BASIS OF DESIGN

Project Description

Sector 20 Alcove Improvements:

Demolish the existing 1,700 square foot Sector 20 building and in its place construct a new 2,160 square foot building. The new building will contain a series of clean room equivalent class 100,000 rooms based around the remaining stair shaft to the Linac housing 35 feet below. Layouts of the rooms will follow the room layouts found in the *Architectural/Engineering Design Guidelines*, December 2003 and as modified in subsequent meetings with SLAC personnel.

Provide a monorail crane within the building to move heavy equipment and removable hatches in the roof above existing Sector 20 penetrations to allow for the infrequent installation and removal of extremely long equipment. This long equipment would be lifted from a crane positioned parallel to the building in the adjacent roadway. Provide vibration isolation and a critical temperature environment for Laser Lab and control equipment.

Structural Design: Provide vibration isolation from the adjacent Klystron Gallery and adjacent roadway to the north. Structural design of the new building will conform to the Specification for Seismic Design of Buildings, Structures, Equipment, and Systems at the Stanford Linear Accelerator Center dated December 4, 2000; Seismic Performance Level: 7.0 and be reinforced to allow reuse of the existing 5-ton monorail crane. Provide methods of attachment for cable trays (by Owner) ductwork and other mechanical and life-safety systems. Provide mechanical and electrical equipment housekeeping pads.

New construction will consist of moment frame steel construction in the north-south direction and brace frame construction in the east-west direction. A separate foundation, disassociated from the adjacent Klystron Gallery will consist of continuous wall footings along the east-west direction with an 8" reinforced concrete slab on grade; recessed to allow for a grade level access floor. Interior partitions will be constructed of light gauge metal framing. The clear distance between the existing Klystron Gallery framing and new building framing will be far enough apart so that they will not collide with one another in a seismic event.

Architectural Design: To the degree possible, the appearance of new Sector 20 building shall match the existing design, exterior materials and color of the adjacent Klystron Gallery. Architectural design will coordinate the work of engineering disciplines and coordinate equipment layouts with SLAC.

RF Hut:

Construct a 14' wide x 20' long environmentally controlled room to contain eight 24" x 24" electronic equipment racks, equipment and cable tray supports. The room will be constructed in an open floor area within the existing Klyston Gallery adjacent to the new Sector 20 Building. The required RF Hut ceiling height will require the relocation of some existing utility piping and supports.

Structural Design: Provide equipment and cable tray support designs plus wall and ceiling construction.

Architectural: Coordinate the work of engineering disciplines and refine and coordinate equipment layout with SLAC.

Off Axis Injector Housing Improvements:

Construct a wall at the base of the stairwell with an intervening door so that the temperature in this area is constant with the temperature in the adjacent Linac tunnel. Occasional breaches to the temperature envelope can occur with R&R of laser equipment and the movement of personnel to and from the area.

Structural Design: Provide MEP equipment and cable tray supports.

Architectural: Coordinate the work of engineering disciplines and refine and coordinate equipment layout with SLAC.

Design Criteria

Governing Design Code: **Uniform Building Code 1997** with the exception of Seismic Criteria which shall be conformed to the **Specification for Seismic Design of Buildings, Structures, Equipment, and Systems at the Stanford Linear Accelerator Center dated December 4, 2000.**

Seismic Performance Level: 7.0

ELECTRICAL SYSTEMS

Introduction

The information included in the following narrative is intended to provide a general description of the electrical systems and materials that will be used in the new facility located at Sector 20. This information will form the basis of the next stage of project development for the new facility.

Existing Utilities

The existing 1500 KVA transformer will be the source of electrical power to the new facility located at Sector 20.

New Electrical Service

A new 1600A bus, 480V, 3-phase, 3-wire, 65,000 AIC, motor control center (MCC) will be installed at outside east wall of columns 20. This MCC will be the main source of power for the Sector 20 new facility. The power for the MCC will be fed from the existing 1500KVA transformer via existing switchboard.

MCC will be used instead of main distribution board for ease of maintenance. In addition, 100% spare capacity will be provided at the MCC.

Motors ¾ horsepower (HP) and above will be powered by 480V, 3-phase, 60HZ system. Motors ½ HP and below will be powered by 208/120V distribution panel

Conduits/Raceways

Electrical metallic tubing (EMT) or rigid conduit will be used where required by code. All conduits will be 3/4-inch minimum. Rigid galvanized steel conduit (RGS) with threaded fittings shall be used for feeder conduit. EMT with compression fittings will be used for branch circuits, and PVC, Schedule 40 or 80, for underground conduit installations. Conduits will be exposed in RF Hut and Injector Housing areas.

The conduits and cables (via cable tray) will be routed under the 22 inches raised floor in the laser room area. The raised floor is in the same level with the gallery level.

Transformers

480V delta-208Y/120V, transformers will be installed with the corresponding 208Y/120V distribution panels:

1. RF Hut—Four (4) transformers
2. Injector Housing area-Two (2) transformers
3. Sector 20 Laser Building-Two (2) transformers

Low voltage dry type transformers will be provided to serve receptacles and small power loads. Two, 2-½ percent taps above and four, 2-½ percent taps below rated voltage will be provided. K rated and electrostatically shielded transformers will be installed in areas containing electronic equipment with switch-mode power supplies.

Safety Switches/Disconnect Switches

For indoor application, NEMA type 1, heavy-duty type safety switches, phosphate-coated or equivalent, code-gauge steel with baked-enamel finish will be provided. For outdoor application, NEMA 3R rain-tight enclosures will be provided. Padlockable in open or closed position switches will be provided.

Panelboards/Distribution Panels

Lighting and receptacle panelboards will be 208Y/120-volt, 3-phase, 4-wire, solid neutral, with bolt-on circuit breakers and 10,000-ampere symmetrical interrupting capacity. Panelboards serving sensitive electronic equipment will be equipped with 200 percent rated solid neutrals. Panelboards serving electronic equipment will have transient voltage surge suppressor (TVSS).

All electrical equipment, i.e. transformers, MCC, distribution panels, make-up unit, air cooled chiller, etc, will be grounded and tied to the existing ground loop. Grounding will be in compliance with all codes and ordinances including SLAC grounding policy.

Receptacles

All general type duplex receptacles shall be limited to a maximum of six receptacles per circuit. Receptacles shall be provided as follows:

- General convenience duplex receptacles shall be provided throughout all areas as shown on plans, with a minimum of one per 80 square feet, or any part thereof, with a minimum of one receptacle per occupied room, unless otherwise noted
- Enclosed offices: A minimum of three receptacles per room.
  - Receptacles will be provided for both a computer and a printer in each office.
- Special receptacle types shall be provided to meet specific equipment load requirements
  - All receptacles will be marked with panel and circuit number
- Ground Fault Circuit Interruption (GFCI) type receptacles will be installed outdoors and for locations required per the National Electrical Code.
- General type receptacle for electric water coolers, microwave ovens, coffee machines, vending machines, printers, fax machines, etc, will be provided as required.

Conductors and Flexible Conduits

All conductors shall be THHN, 600 volt, 98 percent conductivity copper, #12 minimum. Wire size, #10 and smaller, shall be solid and #8 and larger shall be stranded. All conductors shall be installed in raceways.

Flexible conduits shall be used for lighting fixture connections.

Flexible connections shall be provided for all motors and equipment subject to vibration or movement. The flexible metal conduit shall be covered with extruded vinyl tubing.

Cable Trays

Cable trays will be routed by Owner inside the laser room building and under the raised floor of the laser room. Cable tray in the RF Hut will be routed above the ceiling by Owner and grounded. Owner will also install cable tray and grounded in the injector housing. Cable tray supporting devices will be designed by Jacobs and installed by selected contractor.

Lighting Fixtures

Interior building lighting fixtures will be energy efficient fluorescent light fixtures rated 120V, single phase, and lamps (T8 with electronic ballast) will be used throughout the facility. Light fixtures will be surface and pendant mounted. All new lighting fixtures will have illumination intensity of 100 foot-candle (FC) in the laser and control room areas inside the laser room building. In addition, 100FC illumination intensity will be designed in RF Hut, and in injector housing areas. Fluorescent type low profile lighting fixtures will be provided for surface mounting conditions.

Lay-in lighting fixtures with parabolic louver lens constructed of pre-anodized specular low iridescent aluminum louvers will be installed in the control room and laser room.

Local battery backup for egress lighting will be provided.

LED exit lights with integral battery backup will be provided along paths of egress.

Occupancy light sensors will be provided to maximize lighting energy efficiency.

Telecommunication/data

Telecommunication/data outlet and conduit only will be installed. Owner will provide the interconnection wiring for a complete telecommunication/data system. Each telecommunication/data outlet box in hard walls will consist of a 4-inch by 4-inch by 2-⅛-inch outlet box and single gang plate, with ¾-inch conduit stub out into ceiling spaces or cable tray, or routed back to the telecommunication room (TR) where required.

Cable tray will be used throughout the facility where suitable to provide flexibility for moves, adds, and changes.

A nylon pull cord will be installed in all telecommunication/data raceways.

Telecommunication/data outlets in hard walls will be provided in control room, at the desk location, and at each workstation.

Telecommunication outlets will be provided at each fax machine location.

Fire Detection

The building will be provided with a complete analog addressable fire alarm system, to provide alarm, trouble, and supervisory reporting to the remote control room.

A complete analog addressable and supervised local fire alarm system of manual and automatic, non-coded, general alarm type shall be provided. The system shall comply with the requirements of the National Fire Alarm Code (NFPA-72, Americans with Disabilities Act (ADA) and all applicable state and local codes.

The system shall include fire alarm control panels, manual fire alarm stations, smoke and thermal detectors, and provisions for monitoring fire protection system and audio/visual devices. Include the following:

- Manual fire alarm stations shall be addressable, double action, non-breakable glass, key re-settable, and shall be located in the main flow of traffic and/or exit paths.
- Audio/visual devices shall be wall mounted at strategic locations to be seen in any portion of the buildings.
- Smoke detectors shall be analog, addressable, photoelectric types with LED indication.

- The fire alarm system shall be provided with a battery back-up system.
- All cabling shall be installed in raceways.
- Smoke detectors shall be installed in all normally unoccupied and occupied areas required by code.

MECHANICAL SYSTEMS

Heating, Ventilation and Air Conditioning (HVAC) System:

The Class 100,000 clean room equivalent HVAC system for Sector 20 Alcove improvements will consist of Circulating Air Handling Unit, Make-up Air Unit, Air Cooled Chiller, Electric Hot Water Boiler, air distribution system, chilled water system, hot water system, and Direct Digital Control System.

The HVAC equipment for the Laser and Load Lock rooms will be located outside the building. This arrangement would utilize one (1) circulating air handling unit (AHU-1) for class 100,000 clean room equivalent, one (1) make-up air unit (MAU-1), one (1) air cooled chiller (CH-1), one (1) electric boiler, two (2) inline chilled water pumps (CWP-1 and CWP-2) and two (2) inline hot water pumps (HWP-1 and HWP-2).

Air Handling Unit AHU-1 will consist of 95% high efficiency filter, chilled water-cooling coils for internal sensible loads, circulating fan, hot water reheat coil, 99.99% Hepa filters, and variable frequency drive. The variable frequency drive will modulate circulating fan to provide a constant airflow to the clean area. Air will move downward and will be removed near the floor level through wall return air plenums.

Make-up Air Unit MAU-1 will provide treated outside air to the return plenum. The unit will consist of 30% prefilter, hot water heating coil, chilled water-cooling coil and 85% final filter.

Air Cooled Chiller CH-1 provide chilled water to MAU-1 and AHU-1cooling coils.

Hot Water Boiler B-1 will provide hot water to MAU-1 and AHU-1 reheat coils.

The HVAC equipment for RF Shielding Room will consist of a fan coil unit (FC-1); a condensing unit (CU-1), refrigerant and condensate drain piping to the outside at the Klystron Gallery.

The FC-1 will be floor mounted indoor unit and will consist of filter section, DX cooling coil, supply fan, reheat coil, condensate drain pump, and Control System.

The CU-1 will be floor mounted outdoor unit and will consist of compressor, condenser coil, condenser fan(s), refrigerant piping and control system.

Plumbing and Fire Protection System

The plumbing system will be comprised of condensate water system and low conductivity water (LCW) to the Injector Housing below.

The condensate drain from MAU-1 and AHU-1 will be drained to the nearest floor sinks.

The low conductivity water will be provided from existing system located in either the nearby Pump Alcove or overhead adjacent to the Sector 20 Alcove and will be connected to the equipment in the Laser Room and Injector Housing area.

The fire protection system for the Laser Room, RF Hut and Injector Housing will be a wet pipe system.

Air handling unit AHU-1 will be interconnected to the control panel and shutdown in case of fire. Smoke duct detector will also be required in this system.

FACILITY COMPONENT	SECTOR 20 ALCOVE		
	Name of Building	Sector 20 Alcove	
	Organization or Department	SLAC, Stanford University	
	Net area	200.7 sq. meters	2160 SF
	Critical dimensions	H: 4.9 meters	16'-0"
		W: 7.3 meters	24'-0"
		L: 27.4 meters	90'-0"
	Hours of operation	24/7	
	Users/Occupancy	Scientists - 4/6 typical	
	Building orientation	Located at the eastern end of the 2-mile long linear accelerator, in an east-west direction.	
FUNCTIONAL OBJECTIVE	A new 2160 SF facility adjacent to the Klystron Gallery. It is located above the Off-Axis Injector Housing number 2. It houses the drive & monitoring equipment for the laser in the housing (injector) below.		
PLANNING CONSIDERATIONS & CRITICAL FACTORS	To look like the adjacent Klystron Gallery in height, bldg. material and color. Temperature control and the elimination of disruptive vibration are essential. A class 100,000 clean room environment is required and new electrical systems are to be designed at 100% excess capacity.		
FINISHES	Wall	5/8" gypsum board with epoxy paint.	
	Ceiling	Lay-in acoustical panels with clean room finish.	
	Floor	Polyurethane flooring - clean room tile + epoxy paint.	
	Base	Rubber.	
	Doors	Hollow metal doors.	
	Fenestrations	None	
	Acoustical	STC 50	
APPLICABLE STANDARDS	UBC 1997, OSHA, NEC, NFPA 5000.		
	Conform to DOE Standard 10 CFR, Part 435, UBC, UMC, UPC, Title 24 Energy Standards,		
	ASHRAE/IES Standards 90.1. Fire Protection .		
	System compliance with NFPA Standard 13.		
	Minimum Seismic Performance Level of 7.0; to comply with SLAC Seismic Requirements		
	To comply with SLAC Radiological Criteria		
VIEWS & SCHEMATICS (N. T. S.)			

SECTOR 20 - *Continued...*

MECHANICAL REQUIREMENTS	HVAC		
		☒ Heating system (Temp:)	☒ Mechanical humidification
		☒ Air conditioning (Temp:)	☒ Direct exhaust system
		☒ Direct supply	☒ Positive pressure system
		☐ Indirect supply	☐ Negative pressure system
		☒ Smoke control system	☒ Standard registers
		☒ Thermostat	☒ Requirement for gases
		Coments: In accordance with DOE Order 6430.1A, General Design Criteria and with the requirements as defined by the UBC, UCRL - 15910, DOE Standard 10 CFR - Part 435, UMC, UPC, Title 24 for Non-Residential, and ASHRAE/IES. Tempurature at 20 deg C (+/- 0.2 deg C). Humidity at 50%. Alcove and Laser Rooms to have minimal acoustic noise due to air flow. Alcove to be provided with stand-alone HVAC system w/year round control. Passageway to lower level to require tempurature control - lower level temp. to not affect Laser Bay above. VESDA smoke detectors required. Building will have Direct Digital Control, and interface with SLAC EMS and SLAC Automated Logic/System 2020.	
	Communications	☒ Telephone	☐ PA speakers
		☒ Dataport	☐ PA station
		☐ Payphone	☐ CCTV camera
		☒ Fire alarm station	☐ CCTV monitor
		☐ Intercom	
		Comments: 2 phone lines per Laser Room, Control Room and Load Lock Room. Network/Dataport - 6 in Laser Room, 6 in Control Room and 4 in Load Lock Room.	
	Plumbing/Fire Protection	☐ Hot water system	☒ Electric watercooler
		☒ Cold water system	☐ Drinking fountain
		☐ Tempered water	☒ Smoke detection system
		☐ Waste drain	☒ Standard sprinkler heads
		☒ Floor sink	☐ Eye wash
		☐ Trench drain	
		Comments: Building fire water to utilize existing site water distribution system through a riser assembly. Fire department connection needed. Compliance with NFPA Standard 13 needed. Switches tie in with the site fire alarm system.	
ELECTRICAL REQUIREMENTS	Power supply	☒ 208V outlets	☐ Uninterrupted power supply
		☒ 120V outlets	☐ Special electric (Type:)
		☒ Emergency power	
		Comments: Receptacles - Osc: 110 VAC-10A x2. Regen Amps: 110 VAC-15A x4. Power Amps: 208 VAC-55A-1phase x4. Chillers: 110 VAC-15A x8.	
	Lighting	☒ Light fixtures	☐ Remote lighting control
		☒ Fixture type I: Compact Flourescent	☒ Light switches
		☐ Fixture type II: Bollard (exterior)	Lighting level (FC: 100)
		☒ Emergency lighting	
		Comments: All lighting and conduit will be low profile, surface mounted, flourescent type fixtures. Lighting design should provide for at least 100 Lumens.	
RADIATION/SEISMIC/VIBRATIONS ISSUES	**Comments:** Flooring in the Sector 20 building is to be made independent from the Klystron Gallery area. Floor slab must be designed for sub-micron vibration amplitude. Short and long term distortion of thermal expansion to be minimized.		
OTHER SPECIAL REQUIREMENTS	**Comments:** Cable tray mounting system on the walls of alcoves. Provision for cable tray expansion in the ceiling in the plenum. Equipment cooling water needed.		
ENVIRONMENTAL NEEDS	1.0	Radiation protection is a must for surrounding facilities.	

JACOBS

FACILITY COMPONENT	RF HUT		
	Name of Building	RF HUT - LCLS Conventional Facilities	
	Organization or Department	SLAC, Stanford University	
	Net area	26.0 sq. meters	280 SF
	Critical dimensions	H: 2.7 meters	9'-0"
		W: 4.3 meters	14'-0"
		L: 6.1 meters	20'-0"
	Hours of operation	24/7	
	Users/Occupancy	Scientist - 1	
	Building orientation	Located inside the Klystron Gallery at the east end of the 2-mile linear accelerator. Oriented east-west.	
FUNCTIONAL OBJECTIVE	Temperature stabilized housing for electrical equipment racks used to monitor and control the Laser Injector system.		
PLANNING CONSIDERATIONS & CRITICAL FACTORS	RF Hut is to be located inside Klystron Gallery, between existing equipment and adjacent to the new Sector 20 Alcove building. Power, HVAC, cable trays and other equipment is to be provided. RF cables to route through penetrations (20-16 & 20-17) in to the tunnel. Heliax cables will be used with temperature coefficients less than 5 ppm/degC. Cables and RF hut to be held within 1/2 degree F changes. Constant temp. needed at all locations within the Hut.		
FINISHES	Wall	5/8" gypsum board with epoxy paint	
	Ceiling	5/8" gypsum board with epoxy paint	
	Floor	Polyurethane flooring	
	Base	Rubber	
	Doors	Hollow metal	
	Fenestrations	None	
	Acoustical	STC 50	
APPLICABLE STANDARDS	UBC 1997, OSHA, NEC, NFPA 5000.		
	Conform to DOE Standard 10 CFR, Part 435, UBC, UMC, UPC, Title 24 Energy Standards,		
	ASHRAE/IES Standards 90.1. Fire Protection .		
	System compliance with NFPA Standard 13.		
	Minimum Seismic Performance Level of 7.0; to comply with SLAC Seismic Requirements		
	To comply with SLAC Radiological Criteria		
VIEWS & SCHEMATICS (N. T. S.)			

RF HUT - *Continued...*

MECHANICAL REQUIREMENTS	HVAC	☒ Heating system	Temp:	☐ Mechanical humidification
		☒ Air conditioning	Temp:	☐ Direct exhaust system
		☒ Direct supply		☒ Positive pressure system
		☐ Indirect supply		☐ Negative pressure system
		☒ Smoke control system		☐ Standard registers
		☒ Thermostat		☒ Requirement for gases
		Comments: In accordance with DOE Order 6430.1A, General Design Criteria and with the requirements as defined by the UBC, UCRL - 15910, DOE Standard 10 CFR - Part 435, UMC, UPC, Title 24 for Non-Residential, and ASHRAE/IES. HVAC year round temp. control within established parameters. Building will have Direct Digital Control, and interface with SLAC EMS and SLAC Automated Logic/System 2020.		
	Communications	☒ Telephone		☐ PA speakers
		☒ Dataport		☐ PA station
		☐ Payphone		☐ CCTV camera
		☒ Fire alarm station		☐ CCTV monitor
		☐ Intercom		
		Comments: See above.		
	Plumbing/Fire Protection	☐ Hot water system		☐ Electric watercooler
		☐ Cold water system		☐ Drinking fountain
		☐ Tempered water		☒ Smoke detection system
		☐ Waste drain		☒ Standard sprinkler heads
		☐ Floor drain		☐ Eye wash
		☐ Trench drain		
		Comments: Building fire water to utilize existing site water distribution system through a riser assembly. Fire department connection needed. Compliance with NFPA Standard 13 needed. Switches tie in with the site fire alarm system.		
ELECTRICAL REQUIREMENTS	Power supply	☐ 220V outlets		☐ Uninterrupted power supply
		☒ 120V outlets		☐ Special electric Type:
		☒ Battery back-up for emergency light		
		Comments: RF Hut to have 8 racks, each requiring 7.5 KVA. An additional two RF support racks will be located immediately outside the hut and require 7.5 KVA each. **Located outside RF Hut:** Total - 10 racks, 75 KVA, 120 VAC. Several 120-V receptacles needed. Magnet power requirements - Gun Spectrometer: 0.2 KVA, 120 VAC. Gun Solenoid: 12 KVA, 208 VAC. Linac Solenoid: 37.7 KVA, 480 VAC. B01 Dipoles: 9,.7 KVA, 208 VAC. Straight Ahead Spectrometer: 9.7 KVA, 208 VAC. Cooling requirements for Linac Solenoid Power Supply. 4 Vacuum Racks @ 7.5 KVA/rack.		
	Lighting	☒ Light fixtures		☐ Remote lighting control
		☒ Fixture type I: Flourescent		☒ Light switches
		☐ Fixture type II: Bollard (exterior)		Lighting level FC:
		☒ Emergency lighting		
		Comments: All lighting and conduit will be low profile, surface mounted, flourescent type fixtures. Lighting design should provide for at least 100 Lumens. Lights to remain on 100% illumination during normal operation.		
RADIATION/SEISMIC/VIBRATIONS ISSUES	**Comments:**			
OTHER SPECIAL REQUIREMENTS	**Comments:**			
ENVIRONMENTAL NEEDS	1.0	Radiation protection is a must for surrounding facilities.		

JACOBS

FACILITY COMPONENT: OFF-AXIS INJECTOR HOUSING

Name of Building	Off-Axis Injector Housing
Organization or Department	SLAC, Stanford University
Net area	65.1 sq. meters — 700 SF
Critical dimensions	H: 7'-0" to 10'-0"; W: ; L:
Hours of operation	24/7
Users/Occupancy	
Building orientation	Facility located 35'-0" below grade, adjacent to the main linear accelerator tunnel at Sector 20.

FUNCTIONAL OBJECTIVE

The Off-Axis Injector Housing will be used to house the injector laser and related equipment.

PLANNING CONSIDERATIONS & CRITICAL FACTORS

SLAC radiation criteria to be stringently adhered to. Stairwell connecting to the upper level shall be temperature controlled.

FINISHES

Wall	Existing concrete for epoxy paint.
Ceiling	Existing concrete for epoxy paint.
Floor	Existing concrete for epoxy paint.
Base	None
Doors	Hollow metal door
Fenestrations	None
Acoustical	None

APPLICABLE STANDARDS

UBC 1997, OSHA, NEC, NFPA 5000.
Conform to DOE Standard 10 CFR, Part 435, UBC, UMC, UPC, Title 24 Energy Standards,
ASHRAE/IES Standards 90.1. Fire Protection .
System compliance with NFPA Standard 13.
Minimum Seismic Performance Level of 7.0; to comply with SLAC Seismic Requirements
To comply with SLAC Radiological Criteria

VIEWS & SCHEMATICS (N. T. S.)

OFF-AXIS INJECTOR HOUSING - *Continued...*

MECHANICAL REQUIREMENTS

HVAC

☐	Heating system	Temp:	☐	Mechanical humidification
☐	Air conditioning	Temp:	☐	Direct exhaust system
☐	Direct supply		☐	Positive pressure system
☐	Indirect supply		☐	Negative pressure system
☒	Smoke control system		☐	Standard registers
☐	Thermostat		☒	Requirement for gases

Coments: In accordance with DOE Order 6430.1A, General Design Criteria and with the requirements as defined by the UBC, UCRL - 15910, DOE Standard 10 CFR - Part 435, UMC, UPC, Title 24 for Non-Residential, and ASHRAE/IES. Passage way leading from upper level to require tempurature control - upper level temp. to not affect Laser Bay and vice-versa.

Communications

☒	Telephone	☐	PA speakers
☒	Dataport	☐	PA station
☐	Payphone	☐	CCTV camera
☒	Fire alarm station	☐	CCTV monitor
☐	Intercom		

Comments: See above.

Plumbing/Fire Protection

☐	Hot water system	☐	Electric watercooler
☐	Cold water system	☐	Drinking fountain
☐	Tempered water	☒	Smoke detection system
☐	Waste drain	☒	Standard sprinkler heads
☐	Floor drain	☐	Eye wash
☐	Trench drain		

Comments: Building firewater to utilize existing site water distribution system through a riser assembly. Fire department connection needed. Compliance with NFPA Standard 13 needed. Switches tie in with the site fire alarm system.

ELECTRICAL REQUIREMENTS

Power supply

☒	240V outlets	☐	Uninterrupted power supply	
☒	120V outlets	☐	Special electric	Type:
☐	Emergency power			

Comments: Also required - 240 V and 480 V receptacles.

Lighting

☒	Light fixtures	☐	Remote lighting control	
☐	Fixture type I: Downlight	☒	Light switches	
☐	Fixture type II: Bollard (exterior)		Lighting level	FC:
☒	Emergency lighting			

Comments: All lighting and conduit will be low profile, surface mounted, flourescent type fixtures. Lighting design should provide for at least 100 Lumens. Lights to remain on 100% time during normal operation.

RADIATION/SEISMIC/VIBRATIONS ISSUES

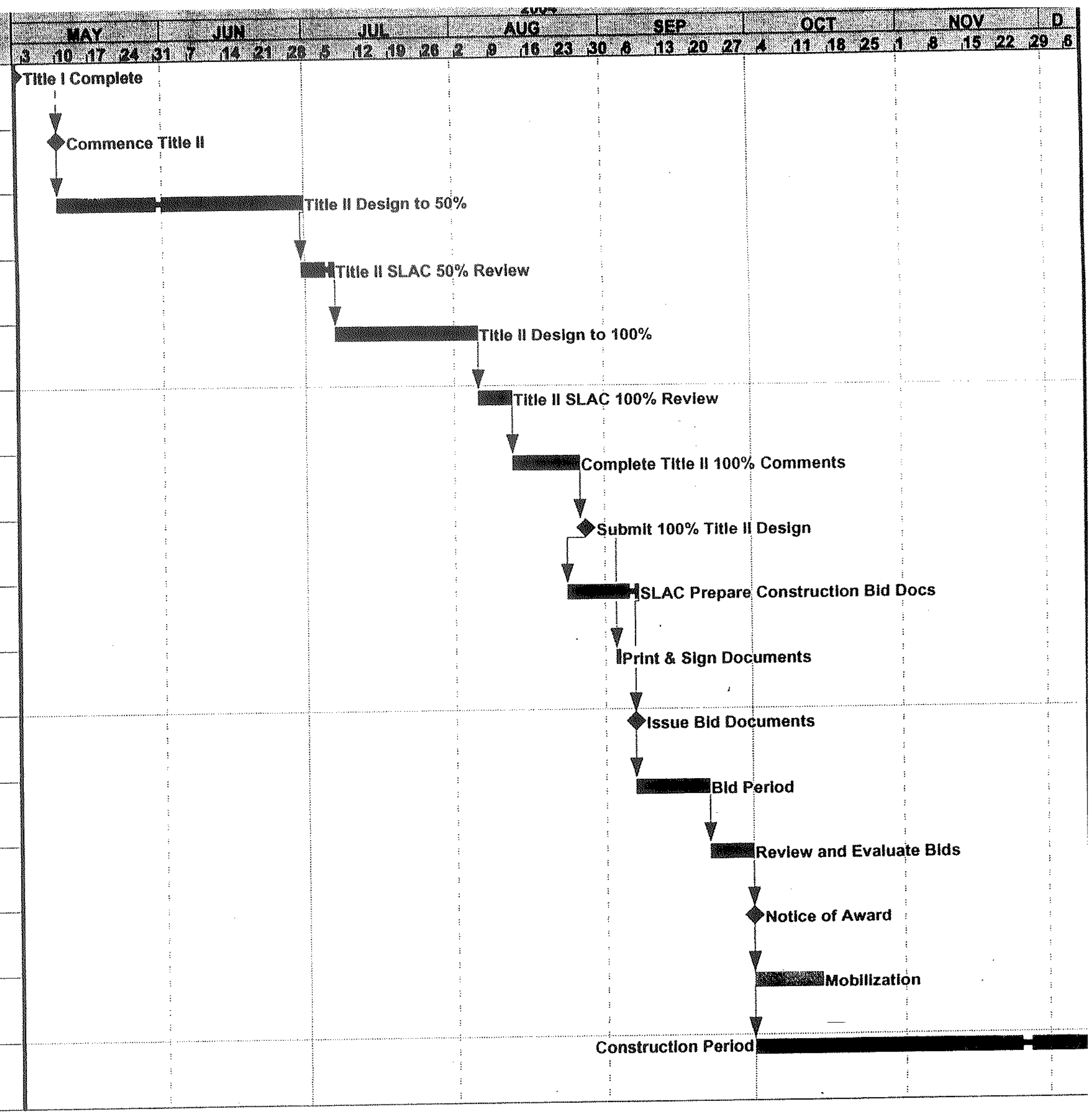
Comments:

OTHER SPECIAL REQUIREMENTS

Comments:

ENVIRONMENTAL NEEDS — 1.0 — Radiation protection is a must for surrounding facilities.

Activity ID	Activity Description	Orig Dur	Early Start	Early Finish
00000	Title I Complete	0		30APR04
00100	Commence Title II	0	10MAY04*	
00110	Title II Design to 50%	37	10MAY04	30JUN04
00170	Title II SLAC 50% Review	4	30JUN04	06JUL04
00120	Title II Design to 100%	22	07JUL04	05AUG04
00130	Title II SLAC 100% Review	5	06AUG04	12AUG04
00140	Complete Title II 100% Comments	10	13AUG04	26AUG04
00150	Submit 100% Title II Design	0		27AUG04
00160	SLAC Prepare Construction Bid Docs	10	24AUG04	07SEP04
00180	Print & Sign Documents	1	03SEP04	03SEP04
00200	Issue Bid Documents	0	07SEP04	
00210	Bid Period	11	07SEP04	21SEP04
00220	Review and Evaluate Bids	7	22SEP04	30SEP04
0900	Notice of Award	0	01OCT04	
0910	Mobilization	10	01OCT04	14OCT04
100000	Construction Period	168	01OCT04	31MAY05



Start Date	01MAY04	Early Bar	S020
Finish Date	31MAY05	Progress Bar	Sheet 1 of 1
Data Date	01MAY04	Critical Activity	**Preliminary Schedule**
Run Date	05MAY04 15:56		**Sector 20 Facility**

STANFORD LINEAR ACCELERATOR CENTER
SLAC
JACOBS FACILITIES INC

Project name	SLAC - Sector 20 Bldg. Stanford University Palo Alto CA
Estimator	Lal Yapa
Labor rate table	CA-SANFRANCISCO-02-U
Equipment rate table	AVG-30 CITY-01-EQ-D
Report format	Sorted by 'Group phase/Phase' 'Detail' summary

Item	Description	Takeoff Qty		Total Unit Cost	Total Amount
2200.000	***SITE WORK***				
2220.100	**Building demolition**				
50	Demo existing Sector 20 Building	1,680.00	sf	12.50 /sf	21,000
50	Demo existing slab	1,530.00	sf	3.50 /sf	5,355
50	Hazmat remediation	1,680.00	sf	5.50 /sf	9,240
50	Haul away debris	20.00	load	275.00 /load	5,500
	Building demolition				**41,095**
	20.524 Labor hours				
	10.262 Equipment hours				
	SITE WORK				***41,095***
	20.524 Labor hours				
	10.262 Equipment hours				
2300.000	***EARTHWORK***				
2310.000	**Grading**				
10	Finegrade SOG	2,160.00	sf	0.12 /sf	259
55	Polyethylene Vapor Barrier 6 mil	2,160.00	sf	0.10 /sf	216
	Grading				**475**
	216.000 Labor hours				
2315.000	**Excavation and fill**				
202	Overexcavate, Recompact, 5' below building	400.00	cy	5.80 /cy	2,320
202	24" Engineered fill	160.00	cy	24.00 /cy	3,840
232	2" Sand bedding onder SOG	13.00	cy	29.00 /cy	377
306	4" Gravel under SOG	26.00	cy	22.00 /cy	572
506	Misc. Backfill @ Stairs, Slab Edges	40.00	cy	19.20 /cy	768
952	Perforated Drain / Gravel @ Footing	228.00	lf	14.70 /lf	3,352
1130	Erosion and Dust Control	1.00	ls	550.00 /ls	550
	Excavation and fill				**11,779**
	2,313.21 Labor hours				
	EARTHWORK				***12,254***
	2,529.210 Labor hours				
3100.000	***CONCRETE FORMS&ACCESSORSS***				
3110.425	**Fip,equipment foundations**				
10	Footing Forms	2,280.00	sf	4.50 /sf	10,260
	Fip,equipment foundations				**10,260**
	0.000 Labor hours				
	CONCRETE FORMS&ACCESSORSS				***10,260***
	0.000 Labor hours				
3200.000	***CONCRETE REINFORCEMENT***				
3210.600	**Reinforcing in place**				
100	Reinforcing steel @ 165# / cy	20,955.00	lbs	0.73 /lbs	15,297
	Reinforcing in place				**15,297**
	CONCRETE REINFORCEMENT				***15,297***

Item	Description	Takeoff Qty		Total Unit Cost	Total Amount
3300.000	***CAST-IN-PLACE CONCRETE***				
3310.000	**Structural concrete**				
5	Excavation	127.00	cy	8.10 /cy	1,029
5	Set Anchors, Plates, Grout	25.00	sets	125.00 /sets	3,125
5	Place and Finish concrete, pump	127.00	cy	80.00 /cy	10,160
	Structural concrete				**14,314**
	248.000 Labor hours				
	CAST-IN-PLACE CONCRETE				***14,314***
	248.000 Labor hours				
5100.000	***STRUCTURAL METAL FRAMING***				
5120.000	**Structural steel**				
75	Raised Floor Support edge framing @ 5# / sf	2.16	tn	2,500.00 /tn	5,400
105	Roof Structure @ 9# /sf	11.00	tn	2,500.00 /tn	27,500
110	Structural Steel Framing @ 9# / sf	11.00	tn	2,500.00 /tn	27,500
110	Structural Steel future price increases	23.00	tn	75.00 /tn	1,725
110	Exterior skin Metal Panels	3,420.00	sf	14.50 /sf	49,590
	Structural steel				**111,715**
	31,196.01 Labor hours				
	STRUCTURAL METAL FRAMING				***111,715***
	31,196.01 Labor hours				
5500.000	***METAL FABRICATIONS***				
5517.300	**Miscellaneous Metals**				
200	Miscellaneous Steel	1.00	ls	1,000.00 /ls	1,000
	Miscellaneous Metals				**1,000**
	1.60 Labor hours				
	METAL FABRICATIONS				***1,000***
	1.60 Labor hours				
7100.000	***THERMAL & MOISTURE PROTEC***				
7110.000	**Water & Fire Proof/Roofin**				
100	Wateproofing footings	1,140.00	sf	3.10 /sf	3,534
100	Standing Seam Roofing	2,160.00	sf	14.50 /sf	31,320
100	Roof Insulation	2,160.00	sf	1.50 /sf	3,240
100	Wall Insulation	6,120.00	sf	0.30 /sf	1,836
	Water & Fire Proof/Roofin				**39,930**
	92.640 Labor hours				
	THERMAL & MOISTURE PROTEC				***39,930***
	92.640 Labor hours				
8200.000	***DOORS AND WINDOWS***				
8210.900	**Doors**				
20	4070 Door, Frame & Hardware	6.00	ea	1,600.00 /ea	9,600
20	6080 Sliding doors, frame and hardware	4.00	ea	2,500.00 /ea	10,000

Item	Description	Takeoff Qty		Total Unit Cost		Total Amount
	Doors					**19,600**
	9.412 Labor hours					
	DOORS AND WINDOWS					***19,600***
	9.412 Labor hours					
9100.000	***METAL SUPPORT ASSEMBLIES***					
9110.100	**Metal studs, partitions**					
1600	LGM stud framing and gyp. board in walls	6,120.00	sf	7.00	/sf	42,840
	Metal studs, partitions					**42,840**
	79.070 Labor hours					
	METAL SUPPORT ASSEMBLIES					***42,840***
	79.070 Labor hours					
9500.000	***CEILINGS***					
9510.000	**Acoustical ceilings**					
110	Acoustical Ceiling	1,560.00	sf	3.75	/sf	5,850
	Acoustical ceilings					**5,850**
	1,560.00 Labor hours					
	CEILINGS					***5,850***
	1,560.00 Labor hours					
9900.000	***PAINTS & COATINGS***					
9910.200	**Interior Paints**					
5	Paint Walls	8,820.00	sf	0.70	/sf	6,174
5	Paint underside of roof deck	2,160.00	sf	0.85	/sf	1,836
5	Floor coating - Polyurethene	2,160.00	sf	1.50	/sf	3,240
10	Paint doors and frames	10.00	sf	115.00	/sf	1,150
	Interior Paints					**12,400**
	10,829.03 Labor hours					
	PAINTS & COATINGS					***12,400***
	10,829.03 Labor hours					
10270.000	***ACCESS FLOORING***					
10275.150	**Pedestal access floors**					
300	Raised Floor	1,560.00	sf	16.50	/sf	25,740
	Pedestal access floors					**25,740**
	55.474 Labor hours					
	ACCESS FLOORING					***25,740***
	55.474 Labor hours					
13900.000	***FIRE SUPPRESSION***					
13965.000	**Fire Protection**					
0005	Wet Pipe Fire Sprinkler System	2,160.00	sf	4.00	/sf	8,640
0005	Riser / Supply for Sprinkler System	1.00	ls	10,000.00	/ls	10,000

Item	Description	Takeoff Qty		Total Unit Cost	Total Amount
	Fire Protection				**18,640**
	64.83 Labor hours				
	FIRE SUPPRESSION				***18,640***
	64.83 Labor hours				
15000.000	***MECHANICAL***				
15120.003	**Plumbing**				
0005	Plumbing - CW/HW/Condensate piping	2,160.00	sf	5.50 /sf	11,880
0005	Cooling water piping for cooling of the laser	400.00	lf	15.00 /lf	6,000
	Plumbing				**17,880**
	0.13 Labor hours				
15130.000	**Pumps**				
0005	HVAC Pumps Chilled water	2.00	ea	900.00 /ea	1,800
0030	1 - 2 HP Inline Recir Pump	2.00	ea	1,400.00 /ea	2,800
0030	1-2 HP Pump for Cooling water	1.00	ea	1,400.00 /ea	1,400
	Pumps				**6,000**
	11.50 Labor hours				
15510.000	**Heating Boilers & Acsrs**				
0010	40KW Electric Boiler	1.00	ea	6,000.00 /ea	6,000
	Heating Boilers & Acsrs				**6,000**
	0.07 Labor hours				
15620.000	**Packaged Water Chillers**				
0080	70 Ton Air Cooled Chiller	1.00	ea	35,000.00 /ea	35,000
	Packaged Water Chillers				**35,000**
	24.00 Labor hours				
15720.000	**Air Handling Units**				
0005	Air handling unit with hepa filter	1.00	ea	38,000.00 /ea	38,000
0005	Make-up Air unit	1.00	ea	20,000.00 /ea	20,000
	Air Handling Units				**58,000**
	0.01 Labor hours				
15780.000	**Energy Recovery Eqpt**				
0010	VAV Boxes	2.00	ea	800.00 /ea	1,600
	Energy Recovery Eqpt				**1,600**
	17.00 Labor hours				
15810.000	**Ducts**				
0005	Ductwork/Insulation/Dampers	2,160.00	sf	5.50 /sf	11,880
	Ducts				**11,880**
	194.400 Labor hours				
15830.000	**Fans**				
0005	Exhaust Fans	1.00	ea	2,000.00 /ea	2,000
	Fans				**2,000**
	0.003 Labor hours				
15910.000	**Direct Digital Controls**				
0005	Energy management control system	1.00	ls	15,000.00 /ls	15,000
	Direct Digital Controls				**15,000**

Item	Description	Takeoff Qty		Total Unit Cost	Total Amount
	MECHANICAL				***153,360***
	247.11 Labor hours				
16000.000	***ELECTRICAL***				
16400.000	**Service & Distribution**				
3005	Power Panels	6.00	ea	2,200.00 /ea	13,200
4075	Disconnect Switches	10.00	ea	400.00 /ea	4,000
4415	Motor Control Center	1.00	ea	30,000.00 /ea	30,000
5045	Dry Type 45 KVA Transformer	6.00	ea	3,000.00 /ea	18,000
6010	Conduits	1.00	ls	5,000.00 /ls	5,000
6010	Cables	1.00	ls	22,000.00 /ls	22,000
6010	Grounding	1.00	ls	10,000.00 /ls	10,000
6010	VESDA Alarm/ Smoke Detection System	1.00	ls	35,000.00 /ls	35,000
6010	Addl. cables, transf. etc. for laser cooling	1.00	ls	8,000.00 /ls	8,000
	Service & Distribution				**145,200**
	335.80 Labor hours				
16510.000	**Electrical Lghting & Dist**				
55	Interior Lighting, Receptacles etc	2,160.00	sf	18.00 /sf	38,880
	Electrical Lghting & Dist				**38,880**
	2,483.98 Labor hours				
	ELECTRICAL				***184,080***
	2,819.78 Labor hours				

Estimate Totals

Labor	0	0		49,752.678	hrs	
Material	0	0				
Subcontract	708,375	708,375				
Equipment				10.262	hrs	
	708,375	708,375	708,375			
General Conditi	85,005			12.000 %		T
Bond (%)	7,792			1.100 %		T
Escalation (%)	48,070			6.000 %		T
RF Shield Roon	83,414					L
	Total		***932,656***			

WILSON, IHRIG & ASSOCIATES, INC.
ACOUSTICAL CONSULTANTS

5776 BROADWAY
OAKLAND, CA
U.S.A. 94618-1531
Tel: (510) 658-6719
Fax: (510) 652-4441
E-mail: swolfe@wiai.com
www.wiai.com

SLAC SECTOR 20 OFF-AXIS INJECTOR PROJECT

VIBRATION MEASUREMENT RESULTS

29 April 2004

Submitted to:

Mr. Steven Hill
Project Manager
Jacobs Civil, Inc.
5757 Plaza Drive, Suite 100
Cypress, CA 90630

By:

William A. Pritchard
Associate

Reviewed By:

James T. Nelson, Ph.D., P.E.
Vice President

INTRODUCTION

Vibration data were collected at three positions for the Sector 20, Off-Axis Injector Laser project at the Stanford Linear Accelerator Center (SLAC) on April 8, 2004. Vibration velocity data for ambient and single-event conditions were analyzed and compared with vibration velocity criteria presented in our March 7, 2004 letter, "Vibration Criteria for SLAC LCLS Project."

MEASUREMENT LOCATIONS

The three vibration measurement positions for the Sector 20 project are shown in Figure A-1 (street level) and A-2 (lower level) in Appendix A, and described in Table I below. Measurements were made on the concrete slab of the existing street-level room and lower-level vault.

TABLE I MEASUREMENT POSITIONS FOR SECTOR 20 VIBRATION SURVEY

Position Designation	Position Description	Sector 20 Level	Distances from East & South Walls (Ch.1-3)**	Distances from East & South Walls (Ch.4)**
Pos.1	Street Level - East	Upper - Roadway	125 in & 117 in	125 in & 195 in
Pos.2	Street Level - West	Upper - Roadway	240 in & 116 in	240 in & 194 in
Pos.3	Lower Level - Injector Hall	Lower - Injector Hall	76 in from S. Wall, Centered on N. Penetration	38 in from S. Wall, Centered on N. Penetration

** See Figures A-1 and A-2 for visual comparison. Note also the difference in locations at street level of the building's East Wall at the time of measurements and for the proposed new building.

INSTRUMENTATION

Simultaneous measurements were made with four Wilcoxon Research Seismic Accelerometers (Types 731 and 731A). The accelerometers were individually mounted inside aluminum brackets and then adhered to the concrete floor with wax. The accelerometer signals were amplified with WIA Type 222, 2-channel, decade amplifiers. The output of each channel from the decade amplifier was recorded on a Teac Model RD 135T, 8-channel digital audio tape (DAT) recorder. The decade amplifier outputs were also split and integrated with WIA Type 402, 2-channel, selectable high-pass filter integrators to provide a direct recording of vibration velocity on the remaining four channels of the 8-channel recorder.

The four channels of recorded vibration velocity data were analyzed simultaneously with two, 2-channel Larson Davis Laboratories Type 2900B Real Time Analyzers, which generated 1/3 octave band, RMS velocity levels and statistics for comparison with appropriate criteria. The analyzed data were stored on a Pentium based personal computer for further processing and plotting of the data.

Appendix B presents specific details on the vibration instrumentation and calibrations used for these measurements. Calibrations were made using a reference accelerometer that is tested annually at a NIST-certified calibration facility.

FIELD PROCEDURE

Four-channel measurements were made at all measurement positions. First, a tri-axial array was positioned according to the right-hand rule, with vertical, longitudinal (parallel to the beam, pointing east), and transverse (horizontally perpendicular to the beam, pointing north) orientations for the transducers. Then, a fourth transducer, also with vertical orientation, was positioned 1 or 2 meters from the first vertical transducer, along a line perpendicular to the beam, to provide comparative data and allow more complex future analysis if necessary.

Minimum 10-minute, ambient recordings were made at each of the three positions shown in Figure A-1 and A-2. While these recordings included passage of light vehicles and the occasional heavy vehicle, additional single-event sources were recorded separately. These sources included foot steps, banging/opening of doors and gates, and passes by a tractor cab and loaded dump truck. Analyses of all recordings were performed in the WIA laboratory and included computation of statistical vibration velocity levels for the 10-minute ambient samples (using a one-second integration time). Single-event sources were analyzed by computing the equivalent continuous RMS velocity level, averaged over two to four seconds, for each event.

Statistical levels are reported according to the Ln level, which represents the vibration velocity level exceeded during n% of the sample period. For example the L1, L10, L50, and L90 give the velocity level exceeded during 1%, 10%, 50%, and 90% of the sample period, respectively. Single-event plots show only the equivalent continuous rms level for each event, averaged over two to four seconds, depending on the event's duration.

More detailed definitions for these and other acoustical and vibration terms can be found in the Glossary in Appendix C.

CRITERIA

Measurement data are compared with several criteria curves discussed in our March 7, 2004 letter "Vibration Criteria for SLAC LCLS Project." Three curves, labeled IES VC-C (500 micro-in/sec), IES VC-D (250 micro-in/sec), and IES VC-E (125 micro-in/sec), originate from the Institute of Environmental Sciences (IES) publication *Recommended Practice IES-RP-CC012.1.* A fourth curve, below the other three and labeled "Sub VC-E (40 micro-in/sec)," is custom for this project and is the most restrictive of the presented criteria. All plots of the measurement data show these four criteria curves for comparison.

RESULTS AND DISCUSSION

The results of the statistical ambient and single-event vibration analyses are presented in Figures 1A to 9D, with single-event, overall vibration levels also summarized in Table II below. Figures show spectral plots of 1/3 octave band vibration velocity level verses 1/3 octave band center frequency. Each figure number, 1 to 9, has four corresponding letter designations, A to D, for data from Channel 1 - vertical (A), Channel 2 - parallel to beam (B), Channel 3 - horizontally perpendicular to beam (C), and Channel 4 - vertical at 1 or 2 m from Channel 1 (D). For ease of comparison, all plots also have the same full scale (70 dB) and show the four criteria curves discussed above.

<u>Results from Statistical Analyses</u>
Statistical vibration levels from the 10-minute, ambient recordings are shown in Figures 1 to 3, for Positions 1 to 3, respectively. See Figures A-1 and A-2 and Table I above for details of the measurement positions.

For sources including mechanical and electrical equipment and vehicle passbys, street-level Positions 1 and 2 show greater vibration levels than does Position 3 on the lower level. Vehicle passbys, including mini-vans and light trucks, show up most clearly in the L1 curves in the figures, because the L1 most closely resembles the maximum event vibration level during the sample period. Levels for the horizontal accelerometers (in figures labeled B and C, or CH.2 and CH.3) were substantially below those for the vertical accelerometers for all measurements.

At Positions 1 and 2, the Channel 4 accelerometer location was 2 m closer to the roadway than the Channel 1 location. Higher resulting vibration levels from vehicle passbys at Channel 4 are shown in the figures for both of these positions.

Overall, exceedances of the of the IES VC-E (125 micro-in/sec) curve are unusual within the statistical results. Only Figures 2A and 2D, which present vertical data from Position 2, show spectra exceeding the IES VC-D curve. Sources of these exceedances are vehicles striking the steal plates crossing the service roadway west of the Sector 20 building, and several pumps in the area. Similarly, all exceedances of even the "Sub VC-E (40 micro-in/sec)" curve appear to be caused by these same two sources.

<u>Results from Single-Event Analyses</u>
Data were captured for several single-event sources, including repeated passes by a medium-sized dump truck loaded with gravel and a semi-truck tractor cab (no trailer attached). Both of these vehicles had a single rear axle. Data were also collected for rolling and slamming of a large door, labeled 20-5, located immediately east of the Sector 20 building, along the north wall of the beam hall structure. Vibration data from walking on the upper- and lower-level slabs and connecting stairs were also collected. Other sources were measured, but not reported here because of very low corresponding vibration levels or because the source will be removed as part of the Sector 20 project.

Table II below presents a summary of single-event vibration levels collected by the Channel 1 accelerometer at each measurement position. See Figures A-1 and A-2 for position details. Spectral data for the sources of greatest interest - the dump truck and tractor cab - are shown in Figures 4A to 9D. Separate figures are shown for each measurement channel and measurement position. Spectra are shown for individual samples of the trucks passing the Sector 20 building and for the same trucks striking the steal plates crossing the service roadway west of the Sector 20 building. Note that spectra in Figures 4, 6, and 8 do not include influence from the steal plates, and instead show only the highest vibration levels created by the vehicles passing directly in front of the Sector 20 building. In contrast, Figures 5, 7, and 9 show only the vibration levels created as the trucks struck the steal plates, which are to be removed as part of the Sector 20 project.

All single-event figures show vertical vibration levels that are consistently higher than those from horizontal measurement channels. For Positions 1 and 2, maximum levels from truck passbys (not including the effects of the steal plates) typically equaled IES VC-E at Channel 1 and IES VC-D at Channel 4, which was 2 m closer to the roadway than Channel 1. Single-event levels from Position 3 (lower level) were lower than those from Positions 1 and 2 (street level).

TABLE II MAXIMUM RMS VIBRATION VELOCITIES FROM SINGLE-EVENT SOURCES - OVERALL LEVELS (Data from Channel 1 Accelerometer Only)

Ch.1 Position	**Description of Single-Event Source** (Figure Referenced Parenthetically where Applicable)	**Overall Vibration Velocity Level** (dB re: 10^{-6} in/sec)
Pos.1	Dump Truck and Tractor Cab Passing Building (Fig.4A)	44-51
	Dump Truck and Tractor Cab Striking Steal Plates (Fig.5A)	64-72
	Large Door (20-5), Rolling	50-55
	Large Door (20-5), Slamming Shut	67-69
	Walking, Small Doors, Footsteps on Stairs, etc.	43-48
Pos.2	Dump Truck and Tractor Cab Passing Building (Fig.6A)	43-58
	Dump Truck and Tractor Cab Striking Steal Plates (Fig.7A)	59-70
	Large Door (20-5), Rolling	43-45
	Large Door (20-5), Slamming Shut	55-56
	Walking, Small Doors, Footsteps on Stairs, etc.	43-49
Pos.3	Dump Truck and Tractor Cab Passing Building (Fig.8A)	33-45
	Dump Truck and Tractor Cab Striking Steal Plates (Fig.9A)	47-53
	Walking on Lower Level, Footsteps on Stairs, Jumping	42-49

CONCLUSION

The highest 1/3 octave band vibration velocities from both statistical and single-event data analyses are typically between the IES VC-D (250 micro-in/sec) and IES VC-E (125 micro-in/sec) criteria curves for sources that will remain after completion of the Sector 20 project. Higher levels were generated by a loaded dump truck and semi-truck tractor cab striking the existing steal plates located west of the project building, but this source is to be eliminated as part of the project.

Equipment that can withstand vibration velocities of IES VC-C (500 micro-in/sec) or greater can thus be used without significant concern for vibration. However, occasional sources of vibration associated with construction, repair, or other unusual activities in the immediate vicinity could certainly exceed this criteria. If equipment requiring a vibration limit below IES VC-C will be used, vibration mitigating design features should be considered and developed as part of the equipment's installation.

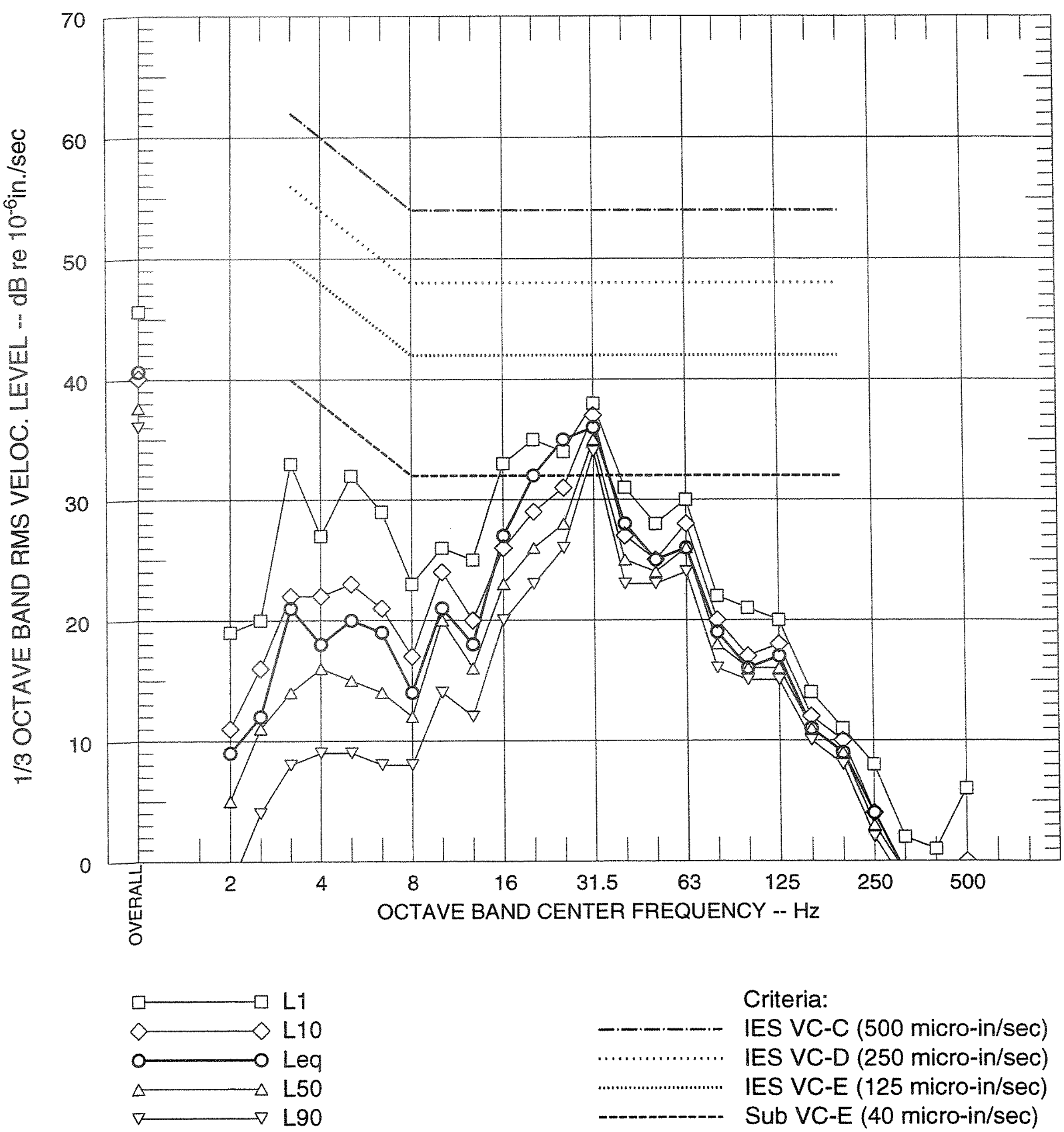


FIGURE 1A STATISTICAL VIBRATION LEVELS AT POSITION 1
CH.1 - VERTICALLY PERPENDICULAR TO BEAM HALL
STREET LEVEL - EAST

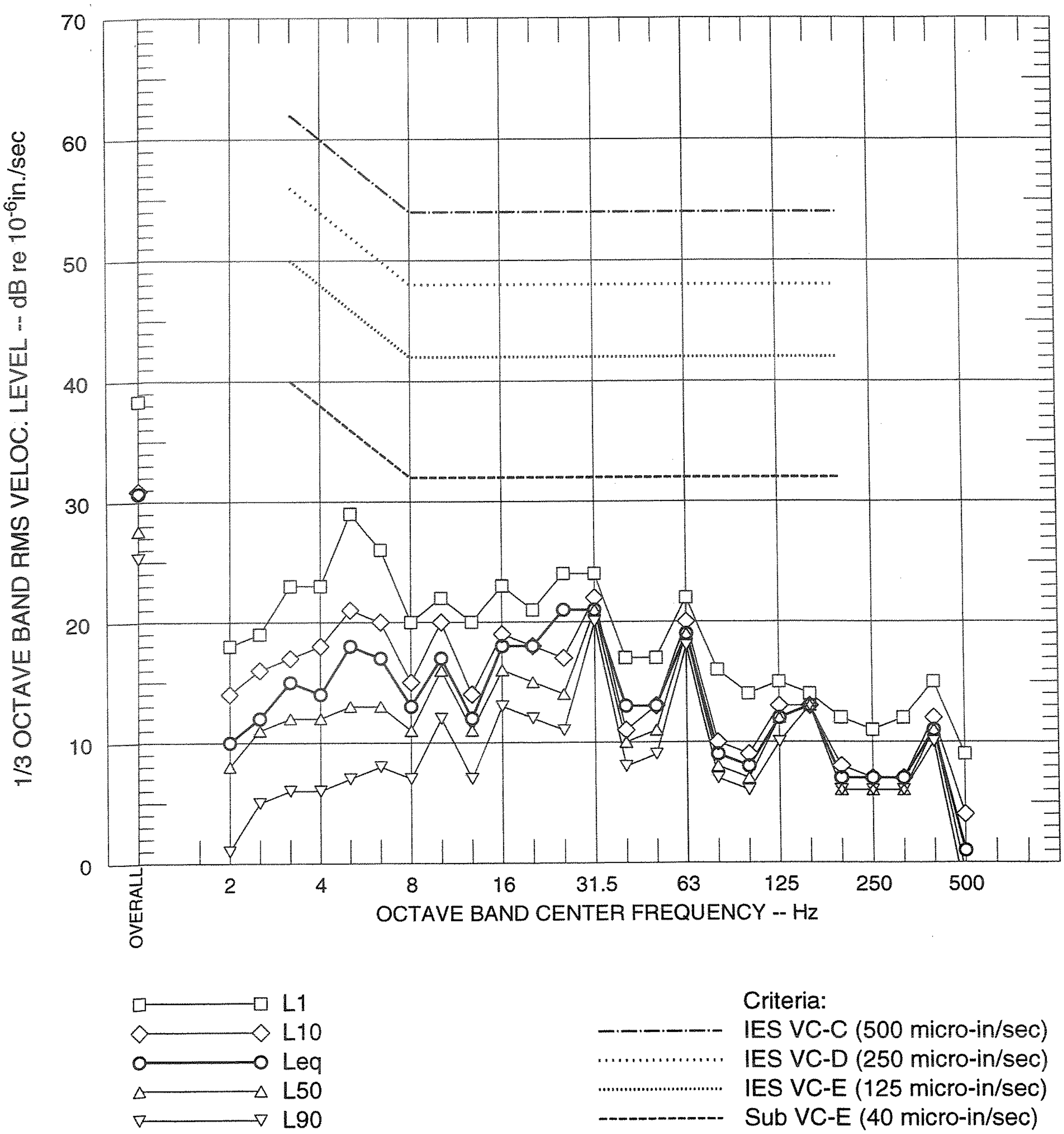


FIGURE 1B STATISTICAL VIBRATION LEVELS AT POSITION 1
CH.2 - PARALLEL TO BEAM HALL
STREET LEVEL - EAST

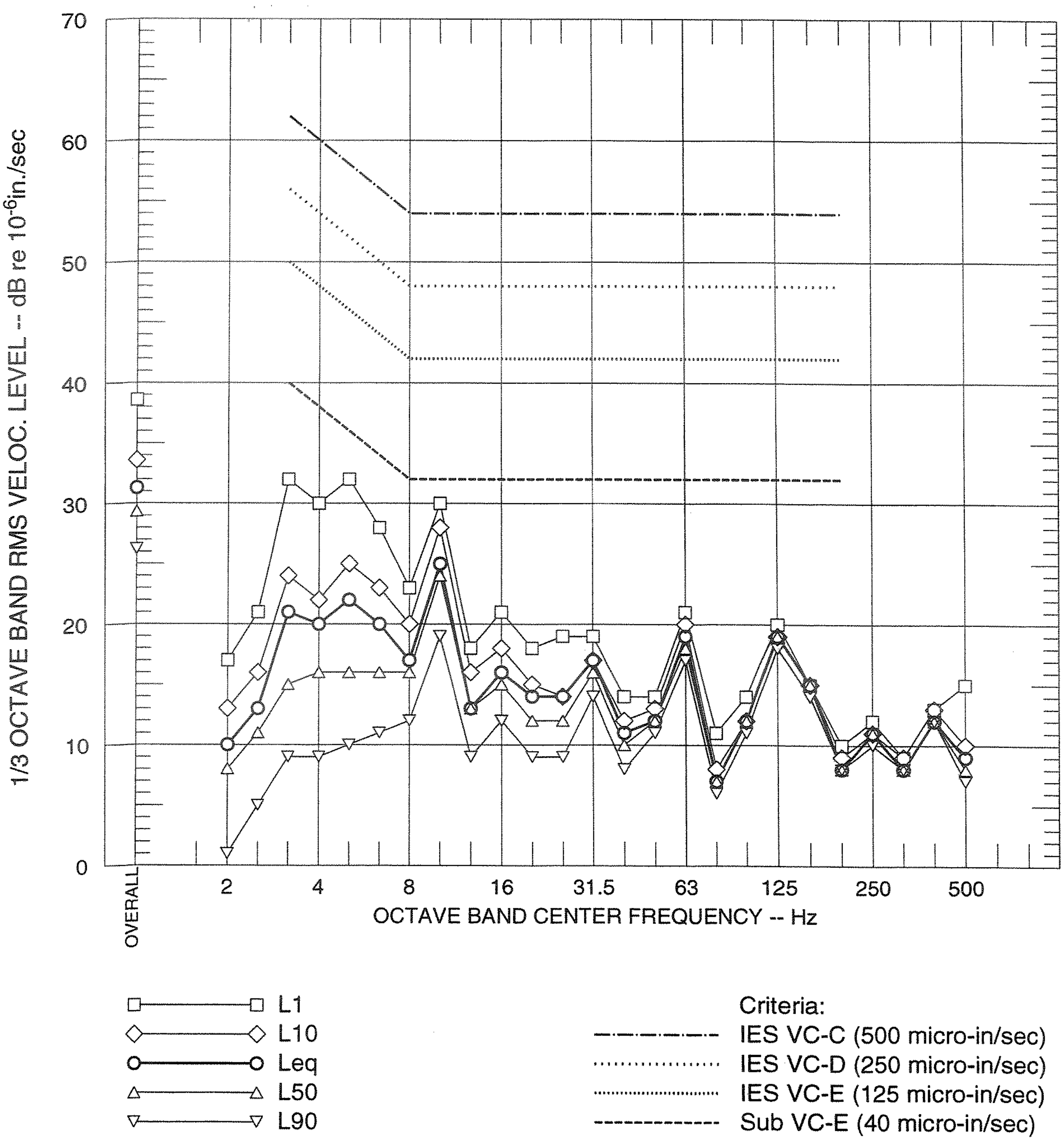


FIGURE 1C STATISTICAL VIBRATION LEVELS AT POSITION 1
CH.3 - HORIZONTALLY PERPENDICULAR TO BEAM HALL (TRANSVERSE)
STREET LEVEL - EAST

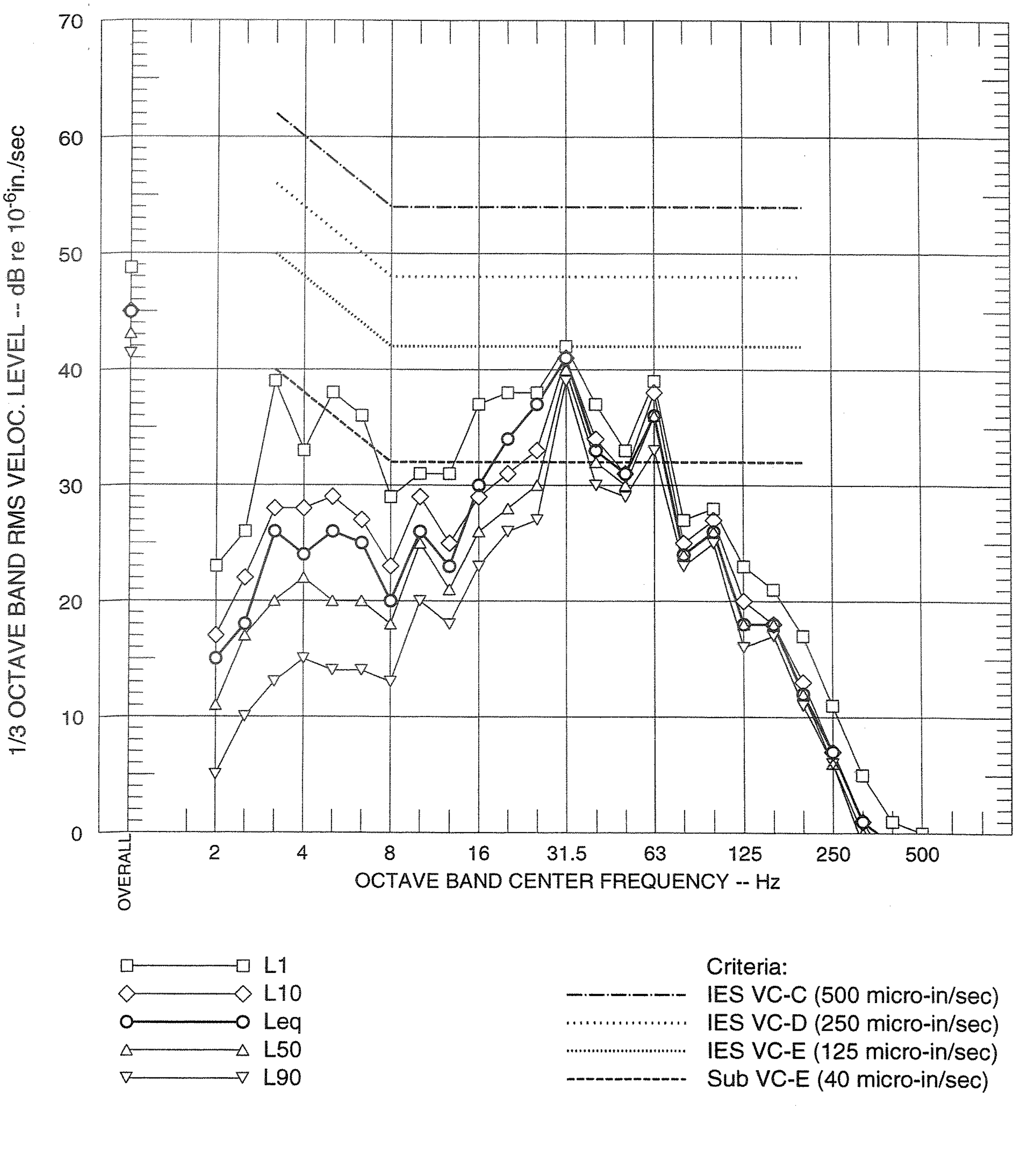


FIGURE 1D STATISTICAL VIBRATION LEVELS AT POSITION 1
CH.4 - VERTICALLY PERPENDICULAR TO BEAM HALL (at 2 m)
STREET LEVEL - EAST

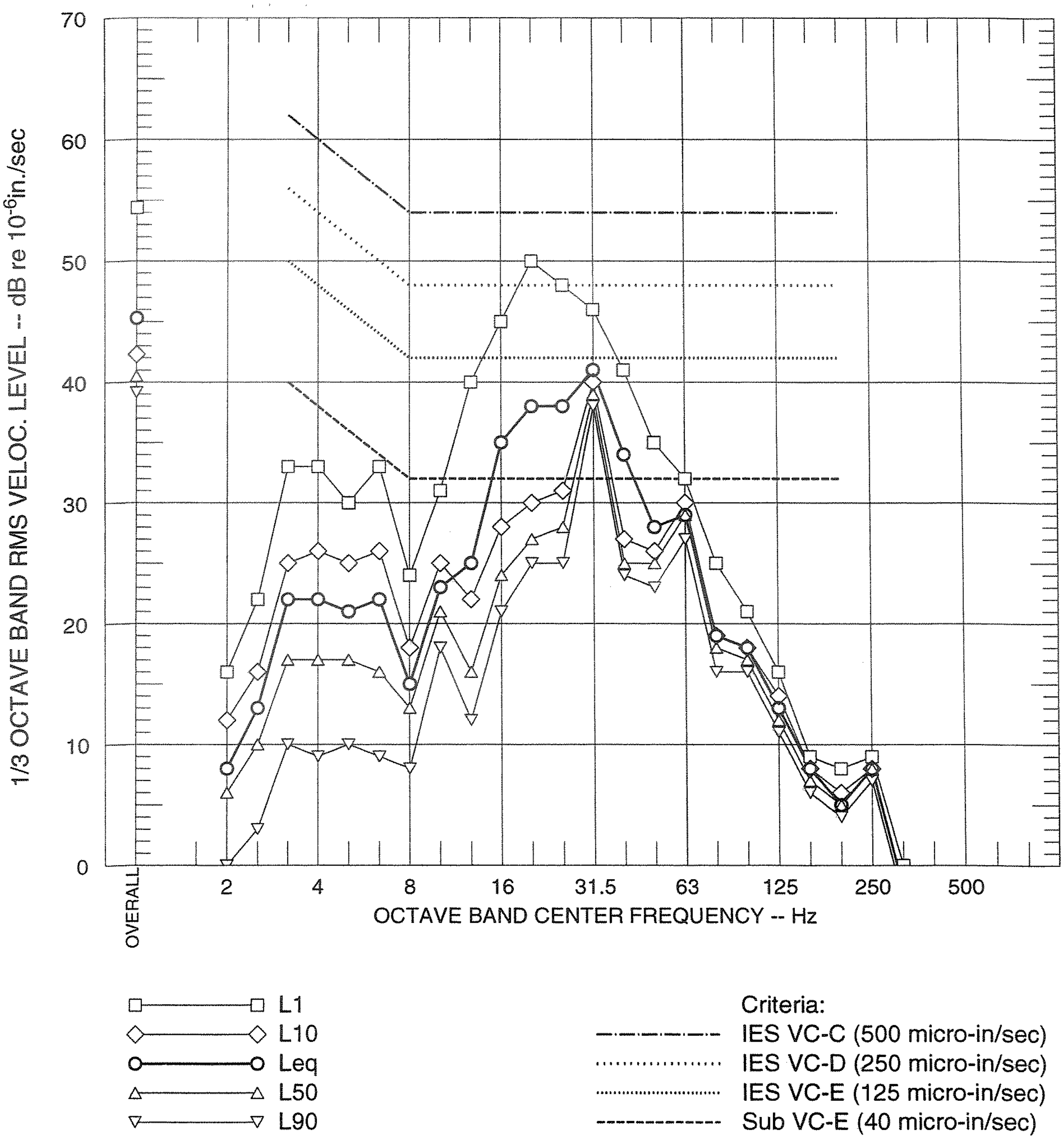


FIGURE 2A STATISTICAL VIBRATION LEVELS AT POSITION 2
CH.1 - VERTICALLY PERPENDICULAR TO BEAM HALL
STREET LEVEL - WEST

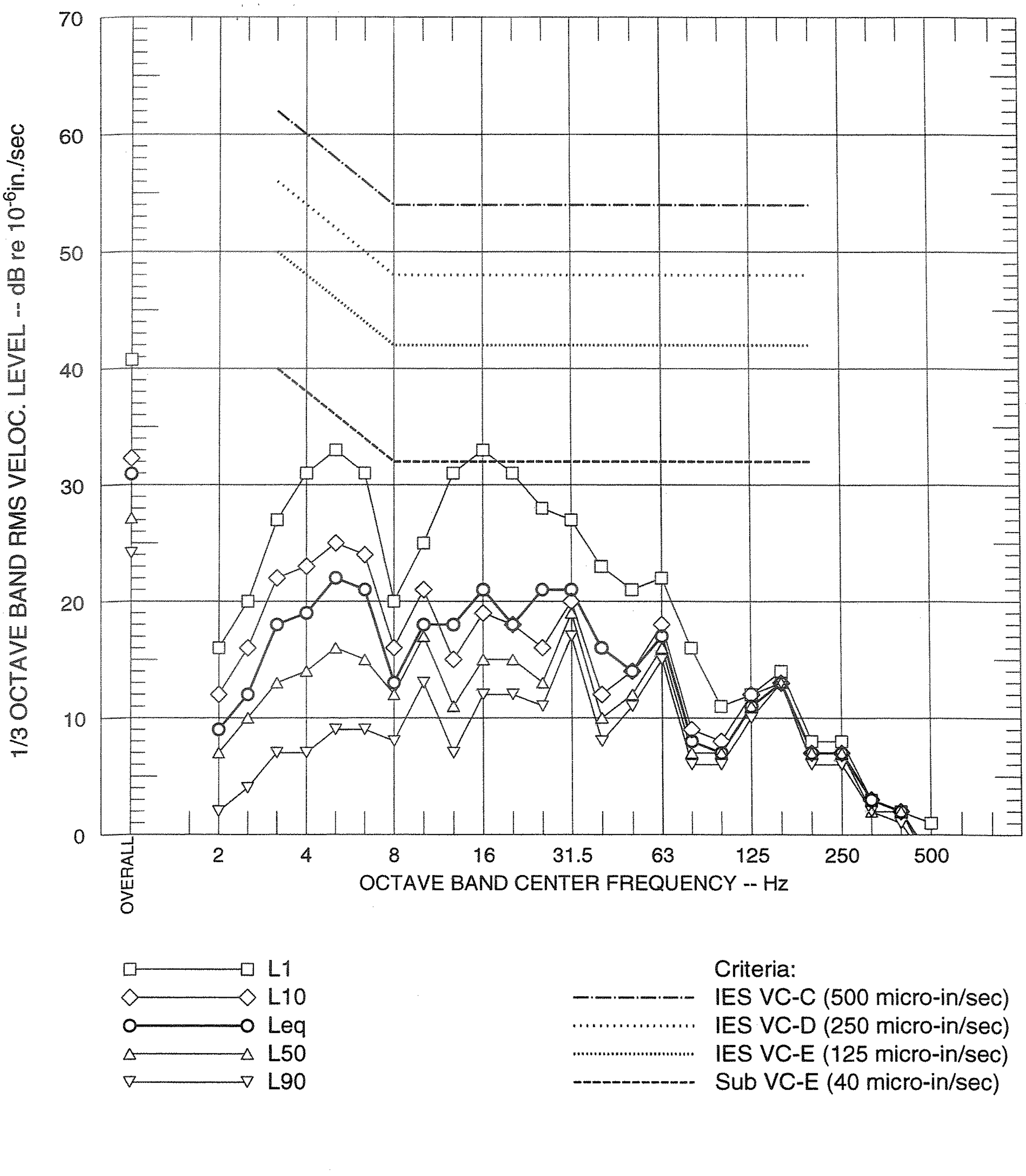


FIGURE 2B STATISTICAL VIBRATION LEVELS AT POSITION 2
CH.2 - PARALLEL TO BEAM HALL
STREET LEVEL - WEST

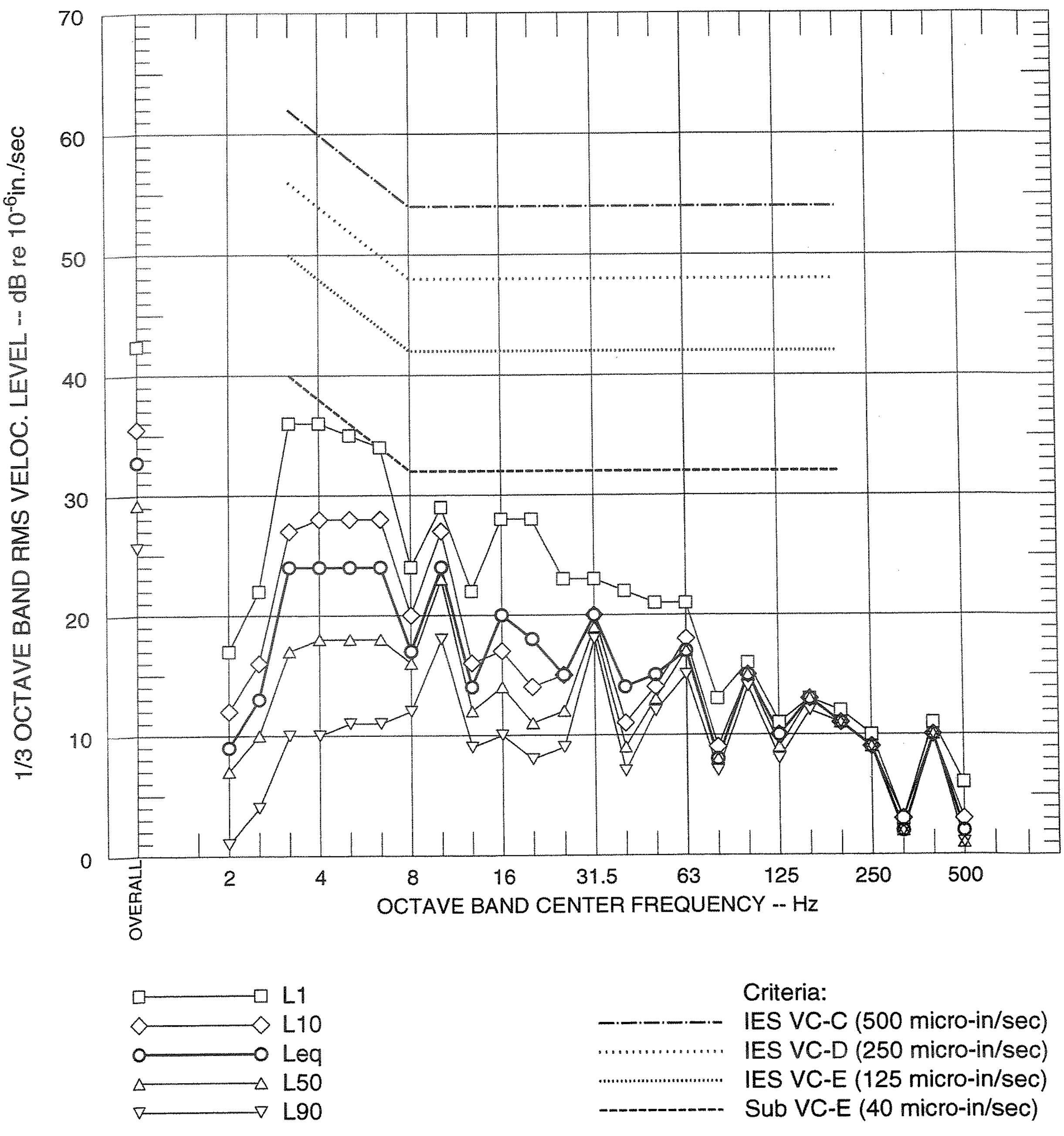


FIGURE 2C STATISTICAL VIBRATION LEVELS AT POSITION 2
CH.3 - HORIZONTALLY PERPENDICULAR TO BEAM HALL (TRANSVERSE)
STREET LEVEL - WEST

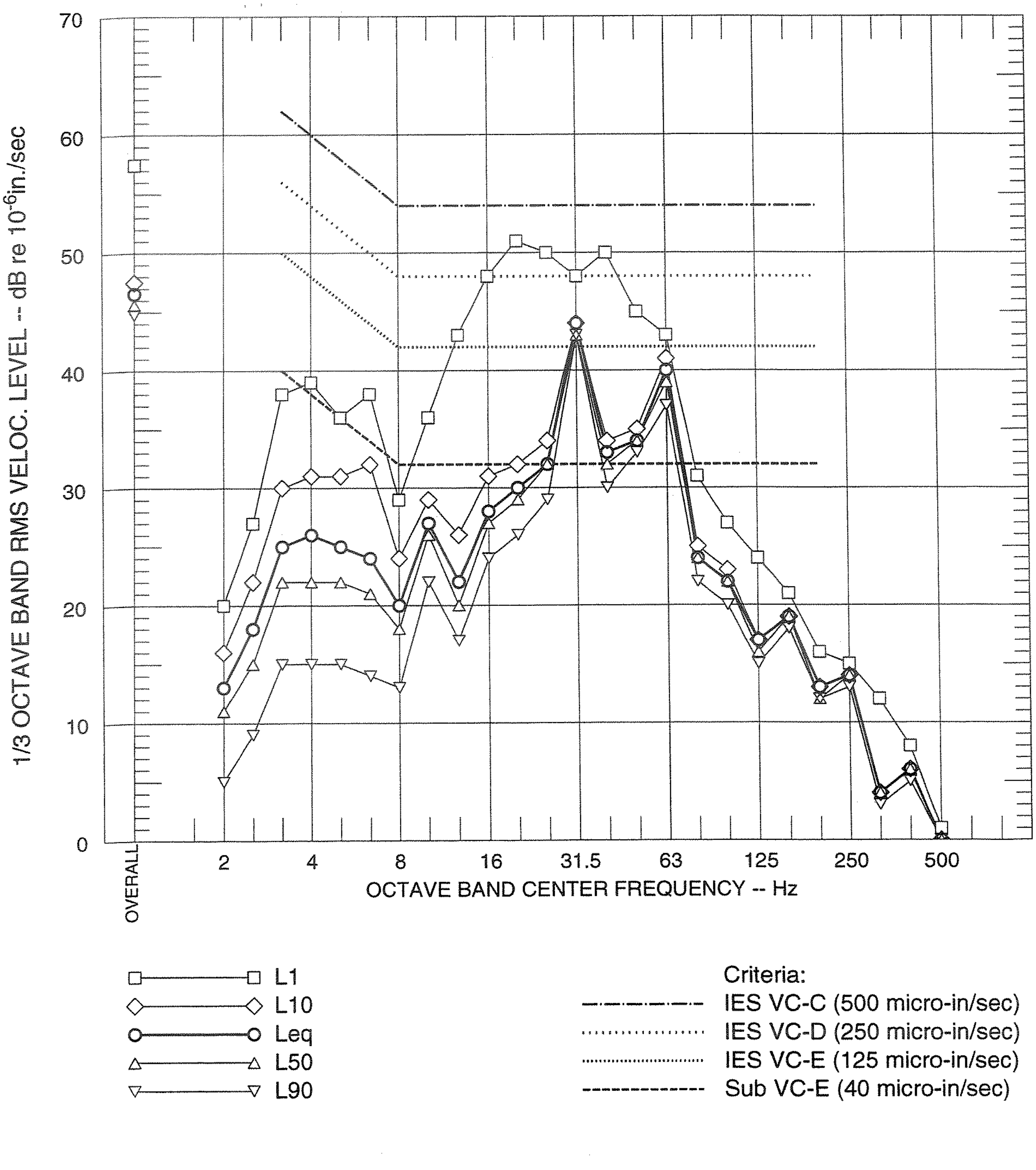


FIGURE 2D STATISTICAL VIBRATION LEVELS AT POSITION 2
CH.4 - VERTICALLY PERPENDICULAR TO BEAM HALL (at 2 m)
STREET LEVEL - WEST

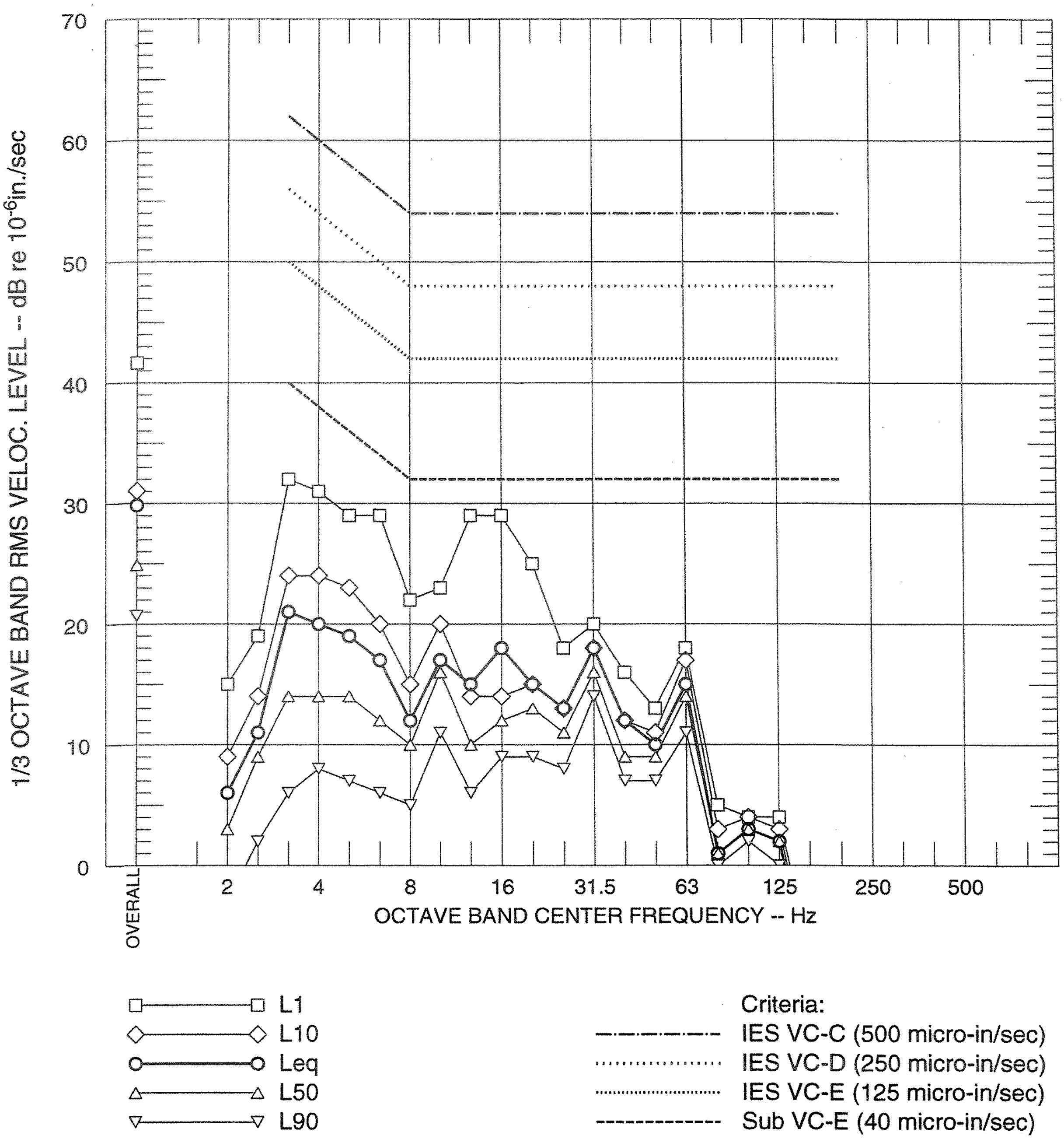


FIGURE 3A STATISTICAL VIBRATION LEVELS AT POSITION 3
CH.1 - VERTICALLY PERPENDICULAR TO BEAM HALL
LOWER LEVEL - INJECTOR HALL

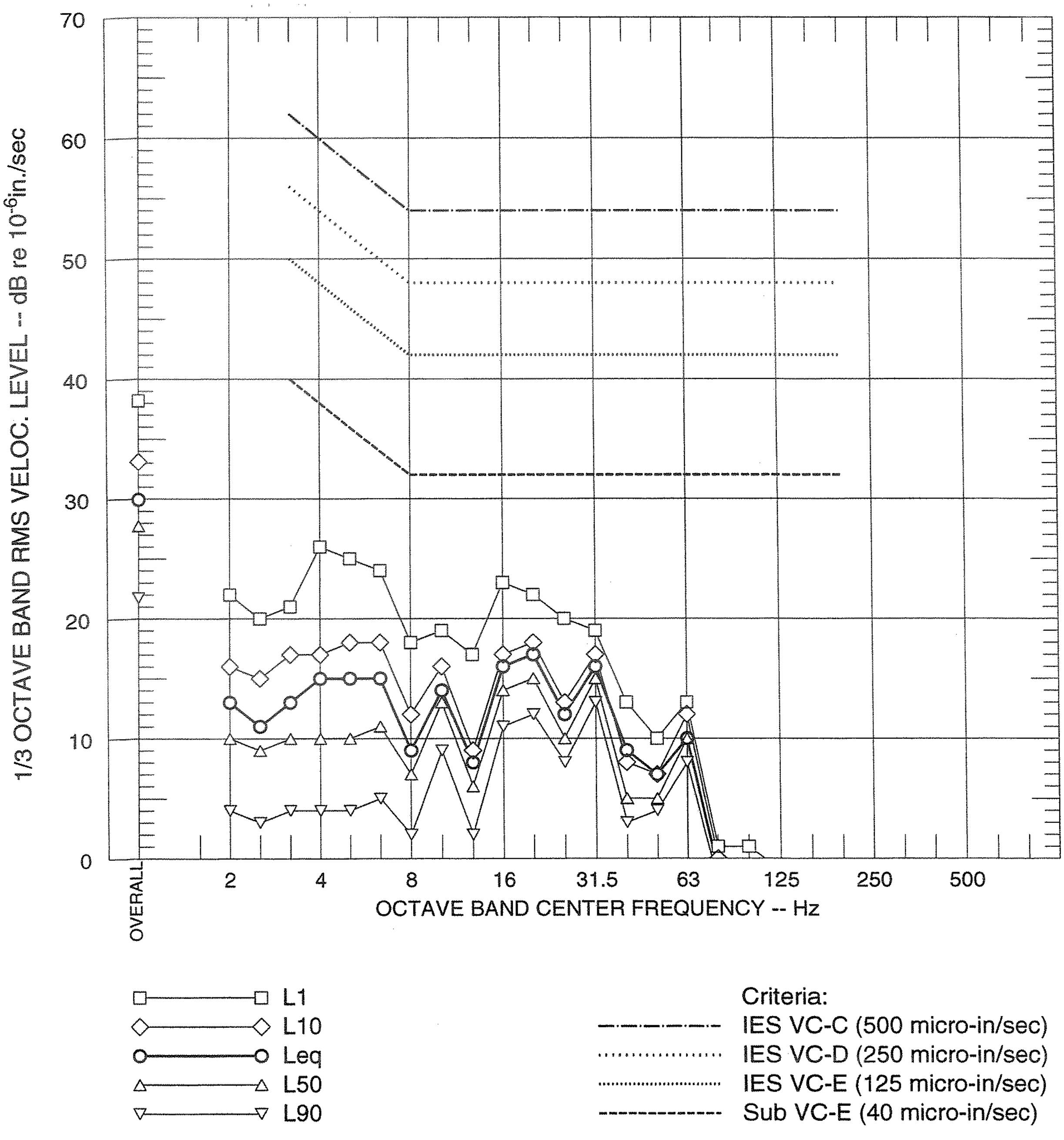


FIGURE 3B STATISTICAL VIBRATION LEVELS AT POSITION 3
CH.2 - PARALLEL TO BEAM HALL
LOWER LEVEL - INJECTOR HALL

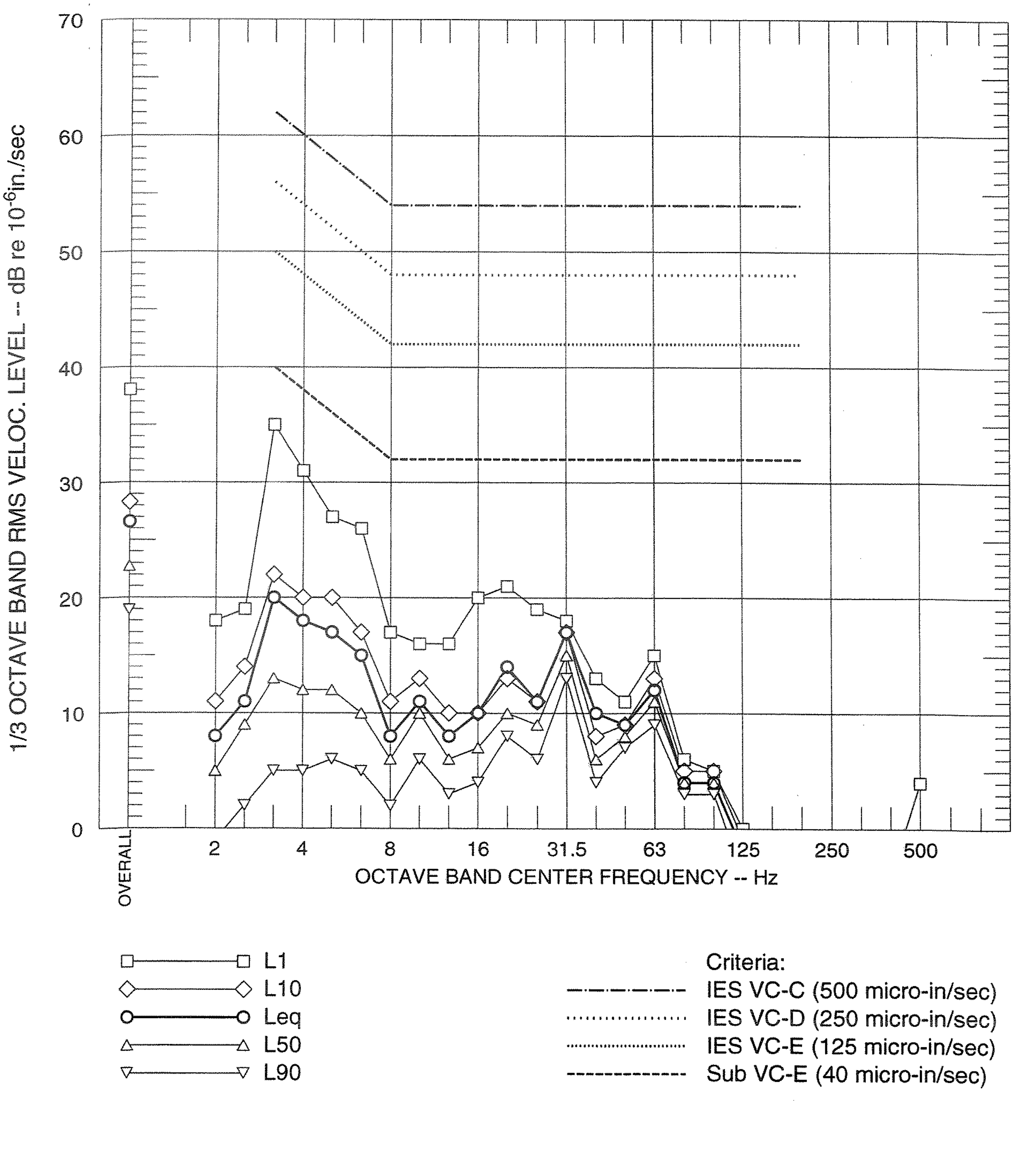


FIGURE 3C STATISTICAL VIBRATION LEVELS AT POSITION 3
CH.3 - HORIZONTALLY PERPENDICULAR TO BEAM HALL (TRANSVERSE)
LOWER LEVEL - INJECTOR HALL

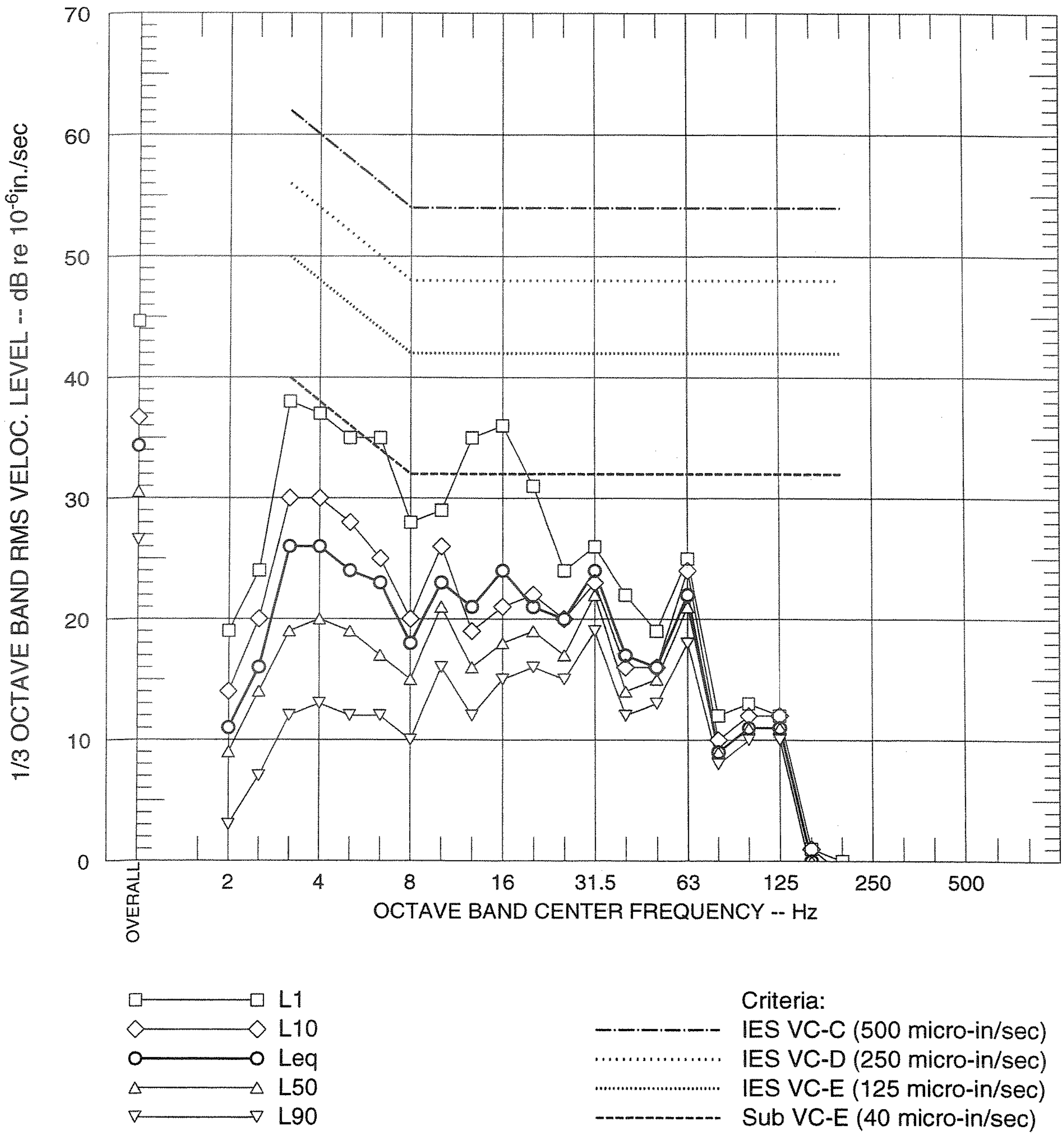


FIGURE 3D STATISTICAL VIBRATION LEVELS AT POSITION 3
CH.4 - VERTICALLY PERPENDICULAR TO BEAM HALL (at 1 m)
LOWER LEVEL - INJECTOR HALL

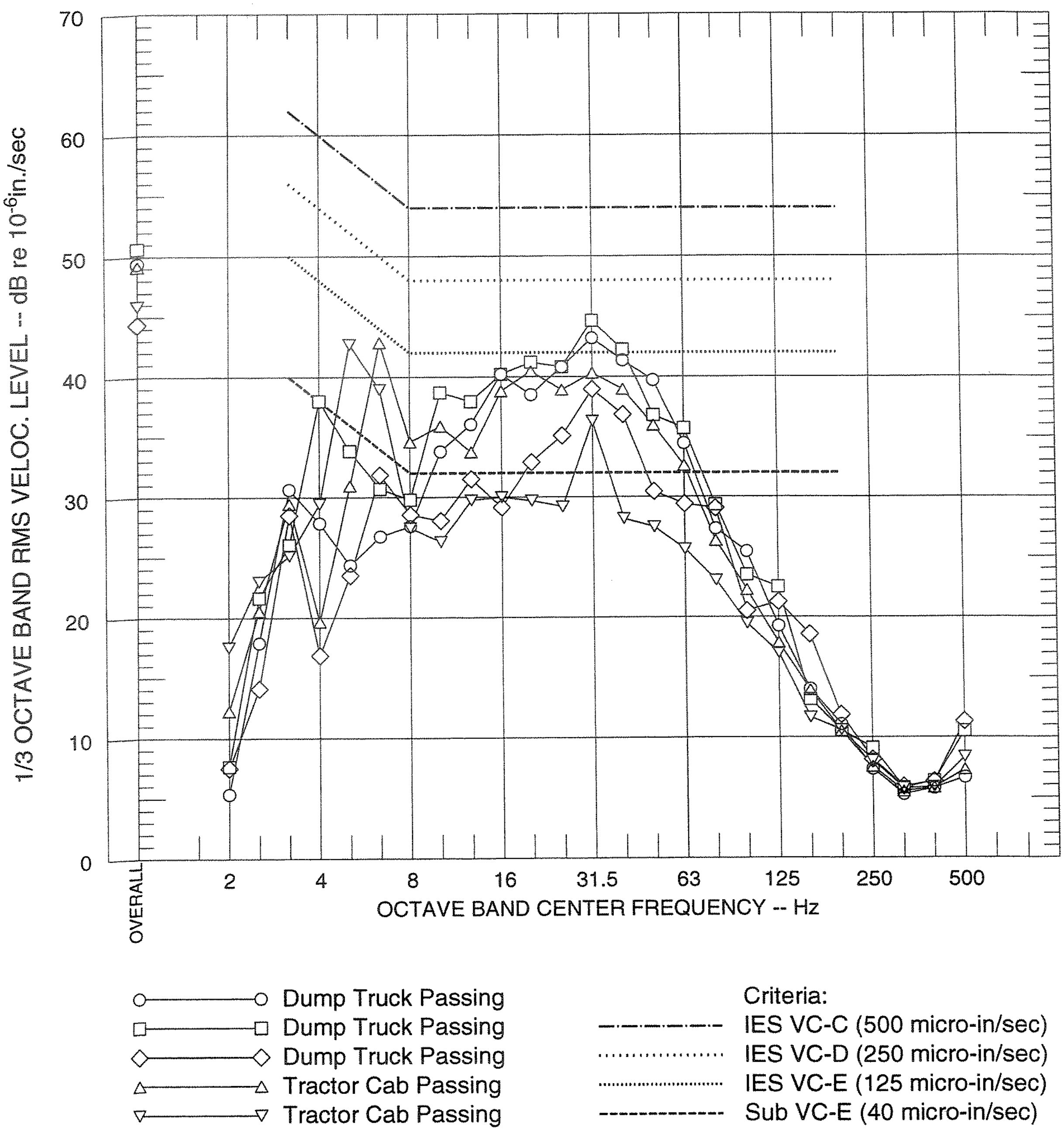


FIGURE 4A SINGLE-EVENT VIBRATION LEVELS AT POSITION 1
CH.1 - VERTICALLY PERPENDICULAR TO BEAM HALL
STREET LEVEL - EAST

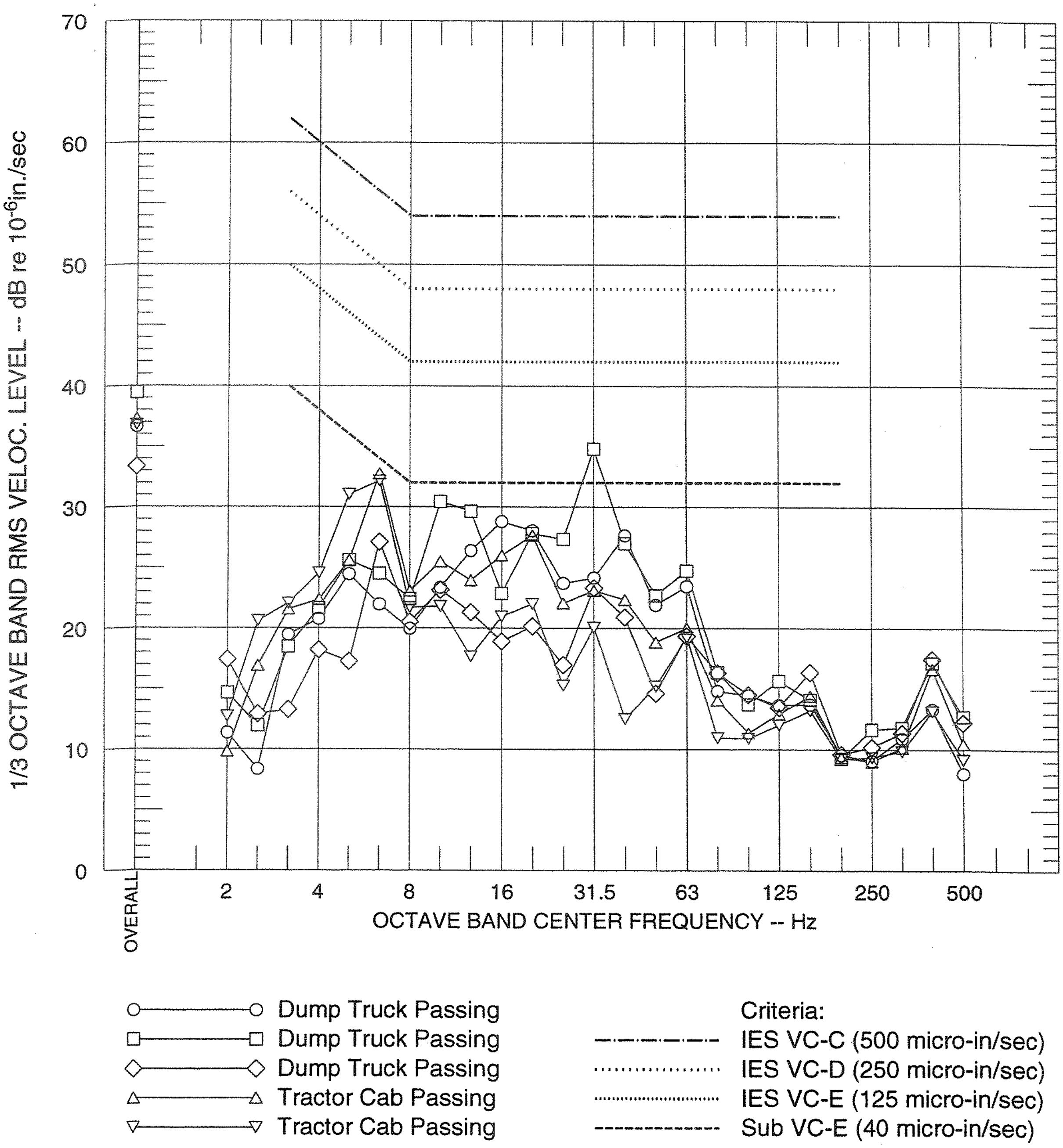


FIGURE 4B SINGLE-EVENT VIBRATION LEVELS AT POSITION 1
CH.2 - PARALLEL TO BEAM HALL
STREET LEVEL - EAST

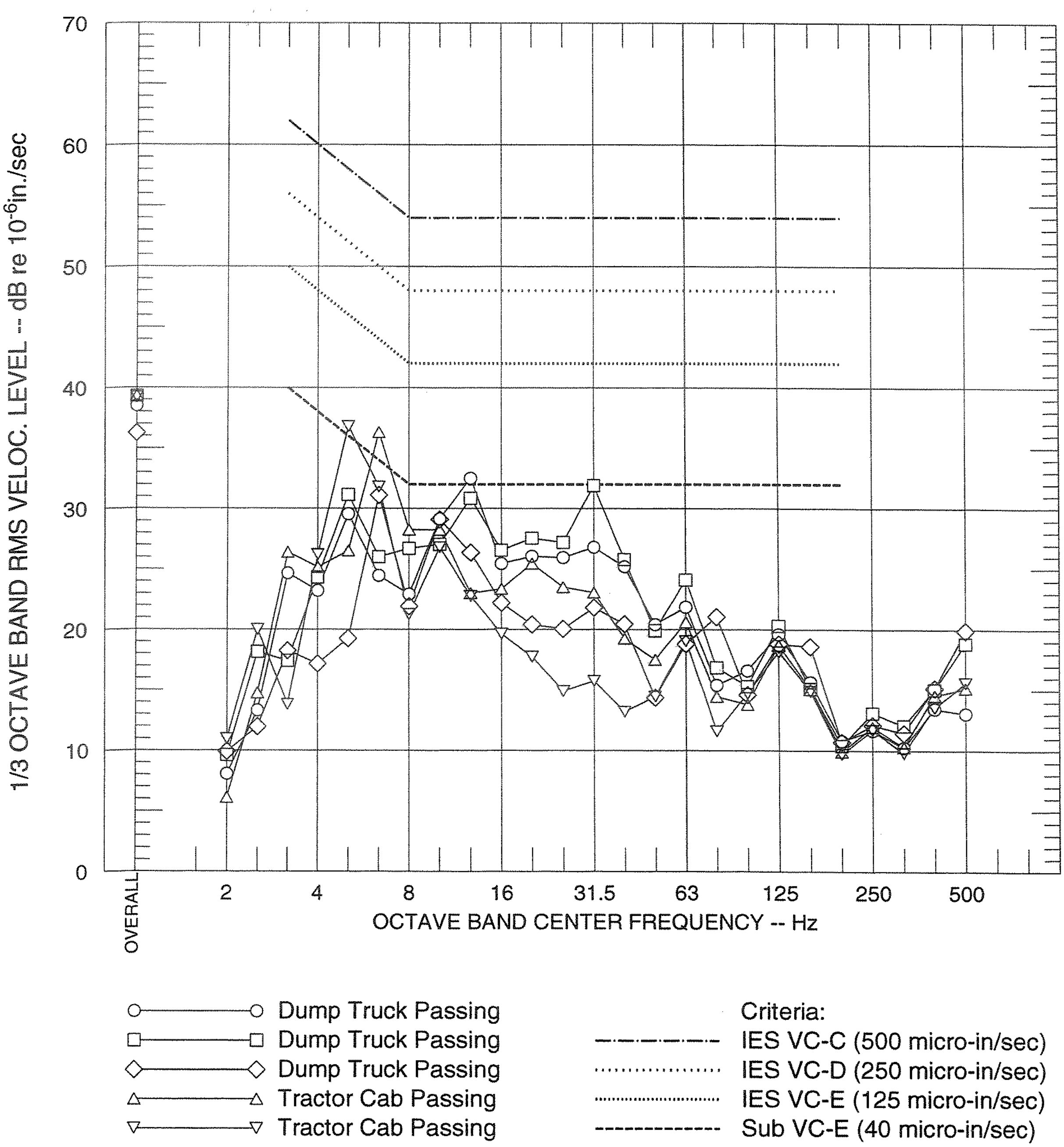


FIGURE 4C SINGLE-EVENT VIBRATION LEVELS AT POSITION 1
CH.3 - HORIZONTALLY PERPENDICULAR TO BEAM HALL (TRANSVERSE)
STREET LEVEL - EAST

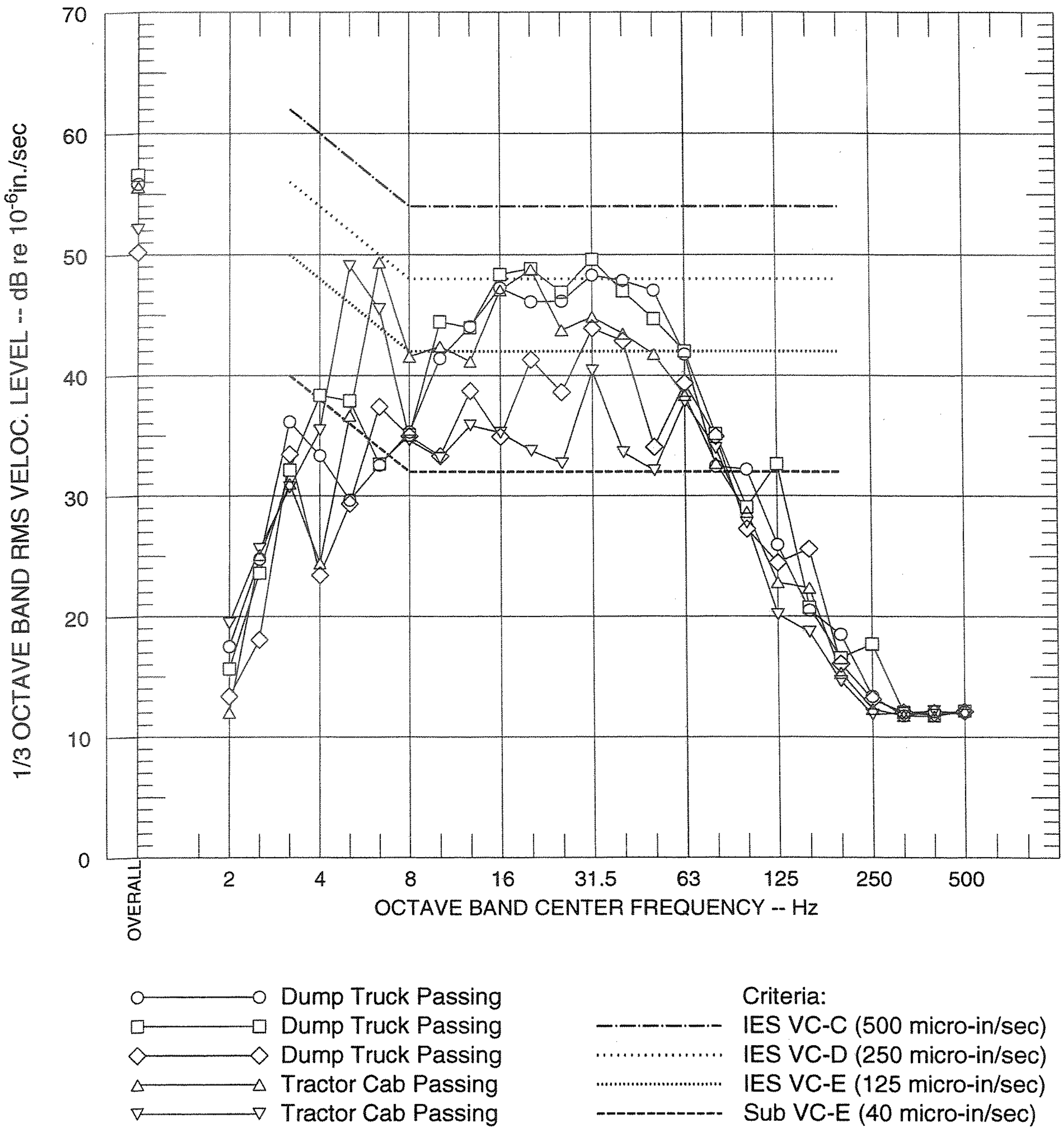


FIGURE 4D SINGLE-EVENT VIBRATION LEVELS AT POSITION 1
CH.4 - VERTICALLY PERPENDICULAR TO BEAM HALL (at 2 m)
STREET LEVEL - EAST

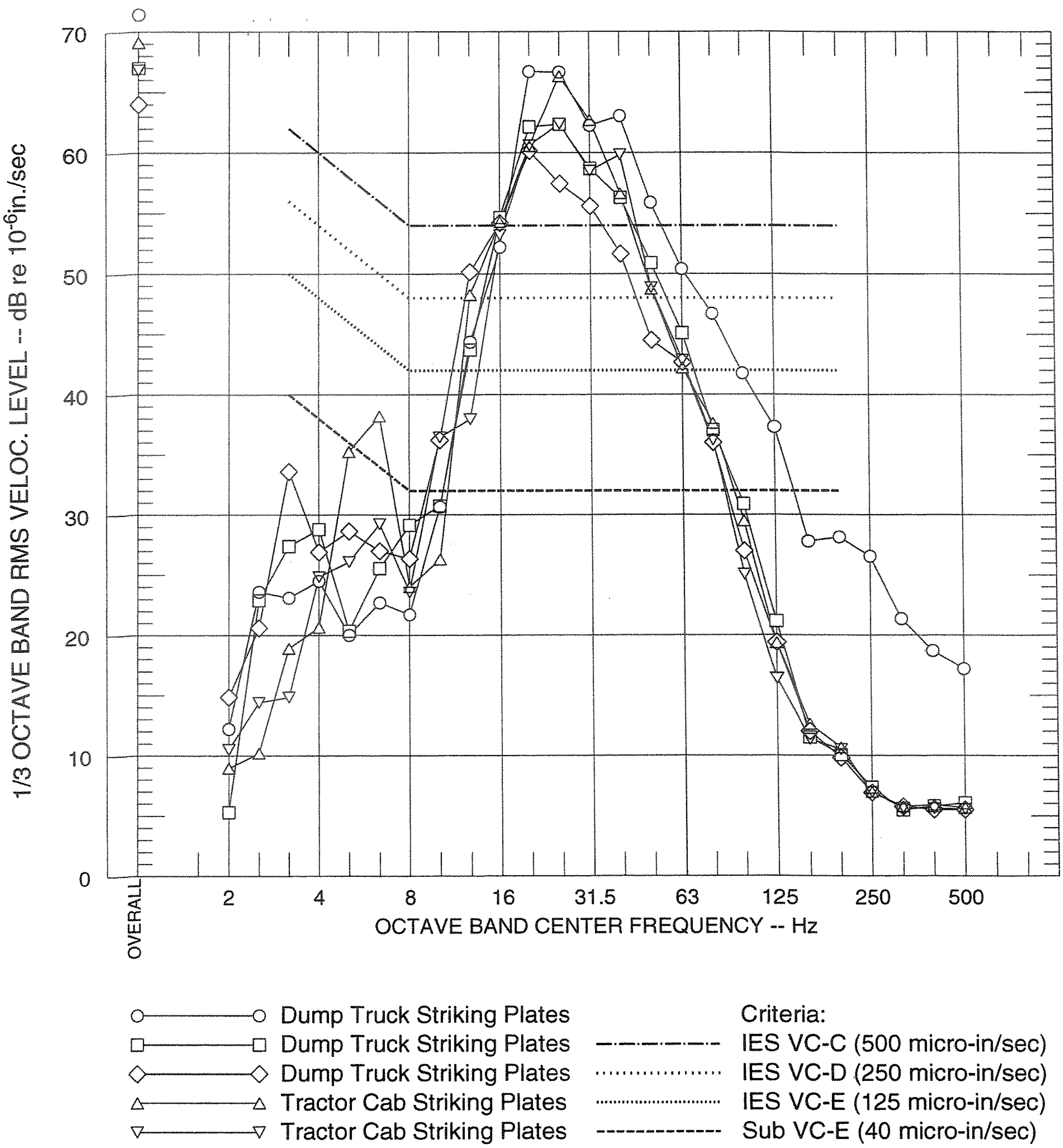


FIGURE 5A SINGLE-EVENT VIBRATION LEVELS AT POSITION 1
CH.1 - VERTICALLY PERPENDICULAR TO BEAM HALL
STREET LEVEL - EAST

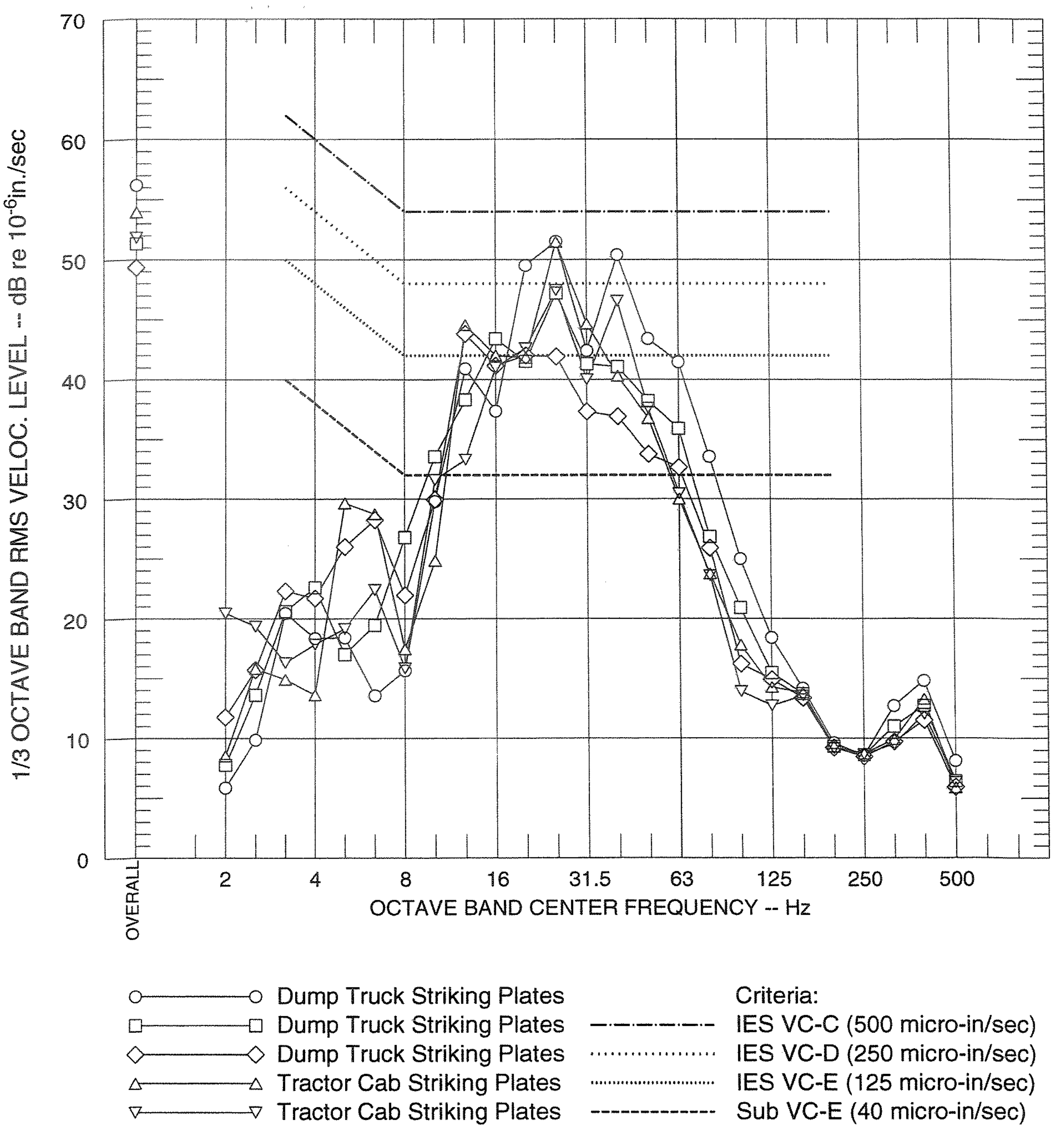


FIGURE 5B SINGLE-EVENT VIBRATION LEVELS AT POSITION 1
CH.2 - PARALLEL TO BEAM HALL
STREET LEVEL - EAST

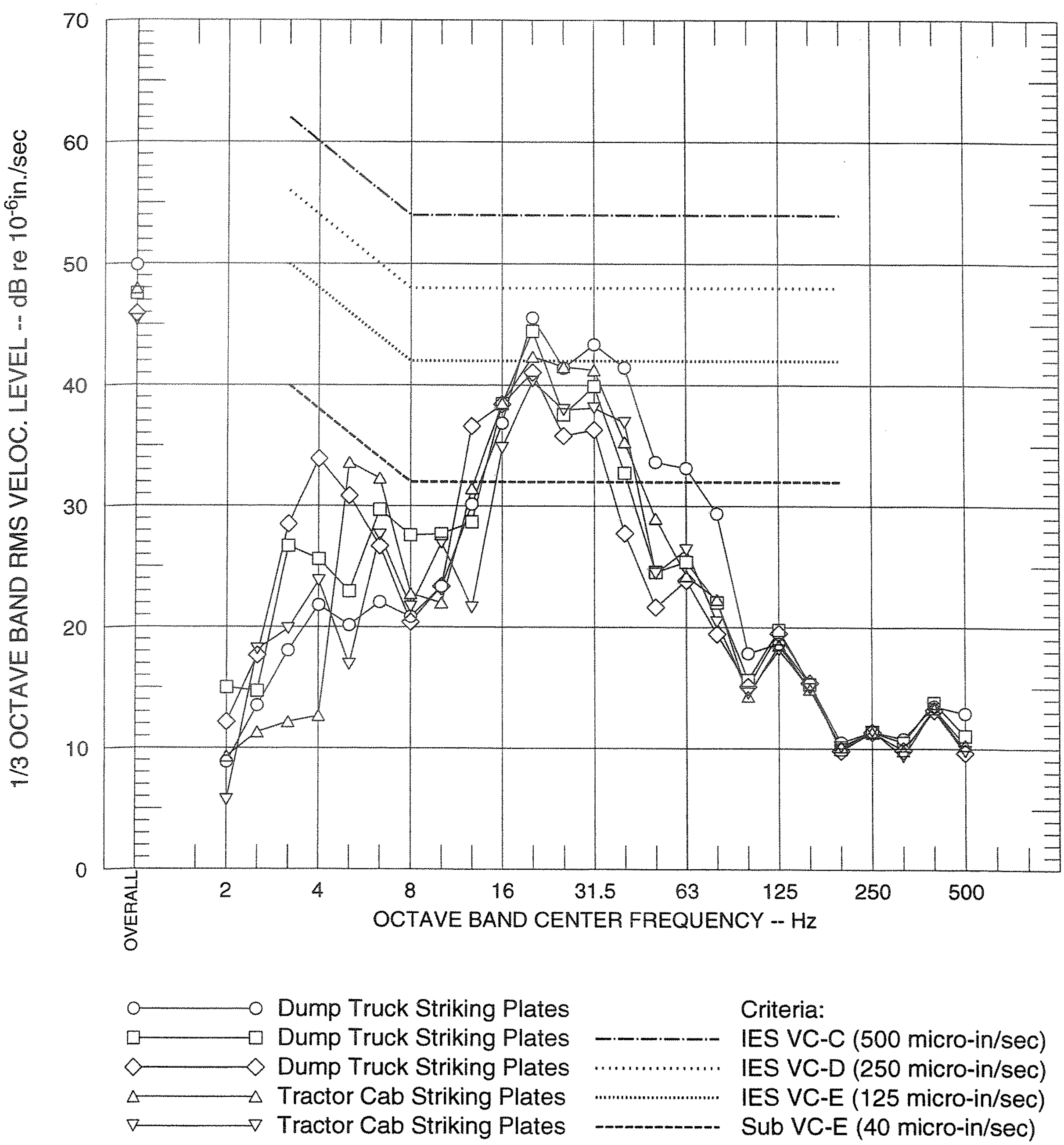


FIGURE 5C SINGLE-EVENT VIBRATION LEVELS AT POSITION 1
CH.3 - HORIZONTALLY PERPENDICULAR TO BEAM HALL (TRANSVERSE)
STREET LEVEL - EAST

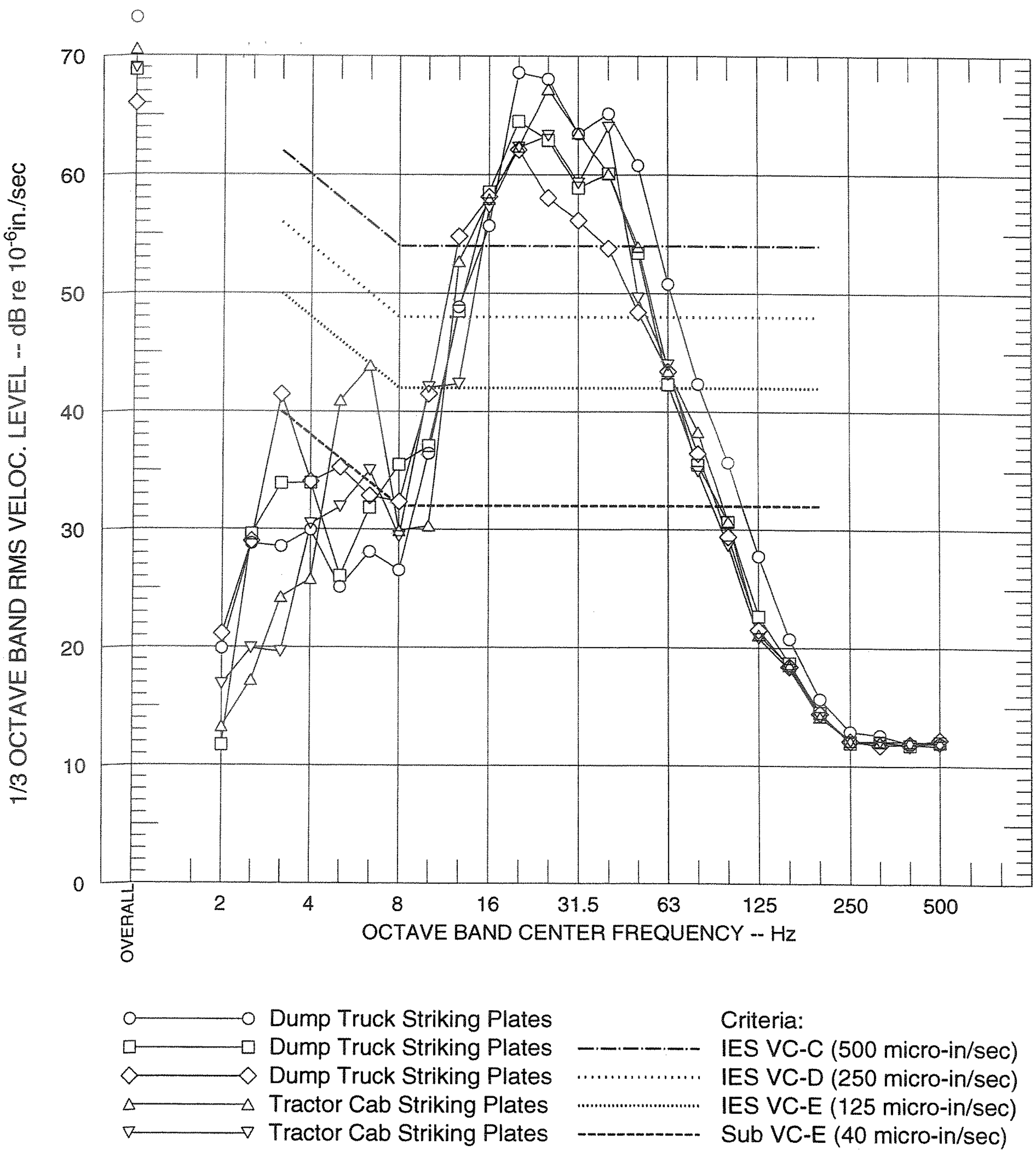


FIGURE 5D SINGLE-EVENT VIBRATION LEVELS AT POSITION 1
CH.4 - VERTICALLY PERPENDICULAR TO BEAM HALL (at 2 m)
STREET LEVEL - EAST

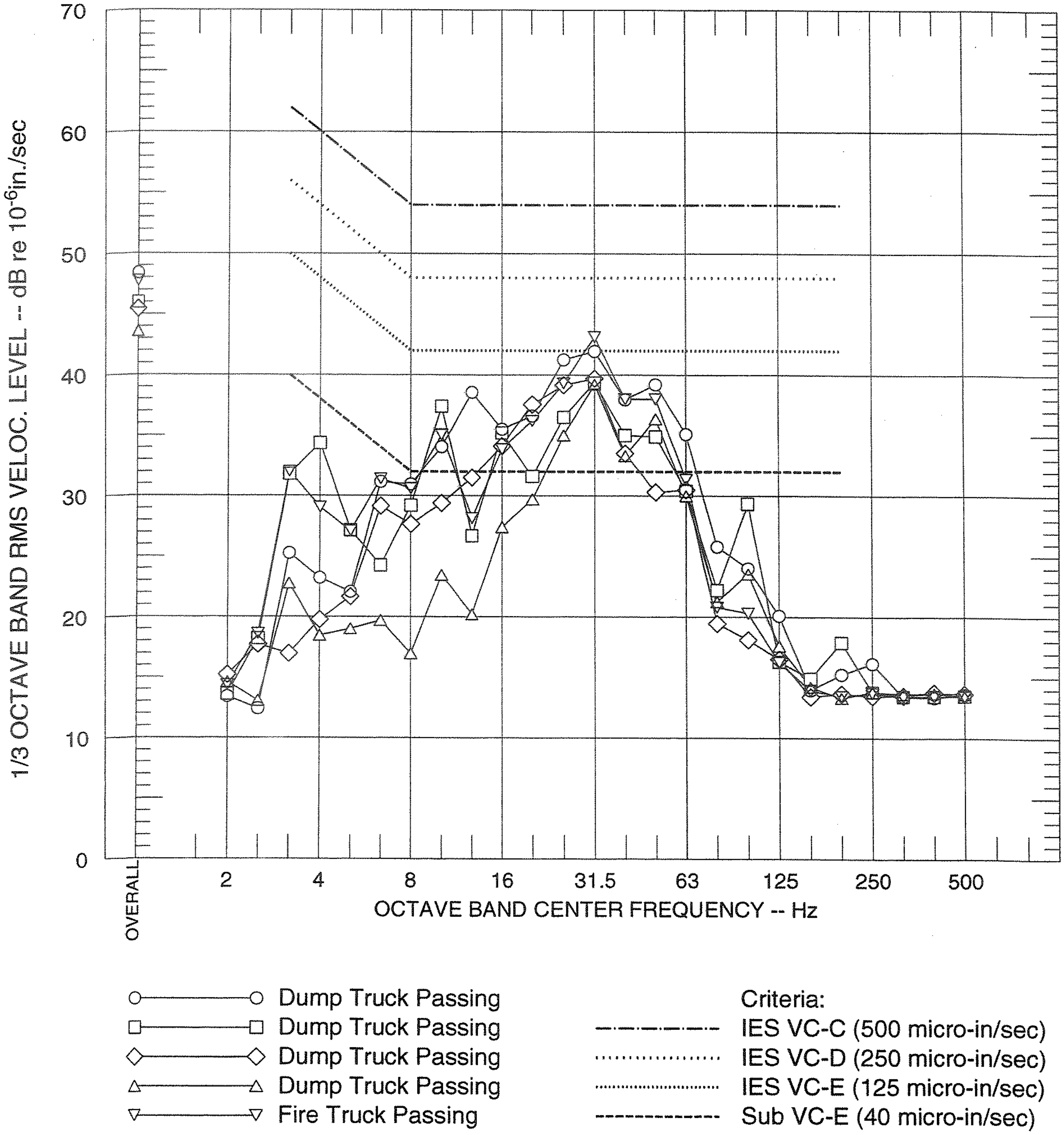


FIGURE 6A SINGLE-EVENT VIBRATION LEVELS AT POSITION 2
CH.1 - VERTICALLY PERPENDICULAR TO BEAM HALL
STREET LEVEL - WEST

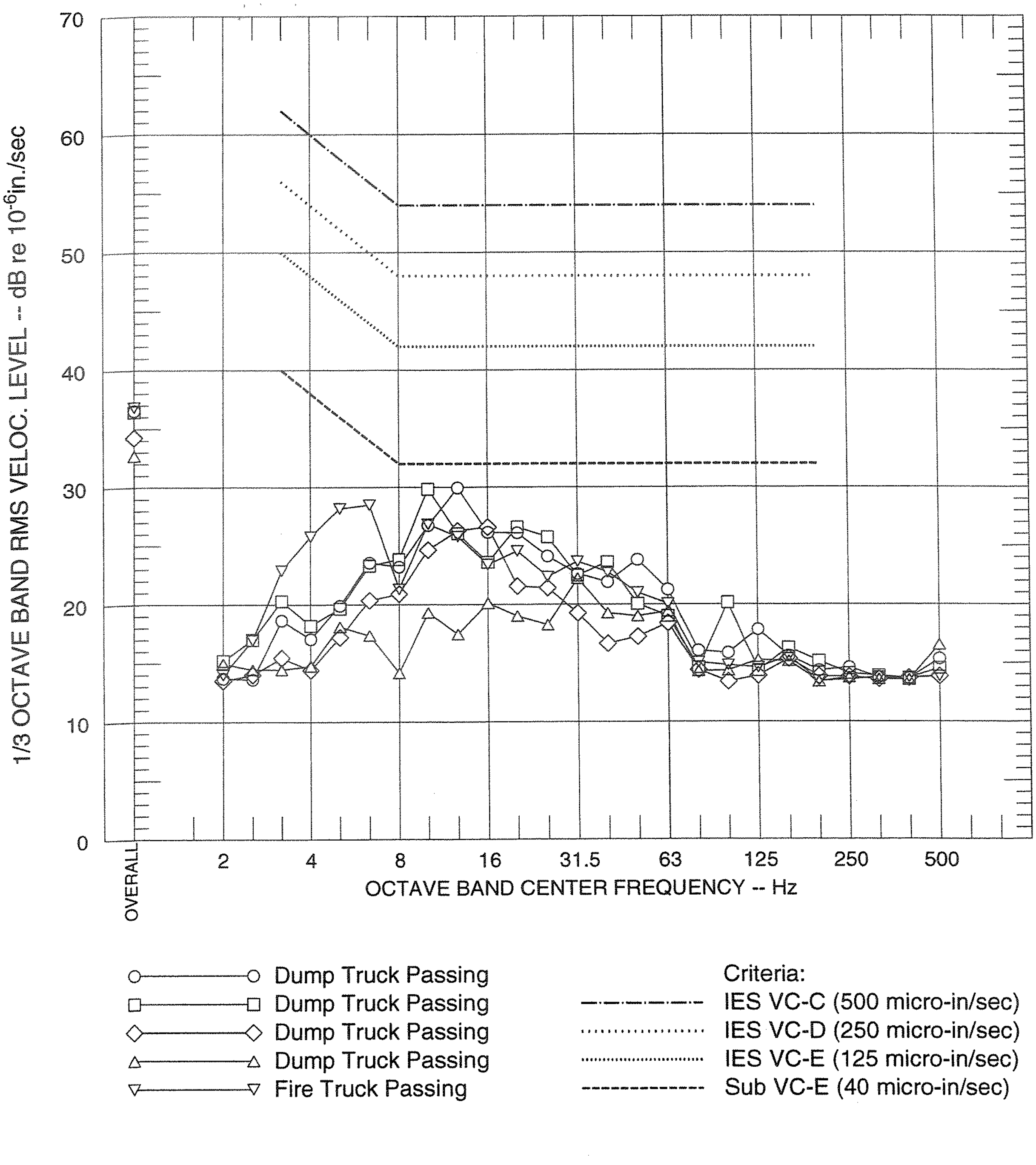


FIGURE 6B SINGLE-EVENT VIBRATION LEVELS AT POSITION 2
CH.2 - PARALLEL TO BEAM HALL
STREET LEVEL - WEST

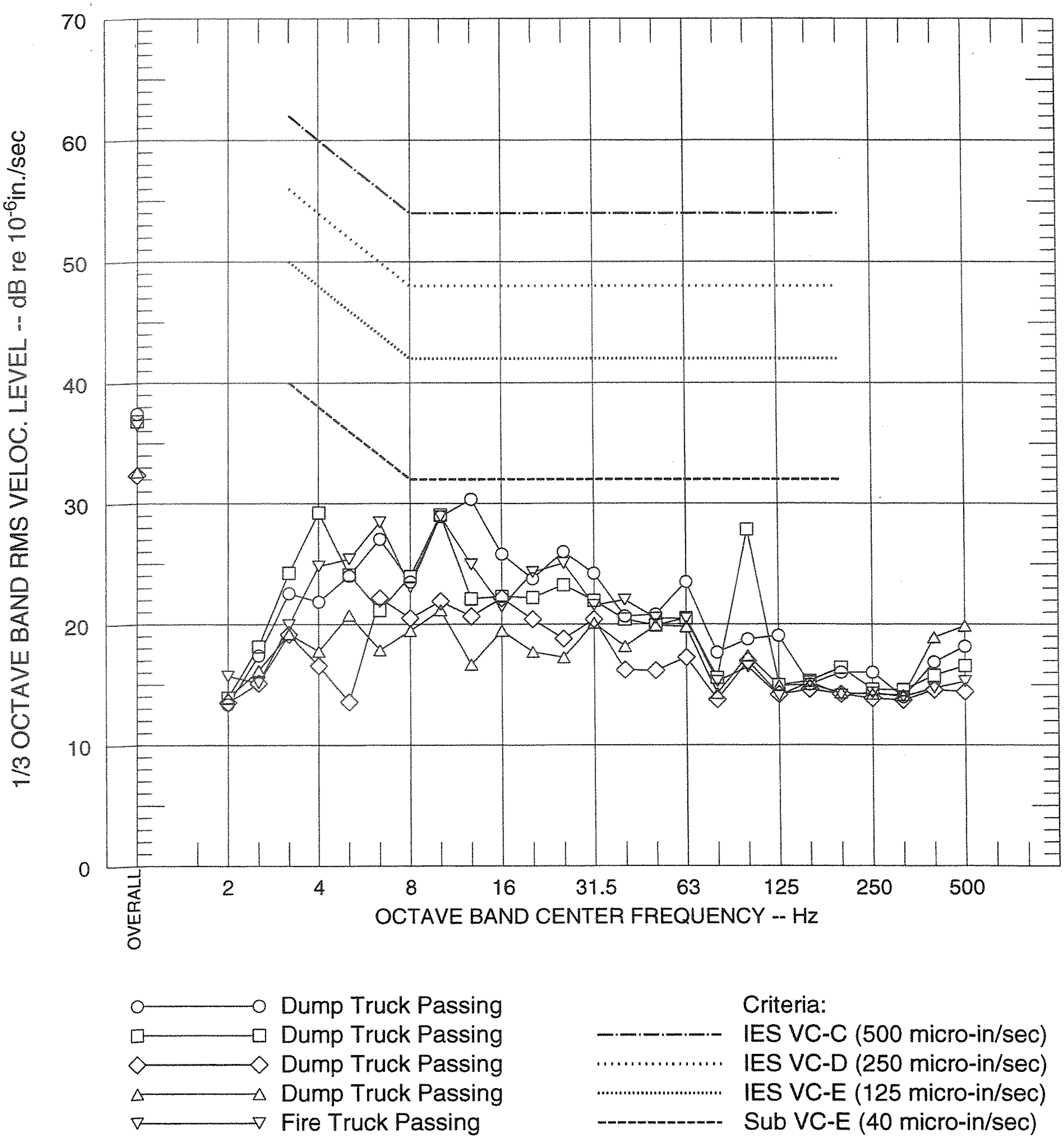


FIGURE 6C SINGLE-EVENT VIBRATION LEVELS AT POSITION 2
CH.3 - HORIZONTALLY PERPENDICULAR TO BEAM HALL (TRANSVERSE)
STREET LEVEL - WEST

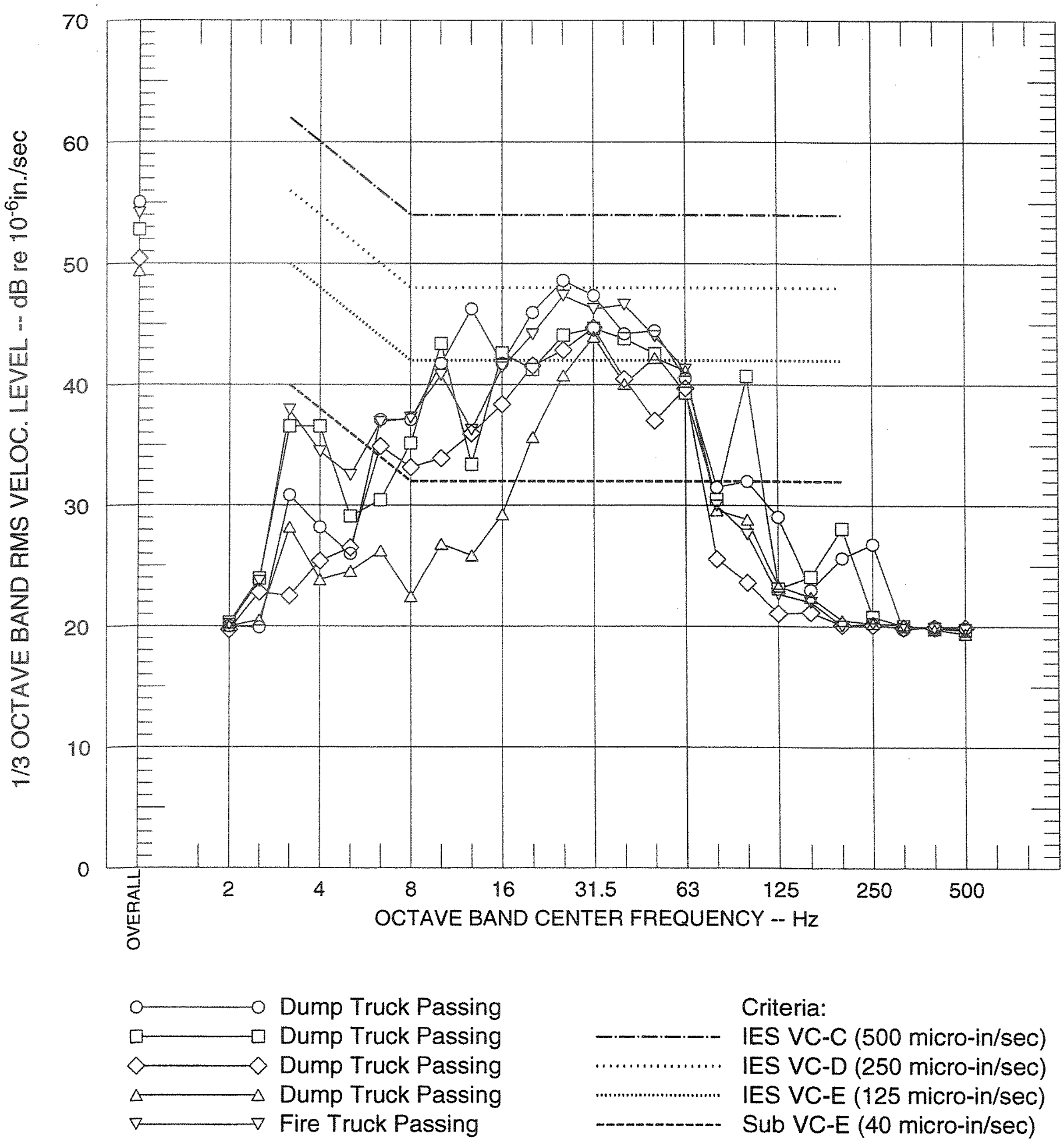


FIGURE 6D SINGLE-EVENT VIBRATION LEVELS AT POSITION 2
CH.4 - VERTICALLY PERPENDICULAR TO BEAM HALL (at 2 m)
STREET LEVEL - WEST

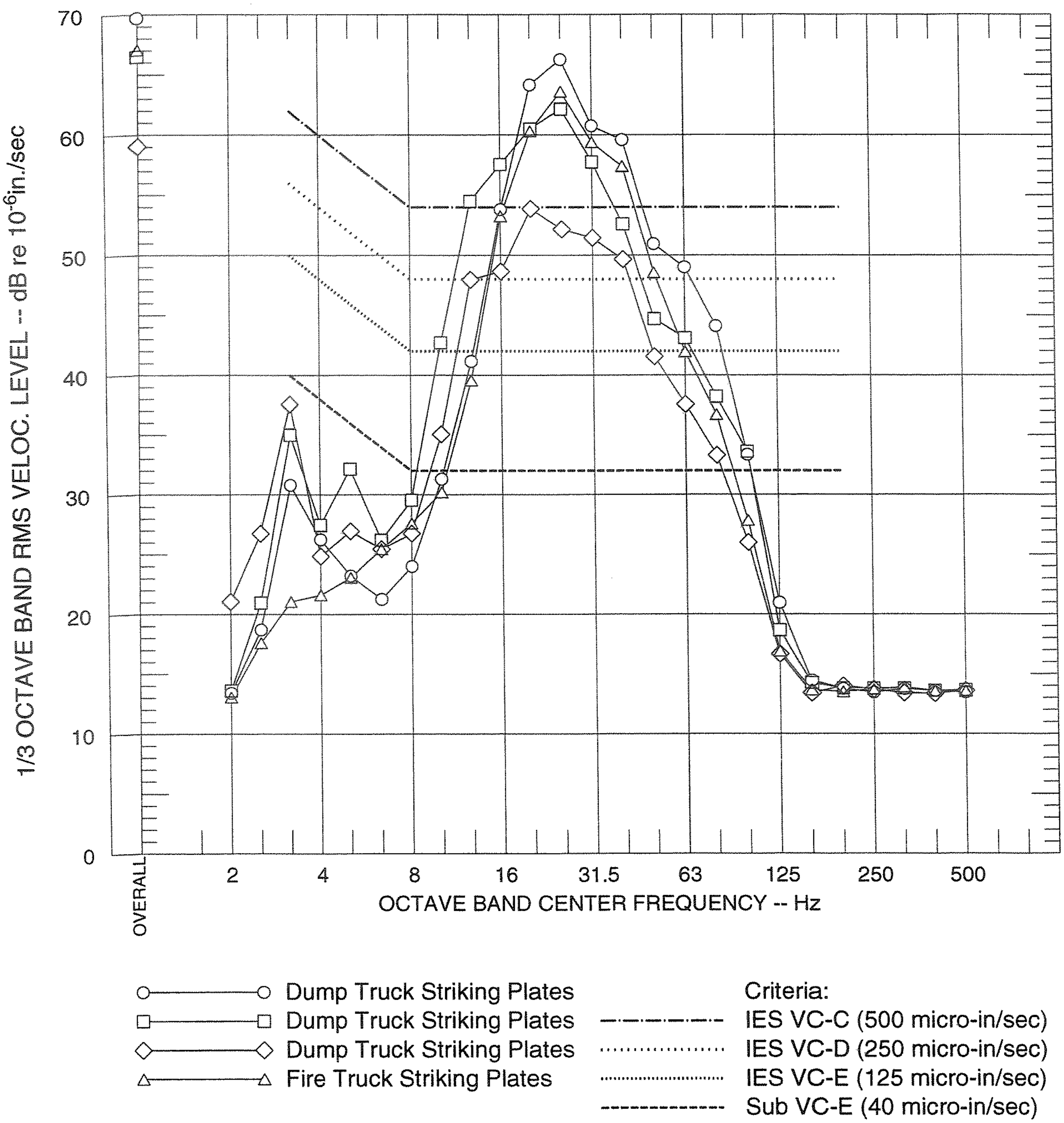


FIGURE 7A SINGLE-EVENT VIBRATION LEVELS AT POSITION 2
CH.1 - VERTICALLY PERPENDICULAR TO BEAM HALL
STREET LEVEL - WEST

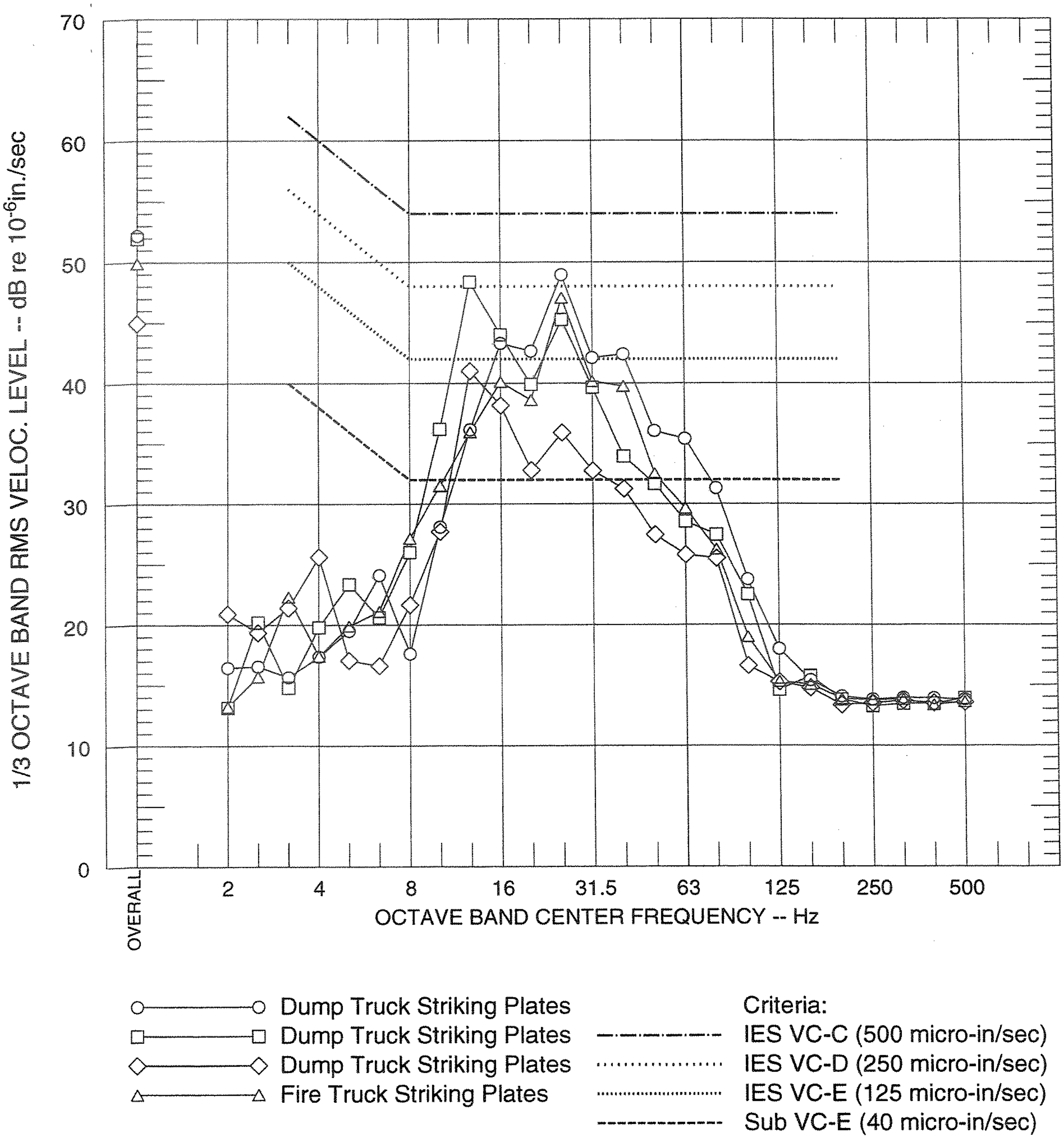


FIGURE 7B SINGLE-EVENT VIBRATION LEVELS AT POSITION 2
CH.2 - PARALLEL TO BEAM HALL
STREET LEVEL - WEST

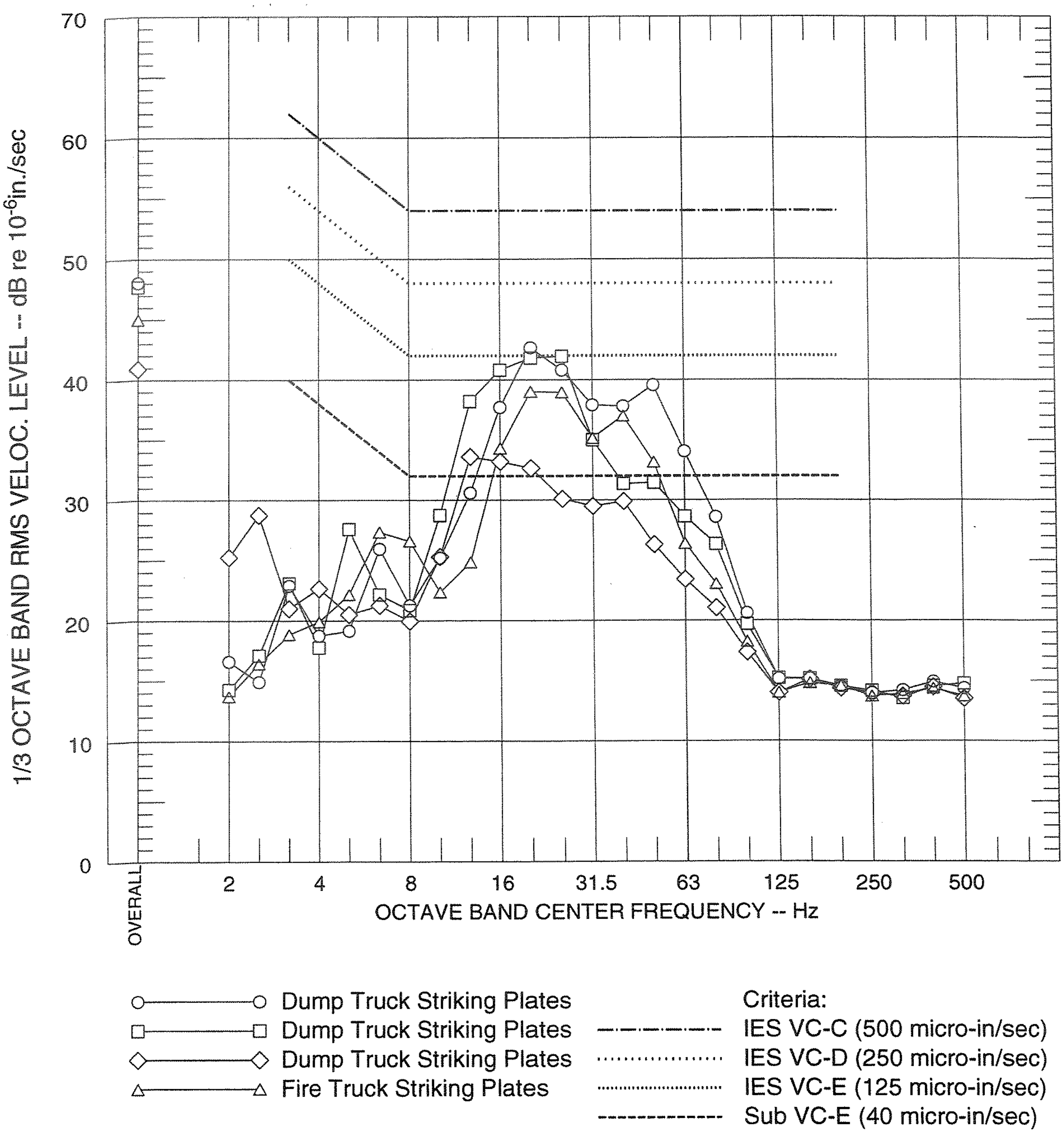


FIGURE 7C SINGLE-EVENT VIBRATION LEVELS AT POSITION 2
CH.3 - HORIZONTALLY PERPENDICULAR TO BEAM HALL (TRANSVERSE)
STREET LEVEL - WEST

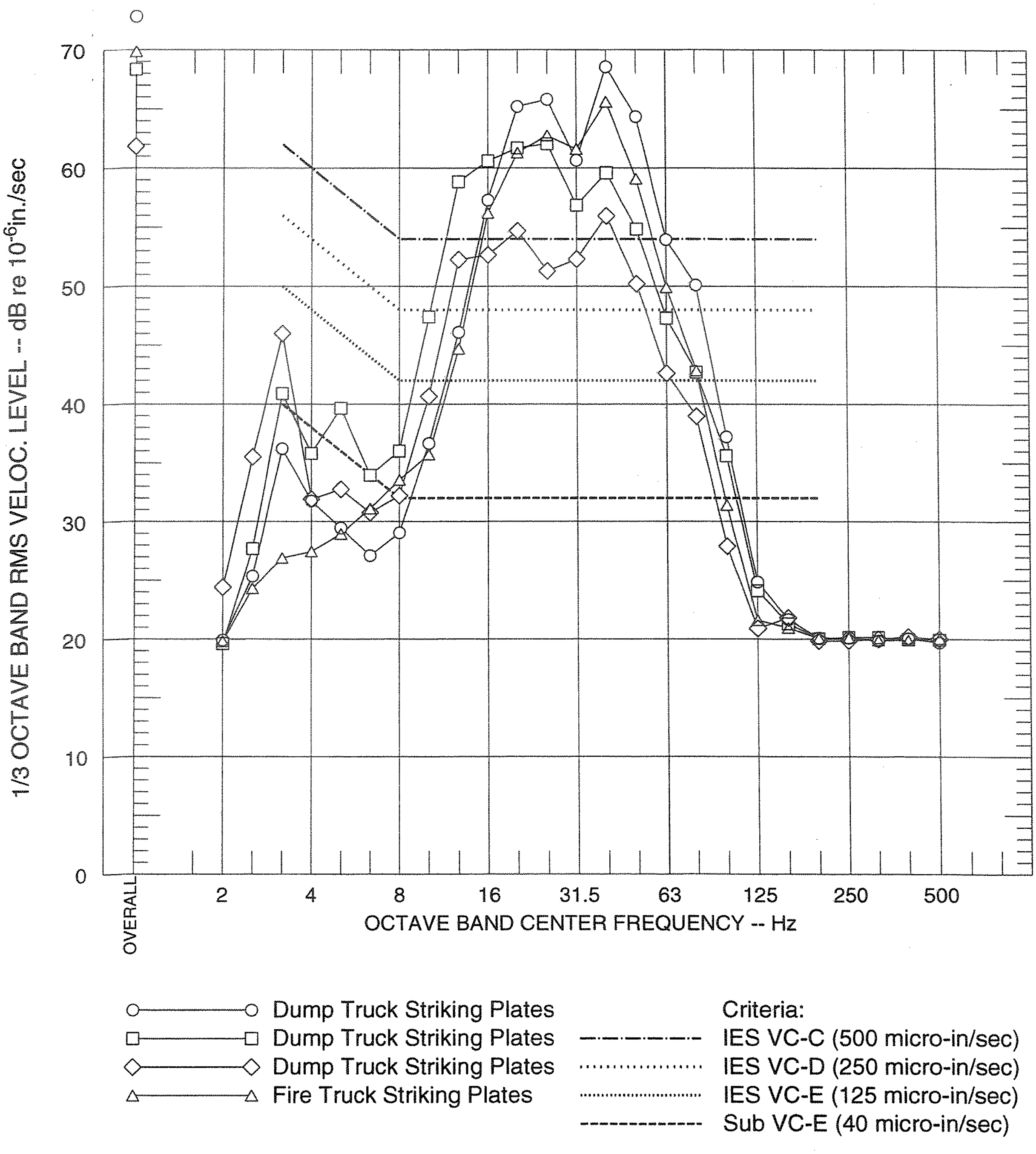


FIGURE 7D SINGLE-EVENT VIBRATION LEVELS AT POSITION 2
CH.4 - VERTICALLY PERPENDICULAR TO BEAM HALL (at 2 m)
STREET LEVEL - WEST

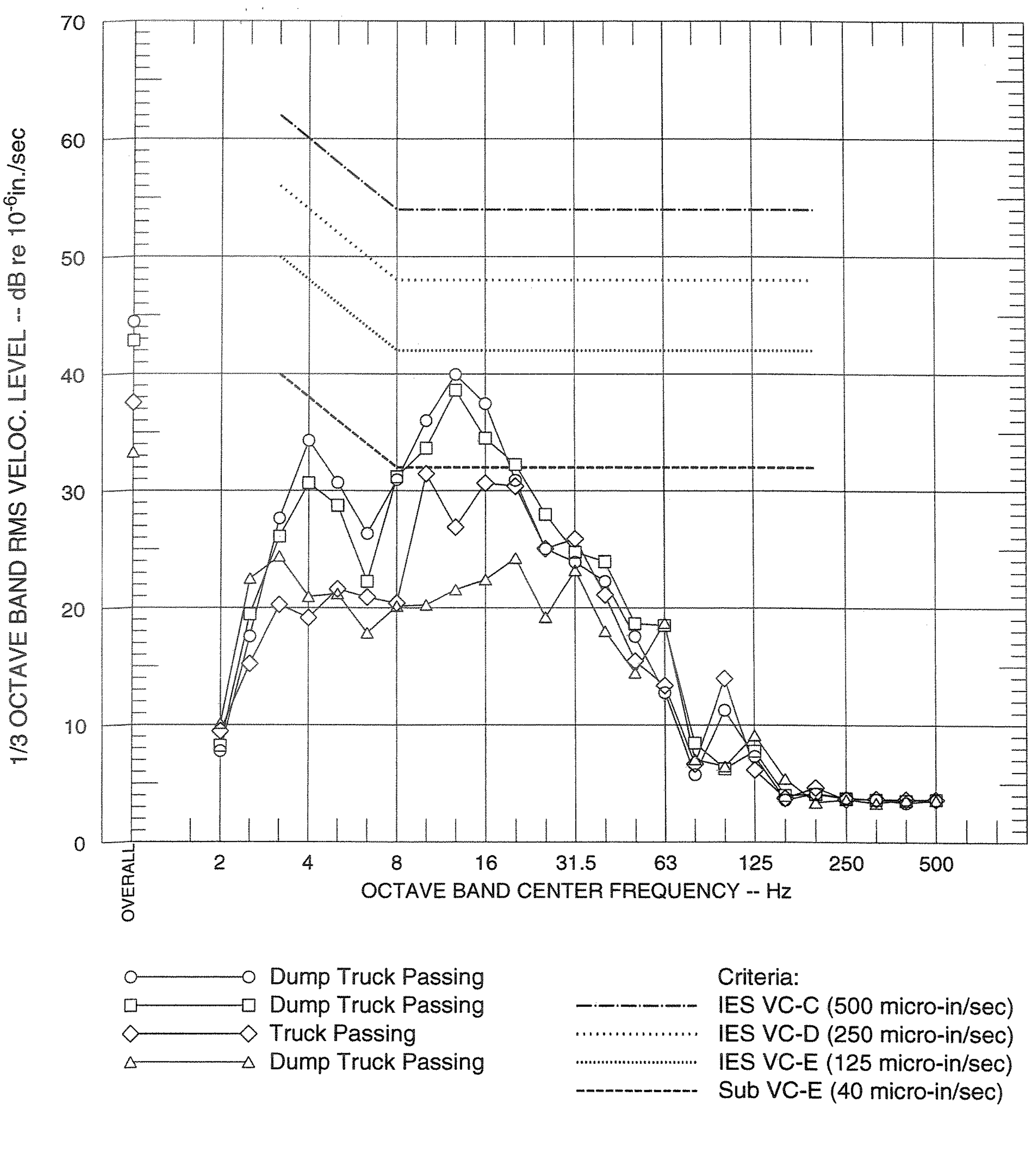


FIGURE 8A SINGLE-EVENT VIBRATION LEVELS AT POSITION 3
CH.1 - VERTICALLY PERPENDICULAR TO BEAM HALL
LOWER LEVEL - INJECTOR HALL

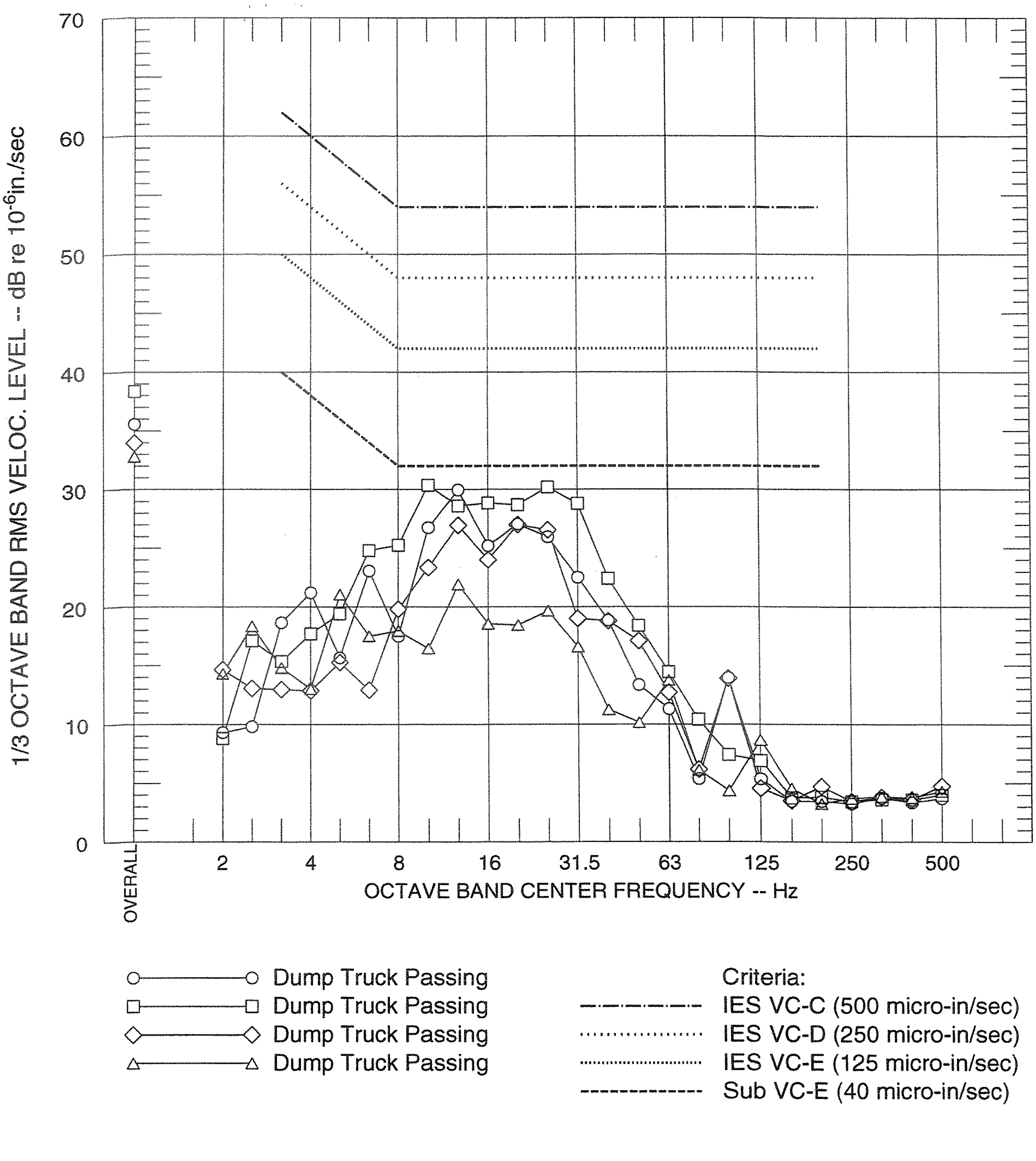


FIGURE 8B SINGLE-EVENT VIBRATION LEVELS AT POSITION 3
CH.2 - PARALLEL TO BEAM HALL
LOWER LEVEL - INJECTOR HALL

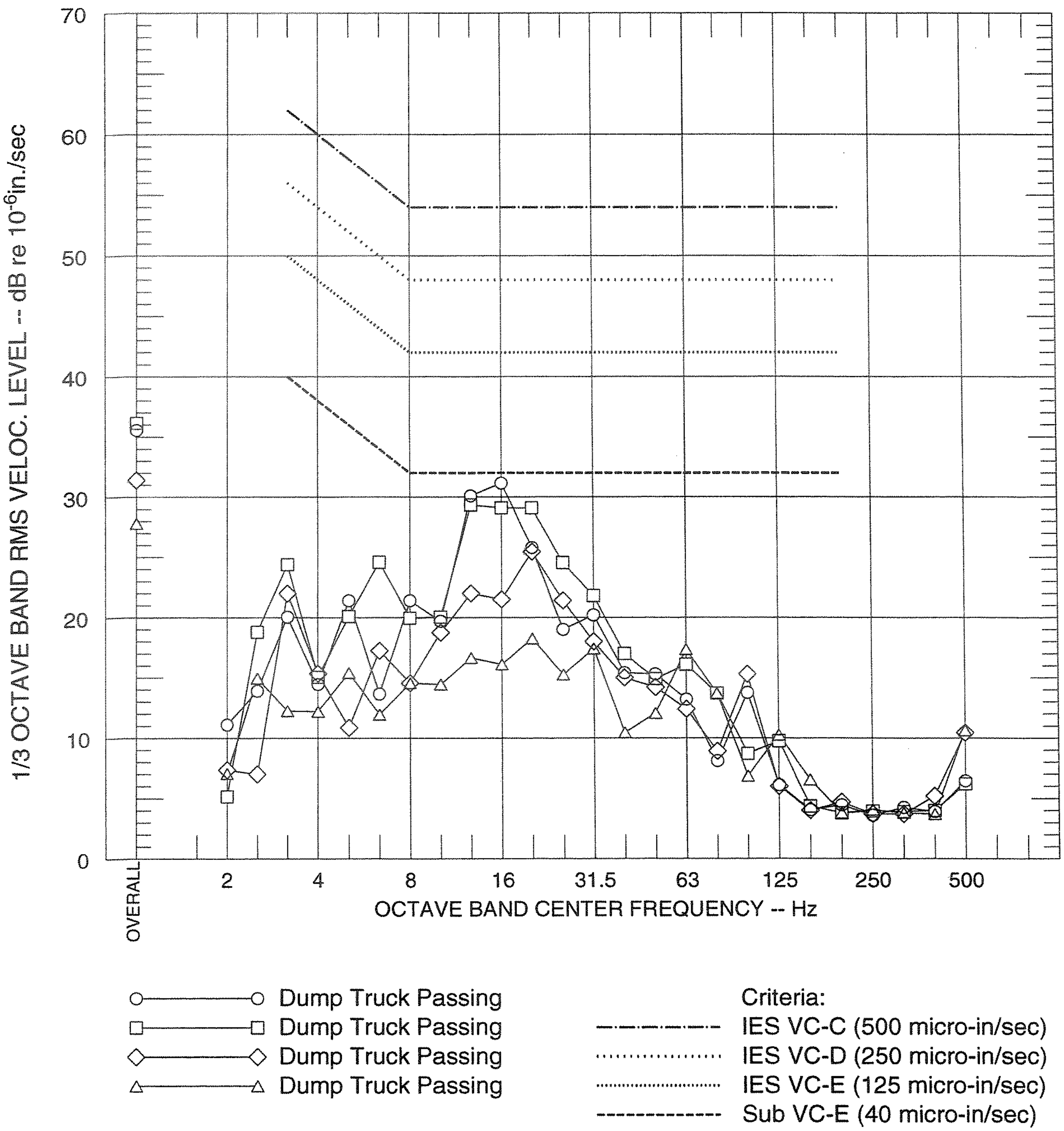


FIGURE 8C SINGLE-EVENT VIBRATION LEVELS AT POSITION 3
CH.3 - HORIZONTALLY PERPENDICULAR TO BEAM HALL (TRANSVERSE)
LOWER LEVEL - INJECTOR HALL

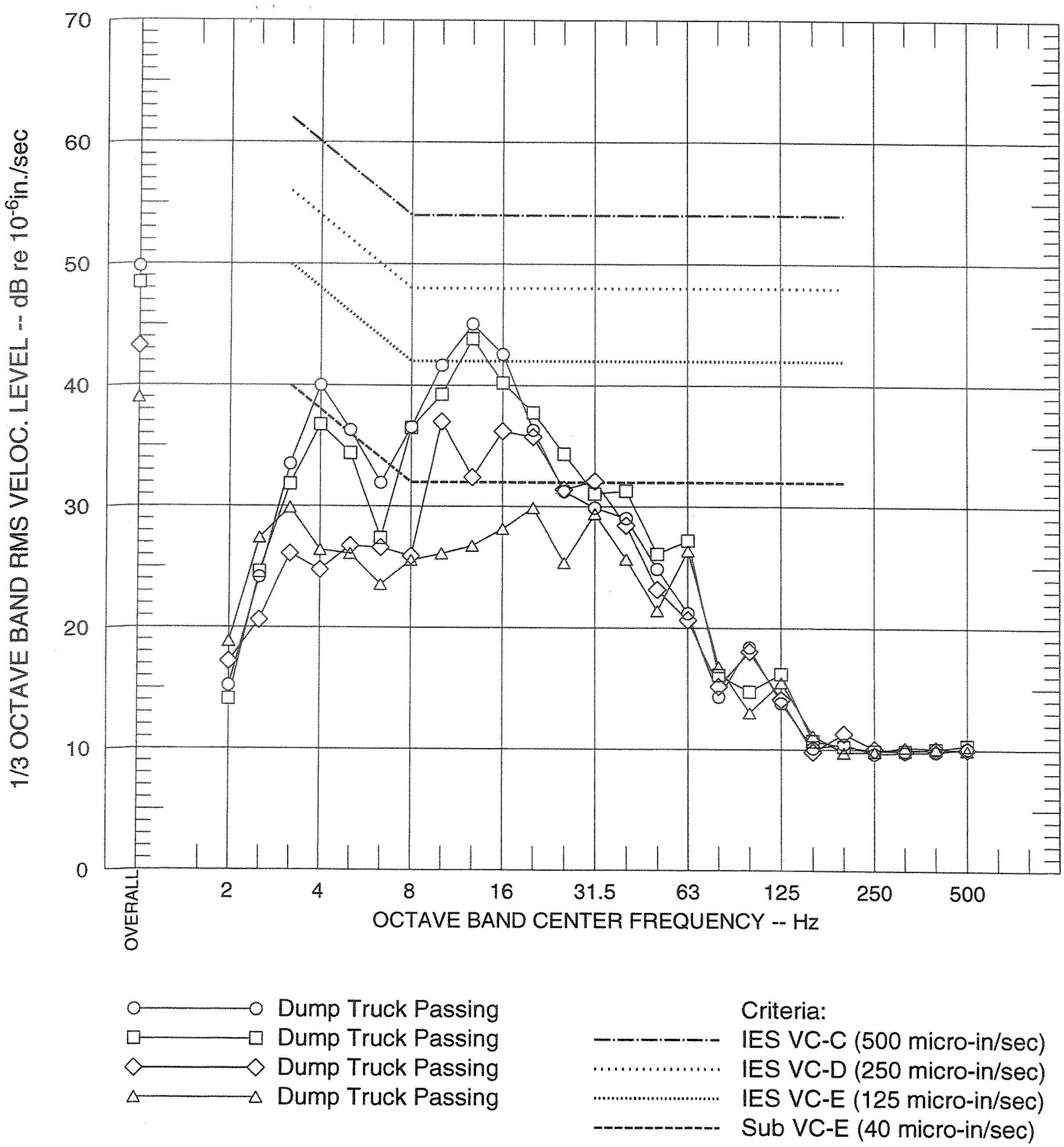


FIGURE 8D SINGLE-EVENT VIBRATION LEVELS AT POSITION 3
CH.4 - VERTICALLY PERPENDICULAR TO BEAM HALL (at 1 m)
LOWER LEVEL - INJECTOR HALL

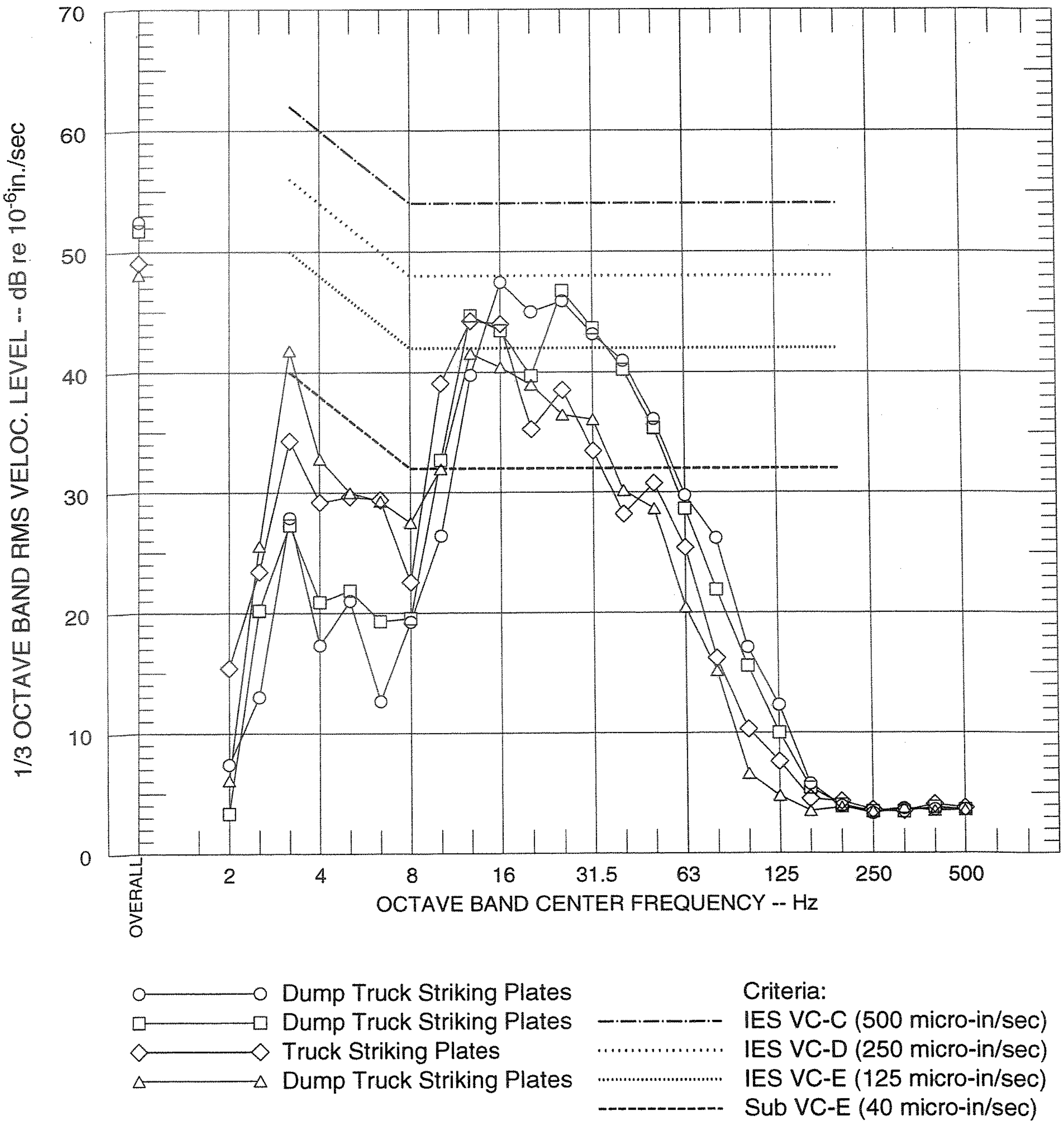


FIGURE 9A SINGLE-EVENT VIBRATION LEVELS AT POSITION 3
CH.1 - VERTICALLY PERPENDICULAR TO BEAM HALL
LOWER LEVEL - INJECTOR HALL

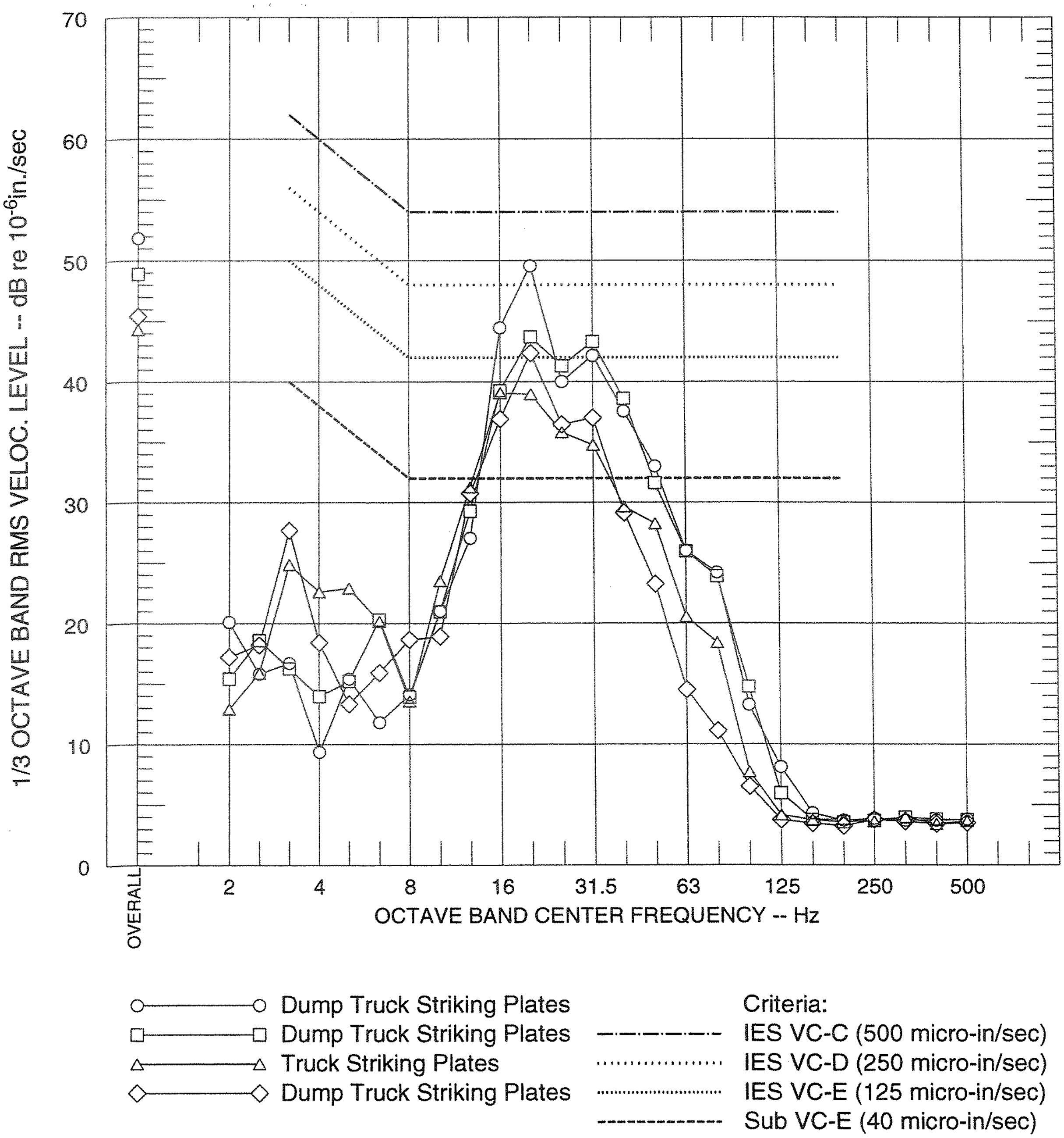


FIGURE 9B SINGLE-EVENT VIBRATION LEVELS AT POSITION 3
CH.2 - PARALLEL TO BEAM HALL
LOWER LEVEL - INJECTOR HALL

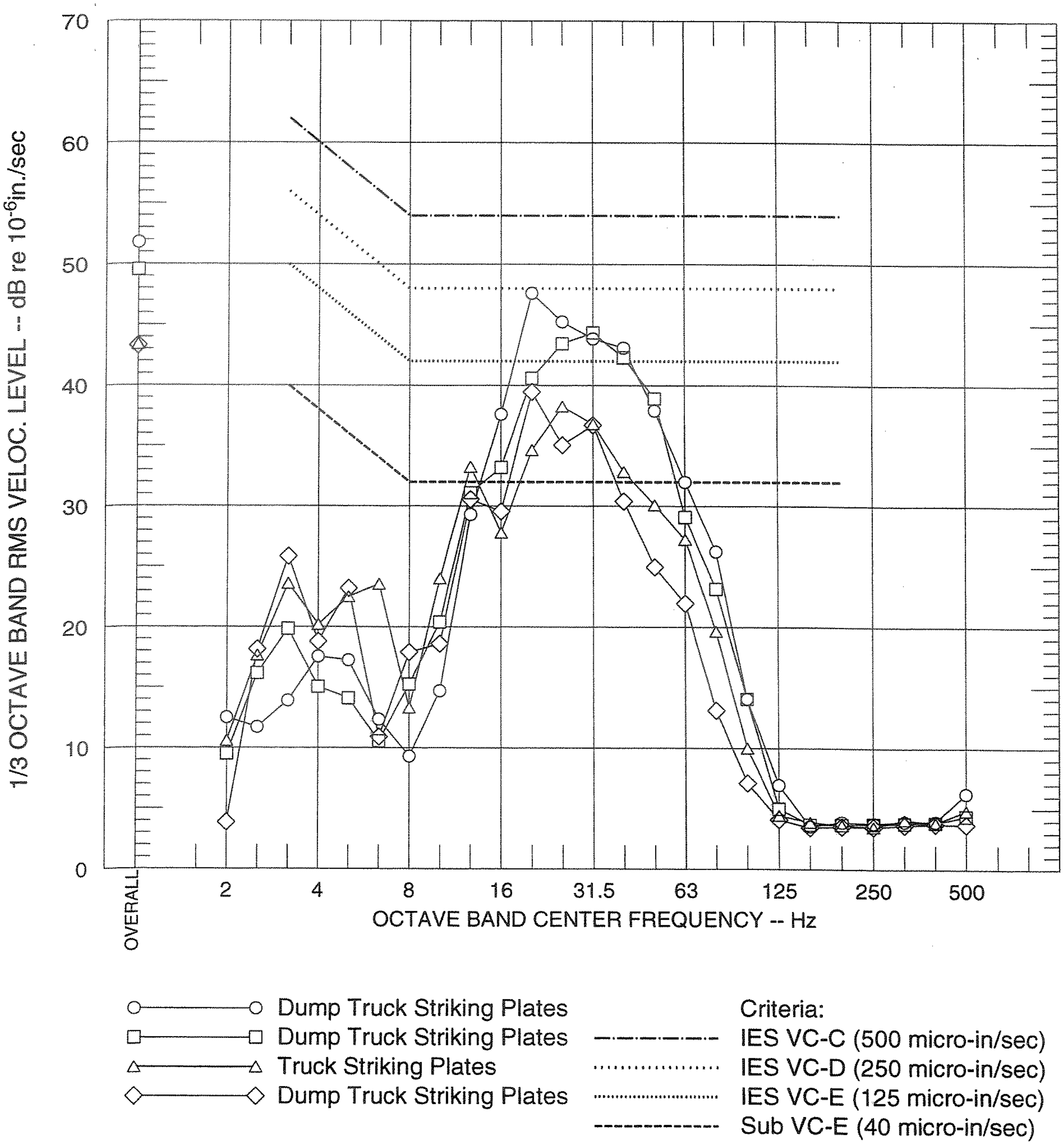


FIGURE 9C SINGLE-EVENT VIBRATION LEVELS AT POSITION 3
CH.3 - HORIZONTALLY PERPENDICULAR TO BEAM HALL (TRANSVERSE)
LOWER LEVEL - INJECTOR HALL

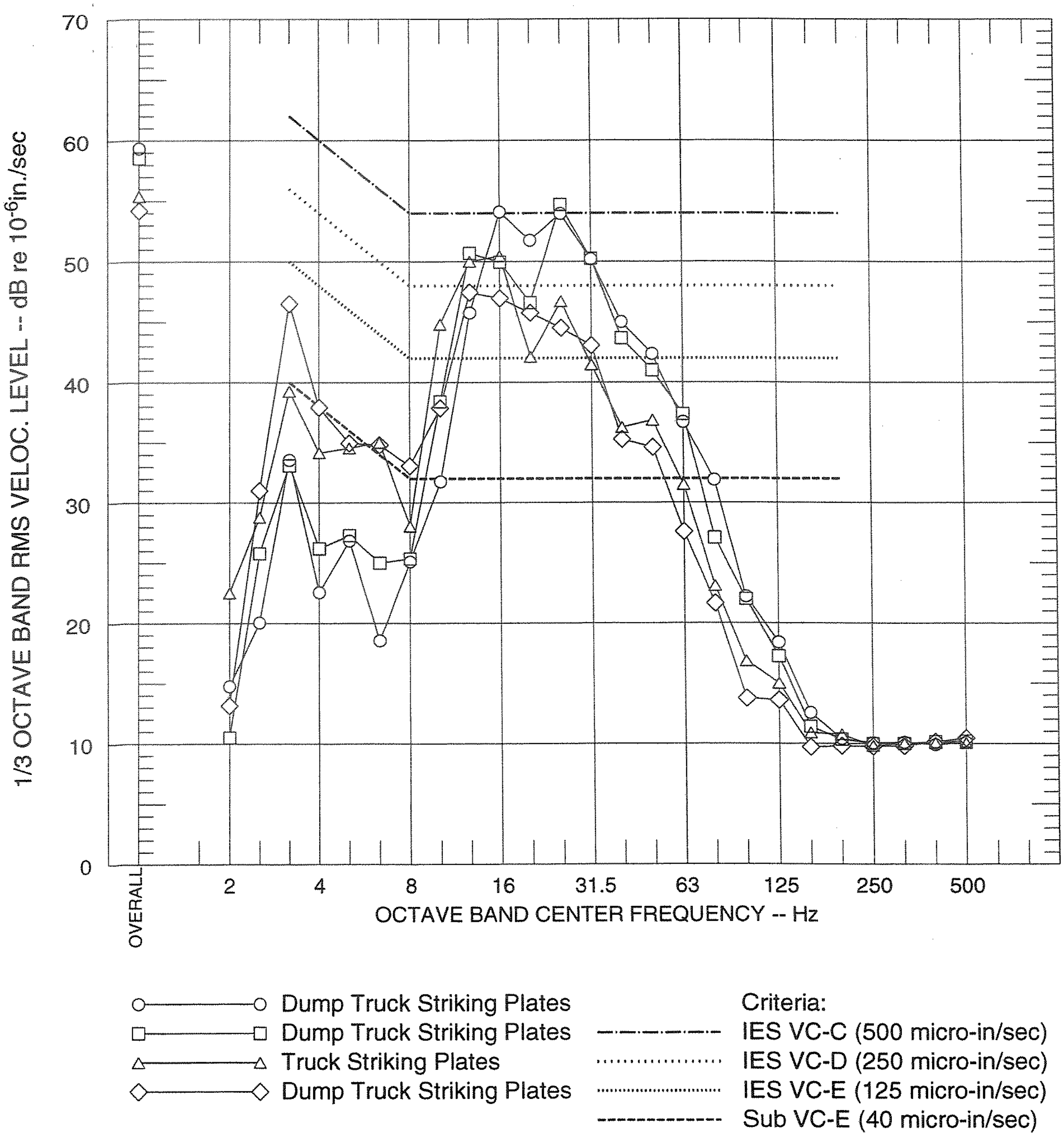


FIGURE 9D SINGLE-EVENT VIBRATION LEVELS AT POSITION 3
CH.4 - VERTICALLY PERPENDICULAR TO BEAM HALL (at 1 m)
LOWER LEVEL - INJECTOR HALL

APPENDIX A

FIGURE A-1: SECTOR 20 VIBRATION MEASUREMENT POSITIONS - STREET LEVEL POSITIONS 1 & 2

FIGURE A-2: SECTOR 20 VIBRATION MEASUREMENT POSITION - LOWER LEVEL (INJECTOR HALL) POSITION 3

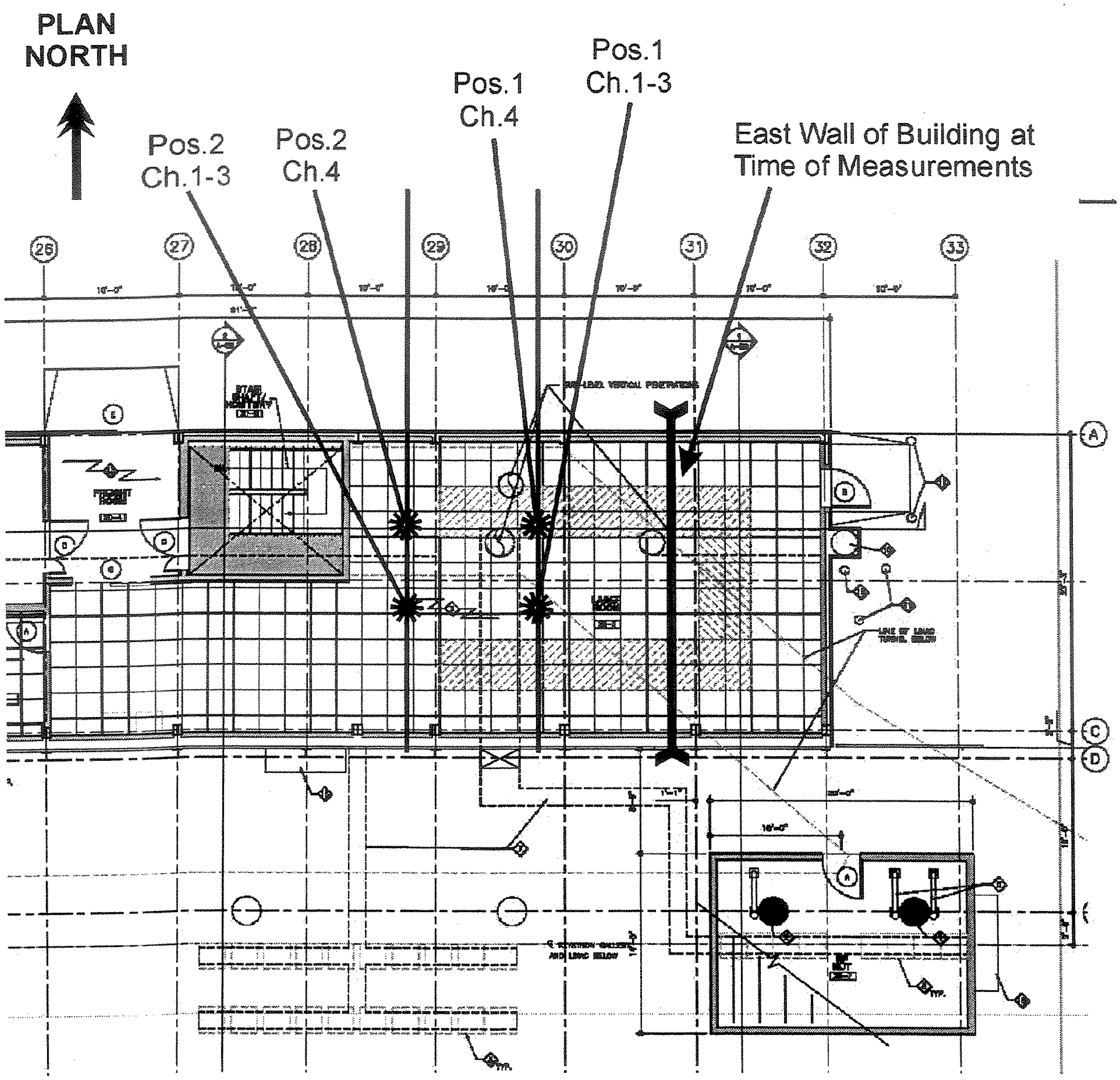


FIGURE A-1 SECTOR 20 VIBRATION MEASUREMENT POSITIONS - STREET LEVEL POSITIONS 1 & 2

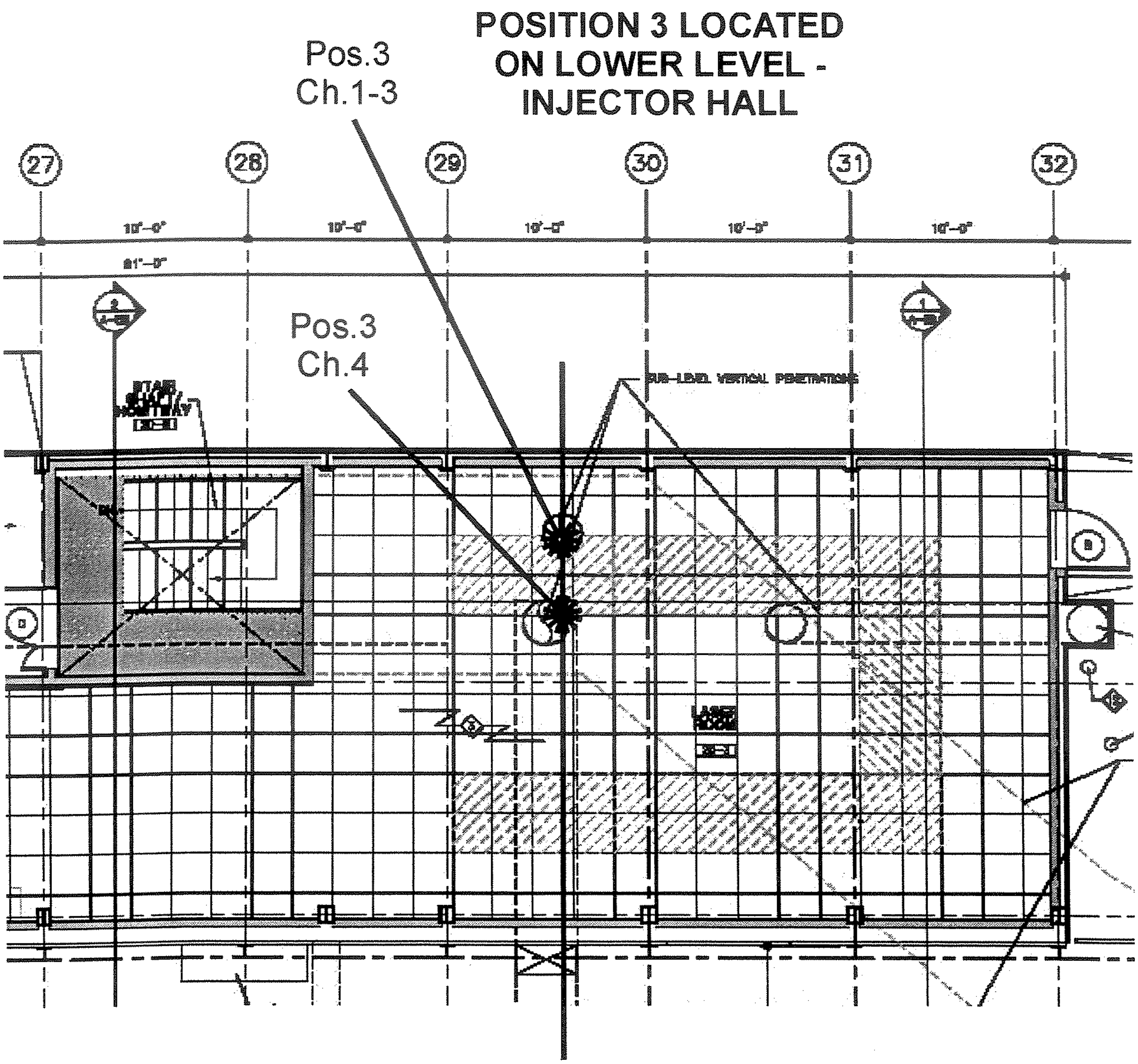


FIGURE A-2 SECTOR 20 VIBRATION MEASUREMENT POSITION - LOWER LEVEL (INJECTOR HALL) POSITION 3

APPENDIX B

FIELD EQUIPMENT USED FOR OBTAINING VIBRATION MEASUREMENTS

Channel	Accelerometer	Decade Amplifier
1 (vertical)	Wilcoxon Research Type 731, S/N 111	WIA Type 222, S/N 2, Ch. 1
2 (parallel to beam)	Wilcoxon Research Type 731, S/N 112	WIA Type 222, S/N 2, Ch. 2
3 (horizontally perpendicular to beam)	Wilcoxon Research Type 731, S/N 348	WIA Type 222, S/N 5, Ch. 1
4 (vertical, at 1 or 2 m from Ch.1)	Wilcoxon Research Type 731A, S/N 1810	WIA Type 222, S/N 5, Ch. 2

All of the vibration data were recorded on a Teac Model RD 135T 8-channel digital tape recorder, S/N 723884.

Vibration measuring systems are checked prior to field use and calibrated in the WIA laboratory with a shaker and simultaneous measurement between the seismic accelerometers and a reference accelerometer used solely for this purpose. The reference accelerometer used for this purpose is a Kistler Type 808K, S/N 849, which was most recently calibrated by Odin Metrology on October 10, 2002. This calibration is traceable to NIST Test No. 822/263351-00 and certified through 24 August 2004.

APPENDIX C

GLOSSARY AND SIGNIFICANCE OF ACOUSTICS AND VIBRATION TERMINOLOGY

A-Weighted Sound Level (dBA):

The sound pressure level in decibels as measured on a sound level meter using the internationally standardized A-weighting filter or as computed from sound spectral data to which A-weighting adjustments have been made. A-weighting de-emphasizes the low and very high frequency components of the sound in a manner similar to the response of the average human ear. A-weighted sound levels correlate well with subjective reactions of people to noise and are universally used for community noise evaluations.

Accelerometer:

A vibration sensitive transducer that responds to the vibration acceleration of a surface to which it is attached. The electronic signal generated by an accelerometer is directly proportional to the surface acceleration.

Acceleration Level:

Also referred to as the "vibration acceleration level". Vibration acceleration is the rate of change of the speed and direction of a vibration. An accelerometer generates an electronic signal that is proportional to the vibration acceleration of the surface to which it is attached. The acceleration level is 20 times the logarithm to the base 10 of the ratio of the RMS value of the acceleration to the reference acceleration. The generally accepted reference vibration acceleration is 10^{-6} g (10^{-5} m/sec).

Airborne Sound:

Sound that travels through the air, as opposed to structure-borne sound.

Ambient Noise:

The prevailing general noise existing at a location or in a space, which usually consists of a composite of sounds from many sources near and far.

Background Noise:

The general composite non-recognizable noise from all distant sources, not including nearby sources or the source of interest. Generally background noise consists of a large number of distant noise sources and can be characterized by L_{90} or L_{99}.

Community Noise Equivalent Level (CNEL):

The L_{eq} of the A-weighted noise level over a 24-hour period with a 5 dB penalty applied to noise levels between 7 p.m. and 10 p.m. and a 10 dB penalty applied to noise levels between 10 p.m. and 7 a.m.

Day-Night Sound Level (L_{dn}):

The L_{eq} of the A-weighted noise level over a 24-hour period with a 10 dB penalty applied to noise levels between 10 p.m. and 7 a.m.

Decibel (dB):

The decibel is a measure on a logarithmic scale of the magnitude of a particular quantity (such as sound pressure, sound power, sound intensity) with respect to a standardized quantity.

Energy Equivalent Level (L_{eq}):

The level of a steady noise which would have the same energy as the fluctuating noise level integrated over the time period of interest. L_{eq} is widely used as a single-number descriptor of environmental noise. L_{eq} is based on the logarithmic or energy summation and it places more emphasis on high noise level periods than does L_{50} or a straight arithmetic average of noise level over time. This energy average is not the same as the average sound pressure levels over the period of interest, but must be computed by a procedure involving summation or mathematical integration.

Frequency (Hz):

The number of oscillations per second of a periodic noise (or vibration) expressed in Hertz (abbreviated Hz). Frequency in Hertz is the same as cycles per second.

Groundborne Noise:

Noise propagated through soil and building structures. It is normally radiated by the ground in open air and by walls, floors and ceilings inside a building as a result of vibration which, after being produced by a source some distance away, travels through the soil in the form of elastic waves.

Octave Band - 1/3 Octave Band:

One octave is an interval between two sound frequencies that have a ratio of two. For example, the frequency range of 200 Hz to 400 Hz is one octave, as is the frequency range of 2000 Hz to 4000 Hz. An octave band is a frequency range that is one octave wide. A standard series of octaves is used in acoustics, and they are specified by their center frequencies. In acoustics, to increase resolution, the frequency content of a sound or vibration is often analyzed in terms of 1/3 octave bands, where each octave is divided into three 1/3 octave bands.

Sound Pressure Level (SPL):

The sound pressure level of sound in decibels is 20 times the logarithm to the base of 10 of the ratio of the RMS value of the sound pressure to the RMS value of a reference sound pressure. The standard reference sound pressure is 20 micro-pascals as indicated in ANSI S1.8-1969, "Preferred Reference Quantities for Acoustical Levels".

Statistical Distribution Descriptors (L_1, L_{10}, L_{50}, L_{90}, etc):

Also called *Exceedance Levels,* they represent the level of the noise (A-weighted for environmental studies) which is exceeded a percentage of the duration of the measurement period, as denoted by the subscript. So, for instance, L_{10} is the level of the noise exceeded for 10% of the measurement period (usually 1 hour in long-term environmental studies)

L_{99} and L_{90} are descriptors of the typical minimum or "residual" background noise (or vibration) levels 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 noise sources. Generally, the prevalent source of this residual noise is distant street traffic. L_{90} and L_{99} are not strongly influenced by occasional local motor vehicle passbys. However, they can be influenced by stationary sources such as air conditioning equipment.

L_{50} represents a long-term statistical median noise level over the measurement period and does reveal the long-term influence of local traffic.

L_{10} describes typical levels or average for the maximum noise levels occurring, for example, during nearby passbys of trains, trucks, buses and automobiles, when there is relatively steady traffic. Thus, while L_{10} does not necessarily describe the typical maximum noise levels observed at a point, it is strongly influenced by the momentary maximum noise level occurring during vehicle passbys at most locations.

L_1, the noise level exceeded for 1% of the time is representative of the occasional, isolated maximum or peak level which occurs in an area. L_1 is usually strongly influenced by the maximum short-duration noise level events which occur during the measurement time period and are often determined by aircraft or large vehicle passbys.

Velocity Level:

Also referred to as the "vibration velocity level". Vibration velocity is the rate of change of displacement of a vibration. The velocity level is 20 times the logarithm to the base 10 of the ratio of the RMS value of the velocity to the reference velocity. In this report, the reported vibration velocity levels are all referenced to 10^{-6} in/sec. Above approximately 10 Hz, human response to vibration is more closely correlated to the velocity level than to the acceleration level.