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CONCORDE NOISE-INDUCED BUILDING VIBRATIONS

JOHN F. KENNEDY INTERNATIONAL AIRPORT

REPORT NUMBER 1

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Langley Research Center
Hampton, Virginia 23665

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By Staff-Langley Research Center*

SUMMARY

The NASA, in cooperation with the FAA, made measurements of noise-induced building vibrations in the vicinity of John F. Kennedy International Airport on January 18-19, 1978, as part of the Concorde monitoring program. The purpose of the study was to expand the data base developed at Dulles International Airport during the early months of Concorde operations by obtaining aircraft noise and building vibration data on typical residential structures in the New York area. The outdoor/indoor noise levels and associated vibration levels resulting from aircraft and nonaircraft events were recorded at six home sites. In addition, limited subjective tests were conducted to examine the human detection/annoyance thresholds for building vibration and rattle caused by aircraft noise. A description of the test plan and procedures along with sample data are presented in this report. A quantitative assessment of the data is currently underway and the results along with those from additional measurements at JFK will be presented in follow-on reports.

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INTRODUCTION

Measurements of aircraft noise-induced building vibrations are being conducted by the NASA as part of the DOT/FAA monitoring program to assess the environmental impact of Concorde operations at JFK (ref. 1). The purpose of this element of the monitoring program is to make a comparative assessment of the building response resulting from Concorde, subsonic aircraft, and nonaircraft events.

The approach being following in the assessment of Concorde noise-induced building vibrations involves the following steps: (1) the measurement of the vibratory response of selected buildings; (2) the development of functional relationships ("signatures") between the vibration response of building elements and the outdoor and/or indoor noise levels associated with events of interest; and (3) the comparison of Concorde-induced response with the response associated with other aircraft as well as common domestic events and/or criteria. This approach was followed by NASA in making measurements in the vicinity of Dulles International Airport during the early months of Concorde operations. Noise and vibration measurements were made at Sully Plantation, an historic site located near Dulles, and at three homes in Montgomery County, Maryland where residents had complained of building vibration. The results of these studies were published in references 2 through 5. The JFK studies are directed at expanding the data base developed at Dulles by obtaining aircraft noise and vibration data on typical residential structures for both takeoff and approach operations and, secondly, to explore in some detail human response to building vibration and rattle. This latter issue requires that the physical measurements be augmented by subjective tests to determine the level of noise and/or vibration required to produce perceptible vibration and rattle and to determine, if possible, the degree of annoyance associated with perceptible building response. The subjective tests are exploratory in nature since neither the way in which a person perceives vibration (for example, tactile, wholebody, visual) nor the dominant building stimulus elements (for example, floor, window, wall) have been studied in any detail for human response to building vibrations.

This report presents a description of the test plan and test procedures for acquiring both physical and subjective data. In addition, sample data are presented for one site to illustrate the data reduction/analysis procedures and to indicate preliminary findings in the JFK area. Follow-on monthly reports will present additional data from the January tests as well as data from any future tests at JFK.

TEST SITES

The six residential houses used for the January studies were located in the communities of Cedarhurst, Inwood, and Rosedale which are east of the airport boundary as shown on the map, figure 1. The approximate locations of the houses relative to the main runways at JFK are shown in figure 2. Test sites 1, 3, and 6 were monitored on January 18, 1978, during landing operations on runway 31R, whereas test sites 9, 10, and 11 were monitored on January 19, 1978, for Concorde landings on runway 31R and subsonic departure operations on runway 04R. Measurements were obtained at all six test sites during Concorde ground operations and departures on runway 31L. Table I is a summary of the aircraft events for which both physical and subjective measurements were obtained. In addition, several nonaircraft events were recorded at each house including people walking, jogging in place, dropping a book, closing doors and windows, ground vehicles, etc.

The houses were selected from homeowners who had volunteered to participate in this phase of the assessment program. The houses represent a range of construction typical of the neighborhoods surrounding the east boundary of the airport. The room selected for measurement in a particular house was based on information provided by the homeowner concerning maximum noise and/or vibration exposure to aircraft flyovers. Accelerometers were located on a window, wall, and in the center of the floor, and microphones were located both in the test room and outside the house.

Data are presented in this report for test site 3 which is shown in figure 3(a). The house is a two-story frame structure located in Cedarhurst. The exterior walls have a stucco finish while the interior walls are painted plaster. A plan-view sketch of the house and instrument locations are provided in figure 3(b). The living room was chosen for measuring the wall, window, and floor responses since that side of the house received the greatest exposure to aircraft overflights. The inside and outside sound pressure levels were measured using microphones located in the living room and in the yard north of the house. (See figure 3(b).)

DATA ACQUISITION AND PROCEDURES

Instrumentation

Acoustic measurements were made of both interior and exterior sound pressure levels with special low-frequency response microphones being used for the interior measurements. Vibration data were obtained from piezoelectric crystal accelerometers mounted on the window and from more sensitive, but heavier, servoaccelerometers mounted on the wall and the floor. The floor measurements consisted of the vertical and horizontal acceleration imparted to a 50 kg (110 lb) cement block which was placed in the center of the room to simulate the loading of a person. All data were recorded on analog FM tape, accommodating the low-frequency requirements, so that subsequent analysis employing specialized weighting functions could be applied as the need dictated.

For data analysis, a General Radio 1926 multichannel, true rms, log voltmeter is used to sample the analog signals and perform the analog-to-digital conversion, averaging, and logarithmic conversion on each of the analog signals. The digitized acoustic and vibration data are fed into a Hewlett-Packard 21M20 digital computer where the data are formatted into numerical or graphical form according to various requirements.

Frequency Response and Calibration

Extensive pretest documentation of all items of the acquisition systems was performed to include frequency response, deviation linearities, gain accuracies, and dynamic range. Daily calibrations in the field consisted of pink noise (exhibiting flat 1/3-octave band spectrum level) insertion in all microphone channels, a fixed sine wave reference voltage insertion into the accelerometer channels as well as a 1 g static calibration of the servo-accelerometers, and a 250 Hz piston-phone acoustic calibration of the microphone systems during pretest and posttest periods. Frequency response of the acoustic channels was nominally ± 1dB over the range 5 Hz to 10 kHz for the exterior measurement systems and 1.5 Hz to 10 kHz for the lower frequency interior measurement systems. The accelerometer channel frequency response extended from dc to approximately 1 kHz for the servoaccelerometers and from 3 Hz to in excess of 3 kHz for the piezoelectric type. Amplitude response for both systems was nominally ± 1/2dB over the applicable frequency range.

Test Procedures

Physical.- Aircraft control tower communications were monitored and aircraft spotters were located near each test house to identify aircraft as well as to control and coordinate data acquisition. Time code was recorded at each test house to provide a common time base for use in subsequent analysis of the data. Radio communications were used to obtain time synchronization between houses and for data acquisition control and calibrations at each test house.

Subjective.- Subjective tests were conducted utilizing members of the NASA Concorde monitoring team and residents of a particular test site. The members of the monitoring team participated at each house (three per day) whereas the resident subjects participated only at their own home. The subjective test sessions were approximately 1 hour in length and were scheduled to include one or more Concorde operations at each house although this was not always possible due to variations in Concorde schedules.

The instructions on test procedure and use of the rating form, along with a copy of the rating form, are contained in Appendix A. The rating form was designed to collect information on several aspects of an aircraft flyover including detection threshold of vibration, detection threshold of rattle, annoyance threshold of vibration, annoyance threshold of rattle, annoyance threshold of noise, and overall annoyance rating of the flyover. During the testing session, all subjects were seated in the room which was being monitored for indoor sound and vibration levels. For each aircraft event, the test conductor would announce the flyover number which each subject entered on his rating form. Each subject would then rate the flyover as to whether or not vibration and/or rattle was detected and whether or not the detected vibration, rattle, and noise was annoying. Also, each subject rated the overall annoyance of the flyover on a scale from 0 to 9, where "0" was defined as zero annoyance and "9" was defined as maximum annoyance. In order to correlate the subjective response data with the physical data, the test conductor recorded the time of day corresponding to each noise event which was synchronized with the physical measurement.

At the conclusion of each test session, the flyover event rating forms were collected and a posttest session rating form was administered. The instructions for the use of this form, along with a copy of the form, are contained in Appendix B. The primary purpose of this form was to determine how subjects perceived vibration and rattle and to obtain an annoyance rating of vibration, rattle, and noise. The purpose in obtaining the annoyance ratings was to assess the relative contribution of each of the three components in the subject's overall annoyance to aircraft flyovers.

RESULTS OF INITIAL DATA ANALYSIS

Scope

Noise-induced vibration measurements were made on the walls, windows, and floors of six houses in the JFK area in January 1978. It has not been possible to analyze all of these data for inclusion in the January issue of the FAA's monthly Concorde assessment report. The data available at this time are limited to outside aircraft noise levels and the resultant vibration response of a window in one of the test houses. These results are generally representative of the main body of data acquired at JFK in January and are being presented to illustrate some of the early findings in the JFK building response assessment. Follow-on reports will include detailed frequency and amplitude analyses of additional noise and vibration data as well as the results of vibration and rattle threshold detection tests described elsewhere in this report.

Analysis Procedure

Two channels of noise data (inside and outside) and four channels of vibration data (window, wall, vertical floor, and horizontal floor) were recorded on FM magnetic tape and later played back into a multichannel, true rms logarithmic ditital voltmeter. The voltmeter sampled the data and performed the analog-to-digital conversion and averaging tasks necessary to convert these signals to overall levels suitable for digital processing. Overall, that is, nonweighted noise and vibration levels were obtained in this way for each flyover. The voltmeter was interfaced to a digital computer which, with its associated peripherals, corrected the raw data for changes in gain settings and calibration levels and provided a printed time history for each flyover, listing the overall levels of noise and vibration for each of the six data channels at 1/2-second intervals. These data were then recorded on digital magnetic tape for subsequent analysis.

Preliminary Results and Discussion

Data are presented in this report in two formats. In figures 4(a) through 4(f), noise and vibration time histories are presented for representative flyovers of each of six aircraft types, including the Concorde. These figures illustrate the relationship between noise and vibration level at 1/2-second intervals during each flyover. Figures 5(a) through 5(f) and figure 6 present data in the form of vibration/noise "signatures," and illustrate how vibration levels change as a function of outdoor noise level. With the exception of the Concorde, which represents a single event, each of the signatures presented in figures 5 and 6 contain data from several flyovers of a given type aircraft and, thus, represent a composite signature describing the response of the test structure to all recorded flyovers of the indicated aircraft type.

A number of observations can be made from these data. The time histories reveal that the highest vibration levels recorded on the window generally did not occur at exactly the same time as the highest noise levels (recorded in the front yard). This suggests that "shadow effects" resulted in a differential loading of the outside microphone and the window accelerometer. That is, the outdoor microphone and the window accelerometer may not have been exposed to exactly the same noise levels at every instant of the flyover. This differential loading phenomenon was also observed during the Dulles Concorde assessment and was reported in reference 1. The window was on the side of the house facing the general direction of the airport (figure 3) and the location of the outdoor microphone was such that during approaches to JFK, the window and microphone were generally exposed to the same noise field during the latter part of each flyover, just after the aircraft passed overhead. The time histories in figures 4(a) through 4(f) (all approaches) indicate that the vibration levels measured on the window follow the outdoor noise levels quite well, especially in the last half of the flyover, when the differential loading effect was a minimum. Table II lists average peak values of noise and window vibration recorded at this test site.

The data presented in figures 5(a) through 5(f) were taken from the latter part of each of the flyovers recorded at the test house, while the microphone and the accelerometer were in the same noise field. The small spread in the data which comprises these signatures suggest that there is relatively little variation in the response of the window when it is exposed to the same noise level from the same aircraft type, under similar flight conditions. As a result, the composite signatures are used instead of single-event signatures as the basis for making interaircraft response comparisons which will be discussed below. Table III lists the slope, y-intercept, and correlation coefficient for each of the composite response signatures presented in figure 5.

The composite response signatures of figure 5 are overlaid in figure 6 to facilitate interaircraft comparisons. The data points in this figure are from the Concorde signature. Figure 6 indicates that, for a given noise level, the vibration levels induced in the window by the Concorde under approach conditions are not markedly different from the vibration levels induced by any one of the five conventional aircraft types tested, and that differences between the Concorde response signature and any other conventional aircraft signature are no greater than differences among conventional aircraft signatures.

Subjective Test Results

Subjective response tests of vibration, rattle, and noise included both Concorde and a variety of subsonic aircraft operations. The subjective tests were designed to obtain vibration and rattle detection thresholds*; vibration, rattle, and noise annoyance thresholds; and an overall annoyance rating of each aircraft noise event. The data are currently being analyzed to correlate with the physical measures to establish detection and annoyance thresholds.

*Threshold is defined as a positive rating by 50 percent of the subjects.

Both vibration and rattle were detected in several houses for some operations of both the Concorde and subsonic aircraft.

CONCLUDING REMARKS

Aircraft noise and vibration data were acquired at six residential sites near JFK International Airport. This report presents noise and window vibration data acquired at one of these test sites. These results, which are being released for the January FAA Concorde assessment report, represent a relatively small fraction of the data acquired at JFK; final conclusions will be based on the results of a more comprehensive analysis of the data and will be presented in follow-on reports. While a large portion of the data are still under evaluation, the following preliminary results are offered:

o Both vibration and rattle were detected subjectively in s[illegible] houses for some operations of both the Concorde and subsonic aircraft.

o The relationship between window vibration and aircraft noise is:

- linear, with vibration levels being accurately predicted from OASPL levels measured near the window
- consistent from flyover to flyover for a given aircraft type under approach conditions
- no different for Concorde than for other conventional jet transports (in the case of window vibrations induced under approach power conditions)

o Relatively high levels of window vibration measured during Concorde operations are due more to higher OASPL levels than to unique Concorde source characteristics.

Follow-on reports will contain the results of further analyses of the data currently in progress.

APPENDIX A

INSTRUCTIONS

FLYOVER EVENT RATING

GOOD MORNING, MY NAME I. ____.

MY COLLEAGUES AND I ARE FROM THE NASA LANGLEY RESEARCH CENTER WHICH IS LOCATED IN HAMPTON, VIRGINIA. WE APPRECIATE THE OPPORTUNITY TO COME INTO YOUR HOME AND COLLECT INFORMATION ON AIRCRAFT NOISE. WE WOULD LIKE YOU TO HELP US BY "RATING" THE AIRCRAFT THAT WE WILL HEAR FOR THE NEXT 30 TO 45 MINUTES.

TO AID IN THIS TEST, WE HAVE PREPARED THESE "FLYOVER EVENT RATING FORMS." BASICALLY, WHAT WE WANT YOU TO DO EACH TIME AN AIRPLANE FLYS OVER IS TO PROVIDE INFORMATION ON THE VIBRATION, RATTLE, AND NOISE PRODUCED BY THE AIRPLANE. BY VIBRATION, WE ARE REFERRING TO MOTION THAT YOU FEEL IN YOUR BODY. BY RATTLE, WE MEAN ANYTHING THAT YOU HEAR DUE TO OBJECTS IN THE HOUSE WHICH ARE CAUSED TO MOVE BY THE AIRPLANE FLYOVER. NOISE, OF COURSE, IS THE SOUND OF THE AIRPLANE.

NOW, FOR THE RATINGS WE WOULD LIKE YOU FIRST TO TELL US WHETHER OR NOT YOU DETECT VIBRATION AND/OR RATTLE. IF YOU DO DETECT EITHER, CHECK "YES" UNDER THE "DETECTION" COLUMN. IF NOT, CHECK "NO." NOTE THAT YOU COULD BE AWARE OF ONE, BUT NOT THE OTHER. NEXT, WE WOULD LIKE YOU TO TELL US WHETHER OR NOT THESE INDIVIDUAL ITEMS WERE ANNOYING TO YOU. IF SO, CHECK "YES" UNDER THE ANNOYANCE COLUMN; IF THE PARTICULAR ITEM WAS NOT ANNOYING TO YOU, OR IF YOU DID NOT DETECT IT, CHECK "NO" UNDER THE ANNOYANCE COLUMN. FINALLY, WE WOULD LIKE YOU TO GIVE US AN OVERALL

ANNOYANCE RATING OF THE FLYOVER ON A SCALE FROM ZERO TO NINE WHERE ZERO INDICATES "ZERO ANNOYANCE" AND NINE INDICATES "MAXIMUM ANNOYANCE."

ARE THERE ANY QUESTIONS?

FLYOVER EVENT RATING FORM

Site ______________________________ Date ______________

Subject ID __________________________ Start Time ____________

Flyover No.		Detection Yes	Detection No	Annoyance Yes	Annoyance No	Annoyance Rating of Flyover
___	Vibration	___	___	___	___	
	Rattle	___	___	___	___	0 1 2 3 4 5 6 7 8 9
	Noise			___	___	
___	Vibration	___	___	___	___	
	Rattle	___	___	___	___	0 1 2 3 4 5 6 7 8 9
	Noise			___	___	
___	Vibration	___	___	___	___	
	Rattle	___	___	___	___	0 1 2 3 4 5 6 7 8 9
	Noise			___	___	
___	Vibration	___	___	___	___	
	Rattle	___	___	___	___	0 1 2 3 4 5 6 7 8 9
	Noise			___	___	
___	Vibration	___	___	___	___	
	Rattle	___	___	___	___	0 1 2 3 4 5 6 7 8 9
	Noise			___	___	
___	Vibration	___	___	___	___	
	Rattle	___	___	___	___	0 1 2 3 4 5 6 7 8 9
	Noise			___	___	
___	Vibration	___	___	___	___	
	Rattle	___	___	___	___	0 1 2 3 4 5 6 7 8 9
	Noise			___	___	
___	Vibration	___	___	___	___	
	Rattle	___	___	___	___	0 1 2 3 4 5 6 7 8 9
	Noise			___	___	
___	Vibration	___	___	___	___	
	Rattle	___	___	___	___	0 1 2 3 4 5 6 7 8 9
	Noise			___	___	

Annoyance rating: 0 - zero annoyance
9 - maximum annoyance

APPENDIX B

POSTTEST SESSION RATING FORM

NOW WE HAVE ONE MORE TASK WE WOULD LIKE TO ASK YOU TO DO. WOULD YOU PLEASE GIVE US AN OVERALL RATING OF THE TEST SESSION BY FILLING IN THIS "TEST SESSION RATING FORM." I THINK THE FORM IS SELF-EXPLANATORY, BUT IF YOU HAVE ANY QUESTIONS PLEASE SPEAK UP.

THANK YOU.

TEST SESSION RATING FORM

Site ______________________________ Date ________________

Subject ID ___________________________ Start Time __________

1. If you sensed either vibration or rattle during the test session, were you able to identify what was vibrating or rattling?

   Vibration: Yes ___, No ___, Did not sense ___

   Rattle: Yes ___, No ___, Did not sense ___

2. If you answered "yes" to either part of question 1, please tell us what vibrated or rattled.

   What vibrated? __________, __________, __________

   What rattled? __________, __________, __________

3. If you sensed either vibration or rattle, please check below all the ways you sensed it.

   Rattle: Heard it ___, Saw it ___, Felt it ___, Not sure ___

   Vibration: Heard it ___, Saw it ___, Felt it ___, Not sure ___

4. If you felt vibration, please indicate how you felt it (i.e. hands, feet, etc.)

   ____

   ____

5. For the test session, please rate the annoyance of the following.

	0	1	2	3	4	5	6	7	8	9
vibration										
rattle										
noise										
	zero annoyance									maximum annoyance

6. Comments (over) . . .

REFERENCES

1. Department of Transportation, Federal Aviation Administration: Concorde Monitoring, John F. Kennedy International Airport, Route - Proving Flights, October 1977.

2. Staff-Langley Research Center: Concorde Noise-Induced Building Vibrations for Sully Plantation, Chantilly, Virginia, NASA TM X-73919, June 1976.

3. Staff-Langley Research Center: Concorde Noise-Induced Building Vibrations Sully Plantation - Report No. 2, Chantilly, Virginia, TM X-73926, June 1976.

4. Staff-Langley Research Center: Concorde Noise-Induced Building Vibrations Montgomery County, Maryland - Report No. 3, TM X-73947. August 1976.

5. Staff-Langley Research Center: Concorde Noise-Induced Building Vibrations, International Airport Dulles - Final Report, NASA TM 74083, September 1977.

TABLE I.- SUMMARY OF AIRCRAFT EVENTS

Site No.	Aircraft Operation	Subsonic Aircraft Physical	Subsonic Aircraft Subjective	Concorde Physical	Concorde Subjective
	arrival	15	8	1	
1	departure				
	ground operation			2	
	arrival	22	9	1	1
3	departure				
	ground operation			2	
	arrival	23	13	1	
6	departure				
	ground operation				
	arrival			2	
9	departure	32	13		
	ground operation			2	1
	arrival				
10	departure	24	5		
	ground operation			2	1
	arrival			2	
11	departure	39	13		
	ground operation			2	

TABLE II.- AVERAGE MAXIMUM LEVELS FOR APPROACHES AT SITE 3

Type	No. of Runs	Average Maximum Level		
		OASPL, dB		Window Acceleration dB re 1μG
		Outside	Inside	
707	4	94.0 ± 4.8	73.4 ± 2.2	95.5 ± 3.3
DC-8	3	95.6 ± 3.1	73.9 ± 2.2	96.9 ± 3.5
727	5	92.2 ± 2.5	72.0 ± 3.0	95.0 ± 3.4
747	4	95.2 ± 3.8	74.8 ± 3.0	97.6 ± 4.8
L1011	3	91.7 ± 1.8	74.6 ± 1.3	92.9 ± 1.3
SST	1	107.2	84.6	110.6

TABLE III.- WINDOW VIBRATION RESPONSE SIGNATURE PARAMETERS

FOR APPROACHES AT SITE 3

A/C Type	No. of Runs	Slope	Y-Intercept	Correlation Coefficient
707	4	0.894	12.4	.909
DC-8	3	1.097	-7.38	.946
727	5	1.354	-28.5	.962
747	4	1.143	-11.2	.947
L1011	3	1.159	-12.7	.942
SST	1	1.104	-9.15	.981

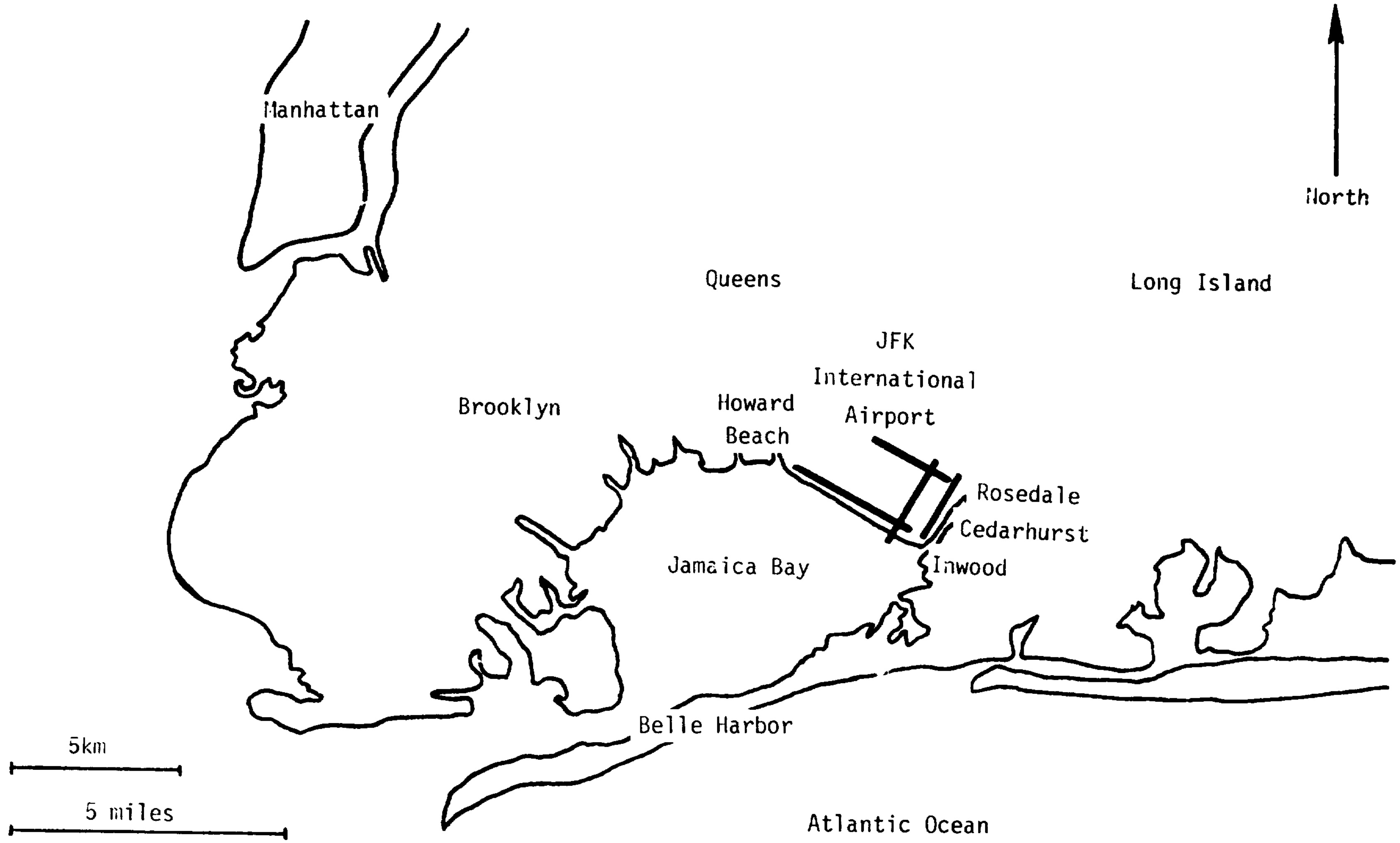

Figure 1. - JFK International Airport and surrounding area.

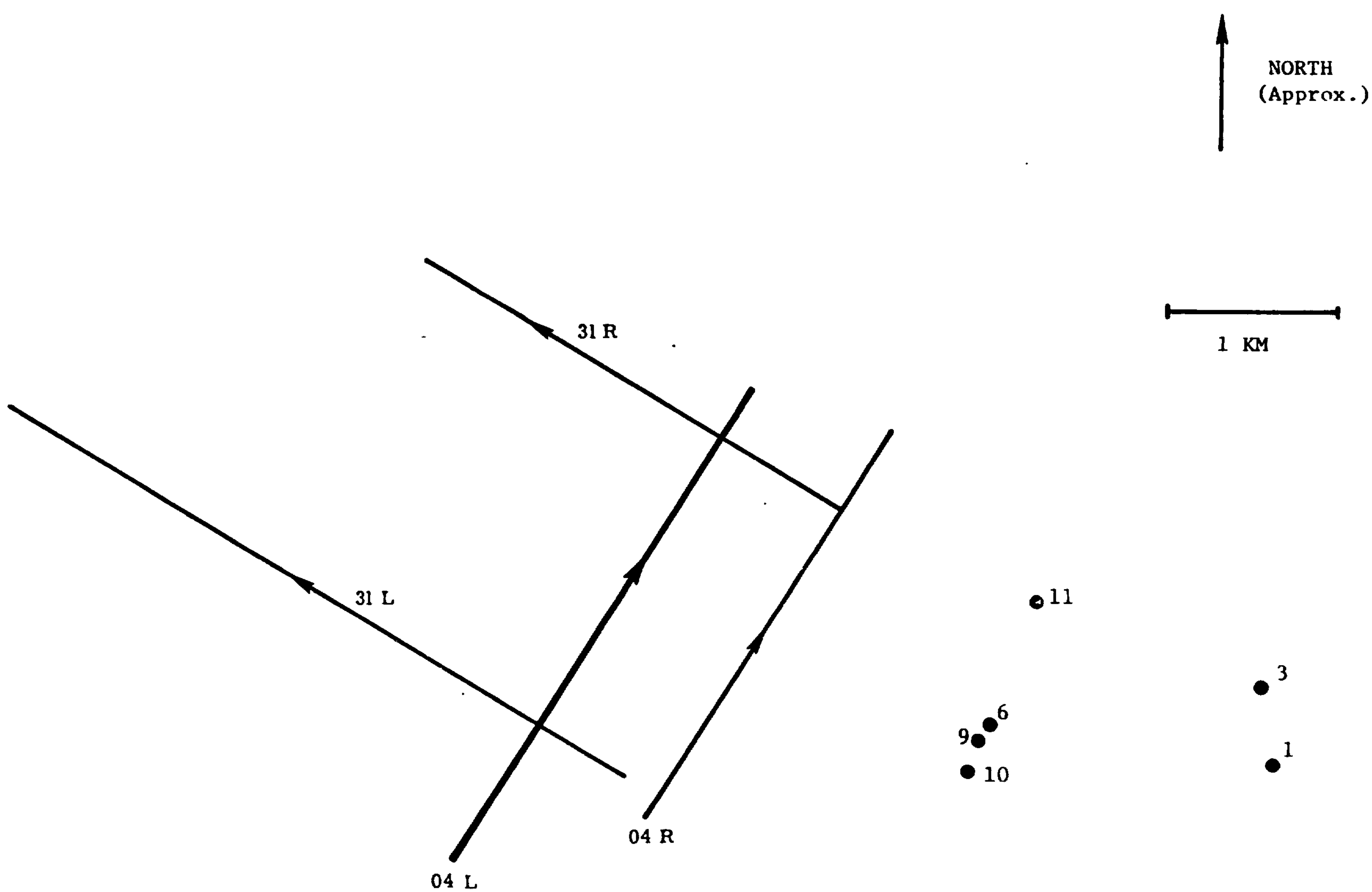

Figure 2. - Structural vibration test site locations.

Figure 3(a). - Test structure 3.

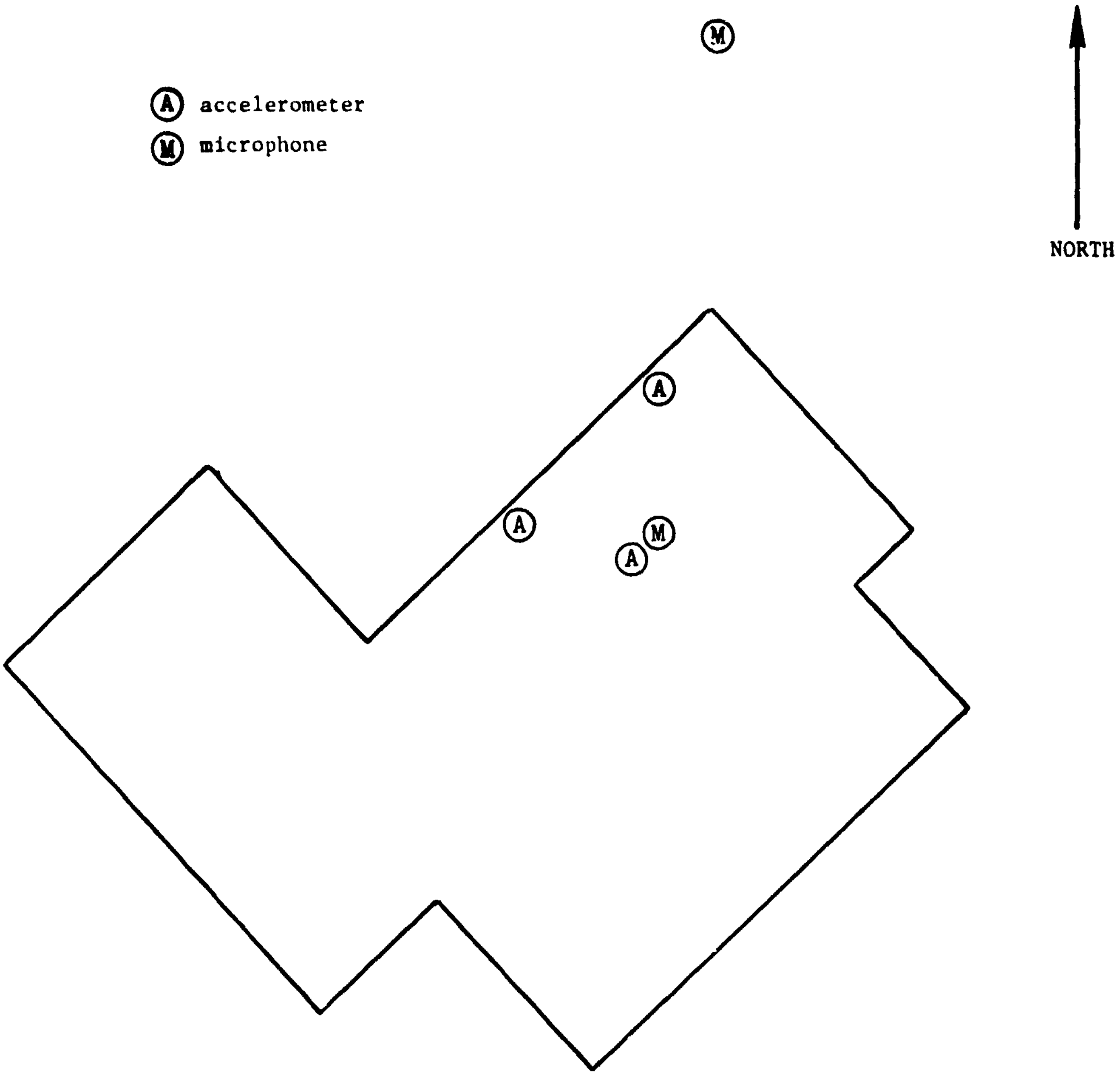

Figure 3(b). - Plan view sketch of test structure 3.

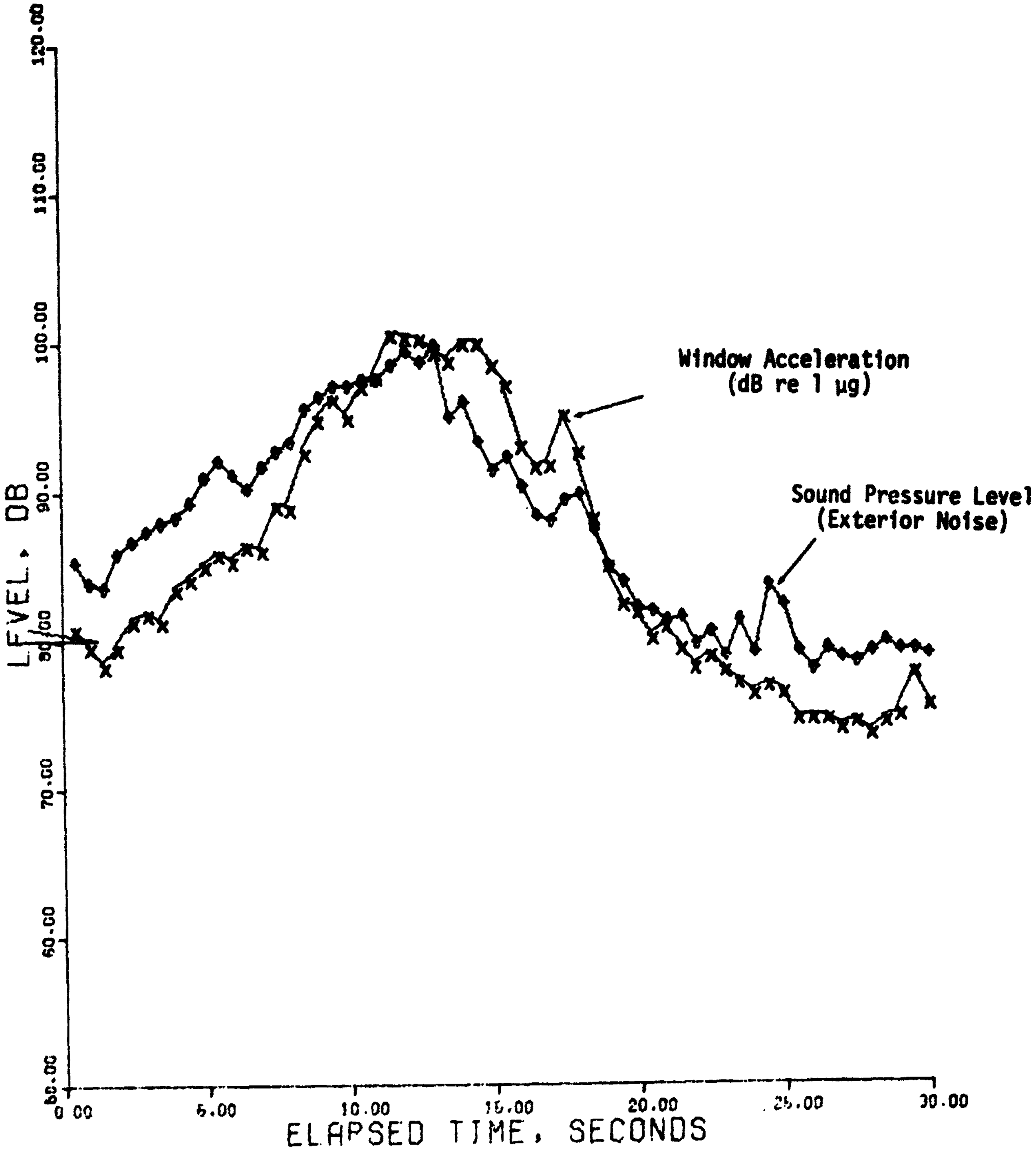

Figure 4(a). - Time history of sound pressure level and window acceleration level during 707 approach (event 112 at site 3).

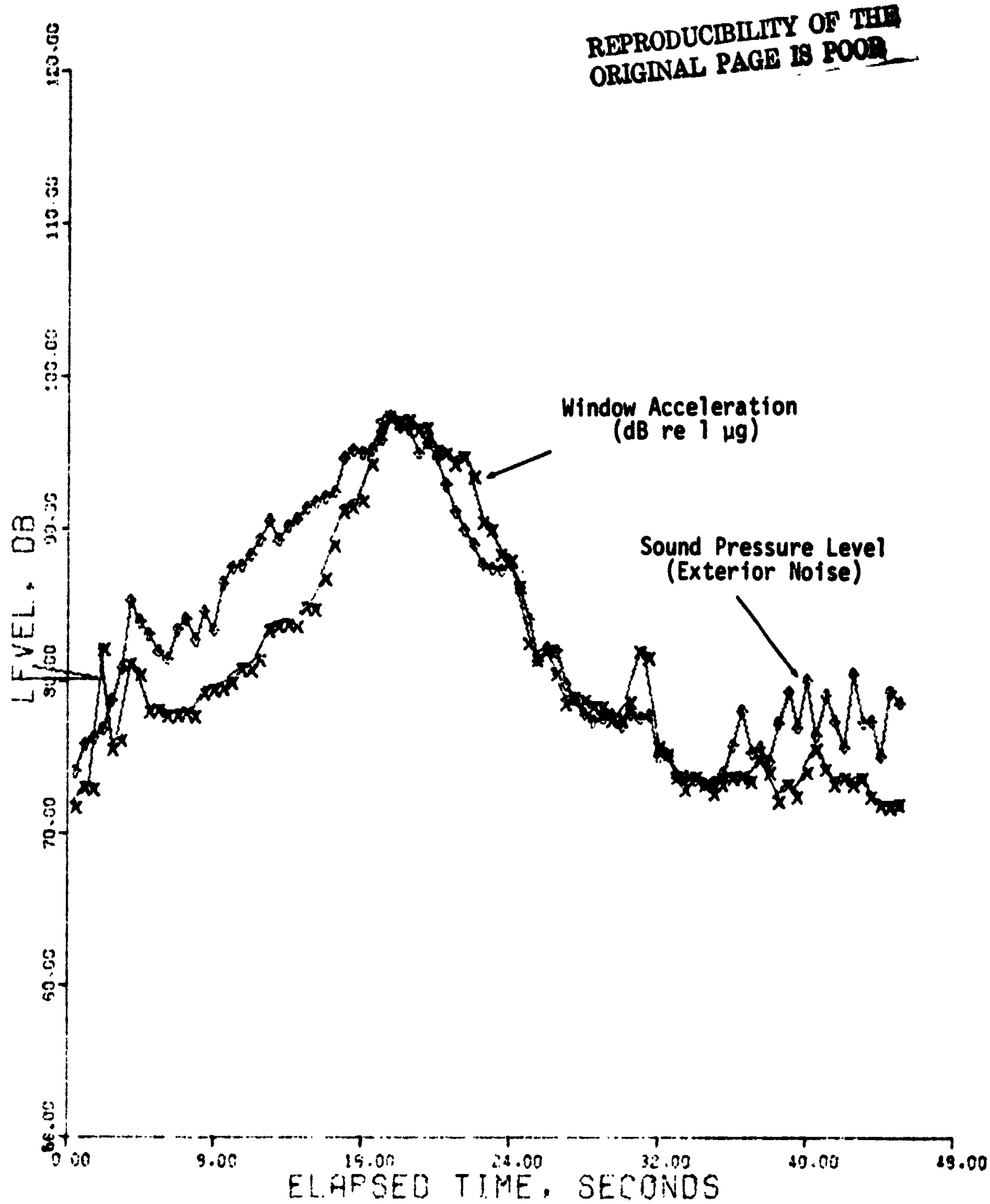

Figure 4(b). - Time history of sound pressure level and window acceleration level during DC-8 approach (event 123 at site 3).

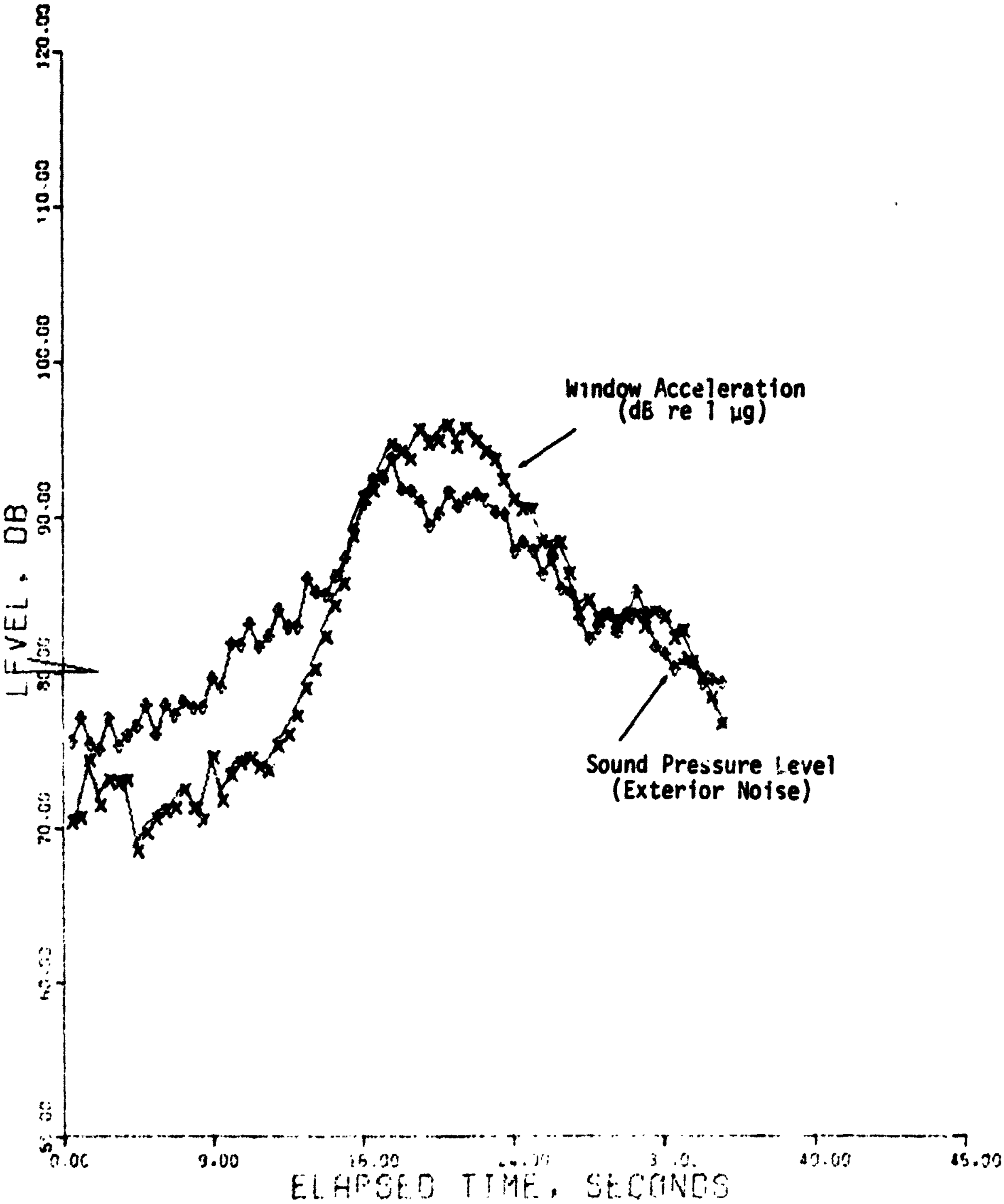

Figure 4(c). - Time history of sound pressure level anJ window acceleration level during 727 approach (event 117 at site 3).

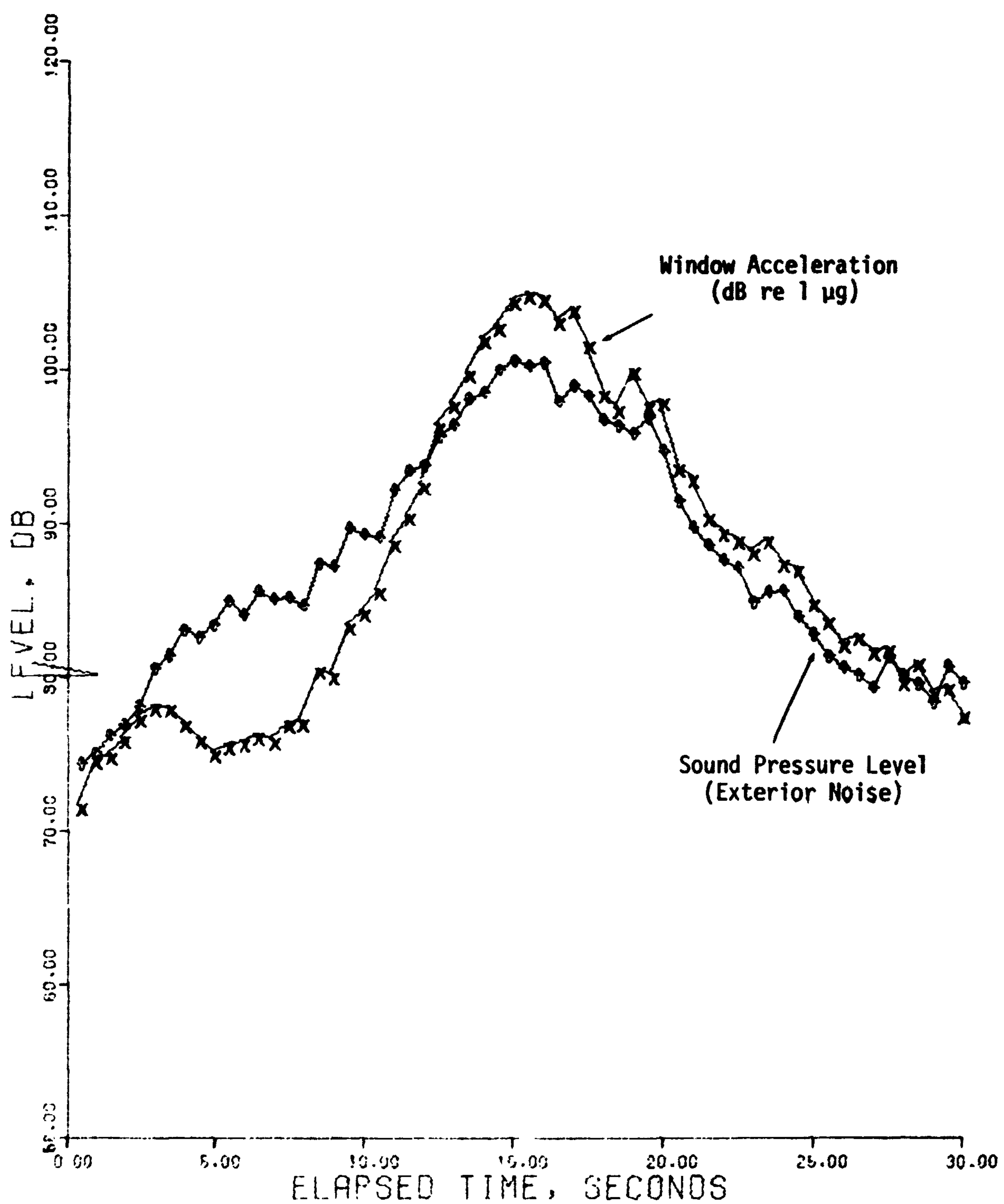

Figure 4(d). - Time history of sound pressure level and window acceleration level during 747 approach (event 126 at site 3).

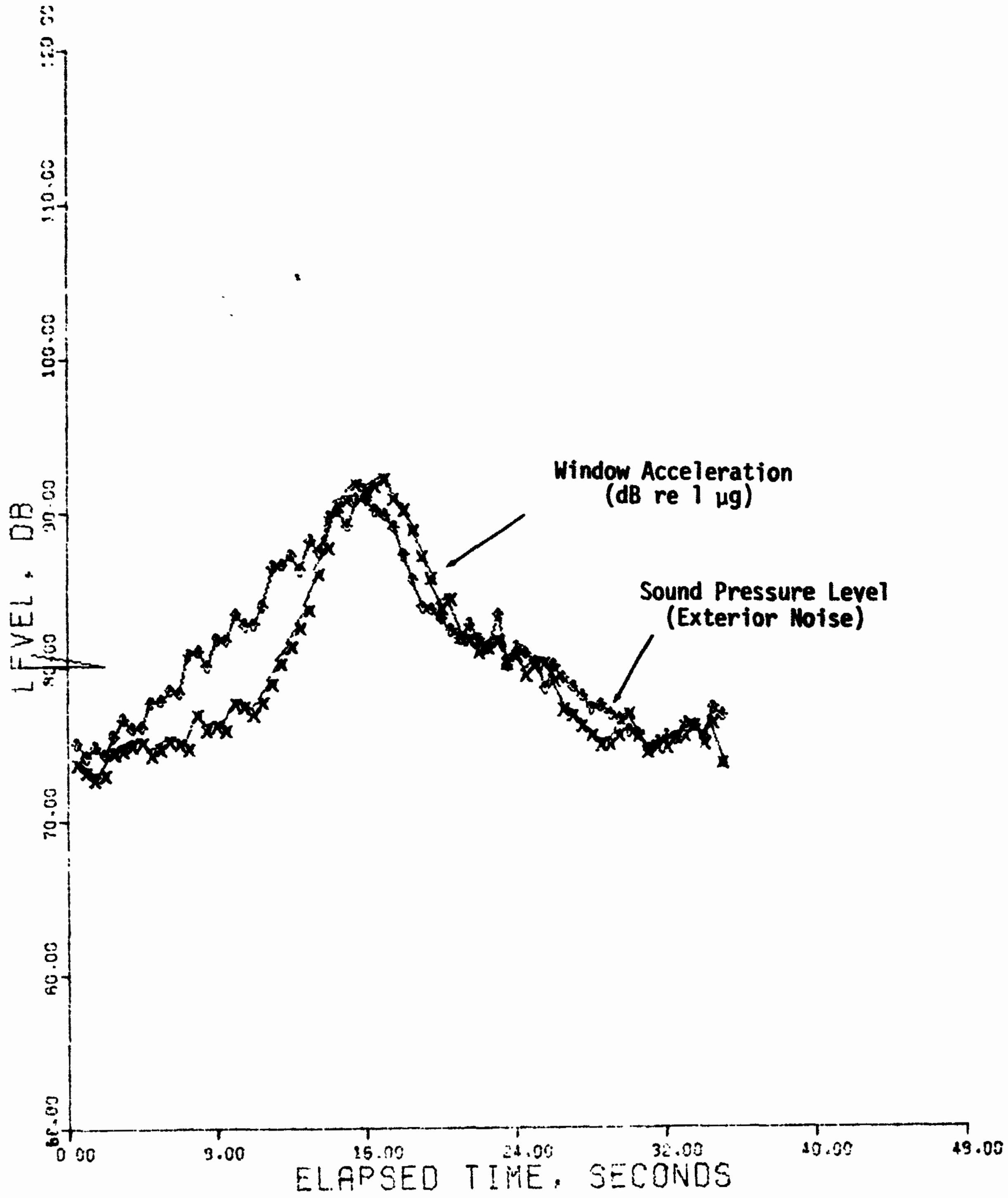

Figure 4(e). - Time history of sound pressure level and window acceleration level during L-1011 approach (event 128 at site 3).

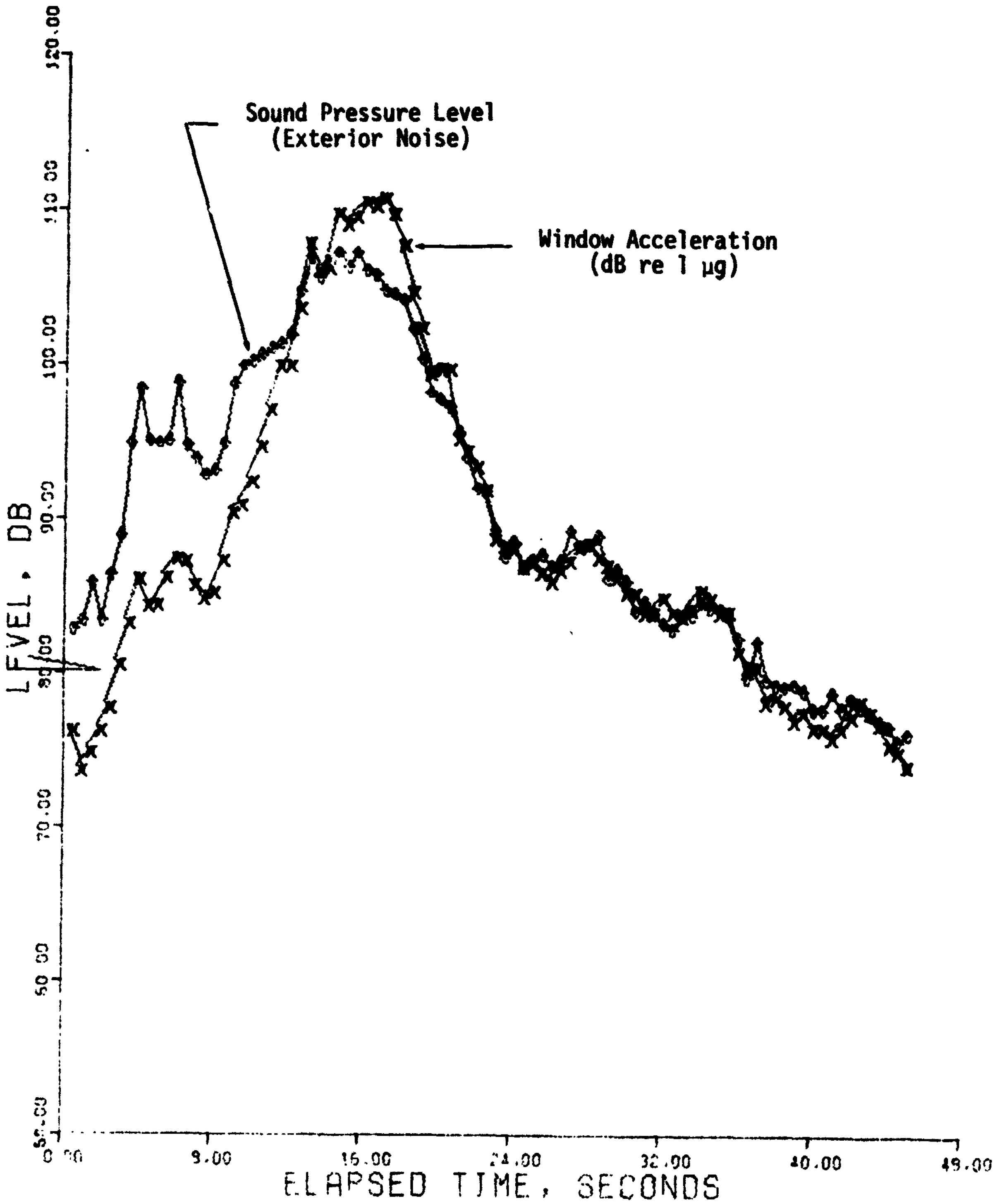

Figure 4(f). - Time history of sound pressure level and window acceleration level during Concorde approach (event 101 at site 3).

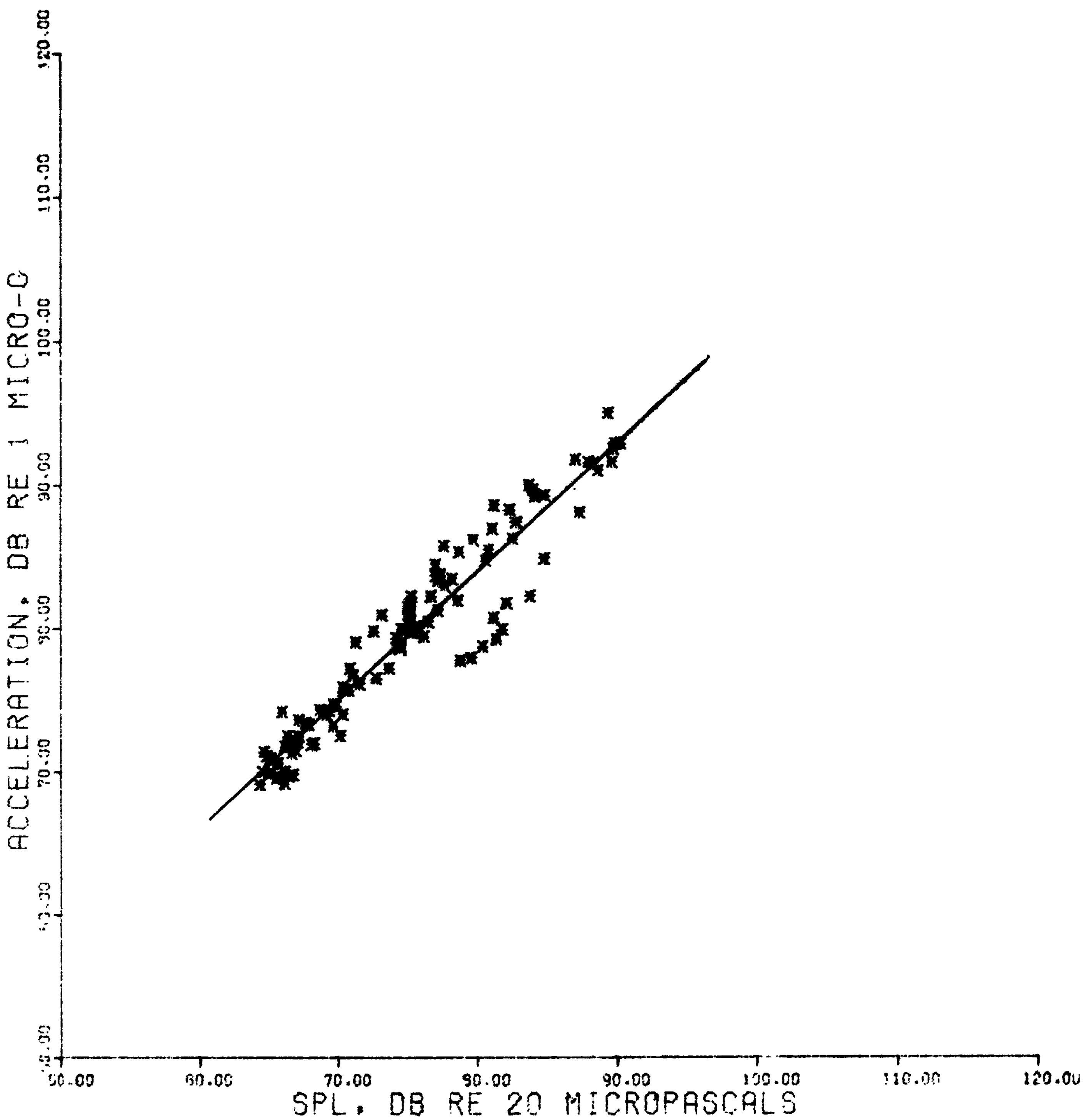

Figure 5(a). - Composite window vibration response signature for 707 approach at site 3 (4 flyovers).

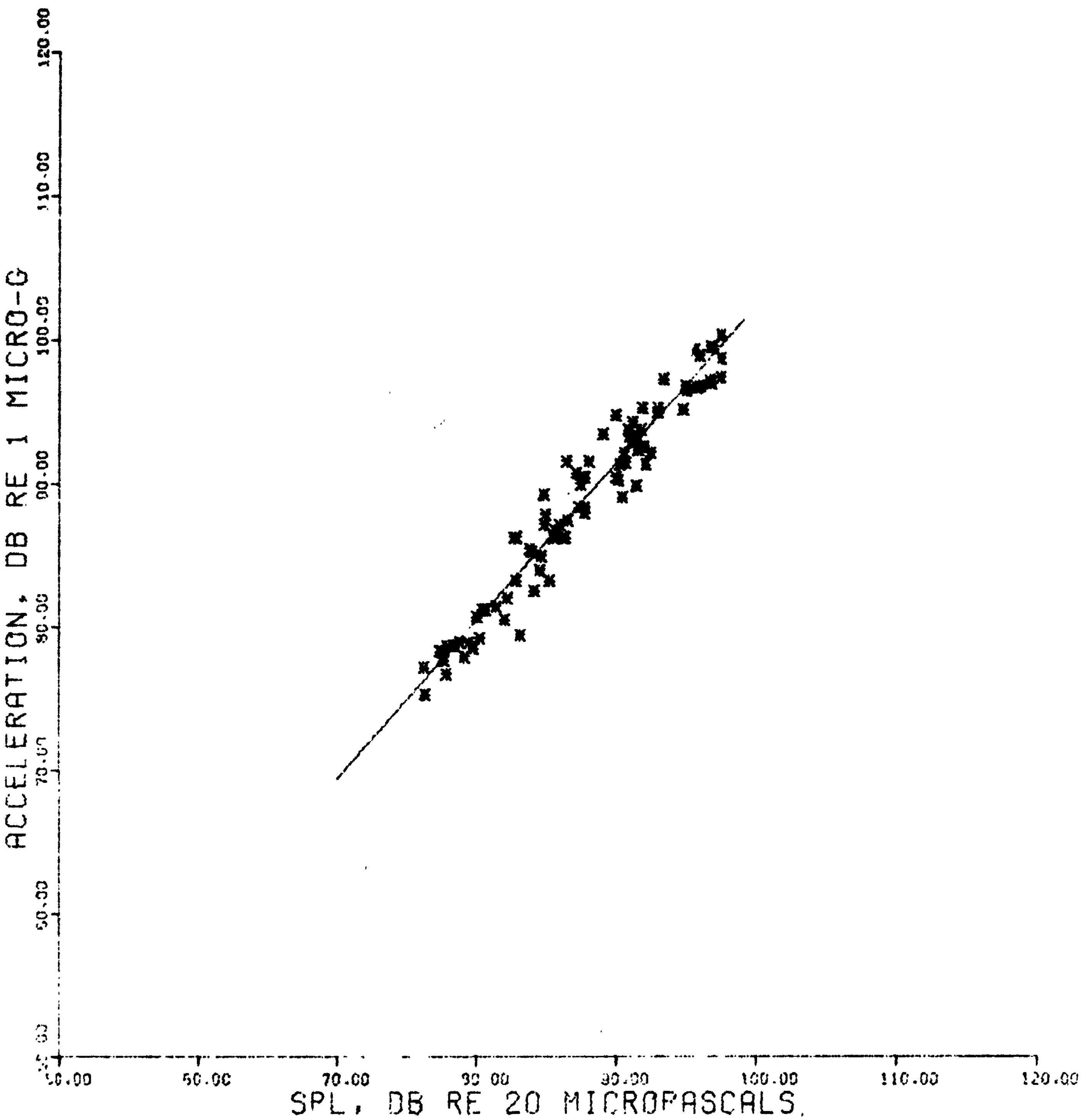

Figure 5(b). - Composite window vibration response signature for DC-8 approach at site 3 (3 flyovers).

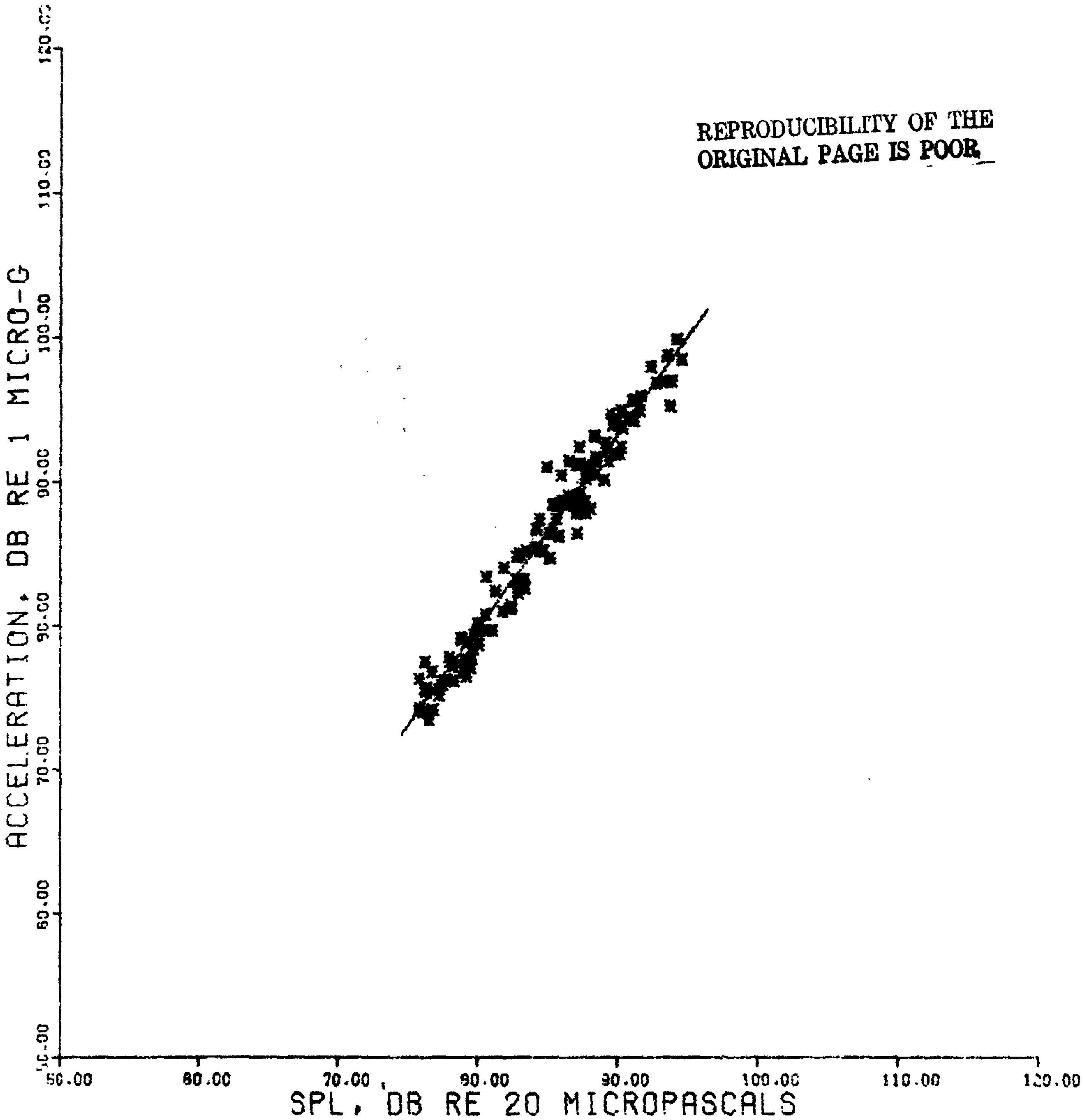

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Figure 5(c). - Composite window vibration response signature for 727 approach at site 3 (5 flyovers).

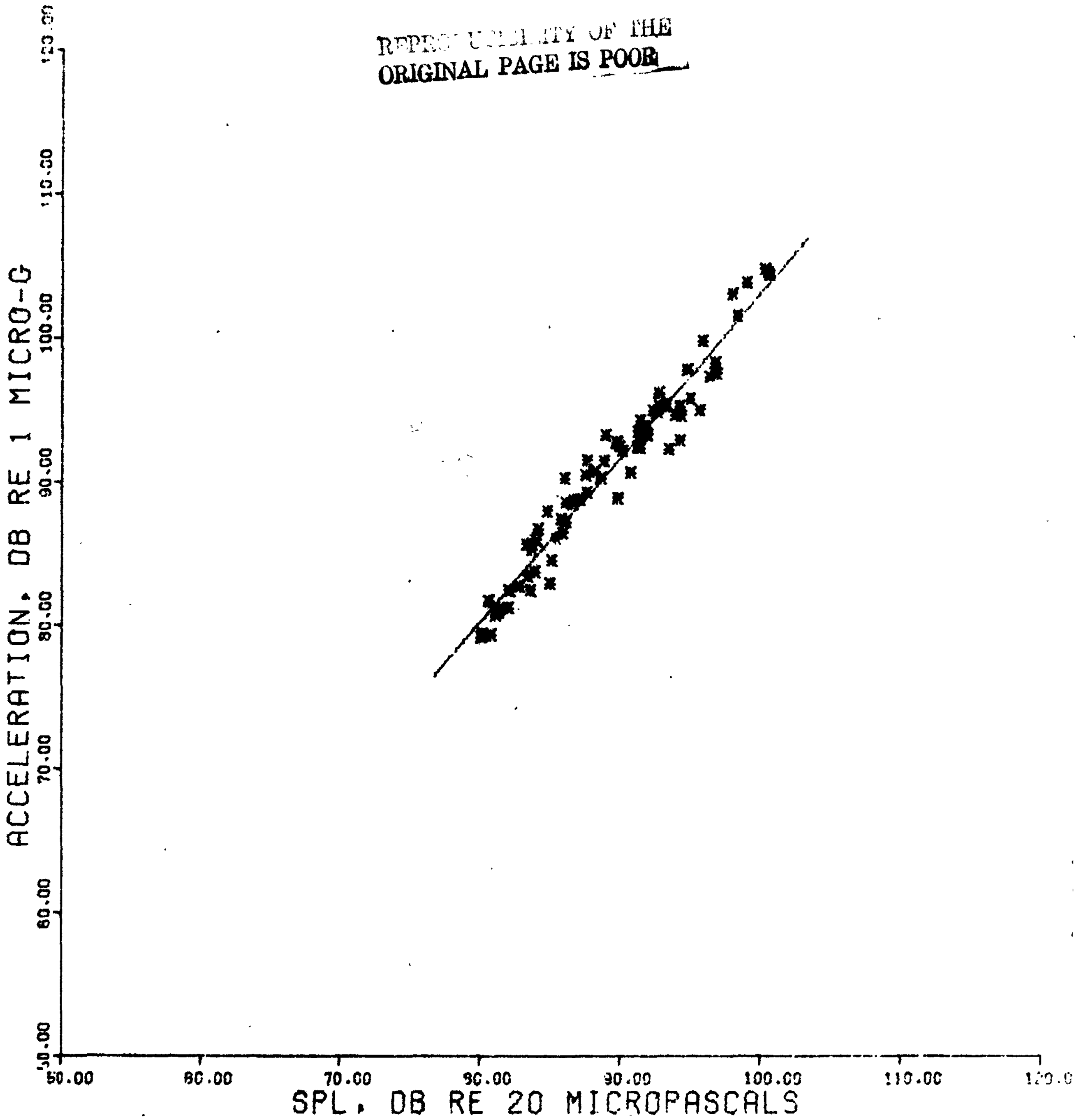

Figure 5(d). - Composite window vibration response signature for 747 approach at site 3 (4 flyovers).

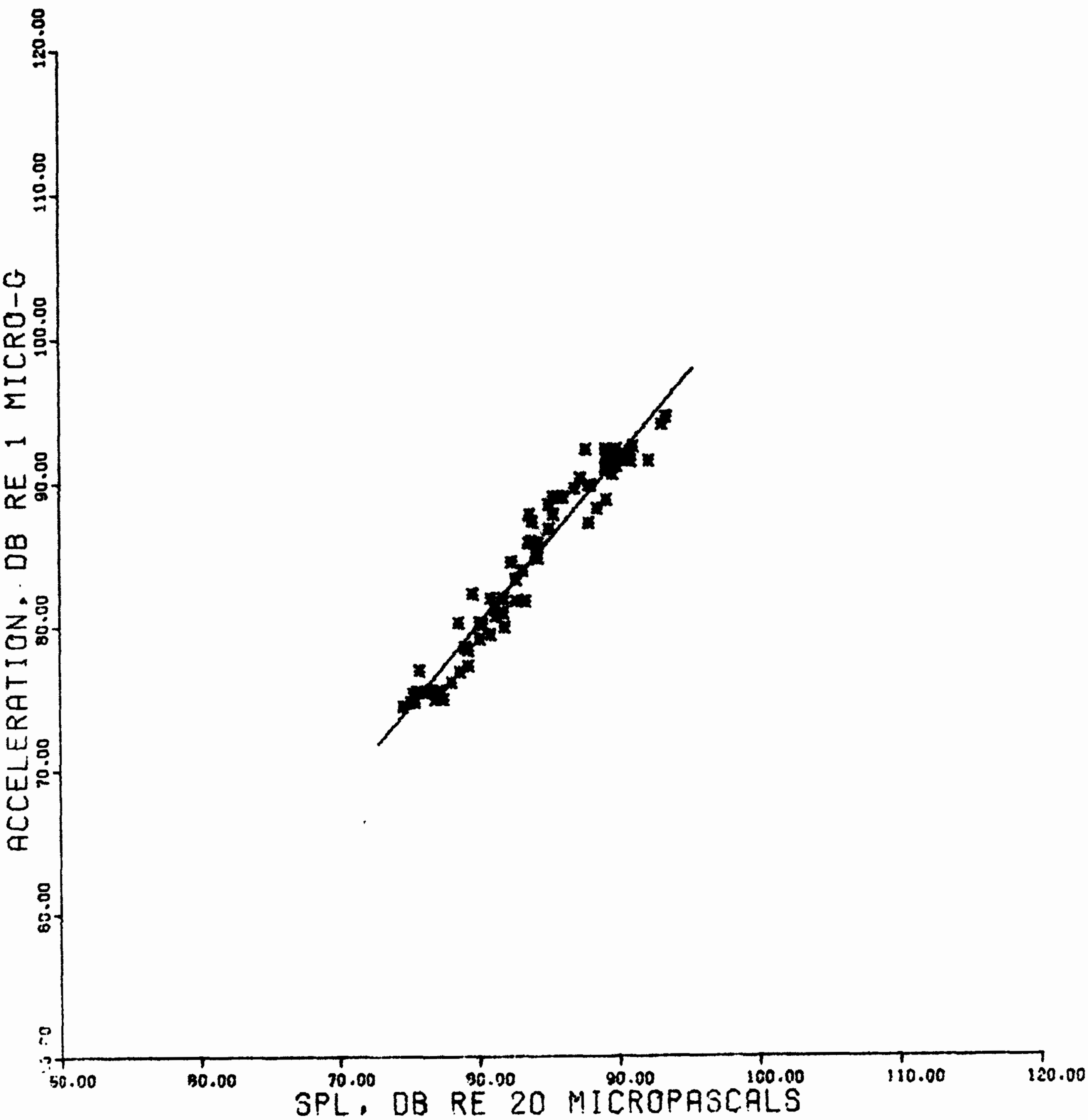

Figure 5(e). - Composite window vibration response signature for L-1011 approach at site 3 (3 flyovers).

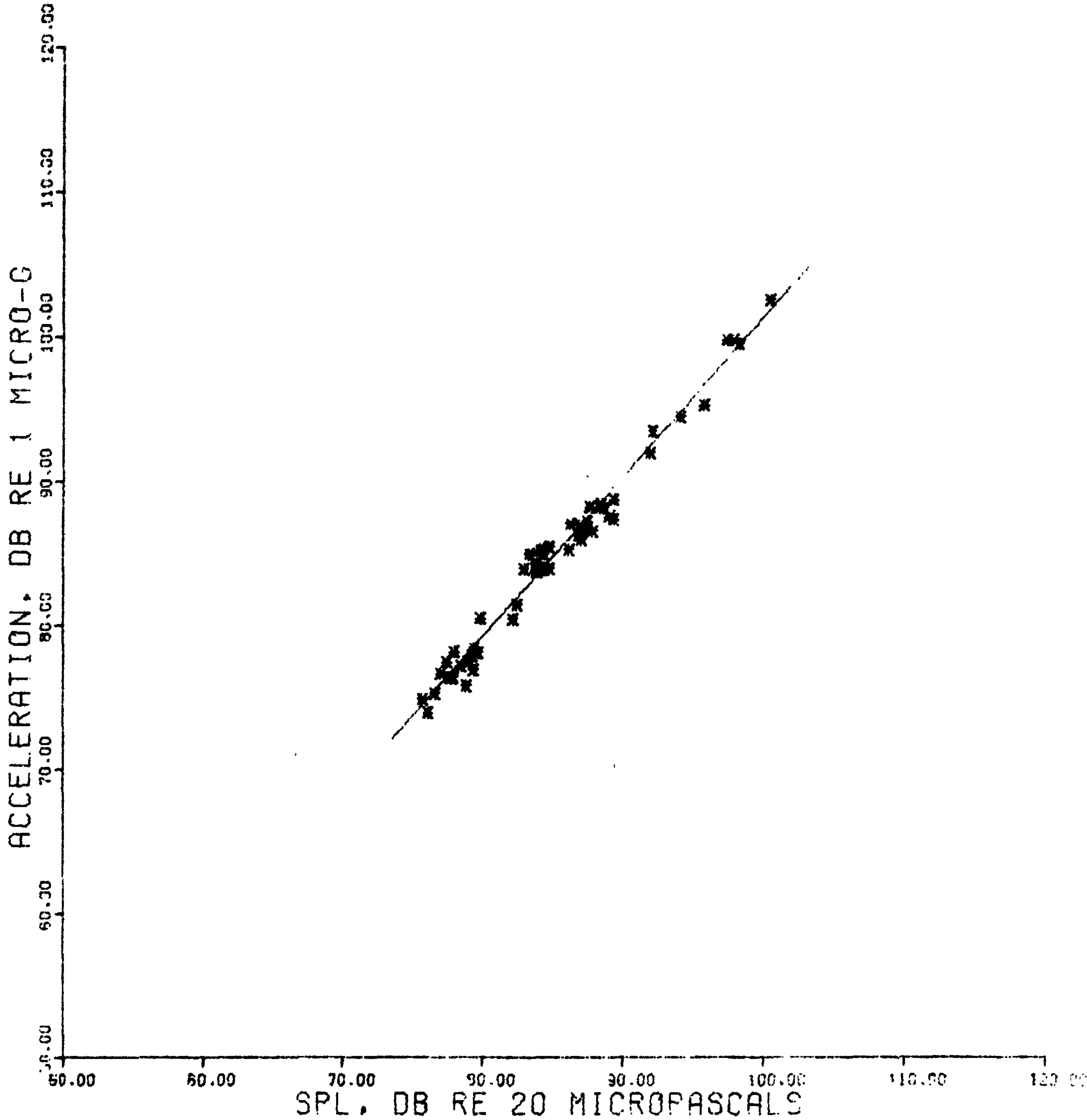

Figure 5(f). - Window vibration response signature for Concorde approach at site 3 (event 101).

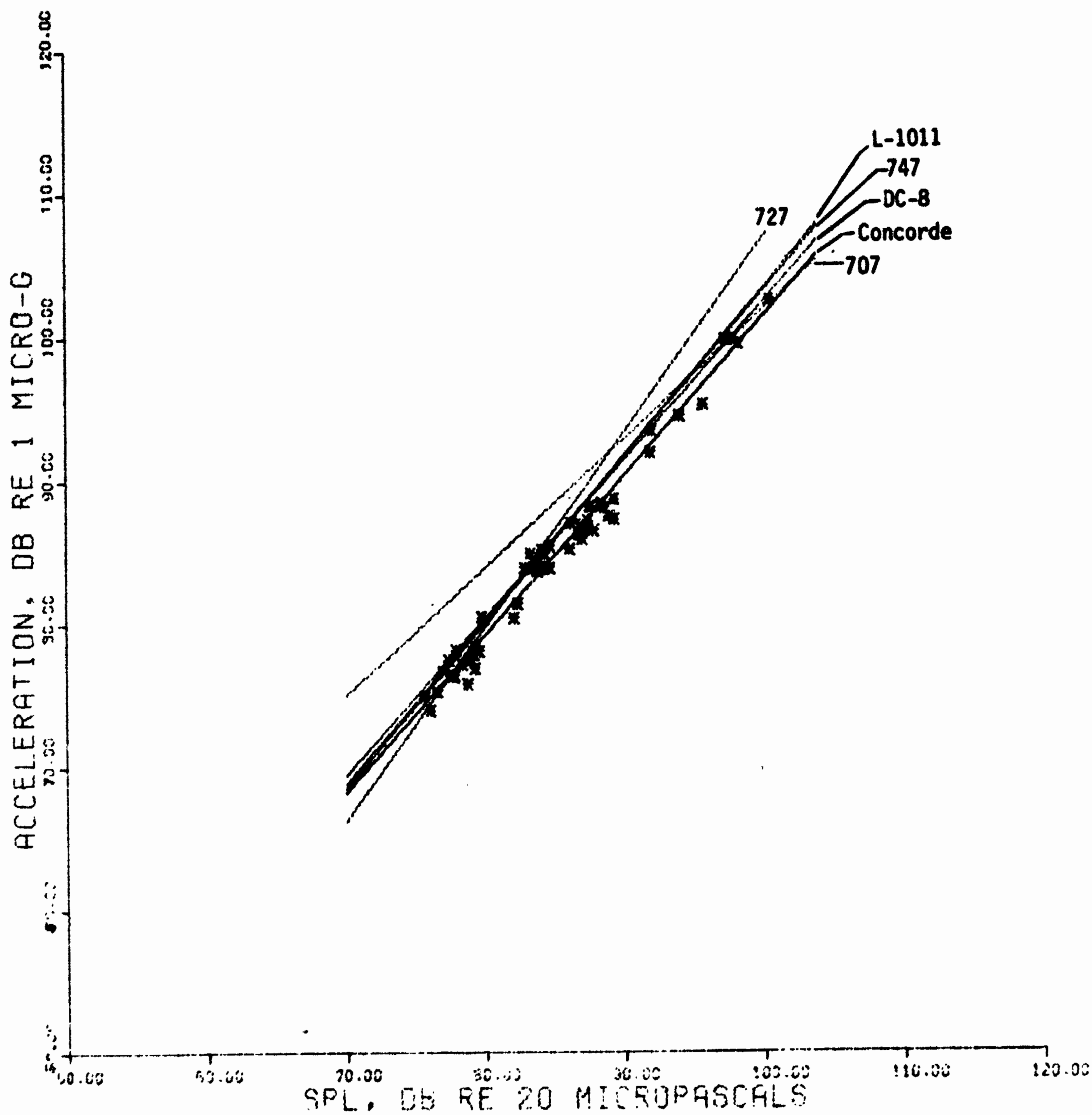

Figure 6. - Composite window vibration response signatures for Concorde and subsonic aircraft approaches at site 3. Data points are for Concorde event 101.

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15. Supplementary Notes

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16. Abstract

The NASA, in cooperation with the FAA, made measurements of noise-induced building vibrations near John F. Kennedy International Airport on January 18-19, 1978, as part of the Concorde monitoring program. The outdoor and indoor noise levels resulting from aircraft flyovers and certain nonaircraft events were recorded at six home sites along with the associated vibration levels in the walls, windows, and floors of these test homes. In addition, limited subjective tests were conducted to examine the human detection and annoyance thresholds for building vibration and rattle caused by aircraft noise. While a large portion of the data are still under evaluation, the following preliminary results are offered:

o Both vibration and rattle were detected subjectively in several houses for some operations of both the Concorde and subsonic aircraft.

o The relationship between window vibration and aircraft noise is:

- linear, with vibration levels being accurately predicted from OASPL levels measured near the window
- consistent from flyover to flyover for a given aircraft type under approach conditions
- no different for Concorde than for other conventional jet transports (in the case of window vibrations induced under approach power conditions)

o Relatively high levels of window vibration measured during Concorde operations are due more to higher OASPL levels than to unique Concorde source characteristics.

Follow-on reports will contain the results of further analyses of the data currently in progress.

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