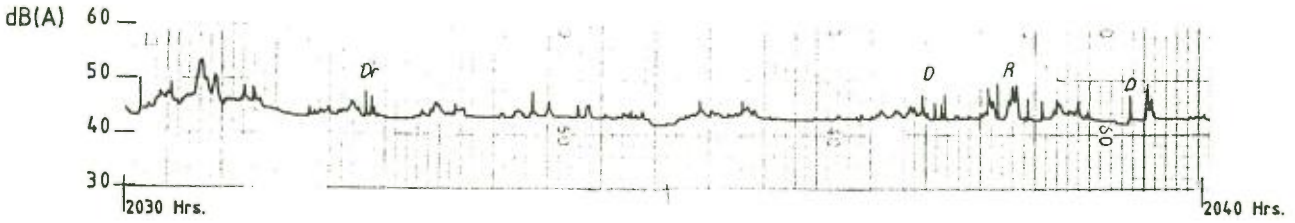
Leq 51 — — — — 0000-0010 Hrs., Tues. 20/9/83:- RUSTLING LEAVES. DOG

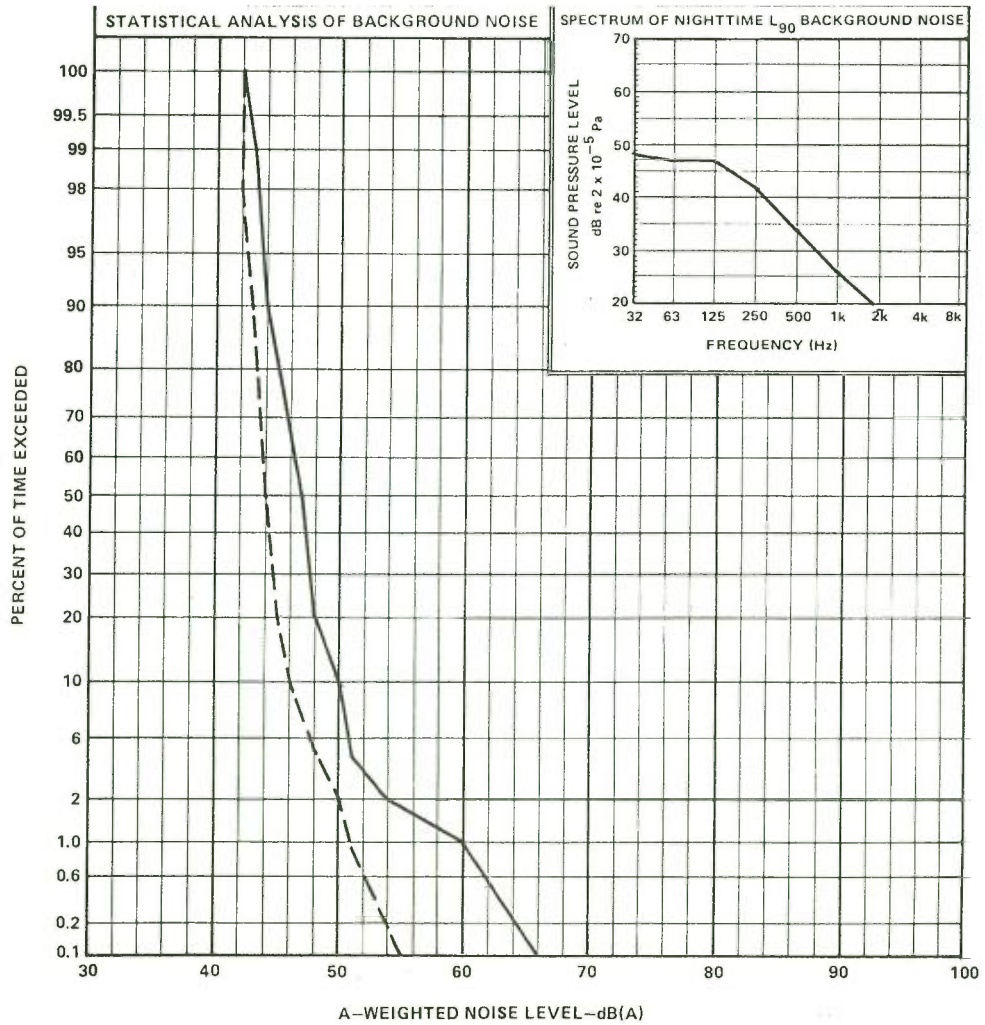
Leq 47 —— -- —— 0130-0140 Hrs., Tues. 20/9/83:- RUSTLING LEAVES. DOG

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Appendix No: 15.1

AMBIENT SOUND LEVELS
POSITION B11, UNANDERRA AREA
DAY TIME MEASUREMENTS





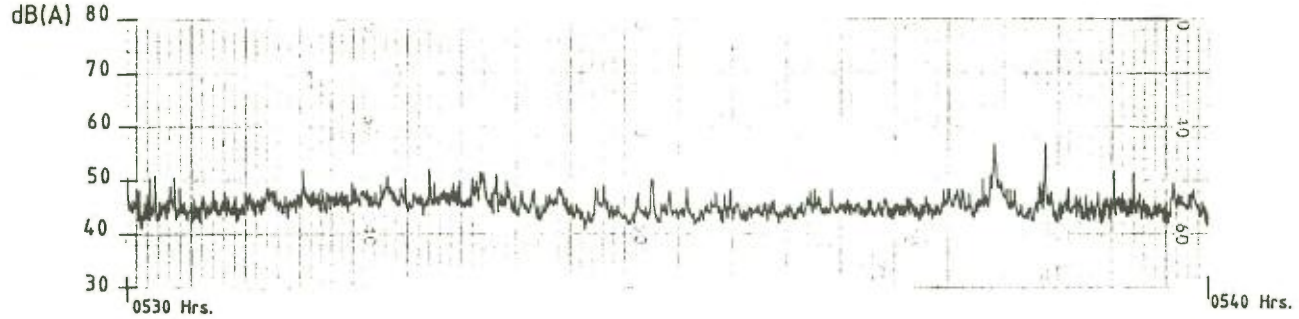


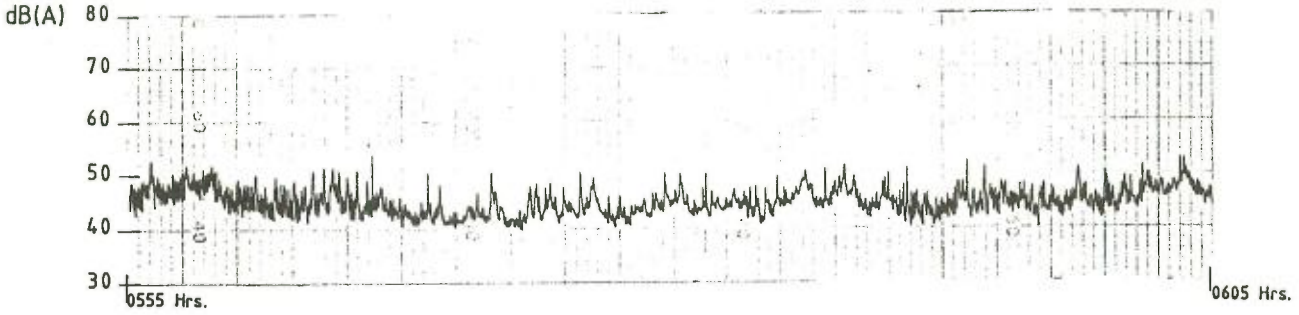
Leq 49 ———— 1249-1259 Hrs., Sun. 18/9/83:- DISTANT TRAFFIC. BIRDS. DOG. HORN. LIGHT WIND.

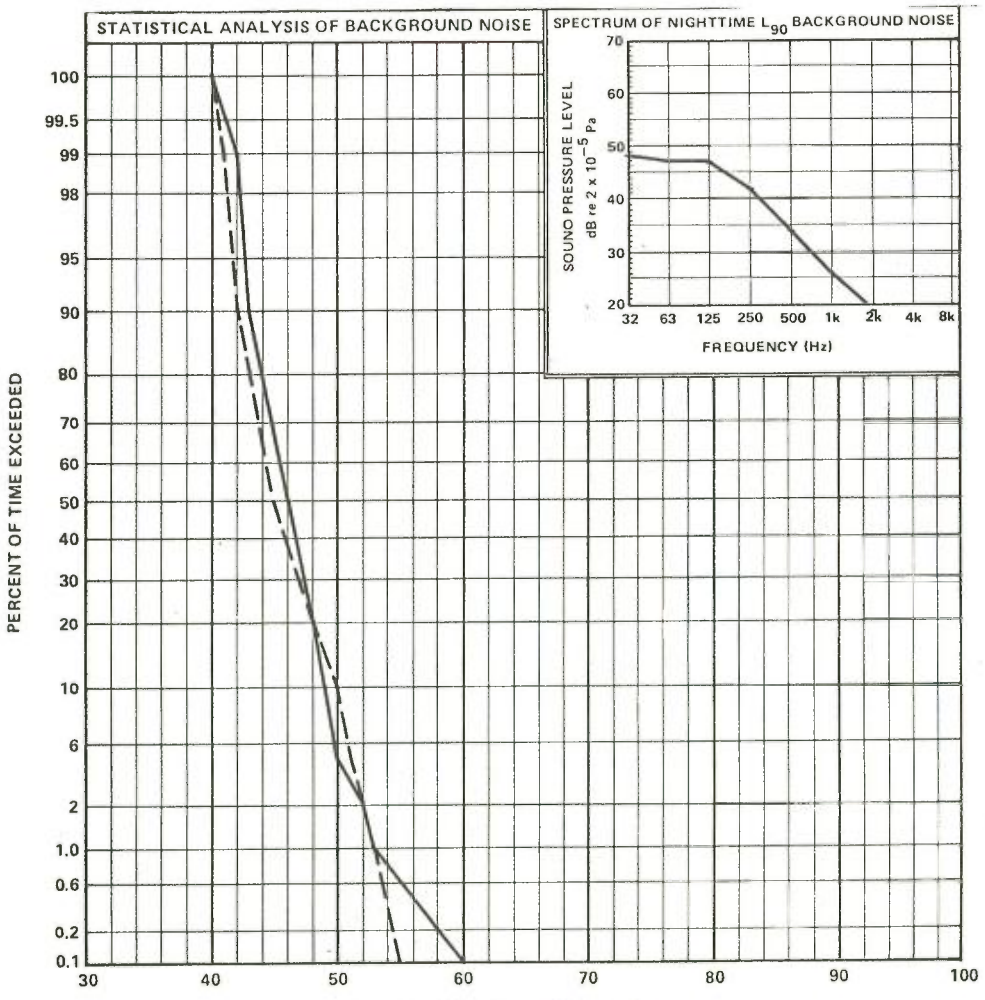
Leq 45 — — — — 2030-2040 Hrs., Sun. 18/9/83:- DISTANT TRAFFIC. DOG.

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AMBIENT SOUND LEVELS
POSITION B11, UNANDERRA AREA
NIGHT TIME MEASUREMENTS





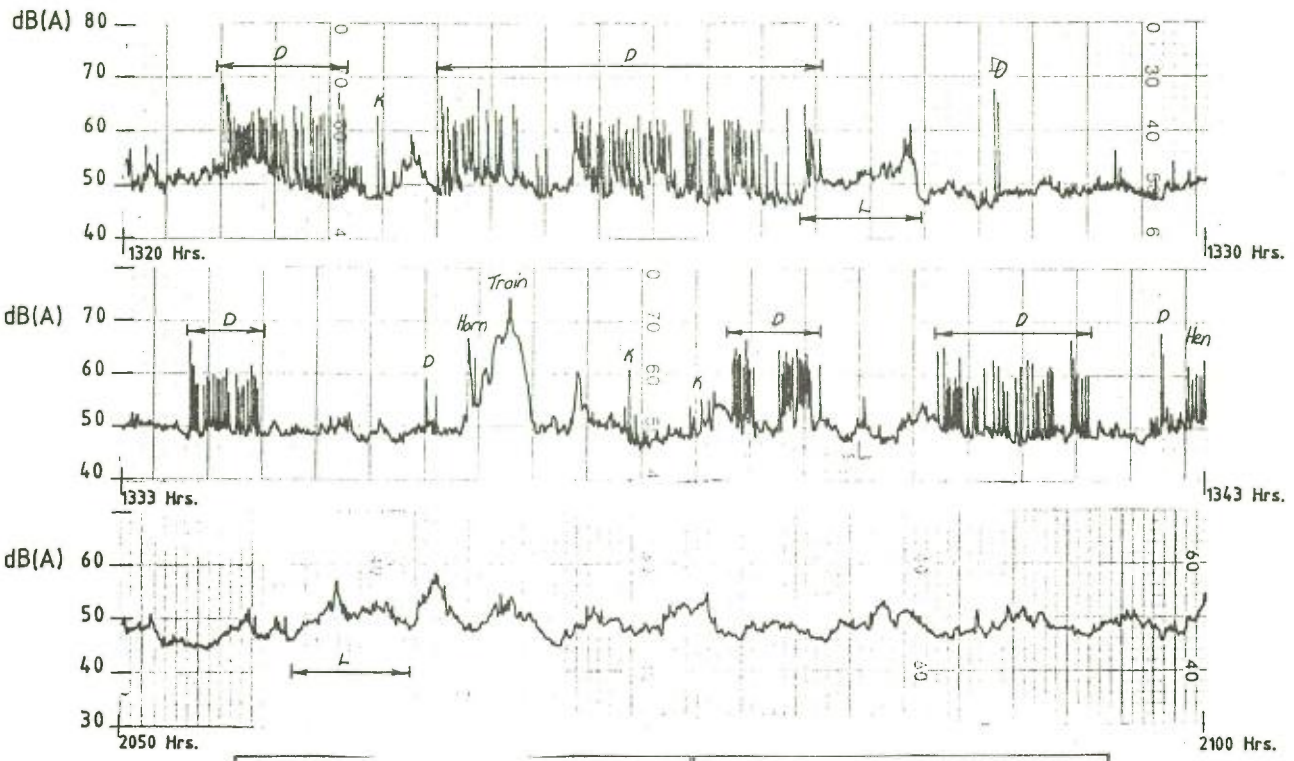


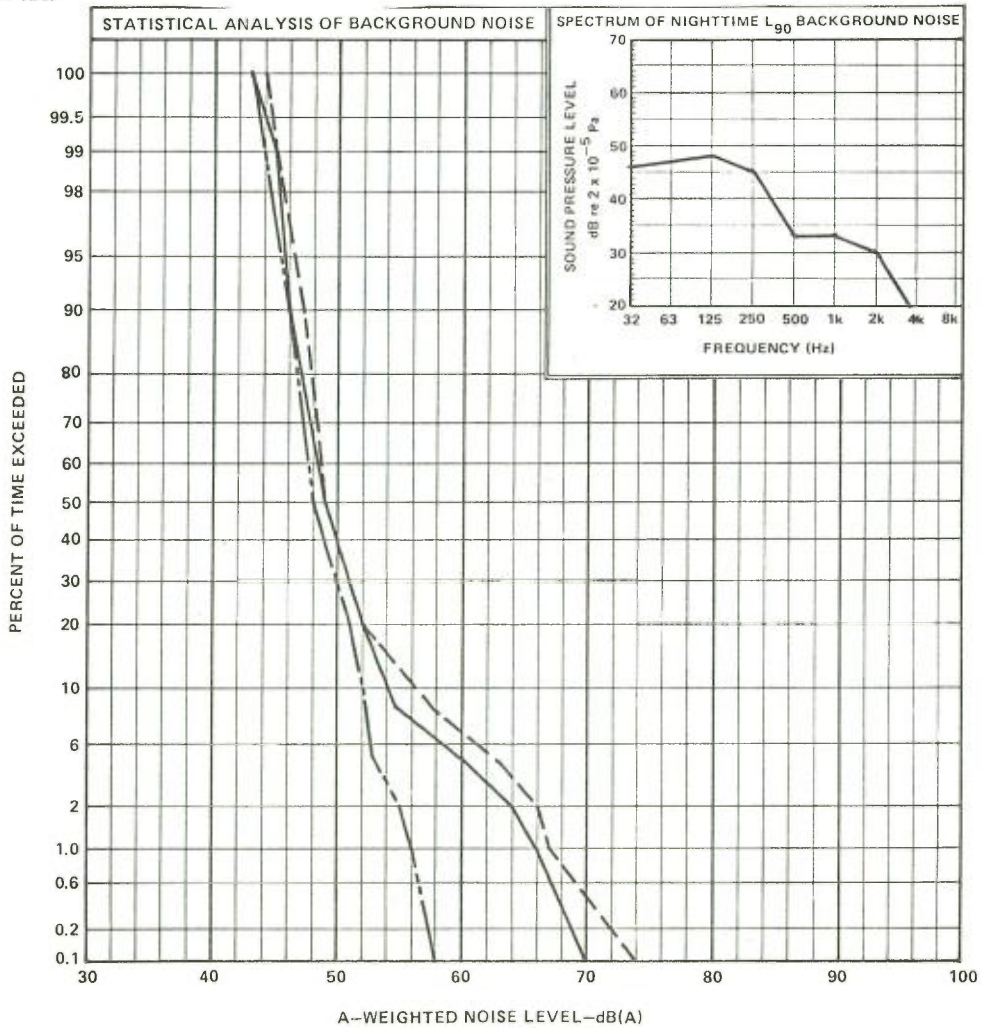
Leq 47 ———— 0530-0540 Hrs., Mon. 19/9/83:- DISTANT TRAFFIC. DOG. BIRDS. HEN LIGHT WIND N.W.

Leq 47 — — — — 0555-0605 Hrs., Mon. 19/9/83:- DISTANT TRAFFIC. BIRDS. DOG. HEN. LIGHT WIND N.W.

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AMBIENT SOUND LEVELS
POSITION B12, UNANDERRA AREA
DAY TIME MEASUREMENTS





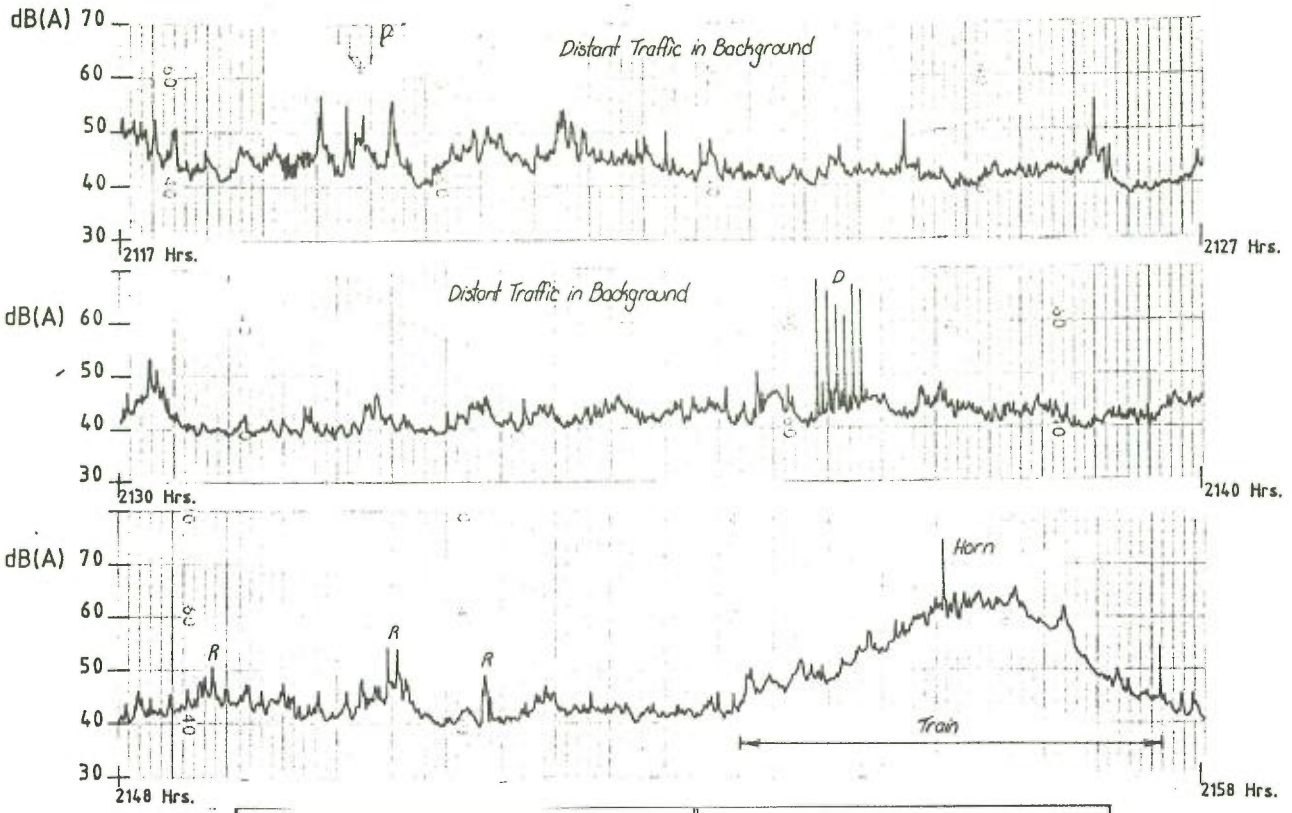
Leq 54 ———— 1320-1330 Hrs., Sun. 18/9/83:- DISTANT TRAFFIC. LIGHT PLANE. BIRDS. DOGS. CHILDREN.

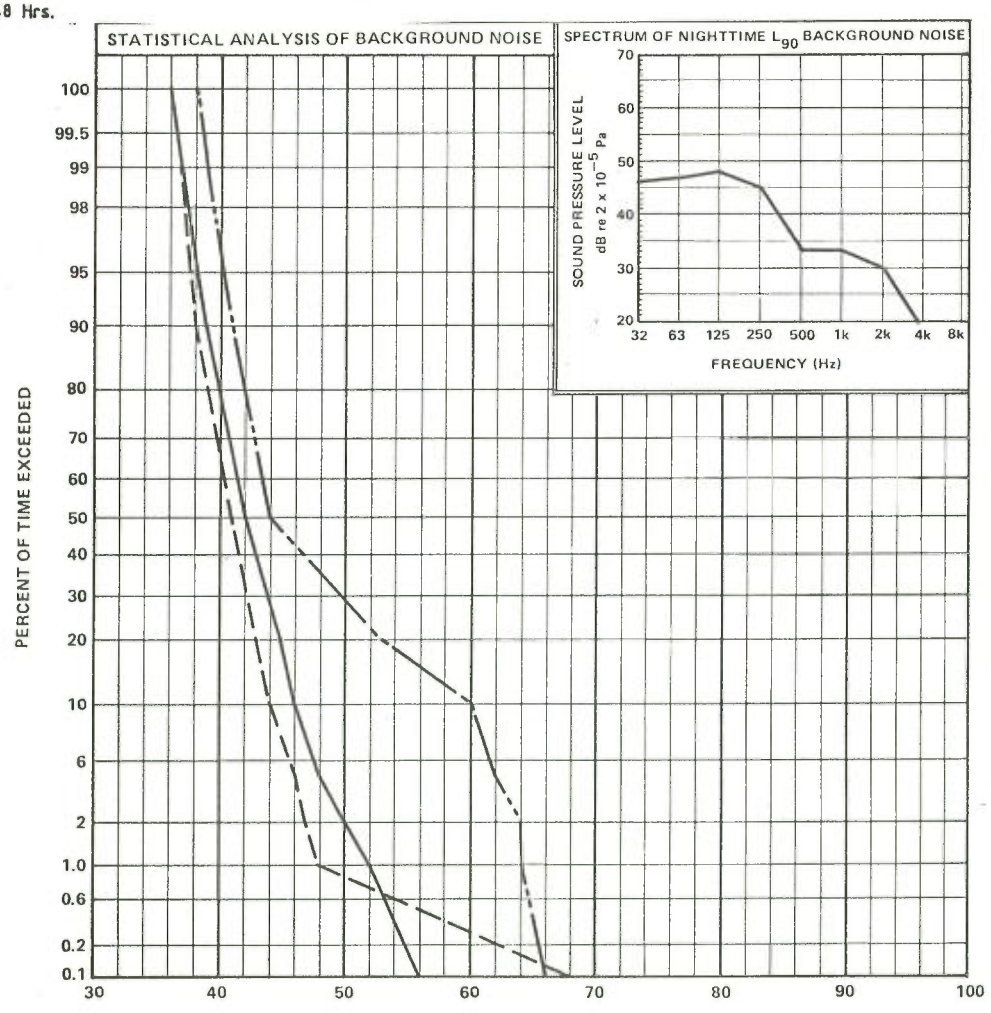
Leq 56 — — — — 1333-1343 Hrs., Sun. 18/9/83:- TRAIN ON SOUTHERN LINE, 1 LOCO, 4 CARRIAGE DISTANT TRAFFIC. 2 LIGHT PLANES. CHILDREN. DOG. BIRDS. DOOR CLOSING.

Leq 49 ——·——· 2050-2100 Hrs., Sun. 18/9/83:- DISTANT TRAFFIC. 2 LIGHT PLANES. INSECTS INDUSTRY (AIS).

AMBIENT SOUND LEVELS
POSITION B12, UNANDERRA AREA
DAY TIME MEASUREMENTS

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Appendix No: 16.2





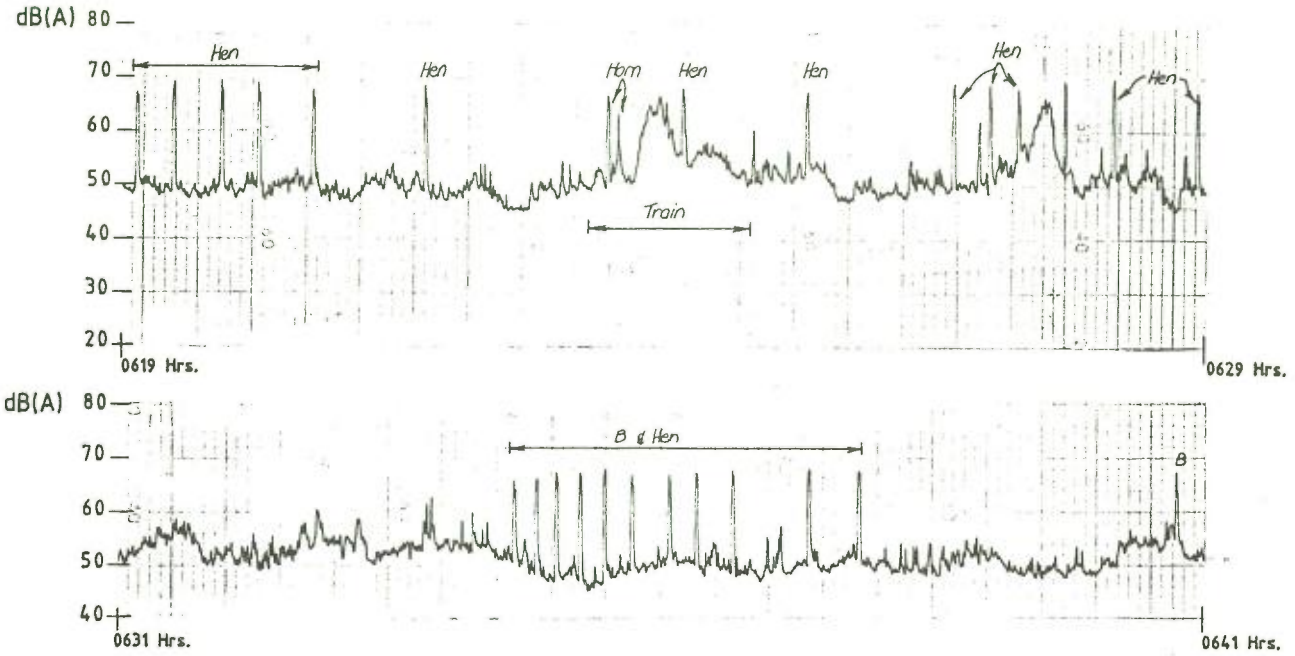
Leq 44 ———— 2117-2127 Hrs., Mon. 19/9/83:- DISTANT TRAFFIC. RUSTLING LEAVES. DOG. LIGHT WIND.

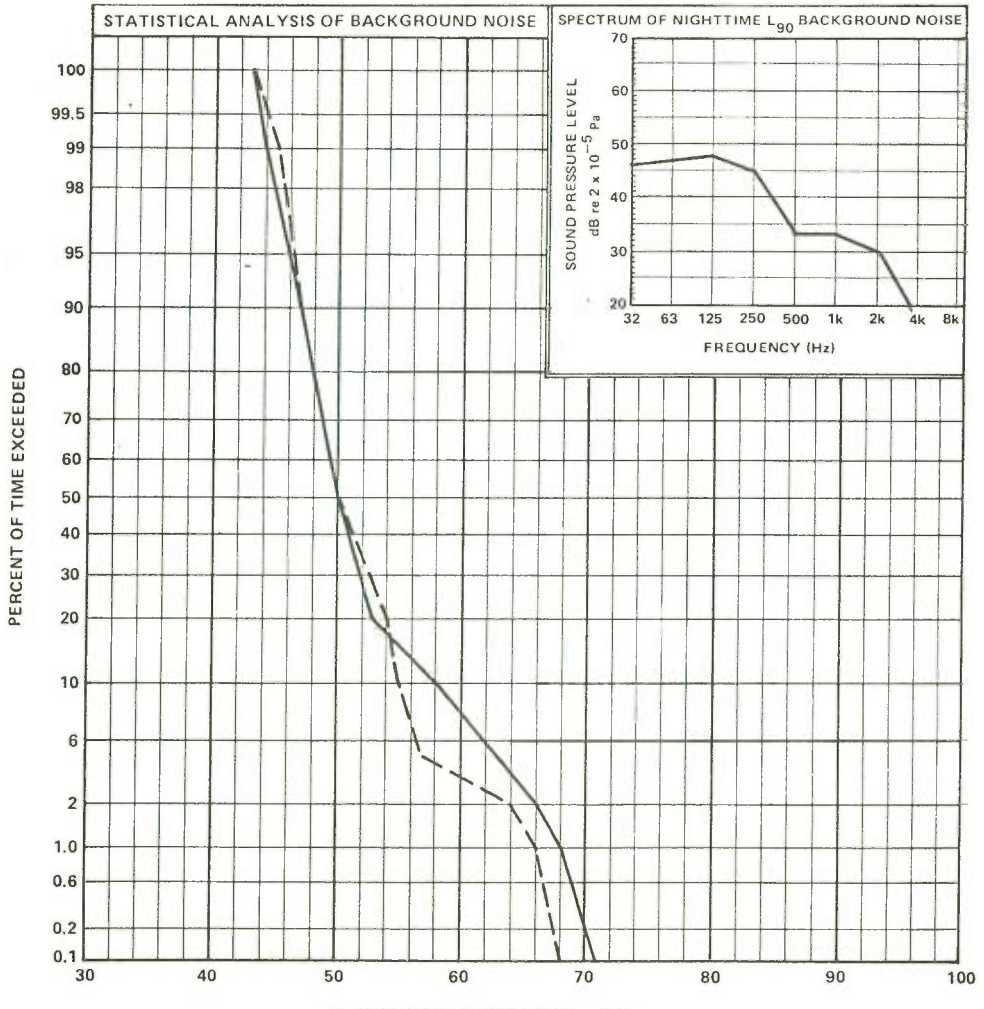
Leq 46 — — — — 2130-2140 Hrs., Mon. 19/9/83:- DISTANT TRAFFIC. 2 LIGHT PLANES. DOG. RUSTLING LEAVES. LIGHT WIND.

Leq 54 ——--—— 2148-2158 Hrs., Mon. 19/9/83:- TRAIN ON SOUTHERN LINE. DISTANT TRAFFIC. RUSTLING LEAVES. LIGHT WIND.

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AMBIENT SOUND LEVELS
POSITION B12, UNANDERRA AREA
NIGHT TIME MEASUREMENTS



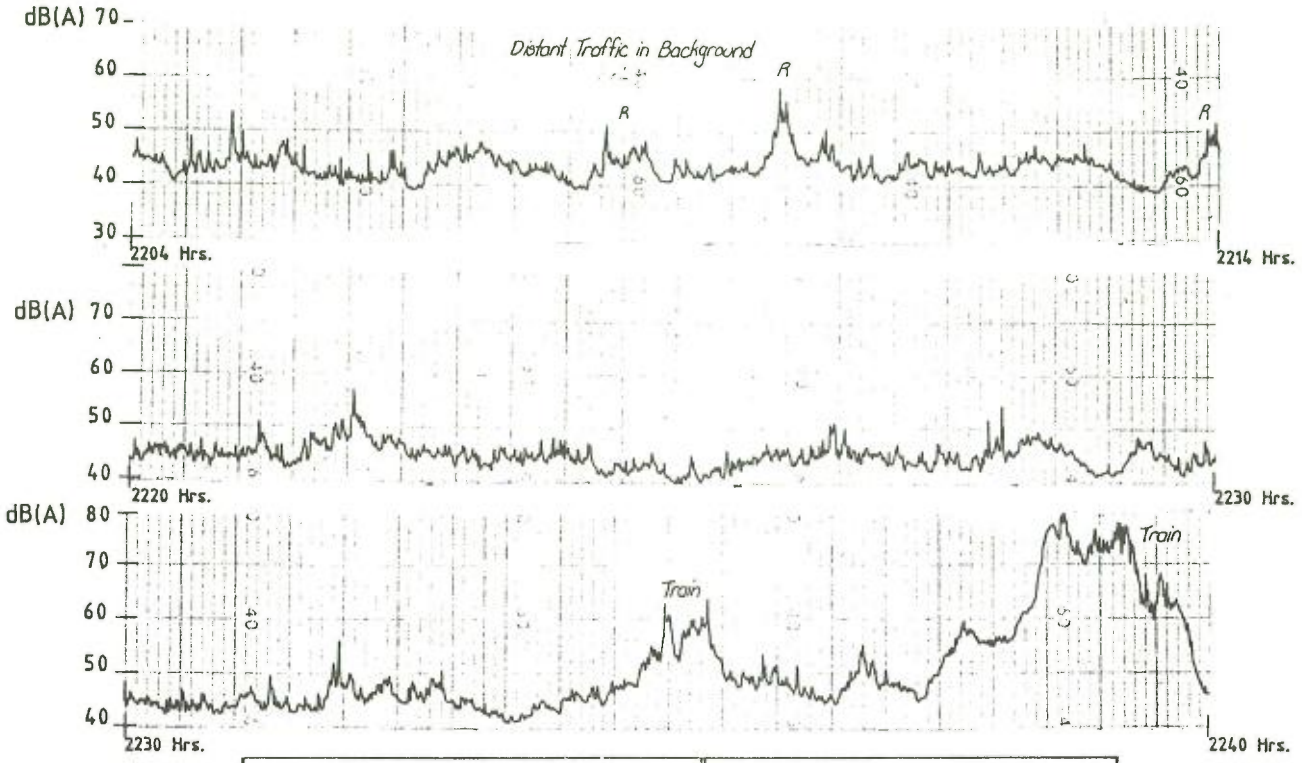


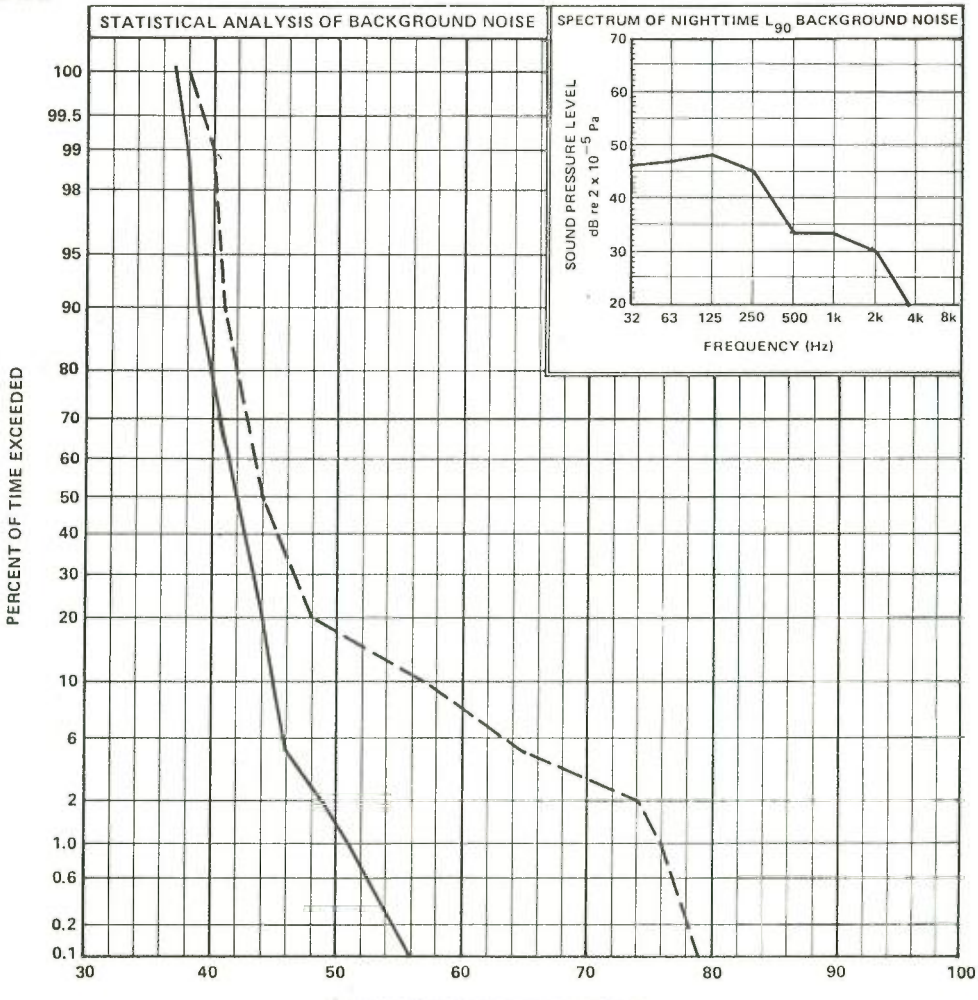
Leq 56 ———— 0619-0629 Hrs., Mon. 19/9/83:- TRAIN ON SOUTHERN LINE, 1 LOCO, 3 CARRIAGES DISTANT TRAFFIC. HEN. BIRDS. HORN. RUSTLING LEAVES.

Leq 54 — — — — 0630-0641 Hrs., Mon. 19/9/83:- DISTANT TRAFFIC. HEN. BIRDS. RUSTLING LEAVES.

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AMBIENT SOUND LEVELS
POSITION B12, UNANDERRA AREA
NIGHT TIME MEASUREMENTS



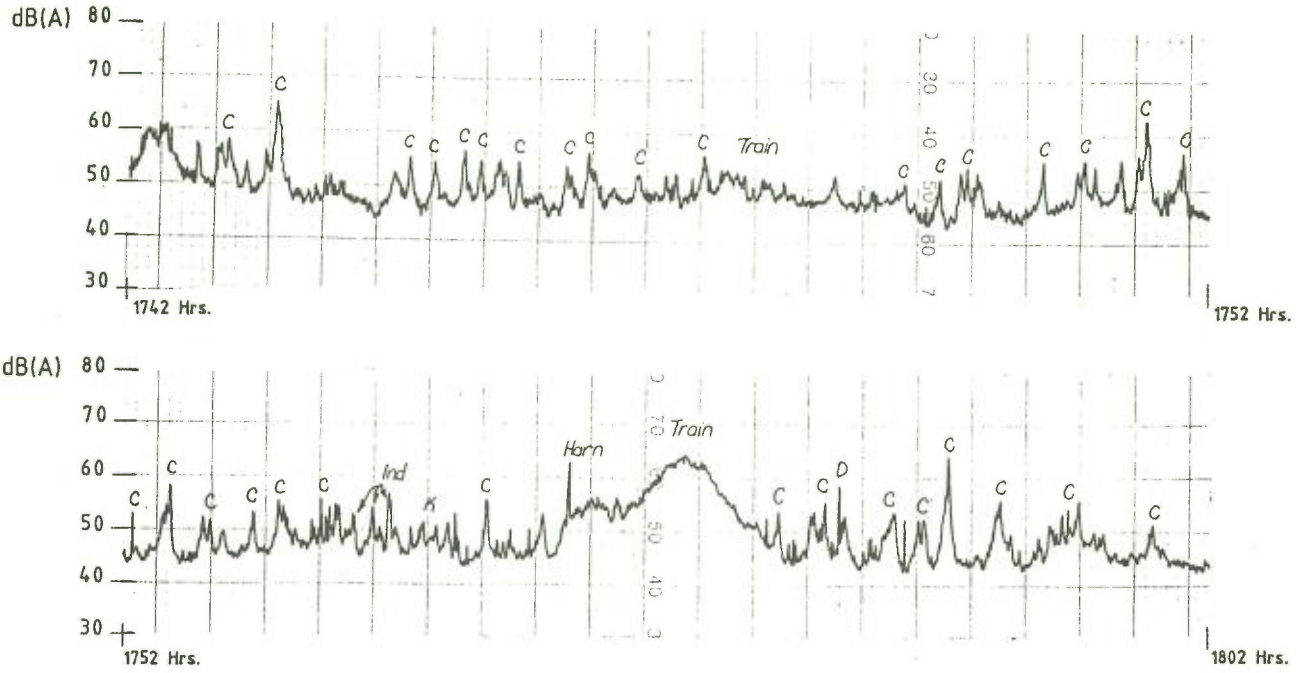


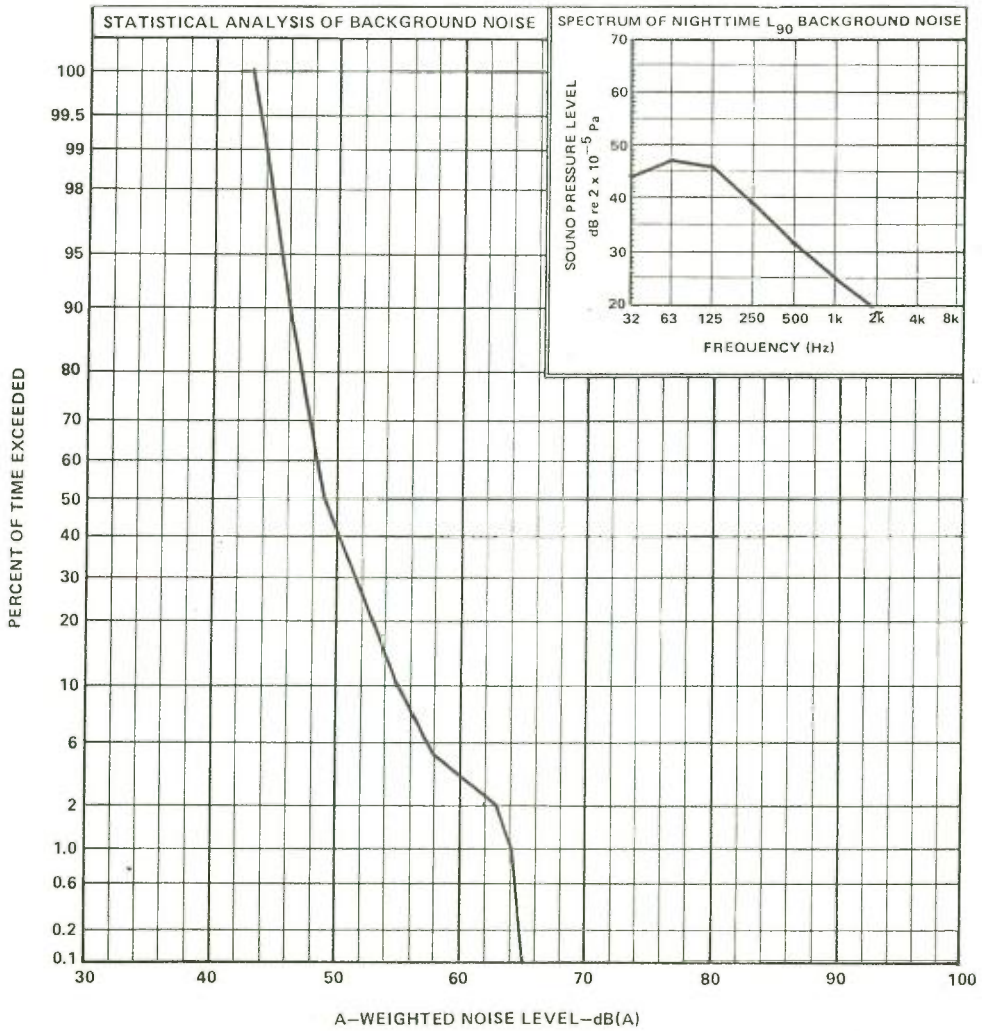
Leq 43 _____ 2204-2214 Hrs., Mon. 19/9/83:- DISTANT TRAFFIC. RUSTLING LEAVES. DOG. LIGHT WIND N.

Leq 61 _ _ _ _ _ 2220-2240 Hrs., Mon. 19/9/83:- TRAIN ON SOUTHERN LINE. TRAIN ON MOSS VALE LINE, 2 LOCOS, 21 CARRIAGES, 1 CABOOSE. RUSTLING LEAVES. LIGHT WIND.

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AMBIENT SOUND LEVELS
POSITION B13, UNANDERRA AREA
DAY TIME MEASUREMENTS

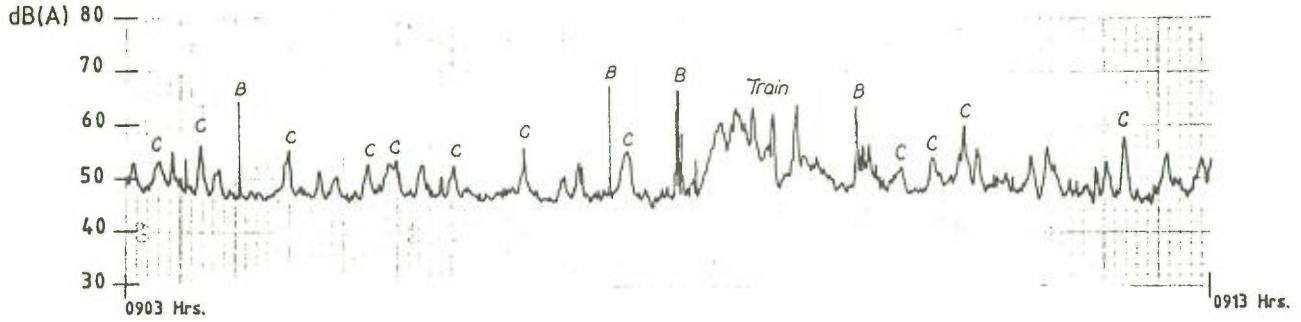


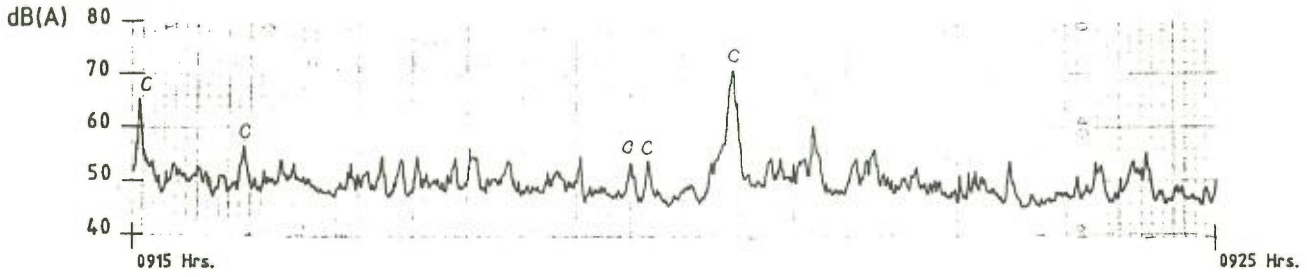


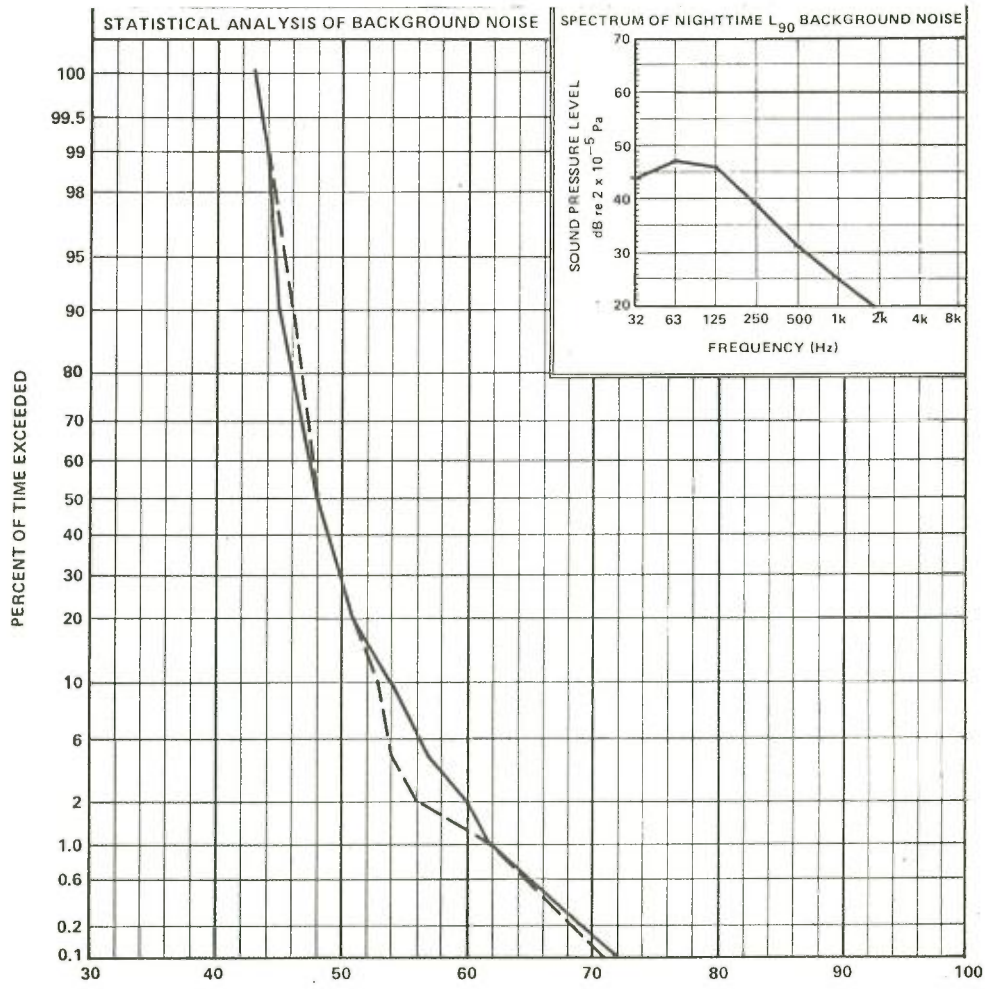
Leq 53 _____ 1742-1802 Hrs., Tues. 13/9/83:- TRAIN ON SOUTHERN LINE, 3 LOCOS, 24 CARRIAGES, 1 CABOOSE. PASSENGER TRAIN ON SOUTHERN LINE. LAWNMOWER. DOG. CHILDREN. HAMMER. INDUSTRIAL NOISE.

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AMBIENT SOUND LEVELS
POSITION B13, UNANDERRA AREA
DAY TIME MEASUREMENTS





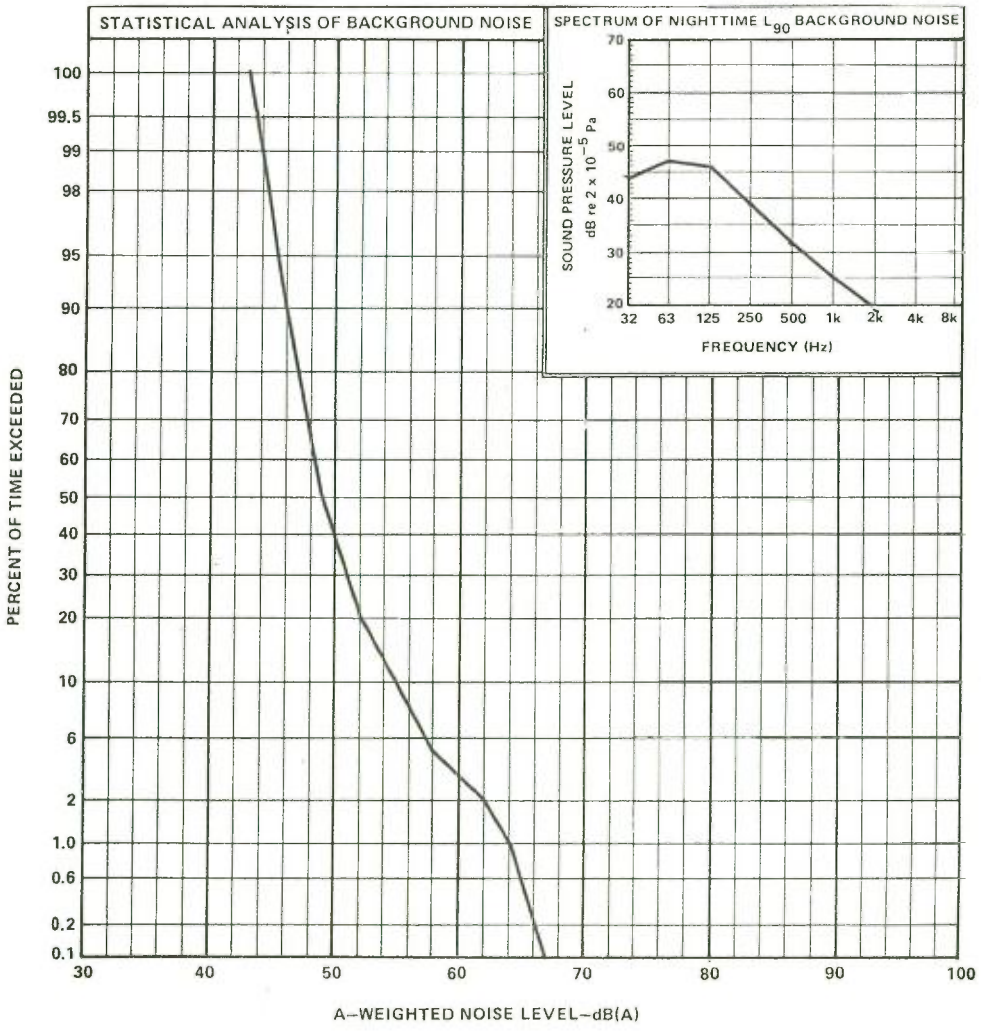


Leq 52 ———— 0903-0913 Hrs., Tues. 20/9/83:- TRAIN ON SOUTHERN LINE, 1 LOCO, 6 CARRIAGES. FARMBOROUGH AVE.: 30 CARS. BIRDS. DOG. RUSTLING LEAVES. LIGHT WIND.

Leq 52 — — — — 0915-0925 Hrs., Tues. 20/9/83:- FARMBOROUGH AVE.: 23 CARS. LIGHT PLANE. BIRDS. CHILDREN. RUSTLING LEAVES. LIGHT WIND.

AMBIENT SOUND LEVELS
POSITION B13, UNANDERRA AREA
NIGHT TIME MEASUREMENTS

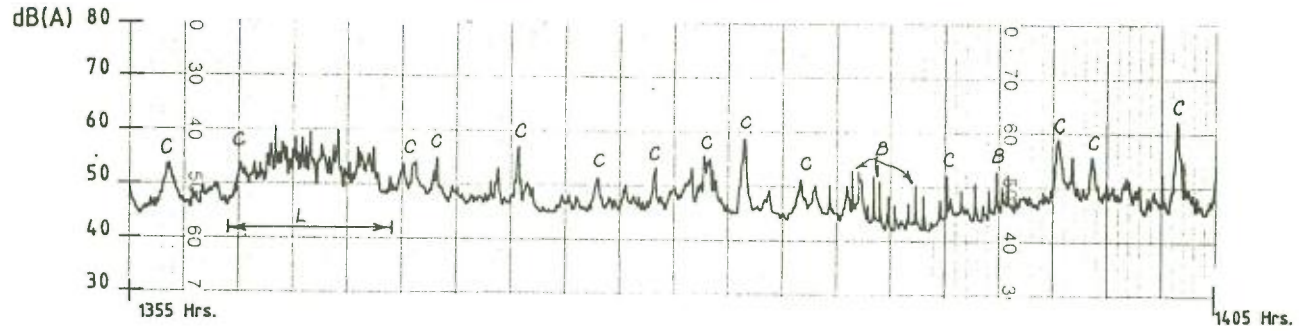


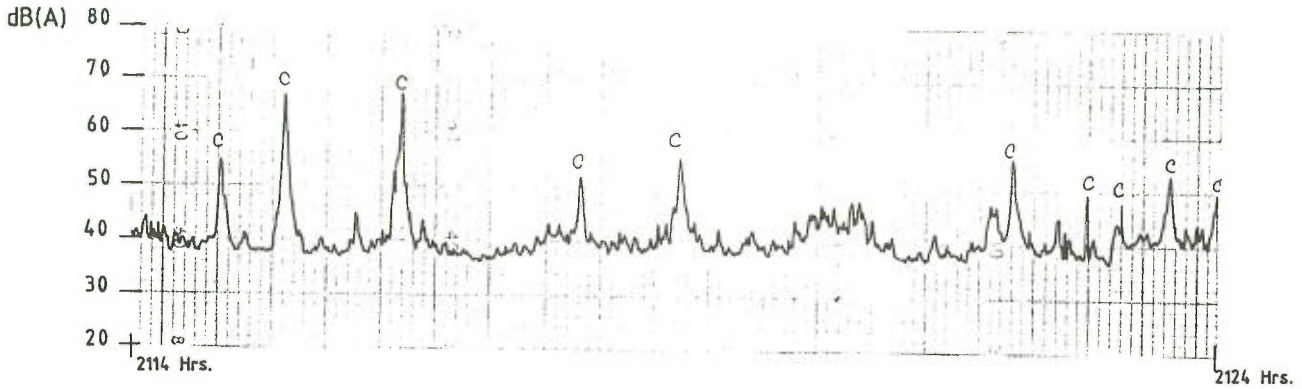


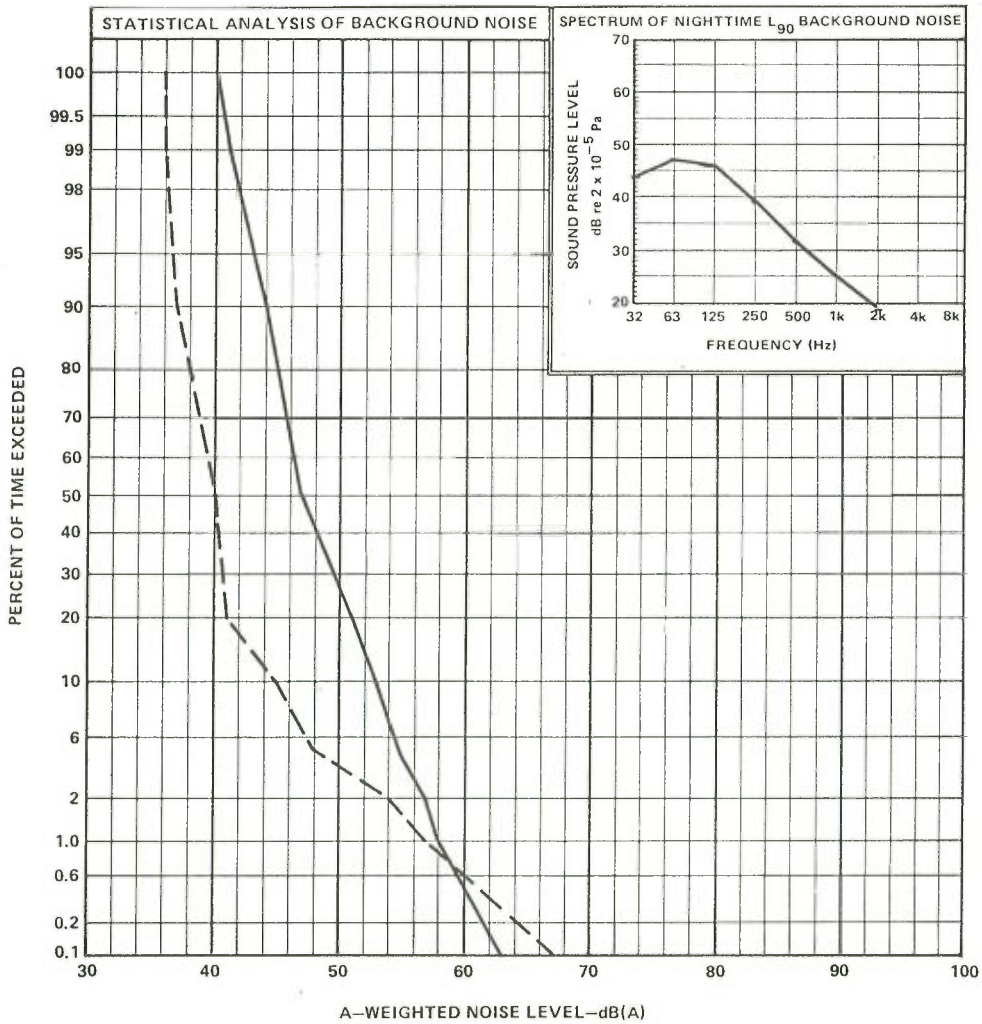
Leq 52 ———— 0650-0700 Hrs., Mon. 19/9/83:- TRAIN ON SOUTHERN LINE. 1 LOCO. 8 CARRIAGES. DISTANT TRAFFIC. BIRDS.

AMBIENT SOUND LEVELS
POSITION B13, UNANDERRA AREA
NIGHT TIME MEASUREMENTS

Report No: 4500-3-83
Appendix No: 17.4





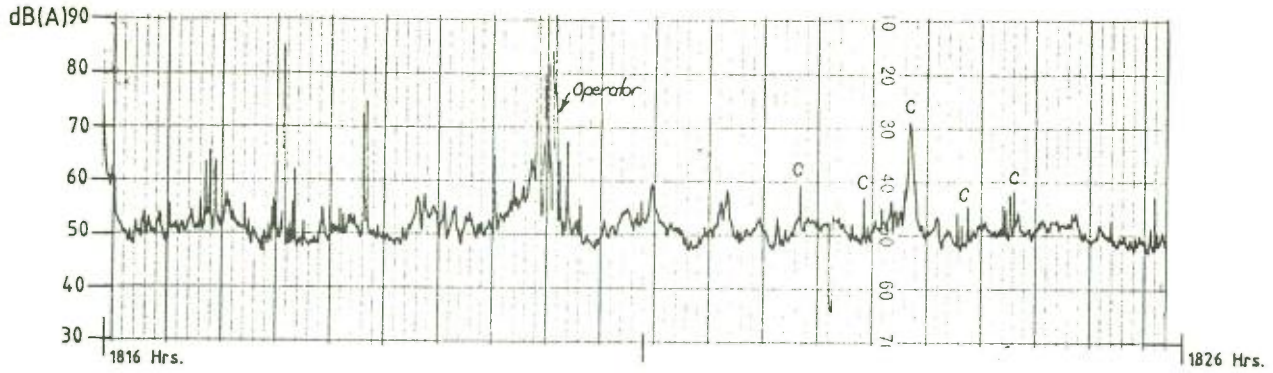


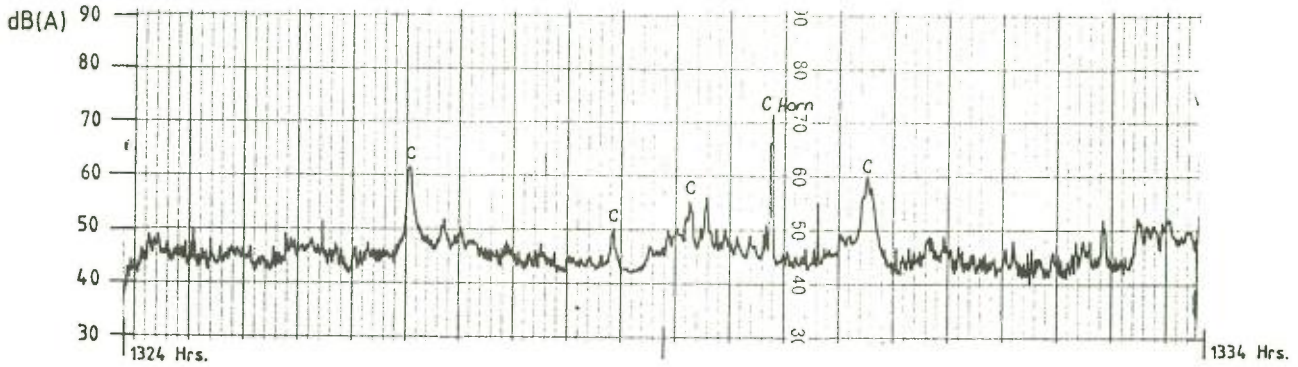
Leq 50 ———— 1355-1405 Hrs., Sun. 18/9/83:- TRAFFIC ON FARMBOROUGH AVE. BIRDS. LIGHT PLANE. PLOUGH.

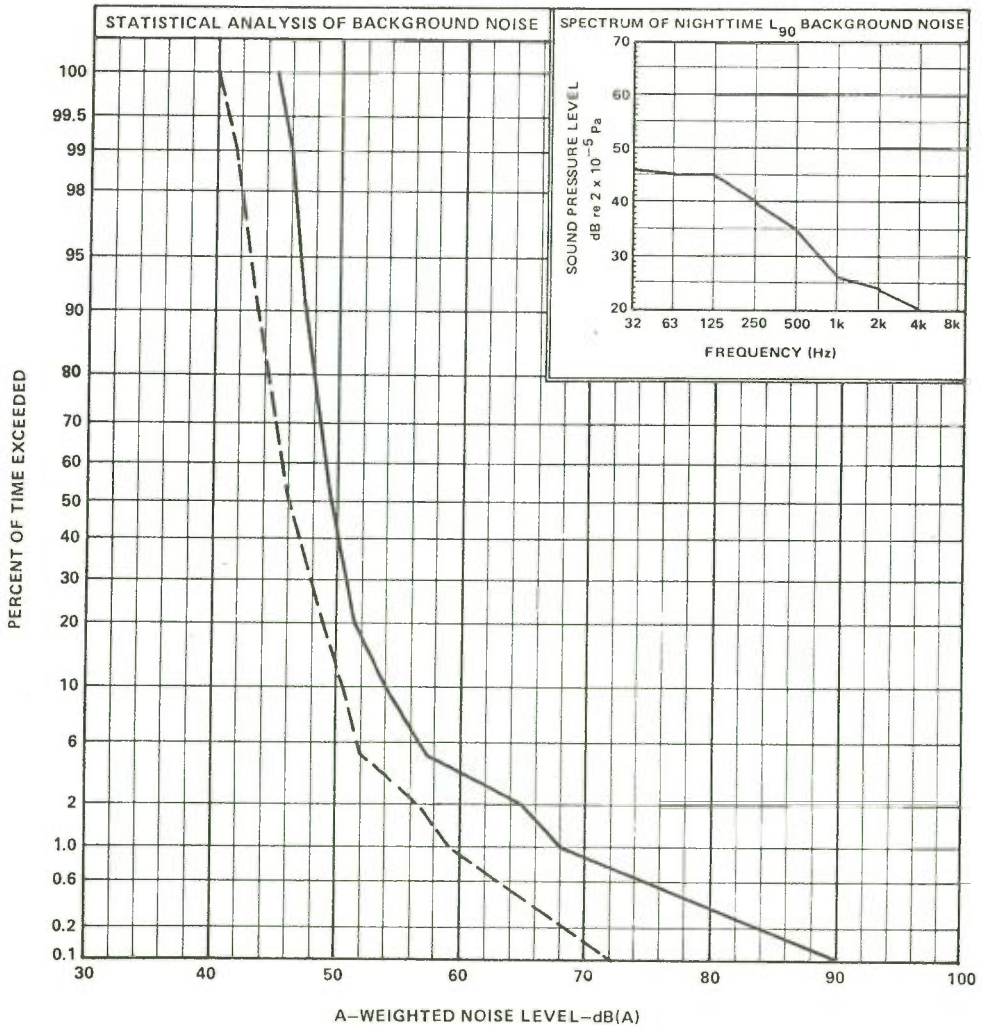
Leq 46 — — — — 2114-2124 Hrs., Sun. 18/9/83:- FARMBOROUGH AVE.: 8 CARS. INSECTS. DISTANT TRAFFIC

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Appendix No: 18.1

AMBIENT SOUND LEVELS
POSITION B14, UNANDERRA AREA
DAY TIME MEASUREMENTS





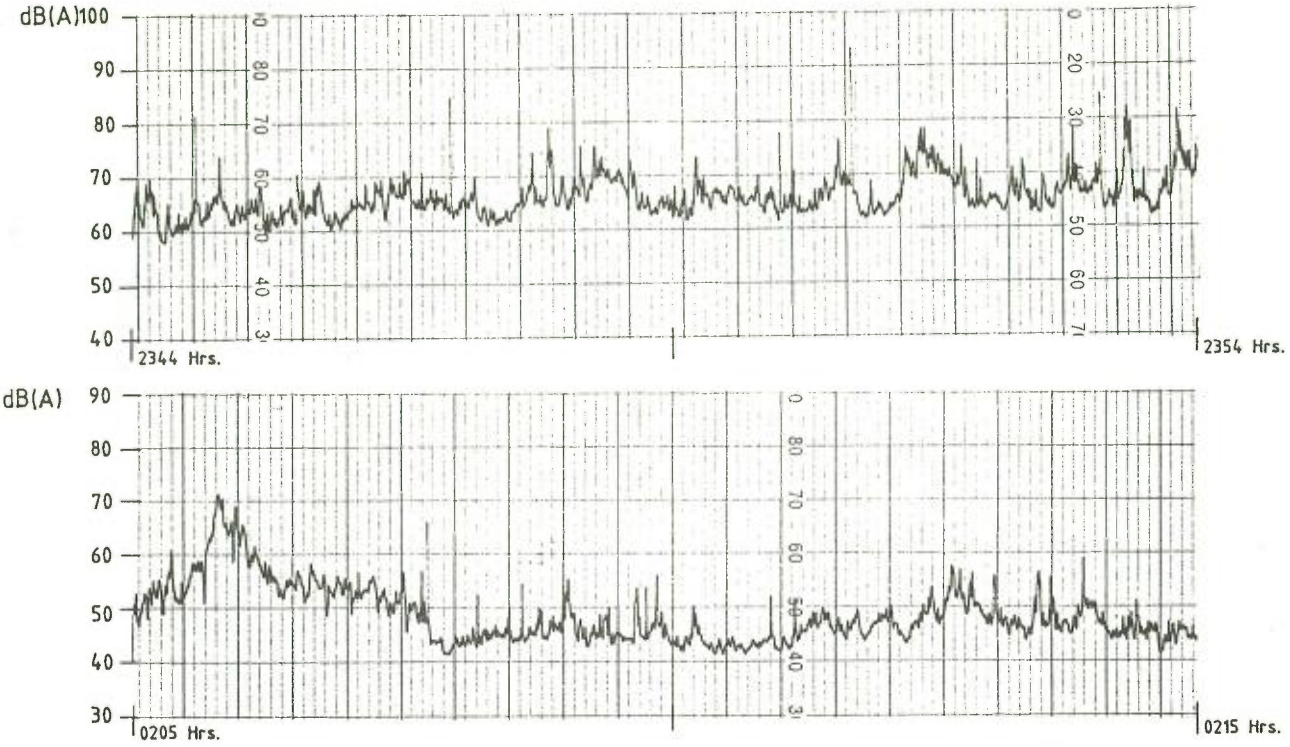


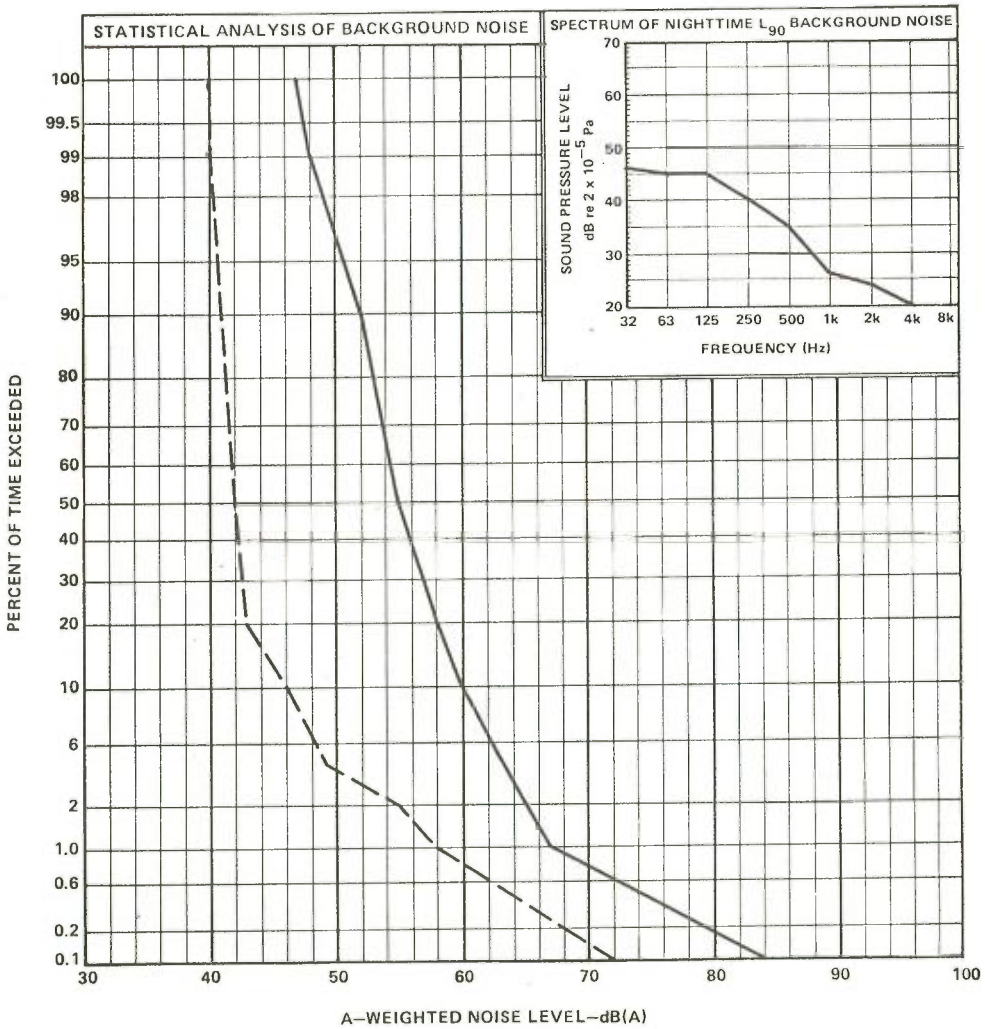
Leq 67.7 ———— 1816-1826 Hrs, Mon. 19/9/83:- TRAFFIC.

Leq 59.8 — — — — 1324-1334 Hrs, Tues. 20/9/83:- DISTANT TRAFFIC, DISTANT INDUSTRY

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Appendix No: 18.2

AMBIENT SOUND LEVELS
POSITION B14, UNANDERRA AREA
NIGHT TIME MEASUREMENTS



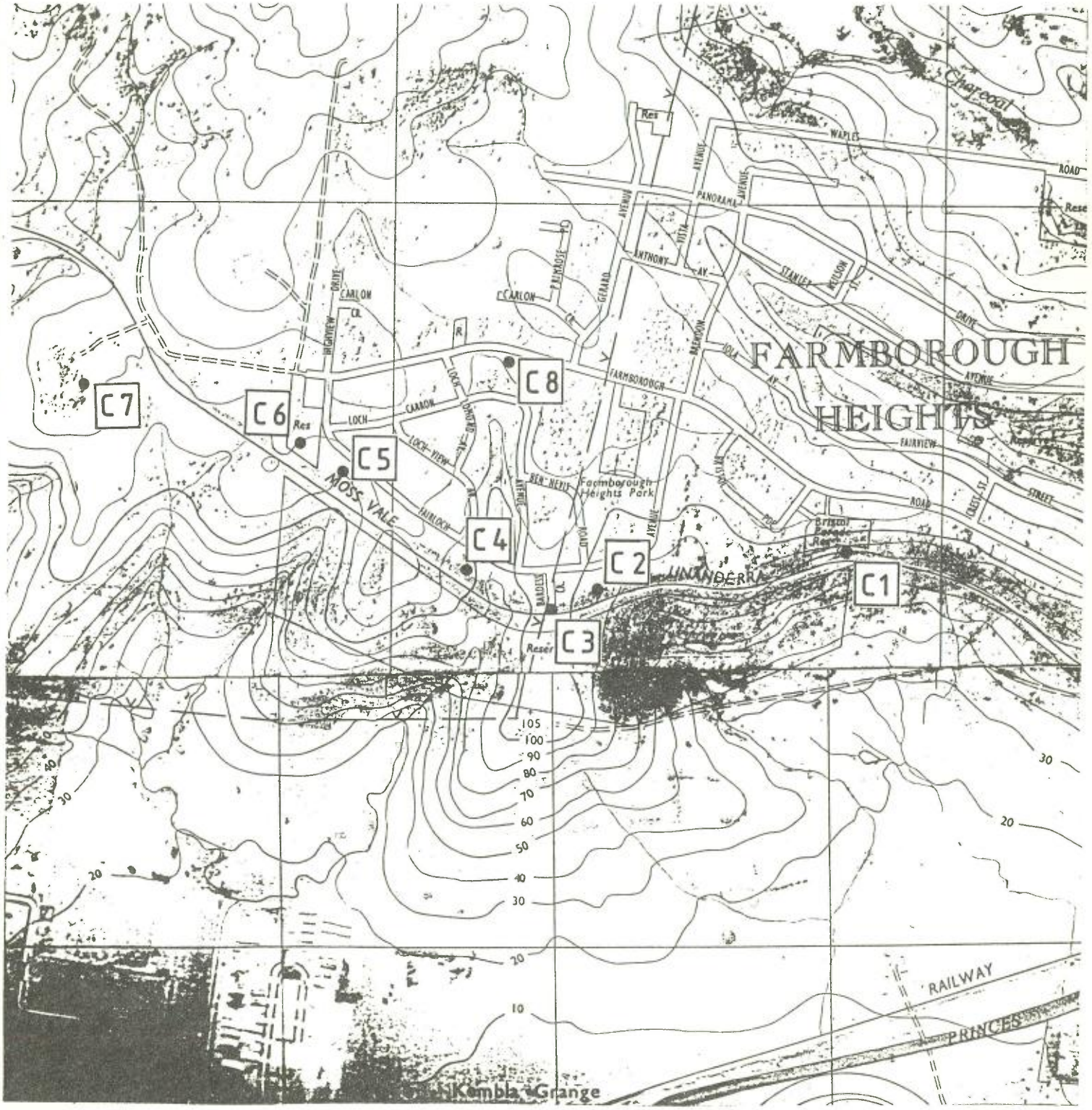


Leq 61.8 ———— 2344-2354 Hrs, Mon. 19/9/83:- WIND 20-30 km/hr

Leq 54.6 — — — — 0205-0215 Hrs, Wed. 21/9/83:-

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LOCATION PLAN
SHOWING MEASUREMENT POSITIONS
FARMBOROUGH HEIGHTS AREA



N

Scale: 1÷10 000.mm

DESCRIPTION OF MEASUREMENT POSITIONS

FARMBOROUGH HEIGHTS
(Designated as Area 'C')

POSITION No: C1
Computational Position. At rear of Hamilton Residence, 23 Bristal Lane

POSITION No: C2
Rear of 41 Fairloch Avenue (off Bardess Crescent), 10m from centreline of existing track

POSITION No: C3
At Bridge on Bardess Crescent, 10m from centreline of existing track

POSITION No: C4
55 Fairloch Avenue (MWSDB pumping station site), level with rear facade of nearest house

POSITION No: C5
Outside 93 Fairloch Avenue, level with rear facade on concrete platform

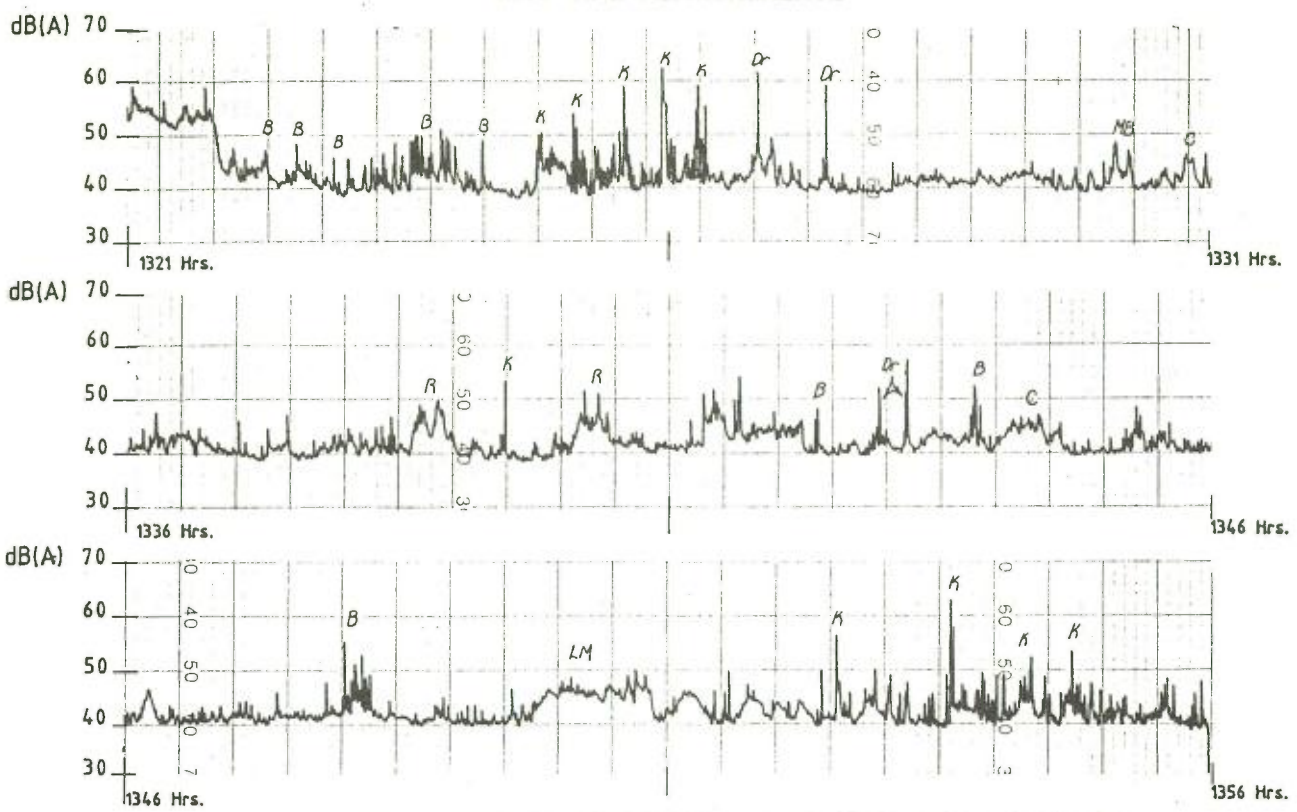
POSITION No: C6
At rear of 106 Farmborough Road

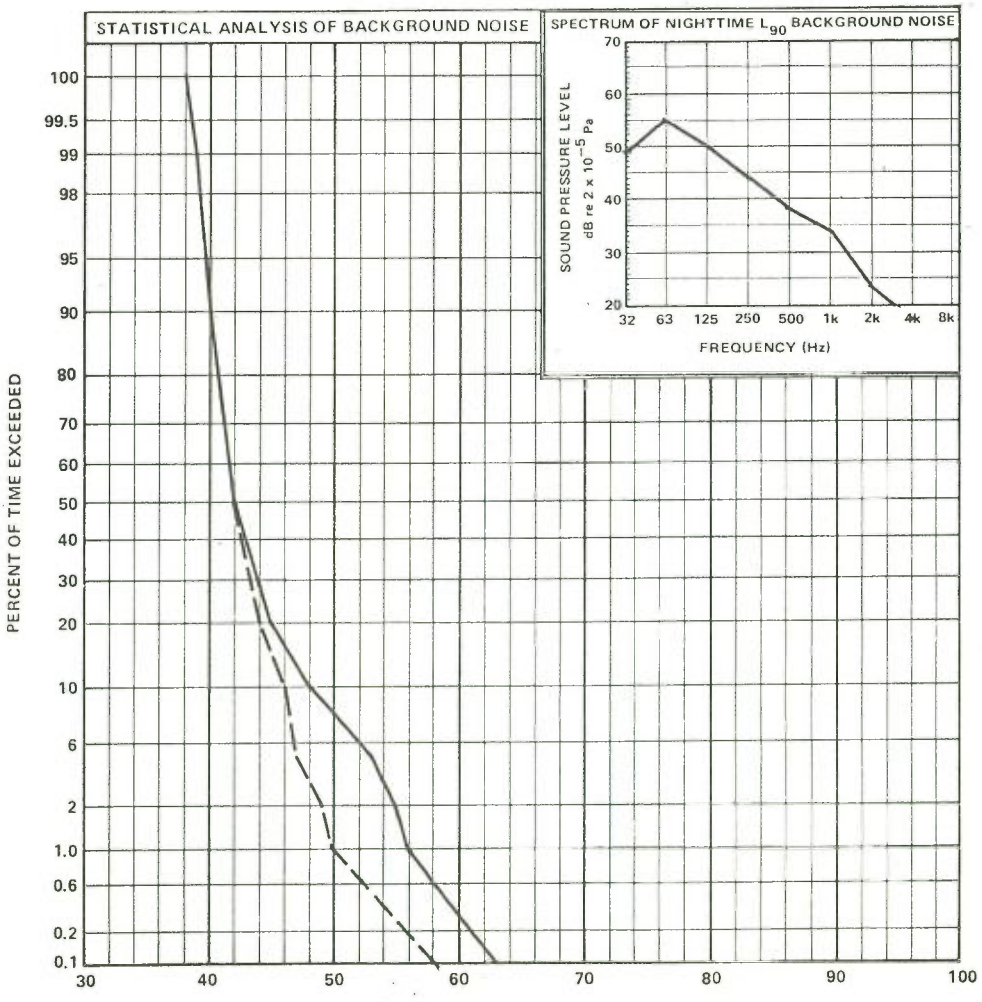
POSITION No: C7
At rear of Van der Haar Residence, off Farmborough Road

POSITION No: C8
309 Farmborough Road

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AMBIENT SOUND LEVELS
POSITION C2, FARMBOROUGH HEIGHTS AREA
DAY TIME MEASUREMENTS



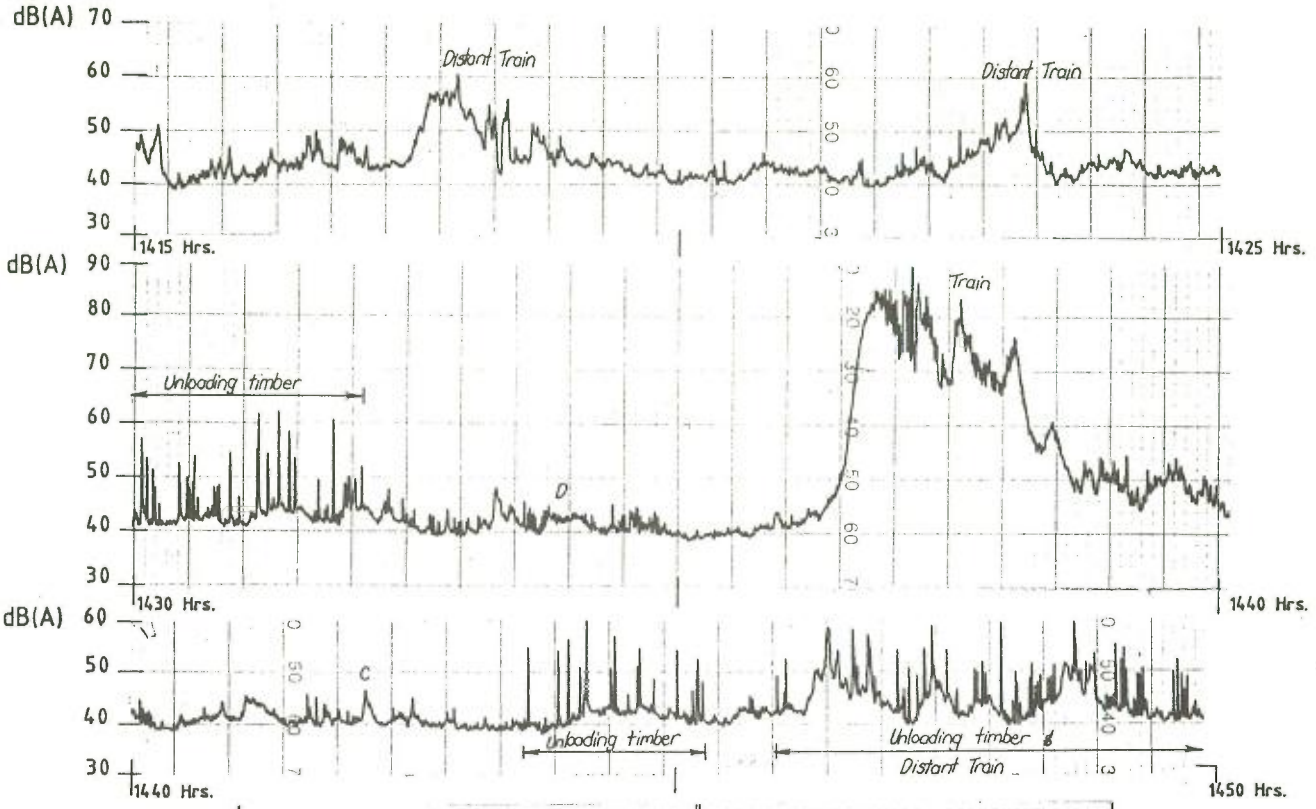


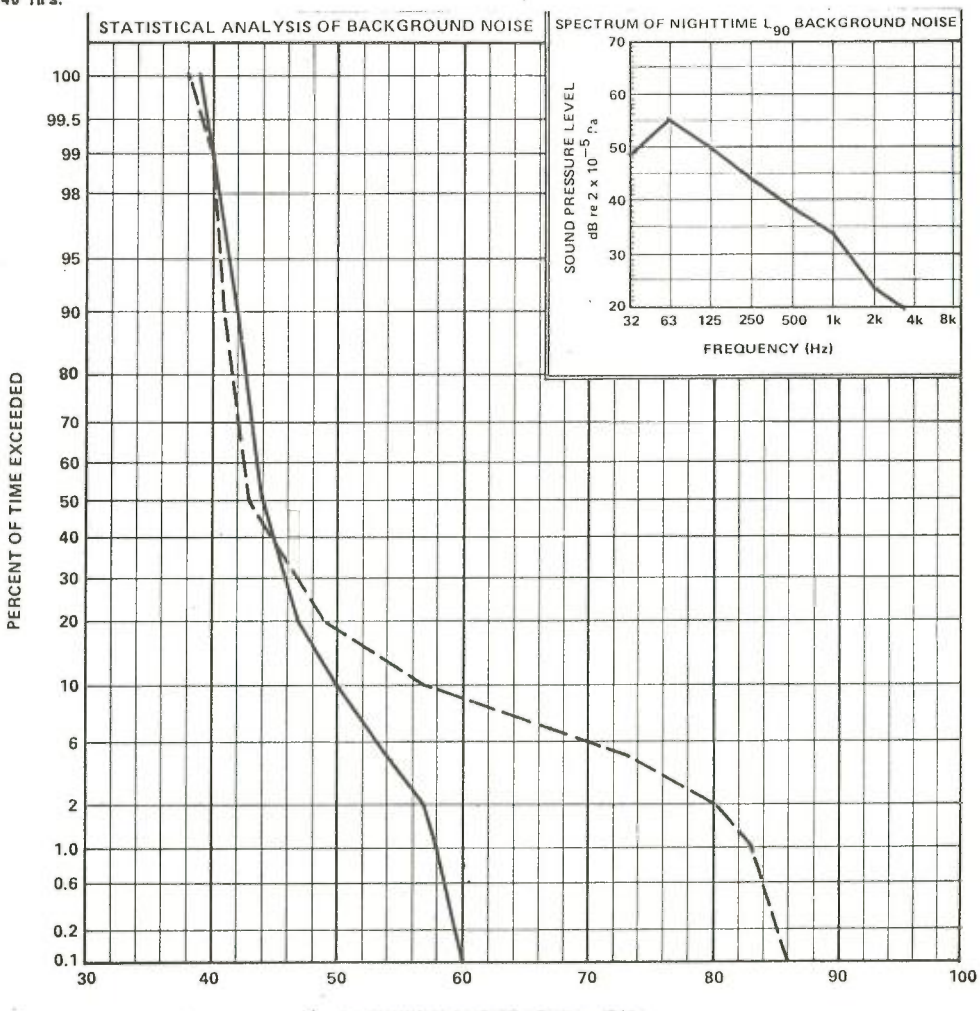
Leq 46 ———— 1321-1331 Hrs., Thurs. 8/9/83:- 2 CARS 1 BIKE IN DISTANCE. BIRDS. DOOR. CHILDREN. RUSTLING LEAVES

Leq 44 — — — — 1336-1356 Hrs., Thurs. 8/9/83:- 1 CAR, 1 BIKE IN DISTANCE. BIRDS. DOOR. LOWNMOWER. RUSTLING LEAVES.

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AMBIENT SOUND LEVELS
POSITION C2, FARMBOROUGH HEIGHTS AREA
DAY TIME MEASUREMENTS



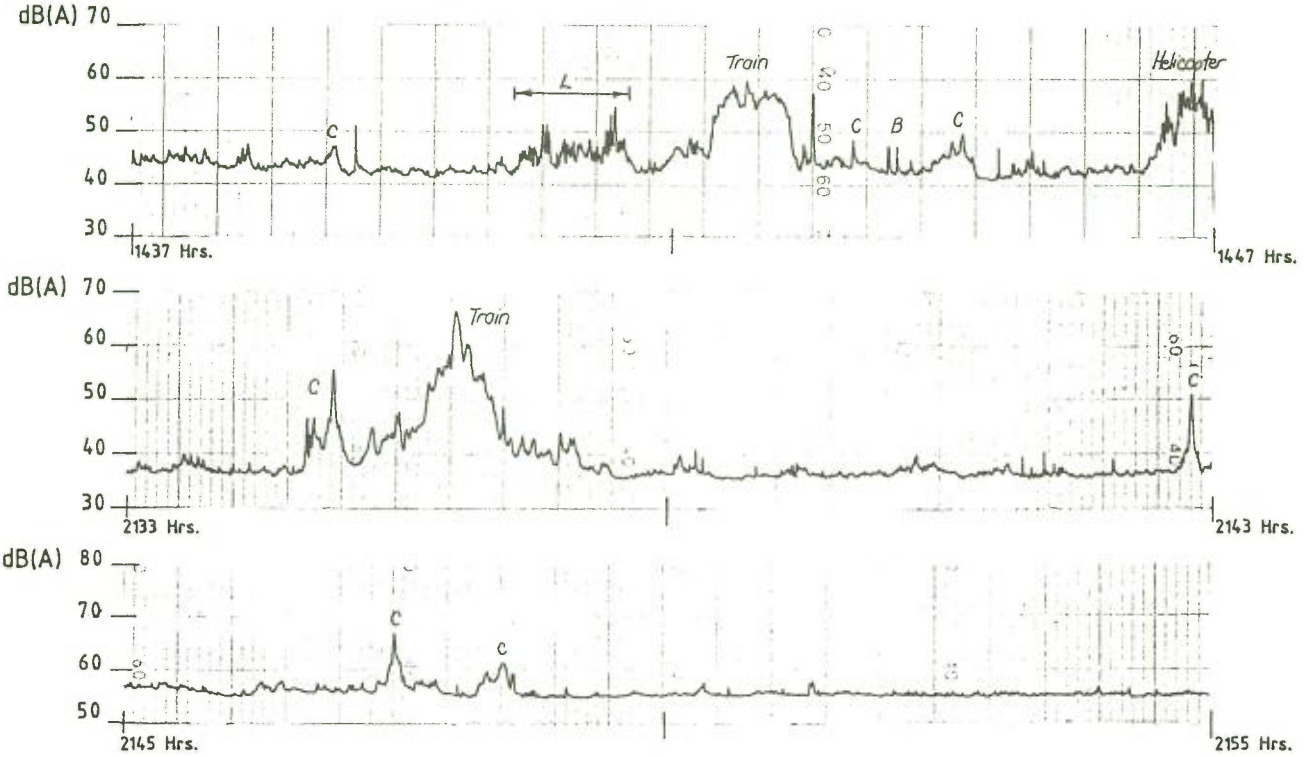


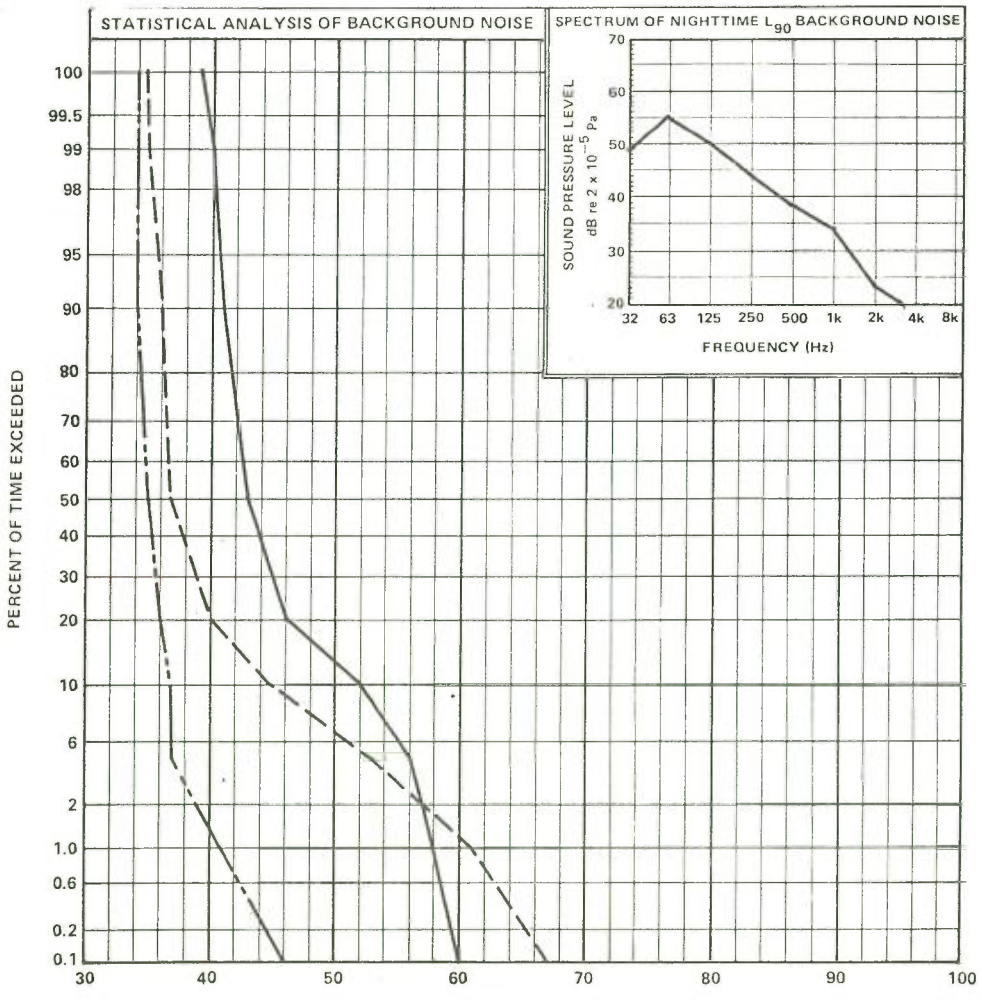
Leq 47 ———— 1415-1425 Hrs., Tues. 13/9/83:- DISTANT TRAFFIC. LIGHT PLANE. BIRDS. DISTANT TRAIN. HAMMERING. RUSTLING LEAVES.

Leq 68 – – – – – 1430-1450 Hrs., Tues. 13/9/83:- GOODS TRAIN ON MOSS VALE LINE, 2 LOCOS, 24 CARRIAGES, 1 CABOOSE. DOG. BIRDS. HAMMERING. RUSTLING LEAVES. DISTANT TRAIN.

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AMBIENT SOUND LEVELS
POSITION C2, FARMBOROUGH HEIGHTS AREA
- DAY TIME MEASUREMENTS





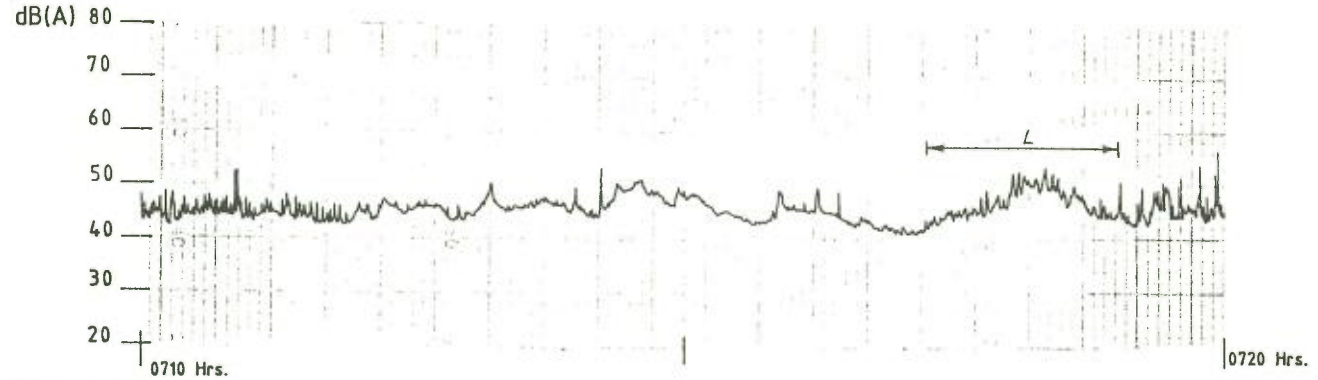
Leq 48 ———— 1437-1447 Hrs., Sun. 18/9/93:- TRAIN ON SOUTHERN LINE. HORN. BIRDS. DISTANT TRAFFIC. LIGHT PLANE. HELICOPTER.

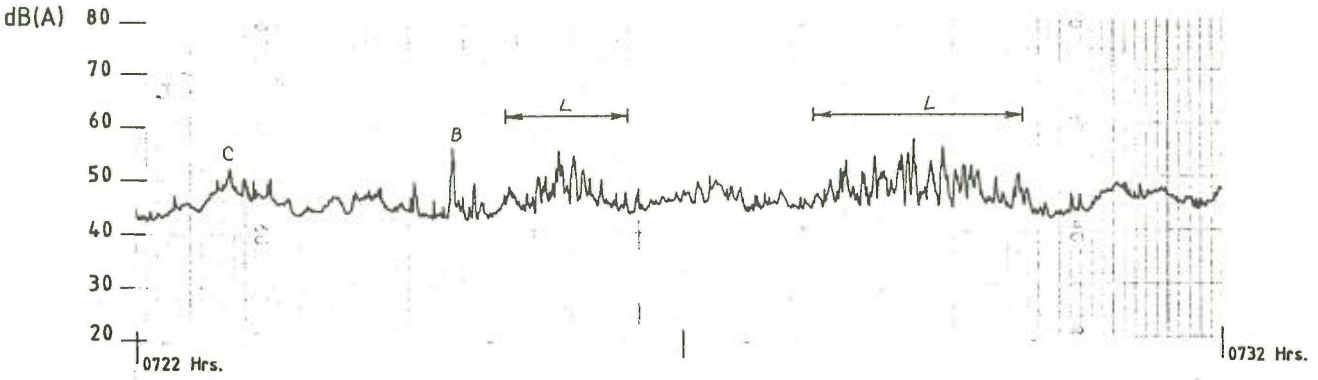
Leq 47 — — — — 2133-2143 Hrs., Sun. 18/9/83:- TRAIN MOSS VALE LINE, 1 LOCO, 1 CARRIAGE. DISTANT TRAFFIC. DOG. INSECTS.

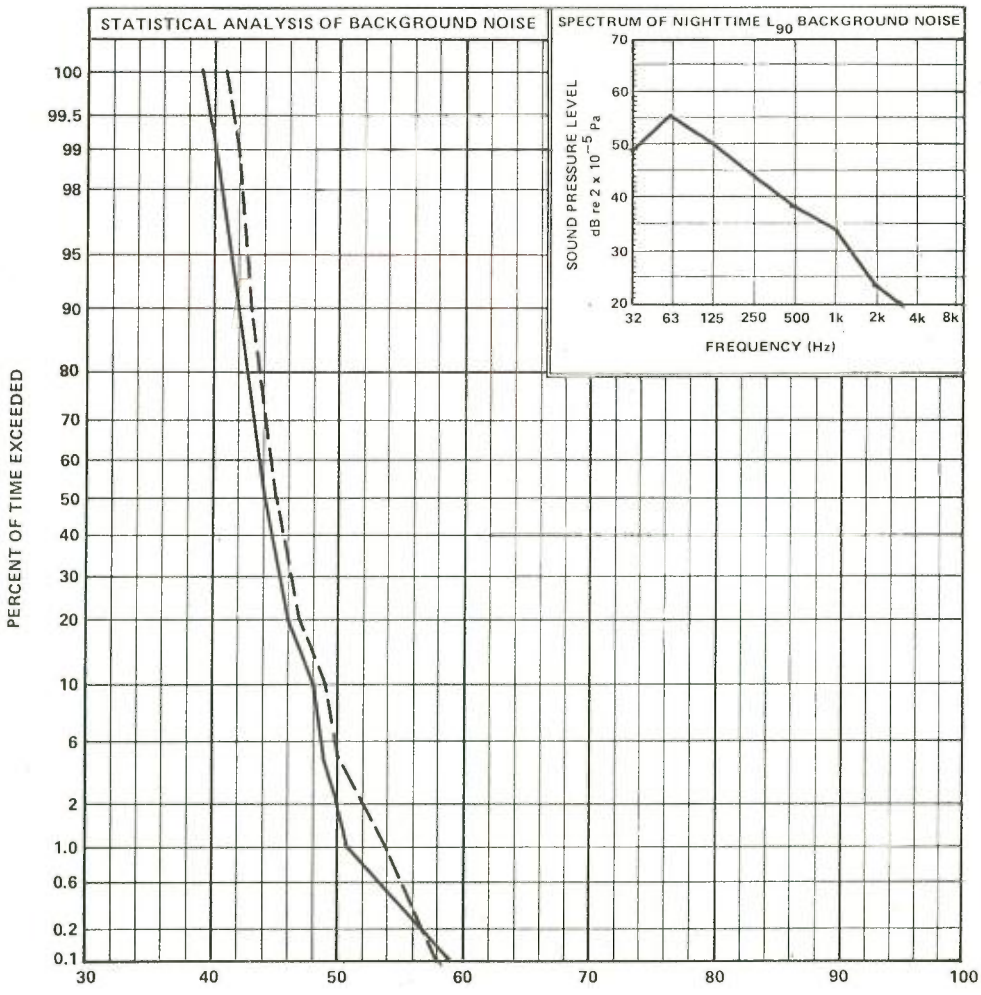
Leq 36 ——·—— 2145-2155 Hrs., Sun. 18/9/83:- DISTANT TRAFFIC. DOG. INSECTS..

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AMBIENT SOUND LEVELS
POSITION C2, FARMBOROUGH HEIGHTS AREA
DAY TIME MEASUREMENTS





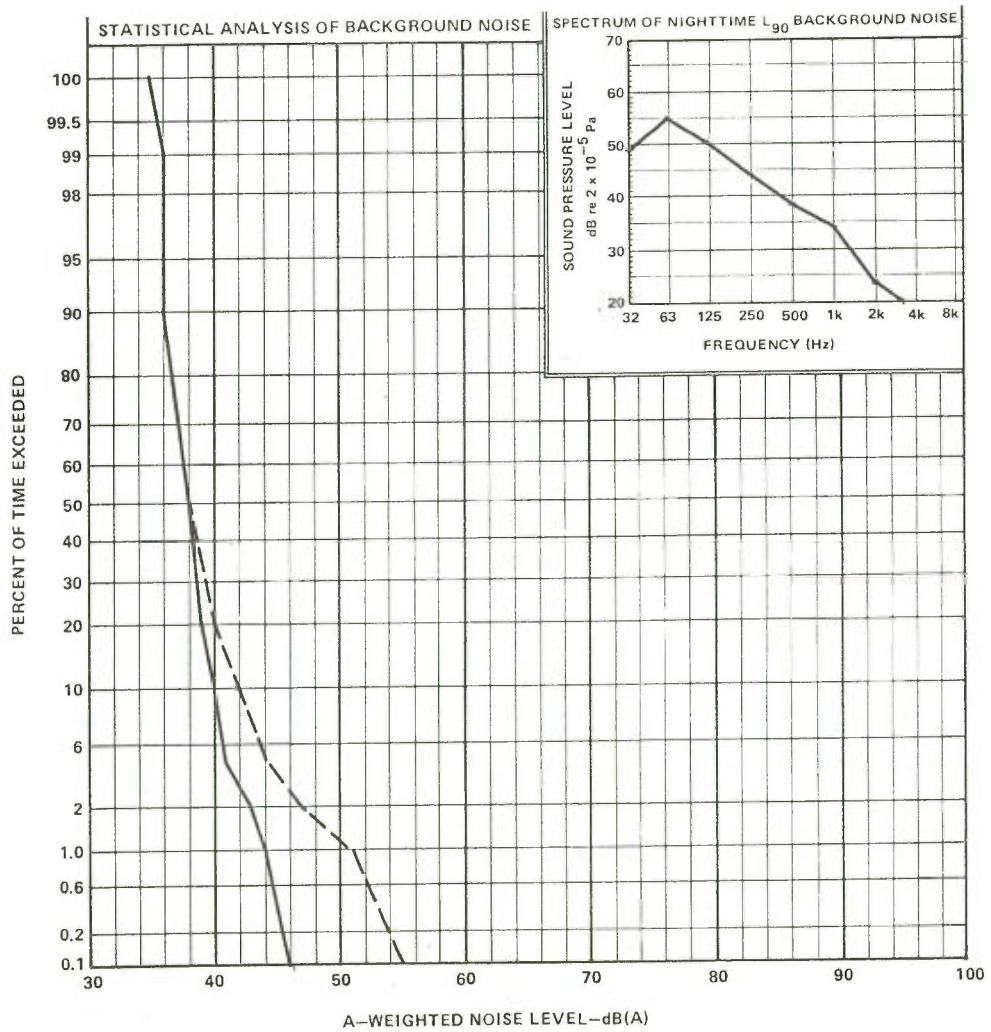


Leq 39 ———— 0710-0720 Hrs., Mon. 19/9/83:- DISTANT TRAFFIC. LIGHT PLANE. BIRDS. RUSTLING LEAVES.

Leq 41 — — — — 0732-0742 Hrs., Mon. 19/9/83:- 2 LIGHT PLANES. BIRDS. RUSTLING LEAVES

AMBIENT SOUND LEVELS
POSITION C2, FARMBOROUGH HEIGHTS AREA
NIGHT TIME MEASUREMENTS

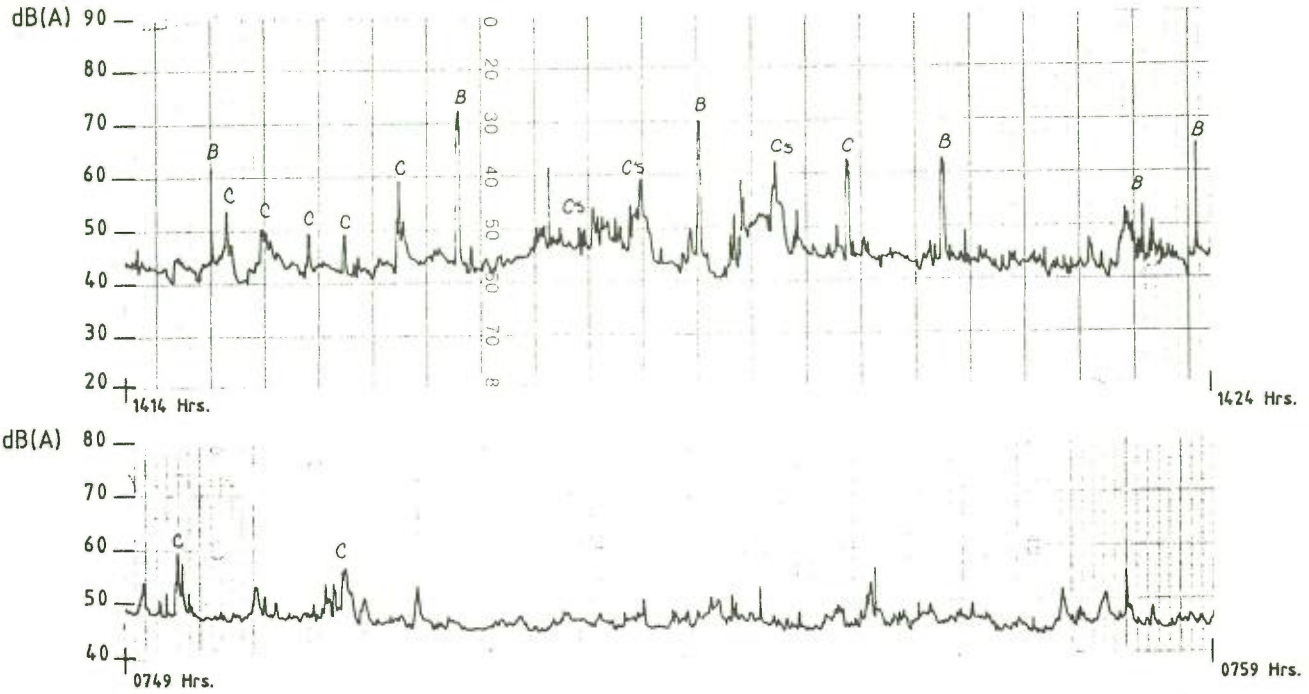


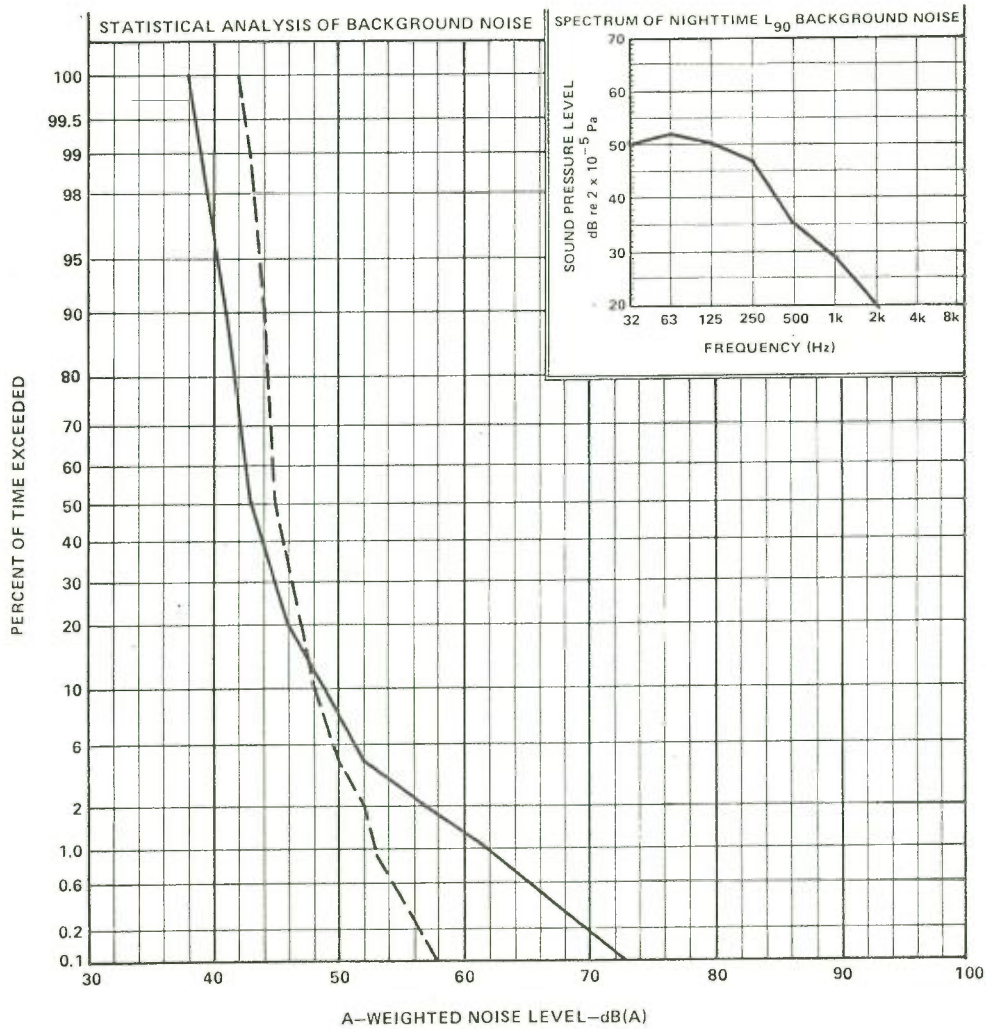


Leq 38 ———— 2340-2350 Hrs., Mon. 19/9/83:-

Leq 40 — — — — 0045-0055 Hrs., Tues. 20/9/83:- RUSTLING LEAVES.

AMBIENT SOUND LEVELS
POSITION C3, FARMBOROUGH HEIGHTS AREA
DAY TIME MEASUREMENTS

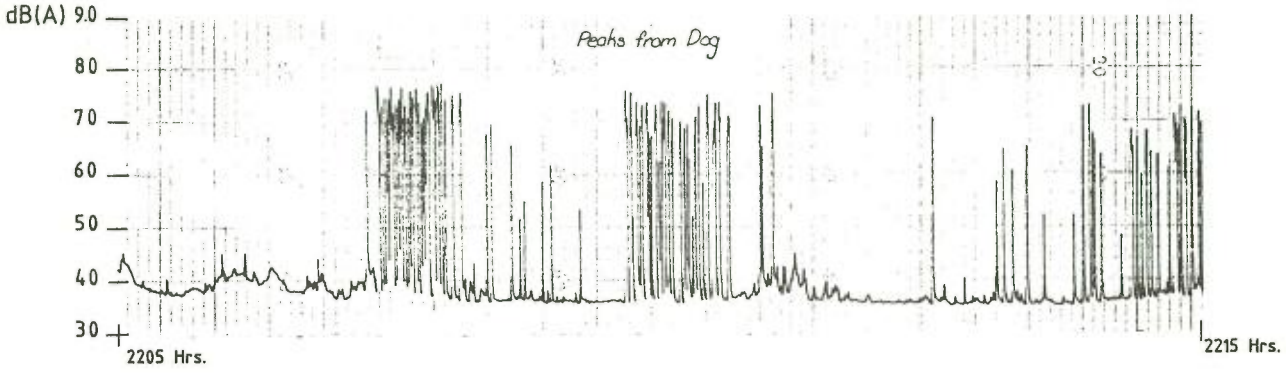


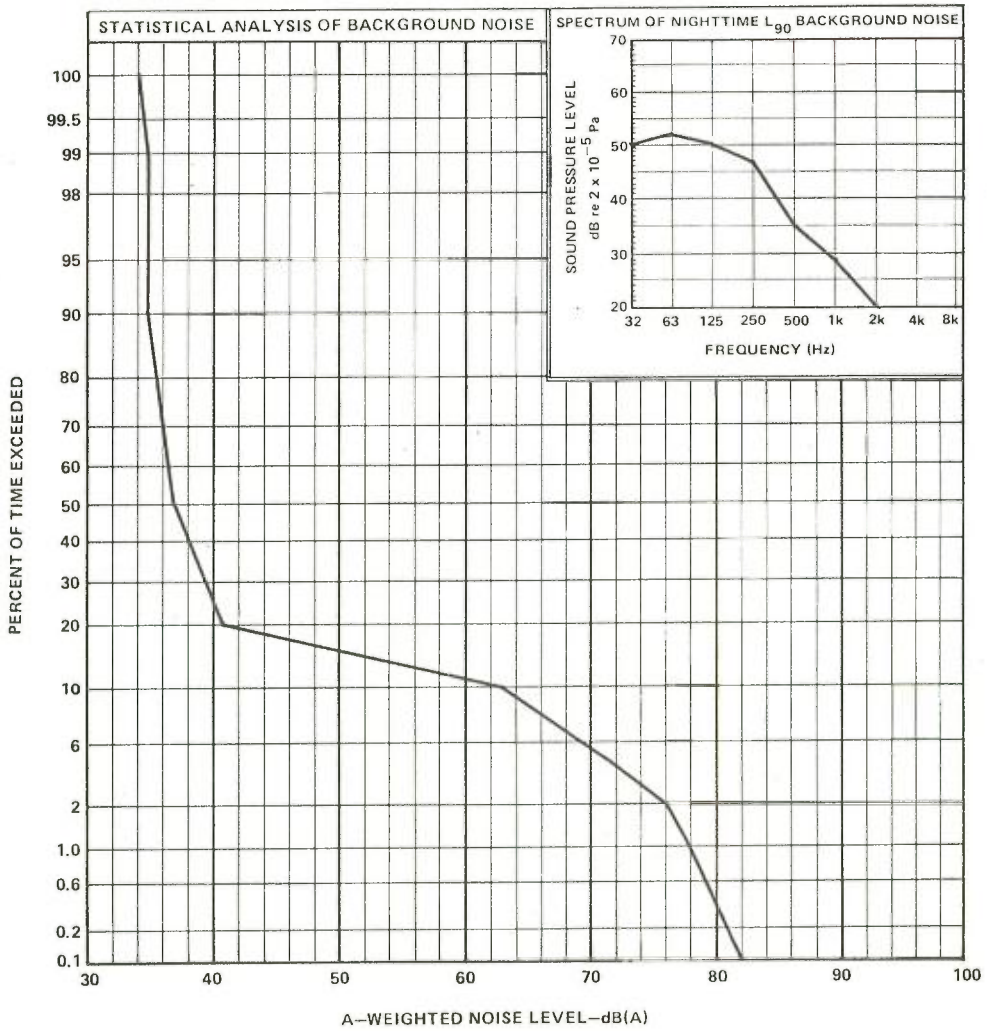


Leq 51 ———— 1414-1424 Hrs., Sun. 18/9/83:- FAIRLOCH AVE.: 15 CARS. BARDESS CR.: 2 CARS. BIRDS. LAWNMOWER. BUILDING.

Leq 46 — — — — 0749-0759 Hrs., Sun. 18/9/83:- RUSTLING LEAVES. DOG.

AMBIENT SOUND LEVELS
POSITION C3, FARMBOROUGH HEIGHTS AREA
NIGHT TIME MEASUREMENTS

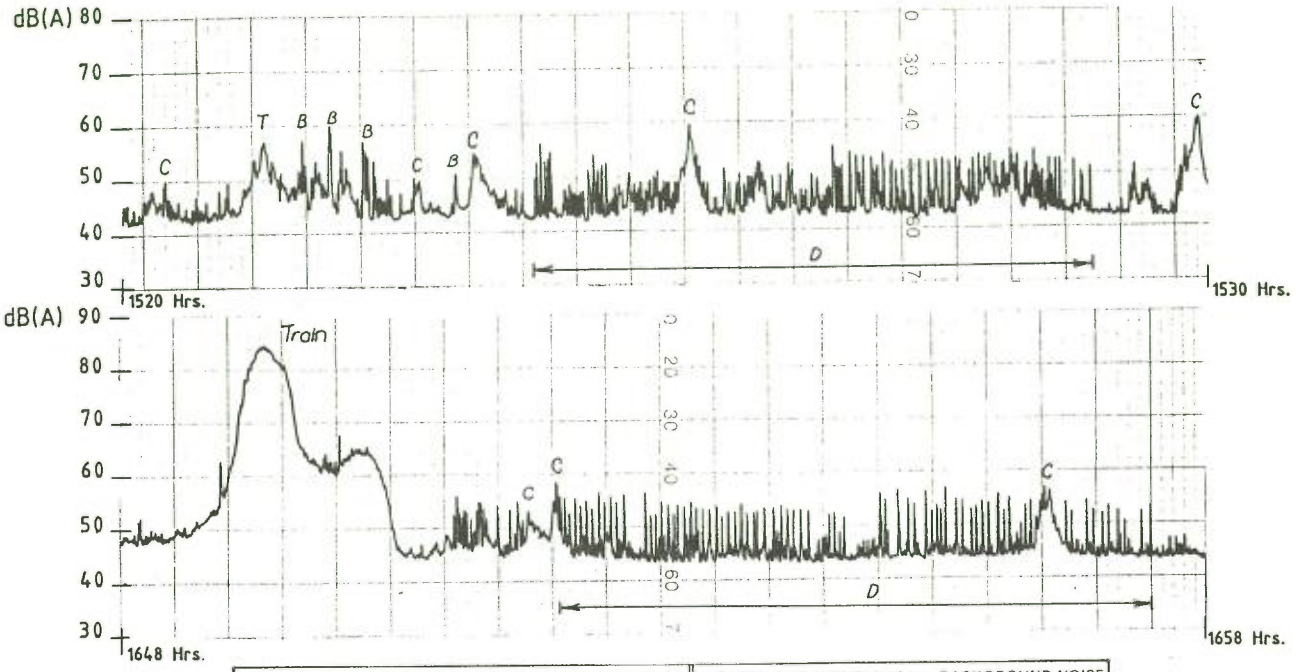


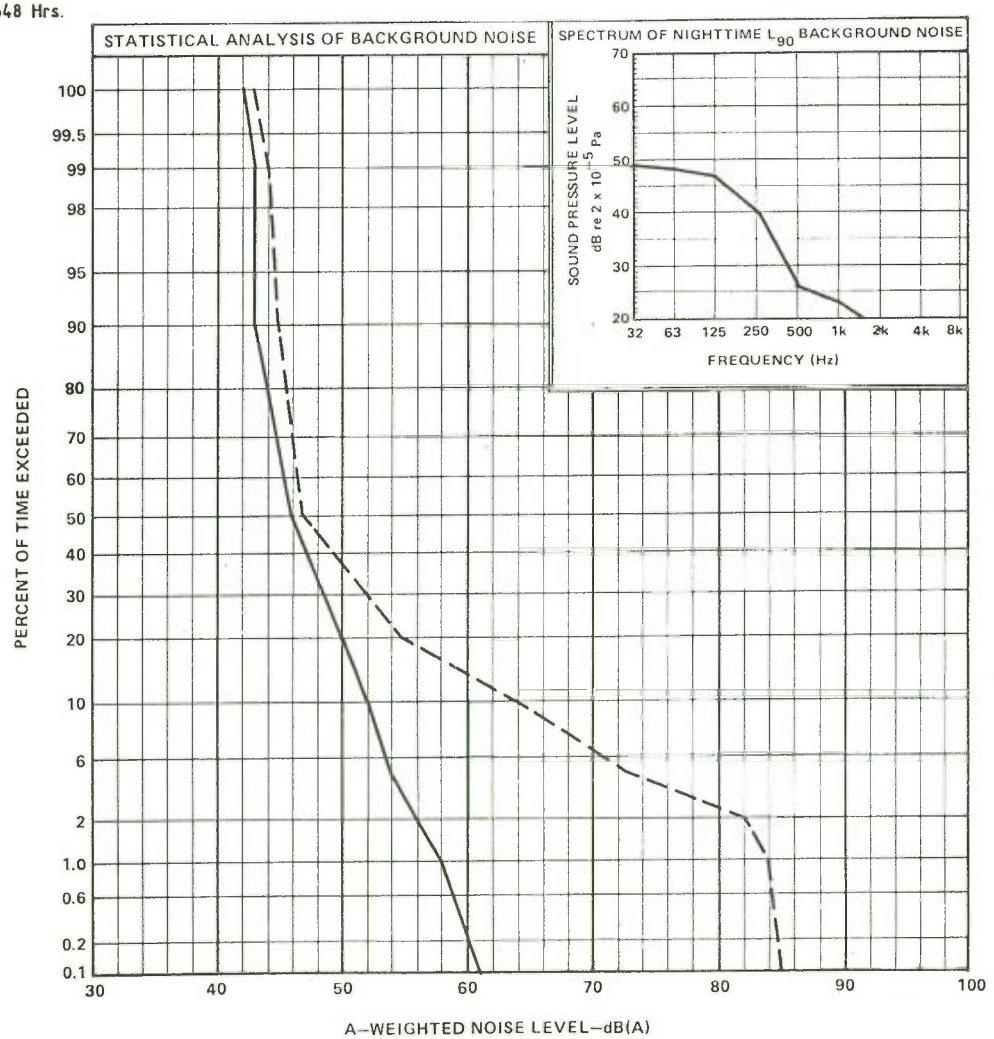


Leq 64 ———— 2205-2215 Hrs., Sun. 18/9/83:- LIGHT PLANE. RUSTLING LEAVES. DOG. INSECTS.

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AMBIENT SOUND LEVELS
POSITION C4, FARMBOROUGH HEIGHTS AREA
DAY TIME MEASUREMENTS



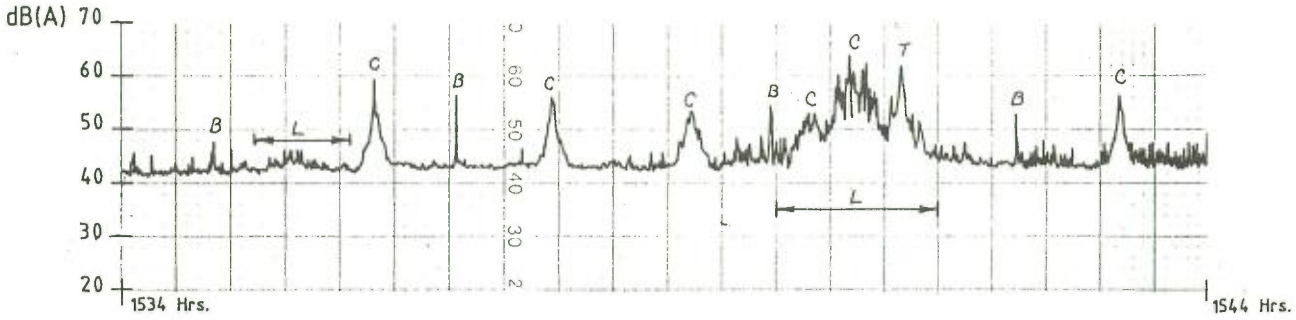


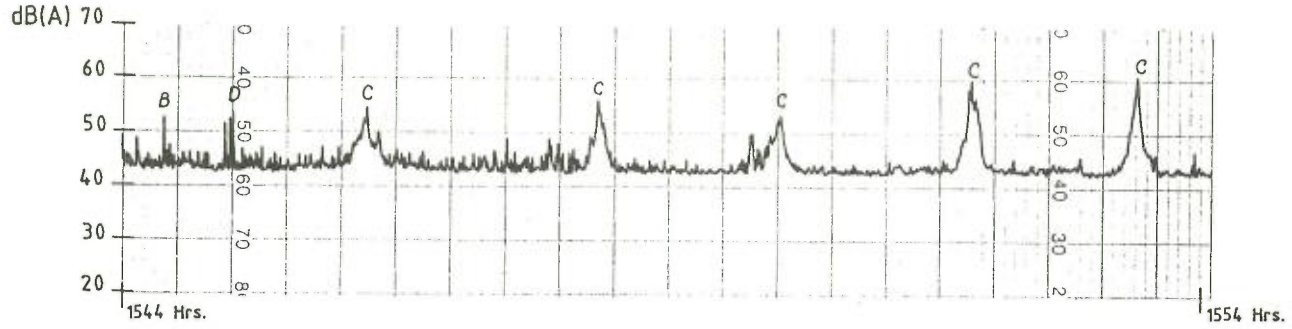
Leq 49 ———— 1520-1530 Hrs., Tues. 13/9/83:- FARMBOROUGH AVE.: 7 CARS, 1 TRUCK. DOG. LIGHT PLANE. BIRDS. BULLDOZER. HAMMER. POOL PUMP. WIND: 8kph N.E.

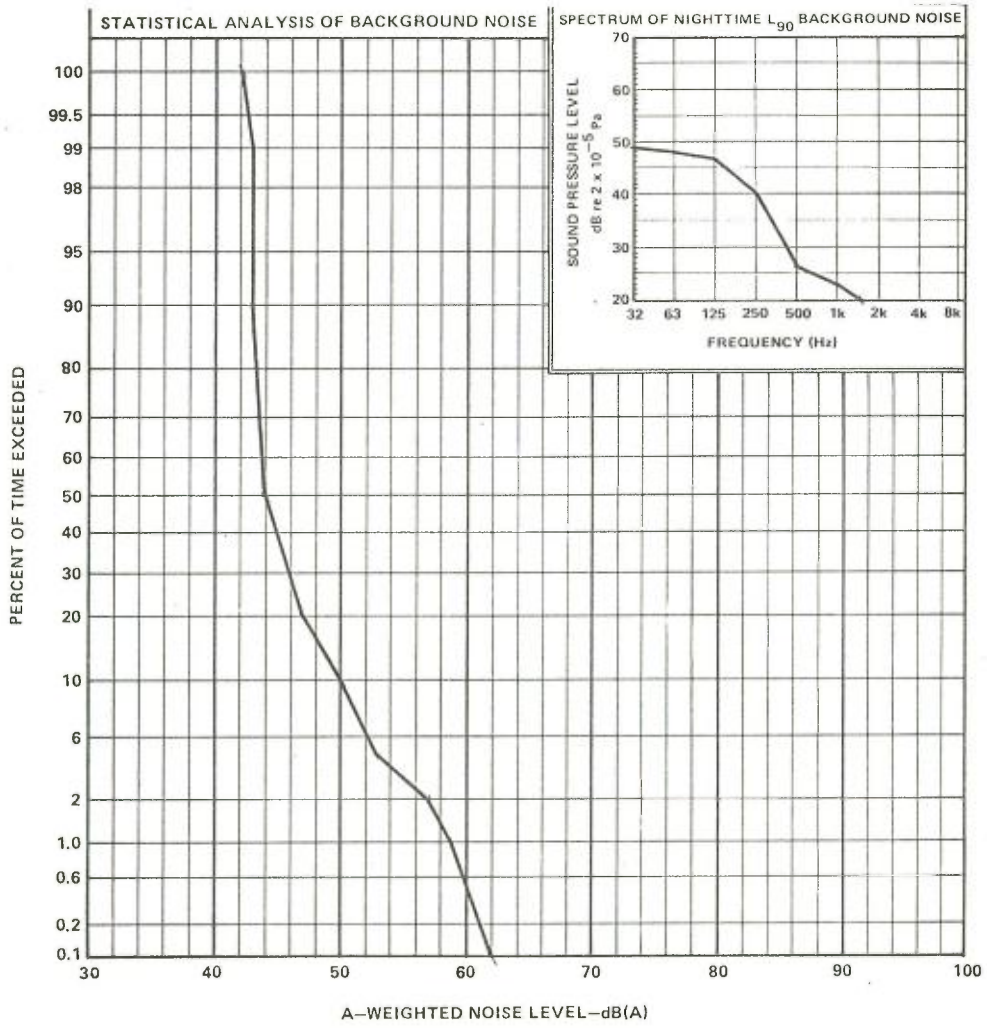
Leq 69 — — — — 1648-1658 Hrs., Tues. 13/9/83:- GOODS TRAIN MOSS VALE LINE, 2 LOCOS, 22 CARRIAGES, 1 CABOOSE. FARMBOROUGH AVE.: 3 CARS. POOL PUMP. DOG. WIND: 8kph N.S.

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Appendix No: 22.2

AMBIENT SOUND LEVELS
POSITION C4, FARMBOROUGH HEIGHTS AREA
DAY TIME MEASUREMENTS





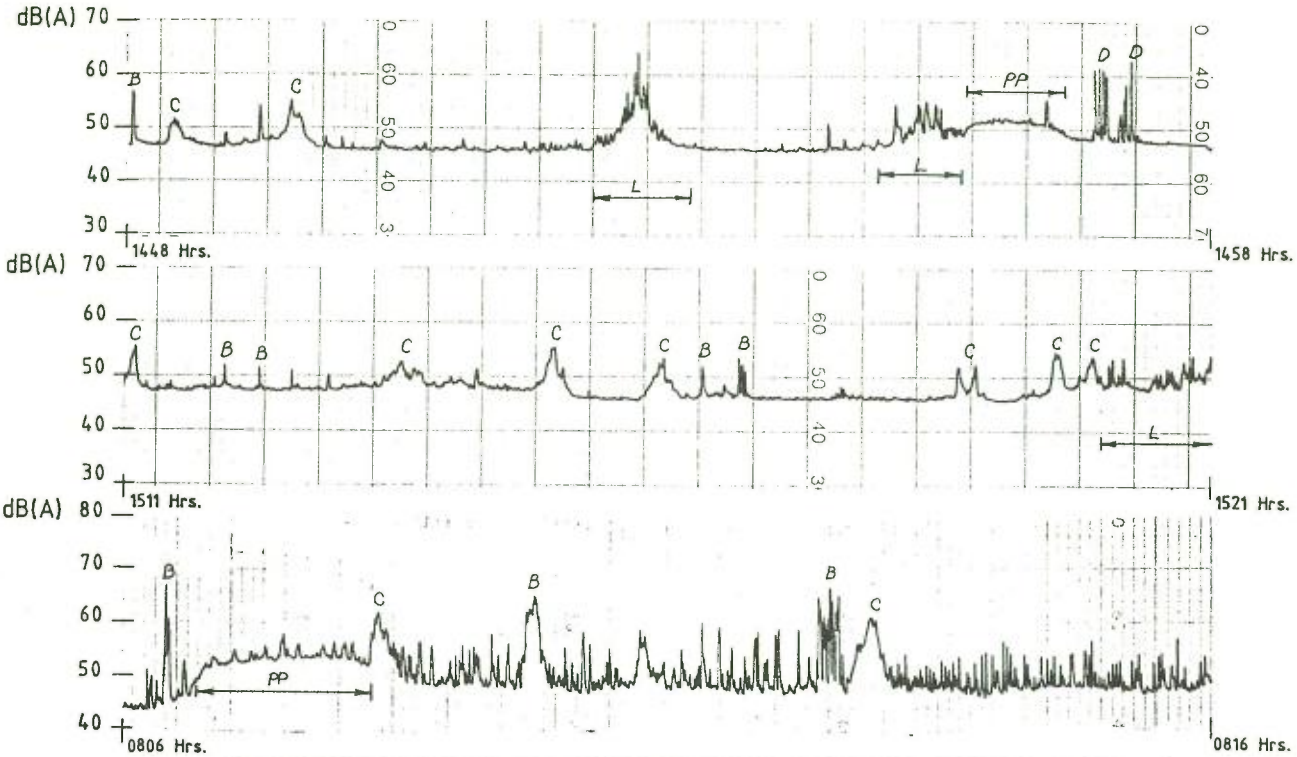


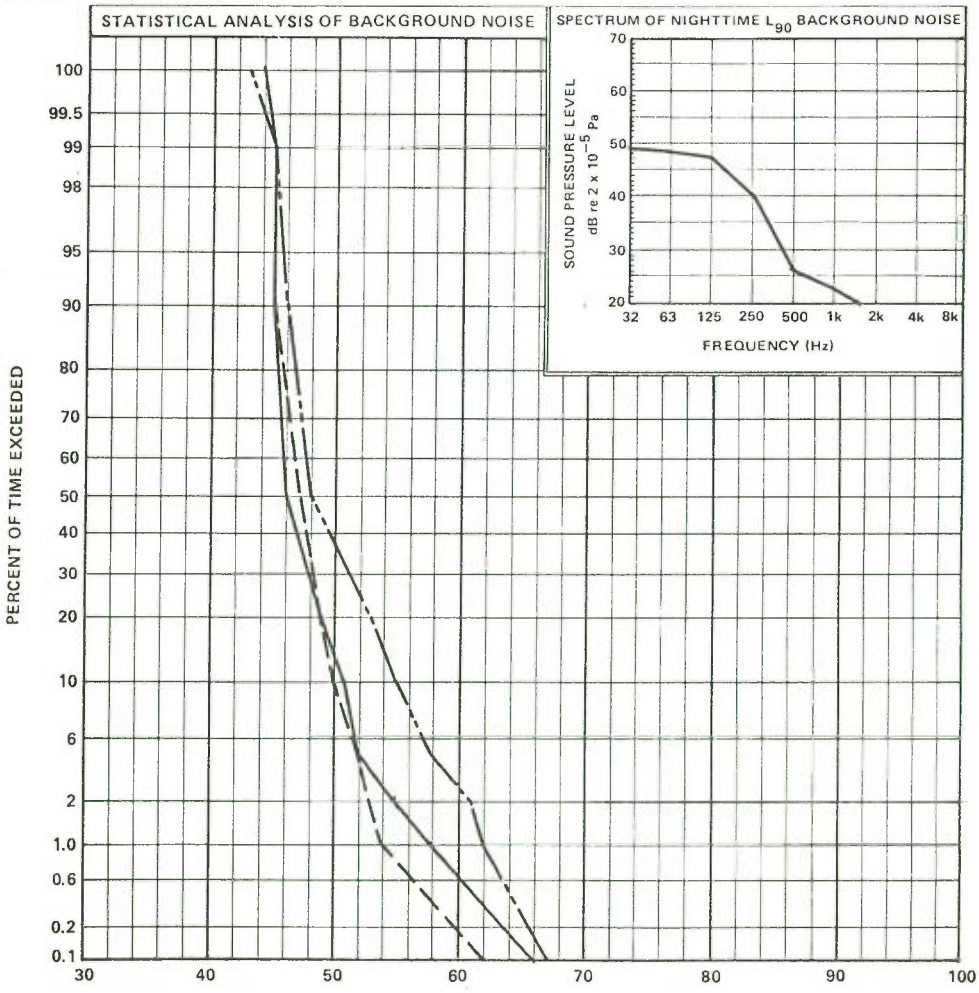
Leq 48 _____

1534-1554 Hrs., Tues. 13/9/83:- FARMBOROUGH AVE.: 10 CARS, 1 TRUCK. BIRDS. BULLDOZER. POOL PUMP. HAMMER. DOG. LAWNMOWER. 2 LIGHT PLANES. WIND: 8kph N.E.

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Appendix No: 22.3

AMBIENT SOUND LEVELS
POSITION C4, FARMBOROUGH HEIGHTS AREA
DAY TIME MEASUREMENTS





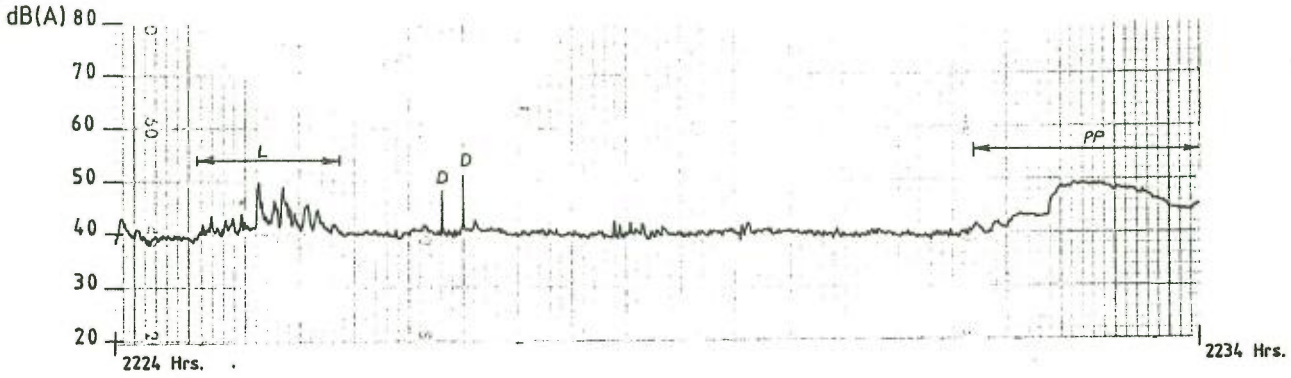
Leq 49 ———— 1448-1458 Hrs., Sun. 18/9/83:- FAIRLOCH AVE.: 6 CARS. 2 LIGHT PLANES. DOG. POOL PUMP. LAWNMOWER. BIRDS. BUILDING.

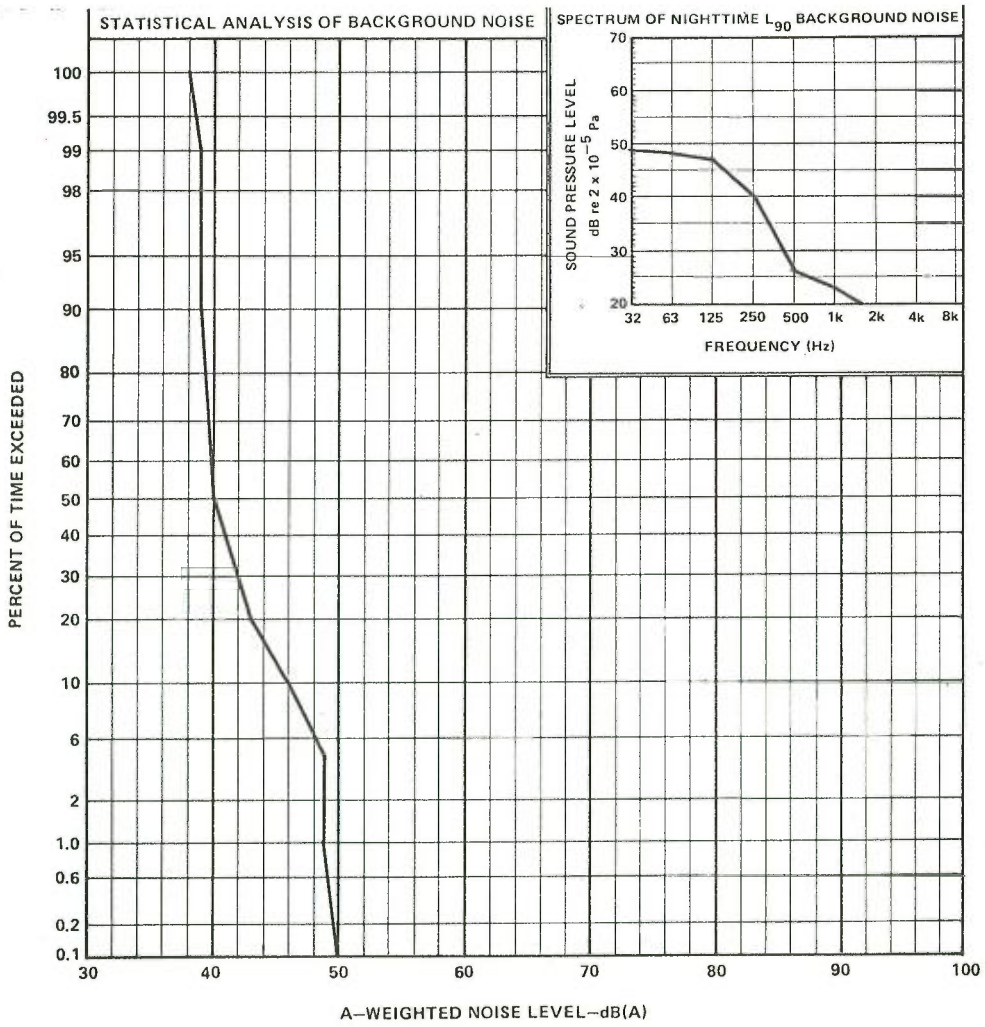
Leq 48 — — — — 1511-1521 Hrs., Sun. 18/9/83:- FAIRLOCH AVE.: 7 CARS. LIGHT PLANE. BIRDS. POOL PUMP. LAWNMOWER.

Leq 52 ——- -—— 0806-0816 Hrs., Sun. 18/9/83:- FAIRLOCH AVE.: 2 CARS. BIRDS. POOL PUMP.

Report No: 4500-3-83
Appendix No: 22.4

AMBIENT SOUND LEVELS
POSITION C4, FARMBOROUGH HEIGHTS AREA
DAY TIME MEASUREMENTS

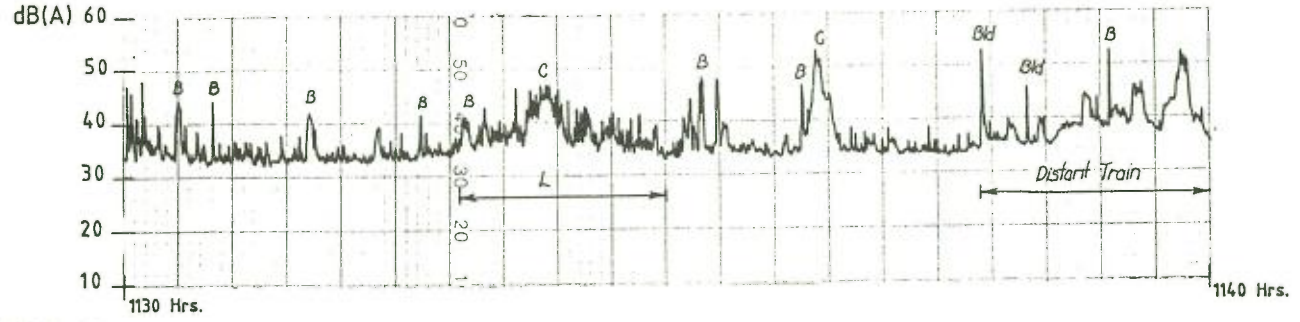


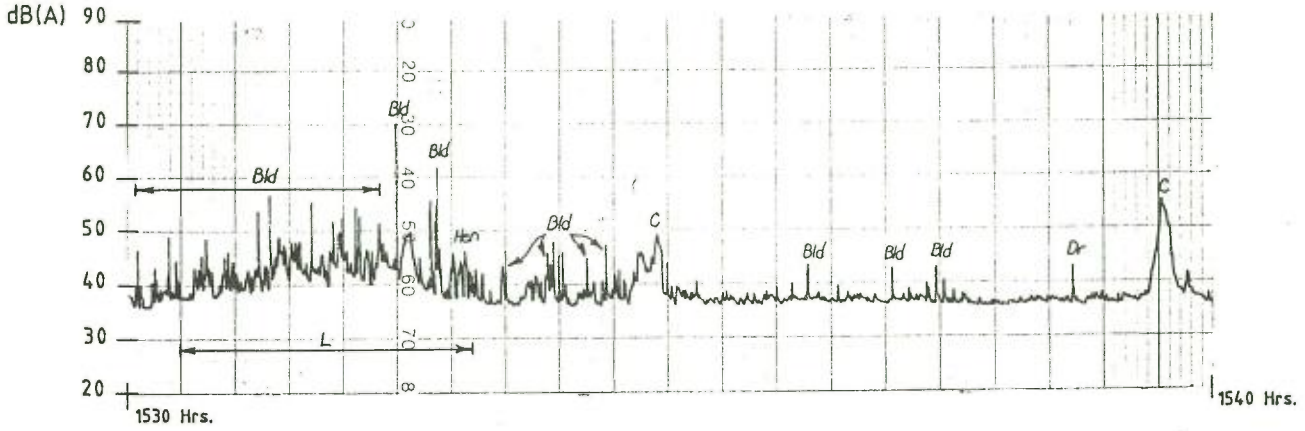


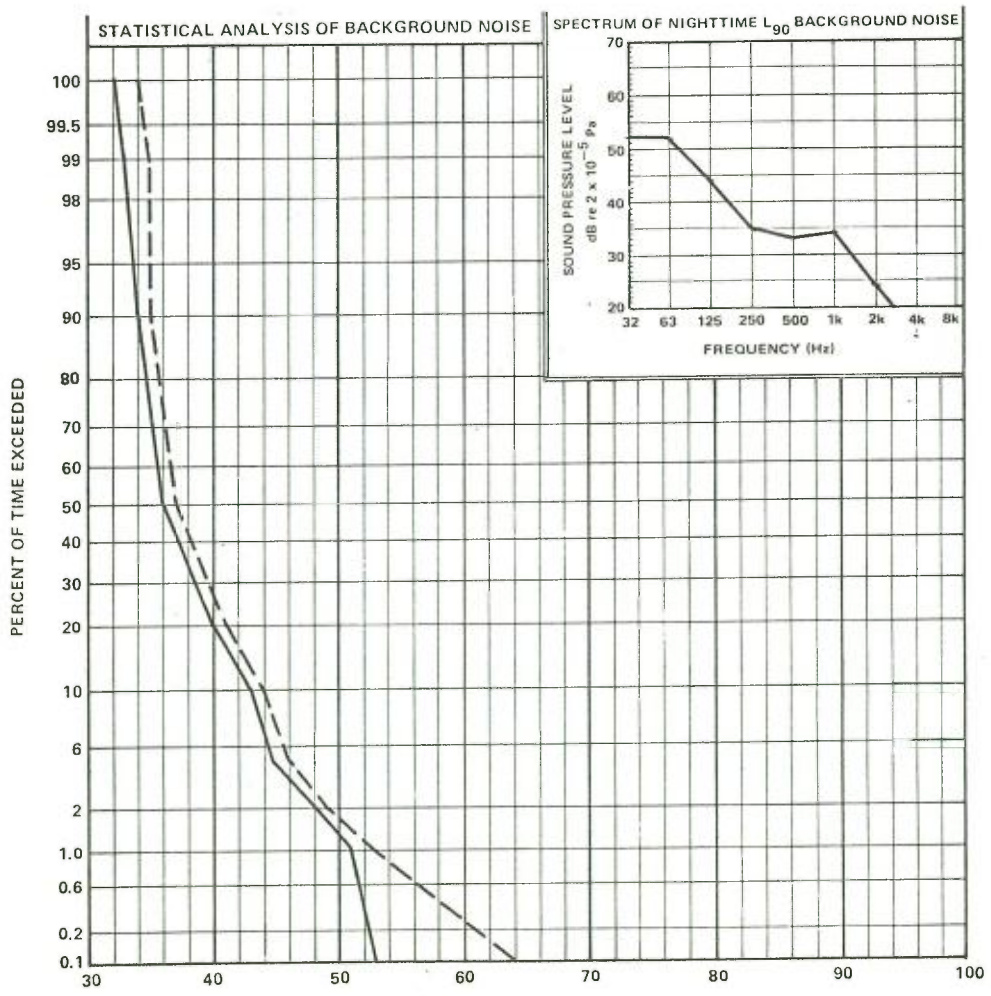
Leq 43 _____ 2224-2234 Hrs., Sun. 18/9/83:- POOL PUMP. DOG. INSECTS. LIGHT PLANE.

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AMBIENT SOUND LEVELS
POSITION C5, FARMBOROUGH HEIGHTS AREA
DAY TIME MEASUREMENTS





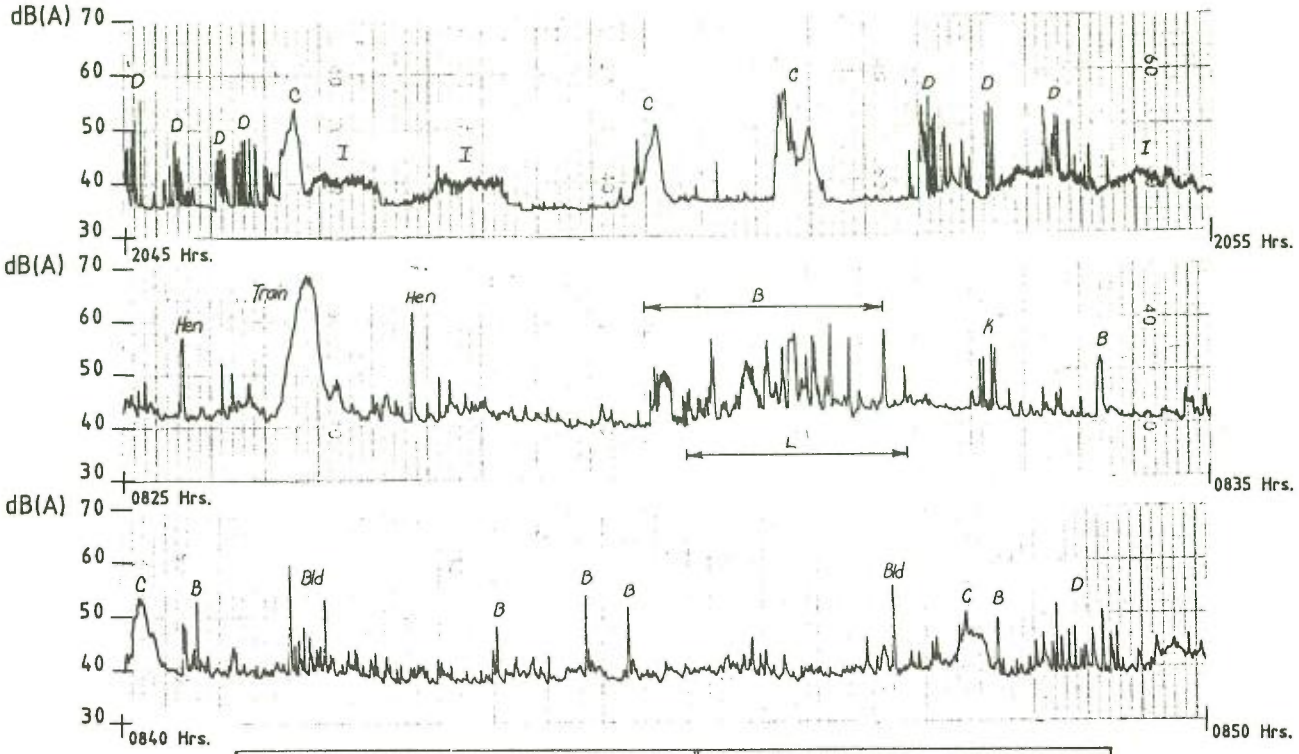


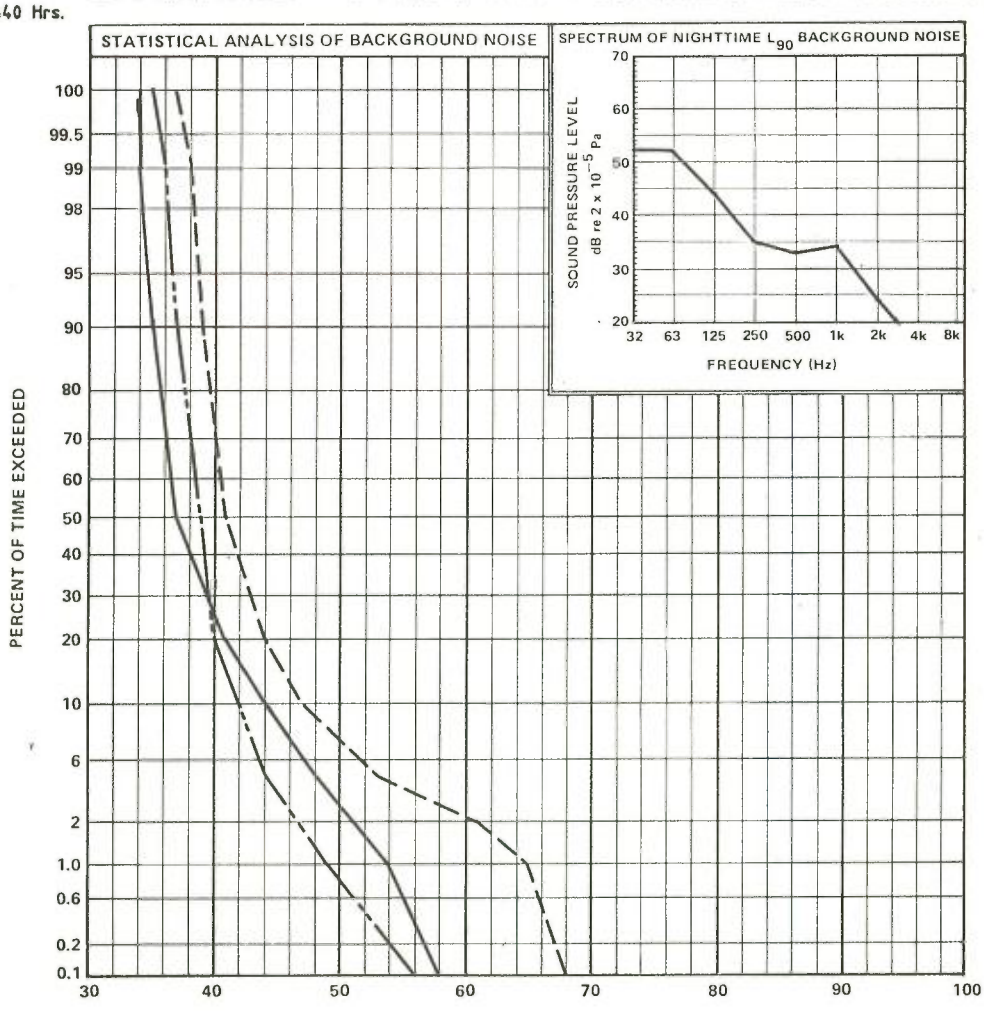
Leq 40 ———— 1130-1140 Hrs., Tues. 13/9/83:- DISTANT TRAIN. FAIRLOCH AVE.: 2 CARS. LIGHT PLANE. BIRDS. BUILDING.

Leq 45 — — — — 1530-1540 Hrs., Sun. 18/9/83:- FAIRLOCH AVE.: 3 CARS. BIRDS. HEN. LIGHT PLANE. BUILDING.

Report No: 4500-3-83
Appendix No: 23.2

AMBIENT SOUND LEVELS
POSITION C5, FARMBOROUGH HEIGHTS AREA
DAY TIME MEASUREMENTS





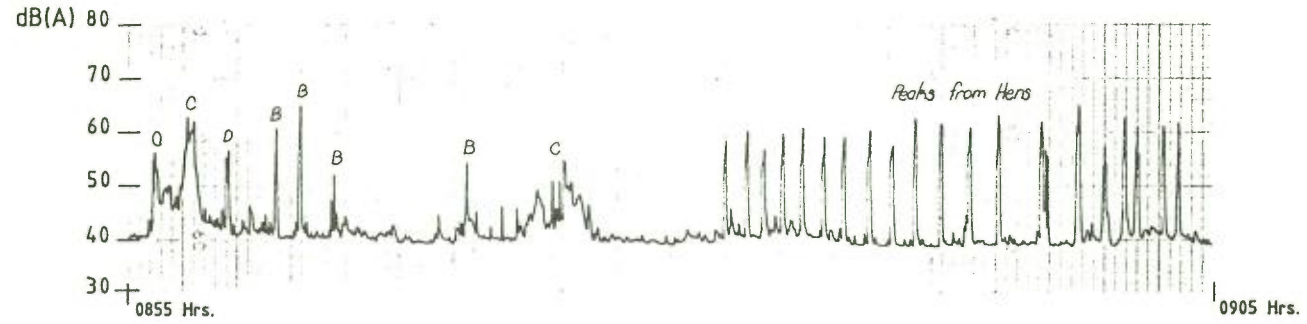
Leq 42 ———— 2045-2055 Hrs., Sun. 18/9/83:- DISTANT TRAFFIC. INSECTS. DOG.

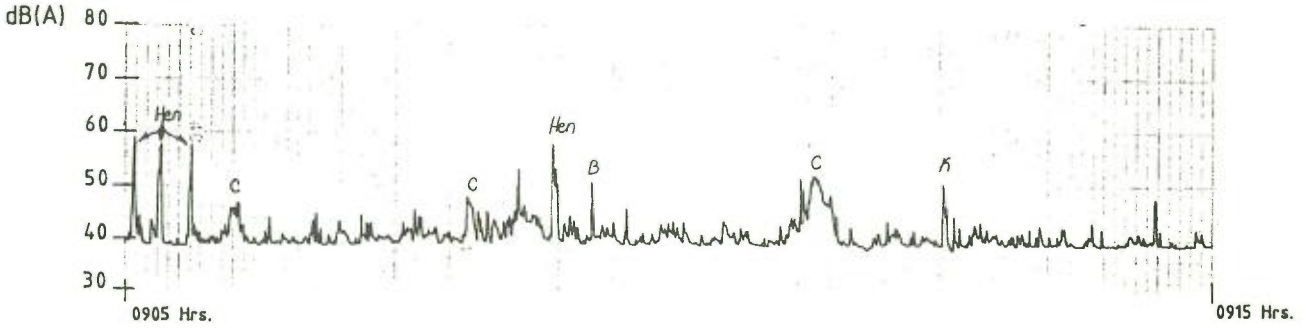
Leq 50 — — — — 0825-0835 Hrs., Mon. 19/9/83:- TRAIN (1 CARRIAGE'). LIGHT PLANE. BIRDS. HEN.

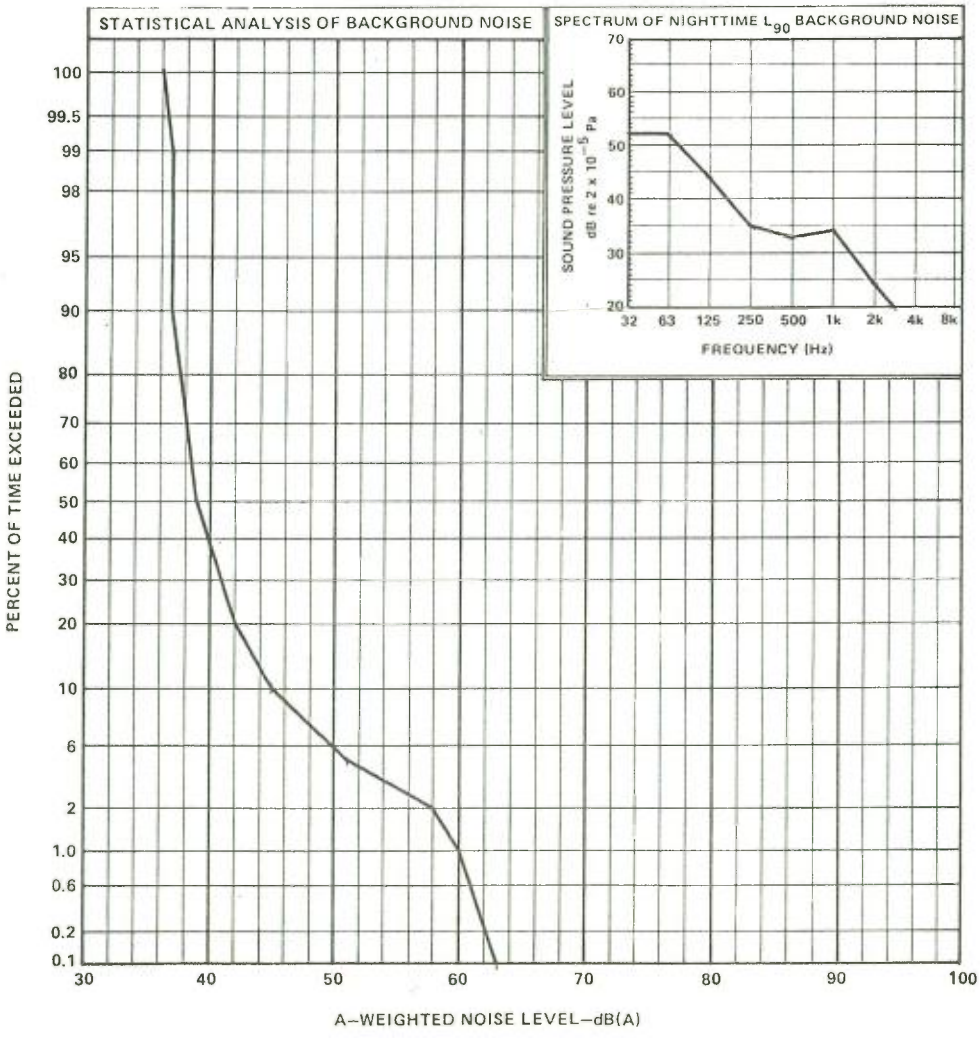
Leq 41 ——-——- 0840-0850 Hrs., Mon. 19/9/83:- DISTANT TRAFFIC. BIRDS. BUILDING. DOG.

Report No: 4500-3-83
Appendix No: 23.3

AMBIENT SOUND LEVELS
POSITION C5, FARMBOROUGH HEIGHTS AREA
DAY TIME MEASUREMENTS



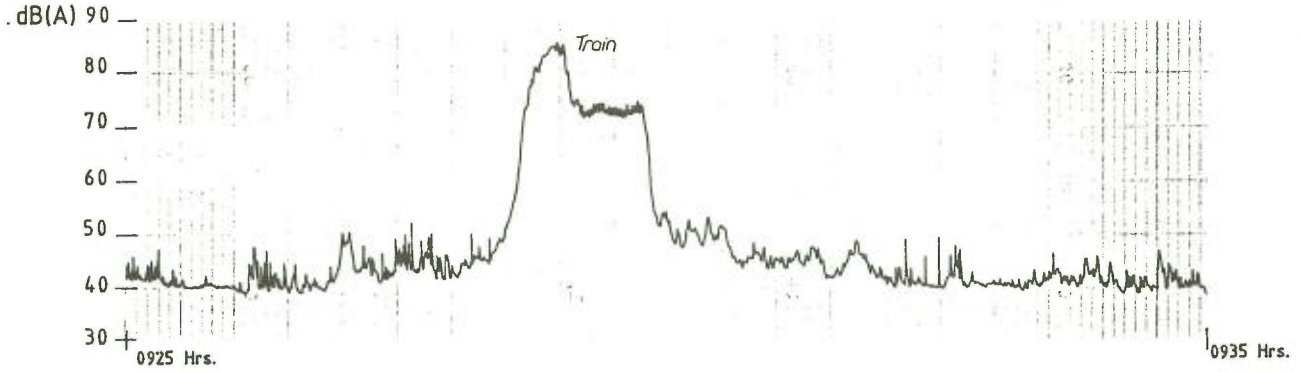


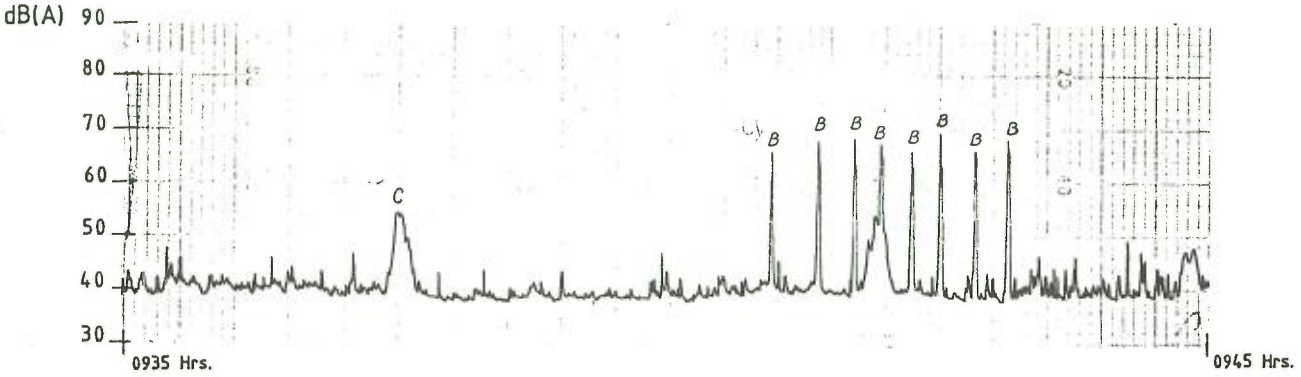


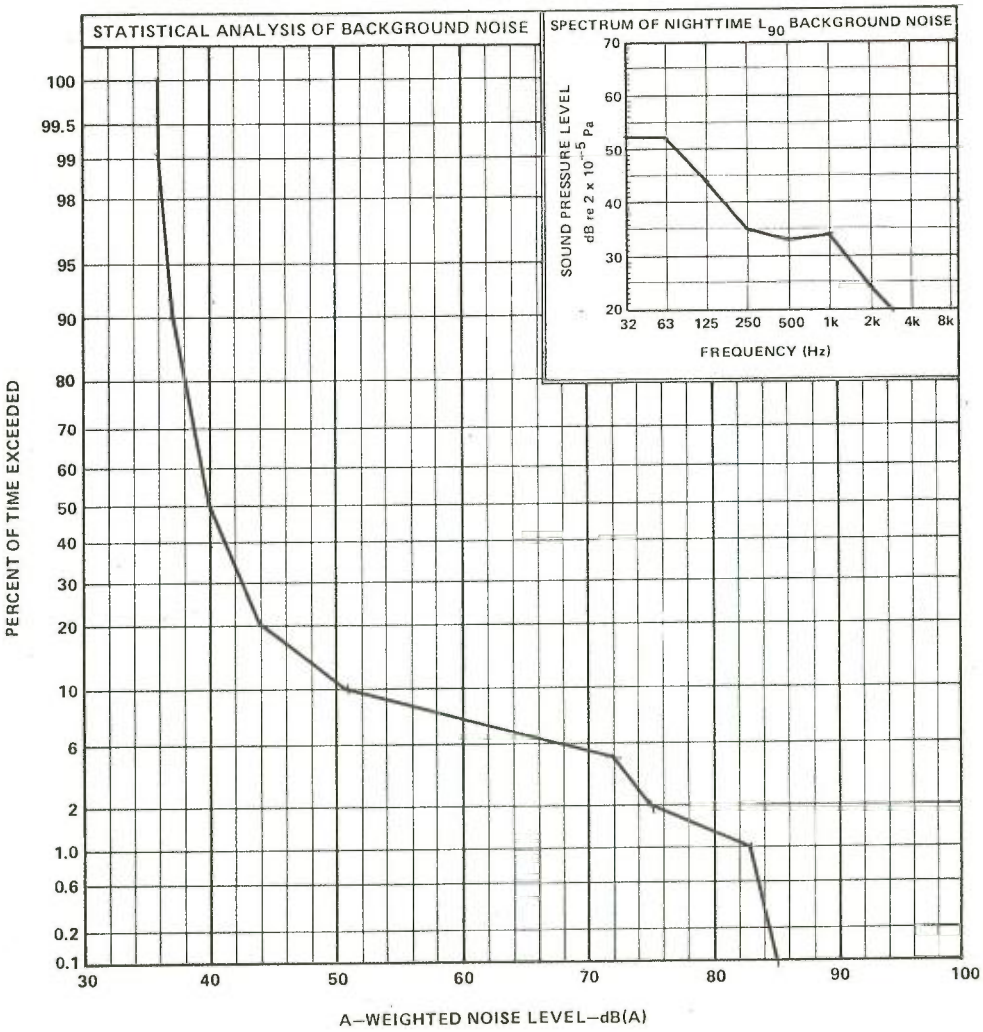
Leq 46 ———— 0855-0915 Hrs., Mon. 19/9/83:- DISTANT TRAFFIC. HORN. BIRDS. HEN. CHILDREN. LIGHT WIND.

Report No: 4500-3-83
Appendix No: 23.4

AMBIENT SOUND LEVELS
POSITION C5, FARMBOROUGH HEIGHTS AREA
DAY TIME MEASUREMENTS



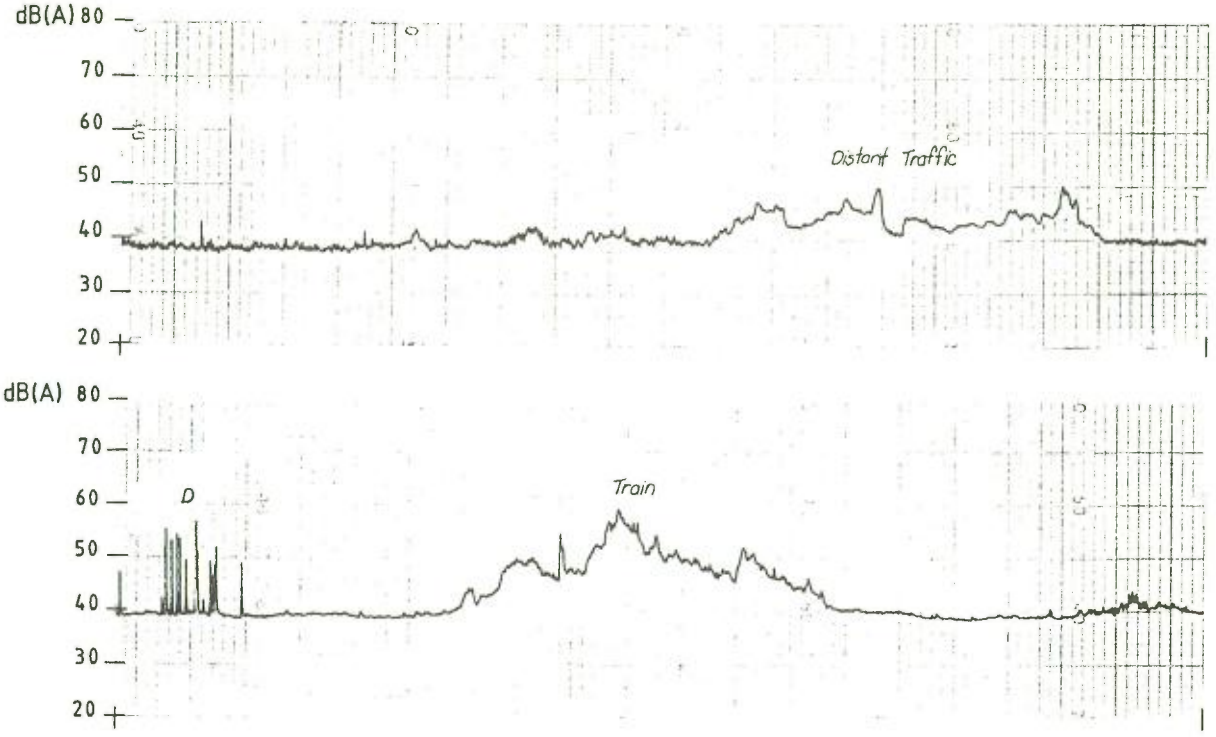


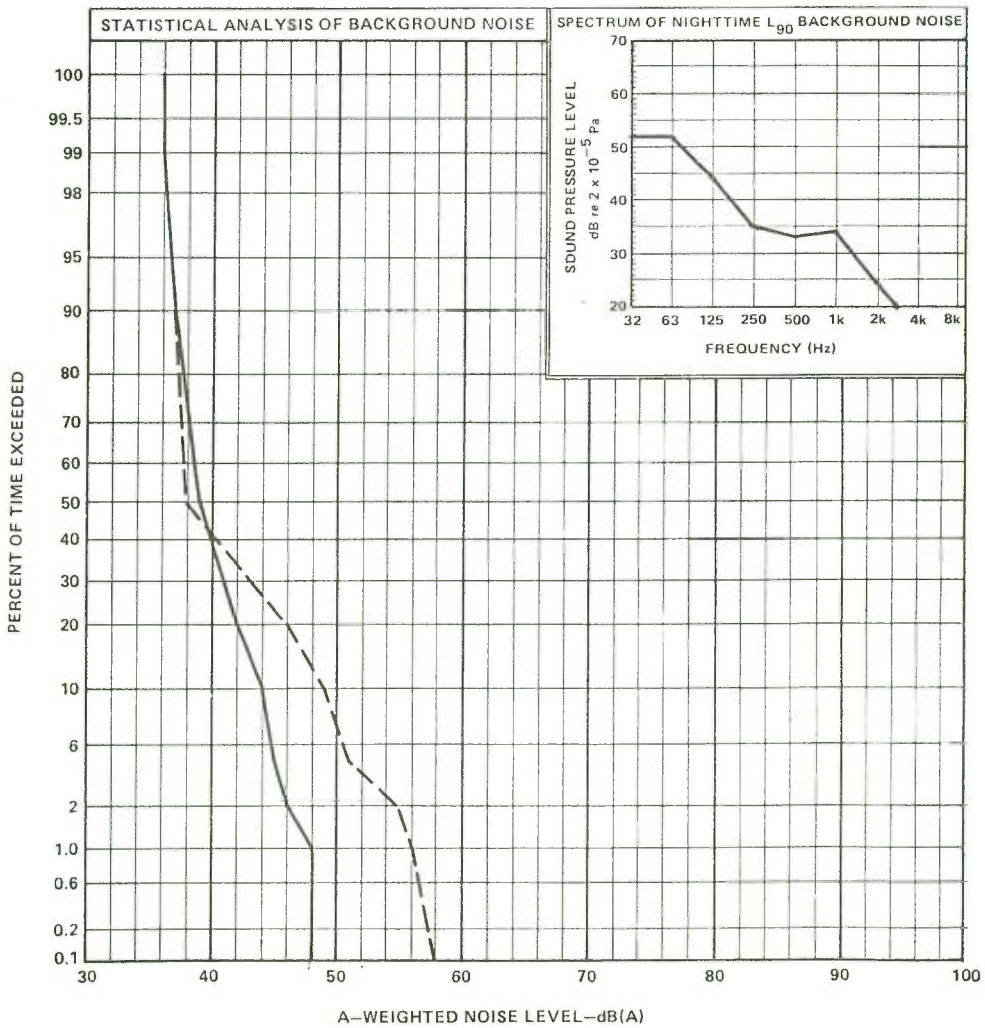


Leq 66 ———— 0925-0945 Hrs., Mon. 19/9/83:- TRAIN ON MOSS VALE LINE, 2 LOCOS, 28 CARRIAGES, 1 CABOOSE. BIRDS.

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Appendix No: 23.5

AMBIENT SOUND LEVELS
POSITION C5, FARMBOROUGH HEIGHTS AREA
NIGHT TIME MEASUREMENTS



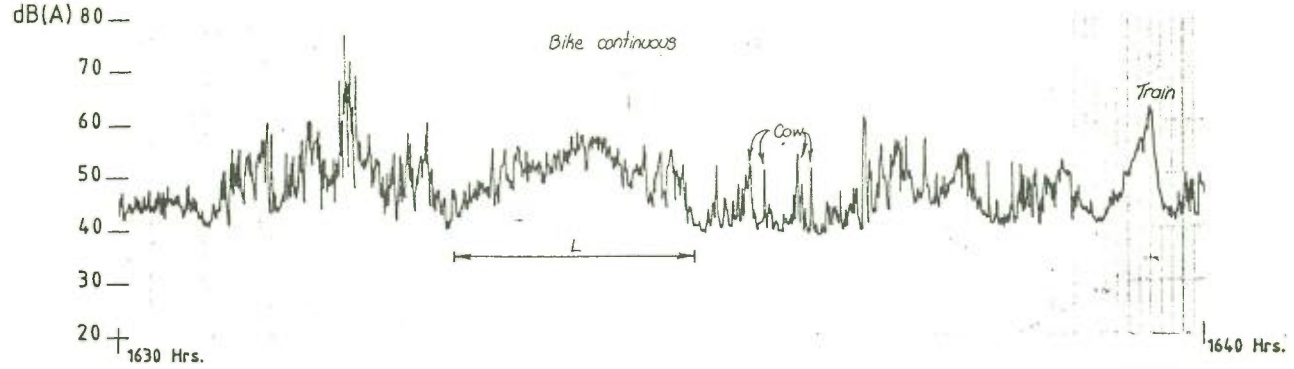


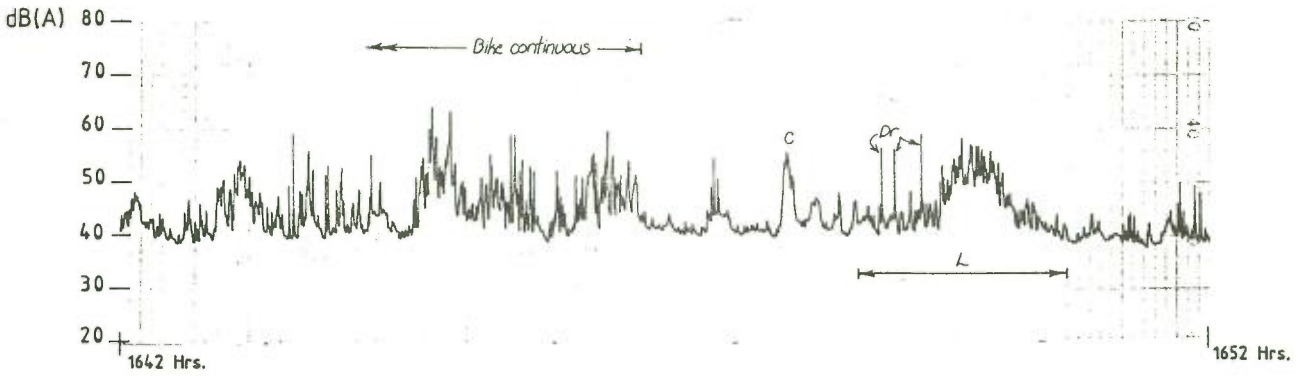
Leq 41 ———— 2319-2329 Hrs., Mon. 19/9/83:- DISTANT TRAFFIC.

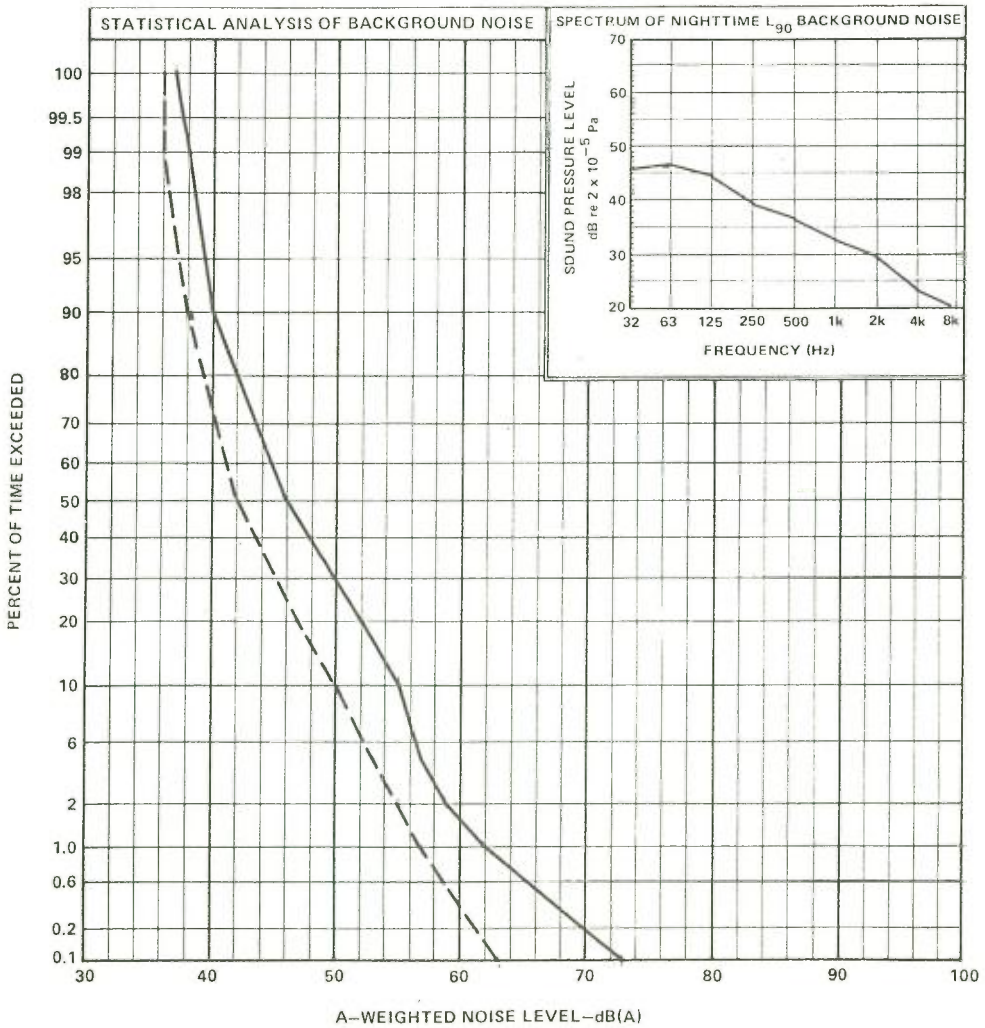
Leq 45 — — — — 0105-0115 Hrs., Tues. 20/9/83:- TRAIN ON SOUTHERN LINE. DOG. RUSTLING LEAVES.

Report No: 4500-3-83
Appendix No: 24.1

AMBIENT SOUND LEVELS
POSITION C6, FARMBOROUGH HEIGHTS AREA
DAY TIME MEASUREMENTS





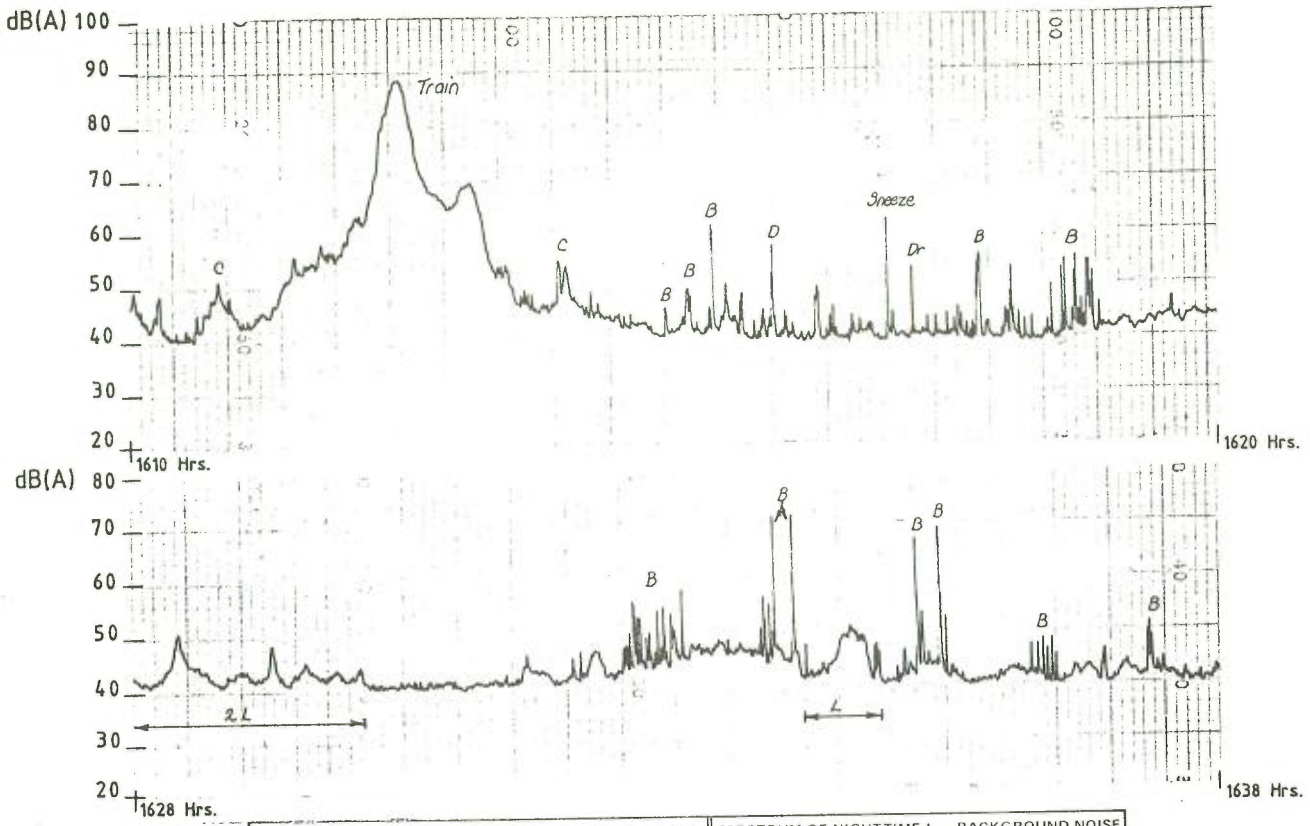


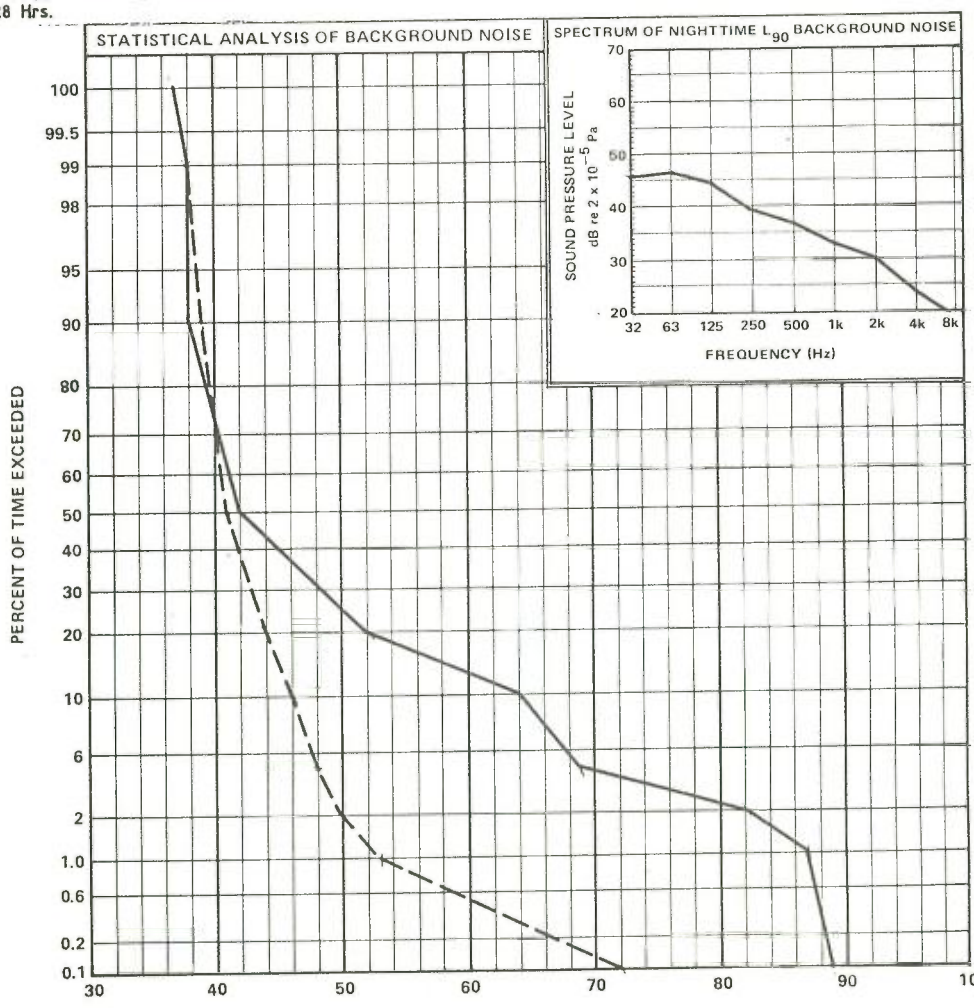
Leq 53 ———— 1630-1640 Hrs., Sun. 18/9/83:- TRAIN ON MOSS VALE LINE. 1 BIKE AT VAN DER HARR PROPERTY. 2 LIGHT PLANES. BIRDS. DOG. DOMESTIC.

Leq 47 — — — — 1642-1652 Hrs., Sun. 18/9/83:- DISTANT TRAIN. BIKE AT VAN DER HARR PROPERTY. 2 CARS. LIGHT PLANE. BIRDS. DOG. CHILDREN. DOMESTIC.

Report No: 4500-3-83
Appendix No: 24.2

AMBIENT SOUND LEVELS
POSITION C6, FARMBOROUGH HEIGHTS AREA
DAY TIME MEASUREMENTS

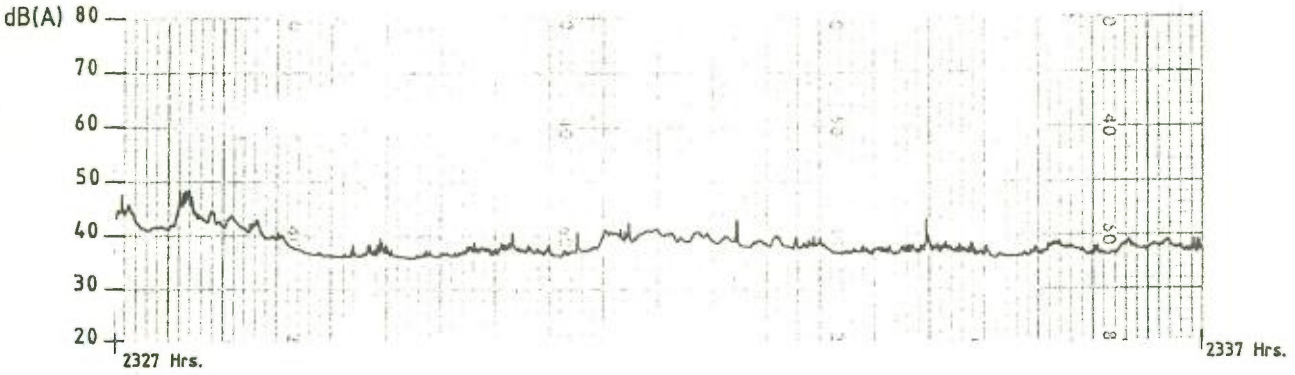


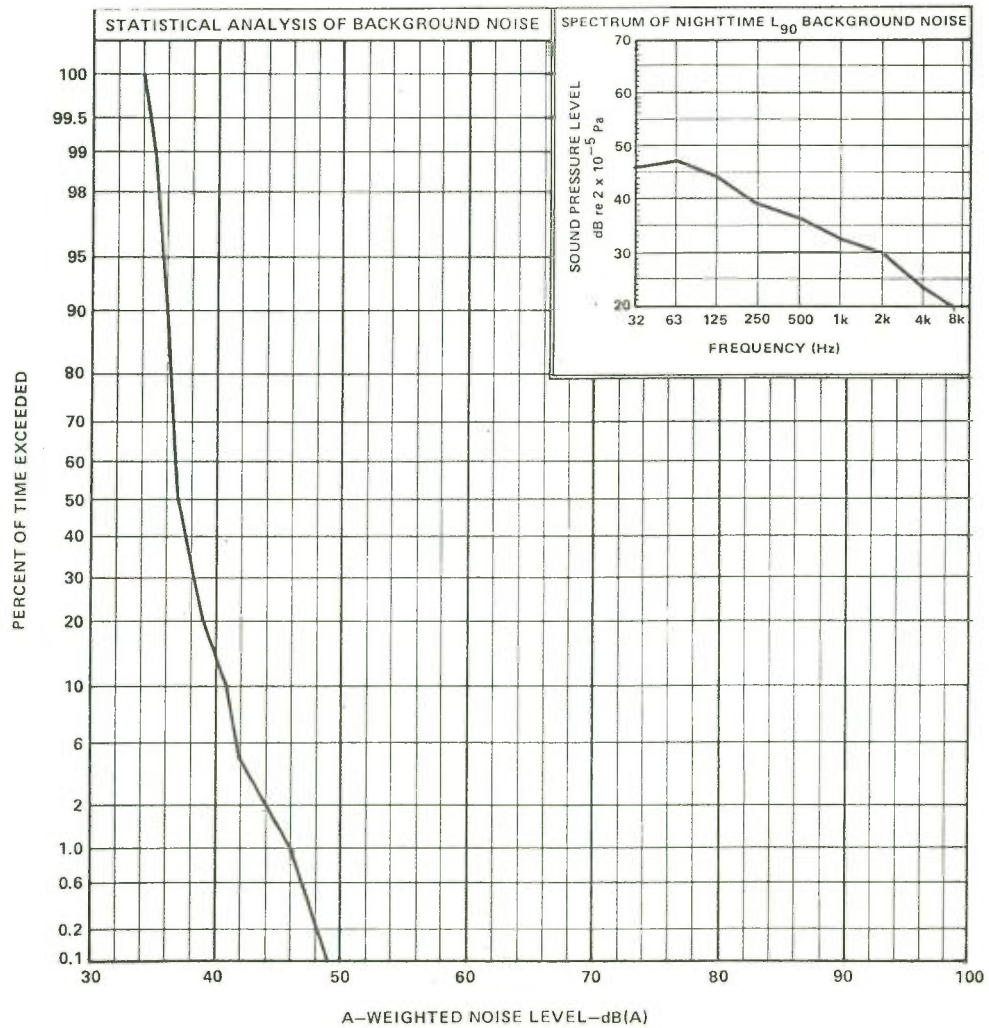


Leq 71 ———— 1610-1620 Hrs., Mon. 19/9/83:- GOODS TRAIN ON MOSS VALE LINE, 2 LOCOS, 30 CARRIAGES, 1 CABOOSE. DISTANT TRAFFIC. DOG. BIRDS. DOOR. SNEEZE.

Leq 48 — — — — 1628-1638 Hrs., Mon. 19/9/83:- 3 LIGHT PLANES. BIRDS.

AMBIENT SOUND LEVELS
POSITION C6, FARMBOROUGH HEIGHTS AREA
NIGHT TIME MEASUREMENTS

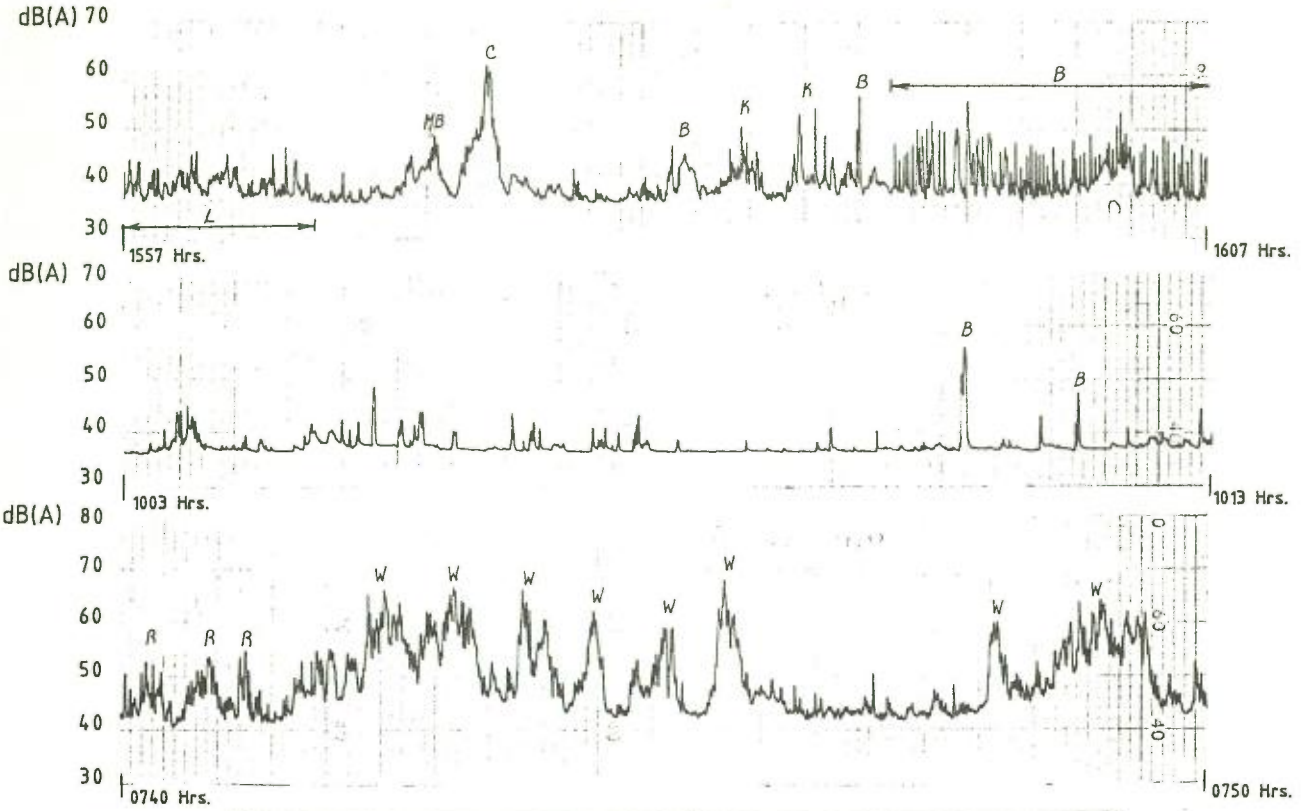


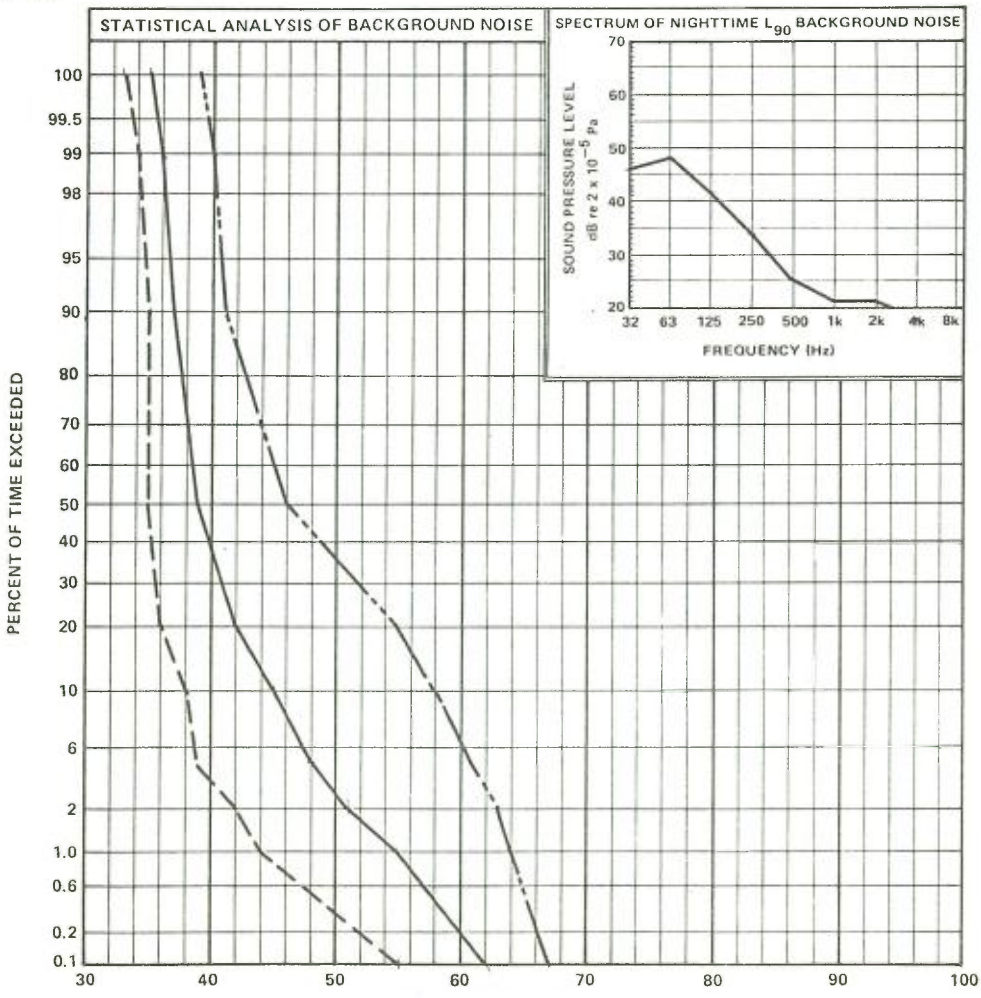


Leq 39 ———— 2327-2337 Hrs., Sun. 18/9/83:- RUSTLING LEAVES.

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Appendix No: 25.1

AMBIENT SOUND LEVELS
POSITION C7, FARMBOROUGH HEIGHTS AREA
DAY TIME MEASUREMENTS





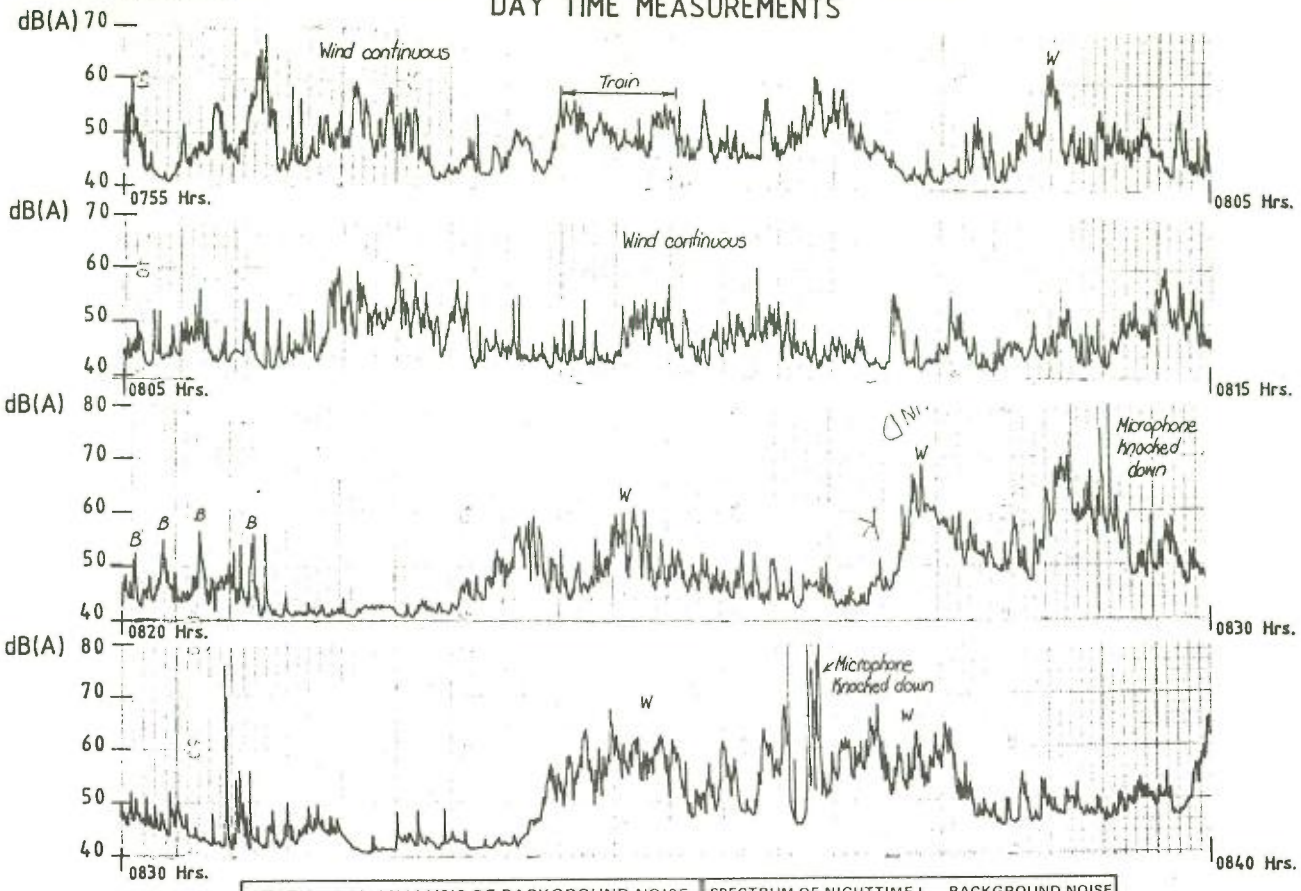
Leq 44 ———— 1557-1607 Hrs., Sun. 18/9/83:- 1 CAR, 1 BIKE. LIGHT PLANE. BIRDS. INSECTS. CHILDREN.

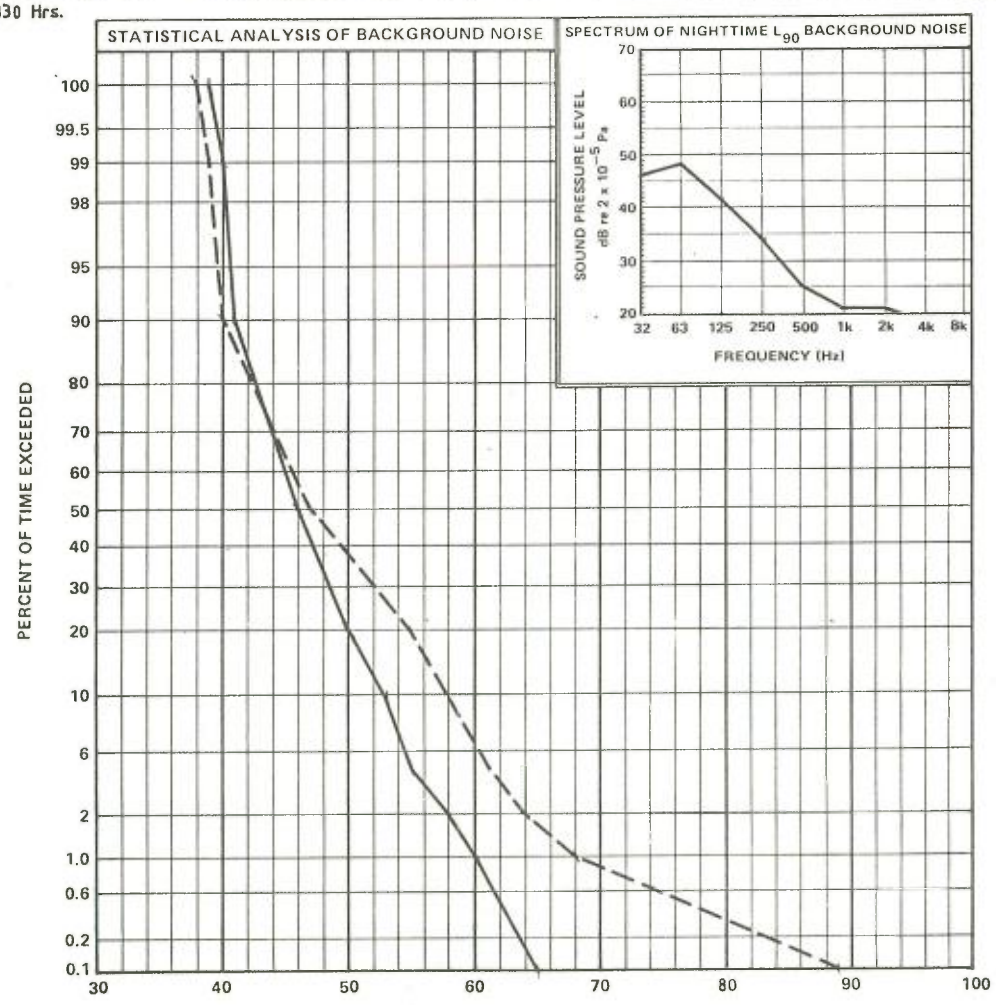
Leq 37 — — — — 1003.-1013 Hrs., Mon. 19/9/83:,-

Leq 54 ——- — ——- 0740-0750 Hrs., Tues. 20/9/83:- 3 CARS. BIRDS. DOG. DOMESTIC NOISE. RUSTLING LEAVES. LIGHT WIND, S.E.

AMBIENT SOUND LEVELS
POSITION C7, FARMBOROUGH HEIGHTS AREA
DAY TIME MEASUREMENTS

Report No: 4500-3-83
Appendix No: 25.2

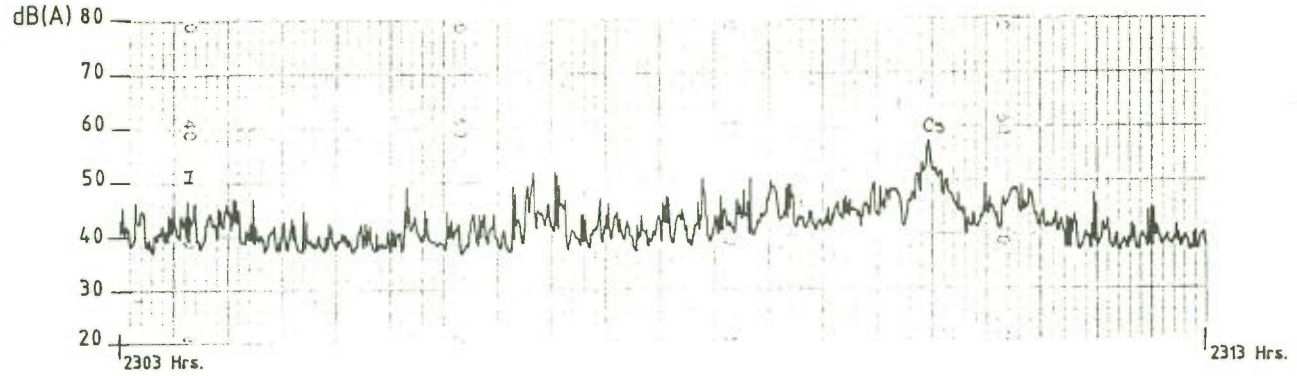


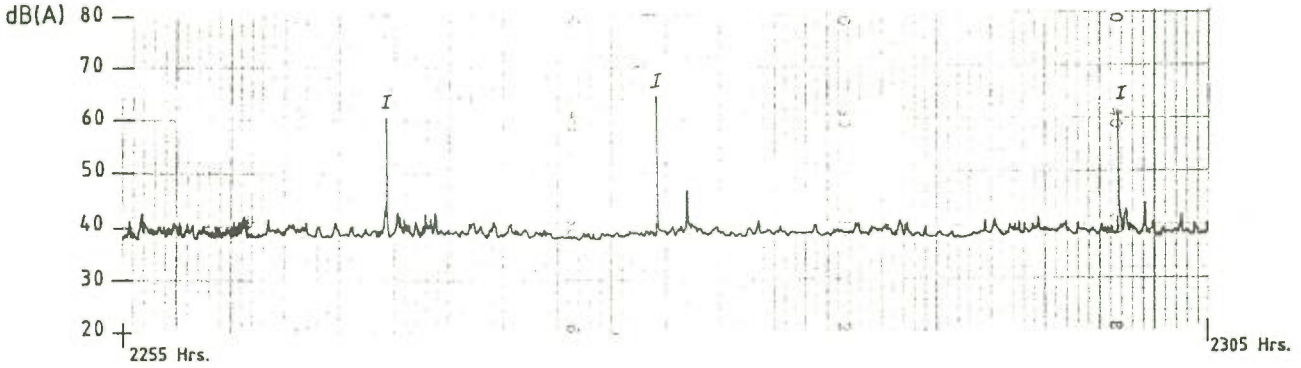


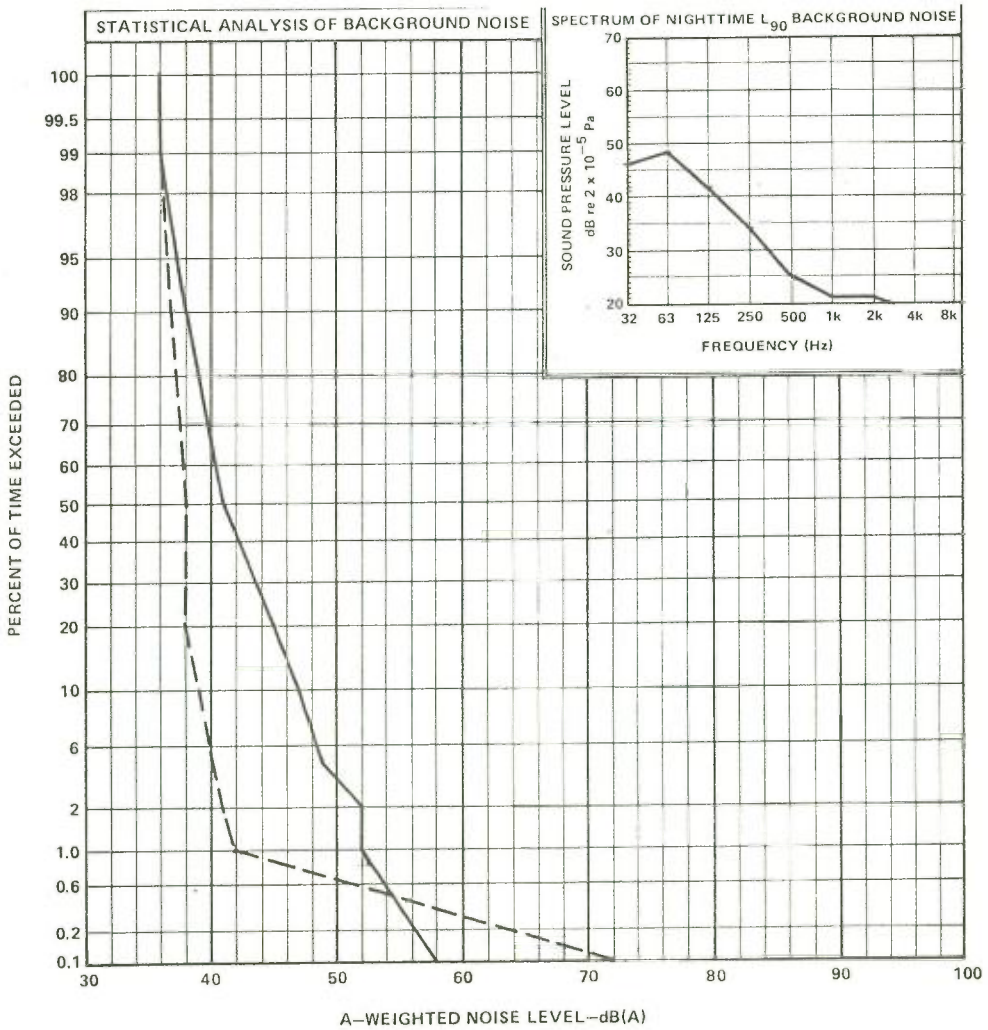
Leq 50 ———— 0755-0815 Hrs., Tues. 20/9/83:- TRAIN ON MOSS VALE LINE. 3 CARS. BIRDS. INDUSTRY (AIS). RUSTLING LEAVES. WIND: 13kph

Leq 80 — — — — 0820-0840 Hrs., Tues. 20/9/83:- 3 CARS. INDUSTRY (AIS). BIRDS. CHILDREN. RUSTLING LEAVES. WIND: 18kph (MICROPHONE KNOCKED DOWN BY WIND)

AMBIENT SOUND LEVELS
POSITION C7, FARMBOROUGH HEIGHTS AREA
NIGHT TIME MEASUREMENTS



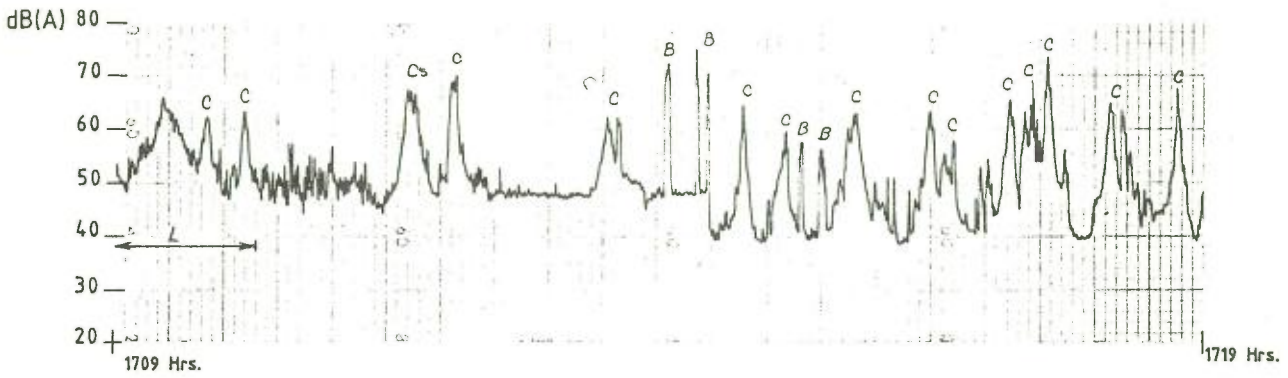


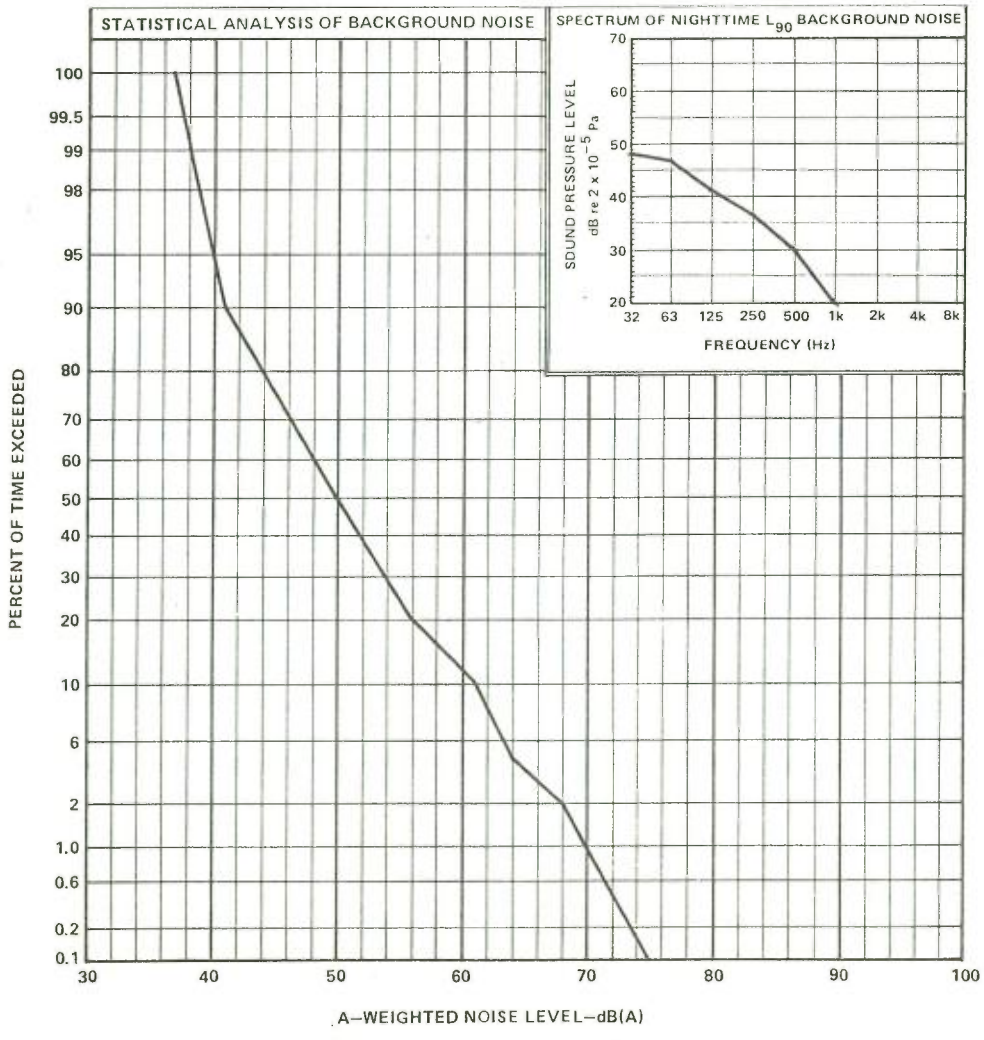


Leq 44 ———— 2303-2313 Hrs., Mon. 19/9/83:- 2 CARS. RUSTLING LEAVES. INSECTS.

Leq 41 — — — — 2255-2305 Hrs., Mon. 19/9/83:- INSECTS.

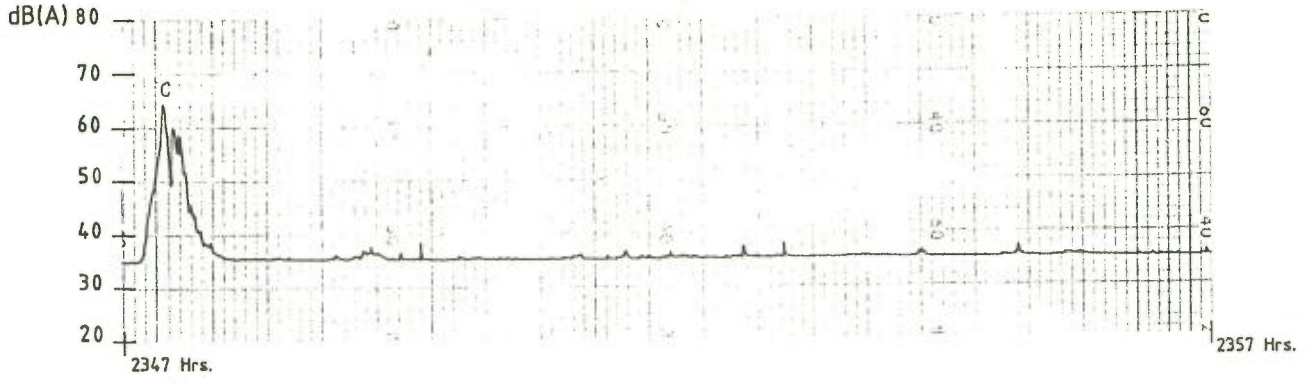
AMBIENT SOUND LEVELS
POSITION C8, FARMBOROUGH HEIGHTS AREA
DAY TIME MEASUREMENTS

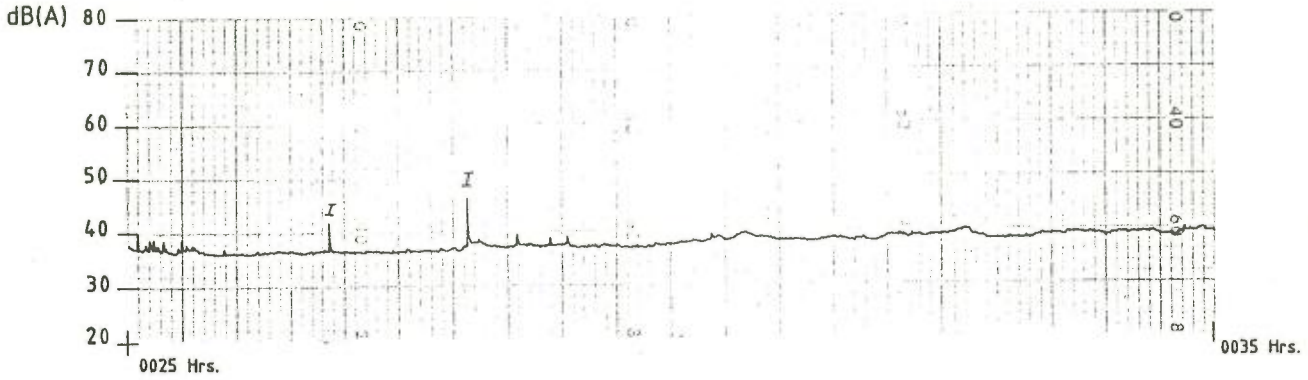


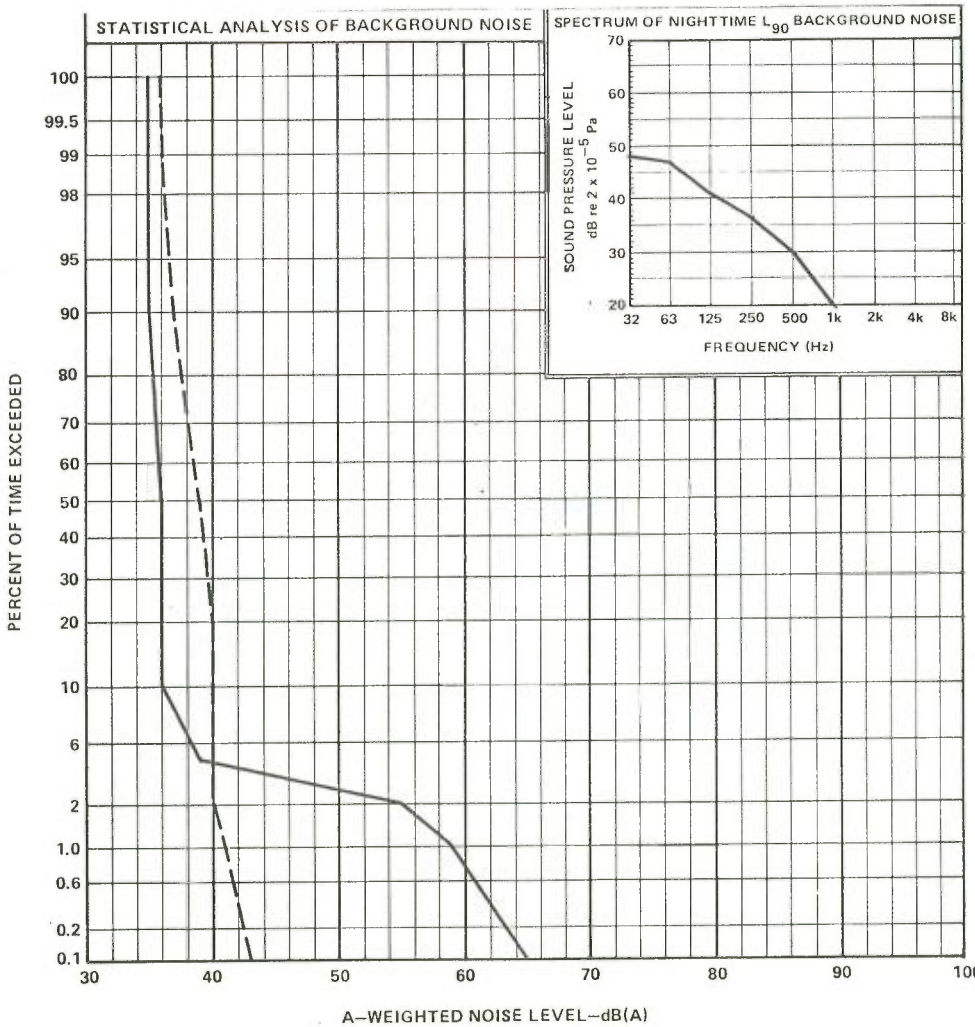


Leq 58 ——— 1709-1719 Hrs., Sun. 18/9/83:- FARMBOROUGH RD,: 15 CARS. LOCH LOMOND AVE.: 8 CARS. BIRDS. 2 LIGHT PLANES. CHILDREN.

AMBIENT SOUND LEVELS
POSITION C8, FARMBOROUGH HEIGHTS AREA
NIGHT TIME MEASUREMENTS





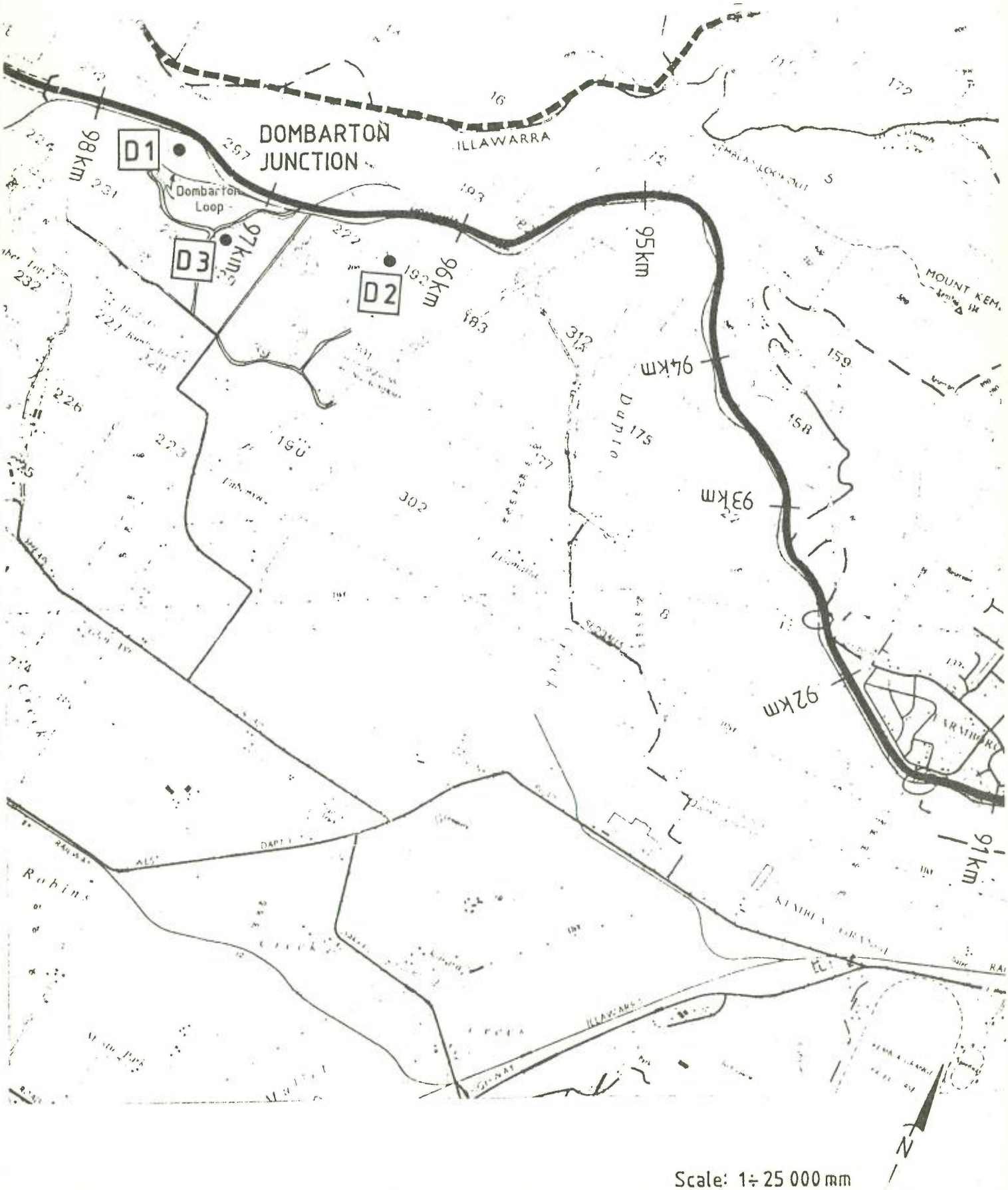


Leq 45 _____ 2347-2357 Hrs., Sun. 18/9/83:- 1 CAR.

Leq 39 _ _ _ _ 0025-0035 Hrs., Tues. 20/9/83:- INSECTS.

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Appendix No: 27.1

LOCATION PLAN
SHOWING MEASUREMENT POSITIONS
DOMBARTON AREA



Scale: 1÷25 000 mm

DESCRIPTION OF MEASUREMENT POSITIONS

DOMBARTON

(Designated as Area 'D')

POSITION No: D1

At nearest residence of three railway cottages at rail loop

POSITION No: D2

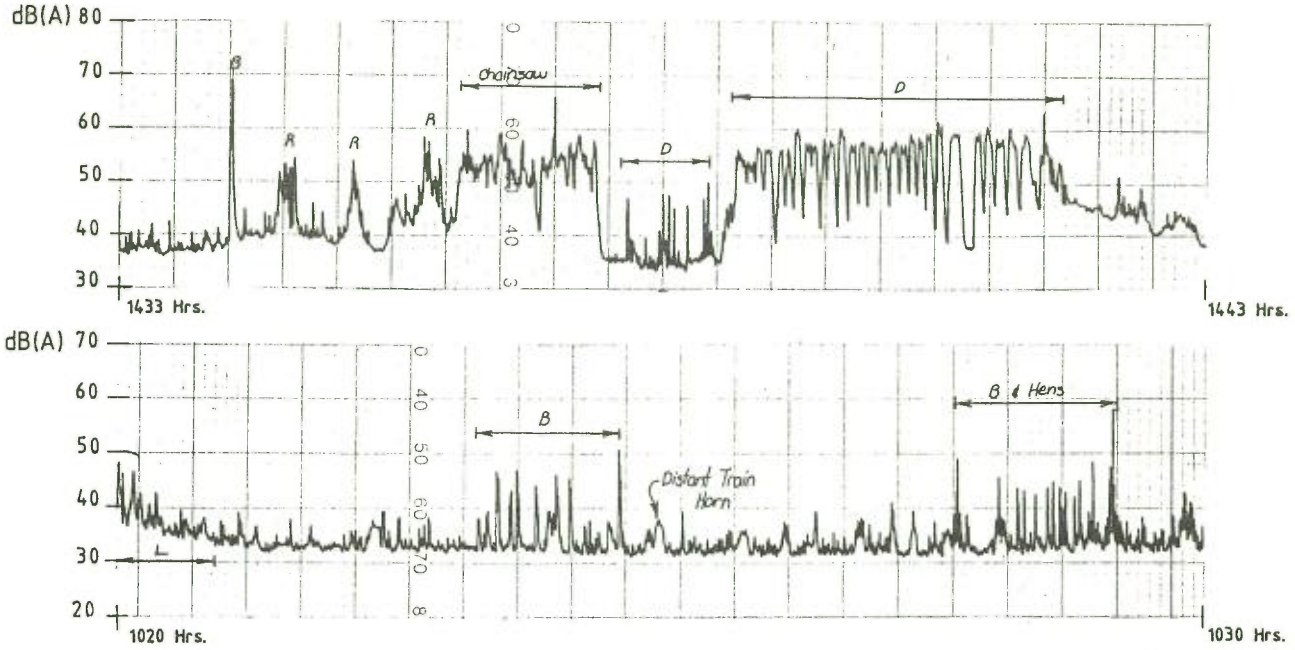
At Arnold's Residence

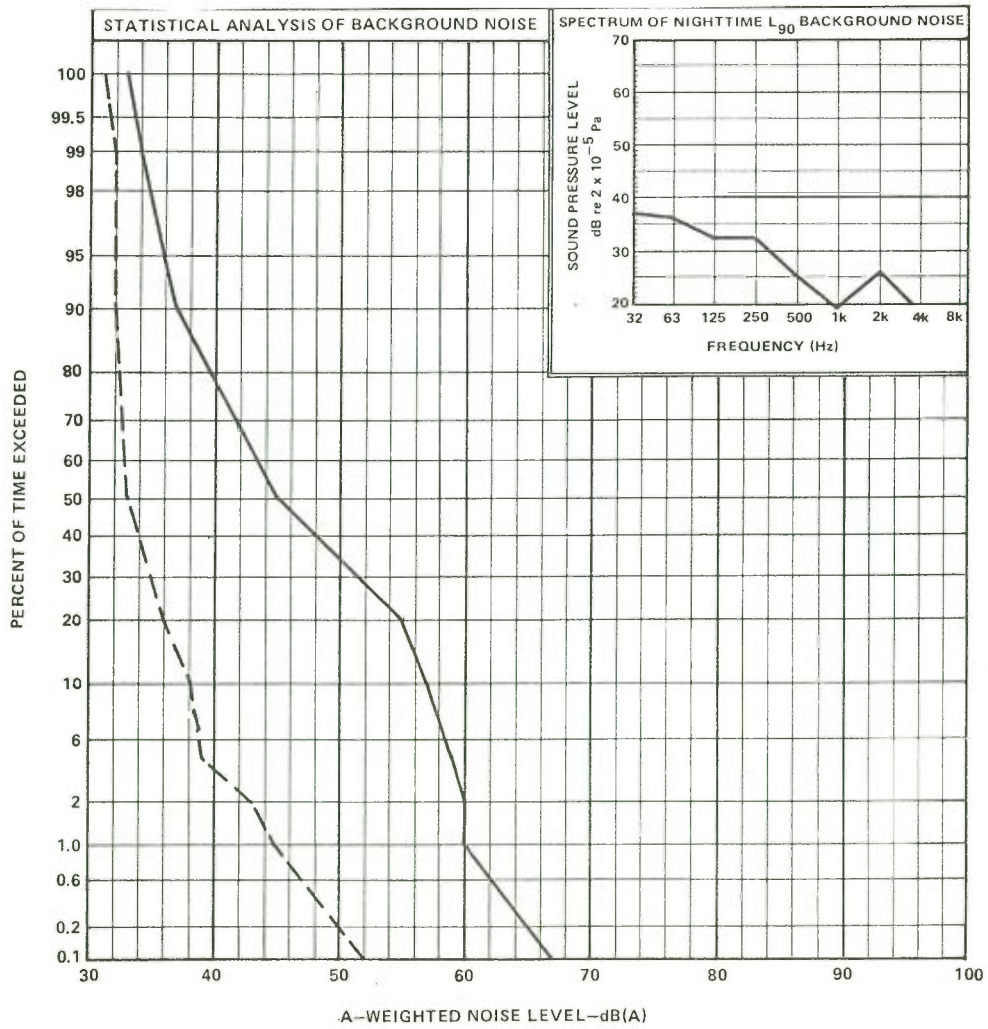
POSITION No: D3

At William's Residence

Report No: 4500-3-83
Appendix No: 28.1

AMBIENT SOUND LEVELS
POSITION D1, DOMBARTON AREA
DAY TIME MEASUREMENTS

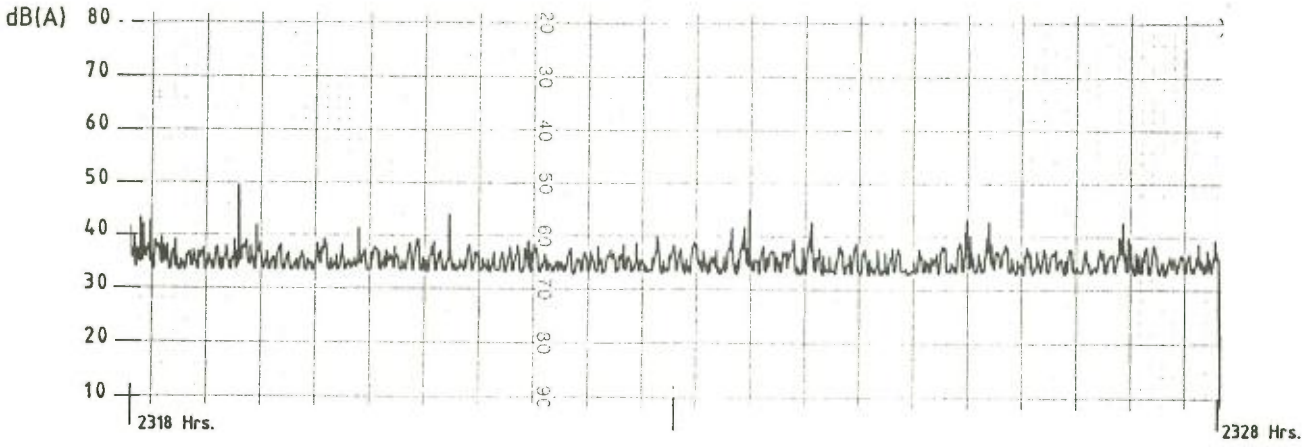


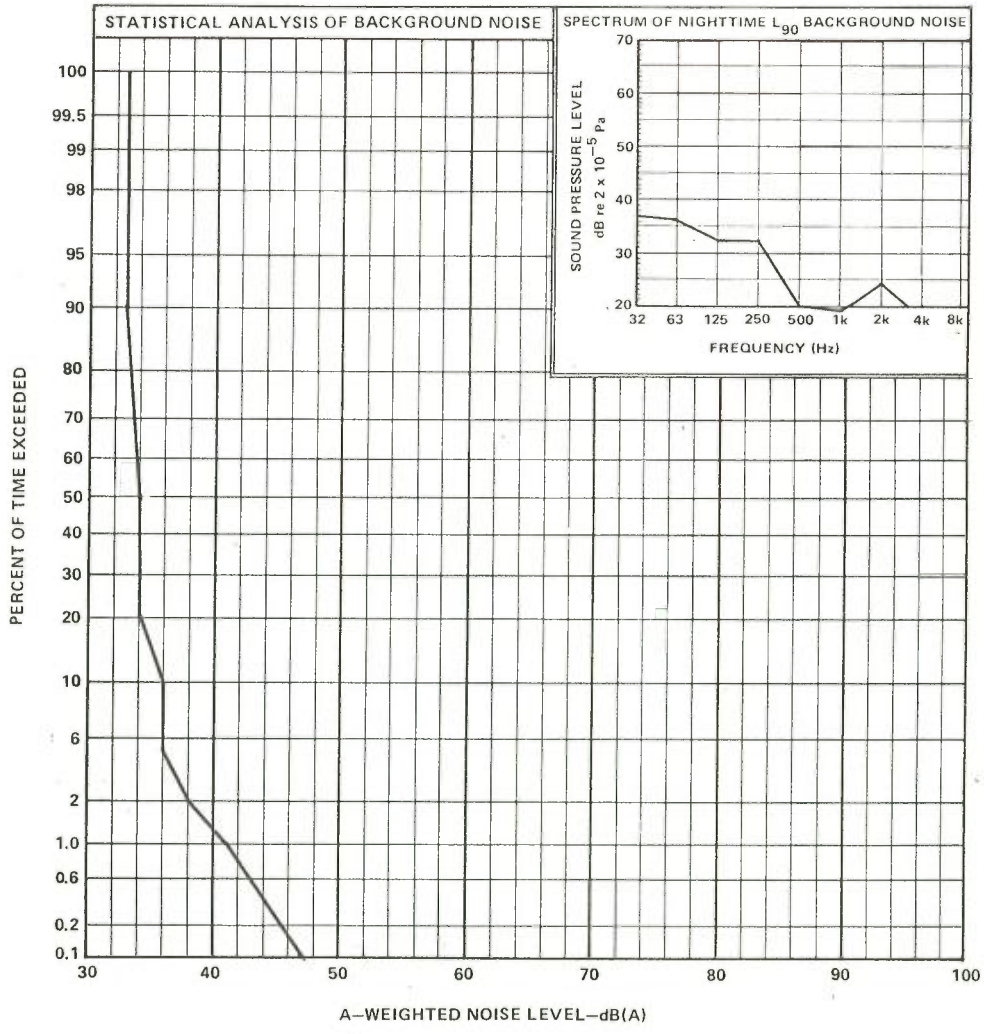


Leq 52 ———— 1433-1443 Hrs., Wed. 7/9/83:- BIRDS. DOG. RUSTLING LEAVES. CHAINSAW

Leq 36 — — — — 1020-1030 Hrs., Tues. 13/9/83:- LIGHT PLANE. BIRDS. HEN. DISTANT TRAN HORN.

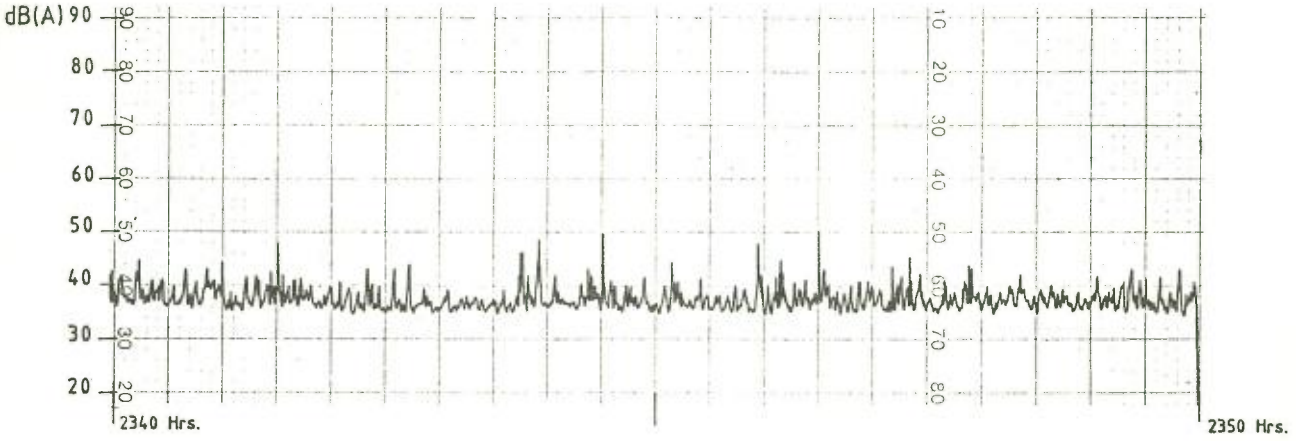
AMBIENT SOUND LEVELS
POSITION D1, DOMBARTON AREA
NIGHT TIME MEASUREMENTS

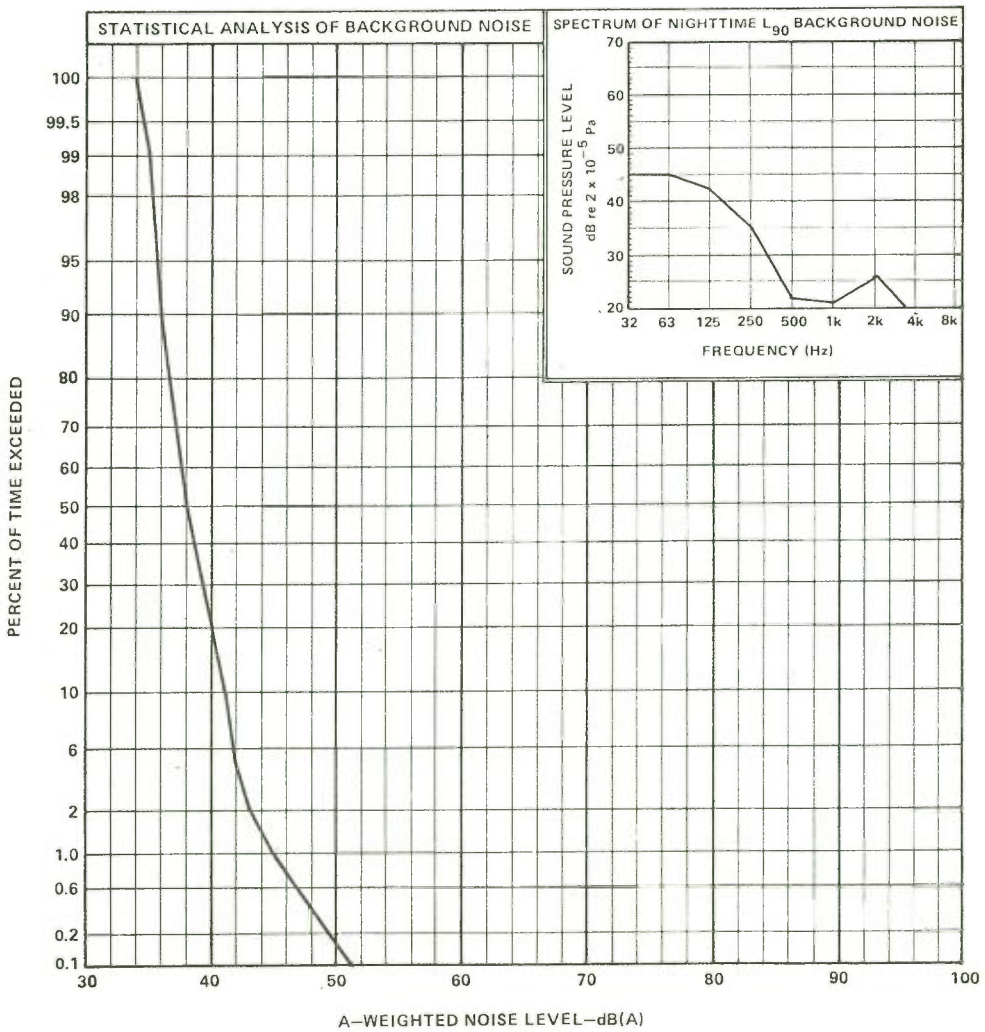




Leq 36 ———— 2318-2328 Hrs., Sat. 29/9/83:- BIRDS. INSECTS. FROGS.

AMBIENT SOUND LEVELS
POSITION D2, DOMBARTON AREA
NIGHT TIME MEASUREMENTS

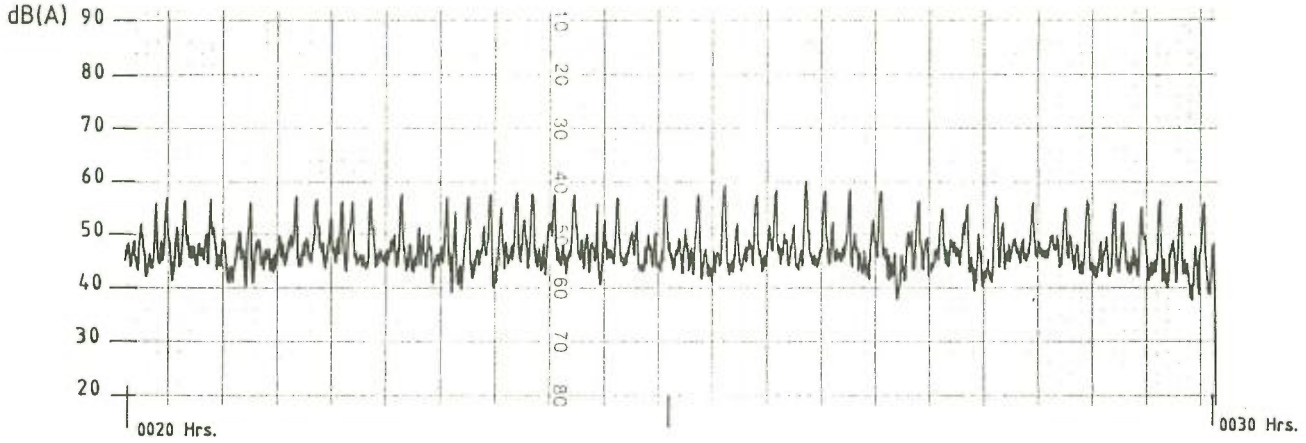


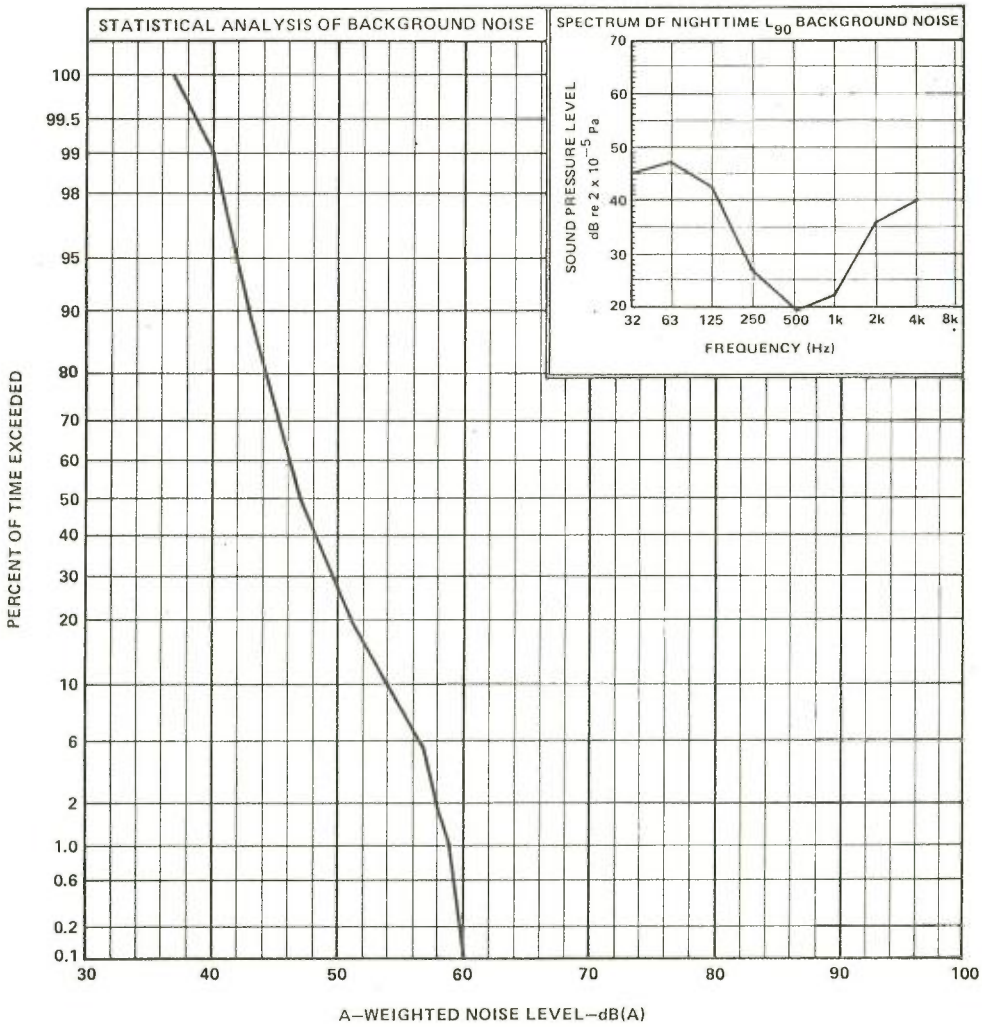


Leq39 _____ 2340-2350 Hrs., Sat. 29/9/83:- DOG. FROGS. INSECTS.

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Appendix No: 30

AMBIENT SOUND LEVELS
POSITION D3, DOMBARTON AREA
NIGHT TIME MEASUREMENTS

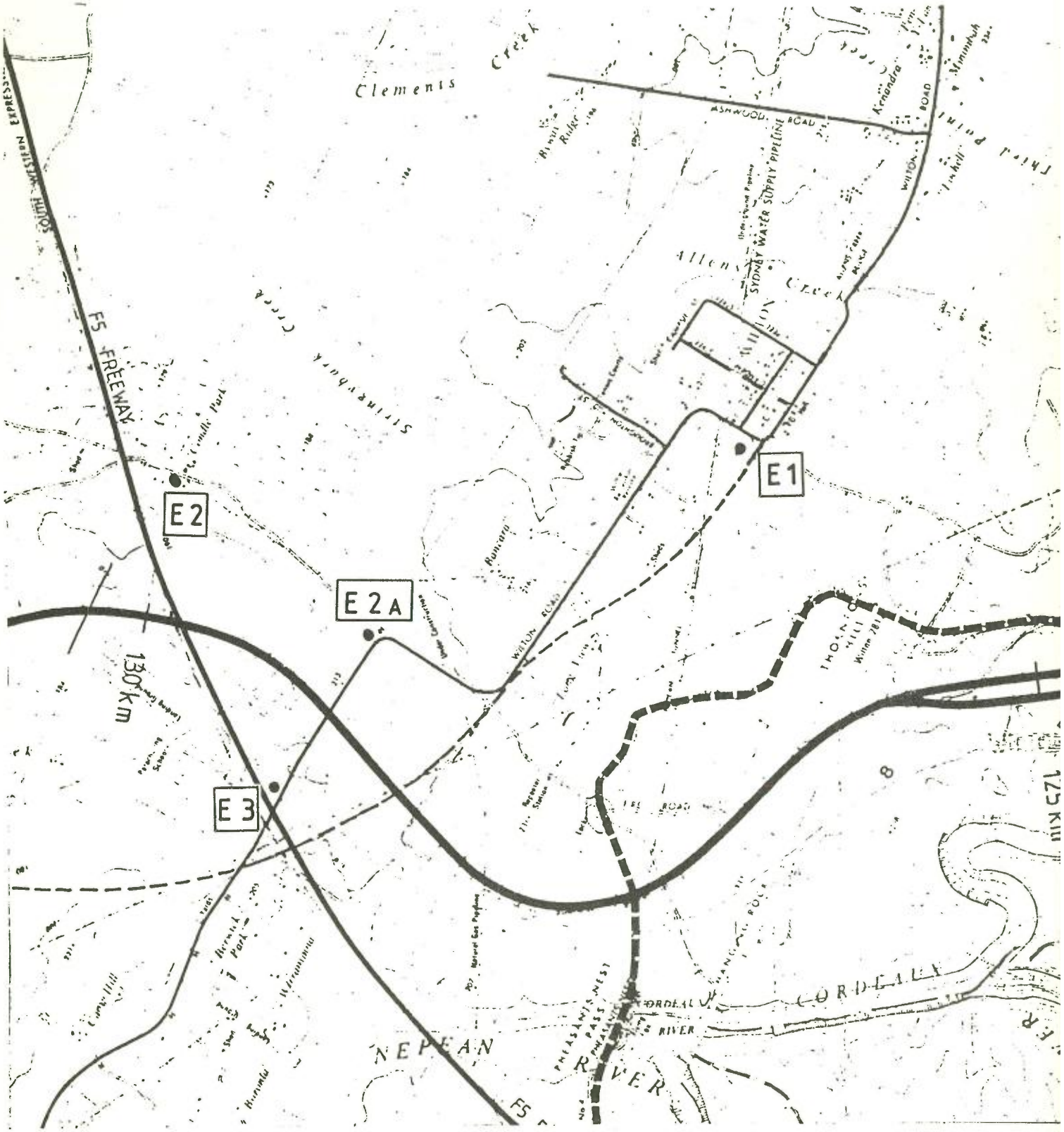




Leq 50 _____ 0020-0030 Hrs., Sun. 30/9/83:- FROGS. INSECTS.

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Appendix No: 31.1

LOCATION PLAN
SHOWING MEASUREMENT POSITIONS
WILTON AREA



Scale: 1-25 000

DESCRIPTION OF MEASUREMENT POSITIONS

WILTON

(Designated as Area 'E')

POSITION No: E1

At corner of Wilton Road & Trunk Road , 100m from residence on Lot No: 18

POSITION No: E2

Outside Mr. Tim Blair's Residence at Condle Park

POSITION No: E2A

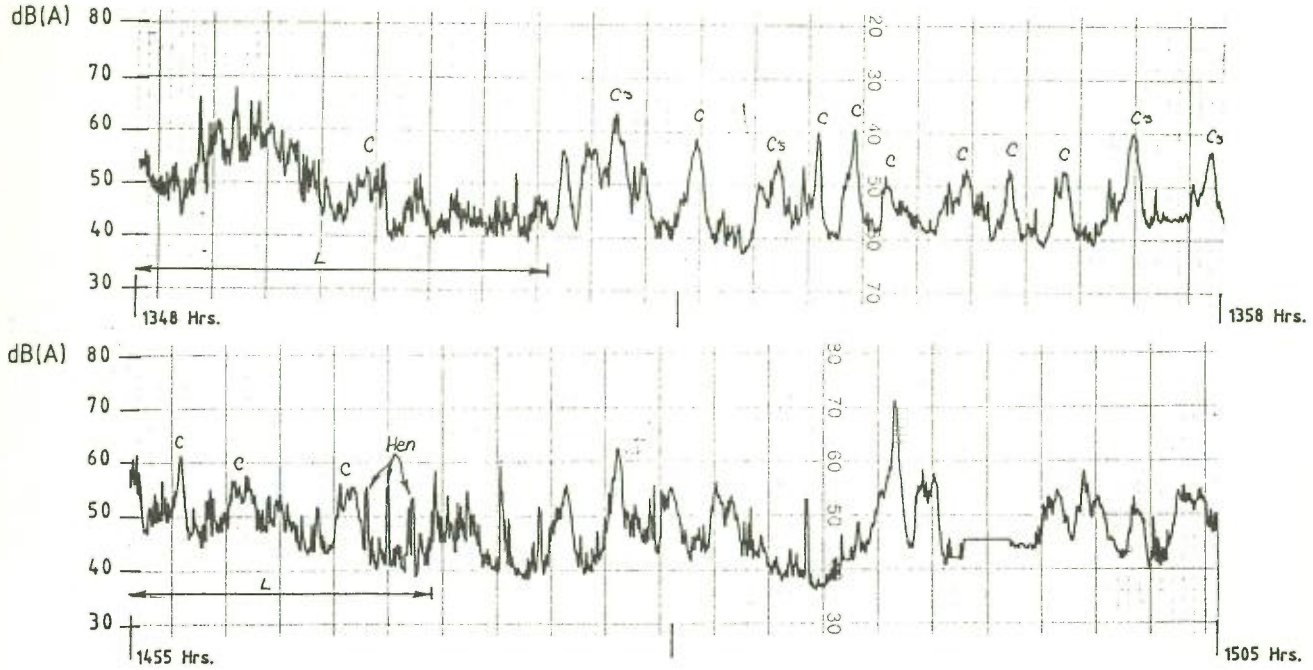
500m away from Mr. Tim Blair's Residence on Wilton Road

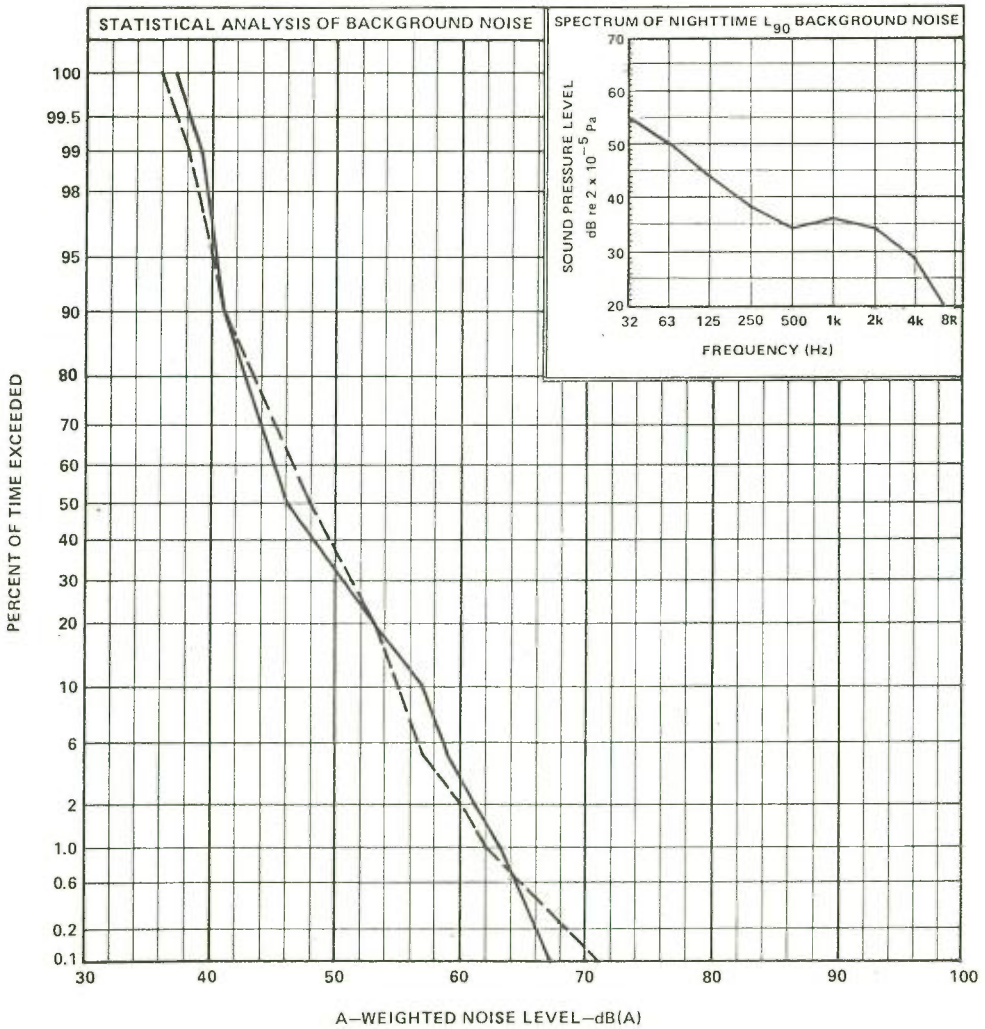
POSITION No: E3

Weston Road, 20m from F5 Highway at entrance to residence

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Appendix No: 32.1

AMBIENT SOUND LEVELS
POSITION E1, WILTON AREA
DAY TIME MEASUREMENTS



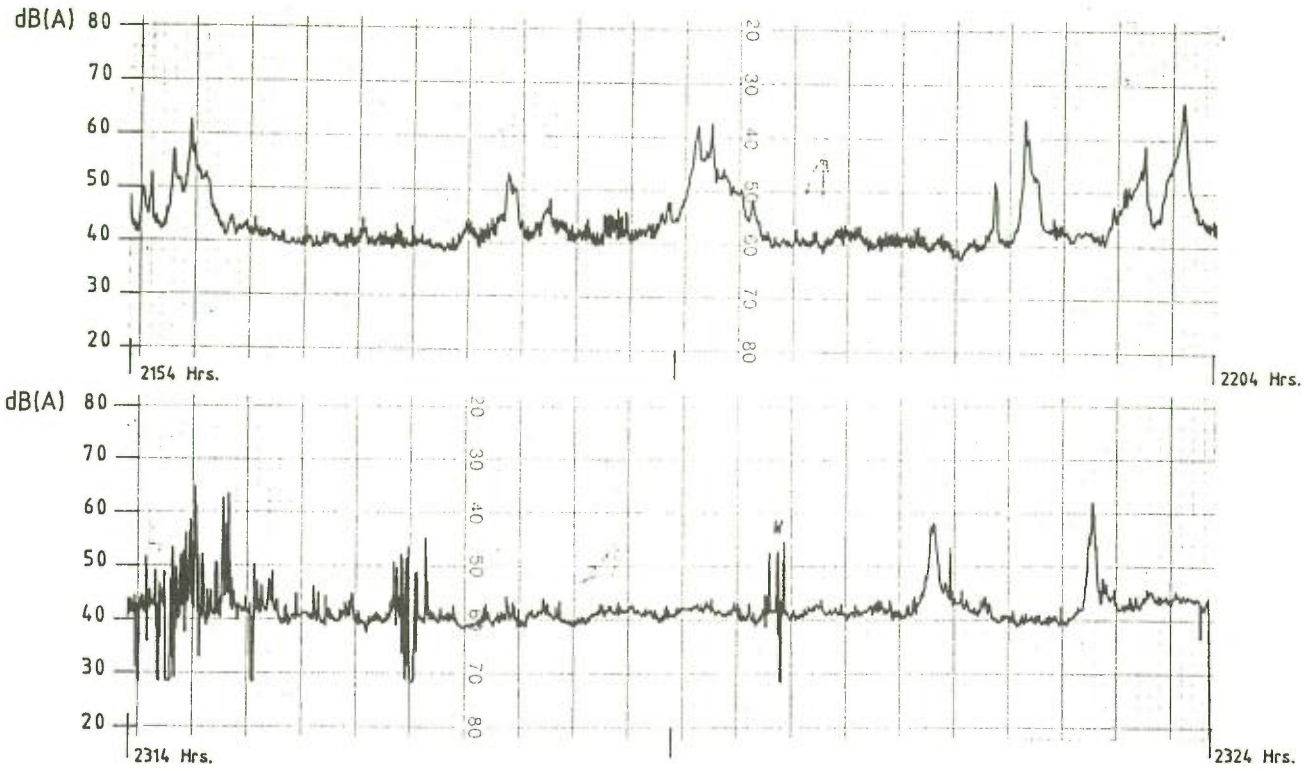


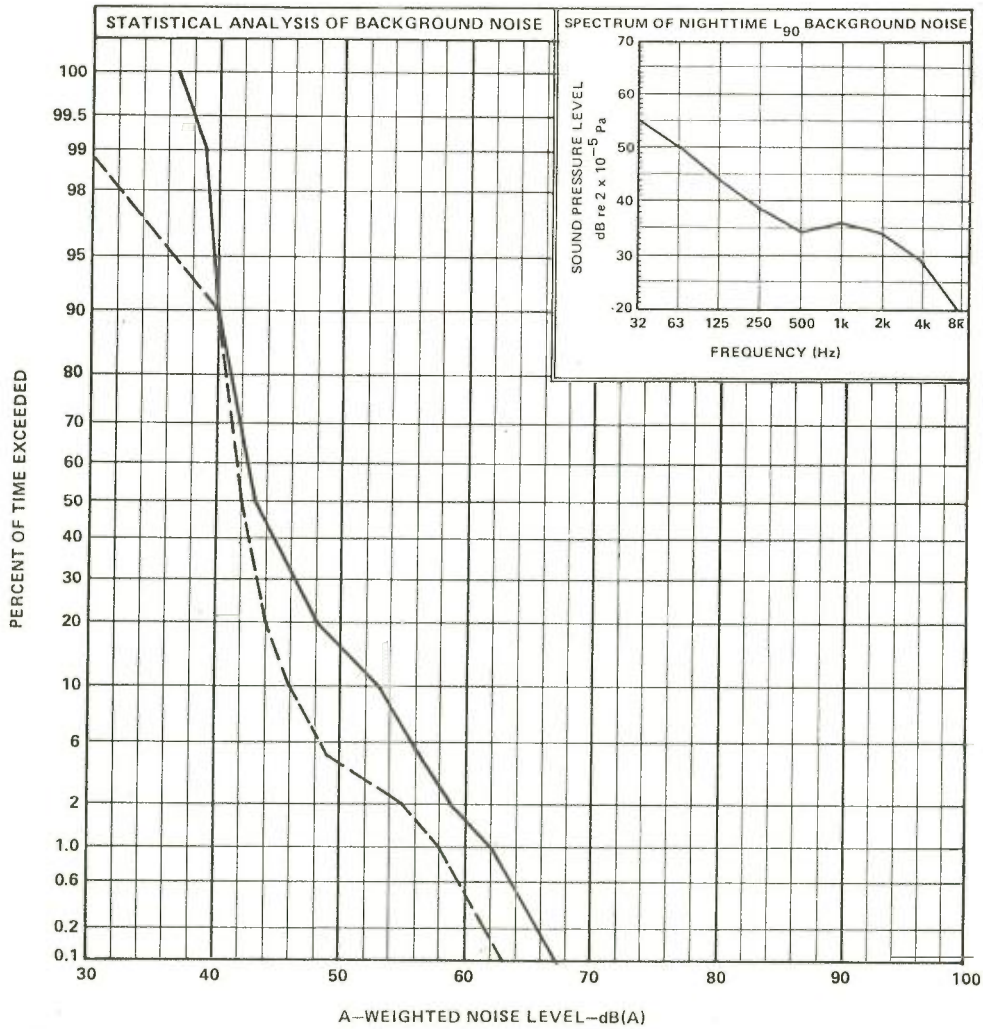
Leq 53 ———— 1348-1358 Hrs., Sun. 2/10/83:- ROAD 88: 29 CARS, 1 BIKE, WILTON RD.: 1 CAR LIGHT PLANE. BIRDS. LAWNMOWER. RUSTLING LEAVES. WIND: 12 kph S.E.

Leq 53 — — — — 1455-1505 Hrs., Sun. 2/10/80:- ROAD 88: 36 CARS, 3 BIKES, WILTON RD.: 2 C LIGHT PLANE. BIRDS. HEN. CHILDREN. DOMESTIC. RUSTLING LEAVES. WIND: 15 kph S.E.

AMBIENT SOUND LEVELS
POSITION E1, WILTON AREA
NIGHT TIME MEASUREMENTS

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Appendix No: 32.2

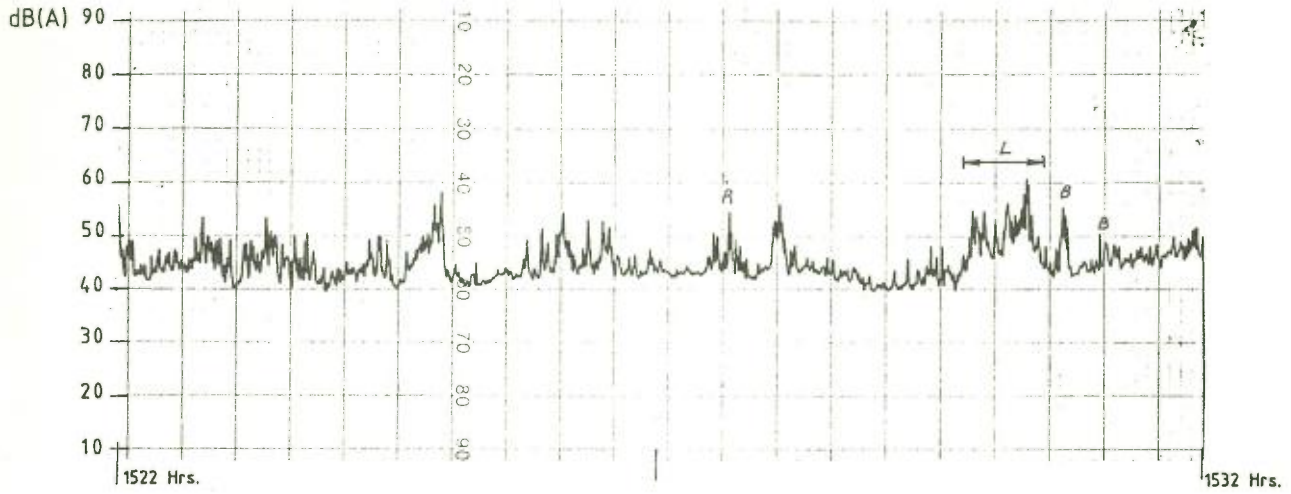


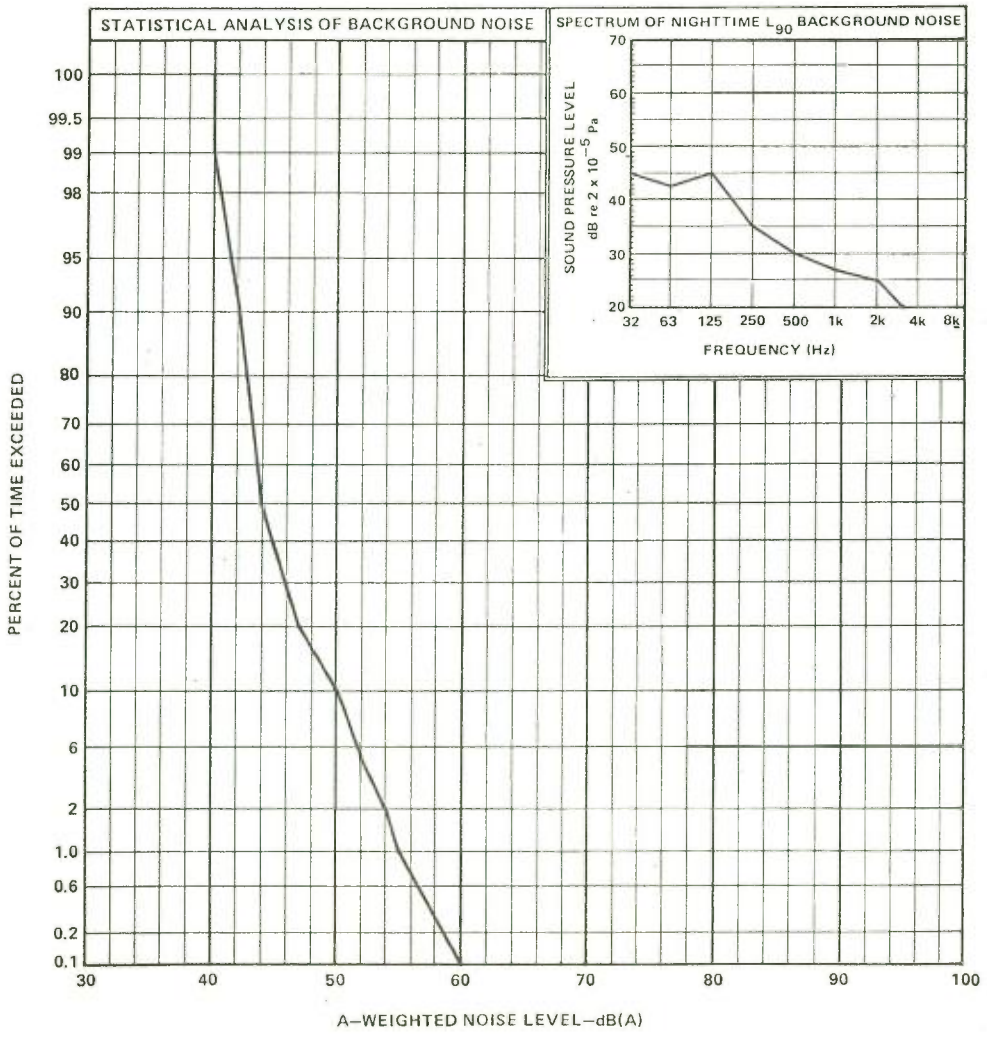


Leq 50 ———— 2154-2204 Hrs., Sun. 2/10/83:- ROAD 88: 4 CARS. WILTON RD.: 1 CAR. INSECTS.

Leq 46 — — — — 2314-2324 Hrs., Sun. 2/10/83:- ROAD 88: 3 CARS. INSECTS. RUSTLING LEAVES WIND: 15 kph S.

AMBIENT SOUND LEVELS
POSITION E2, WILTON AREA
DAY TIME MEASUREMENTS

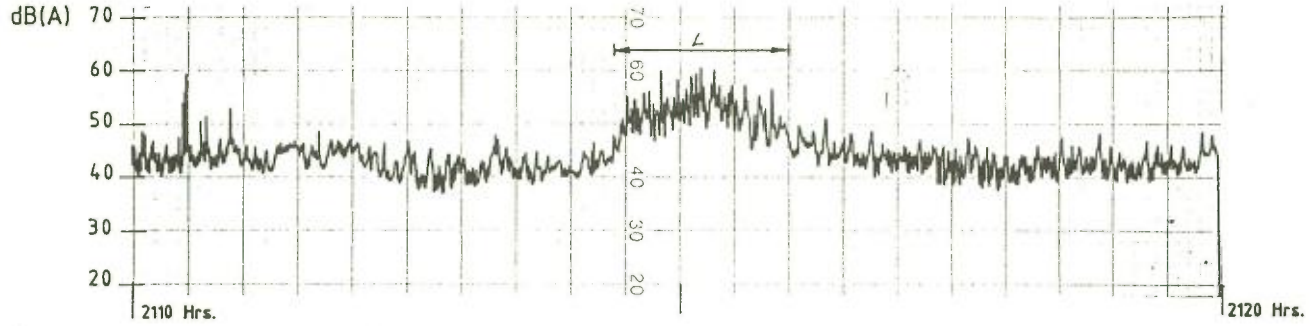


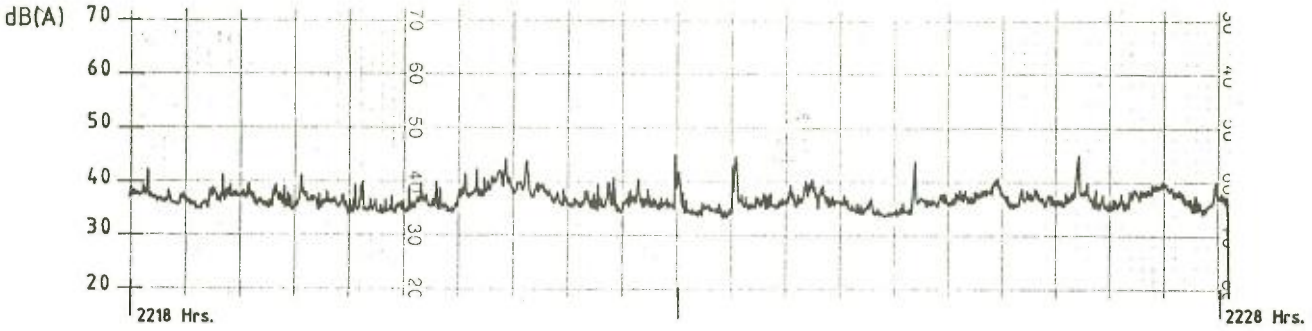


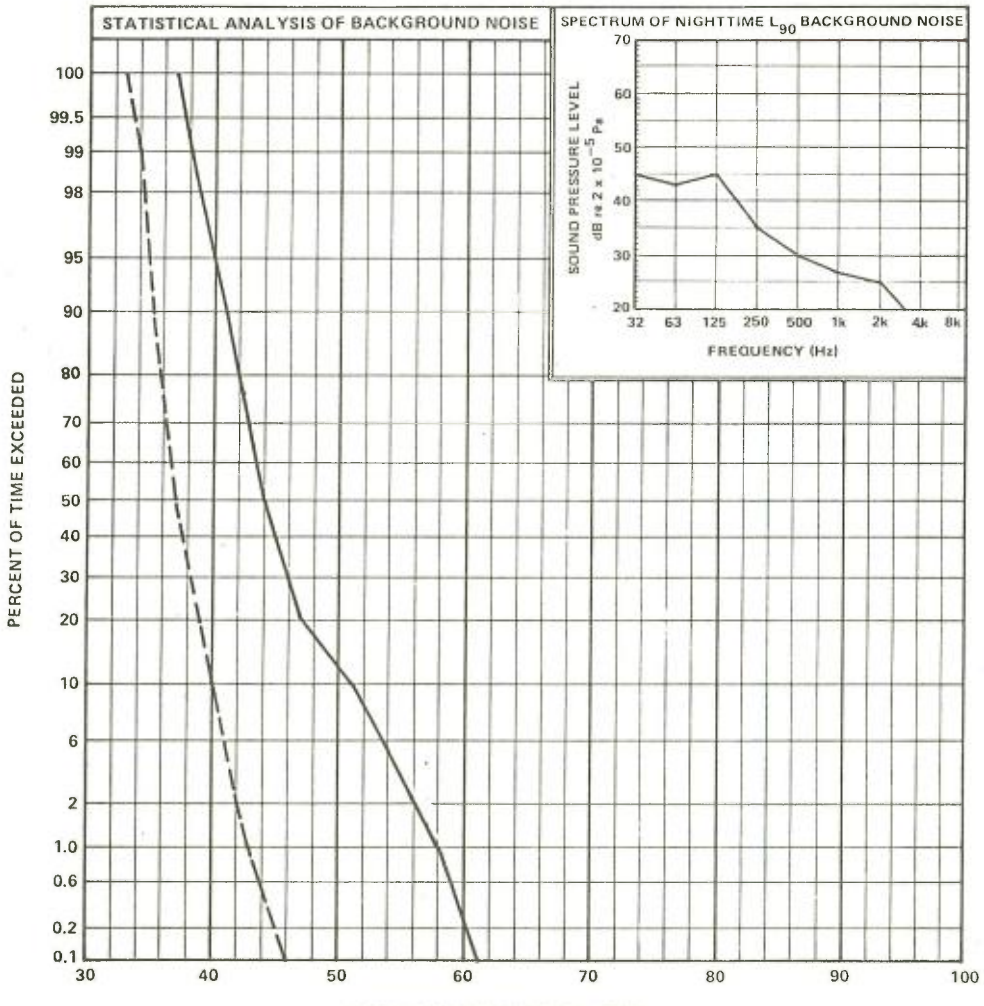
Leq 47 ———— 1522-1532 Hrs., Sun. 2/10/83:- LIGHT PLANE. RUSTLING LEAVES. BIRDS. WIND: 6 kph S.E.

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AMBIENT SOUND LEVELS
POSITION E2, WILTON AREA
NIGHT TIME MEASUREMENTS





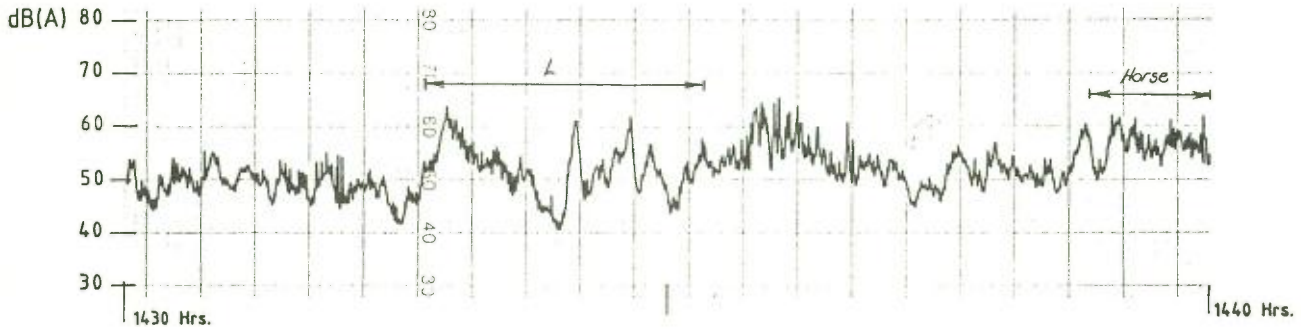


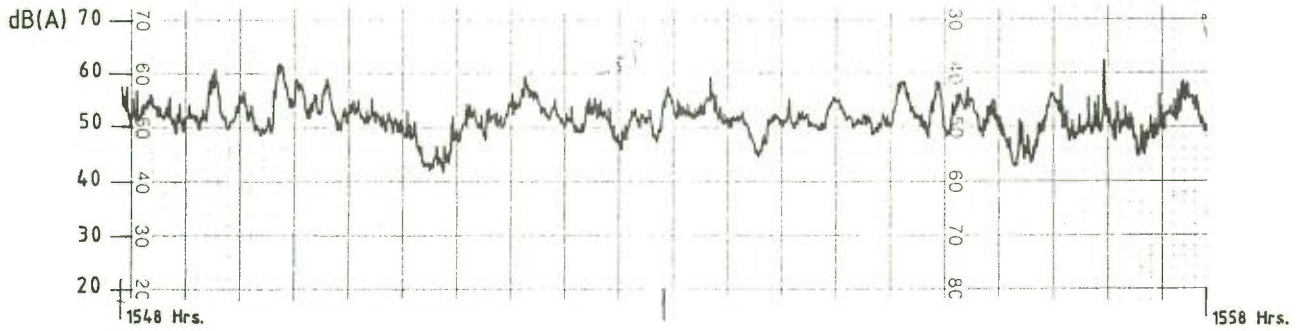
Leq 48 ———— 2110-2120 Hrs., Sun. 2/10/83:- DISTANT TRAFFIC (F5 HIGHWAY). LIGHT PLANE DOG. INSECTS. FROGS.

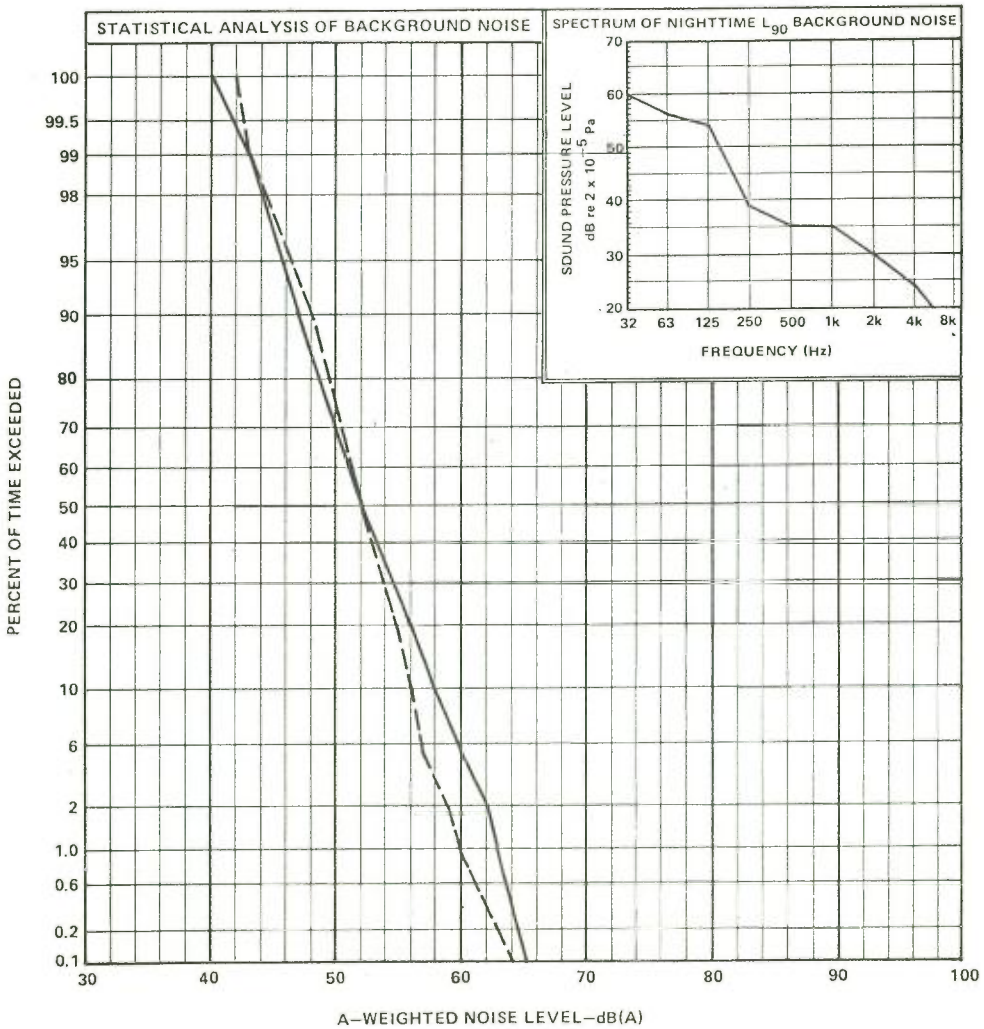
Leq 38 — — — — 2218-2228 Hrs., Sun. 2/10/83:- DISTANT TRAFFIC (F5 HIGHWAY). INSECTS. DOG. FROGS.

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AMBIENT SOUND LEVELS
POSITION E3, WILTON AREA
DAY TIME MEASUREMENTS





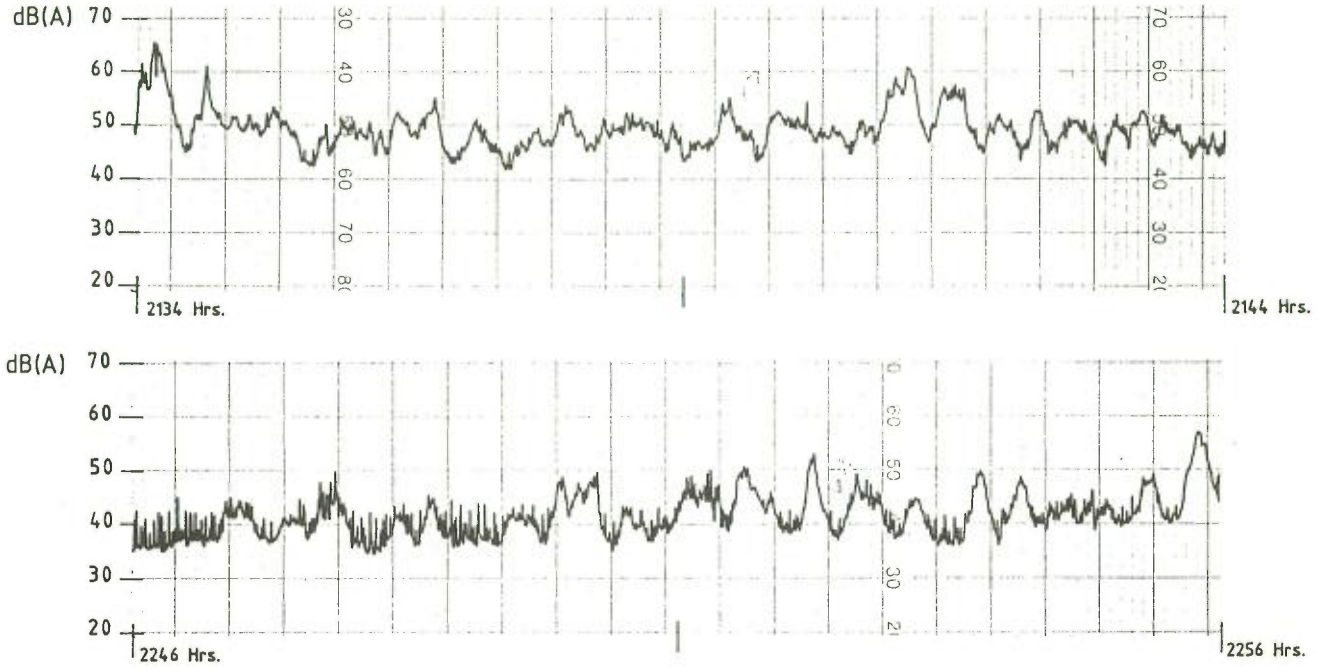


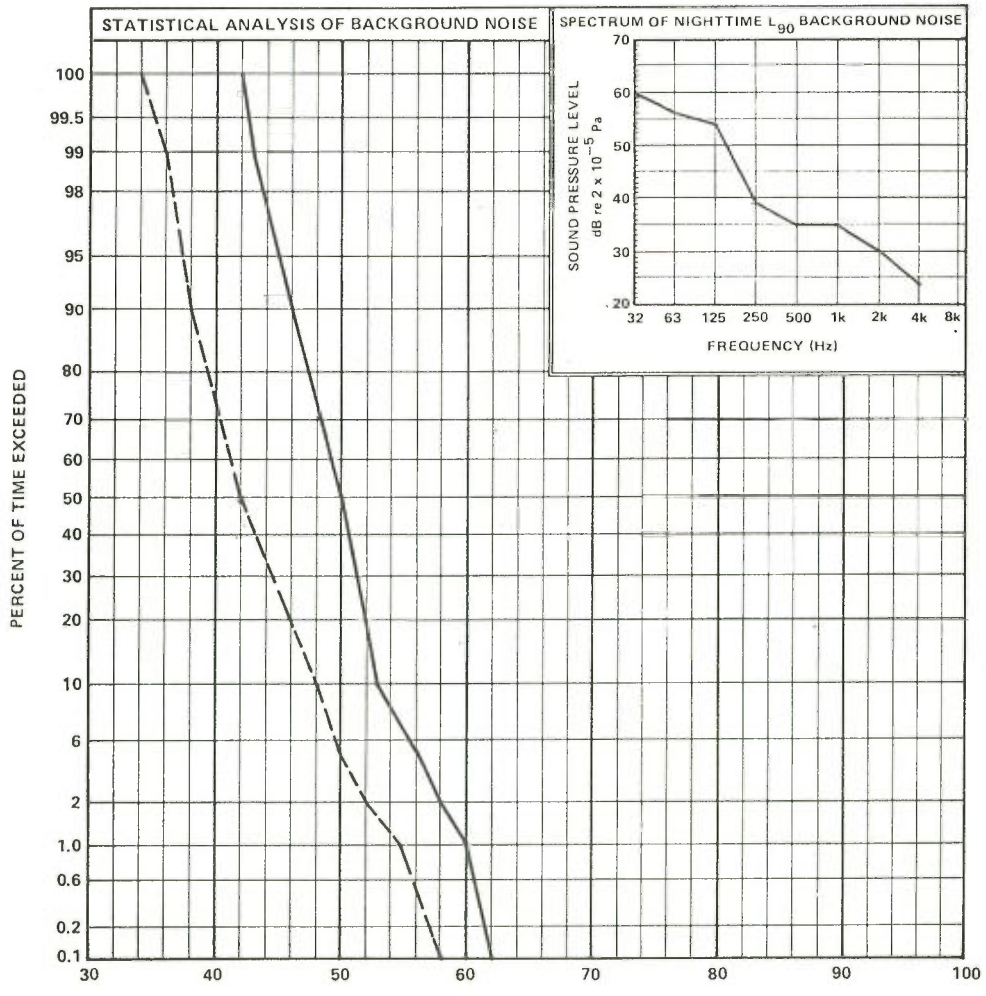
Leq 55 ———— 1430-1440 Hrs., Sun. 2/10/83:- F5 HIGHWAY: 201 CARS, 2 BIKES, 2 TRUCKS. BIRDS. HORSE. LIGHT PLANE (TAKE-OFF & FLIGHT). WIND: 14 kph S.E.

Leq 53 — — — — 1548-1558 Hrs., Sun. 2/10/83:- F5 HIGHWAY: 265 CARS, 3 BIKES. 2 TRUCKS, 1 BIRDS. CHILDREN. HORSE. WIND: 7 kph S. E.

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AMBIENT SOUND LEVELS
POSITION E3, WILTON AREA
NIGHT TIME MEASUREMENTS

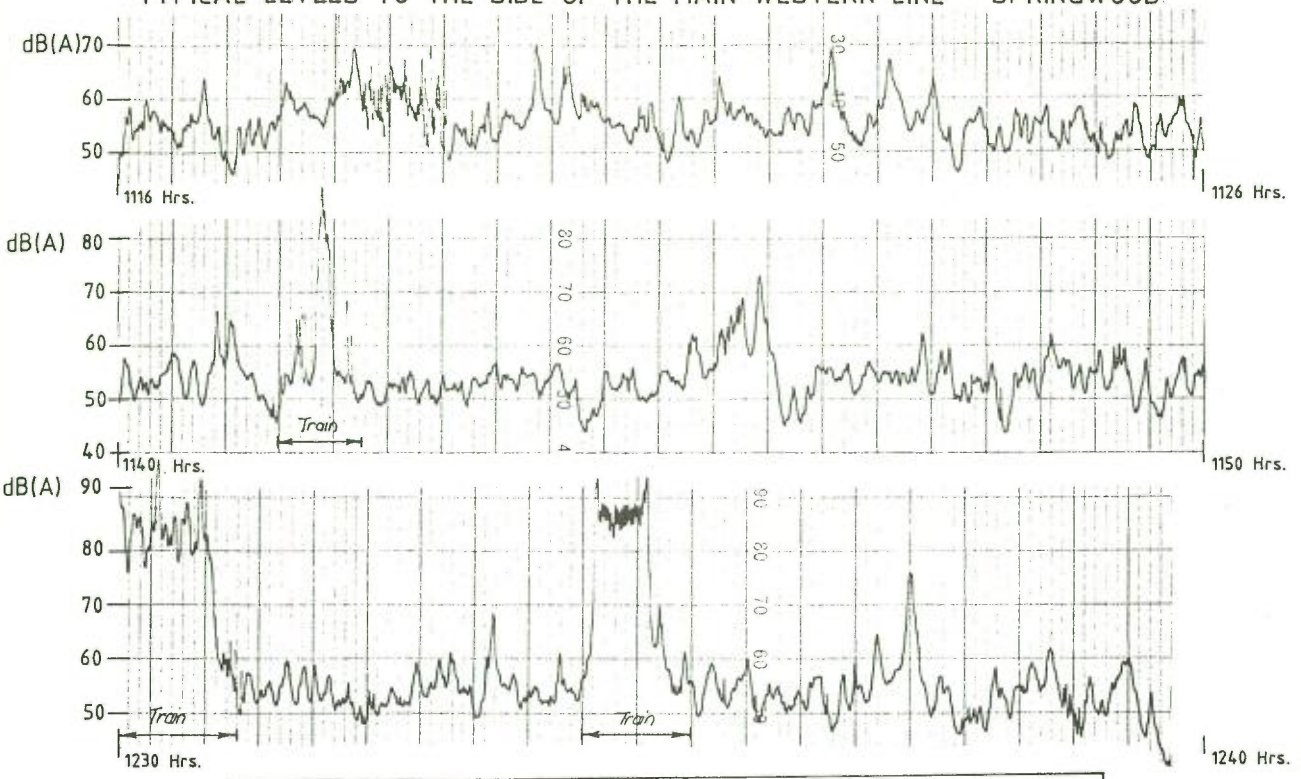


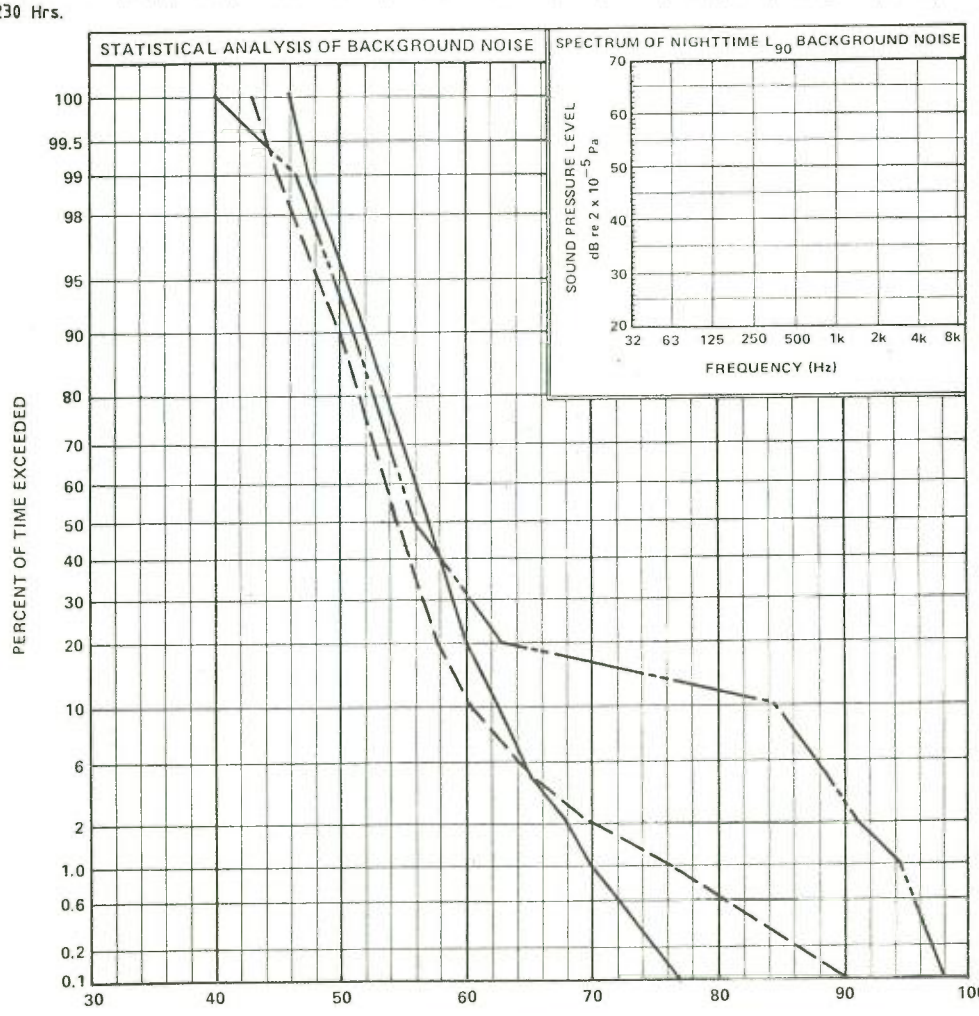


Leq 51 ———— 2134-2144 Hrs., Sun. 2/10/83:- F5 HIGHWAY: 122 CARS, 3 TRUCKS. INSECTS. FROGS.

Leq 45 — — — — 2246-2256 Hrs., Sun. 2/10/83:- F5 HIGHWAY: 49 CARS, 3 TRUCKS. INSECTS. DOG. WIND: 7 kph S.E.

AMBIENT SOUND LEVELS
POSITION 1 - 7 m FROM CENTRE OF RAILWAY TRACKS
TYPICAL LEVELS TO THE SIDE OF THE MAIN WESTERN LINE - SPRINGWOOD





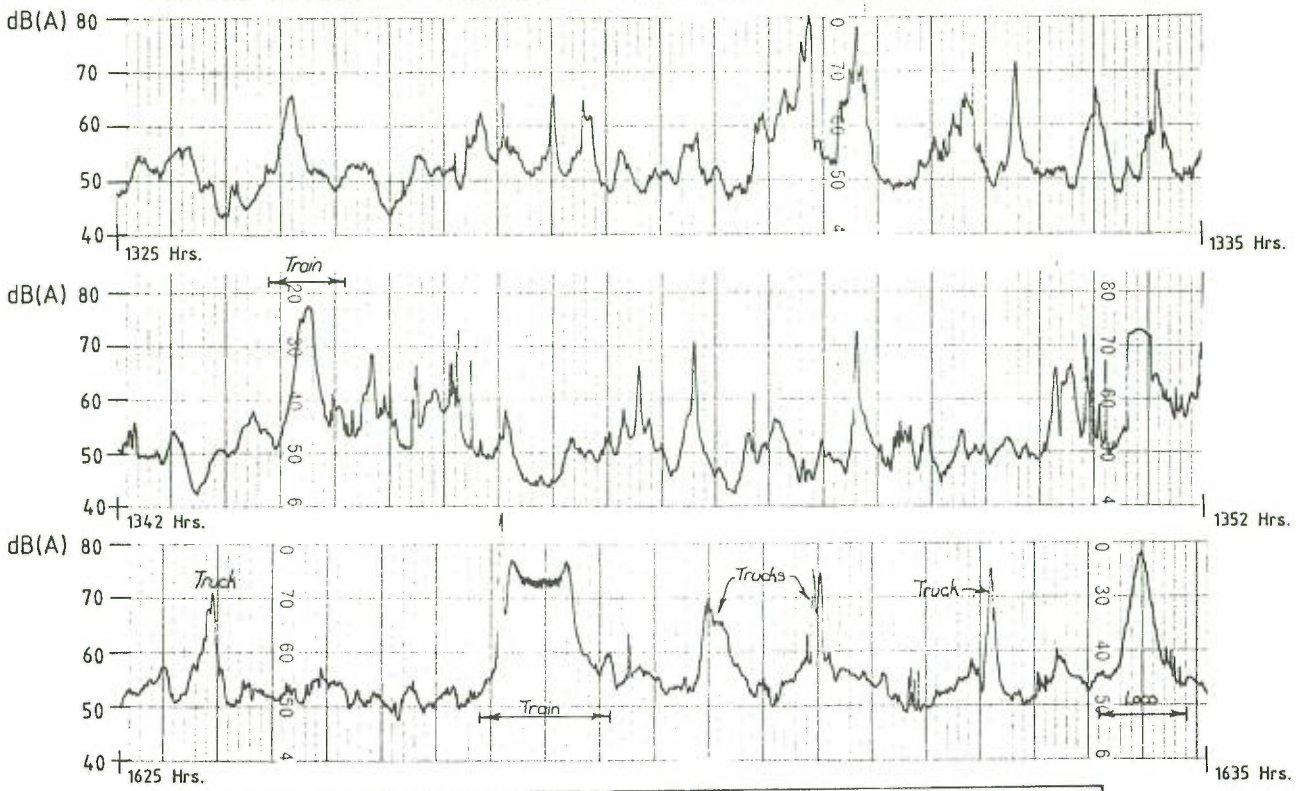
Leq 62.6 ———— 1116-1126 Hrs, Mon, 24/9/83:- NO TRAINS, CONSISTANT TRAFFIC

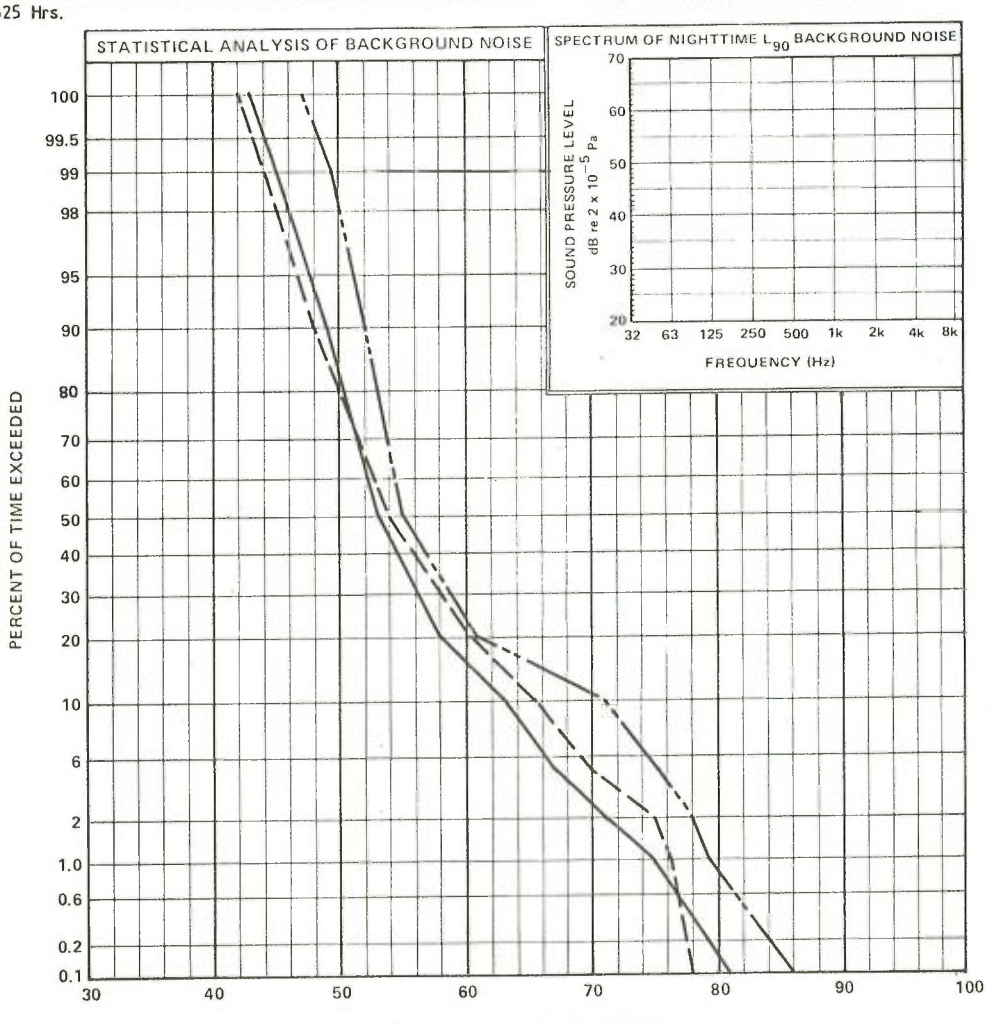
Leq 67.1 — — — — 1140-1150 Hrs, Mon. 24/9/83:- PASSENGER TRAIN TO SPRINGWOOD
CONSISTANT TRAFFIC

Leq 81.4 ——·—— 1230-1240 Hrs, Mon. 24/9/83:- 2 GOODS TRAINS TO LAWSON
CONSISTANT TRAFFIC

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AMBIENT SOUND LEVELS
POSITION 2 - 37m FROM CENTRE OF RAILWAY TRACKS
TYPICAL LEVELS TO THE SIDE OF THE MAIN WESTERN LINE - SPRINGWOOD



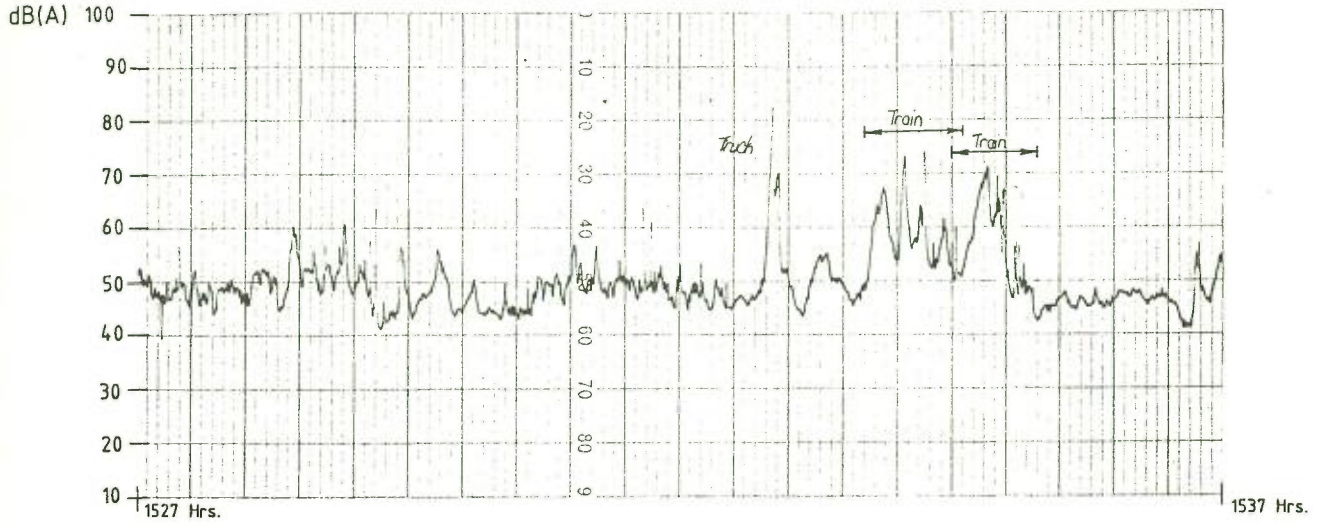


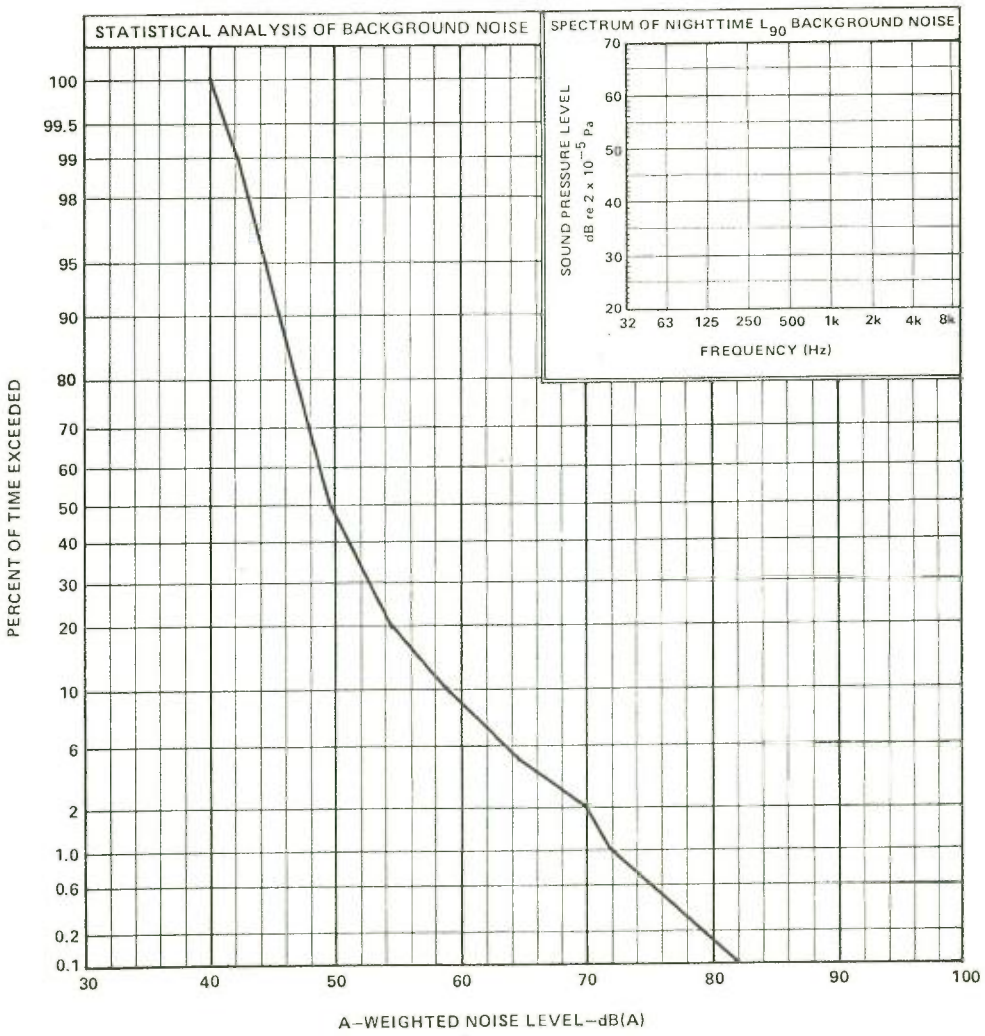
Leq 63.9 ———— 1325-1335 Hrs, Mon. 24/9/83:- NO TRAINS, CONSISTANT TRAFFIC

Leq 65.1 — — — — 1342-1352 Hrs, Mon. 24/9/83:- PASSENGER TRAIN, CONSISTANT TRAFFIC

Leq 68.3 ——— 1625-1635 Hrs, Mon. 24/9/83:- GOODS TRAIN TO LAWSON, 1 LOCO TO LAWSON, CONSISTANT TRAFFIC

AMBIENT SOUND LEVELS
POSITION 3 - 67m FROM CENTRE OF RAILWAY TRACKS
TYPICAL LEVELS TO THE SIDE OF THE MAIN WESTERN LINE - SPRINGWOOD





Leq 62.6 ———— 1527-1537 Hrs, Mon. 24/9/83:- PASSENGER TRAIN TO SPRINGWOOD, PASSENGER TRAIN TO LAWSON, CONSISTANT TRAFFIC

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Appendix No. 37.1

CALCULATIONS OF L_{eqA24}

In determining the basic parameters associated with the environmental impact of the existing, short term future (pre 1990) and long term future (post 1990) impact of the proposed railway line development, the computaions have been based on a series of models. These models are as follows :

1. The present traffic consists of three up and three down trains daily carrying limestone. Each train is hauled by two 81 class (or equivalent) diesel electric locomotives.

2. The short term future, (pre 1990) traffic will consist of the present trains travelling between Port Kembla and Moss Vale, supplemented by seven up and seven down line coal trains each hauled by two 86 class electric locomotives together with one up and one down train hauled by two 81 class locomotives.

3. The long term future (post 1990) traffic will consist of a total of eighteen up and eighteen down trains, each hauled by 86 class electric locomotives and nine up and nine down trains, each hauled by two 81 class diesel electric locomotives.

The base data for the analysis is as follows :

Base Noise Levels at 30 metres

Configuration	Uphill	Downhill
2 x 81 Class Locomotives	92 db(A)	89 dB(A)
2 x 86 Class Locomotives	83 dB(A)	81 dB(A)
Wagons effective length 500 metres	73 dB(A)	76 dB(A)

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L_{eqA24} hour corrections (normalised to one train per hour)

Locomotives assumed length 60 metres -30 dB(A)

Wagons effective length 500 metres -22 dB(A)

	Up		Down		Total
	Locos	Wagons	Locos	Wagons	
Diesel Electric	62	51	59	54	64.4
Electric	53	51	51	54	58.5

Corrections for Traffic Volumes at 30 metres on the basis that all trains are hauled by the one type of locomotive

	Diesel-Electric	Electric
Existing	3/day = 0.125/hour = -9.2 dB	--------
Pre 1990	4/day = 0.167/hour = -7.8 dB	7/day = 0.292/hour = -5.4 dB
Post 1990	9/day = 3.75/hour = -4.2 dB	18/day = 0.75/hour = -1.3 dB

Computed L_{eq} (24 hours) at 30 metres for respective years

	Diesel-Electric	Electric	Total
Existing	55.2 dB(A)	--------	55.2 dB(A)
Pre 1990	56.6 dB(A)	53.1 dB(A)	58.2 dB(A)
Post 1990	60.2 dB(A)	57.2 dB(A)	62.0 dB(A)

GLOSSARY OF ACOUSTICAL TERMS

This section presents a glossary and description of the acoustical terms used within this environmental impact assessment

absorption loss — That part of the transmission of acoustical energy which is dissipated in the medium or ground surface upon a reflection from that surface.

ambient noise — The ambient noise is the all encompassing noise associated with the environment at a specific location which is a composite of sounds from many sources both near and far.

audio frequency — Is defined as any audible frequency typically regarded as lying between 20Hz and 20KHz. In practice sounds are audible at frequencies in the range 40Hz to 16KHz for a person age 30 years with normal hearing.

background noise — Is regarded as being the component noise in the absence of either the intruding noise (if such exists) or the foreground noise where some specific component of sound may elevate the perceived ambient noise above its normal level.

band pass filter — A device which transmit with small attenuation the energy between two frequencies whilst greatly attenuating sound at all other frequencies. The most common band pass filter is the octave band filter which attenuates sound above and below a band of frequencies which is one octave wide. Octave bands are normally specified by the bands centre frequencies and not by the band edge frequencies.

decibel — Is by definition 1/10 of a bel and the symbol used to abbreviate it is dB. By definition a decibel is 10 $Log_{10}(P_1/P_2)$ which is a logarithmic ratio. A decibel can be used as a unit of ratio or when referred to a basic reference unit of sound pressure level provides a convenient scale of sound intensity internationally used for specification of loudness.

decibel (A)scale — The decibel (A) scale is the A-weighted intensity of sound or voltage provided by interposing a filter with the A-weighting response in the measurement chain. The A-weighting filter is one which has been internationally standardised and provides a frequency weighting approximating that provided by the human ear at the 40 decibel level (40 phon level).

equivalent sound level (L_{eq}) — Is defined as the sound level for a fluctuating sound over a specified period of time which would produce the same energy equivalence as would a constant level of unvarying sound.

far field — Is that part of the sound field of a source radiating under three field conditions where the sound pressure levels and the particle velocity are substantially in phase. This normally occurs at significant distances from the body radiating the sound so that the sound wave may be described as following the inverse square law.

free field — A free field is one in which the extent and effects of boundaries are negligible throughout the region of interest. This also normally means that sound waves diminish at approximately 6 decibels for each doubling of distance.

frequency — Of a period quantity; the time rate of repetition. Also the reciprocal of the period. The unit of frequency is the hertz previously known as one cycle per second.

frequency analyser — Is one used for measuring band pressure levels over various frequency ranges. The most common analysers used for such analysis are the octave band analyser and the one third octave band analyser.

level — The level of a sound is the number of decibels by which a given quantity differs from a reference quantity. The most common acoustical reference level is 20 micropascals which is by international agreement reference (zero (0)dB).

L_{DN} — This is the time corrected 24 hour value of L_{EQ} except 10 dB(A) is added to levels between 2200 and 0700 hours.

L_{90} — The statistical abbreviation used for the mean minima value of the A-weighted sound pressure level of the background sound.

near field — Is that part of the sound field radiated by a source where the sound pressure and the particle velocity are not in phase. This normally occurs adjacent to a large radiating sound source where the point of observation is closer than the largest dimension of the sound source.

noise — By standard definition is unwanted sound. Sound can only be regarded as being noise when human beings are present to perceive the sound.

octave — The interval between two frequencies having a ratio of two (2).

octave Band Filter — A filter which transmits with small attenuation energy within one or more bands, each one octave wide and which greatly attenuates energy at all other frequencies.

reverberant sound — The sound in an enclosure excluding that which is received directly from the source and which tends to persist after the emission of sound from the source has ceased.

sound — The sensation of hearing excited in a listener by mechanical disturbance.

sound level — A weighted value of the sound pressure level as determined by a sound level meter.

sound pressure level — Abbreviated to SPL is defined as 20 times the logarithm to the base 10 of the ratio of the r.m.s. sound pressure to the reference sound pressure. The reference sound pressure is normally taken to 20 micropascals.

statistical analysis — The statistical analysis of sound is used to present the noise exceedance data for a sample of noise analysed in a specified period of time in the form of indices of the sound intensity against the percentages of the time for which they have occured. Such analysis is most conveniently presented as a graphical presentation for visual assessment.