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NOISE AND VIBRATION STUDY FOR THE METRO RAIL PROJECT

Final Report

VOLUME I - CHAPTERS 1 THROUGH 8

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Prepared for:

Southern California Rapid Transit District

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Chapter 1

REVIEW OF REGULATIONS AND INDUSTRY PRACTICE AFFECTING CONTROL OF NOISE AND VIBRATION FROM CONSTRUCTION AND OPERATIONS OF THE METRO RAIL SYSTEM

1.1 INTRODUCTION

A major environmental effect of all transportation systems is the noise produced by operation of the vehicles and, in some cases, the noise from ancillary facilities. As a result of this fact, and because of other noises which occur in communities, there has been considerable legislative action, both at the local or state and at the federal level, which has produced regulations that may affect the design and operational requirements for a new rail transit facility. Such ordinances in almost all cases address the noise from ancillary facilities and may address the noise from facility construction activities. In fact, there have been some standards or ordinances enacted which directly address the noise from rail transit system vehicle operations.

Note that while some agencies are beginning to consider ground-borne vibration and/or building vibration standards or limits as an adjunct or supplement to noise standards or ordinances, at the present time there are very few standards which specify vibration level limits. Since ground-borne vibration is one of the most significant environmental aspects of a rail transit system, it is appropriate and necessary to consider the effects of ground-borne vibration even though there may be no applicable standards or ordinances which directly address this factor.

Because there are standards or ordinances which may affect the design and equipment requirements of the Southern California Rapid Transit District (SCRTD) Metro Rail Project, a study of the local and federal regulations potentially affecting noise and vibration from construction and operations of the Metro Rail system has been completed. This report presents the findings of that study and includes an outline and discussion of all standards and ordinances applicable to or affecting the design and equipment requirements for the Metro Rail Project.

Also included is a discussion of industry standards and practice. This has been included in order to indicate what noise and vibration design goals and criteria are being used by older existing systems for line extensions, system modifications and procurement of new vehicles, and by new systems which are currently operating or under design and construction.

1.2 SUMMARY

The proposed 18.6 mile route of the Metro Rail Project will be located entirely within the County of Los Angeles and for the most part, within the incorporated area of the City of Los Angeles. Thus, the applicable legislation includes any Federal, State of California, or City and County of Los Angeles standards or ordinances which address noise and vibration aspects of the Metro Rail Project.

One of the most important pieces of legislation that has had a major impact on noise control and on the issuance of noise regulations in the USA is the Noise Control Act of 1972 [1]. Under this Act, States and municipalities retain primary responsibility for noise control. The Act authorizes the U.S. Environmental Protection Agency (EPA) to provide technical assistance to States and municipalities to facilitate development and implementation of their environmental noise control programs. The Act specifies construction equipment as one of the four categories of equipment to be studied by the EPA.

Pursuant to the California Government Code [2], Section 65302 (g), both the County and the City have adopted Noise Elements as part of their General Plans. The California Government Code requires (but does not limit) that the General Plan Element include consideration of the following sources of noise generation:

- Highways and freeways
- Primary arterials and local streets
- Passenger and freight on-line railroad operations
- Rapid transit system operations
- Commercial, general aviation, heliport, helistop and military airport operations, aircraft overflights, jet engine test stands, and all other ground facilities and maintenance functions related to airport operations
- Local industrial plants including railroad classification yards
- Other stationary noise sources identified by local agencies as contributing to the community noise environment [3].

Both the County and City of Los Angeles have complied with the requirements of the California Government Code Section 65302(g) by adopting a Noise Element to the General Plan. These Noise Elements in combination with the City and County Noise Ordinances result in some limitations and requirements of the Metro Rail Project. Primarily these restrictions apply to construction noise and vibration and to ancillary facility noise during operation. They do not apply to vehicle operation during revenue service.

The State of California has enacted a number of laws intended to control noise. None of these state laws directly affect the Metro Rail Project. The California Administrative Code, Title 25, does indirectly establish a noise exposure limit standard for airborne noise from rail transit vehicle operations.

None of the federal agencies, EPA, DOT or UMTA, have produced regulations which are applicable to the Metro Rail Project other than some EPA regulations which affect construction equipment noise emission. The general policy of UMTA is to review and comment on environmental impact statements and to assure compliance with committments of the environmental impact statement.

Transit industry practices generally follow the noise and vibration design limits as outlined in the APTA Publication, "Guidelines for Design of Rapid Transit Facilities". This includes all of the newer system facilities and equipment recently designed and built in Washington, D.C., Baltimore, Atlanta, and Buffalo.

1.3 EXISTING GENERAL PLAN ELEMENTS AND LOCAL NOISE ORDINANCES

1.3.1 County General Plan Noise Element

The Los Angeles County General Plan Noise Element was adopted in 1974 and is essentially an Action Plan which establishes a list of priority actions to be undertaken by the County to meet Plan objectives [4]. One of these recommendations calls for the passage of "a comprehensive Noise Ordinance" and amendments to the "building code, sub-division, and zoning ordinances... to reflect the latest noise abatement techniques." One result of the Action Plan has been the passage of Ordinance 11,778, The Noise Control Ordinance of the County of Los Angeles [5].

1.3.2 County Noise Ordinance

The County Noise Ordinance [5] relates to the control of noise and vibration and states: "It shall be the policy of the County to maintain quiet in those areas which exhibit low noise levels and to implement programs aimed at reducing noise in those areas where noise levels are above acceptable values."

The Ordinance adopts measurement standards, establishes community noise criteria, defines prohibited actions, provides a variance mechanism, and charges the County Health Officer with the principal role of enforcement [5]. The impact of the County Noise Ordinance on the construction and operation of the transit system is evaluated later in this report.

1.3.3 City General Plan Noise Element

The City of Los Angeles General Plan Noise Element was adopted in 1975 and focuses significant attention upon the transportation sector as a noise generator and places particular emphasis on aviation noise sources [6]. The Noise Element does not suggest a specific action program; rather, it outlines broad conceptual programs and leaves it up to various City Departments to develop the required regulations and/or ordinances.

1.3.4 City Noise Ordinance

The City of Los Angeles first Noise Ordinance (144,331) [7] predates the City General Plan Noise Element [6] and was adopted by the City Council in 1973. It is found, commencing with Section 111.01, in the Los Angeles Municipal Code. The Ordinance was recently submitted to the City Council for amendment in areas which do not affect the construction and operation of the transit system. The City Noise Ordinance establishes standards for ambient noise levels within various land use zones and the criteria for maximum noise levels. The potential impact of the City Noise Ordinance upon the construction and operation of the transit system is discussed below.

1.4 POTENTIAL IMPACTS OF LOCAL AND FEDERAL AGENCY REGULATIONS

The impacts of local and Federal regulations upon the construction and operations of the Metro Rail Project are discussed separately herein. Both construction and operations may be affected by either the City and County Noise Ordinances or the EPA noise emission standards, or both.

1.4.1 Construction - Local Regulations

Both the City and County Noise Ordinances prescribe limits for construction noise. Most of the transit alignment is to be located within the municipal boundaries of the City of Los Angeles and will therefore fall under jurisdiction of the Municipal Code [7].

First, the City Noise Ordinance prohibits the generation of construction related noise during the hours of 9:00 p.m. to 7:00 a.m. [8]. Further, Section 112.05(a) of the City Noise Ordinance states that no person shall operate any powered equipment or powered hand tool that exceeds a maximum noise level of 75 dBA at a distance of 50 feet. This maximum noise limit applies to all construction and industrial machinery including crawler-tractors, dozers, rotary drills and augers, loaders, power shovels, cranes, derricks, motor graders, paving machines, off-highway trucks, ditchers, trenchers, compactors, scrapers, wagons, pavement breakers, compressors, and pneumatic powered equipment.

The City Noise Ordinance also states that the noise limits for particular equipment listed above shall be deemed to be superseded and replaced by noise limits for such equipment from and after their establishment by final regulations adopted by the Federal Environmental Protection Agency and publication in the Federal Register.

However, the City Noise Ordinance recognizes the difficulty of achieving the strict noise limits for all the equipment and states that said noise limitations shall not apply where compliance therewith is technically feasible (emphasis added). The burden of proving that compliance is technically infeasible shall be upon the person or persons, i.e., the contractor, charged with non-compliance. Technical infeasibility shall mean that said noise limitations cannot be achieved despite the use of mufflers, shields, sound barriers and/or any other noise reduction devices or techniques during operation of the equipment [7].

The County Noise Ordinance [5] also addresses construction related noise and vibration nuisance. It states (in part): "Notwithstanding any other provisions of this ordinance, the following acts and the causing or permitting thereof are declared to be in violation of this ordinance: Operating or causing the operation of any tools or equipment used in construction, drilling, repair, alteration, or demolition work, between weekday hours of 7:00 p.m. and 7:00 a.m., (note that this should be 8:00 p.m. to be consistent with other provisions of the Ordinance) or at any time on Sundays or holidays, such that the sound therefrom creates a noise disturbance across a residential or commercial real property line, except for emergency work of public service utilities or by variance issued by the Health Officer." The County Noise Ordinance stipulates that the contractor shall conduct construction activities in such a manner that the maximum noise levels at the affected buildings will not exceed those listed in the following schedule:

I. AT RESIDENTIAL STRUCTURES:

a) Mobile Equipment

Maximum noise levels for nonscheduled, intermittent, short-term operation (less than 10 days) of mobile equipment:

	Single Family Residential	Multi-Family Residential	Semi-Residential/ Commercial
Daily, except Sundays and Legal Holidays 7 a.m. to 8 p.m.	75 dBA	80 dBA	85 dBA
Daily, 8 p.m. to 7 a.m. and all day Sundays and Legal Holidays	60 dBA	65 dBA	70 dBA

b) Stationary Equipment

Maximum noise levels for repetitively scheduled and relatively long-term operation (periods of 10 days or more of stationary equipment):

	Single Family Residential	Multi-Family Residential	Semi-Residential/ Commercial
Daily, except Sundays and Legal Holidays 7 a.m. to 8 p.m.	60 dBA	65 dBA	70 dBA
Daily, 8 p.m. to 7 a.m. and all day Sundays and Legal Holidays	50 dBA	55 dBA	60 dBA

II. AT BUSINESS STRUCTURES:

a) Mobile Equipment
Maximum noise levels for nonscheduled, intermittent, short-term operation of mobile equipment:
Daily, including Sundays and Legal Holidays, all hours; maximum of 85 dBA.

The County Noise ordinance also states that in case of a conflict between this ordinance and any other ordinance regulating construction activities, provisions of any specific ordinance regulating construction activities shall control. This statement implies that in areas of the City, the City Noise Ordinance shall apply. The implication is also that any ordinance which has more strict regulations will control, however this is not explicitly stated.

In addition to the noise limits, the County Noise Ordinance prohibits operating or permitting the operation of any device that creates a vibration which is above the vibration perception threshold of an individual at or beyond the property boundary of the source, if on private property, or at 150 feet (46 meters) from the source if on a public space or public right of way. The perception threshold shall be a motion velocity of 0.01 in/sec. over the range of 1 to 100 Hertz. The Ordinance fails to clarify whether peak or RMS vibration velocity is to be considered.

1.4.2 Construction - EPA Emission Standards

The pertinent EPA noise emission standards are those relating to portable air compressors and for new wheel and crawler tractors.

On January 14, 1976, EPA published final regulations on newly manufactured portable air compressors [9]. This document specifies a test procedure involving measurement at five orthogonal positions 7 m from the compressor surface, the measurement positions in the plane horizontal to the (hard) ground being at a height of 1.5 m. The specified operating condition is full load and the results are computed on the basis of energy averaged sound level at 7 m distance. The noise emission standard was set at 76 dBA.

On July 11, 1977, EPA further published noise emission regulations for new wheel and crawler tractors having horsepower ratings from 20 hp to 500 hp [10]. The regulation stipulates the following limits, measured at a distance of 15 m.

Machine Type	Horsepower	Not to exceed A-weighted Sound Level (dBA)	Effective Date
Crawler Tractor	20 to 199	77	March 1981
		74	March 1984
Crawler Tractor	200 to 450	83	March 1981
		80	March 1984
Wheel Loader	20 to 249	79	March 1981
		76	March 1984
Wheel Loader	250 to 500	84	March 1981
		80	March 1984
Wheel Tractor	20 plus	74	March 1981

1.4.3 Transit System Operations - Local Regulations

Neither the City nor County of Los Angeles Noise Ordinances establish specific criteria for transportation vehicle generated noise. This may be partially due to the fact that the Federal and State governments have pre-empted much of this area of law. In the case of transit operations, the pertinent noise and vibration criteria are generally based on the American Public Transit Association document, "Guidelines for Design of Rapid Transit Facilities," usually referred to as the "APTA Guidelines" [11]. These criteria are fully considered in the chapter "Noise and Vibration Design Criteria for the Metro Rail Project." The standards regarding noise and vibration in general use by the transit industry are presented in Section 5 of this chapter.

Although there are no noise regulations of the City of Los Angeles which directly affect the operation of transit trains, the Los Angeles City Planning Department uses the "Guidelines for Environmental (Exterior) Noise Compatible Land Use" which is presented in Figure 1-1.

While the City and County Noise Ordinances do not specifically address (through prohibitions, establishment of criteria, etc.) transit vehicle noise, they do address transit ancillary facility noise sources associated with the system operations, specifically ventilation and air conditioning equipment noise.

Section 112.02 of the Los Angeles Municipal Code [7] is currently under consideration for amendment to read: "It shall be unlawful for any person, within any zone of the City to operate any air conditioning, refrigeration, or heating equipment for any residence or other structure or to operate any pumping, filtering, or heating equipment for any pool or reservoir in such a manner as to create on the premises of any other occupied property any noise which would cause the noise level to exceed the ambient noise level by more than five (5) decibels."

Article V of the County Noise Ordinance [5] prohibits the operation of any air conditioning or refrigeration equipment in such a manner as to elevate the ambient noise level on the property line of any adjoining residence beyond 55 dBA.

1.4.4 Transit System Operations - State Regulations

The California Noise Control Act of 1973 [12] does not specifically address rapid transit system operations or construction. However, it does declare that excessive noise is a serious hazard to the public health and welfare and that it is a policy of the State to provide an environment for all Californians free from noise that may be hazardous to their health or welfare. Thereafter, the Act assigns the Office of Noise Control of the California Department of Health the responsibility for developing criteria and guidelines for use in setting standards for human exposure to noise in cooperation with local governments or the State Legislature. Most of the effect of the California Noise Control Act is via the local noise ordinances and standards, as discussed above. However, there are some state laws or standards which potentially affect the operation of a transit system.

The California Vehicle Code [13] includes a number of sections which provide specific noise limits for motor vehicles subject to registration and off-highway vehicles subject to identification. Because of the definition as motor vehicles and the requirements for registration or identification, these limits do not apply to transit vehicles.

The California Noise Insulation Standards [14] include a provision which indirectly affects noise from rail transit system operations. In Subsection (e)(4) of T25-28, Noise Insulation Standards, the indication is that, where residential buildings or structures will be located within an annual exterior Community Noise Equivalent Level (CNEL) contour of 60 dBA adjacent to rapid transit lines, there shall be an acoustical analysis showing that the proposed building has been designed to limit intruding noise to the allowable interior noise levels prescribed in Section (e)(2). An exception is listed for railroads where there are no nighttime operations and daytime operations do not exceed four trains per day. This requirement applies to new residential buildings or structures to be located near the noise source. However, the implication is that when a new noise source, such as a rail transit system, is placed in proximity to residential structures, the noise exposure level created by that new noise source should not exceed a CNEL 60 dBA level at the residential structures. While this interpretation is not specifically stated in any of the California Administrative Code Sections, the Standard does provide an appropriate design criterion for airborne noise from transit vehicle operations for a new transit system. Note that many jurisdictions are applying the California Administrative Code standards to any change in use of residential structures, such as conversion of apartments to condominiums.

There are a number of other California laws involving noise including: the California Noise Control Safety Orders [15], the California Airport Noise Standards [16], the California Aircraft Noise Limits Law [17], the California Law on Freeway Noise Affecting Classrooms [18], and the California Motorboat Noise Law [19]. However, none of these address any of the noise or vibration aspects of a rail transit project.

1.4.5 Transit System Operations - Federal Agency Regulations

While the U.S. EPA provides technical assistance to states and local agencies to facilitate implementation of environmental noise control programs, the EPA has not produced any regulations specific to transit system operations. The only regulations implemented are those which apply to some types of equipment used in construction and trucks used in interstate commerce.

The U. S. Department of Transportation (DOT) and the Urban Mass Transportation Agency (UMTA) of DOT also do not have any specific noise and vibration guidelines or criteria for rapid transit system. Their activity in this area is limited to review of environmental impact statements and review of design features to assure compliance with the environmental impact statement requirements and standard industry practices.

However, UMTA does have some general guidelines for evaluating the significance of noise impacts. These guidelines indicate that noise impacts are generally not significant (1) if no noise-sensitive sites are located in the project area, and (2) if increases in the equivalent noise levels (L_{eq}) with implementation of the project are expected to be $\leq$3 dBA at noise sensitive locations and the proposed project would not result in violations of noise ordinances or standards. Noise impacts are possibly significant if increases in equivalent noise levels (L_{eq}) with implementation of the project are expected to be no greater than 5 dBA. Determination of significance must consider existing noise levels and the presence of noise-sensitive sites. Noise impacts are generally significant if the proposed project would cause (1) noise standards or ordinances to be exceeded, (2) an increase in the equivalent noise level (L_{eq}) of 6-10 dBA in built-up areas, and (3) an increase in the equivalent noise level (L_{eq}) of 10 dBA.

1.5 TRANSIT INDUSTRY PRACTICES

There are basically two sets of standards regarding noise and vibration which are in general use by the transit industry. These are:

1. The Institute for Rapid Transit (IRT) Guidelines developed between 1970 and 1972, and published in May 1973 [20], entitled: "Guidelines and Principles for Design of Rapid Transit Facilities."
2. The revised noise and vibration standards in the American Public Transit Association document, "Guidelines for Design of Rapid Transit Facilities," developed between 1976 and 1978, and published in 1979 [11], usually referred to as the "APTA Guidelines."

The noise and vibration standards indicated in the original IRT Guidelines and in the APTA Guidelines are widely used by the transit industry for determining appropriate design criteria or design goals for noise and vibration produced by various components of a transit system. The guidelines include noise and vibration from transit vehicles for operations both below ground and above ground, design criteria for stations for control of noise from all sources and design criteria for fan and vent shaft noise or other ancillary facility noise. Also the guidelines include the noise and vibration limit specifications to be applied to transit vehicles via the purchase contract documents.

The main difference between the noise and vibration guidelines or design goals in the newer APTA 1979 publication, compared to the original IRT specification, is some modification of the transit vehicle noise level limits or design goals. Because of experience with some of the vehicles produced in the 1970's it was thought that the noise limit specifications for some items of the vehicle equipment were too severe and were causing extra cost and difficulty in producing the cars. As a result, some of the car interior and car exterior noise limits, particularly for auxiliary equipment, were increased by 2 to 5 dBA. This was in response to criticism and requests from the manufacturers. As it has turned out, evaluation of vehicles and equipment produced by manufacturers have shown that it was, in fact, possible to have produced the equipment within the noise level specifications required with simple designs and at reasonable costs. Thus, it was not necessary to have raised the limits. However, insufficient information on the characteristics of the equipment was available at the time the guidelines were developed.

As mentioned above, many of the newer transit systems or systems building new facilities apply the IRT or APTA Guidelines in determining the required characteristics of the equipment and facilities regarding noise and vibration. The following outlines the general policy for several transit systems.

1.5.1 WMATA

The Washington Metropolitan Area Transit Authority (WMATA) Metro system applies the original IRT Guidelines as the design goals or limits for noise from all facilities and for station acoustical treatment. In fact, the 1973 IRT Guidelines were developed from the WMATA Metro noise limit specifications. The first series of transit cars for WMATA Metro used the 1973 IRT Guidelines. Later series of cars are using a slight variation of the APTA 1979 Guidelines.

1.5.2 MARTA

The Metropolitan Atlanta Rapid Transit Authority (MARTA) uses the original IRT Guidelines in defining the design limits for facilities and for station acoustical treatment. The environmental impact statement for the MARTA system committed the system design to the IRT Guidelines and they have followed this requirement. In the car purchases the original car contract documents included specifications similar to the IRT Guidelines but more restrictive in a few respects. For subsequent orders the MARTA system is using specifications similar to the 1979 APTA Guidelines.

1.5.3 BRRT

The Baltimore Region Rapid Transit System (BRRT) is using guidelines very similar to the IRT Guidelines for the design noise and vibration limits on facilities. For the vehicles, a specification similar to the 1979 APTA Guidelines is being used.

1.5.4 CTA

The Chicago Transit Authority (CTA) has used the IRT and APTA Guidelines as the basis for car purchase documents for two series of cars. The CTA 2400 series cars used specifications similar to the 1973 IRT Guidelines in defining the noise and vibration requirements for the vehicles. The newest series of cars, the CTA 2600 series, use specifications very similar to the 1979 APTA Guidelines.

The City of Chicago, in designing the O'Hare Extension for the CTA, used guidelines or design goals similar to the APTA 1979 guidelines for facilities, including station interiors.

1.5.5 CUTD

The Chicago Urban Transportation District (CUTD) in preliminary designs for several new subway lines proposed for addition to the Chicago system, used design guidelines for the facilities similar to those of the 1973 IRT Guidelines and the 1979 APTA Guidelines. These criteria were implemented in the preliminary designs and the details included provision for noise and vibration reduction treatments and station acoustical treatment to comply with the guideline limits. However, the facilities were never developed beyond the preliminary design stage.

1.5.6 NFTA

The Niagara Frontier Transportation Authority Light Rail Rapid Transit system (NFTA LRRT) in Buffalo, NY, has throughout the design and construction period used design criteria based on the 1979 APTA Guidelines. All of the facilities have included provisions for controlling the noise and vibration to the levels recommended in the APTA Guidelines. The stations have also included all of the necessary acoustic treatment for control of noise in the stations. The vehicle specifications are similar to but not as complete as suggested in the APTA Guidelines.

1.5.7 Summary

For all of the above-mentioned new transit facilities and vehicles, the IRT and the APTA Guidelines have been used as the general starting point for the specifications. In most cases there were either no changes or minor changes to fit the particular requirements of the system relative to the general guidelines. Most variations occur with respect to the vehicle noise and vibration limits and depend somewhat on the experience and background of the particular group of engineers preparing the overall vehicle specification document.

In most cases, i.e., at WMATA, MARTA, BRRT, and NFTA, construction noise and vibration limits were included as part of the facility construction contract documents so that contractors were restricted in the amount of noise and vibration they could produce in the community around the construction sites. The IRT and APTA Guidelines documents do not include any comments or guidelines regarding construction noise and vibration. However, there are master or directive type specifications available from WMATA Metro, MARTA, BRRT and NFTA which have been suggested as the starting point for developing appropriate construction noise and vibration criteria for the SCRTD project.

It should also be noted that several Canadian systems have or are adopting criteria similar to those given in the APTA Guidelines, although in most cases the criteria applied are slightly more restrictive regarding community noise than given in the APTA Guidelines. The Toronto Transit Commission (TTC) applies criteria similar to the IRT Guidelines for facility construction and similar to the APTA Guidelines for vehicle performance. The newer Intermediate Capacity Transit Systems, ICTS, in Canada, are applying criteria with similar provisions but lower sound levels consistent with the smaller, lighter weight and lower power vehicles and consistent with the more restrictive environmental standards applied in some Canadian cities.

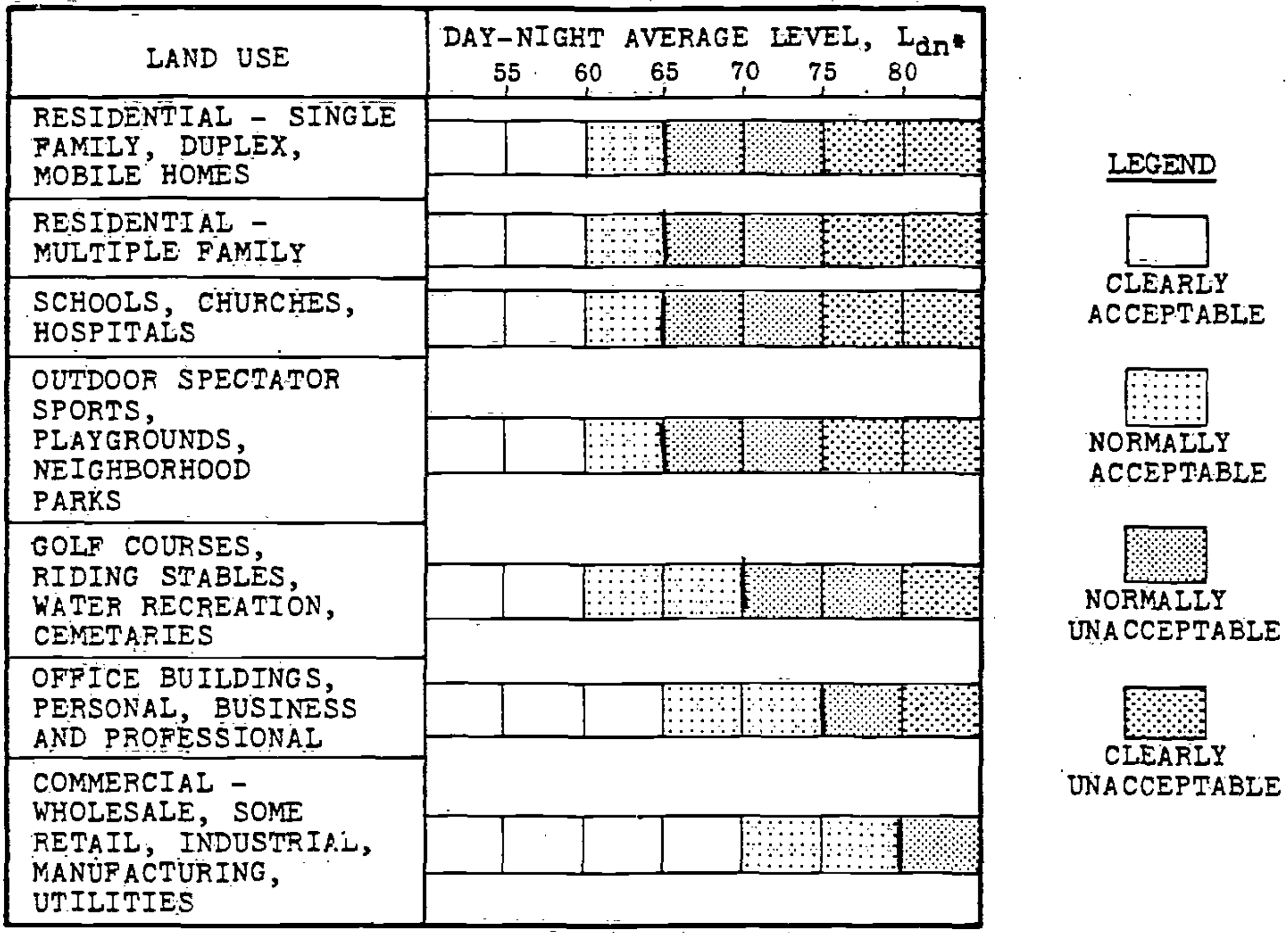

Figure 1-1 - Guidelines for Environmental (Exterior) Noise Compatible Land Use

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* Definition - L_{dn} Day-Night Average Sound Level

The Day-Night Sound Level is a measure of the cumulative noise exposure in the community. It results from the summation of hourly Leq's over a 24-hour time period with an increased weighting factor applied to the nighttime time period. For Ldn calculations, day is defined at 7am to 10pm with a weighting factor of unity. Night is defined as 10pm to 7am with occurrences during this time period deemed 10 times as significant as those occurring in the daytime.

REFERENCES

1. Noise Control Act of 1972, Public Law 92-574, Enacted by Congress October 18, 1972, signed by the President October 27, 1972.

2. "California Noise Planning in Land Use Act," California Government Code, Division 1, Planning and Zoning, Chapter 3 - Local Planning, Article 5, Section 65302(g), June 1972. As amended by Senate Bill 860 (Bielenson, 1975) adopted January 1, 1976.

3. "Guidelines for the Preparation and Content of Noise Elements of the General Plan," California Department of Health and Governor's Office of Planning and Research, Berkeley, CA, February 1976.

4. "Los Angeles County General Plan, Noise Element and Draft Environmental Impact Report," Los Angeles County Department of Regional Planning, October 1974.

5. "Noise Control Ordinance of the County of Los Angeles (Ordinance No. 11,778)," Los Angeles County Board of Supervisors, un-dated.

6. "General Plan of the City of Los Angeles, Noise Element," Los Angeles Department of City Planning September 1975.

7. "Noise Control Ordinance of the City of Los Angeles (as proposed for amendment)," (Ordinance No. 144,331), Administrative Code of the City of Los Angeles, 1973.

8. "Telephone Interview;" Slaughter, Otis; Los Angeles Department of Building and Safety, November 6, 1981.

9. "Noise Emissions Standards for Construction Equipment: Portable Air Compressors," Federal Register, 41(9), January 14, 1976.

10. "Noise Emissions Standards for Construction Equipment: New Wheel and Crawler Tractors," Federal Register, 42(132), July 11, 1977.

11. "Guidelines for Design of Rapid Transit Facilities," American Public Transit Association, January 1979.

12. "California Noise Control Act of 1973," California Health and Safety Code; Division 28, Noise Control Act; Approved October 2, 1973, Laws of 1973, Chapter 1095; Amended by Laws of 1975, chs. 957, 1124; Laws of 1976, ch. 1063.

13. "California Vehicle Code;" Division 11, Rules of the Road, Chapter 12 - Public Offenses; As amended by Laws of 1974, Chapter 359; Laws of 1975, ch. 993; and Division 12, Equipment of Vehicles, Chapter 5 - Other Equipment; As amended by Laws of 1974, chs. 359,769, 1080; Laws of 1975, chs. 83, 993; Laws of 1977 ch. 558; Laws of 1980, ch. 382; Laws of 1982, Chapters 356, 793; and Chapter 6 - Equipment of Off-Highway Vehicles, Article 4; As amended by Laws of 1976, ch 1093.

14. "California Noise Insulation Standards," California Administrative Code, Title 25, Housing and Community Development, Chapter 1 - State Housing Law Regulations and Earthquake Protection Laws Regulations, Subchapter 1, Article 4, Section 28; As amended through June 16, 1979.

15. "California Occupational Noise Control Standards," California Administrative Code, Title 8, Industrial Relations, Chapter 4 - Divison of Industrial Safety, Subchapter 7, Group 15, Article 105; As revised June 28, 1982; effective July 28, 1982.

16. "California Airport Noise Standards," California Administrative Code, Title 21, Public Works, Chapter 2.5 - Division of Aeronautics (Department of Transportation), Subchapter 6; As amended through May 26, 1979.

17. "California Aircraft Noise Limits Law," California Health and Safety Code, Division 20, Miscellanous Health and Safety Provisions, Chapter 1.5 - Noise Pollution, Sections 24180, 24181; Enacted by Laws of 1971, Chapter 1770.

18. "California Law on Freeway Noise Affecting Classrooms," California Streets and Highways Code, Divison 1, State Highways, Chapter 1 - Administration, Article 6; Section 216; Amended by Laws of 1973, Chapter 541; Laws of 1974, ch. 645; Laws of 1975, ch. 969.

19. "California Motor Boat Noise Law," California Harbors and Navigation Code, Divison 3, Vessels, Chapter 5 - Operations and Equipment of Vessels, Article 1, Sections 654, 654.05, 654.06 and 688; Effective July 1, 1973; Amended by Laws of 1974, Chapter 1269; Laws of 1976, ch. 744.

20. "Guidelines and Principles for Design of Rapid Transit Facilities," Institute for Rapid Transit, May 1973.

Chapter 2

NOISE AND VIBRATION SURVEY FOR THE METRO RAIL PROJECT

2.1 INTRODUCTION

This report presents a study of the ambient noise and ground-borne vibration existing in 1981 and 1982 along the proposed alignment of the SCRTD Metro Rail Project.

Noise and vibration measurements were made outside representative buildings and in representative areas along the proposed Metro Rail alignment to provide information and documentation on the existing ambient levels and to provide assistance in determining the acceptable or allowable Metro Rail System noise and vibration levels in nearby buildings. These data used in conjunction with the noise and vibration design criteria provide a basis for determining those areas where special design features are needed to reduce the noise and vibration from transit train operations to acceptable levels.

This noise and vibration survey chapter discusses the survey locations and procedures, presents background information on noise and vibration measurements and descriptors, presents the results of the measurements and identifies community areas and some individual structures along the alignment that may require particular attention to assure acceptable noise and vibration levels once the plan and profile of the alignment are finalized.

2.2 SURVEY PROCEDURE AND BACKGROUND INFORMATION

Establishing the existing noise level or noise environment in a community requires measuring the noise at a large number of locations at several different times of day and, preferably, on several different days and times of the year. Community noise is a continually fluctuating entity dependent on many factors. Because the noise level does fluctuate over a relatively wide range, it is necessary to make measurements which are statistically significant and which can be analyzed on a statistical basis.

Establishing the existing vibration environment requires the same procedures and has the same general statistical variations as does the existing noise environment. Although reference is made throughout this section to ambient or community noise, this discussion for the most part is equally applicable to vibration.

Two noise and vibration surveys were performed. The first noise and vibration survey covered a total of forty-five measurement locations along the Board Preferred Alternative II Route. That survey occurred during September and October 1981. Since that time, certain portions of the route have been revised, as well as the consideration of several alternative alignments in the Hollywood and North Hollywood areas. In order to characterize the existing noise and vibration environment along these new alignments, additional noise and vibration measurements were made at thirty-three new locations in September 1982.

The measurement locations and the alignment adapted in December 1982 are shown on Figures 2.2-1 through 2.2-4. The 1982 measurement locations are numbered 101 through 133 to differentiate them from the 1981 measurement locations which are numbered 1 through 45.

The proposed Metro Rail alignment adopted in December 1982 is entirely underground, beginning at Union Station, continuing west along Macy Street and Hill Street, then along Seventh Street and Wilshire Boulevard to Fairfax Avenue. The alignment then continues north along Fairfax Avenue and east along Sunset Boulevard to a point just west of Cahuenga Boulevard. The alignment turns north and northwest under the Hollywood Freeway, then leaves the freeway and goes through the Santa Monica

Mountains west of the Cahuenga Pass. The final section of the alignment continues north and northwest along Lankershim Boulevard and ends between Chandler Boulevard and Burbank Boulevard.

The alignment passes through several different types of community areas. In the downtown area and along Wilshire Boulevard, the area is primarily commercial with office buildings and retail stores. There are also a significant number of multi-family residences (apartments and condominiums) along some sections of Wilshire Boulevard. Along Fairfax Avenue there are sections of commercial buildings and some multi- and single-family residences. Along Sunset Boulevard and Cahuenga Boulevard the area is made up of commercial buildings with some motels and multi-family residences. North of this area, there are primarily single-family residences before the alignment reaches Lankershim Boulevard. Along Lankershim Boulevard to the end of the alignment, the area consists primarily of commercial buildings. A more detailed description of the land usage along the alignment is given in Table 2.2-1.

For the commercial areas, with principally daytime occupancy, the possibility of intrusion from transit train operations is primarily a daytime consideration. In residential areas, the community ambient or background noise level is generally the lowest during the evening and nighttime hours and the possibility of intrusion from transit train operations is greatest during this time period. Thus, in the commercial areas, the environmental measurements are accomplished mainly in the daytime and the transit system design criteria are based primarily on daytime operations and noise levels. In the residential areas, the measurements are performed at several different characteristic times of the day and the transit system design criteria are based primarily on evening and nighttime operations and noise levels.

Although community noise data for the daytime in commercial areas and noise data for the evening and nighttime in residential areas are sufficient to establish the design criteria and evaluate the potential impact of the transit system, such measurements are not sufficient for a complete assessment of the community area environment. Therefore, measurements are generally made to provide data on the existing noise levels for several different times of day. Complete 24-hour surveys of the noise level can be performed in order to obtain a complete statistical representation of the daily noise exposure in a community area. It has been found, however, that the noise in communities can be characterized adequately by making spot-check measurements during at least four characteristic times of day. Because of the purpose of the noise measurements reported herein, the spot-check type of survey with a measurement duration of 10 minutes was performed at all of the measurement locations during appropriate characteristic times of day and in almost all cases on two different days. These data are supplemented by complete 24-hour noise surveys at several selected measurement locations.

A total of seventy-eight measurement locations were chosen as representative of areas along the Board Preferred Alternative II Route, the revised alignment adopted in December 1982 and alignment alternatives under study at the time of the surveys. "Spot-check" or short-term noise and vibration measurements were made at all seventy-eight locations. Twenty-four hour or long term noise measurements were also performed at sixteen selected locations. A brief description of each measurement location and its relation to the alignment is given in Table 2.2-2. Table 2.2-3 gives a brief description of each of the 24-hour noise survey locations and their relation to the alignment. All of the noise and vibration data for these surveys were obtained between September 21 through 25, September 28 through October 1, 1981 and September 20 through 24, 1982. Results of the noise and vibration surveys are presented in Section 2.3, EXISTING NOISE LEVELS and Section 2.4, EXISTING VIBRATION LEVELS.

For the purpose of this study the day was divided into four characteristic measurement periods representing:

Daytime:	10:00 a.m. to 2:00 p.m.
Rush Hour:	4:00 p.m. to 6:00 p.m.
Evening:	7:00 p.m. to 10:00 p.m.
Nighttime:	11:00 p.m. to 2:00 a.m.

No data were taken during the morning rush hour because it is generally found that the noise level results are essentially the same as for the evening rush hour.

The results of the noise measurements and the description of the noise environments prevailing at each of the measurement locations in the community are based on a statistical analysis of the observed noise levels in decibels. The factors derived from the analysis are the levels exceeded 99% of the time, 90% of the time, 50% of the time, 10% of the time, and 1% of the time designated L_{99}, L_{90}, L_{50}, L_{10}, and L_1, respectively.

L_{99} and L_{90} are descriptors of the typical minimum or "residual" background noise level observed during a measurement period, normally made up of the summation of a large number of sound sources distant from the measurement position and not usually recognizable as individual sound sources. The most prevalent source of this residual noise is distant street and highway traffic, but L_{99} and L_{90} are not strongly influenced by occasional local motor vehicle passbys. However, they can be influenced by nearby stationary sources such as air conditioning equipment.

L_{50} represents a long-term statistical average or median sound level over the measurement period and does reveal the long-term influence of local traffic. If the instantaneous sound level is sampled over a measurement period, the sound level will be above L_{50} 50% of the time and below L_{50} 50% of the time.

L_{10} describes the average peak or maximum sound level occurring for example, during nearby passbys of trucks, buses, automobiles, trains, or airplanes. Thus, while L_{10} does not describe the long-term noise prevailing it does describe the typical maximum noise levels observed at a point and is strongly influenced by the momentary maximum sound level occurring during vehicle passbys.

L_1, the sound level exceeded 1% of the time, is representative of the occasional maximum or peak sound level which occurs in an area.

Because of some inherent deficiencies of the simple percentile measures described above in evaluating the noise exposure effects of short duration, high level sounds (such as truck or bus passbys), the Energy Equivalent level, L_{eq}, has been developed and is widely used as a valid single-number descriptor of environmental noise. Because it is an energy integral over time, L_{eq} represents the constant or steady sound level which would give the same energy level as the fluctuating value integrated over the total time period. Because sound energy is proportional to the square of the sound pressure, L_{eq} places more emphasis on high noise level periods than does L_{50} or a straight arithmetic average of noise level over time. Some consider L_{eq} a more useful measure than L_{50} for the average or typical noise exposure in an area and most recent evaluation systems such as CNEL (Community Noise Equivalent Level) or L_{dn} (Day/Night Average Level) use the energy equivalent concept.

TABLE 2.2-1 LAND USAGE ALONG THE METRO RAIL ALIGNMENT

Station Number (As Delineated in Milestone 10)	Description of Land Usage
100+00 to 138+00	Low rise commercial office buildings, Union Station (historical landmark), and El Pueblo de Los Angeles (historic district).
138+00 to 151+50	County Courthouse, State and City office buiildings, and Law Library.
151+50 to 207+00	Mid rise commercial office buildings, International Jewelry Center, theaters, hotels, apartments, Angeles Plaza Elderly Housing and Pershing Square.
207+00 to 211+00	Mid rise office buildings, Hilton Hotel and Hyatt Regency Hotel.
211+00 to 265+50	Low rise commercial office buildings, and Interstate Bank.
265+50 to 278+00	McArthur Park.
278+00 to 281+80	Art gallery, low rise and mid rise commercial office buildings.
281+80 to 291+50	Low rise and mid rise commercial office buildings.
291+50 to 299+50	Lafayette Park and low rise office buildings.
299+50 to 318+00	Sheraton West Hotel, bank buildings, department stores, low rise and mid rise commercial office buildings.
318+00 to 341+70	Mixed commercial, bank building offices and apartments, Ambassador Hotel, other hotels, South Western University. Immanuel Presbyterian Church at Station 323+00 and Wilshire Chruch at Station 341+70.

TABLE 2.2-1 (CONTINUED)

Station Number	Description of Land Usage
341+70 to 385+00	Wilshire-Hyatt Hotel commercial offices, Union Bank and other bank buildings and theaters. St. Basil Roman Catholic Church at Station 352+50, Wilshire Boulevard Temple at Station 358+00, and St. James Episcopal Church and St. James Episcopal School between Stations 378+50 and 381+00
385+00 to 420+00	Mixed commercial and office buildings, apartments, motels and bank buildings. Theater of Arts at Station 396+00. Scottish Rite and Wilshire Methodist Church between Stations 413+00 and 416+00. Wilshire Ebell Theater at Station 418+50.
420+00 to 440+00	Mixed commercial and office buildings and apartments. Farmers Insurance Home office at Station 438+00.
440+00 to 455+00	Residential and office buildings. Leona School and Burroughs Junior High School between Stations 450+50 and 455+00.
455+00 to 506+00	Commercial, office, bank and residential buildings.
506+00 to 533+00	Office buildings. Hancock Park. County Art Museum at Station 520+50. May Company department store.
533+00 to 558+00	Park La Brea Apartments and mixed commercial and office buildings. Hancock Park School at Station 550+00.
558+00 to 574+00	Mixed commercial, bank and residenial buildings. Farmers Market between Stations 558+00 and 565+50. CBS Television City at Station 568+00.
574+00 to 628+00	Mixed commercial, bank and residential buildings and convalescent homes. Fairfax High School between Stations 589+00 and 602+00.

TABLE 2.2-1 (CONTINUED)

Station Number	Description of Land Usage
628+00 to 640+00	Mixed commercial, office, and residential buildings, and convalescent homes.
640+00 to 660+00	Apartments and single family residences.
660+00 to 735+00	Mixed commercial, office and residential buildings and motels. Hollywood High School between Stations 708+50 and 712+50. Blessed Sacrament School at Station 723+50.
735+00 to 795+00	Mixed commercial, office and residential buildings.
795+00 to 810+00	Hollywood Bowl.
810+00 to 825+00	Open space.
825+00 to 923+00	Single family residential and open space.
923+00 to 935+00	Mixed commercial and office buildings (close to Hollywood Freeway).
935+00 to 950+00	Universal City Studios and some commercial buildings.
950+00 to 1061+50	Mixed commercial, office and bank buildings. St. Charles Borromeo Church between Stations 973+00 and 975+50.

TABLE 2.2-2 LOCATIONS USED FOR EVALUATION OF THE NOISE AND VIBRATION ENVIRONMENT ALONG THE METRO RAIL ALIGNMENT

Location Number	Station Number	Approximate Perpendicular Horizontal Distance From Near Track Centerline (ft)	Site Description
1	122+50	620	Near the band stage platform area located within the El Pueblo State Historical Park Plaza on Olivera Street
2	142+00	240	On the west side of the intersection of North Broadway and Temple Street, near the Los Angeles County Hall of Records
3	168+00	340	On the west side of Broadway between 3rd and 4th Streets
4	202+50	250	On the north side of the intersection of Wilshire Boulevard and Flower Street, near the corner of Wells Fargo Bank
5	226+00	600	On the north side of Wilshire Boulevard and 165 ft southeast of the intersection of Wilshire Boulevard and Witmer, near the Hospital of the Good Samaritan
6	245+70	540	On the south side of Wilshire Boulevard and 60 ft west of the intersection of Wilshire Boulevard and Union Avenue
7	278+50	45	On the north side of the intersection of Wilshire Boulevard and Park View Street, near Otis/Parsons Art Gallery
8	299+40	150	On the northwest of the intersection of Wilshire Boulevard and Commonwealth Avenue, near the corner of Sheraton Hotel

TABLE 2.2-2 (CONTINUED)

Location Number	Station Number	Approximate Perpendicular Horizontal Distance From Near Track Centerline (ft)	Site Description
9	326+00	420	On the south side of the intersection of Wilshire Boulevard and Berendo Street, near the steps to Immanual Presbyterian Church
10	343+80	30	On the north side of the intersection of Wilshire Boulevard and Normandie Avenue, near the Wilshire Christian Church
11	354+00	25	On the north side of Wilshire Boulevard between Kingsley Drive and Harvard Boulevard, near the corner of St. Basil Roman Catholic Church
12	379+70	25	On the north side of Wilshire Boulevard between St. Andrews and Gramercy Place, near the corner of St. James Episcopal School and an office building
13	414+20	25	On the south side of Wilshire Boulevard between Lucerne Boulevard and Plymouth Boulevard, near the corner of Wilshire Methodist Church and the parking area
14	441+30	20	On the north side of Wilshire Boulevard between Rimpau Boulevard and Hudson Avenue, near the Farmers' Insurance building and the parking area
15	453+30	65	On the east side of Longwood Avenue and 40 ft south of Wilshire Boulevard, near the Leona School

TABLE 2.2-2 (CONTINUED)

Location Number	Station Number	Approximate Perpendicular Horizontal Distance From Near Track Centerline (ft)	Site Description
16	492+30	25	On the northeast corner of the intersection of Wilshire Boulevard and Burnside Avenue, near the office building
17	514+00	35	Near the La Brea Tar Fossil Pits located within Hancock Park, on the north side of the intersection of Wilshire Boulevard and Stanley Avenue
18	526+00	450	Near the observation pit located within the grounds of the Art Museum, 140 ft south of the intersection of Ogden Drive and 6th Street
19	524+50	120	Near the south end of Orangegrove Avenue
20	571+20	150	In the parking area of CBS T.V. Studio on Fairfax Avenue and Beverly Boulevard
21	594+50	10	On the west side of Fairfax Avenue and 100 ft north of the intersection of Fairfax Avenue and Clinton Street, near the Theater and King Solomon Home for the elderly
22	613+00	10	On the west side of Fairfax Avenue, 160 ft south of the intersection of Fairfax Avenue and Willoughby Avenue, near the driveway to the underground parking area of the County Villa Convalescent Home
23	640+00	1400	On the northeast corner of the intersection of Spaulding Avenue and Hampton Avenue

TABLE 2.2-2 (CONTINUED)

Location Number	Station Number	Approximate Perpendicular Horizontal Distance From Near Track Centerline (ft)	Site Description
24	672+00	1300	On the northwest corner of the intersection of Fountain Avenue and Gardner Street
25	690+00	1300	On the northwest corner of the intersection of Fountain Avenue and Alta Vista Boulevard
26	698+20	1300	On the northwest corner of the intersection of Fountain Avenue and La Brea Avenue
27	722+50	1300	On the northwest corner of the intersection of Fountain Avenue and Las Palmas Avenue
28	738+50	1400	On the south side of Fountain Avenue and 50 ft west of the intersection of Fountain Avenue and Wilcox Avenue, near the Orchard Gables Convalescent Hospital
29	740+00	1600	On the southeast corner of the intersection of Vine Street and De Longpre Avenue
30	751+00	1000	On the west side of Vine Street, 330 ft north of the intersection of Vine Street and Hollywood Boulevard, near the Capitol Records Building
31	778+00	360	On the south corner of Cerritos Place and Holly Hill Terrace
32	790+00	870	On the west side of the intersection of Las Palmas Avenue and Milner Terrace
33	840+00	10	Within the Hollywood Bowl parking area on Hollywood Bowl Drive

TABLE 2.2-2 (CONTINUED)

Location Number	Station Number	Approximate Perpendicular Horizontal Distance From Near Track Centerline (ft)	Site Description
34	823+50	1000	Outside the apartments at 6720 Parkhill Drive off Cahuenga Boulevard
35	842+00	360	Outside the house at 7010 Pacific View Drive
36	874+00	680	Outside the house at 3149 Oakshire Drive near Adina Drive
37	883+00	430	At the front of the garage of 3340 Bonnie Hill Drive
38	893+00	950	Outside the house at 3827 Broadlawn Drive off Cahuenga Boulevard
39	908+00	870	Outside a commercial building at 3623 Cahuenga Boulevard, located between Fredonia Drive and Regal Place
40	947+00	2400	In the parking area of Howard Johnson's Inn, 70 ft east of the intersection of Vineland Avenue and Aqua Vista Street
41	972+00	1500	On the southeast corner of the intersection of Vineland Avenue and Bloomfield Street
42	993+00	650	On the southwest corner of the intersection of Vineland Avenue and Hortense Street
43	1025+00	900	On the southeast corner of the intersection of Vineland Avenue and Hartsock Street
44	1050+00	1000	On the northwest corner of the intersection of Cumpston Street and Fulcher Avenue
45	1055+00	1500	On the northeast corner of the intersection of Chandler Boulevard and Camellia Avenue

TABLE 2.2-2 (CONTINUED)

Location Number	Station Number	Approximate Perpendicular Horizontal Distance From Near Track Centerline (ft)	Site Description
101	148+00	20	On the east side of Hill St and approximately 350 ft north of 1st St
102	166+70	25	On the west side of Hill St and approximately 250 ft south of 3rd St
103	231+80	30	On the east side of 7th St at the intersection of Hartford Ave and 7th St
104	250+40	25	In the parking lot of the Travelodge Motel near the intersection of 7th St and Little St
105	256+30	30	On the east side of Bonnie Brae St between Wilshire Blvd and 7th St and near the Mid-Wilshire Convalescent Hopsital
106	628+50	700	On the east side of Ogden Dr, 75 ft north of Santa Monica Blvd, adjacent to storage lot for Executive Car Leasing
107	654+50	1000	On the southeast corner of the intersection of Selma Ave and Orange Grove Ave
108	654+50	1950	On the southeast corner of the intersection of Fairfax Ave and Hillside Ave
109	620+50	3100	On the southeast corner of the intersection of Martel Ave and Romaine St
110	684+10	30	On the northeast corner of the intersection of Sunset Blvd and Fuller Ave

TABLE 2.2-2 (CONTINUED)

Location Number	Station Number	Approximate Perpendicular Horizontal Distance From Near Track Centerline (ft)	Site Description
111	687+60	30	On the northeast corner of the intersection of Sunset Blvd and Poinsetta Place
112	697+40	790	On the south side of Hawthorn Ave and 30 ft east La Brea Ave, near the Bank of Hollywood
113	695+30	1550	On the northwest corner of the intersection of El Cerrito Place and Yucca St
114	730+40	660	In the parking lot of the Selma Ave School, near the intersection of Selma Ave and Cassil Place
115	735+00	640	On the northeast corner of the intersection of Selma Ave and Hudson Ave
116	910+00	350	Outside the apartments at 362 Regal Place
117	914+70	340	Outside the house at 7765 Skyhill Drive
118	922+80	750	At the northeast corner of the intersection of Vineland Ave and Willowcrest Ave
119	942+90	240	Within the parking lot of Universal City Studio at the intersection of Lankershim Blvd and Valley Heart Drive, across from the Bank of America
120	942+00	260	At the northeast corner of Valley Heart Drive and Willowcrest Ave

TABLE 2.2-2 (CONTINUED)

Location Number	Station Number	Approximate Perpendicular Horizontal Distance From Near Track Centerline (ft)	Site Description
121	943+00	2950	Outside the apartments at 4185 Arch Drive
122	966+00	600	Outside the house at 4261 Riverton Ave
123	971+50	250	Outside the house at 10705 Bloomfield St
124	1001+00	980	Outside the apartments at 10830 Camarillo St
125	1018+00	520	Outside the house at 11137 Huston St
126	1015+50	700	Outside the house at 10932 Morrison St
127	1047+40	570	In the parking lot of the Community Health Center on Weddington St
Along Chandler Extension (not part of adopted alignment)			
128			On the north side of Weddington St and 60 ft west of the northern extension of Radford Ave
129			Outside the house at 5400 Radford Ave
130			Outside the house at 5524 Vantage Ave
131			Outside the house at 5310 Babcock Ave
132			In the vacant lot at the intersection of Chandler Blvd and Bellaire Ave, and 75 ft south of Chandler Blvd
133			On the southwest corner of the intersection of Goodland Ave and Cumpston St

TABLE 2.2-3 24-HOUR NOISE SURVEY LOCATIONS ALONG THE METRO RAIL ALIGNMENT

Location Number	Station Number	Approximate Perpendicular Horizontal Distance From Near Track Centerline (ft)	Description of Site
5	226+00	600	On the north side of Wilshire Boulevard, 165 ft southeast of the intersection of Wilshire Boulevard and Witmer, near the Hospital of the Good Samaritan
11	354+00	25	On the north side of Wilshire Boulevard between Kingsley Drive and Harvard Boulevard, near the corner of St. Basil Roman Catholic Church
19	524+50	120	Near the south end of Orangegrove Avenue
21	593+60	10	On the northwest corner of the intersection of Fairfax Avenue and Clinton Street
23	640+00	1400	On the northeast corner of the intersection of Spaulding Avenue and Hampton Avenue
25	690+60	1300	Outside the apartments at 7228 Fountain Avenue near Alta Vista Boulevard
28	738+50	1400	On the south side of Fountain Avenue, 50 ft west of the intersection of Fountain Avenue and Wilcox Avenue, near the Orchard Gables Convalescent Hospital
32A	791+60	760	At the intersection of Highland Avenue and Rockledge Road near Las Palmas Avenue
42	993+00	650	On the southwest corner of the intersection of Vineland Avenue and Hortense Street

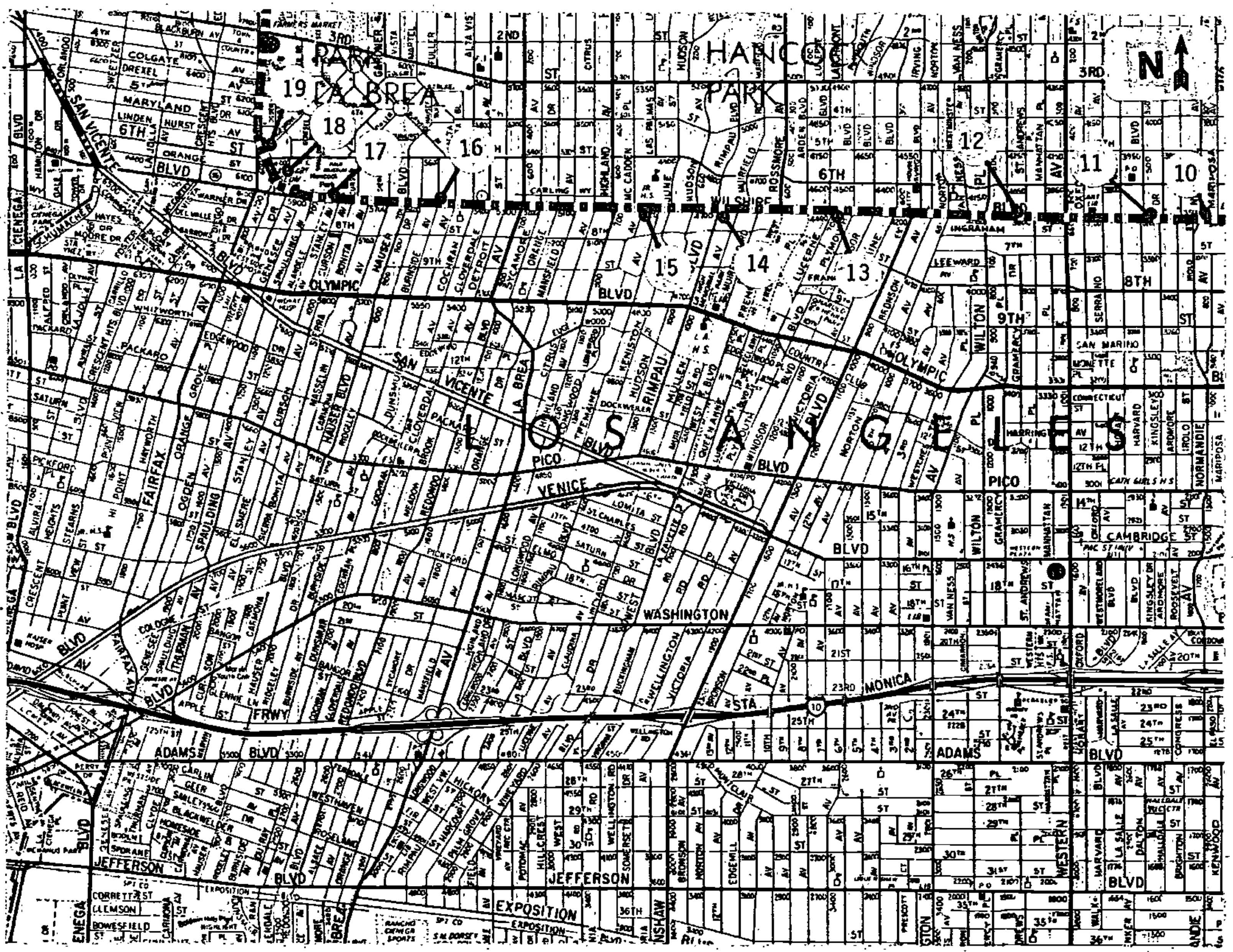
TABLE 2.2-3 (CONTINUED)

Location	Station	Approximate Perpendicular Horizontal Distance from Centerline (ft)	Site Description
102	166+70	25	On the north side of Hill St and approximately 250 ft west of 3rd St
107	654+50	1000	On the southeast corner of the intersection of Selma Ave and Orange Grove Ave
109	620+50	3100	On the northeast corner of the intersection of Martel Ave and Romaine St
118	922+50	770	At the southwest corner of the intersection of Vineland Ave and Willowcrest Ave
*42	993+00	650	On the southwest corner of the intersection of Vineland Ave and Hortense St
125	1018+00	590	Outside the house at 11154 Huston St
Along Chandler Extension (not part of adopted alignment)			
129A			On the northwest corner of the intersection of Radford Ave and Albers St
132			On the south side of Chandler Blvd and 40 ft west of Bellaire Ave

*This site is repeated from the first measurement phase (9/81)

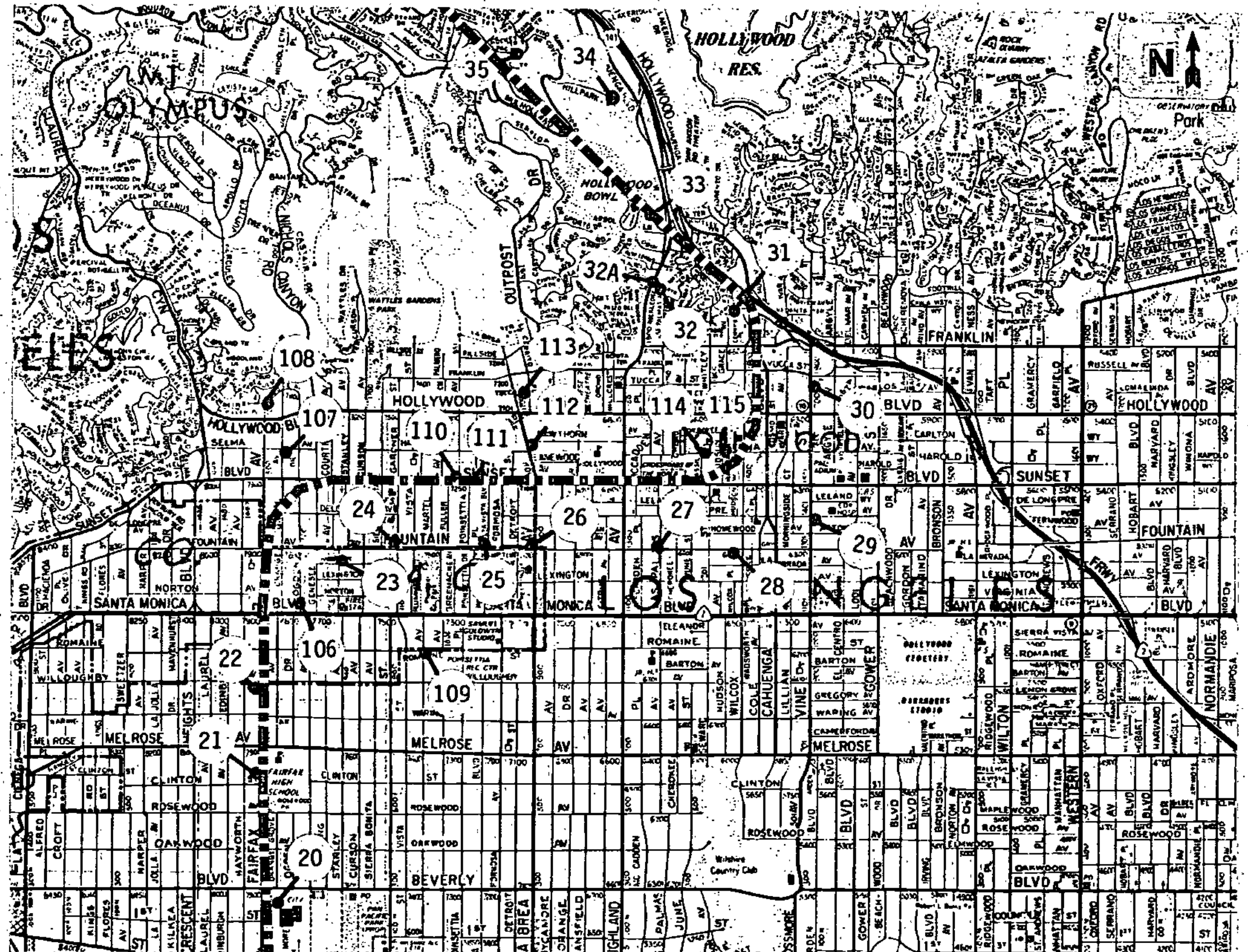
(SCALE: 1 INCH = 2800 FT)

FIGURE 2.2-1 LOCATION OF NOISE AND VIBRATION MEASUREMENT SITES ALONG THE METRO RAIL ALIGNMENT ADOPTED DECEMBER 1982



(SCALE: 1 INCH = 2800 FT)

FIGURE 2.2-2 LOCATION OF NOISE AND VIBRATION MEASUREMENT SITES ALONG THE METRO RAIL ALIGNMENT ADOPTED DECEMBER 1982



(SCALE: 1 INCH = 2800 FT)

FIGURE 2.2-3 LOCATION OF NOISE AND VIBRATION MEASUREMENT SITES ALONG THE METRO RAIL ALIGNMENT ADOPTED DECEMBER 1982

(SCALE: 1 INCH = 2800 FT)

FIGURE 2.2-4 LOCATION OF NOISE AND VIBRATION MEASUREMENT SITES ALONG THE METRO RAIL ALIGNMENT ADOPTED DECEMBER 1982

2.3 EXISTING NOISE LEVELS

Table 2.3-1 presents a tabulation of the statistical analysis of the noise observed at each of the 78 noise measurement locations. All of the noise levels are presented in terms of A-weighted sound level in decibels, abbreviated dBA. This measurement scale is used because it has become accepted as the best compromise scale, using frequency weighting which approximates the hearing characteristics of the average human ear. The A-weighted sound level shows good correlation of the subjective response of people and communities with measured noise levels. Also, most noise ordinances, standards and specifications are written in terms of A-weighted sound level. Figure 2.3-1 indicates the typical A-weighted sound levels for some common noises.

Each measurement to determine the noise data in Table 2.3-1 consisted of a ten minute long continuous sample of noise at the site, recorded by means of a calibrated multi-channel precision magnetic tape recorder equipped with a sound level meter microphone. The recordings obtained were later analyzed to obtain the statistical distribution and other descriptors of the noise levels. The tape recordings can be used in the future to obtain spectral analysis of the noise at the sites (such as octave band or 1/3 octave band analyses) and are permanently retained as a record of the noise environment existing at the time of the measurements. Most measurement sites were visited twice and the data obtained on each day was averaged to obtain the data shown on Table 2.3-1.

Each measurement location was chosen to obtain the noise levels characteristic of an area or near a potentially noise sensitive building. Wherever possible the measuring microphone was located at the set back line of the nearby buildings.

Review of the sound level data obtained during the spot-check or 10-minute measurements indicates that the residual background noise levels, L_{99} and L_{90}, range from 37 to 69 dBA during the rush hour and day, and 34 to 64 dBA during the evening and nighttime hours. At most locations the noise levels do show a significant decrease during the evening and nighttime hours when compared with the rush hour and daytime noise levels. At some locations, a temperature inversion was evident during the evening and nighttime measurement periods and resulted in a somewhat higher residual background noise level during the evening and nighttime than during the daytime and rush hour.

The median or L_{50} noise level for the different sites ranges from 40 to 72 dBA during the rush hour, 39 to 72 dBA during the day, 43 to 69 dBA during the evening and 38 to 65 dBA during the night. As with the residual background noise levels, the L_{50} noise level generally shows a significant decrease during the evening and nighttime hours.

At many measurement locations, the data for L_{10} and L_1 show typical levels for a high volume of vehicular traffic on city streets. This results in L_{10} and L_1 noise levels greater than 70 dBA, and at some locations, greater than 80 dBA. An L_1 noise level of 80 dBA or greater is generally considered a high noise level for commercial and residential developed areas. At several of the measurement locations there was only a slight decrease in the L_1 and L_{10} noise levels during the evening and nighttime hours which indicates that there is a significant volume of nearby vehicular traffic at night.

The Energy Equivalent Level, L_{eq}, ranges from 48 to 76 dBA during the rush hour, 47 to 74 dBA during the daytime, 48 to 70 dBA during the evening and 45 to 67 dBA during the nighttime. As with the noise levels characterized by the other statistical descriptors, the noise levels represented by the upper bound of the range for each time period are quite high and are due primarily to vehicular traffic on the nearby streets.

Since most of the noise impact is from local activities and local traffic, different areas along the proposed alignment have different noise environments as is shown by the wide range of noise levels represented by each statistical descriptor when examining all of the measurement locations over the entire length of the route. The range of noise levels encountered during a particular time period over the entire length of the alignment is 20 to 30 dB which indicates that very different noise environments were observed. Despite this wide range of observed noise levels, the noise data indicate a high level of ambient noise along most of the alignment which is primarily due to vehicular traffic.

The use of digital analysis equipment to derive the statistics of the ambient noise level at each of the measurement locations permits calculation and plotting of continuous graphs or charts giving a complete graphical description of the noise level distribution at each measurement location. Since this information is a supplement to the noise level information given in tabular form for the specific descriptors such as L_{90}, L_{50}, and L_{10}, a series of graphs of the statistical analyses has been prepared as part of the noise data analysis and the graphs are presented in Appendix A. These charts present data similar to that given in Table 2.3-1 except that the complete distribution is shown with a resolution of 1 dBA. A separate chart for each measurement location is included. At those locations where repeat measurements were made, the statistical distribution charts present an average of the data obtained for each visit during a specific time period.

These charts provide a means of graphically comparing the noise distribution along different sections of the route. In addition, since each chart is devoted to one measurement location, the influence of the time of day on the noise levels can be readily discerned.

As stated previously, 24-hour or long-term noise measurements were made at 16 of the 78 noise measurement locations. These measurements were made in order to obtain a complete statistical representation of the daily noise exposure in a community area and to show that the short-term or spot-check sample data correlate well with the variation of noise levels characteristic of the four time periods used. As with the spot-check measurements, the 24-hour or long-term noise measurements are reported in terms of A-weighted sound level in decibels, abbreviated dBA.

The equipment used for the long-term noise evaluation consisted of calibrated, precision, digital acoustical data acquisition systems with a sampling rate of 60 measurements per minute. These digital data acquisition systems digitize the A-weighted noise level each second, and then store these digitized data on tape cassettes for subsequent laboratory statistical analysis of the noise levels observed. Although the digital data acquisition systems can provide information on the noise levels over a long period of time, since these units digitize the A-weighted noise level, they cannot provide information on the spectrum of noise, i.e., octave band or 1/3 octave band analyses are not possible.

Since these digital data acquisition systems operate unattended, they were generally secured to a telephone or street light-pole which usually located the measuring microphone closer to nearby vehicular traffic but higher above the ground than the microphone of the spot-check measuring system. Thus the peak noise levels measured by the digital data acquisition system are often greater than that observed by the spot-check measurement system. However, these data do show good correlation with that obtained with the spot-check measuring system.

With the long-term measurement system, single number descriptors of the noise environment over a 24-hour time period can be obtained. The descriptors, CNEL and L_{dn} are by definition, based on a 24-hour time period and are minor variations of L_{eq}. These descriptors take into consideration the fact that people are generally more annoyed by a given sound level at night than during the day. They are determined in the same manner as L_{eq}, except that both have a 10 dB adjustment factor added to the noise levels between 10 p.m. and 7 a.m. In addition, CNEL has a 5 dB penalty applied to the noise levels between 7 p.m. and 10 p.m. Thus, depending on the noise levels occurring in a community during the evening and nighttime, CNEL and L_{dn} are often several decibels greater than $L_{eq}(24)$, the energy equivalent level over a 24-hour period.

CNEL is the noise descriptor specified in the California State Aeronautic Code for evaluation of noise impact of aircraft operations. CNEL is also specified in the California State Noise Insulation Standards for new multi-family residential dwellings. Hence, local compliance with these standards often necessitates that community noise be specified in terms of CNEL. L_{dn} represents a slight simplification of CNEL and is the noise descriptor preferred by the US EPA. For most environmental noise, L_{dn} and CNEL seldom differ by more than 1 dB. Although no long term noise descriptor levels are specified by any legislative body for operation or construction of the Metro Rail System, CNEL, L_{dn} and $L_{eq}(24)$ are reported for each long-term measurement location. The CNEL ranges from a low of 58 dBA at Location 109 to a high of 78 dBA at Location 32A, while the

$L_{eq}(24)$ ranges from a low of 55 dBA at Location 109 to a high of 73 dBA at Location 32A.

Figures 2.3-2 through 2.3-18 are plots of the time history of the noise levels at the long-term measurement locations. These figures also show the date and time each survey began, as well as the values for CNEL, L_{dn} and $L_{eq}(24)$. These surveys are representative of weekday activities and show the decrease in noise levels during the nighttime and early morning hours which is characteristic of urban noise dominated by transportation activities. The data obtained at Location 125 shows the effect of a temperature inversion. A temperature inversion can have the effect of raising the residual background noise by focusing some distant noise to a receiver, in this case either the Hollywood or Ventury Freeways. Some uncharacteristically high noise levels were observed for short period at Locations 107 and 109. These high noise levels have not been included in the determination of the values for CNEL, L_{dn} and $L_{eq}(24)$ at these locations, since these high noise levels are not considered characteristic of these noise measurements.

As previously stated, at each of the long-term measurement locations, the time history of the noise levels show the characteristic pattern of urban noise dominated by transportation activities. Thus the noise levels are the greatest during the rush hour period, the same or somewhat lower during the daytime, still somewhat lower during the evening and considerably lower during the nighttime. This characteristic pattern of the variation of noise level over a full day was shown at each of the locations where a long-term measurement was made, thus the correlation between the short and long term measurements can be drawn at those locations where both types of measurements were made. This noise level variation over a full day has been shown to be characteristic of noise environments in a large number of urban areas in the U.S.A. and Canada. This correlation of noise measurements during different times of the day can be logically extended to the short term noise measurements, thus validating them as characteristic for the appropriate time of day and accurately characterizing the noise environment at a particular location without the need for a complete 24-hour survey.

TABLE 2.3-1 ENVIRONMENTAL NOISE LEVELS MEASURED AT LOCATIONS ALONG THE METRO RAIL ALIGNMENT - SEPTEMBER 21 THROUGH OCTOBER 1, 1981

Location Number	Time of Day	Date (September or October 1981)	Noise Levels - dBA					
			L_{99}	L_{90}	L_{50}	L_{10}	L_1	L_{eq}
1	Rush Hour	28	62	63	64	66	72	65
	Day	28	57	58	61	64	68	62
	Evening	28	53	54	56	60	66	58
	Night	28	52	53	54	57	60	55
2	Rush Hour	22	65	67	70	74	81	72
	Day	21	65	67	71	75	82	72
	Evening	22	63	64	67	71	76	68
3	Rush Hour	22	62	65	70	77	84	73
	Day	21	64	66	69	74	81	72
	Evening	22	54	57	63	71	79	68
4	Rush Hour	22 & 28	67	68	71	77	84	74
	Day	21 & 28	66	68	72	77	83	74
	Evening	22 & 28	59	61	64	71	79	68
5	Rush Hour	23	56	60	67	73	80	71
	Day	21	55	59	64	69	76	67
	Evening	21	51	54	60	67	77	65
	Night	22	50	51	55	64	70	60
6	Rush Hour	21	57	60	66	74	82	71
	Day	21	56	60	65	73	82	70
	Evening	21	54	57	63	71	80	68
7	Rush Hour	21 & 1	57	59	66	74	80	70
	Day	21 & 29	56	59	66	72	79	69
	Evening	21	51	53	59	69	77	66
	Night	21	49	50	53	62	66	57
8	Rush Hour	21 & 1	61	64	68	73	80	70
	Day	21 & 29	59	62	67	72	78	69
	Evening	21	55	57	64	70	79	67
	Night	21	50	51	57	65	72	61

TABLE 2.3-1 (CONTINUED)

Location Number	Time of Day	Date (September or October 1981)	Noise Levels - dBA L_{99}	L_{90}	L_{50}	L_{10}	L_{1}	L_{eq}
9	Rush Hour	21	63	65	69	77	83	73
	Day	22	59	62	67	74	80	70
	Evening	21	56	57	69	69	77	66
	Night	21	54	55	61	68	75	66
10	Rush Hour	21 & 1	64	67	71	79	83	75
	Day	22 & 29	62	65	70	76	82	72
	Evening	21	57	60	65	71	78	68
	Night	21	55	58	64	70	76	67
11	Rush Hour	21 & 1	60	62	69	74	81	71
	Day	22 & 29	62	64	69	74	78	71
	Evening	21	56	59	65	71	74	67
	Night	22	49	51	58	68	75	64
12	Rush Hour	23	56	59	70	74	82	72
	Day	22	56	58	67	74	80	70
	Evening	23	51	55	65	71	75	67
13	Rush Hour	23	57	61	68	73	77	70
	Day	22	56	61	70	76	82	72
	Evening	22	52	56	66	71	76	68
	Night	23	44	47	57	68	74	63
14	Rush Hour	1	54	57	66	72	76	68
	Day	29	58	60	66	72	81	71
15	Rush Hour	23	57	60	65	69	76	67
	Day	23 & 29	50	53	62	68	77	65
	Evening	23	47	50	59	67	71	63
	Night	25	40	42	47	63	69	58
16	Rush Hour	24	59	62	68	74	83	72
	Day	23	56	59	68	75	84	72
	Evening	23	53	58	66	71	75	67
17	Rush Hour	24	54	58	63	68	73	65
	Day	23	54	58	63	67	73	64
	Evening	23	47	51	58	64	69	61
	Night	23	45	47	57	64	69	60

TABLE 2.3-1 (CONTINUED)

Location Number	Time of Day	Date (September or October 1981)	Noise Levels - dBA L_{99}	L_{90}	L_{50}	L_{10}	L_1	L_{eq}
18	Rush Hour	23	50	52	56	59	63	56
	Day	23 & 30	50	51	54	57	62	55
19	Rush Hour	22 & 30	52	54	57	60	64	58
	Day	22 & 30	49	53	56	60	64	57
	Evening	22	48	51	55	59	64	56
	Night	23	39	41	45	52	60	49
20	Rush Hour	23	50	51	53	57	69	57
	Day	23 & 29	50	51	54	57	62	55
	Evening	23	50	51	54	58	64	55
21	Rush Hour	22	57	62	68	72	76	69
	Day	22 & 30	53	59	66	72	77	68
	Evening	22	50	58	65	71	77	68
	Night	25	44	50	60	71	78	67
22	Rush Hour	22	52	56	64	71	78	68
	Day	22	51	54	63	71	82	69
	Evening	22	48	51	59	69	74	64
	Night	24	44	46	53	64	70	59
23	Rush Hour	24 & 30	46	48	56	60	67	57
	Day	23 & 30	42	44	48	57	66	54
	Evening	23	39	41	47	54	63	51
	Night	24	34	35	38	49	60	47
24	Rush Hour	24	56	62	68	72	79	70
	Day	24	59	62	68	72	78	70
	Evening	24	49	54	62	69	72	65
	Night	24	46	49	61	69	75	65
25	Rush Hour	24 & 30	49	56	65	70	73	67
	Day	24 & 30	48	53	65	71	75	67
	Evening	24	43	48	61	69	73	65
	Night	24	44	47	59	69	73	64
26	Rush Hour	24	66	68	72	75	82	73
	Day	24	63	68	72	76	81	73
	Evening	24	59	62	68	73	78	70
27	Rush Hour	24	59	62	66	70	75	67
	Day	24	55	61	66	71	78	68
	Evening	24	50	55	63	69	76	66
	Night	24	45	49	60	67	72	63

TABLE 2.3-1 (CONTINUED)

Location Number	Time of Day	Date (September or October 1981)	Noise Levels - dBA L_{99}	L_{90}	L_{50}	L_{10}	L_{1}	L_{eq}
28	Rush Hour	28	57	60	65	70	76	67
	Day	28	54	57	64	69	74	66
	Evening	28	54	57	63	69	76	66
	Night	28	45	48	55	63	71	60
29	Rush Hour	24	62	65	70	75	80	72
	Day	24 & 24	57	62	67	71	78	69
	Evening	24	57	60	66	73	79	69
30	Rush Hour	29	59	62	67	71	78	69
	Day	24	61	62	66	72	77	68
	Evening	24 & 24	56	58	62	68	73	64
31	Rush Hour	24	54	56	58	61	65	59
	Day	24	52	54	56	59	62	56
	Evening	24	50	53	56	58	62	56
	Night	24	44	47	52	58	62	54
32	Rush Hour	29	51	55	59	63	67	60
	Day	25	46	49	53	57	65	55
	Evening	29	49	53	58	63	68	61
	Night	29	46	48	54	58	63	55
33	Rush Hour	29	52	53	55	59	64	57
	Day	25	55	57	59	63	71	62
	Evening	29	49	50	52	58	73	59
34	Rush Hour	29	53	54	56	60	72	60
	Day	25	49	51	53	55	68	57
	Evening	29	51	52	54	57	66	57
	Night	30	49	50	52	56	67	56
35	Rush Hour	29	42	44	46	58	67	56
	Day	25	42	43	45	48	60	48
	Evening	29	41	42	44	58	68	55
	Night	29	39	44	45	47	53	46
36	Rush Hour	29	40	43	52	63	70	59
	Day	29	41	42	46	59	70	57
	Evening	29	41	42	43	53	69	55
	Night	29	42	43	44	52	62	52

TABLE 2.3-1 (CONTINUED)

Location Number	Time of Day	Date (September or October 1981)	Noise Levels - dBA L_{99}	L_{90}	L_{50}	L_{10}	L_{1}	L_{eq}
37	Rush Hour	29	38	38	40	46	59	48
	Day	29	37	38	39	42	62	47
	Evening	29	44	44	45	46	62	49
	Night	29	42	42	43	46	52	46
38	Rush Hour	28	45	47	49	55	68	55
	Evening	28	45	46	48	50	54	48
	Night	29	43	44	46	48	55	48
39	Rush Hour	28	64	66	70	75	79	72
	Day	28	61	63	67	73	78	70
	Evening	28	59	61	65	71	79	69
40	Rush Hour	28	56	57	60	66	72	63
	Day	28 & 30	56	57	60	65	71	62
	Evening	28 & 29	53	54	57	63	68	60
	Night	30	49	51	55	60	64	56
41	Rush Hour	28	55	58	63	68	79	68
	Day	28	55	57	63	69	75	66
	Evening	28	52	54	58	65	73	62
	Night	29	41	43	48	56	66	56
42	Rush Hour	28	56	58	63	69	75	66
	Day	28	59	61	64	68	75	65
	Evening	28	55	57	60	65	70	62
	Night	29	43	46	50	58	62	54
43	Rush Hour	28	52	56	65	71	76	67
	Day	28	50	54	64	72	79	68
	Evening	28	49	52	61	69	77	66
	Night	29	42	44	50	63	70	59
44	Rush Hour	28	48	49	54	64	69	59
	Day	28	44	45	53	64	72	61
	Evening	28	44	45	48	54	63	52
	Night	29	42	42	45	46	51	45
45	Rush Hour	28	56	58	62	70	80	68
	Day	28	53	55	59	68	77	66
	Evening	28	53	54	57	68	76	64
	Night	28	48	49	52	56	68	57

TABLE 2.3-1 (CONTINUED)
ENVIRONMENTAL NOISE LEVELS MEASURED AT LOCATIONS ALONG THE METRO RAIL ALIGNMENT ALTERNATIVES - SEPTEMBER 20 THROUGH SEPTEMBER 24, 1982

Location Number	Time of Day	Date (September 1982)	Noise Levels - dBA					
			L_{99}	L_{90}	L_{50}	L_{10}	L_1	L_{eq}
101	Rush Hour	20 & 21	60	62	68	74	81	71
	Day	20 & 21	58	60	64	70	77	67
	Evening	20 & 21	52	54	59	68	77	65
	Night	20 & 22	50	51	54	63	72	60
102	Rush Hour	20 & 21	60	63	67	73	79	70
	Day	20 & 21	59	60	64	70	76	67
	Evening	20 & 21	53	55	60	66	75	64
	Night	21 & 22	50	52	57	66	76	63
103	Rush Hour	20 & 21	55	61	67	73	77	69
	Day	20 & 21	59	62	66	71	77	68
	Evening	20 & 21	52	54	59	67	71	64
	Night	21 & 22	50	51	54	62	68	58
104	Rush Hour	20 & 21	55	58	63	70	75	66
	Day	20 & 21	56	58	63	69	78	67
	Evening	20 & 21	49	52	58	67	74	64
	Night	20 & 22	47	48	52	63	72	60
105	Rush Hour	20 & 21	54	56	59	66	74	63
	Day	20 & 21	54	55	58	65	77	66
	Evening	20 & 21	48	50	54	60	68	58
	Night	20 & 21	45	46	49	57	66	54
106	Rush Hour	20 & 23	50	54	59	65	72	62
	Day	21	50	54	59	65	72	62
	Evening	21 & 23	47	51	57	62	66	59
	Night	21 & 24	44	48	56	61	68	58
107	Rush Hour	20 & 21	47	49	54	65	72	61
	Day	21 & 22	47	48	52	62	74	60
	Evening	20 & 22	44	46	49	57	67	57
	Night	21	41	43	46	55	66	53

TABLE 2.3-1 (CONTINUED)

Location Number	Time of Day	Date (September 1982)	Noise Levels - dBA L_{99}	L_{90}	L_{50}	L_{10}	L_1	L_{eq}
108	Rush Hour	20 & 22	48	50	54	61	72	60
	Day	21 & 22	46	48	52	57	63	54
	Evening	20 & 22	45	48	52	57	64	55
	Night	20	44	46	50	54	64	53
109	Rush Hour	20 & 21	46	48	52	63	72	60
	Day	21 & 22	43	45	49	59	68	57
	Evening	20 & 21	44	46	49	58	68	56
	Night	21 & 22	42	43	44	51	59	49
110	Rush Hour	22	60	62	68	72	78	69
	Day	22	57	60	66	72	79	69
	Evening	22 & 23	59	62	66	71	78	68
	Night	23	56	59	65	70	75	67
111	Rush Hour	21	59	62	70	76	83	74
	Day	21	56	59	68	74	78	70
112	Rush Hour	21 & 22	57	62	66	71	75	68
	Day	21 & 22	57	61	65	70	75	67
	Evening	21 & 22	52	56	61	67	73	64
	Night	21	48	52	58	65	71	62
113	Rush Hour	21 & 22	49	51	55	61	71	59
	Day	20 & 21	48	51	54	61	69	58
	Evening	20 & 23	47	49	53	60	68	58
	Night	20 & 21	44	46	50	57	67	56
114	Rush Hour	23	50	53	58	64	72	62
	Day	23 & 24	47	49	53	58	66	57
	Evening	23	45	47	52	60	64	56
	Night	23	43	45	50	60	66	56
115	Rush Hour	22	54	57	62	67	76	65
	Day	22 & 23	54	56	62	69	76	67
	Evening	23	48	52	59	66	72	63
	Night	21	45	48	54	62	68	58
116	Rush Hour	21 & 22	43	44	46	50	62	50
	Day	21 & 23	43	44	46	53	60	51
	Evening	21 & 22	48	49	51	54	58	52
	Night	20 & 22	43	46	47	49	54	48

TABLE 2.3-1 (CONTINUED)

Location Number	Time of Day	Date (September 1982)	Noise Levels - dBA					
			L_{99}	L_{90}	L_{50}	L_{10}	L_1	L_{eq}
117	Rush Hour	22 & 23	41	42	44	50	58	48
	Day	21 & 22	41	42	44	49	56	47
	Evening	21 & 22	47	48	49	51	56	50
	Night	21 & 22	44	45	47	48	52	47
118	Rush Hour	21 & 22	47	49	53	64	73	62
	Day	21 & 22	44	45	49	59	68	56
	Evening	21 & 22	49	50	51	56	69	56
	Night	20 & 22	46	47	48	51	58	50
119	Rush Hour	21 & 22	55	56	59	63	70	61
	Day	21	54	57	61	66	70	63
	Evening	21 & 22	54	55	57	60	66	58
	Night	21 & 23	52	53	55	59	64	57
120	Rush Hour	23	52	52	54	60	70	60
	Day	23	49	50	54	58	66	56
	Evening	23	46	47	50	53	55	51
	Night	23	47	48	50	52	56	50
121	Rush Hour	22 & 23	44	45	47	58	66	54
	Day	21 & 22	43	44	46	59	69	57
	Evening	20 & 22	49	50	52	55	66	55
	Night	20, 21 & 22	44	45	47	51	61	51
122	Rush Hour	21 & 23	46	47	50	59	67	56
	Day	21 & 23	43	44	47	54	61	51
	Evening	20 & 21	47	48	49	51	67	55
	Night	20 & 21	42	44	45	49	53	47
123	Rush Hour	21 & 23	45	46	48	58	71	60
	Day	21 & 22	43	44	46	52	64	53
	Evening	20 & 23	46	47	48	51	60	51
	Night	21 & 22	44	45	47	50	61	50
124	Rush Hour	21 & 23	48	51	61	68	74	64
	Day	21 & 22	44	48	59	69	79	66
	Evening	20 & 23	46	47	53	65	73	61
	Night	21 & 23	41	42	45	58	71	58
125	Rush Hour	21 & 23	48	49	51	61	71	59
	Day	21 & 23	46	48	50	57	74	60
	Evening	20 & 22	47	48	50	53	64	53
	Night	21 & 23	45	47	49	51	54	49

TABLE 2.3-1 (CONTINUED)

Location Number	Time of Day	Date (September 1982)	Noise Levels dBA L_{99}	L_{90}	L_{50}	L_{10}	L_{1}	L_{eq}
126	Rush Hour	22 & 23	48	49	51	60	76	62
	Day	21 & 23	44	45	48	53	61	51
	Evening	20 & 22	48	49	52	55	62	54
	Night	21 & 23	44	45	48	51	54	49
127	Rush Hour	20 & 23	47	52	56	63	77	63
	Day	21 & 23	50	52	54	61	66	58
	Evening	20 & 22	48	49	51	56	64	55
	Night	21 & 23	47	49	51	53	57	51
128	Rush Hour	20 & 23	46	47	50	56	70	57
	Day	21 & 22	43	44	47	58	65	54
	Evening	21 & 22	49	50	53	59	66	56
	Night	20 & 22	43	44	45	48	52	46
129	Rush Hour	20 & 23	48	51	59	65	69	61
	Day	21 & 22	44	47	55	64	71	60
	Evening	20 & 22	48	49	51	58	66	54
	Night	20 & 22	45	46	47	51	63	52
130	Rush Hour	20 & 22	43	45	49	56	64	54
	Day	21 & 22	42	43	46	56	66	54
	Evening	21 & 23	47	49	52	58	67	56
	Night	20 & 22	42	44	47	49	52	47
131	Rush Hour	21 & 22	42	43	45	55	72	57
	Day	22 & 23	38	40	42	51	66	54
	Evening	21 & 23	45	46	49	51	54	49
	Night	21 & 22	43	44	46	49	59	50
132	Rush Hour	21 & 22	46	48	56	63	69	59
	Day	22 & 23	41	44	51	61	68	57
	Evening	21 & 23	44	45	49	58	65	54
	Night	21 & 22	44	45	47	54	60	51
133	Rush Hour	21 & 22	45	46	50	57	66	55
	Day	22 & 23	41	42	45	50	58	48
	Evening	21 & 23	45	46	48	50	56	48
	Night	21 & 22	46	47	48	51	55	49

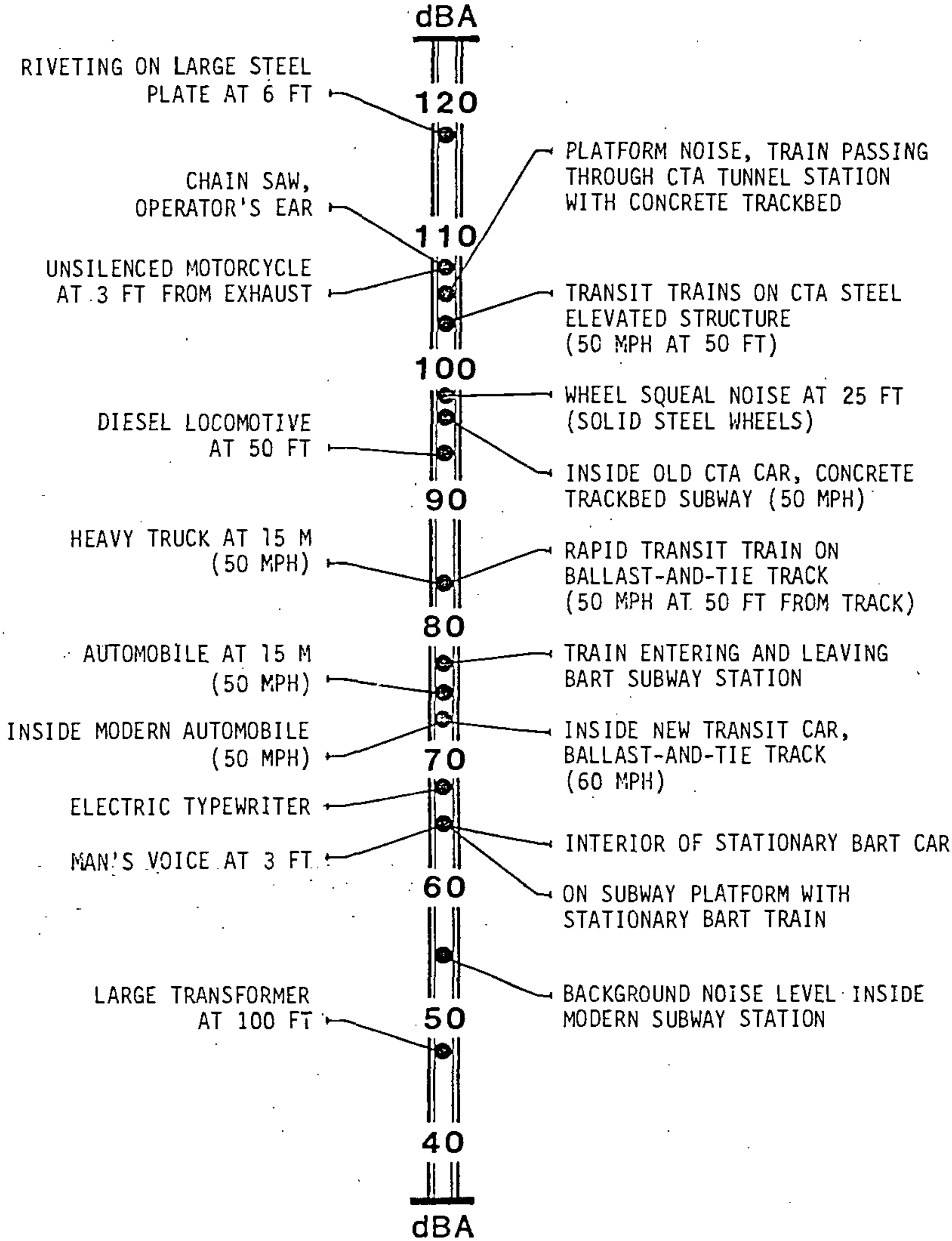


FIGURE 2.3-1 TYPICAL NOISE LEVELS

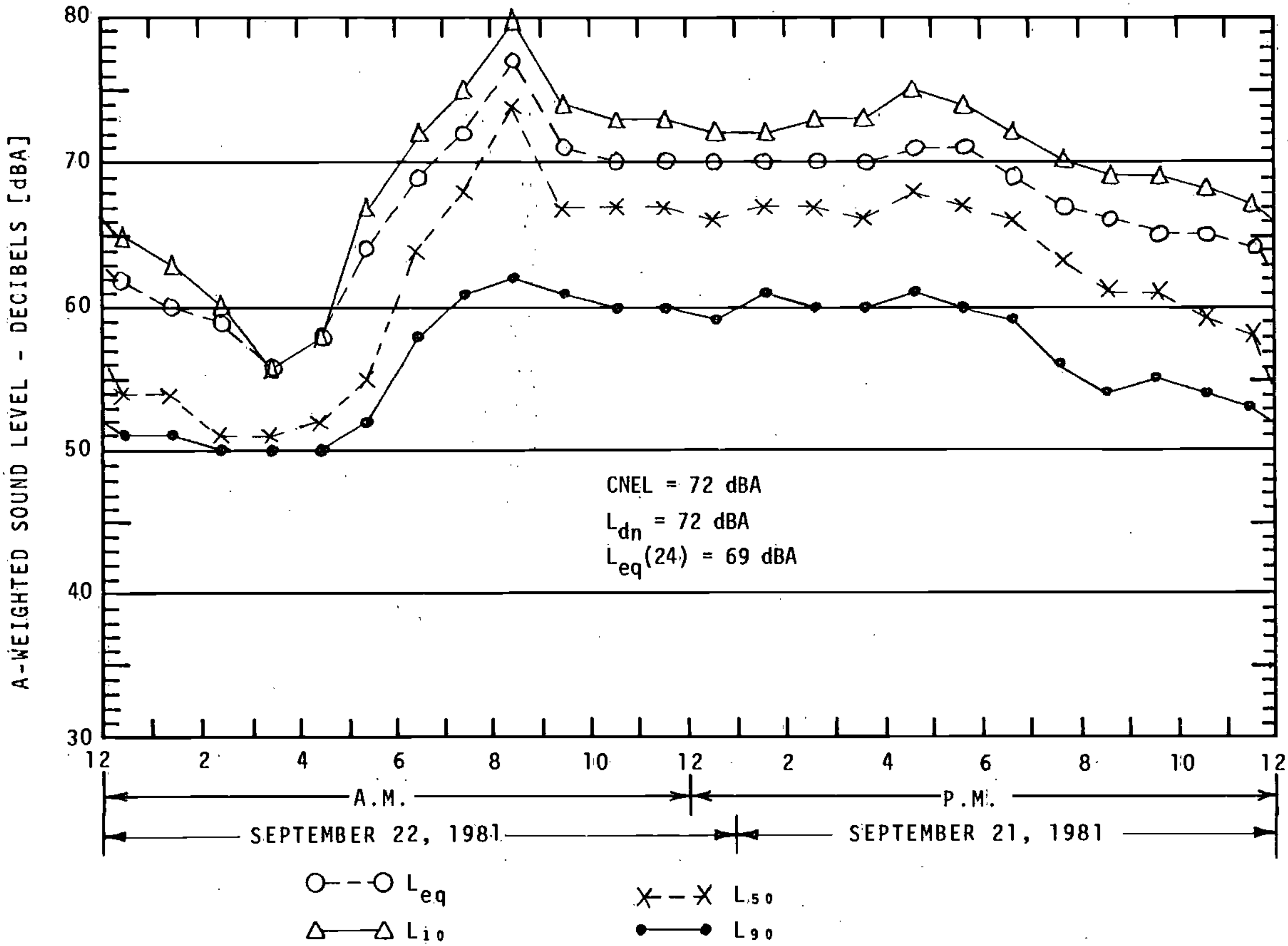


FIGURE 2.3-2 TIME HISTORY OF THE NOISE LEVEL MEASURED AT LOCATION 5, OVER THE 24-HOUR PERIOD BEGINNING 1PM, MONDAY SEPTEMBER 21, 1981

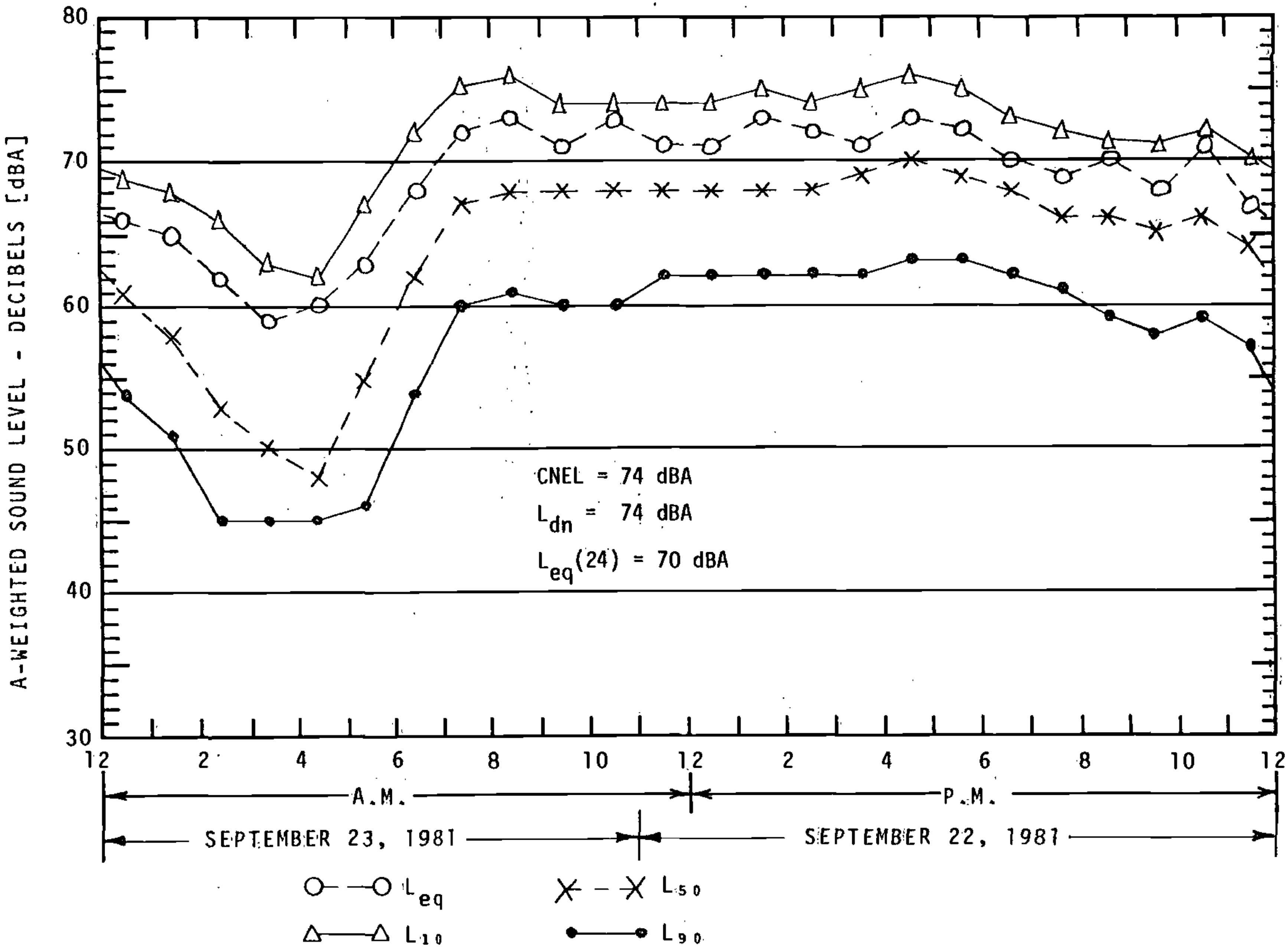


FIGURE 2.3-3 TIME HISTORY OF THE NOISE LEVEL MEASURED AT LOCATION 11, OVER THE 24-HOUR PERIOD BEGINNING 11AM, TUESDAY, SEPTEMBER 22, 1981

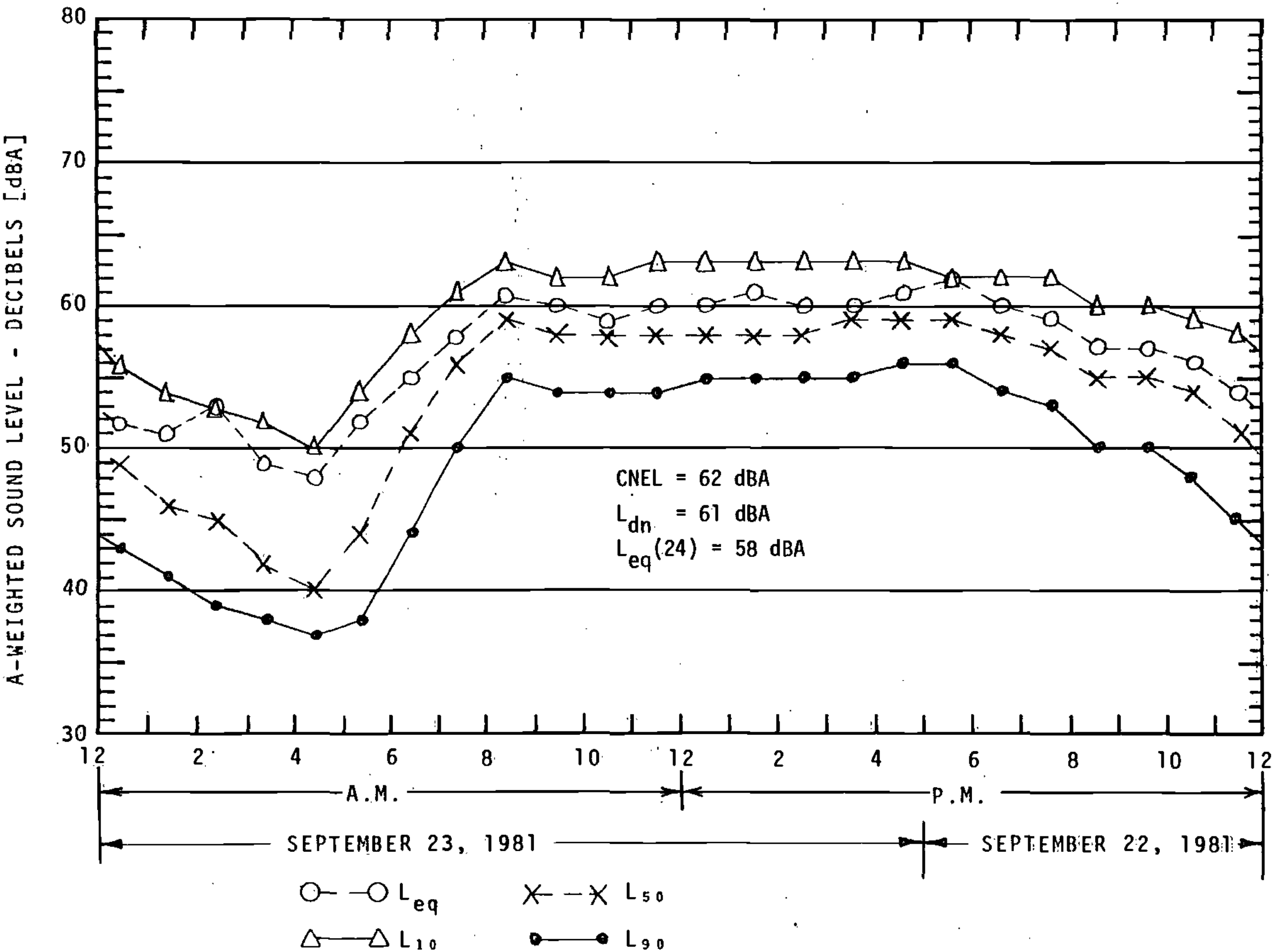


FIGURE 2.3-4 TIME HISTORY OF THE NOISE LEVEL MEASURED AT LOCATION 19, OVER THE 24-HOUR PERIOD BEGINNING 5PM, TUESDAY SEPTEMBER 22, 1981

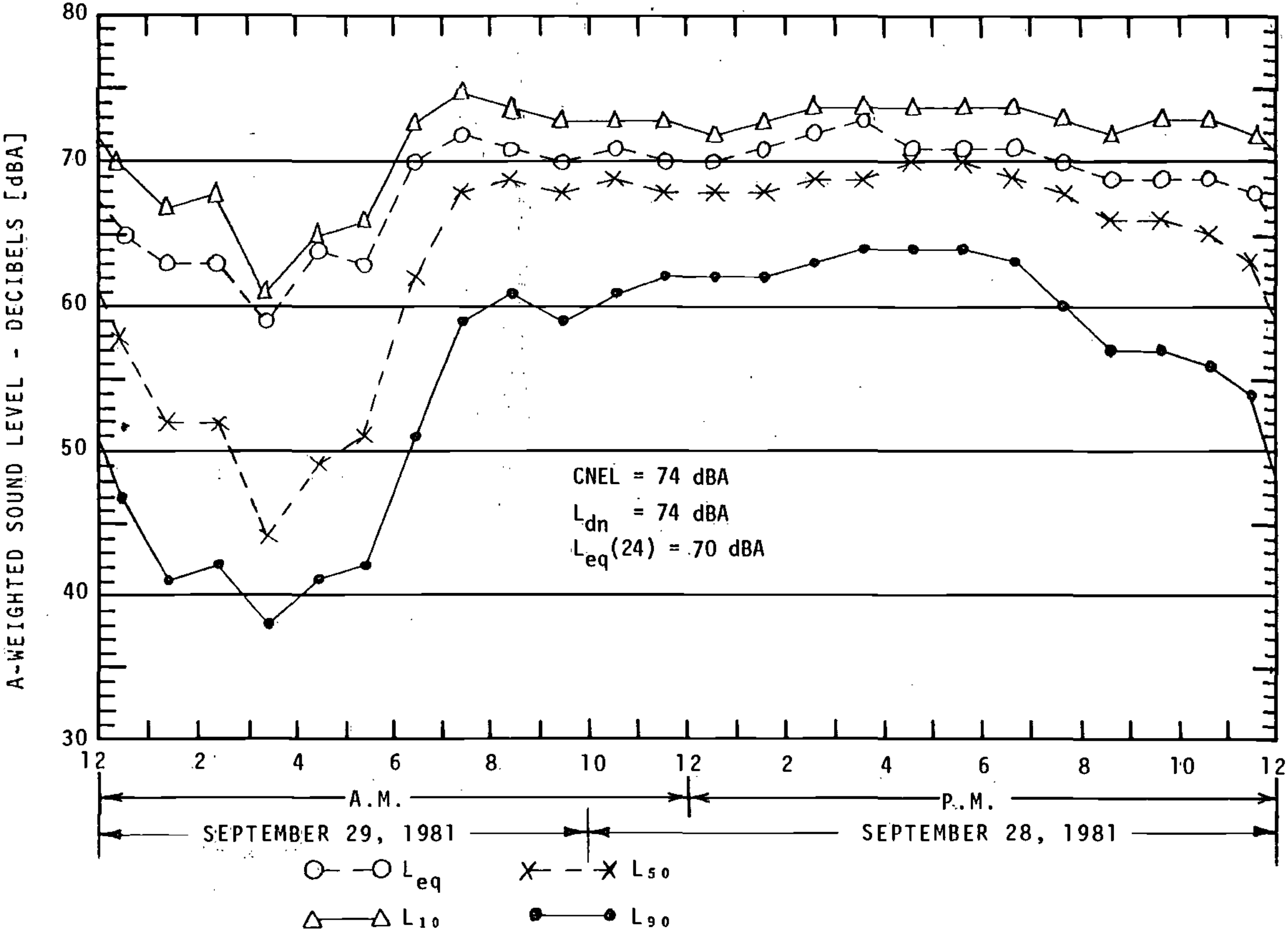


FIGURE 2.3-5 TIME HISTORY OF THE NOISE LEVEL MEASURED AT LOCATION 21, OVER THE 24-HOUR PERIOD BEGINNING 10AM, MONDAY SEPTEMBER 28, 1981

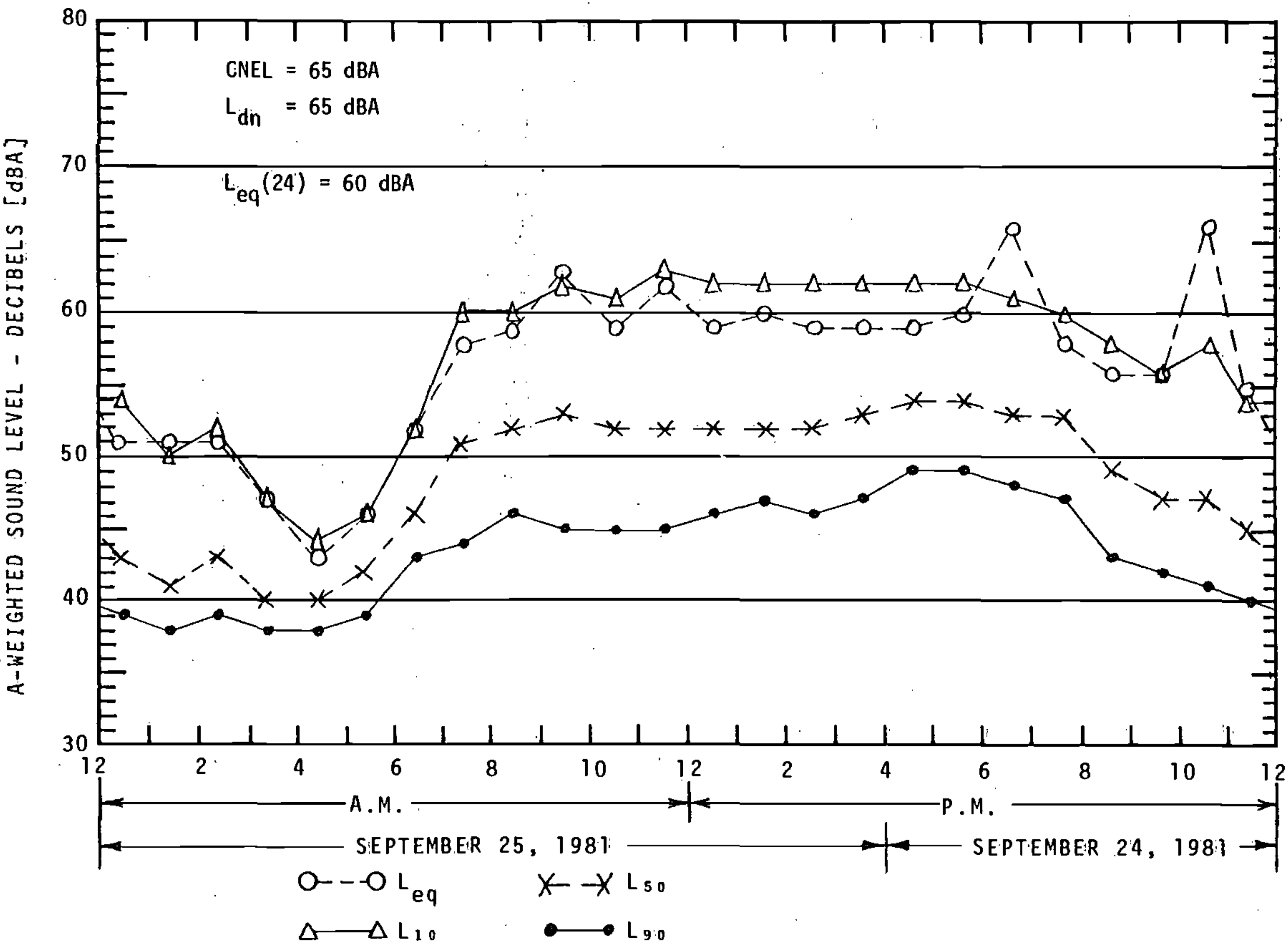


FIGURE 2.3-6 TIME HISTORY OF THE NOISE LEVEL MEASURED AT LOCATION 23, OVER THE 24-HOUR PERIOD BEGINNING 4PM, THURSDAY, SEPTEMBER 24, 1981

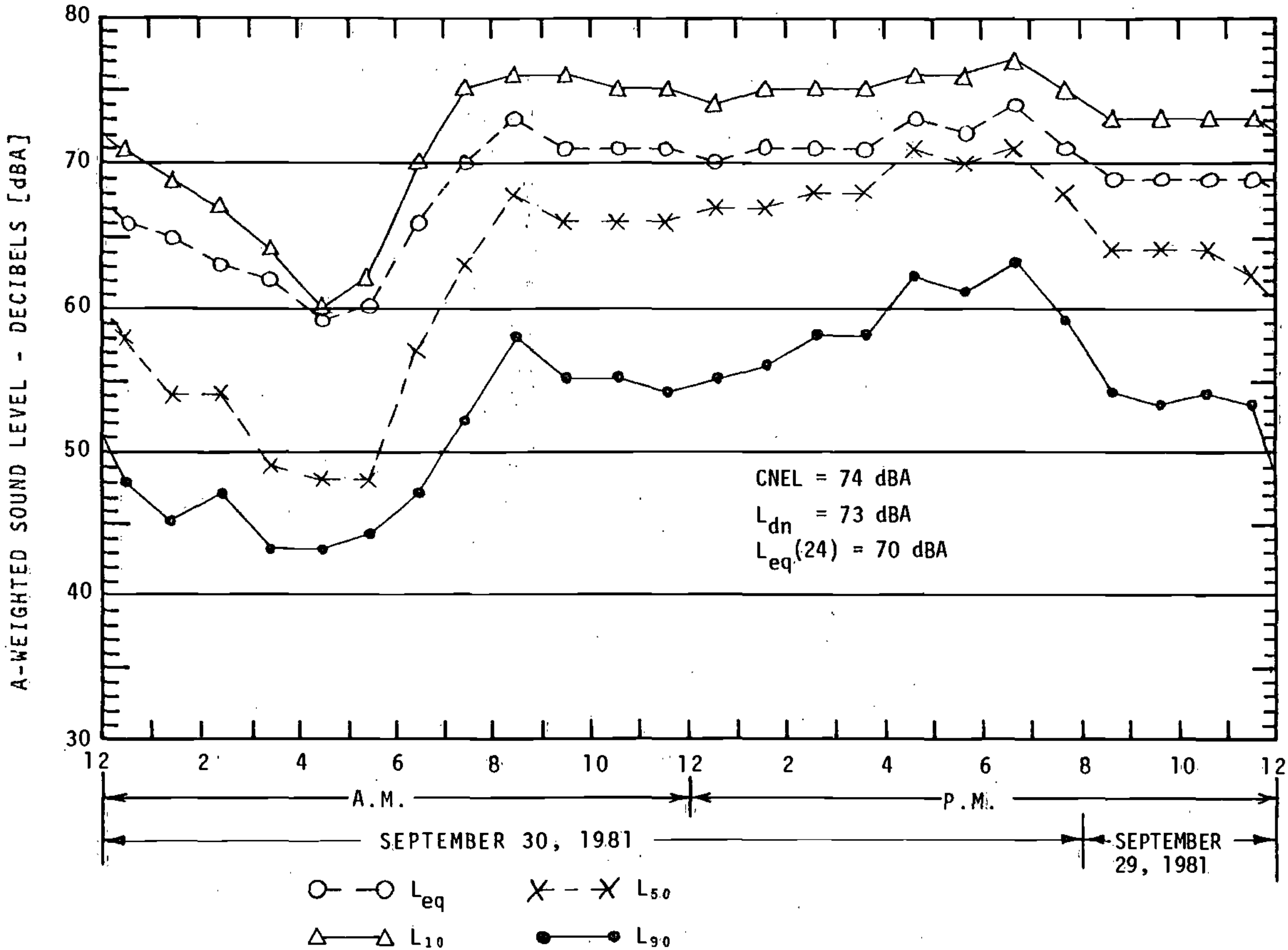


FIGURE 2.3-7 TIME HISTORY OF THE NOISE LEVEL MEASURED AT LOCATION 25, OVER THE 24-HOUR PERIOD BEGINNING 8PM, TUESDAY, SEPTEMBER 29, 1981

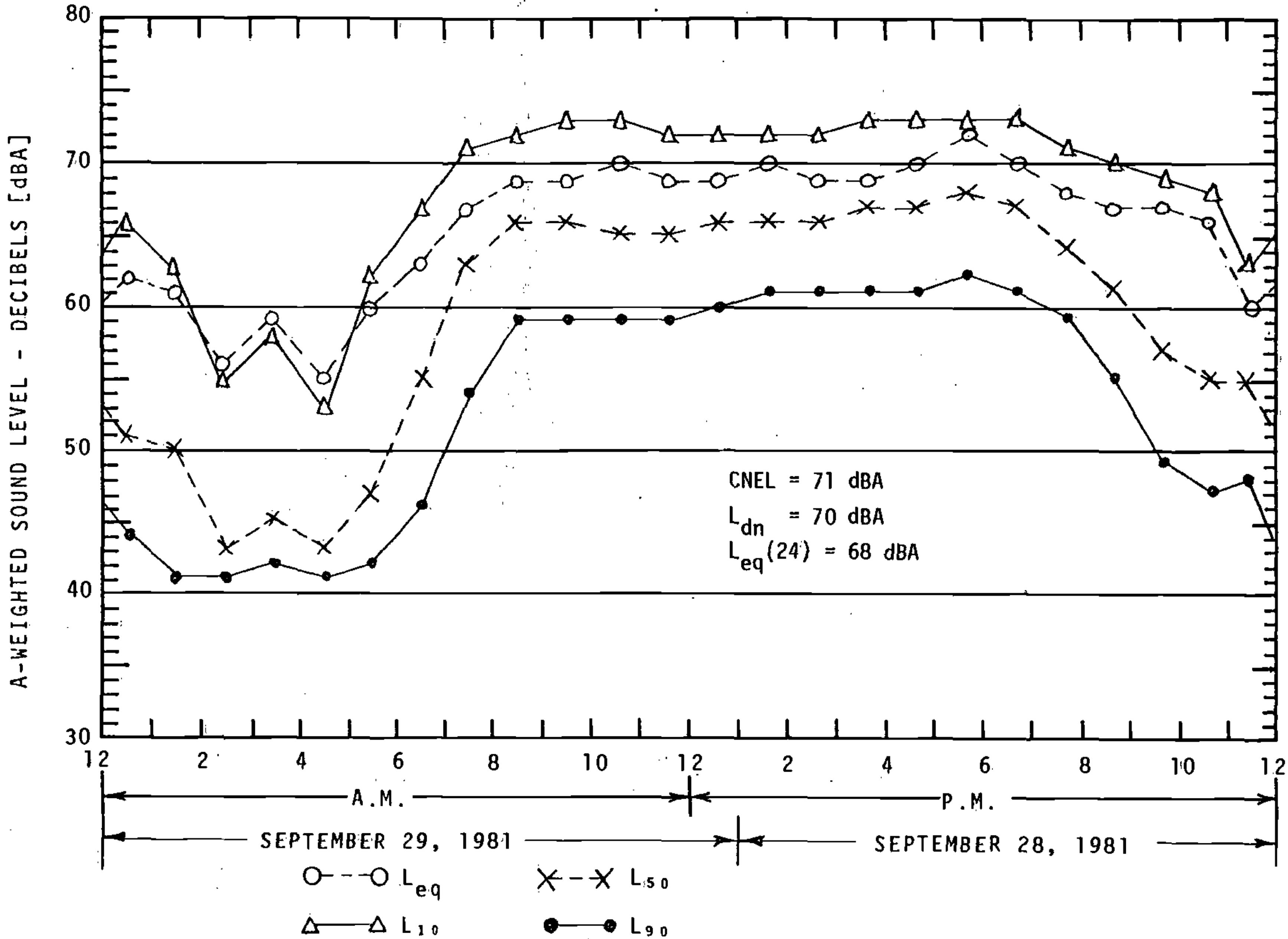


FIGURE 2.3-8 TIME HISTORY OF THE NOISE LEVEL MEASURED AT LOCATION 28, OVER THE 24-HOUR PERIOD BEGINNING 1PM, MONDAY SEPTEMBER 28, 1981

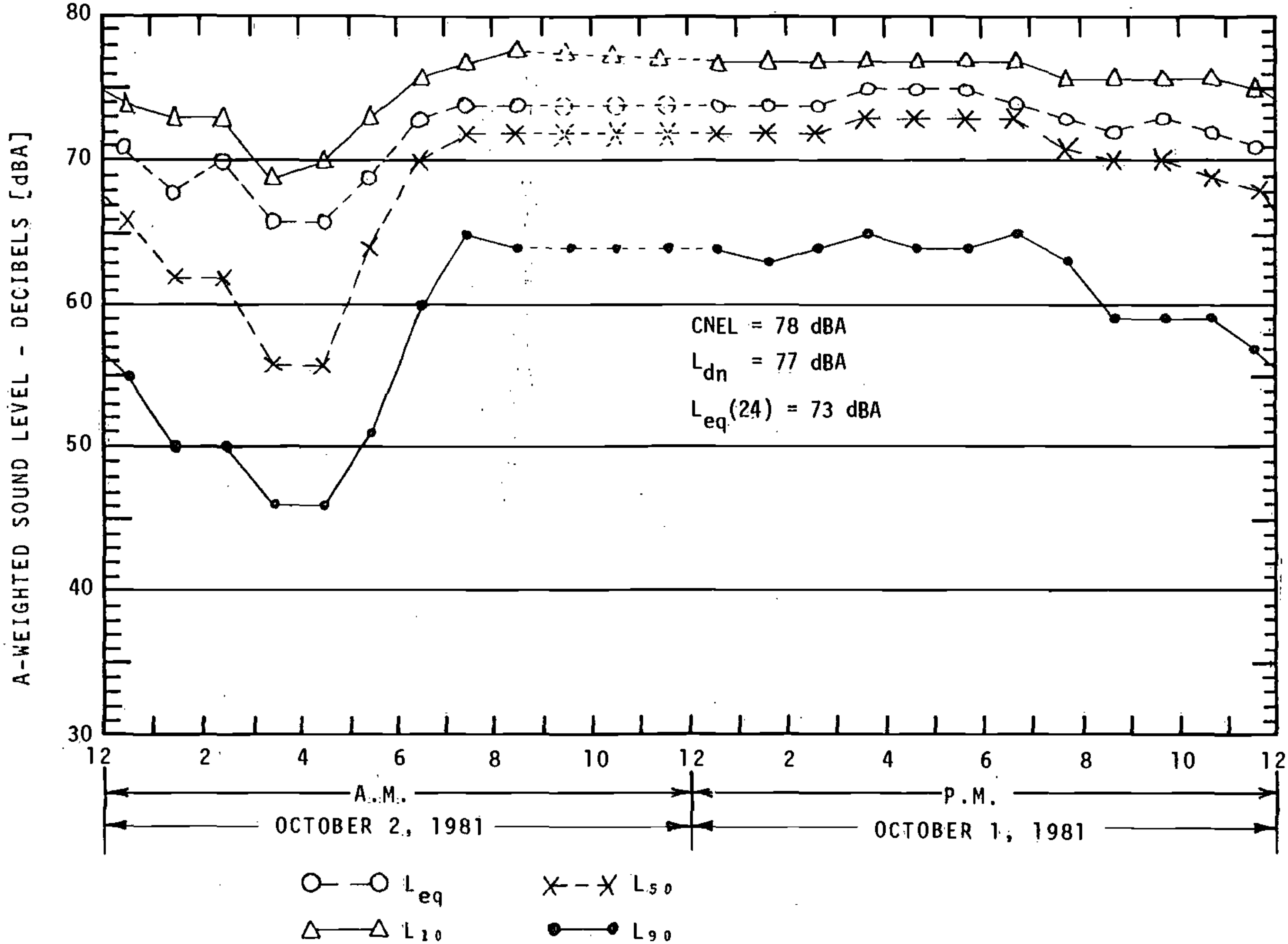


FIGURE 2.3-9 TIME HISTORY OF THE NOISE LEVEL MEASURED AT LOCATION 32a, OVER THE 21-HOUR PERIOD BEGINNING 12NOON, THURSDAY, OCTOBER 1, 1981

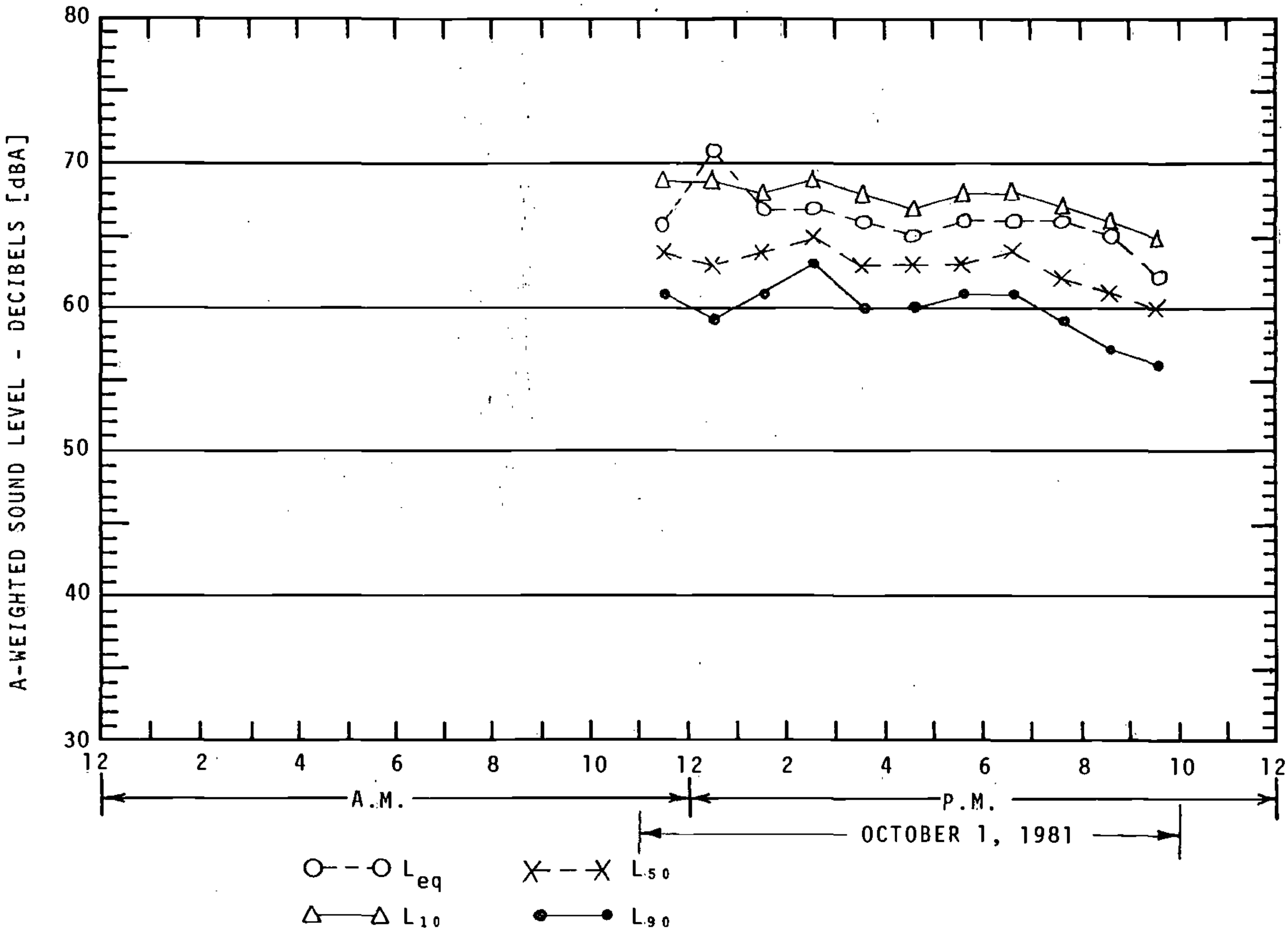


FIGURE 2.3-10 TIME HISTORY OF THE NOISE LEVEL MEASURED AT LOCATION 42, OVER THE 11-HOUR PERIOD BEGINNING 11AM, THURSDAY, OCTOBER 1, 1981

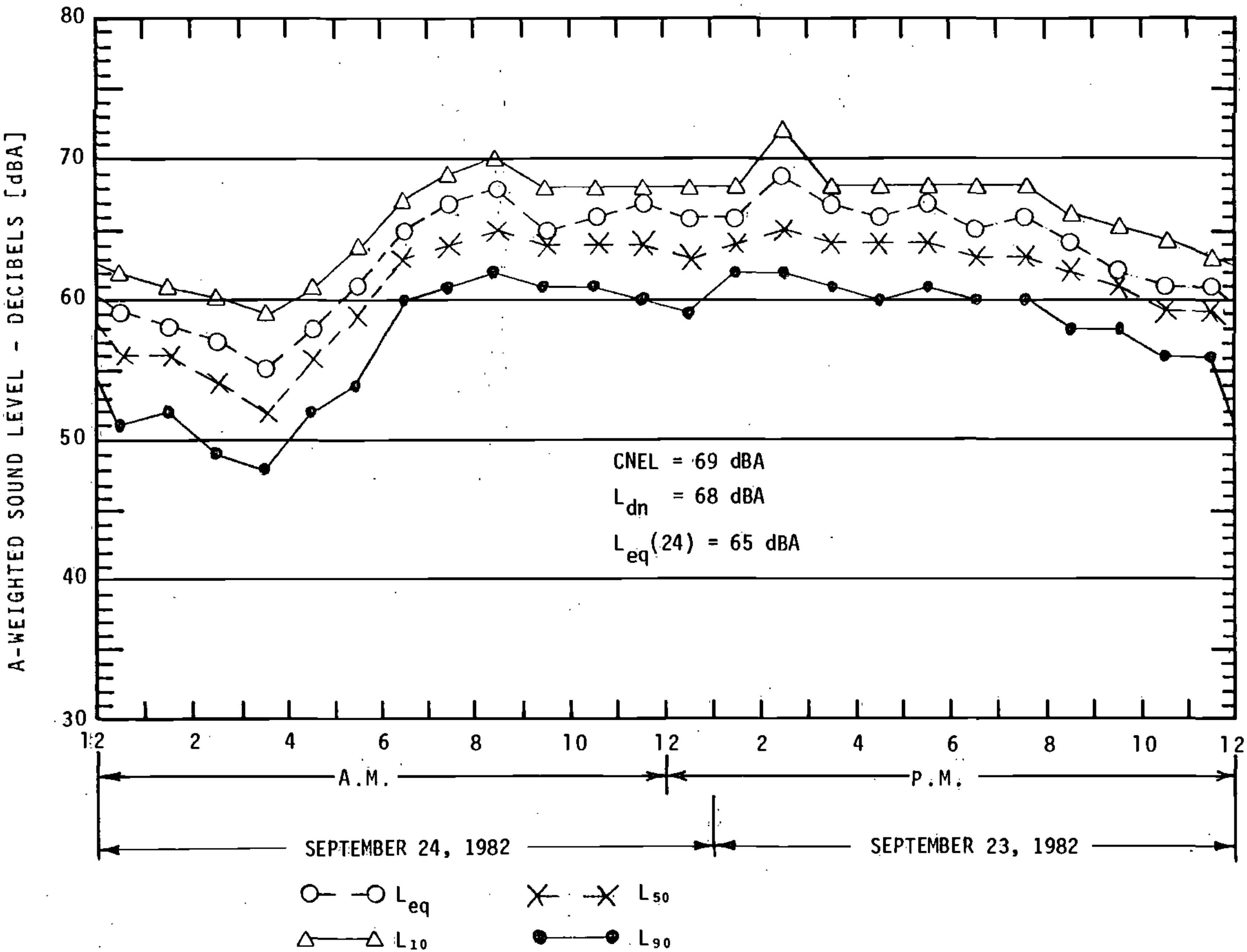


FIGURE 2.3-11 TIME HISTORY OF THE NOISE LEVEL MEASURED AT LOCATION 42, OVER THE 24-HOUR PERIOD BEGINNING 1:00 P.M., THURSDAY, SEPTEMBER 23, 1982

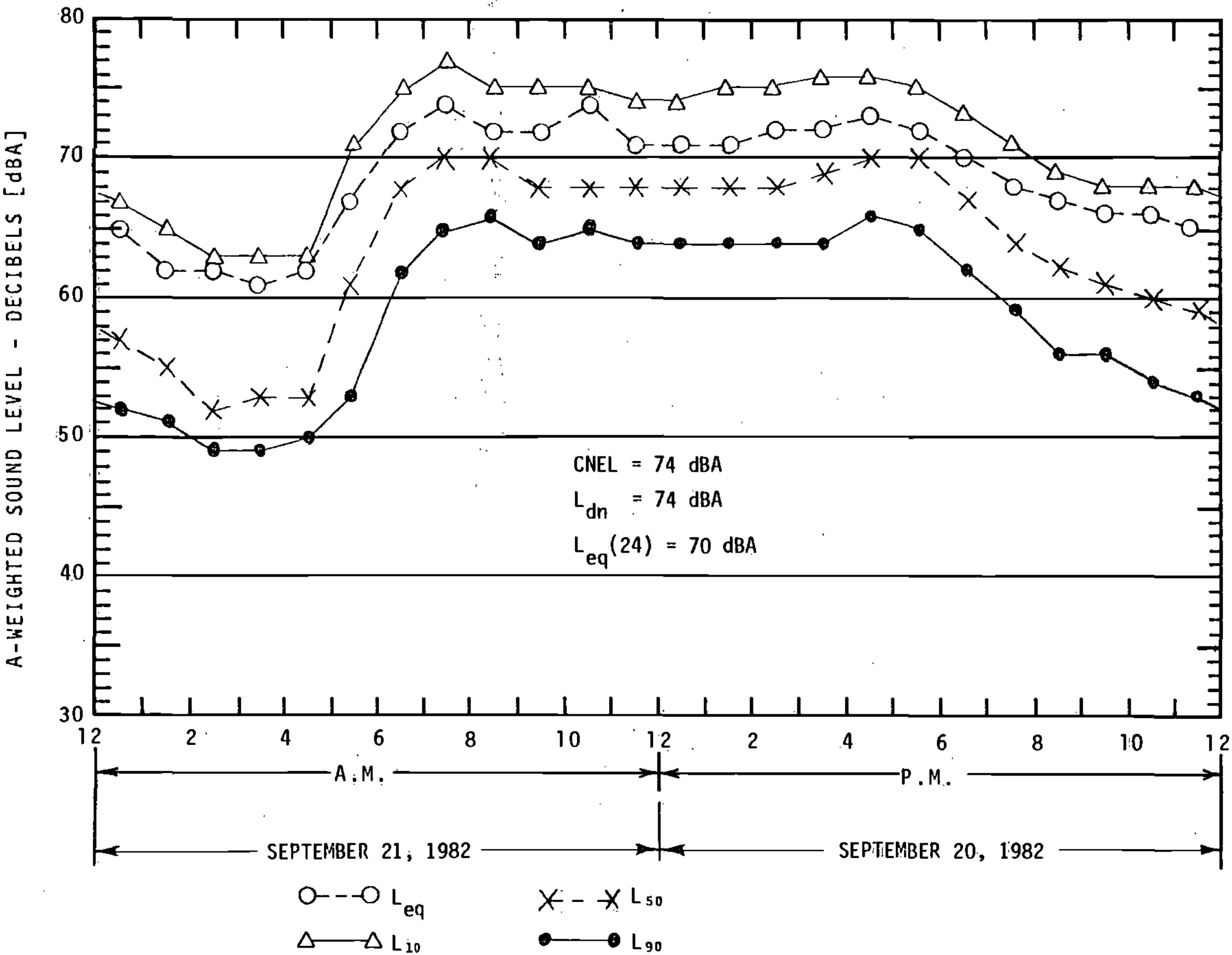


FIGURE 2.3-12 TIME HISTORY OF THE NOISE LEVEL MEASURED AT LOCATION 102, OVER THE 24-HOUR PERIOD BEGINNING 12 NOON, MONDAY, SEPTEMBER 20, 1982

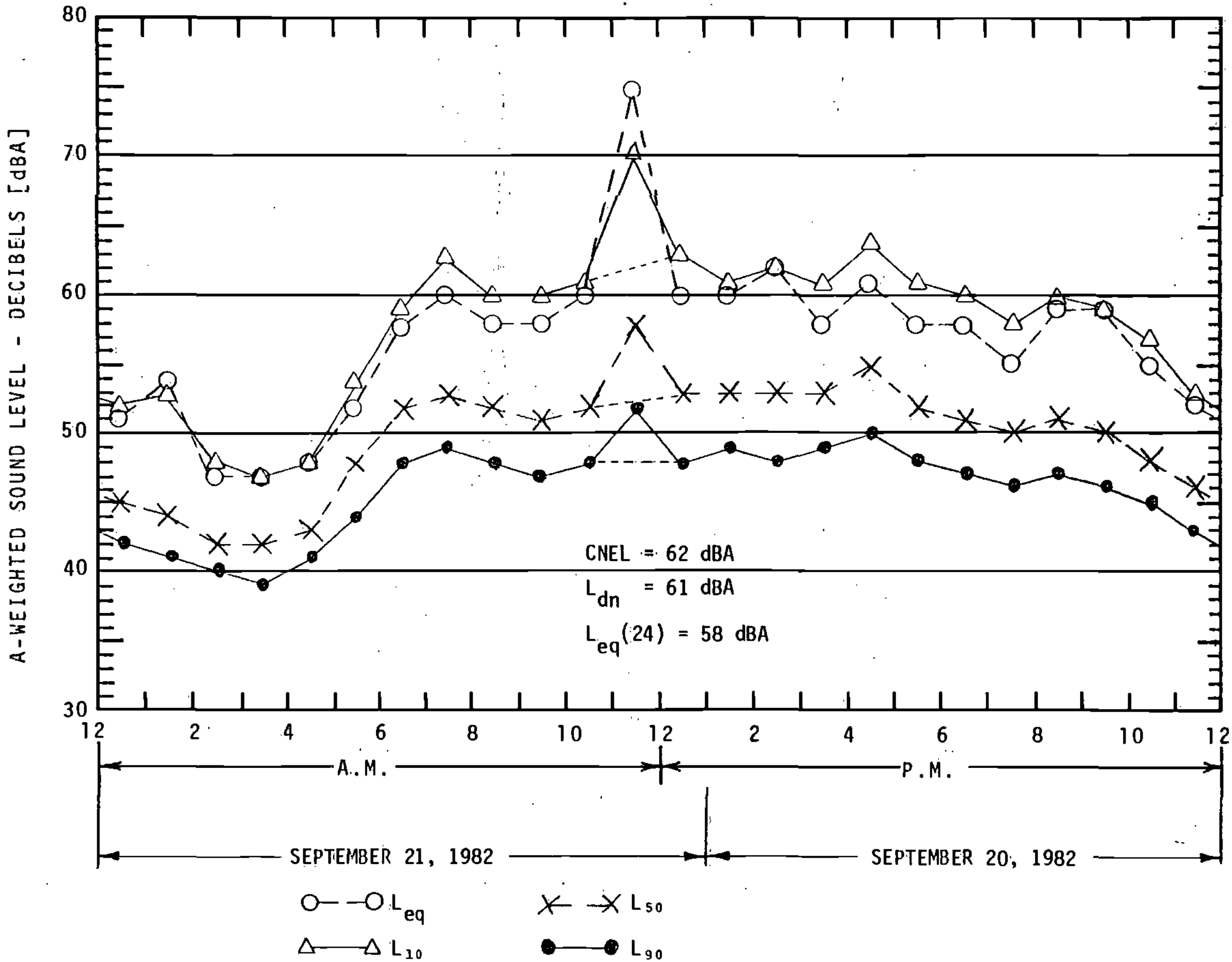


FIGURE 2.3-13 TIME HISTORY OF THE NOISE LEVEL MEASURED AT LOCATION 107, OVER THE 24-HOUR PERIOD BEGINNING 1:00 P.M., MONDAY, SEPTEMBER 20, 1982

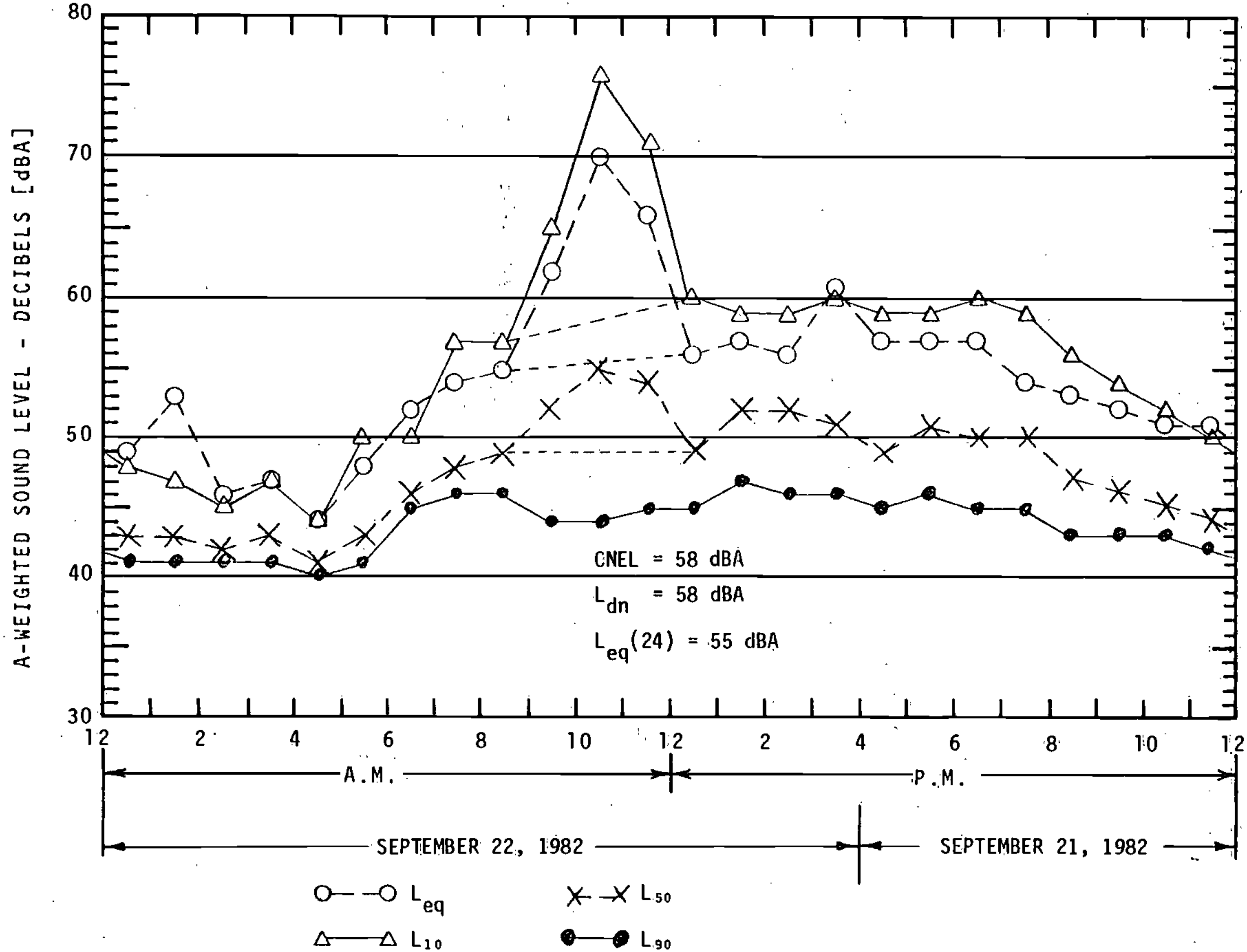


FIGURE 2.3-14 TIME HISTORY OF THE NOISE LEVEL MEASURED AT LOCATION 109, OVER THE 24-HOUR PERIOO BEGINNING 4:00 P.M., TUESDAY, SEPTEMBER 21, 1982

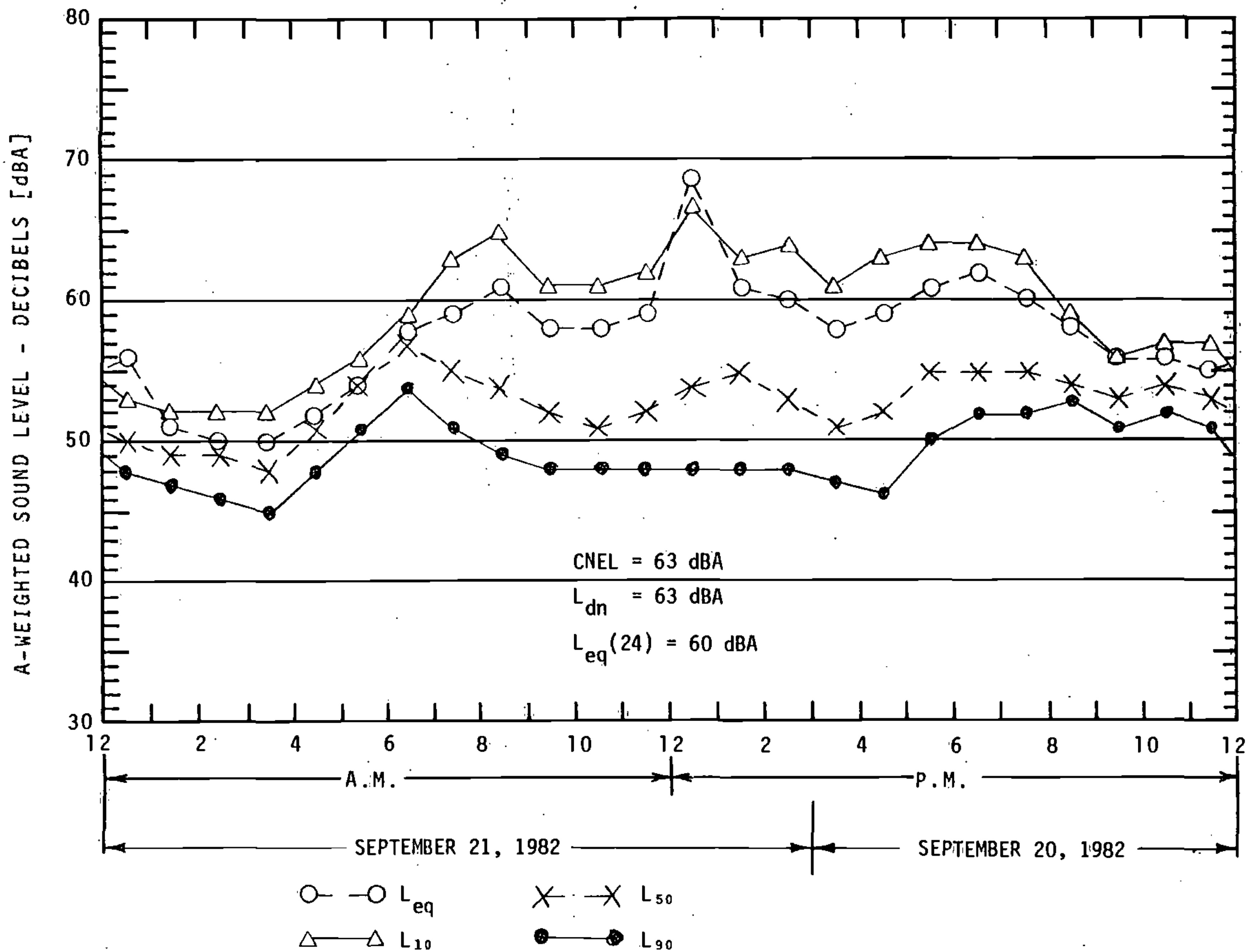


FIGURE 2.3-15 TIME HISTORY OF THE NOISE LEVEL MEASURED AT LOCATION 118, OVER THE 24-HOUR PERIOD BEGINNING 3:00 P.M., MONDAY, SEPTEMBER 20, 1982

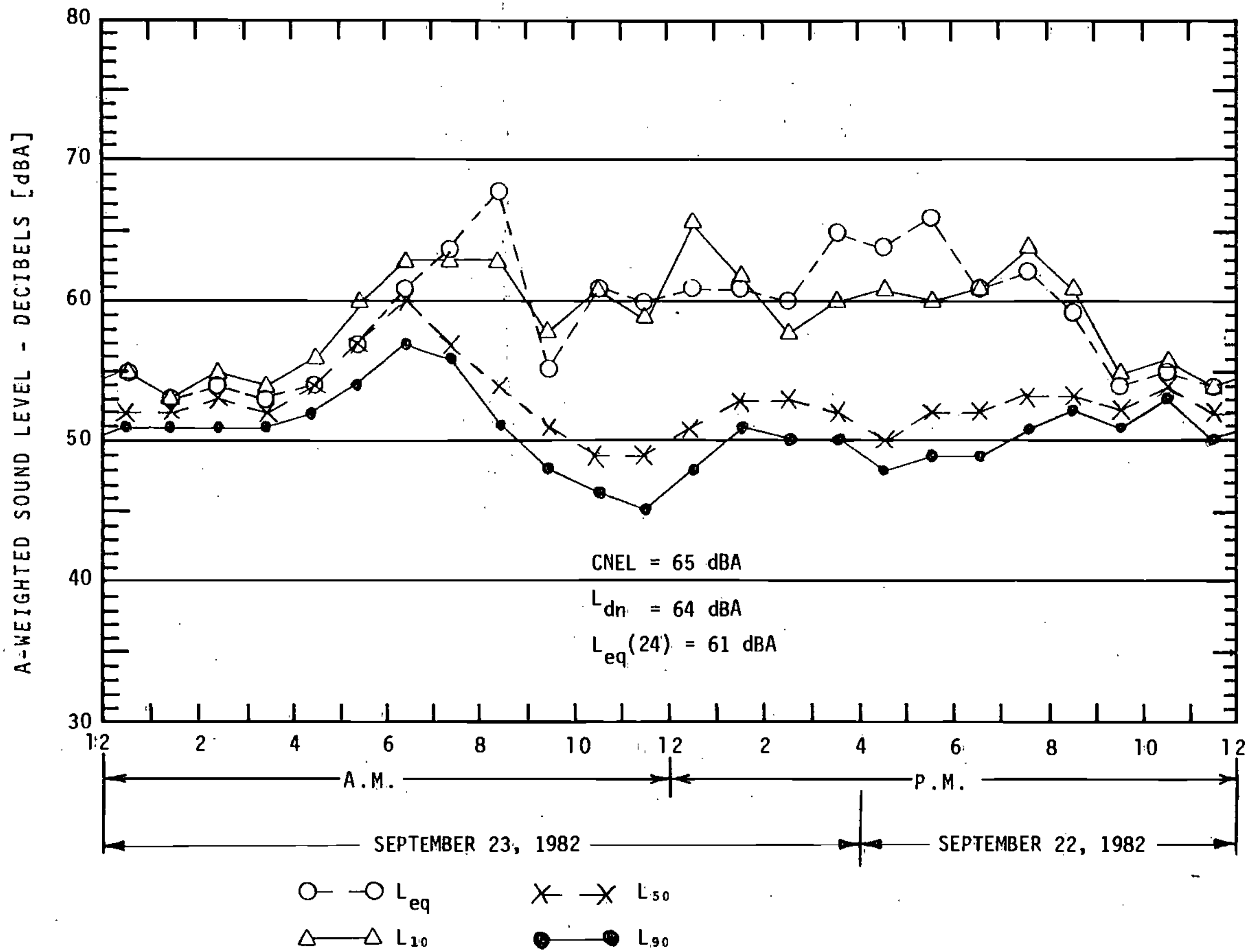


FIGURE 2.3-16 TIME HISTORY OF THE NOISE LEVEL MEASURED AT LOCATION 125, OVER THE 24-HOUR PERIOD BEGINNING 4:00 P.M., WEDNESDAY, SEPTEMBER 22, 1982