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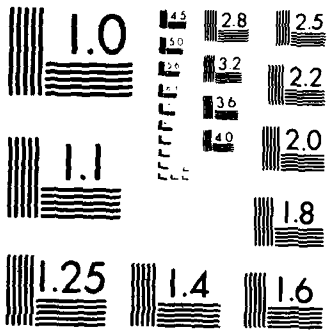

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INTERNATIONAL CIVIL AVIATION ORGANIZATION
COMMITTEE ON AVIATION ENVIRONMENTAL PROTECTION

Helicopter Noise Measurement Repeatability Program Final Report

HNMRP

ICAO·OACI·ИКАО

Prepared by
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16. Abstract
This report summarizes the findings of the Helicopter Noise Measurement Repeatability Program (HNMRP), which was initiated by the International Civil Aviation Organization (ICAO) Committee on Aviation Environmental Protection (CAEP) Working Group II (WG II). The HNMRP was begun with the goal of further developing and refining international helicopter noise certification standards. This international effort has involved the active participation of Australia, Canada, the Federal Republic of Germany, France, Italy, Japan, the United Kingdom, and the United States.

The participating ICAO CAEP WG II nations set out to investigate the degree of variability in test results of the existent helicopter noise certification rule by conducting a multinational noise measurement flight test program using a single, widely available helicopter, the Bell 206L-1 (or the acoustically equivalent 206L-3).

The HNMRP has provided a large number of certificating authorities and industry participants the opportunity to acquire experience in helicopter noise certification and the opportunity to thoroughly test and review the requirements of Chapter 8 and Appendix 4 of ICAO Annex 16 through implementation experience. As a result of this experience, recommendations for improvements and refinements to Annex 16 were developed, and subsequently adopted as proposed amendments at the CAEP/1 meeting in Montreal in June 1986. The HNMRP also provided ICAO WG II the chance to review the inherent repeatability of noise levels for a single helicopter model tested by different teams at different locations.

This report contains: a history of the HNMRP, a summary of the multi-nation comparison data, and discussion of the results of the program, including the refinements proposed for the international helicopter noise certification standard. Future analytical opportunities using HNMRP data are also discussed at the end of the report.

17. Key Words
ICAO, helicopter, noise. Bell 206L-1, noise repeatablity, noise certification, noise measurement. flight test, EPNL, SEL, international noise standards. PNLTM, ALm, variation in noise data

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GLOSSARY

AGL	Above Ground Level
ALm	Maximum A-Weighted Sound Level
BAe	British Aerospace
BRC	Best Rate of Climb
CAA	Civil Aviation Organization
CAEP	Committee on Aviation Environmental Protection
CAN	Committee on Aircraft Noise
CPA	Closest Point of Approach
Ch	Channel
dB	Decibel
dB(A)	A Weighted Sound Levels in dB
DFVLR	German Aerospace Research Establishment
DGAC	Direction General de l'Aviation Civile
DOT	United States Department of Transportation
EPNL	Effective Perceived Noise Level
EPNdB	Effective Perceived Noise Level Expressed in dB
EST	Eastern Standard Time
FPM	Feet per Minute
FPS	Feet per Second
FRG	Federal Republic of Germany
GW	Gross Weight
HIGE	Hover-In-Ground-Effect
HNMRP	Helicopter Noise Measurement Repeatability Program
hp	Horsepower
HV	Height-Velocity
Hz	Hertz

ICAO	International Civil Aviation Organization
IEC	International Electrotechnical Commission
IRIG-B	Inter Range Instrumentation Group B
kg	Kilogram
KHz	Kilo-Hertz
KIAS	Knots Indicated Air Speed
km	Kilometers
km/hr	Kilometers per Hour
kts	Nautical Miles per Hour (Knots)
LEQ	Equivalent Sound Level
m	Meters
MHz	Megahertz
Mic	Microphone
mph	Miles per Hour
OASPLM	Maximum Overall Sound Pressure Level
OAT	On-Board Outside Temperature
PAPI	Precision Approach Path Indicator
PAR	Photo Adjusted Radar Data
PISLM	Precision Integrating Sound Level Meters
PNLTm	Tone Corrected Maximum Perceived Noise Level
PSI	Pounds per Square Inch
RAM	Random Access Memory
RFM	Rotorcraft Flight Manual
rh	Relative Humidity
rpm	Revolutions per Minute
SAE	Society of Automotive Engineers
SEL	Sound Exposure Level

SPL	Sound Pressure Level
SR	Slant Range
STNA	Service Technique de la Navigation Aerienne
T/O	Takeoff
TSC	Transportation Systems Center (US DOT)
UK	United Kingdom
US	United States
VASI	Visual Approach Slope Indicator
Vh	Maximum Speed in Level Flight with Maximum Continuous Power
VNE	Never Exceed Speed
Vr	Reference Velocity
Vt	Test Velocity
Vtoc	Takeoff Climb Out Speed
Vtoss	Takeoff Safety Speed
Vy	Speed for Best Rate of Climb
WG B	Predecessor to WG II
WG II	Working Group II
WHL	Westland Helicopters Limited

1.0 INTRODUCTION

This report summarizes the activities and findings of the Helicopter Noise Measurement Repeatability Program (HNMRP), which was initiated by the International Civil Aviation Organization's (ICAO) Committee on Aviation Environmental Protection (CAEP) Working Group II in October of 1983. This enterprise was begun in the interest of further developing and refining international helicopter noise certification standards.

The HNMRP has been an international effort involving the active participation of technical and regulatory personnel from: Australia, Canada, the Federal Republic of Germany, France, Italy, Japan, the United Kingdom, and the United States.

This report has been published by the US Federal Aviation Administration (FAA). It represents the efforts of the program participants, Working Group II (WG II), the HNMRP Program Coordinator (from the FAA) and the HNMRP support staff.

Participating ICAO CAEP WG II nations set out to investigate the degree of variability in test results measured under the existent helicopter noise certification rule by conducting a multinational noise measurement flight test program which utilized a single, widely available helicopter, the Bell 206L-1 (or the acoustically equivalent Bell 206L-3).

The benefits and results of the HNMRP have been many:

First, the HNMRP provided a large number of certificating authorities and industry participants the opportunity to acquire experience in helicopter noise certification. The experience gained by each participant will be reflected in their future field testing, data reduction and analysis projects.

Secondly, the HNMRP provided WG II members the opportunity to thoroughly test and review the requirements of Chapter 8 and Appendix 4 of ICAO Annex 16 through implementation experience. As a result of this experience, recommendations for improvements and refinements were developed and formally delineated in the WG II Report to CAEP, many of which were subsequently adopted at the CAEP/1 meeting in Montreal (June 1986) as proposed amendments to Annex 16.

Thirdly, the HNMRP provided WG II the chance to review the inherent repeatability of noise levels for a single helicopter model tested by different teams at different locations.

Included in this report are the summary data for each participant, summary multi-nation comparison data, analyses, and discussion of the program results, including the refinements proposed for the international helicopter noise certification standard. Actual single event data for each participant are available in the original data source reference reports used in the construction of this document.

The HNMRP, having completed the important regulatory review portion of its agenda and having collated and summarized participant data, concluded its program activities at the CAEP/1 meeting in Montreal in June 1986. Further analysis of results and field test experiences have been identified as proposed work items for the newly established Working Group II (1987-1990). Those and other spin-off work topics identified through the HNMRP activities and efforts have been summarized in Section 10. These adjunct study topics are also natural candidates for the new Working Group II agenda, or for the agenda of a CAEP Technical Manual committee.

The HNMRP has been a collective effort of all of the program participants. Group meetings, as well as many phone conferences, were held during the span of the program. Pictured in Figure 1.0.A are the program participants who attended the Washington, DC (US) HNMRP Evaluation Meeting held in October of 1985. From left to right, front row are: Tom Kelly (Canada), Alain Depitre (France), Ed Rickley (US), Srini Nagaraja (Italy), John Leverton (HAI), Susan Woolridge (US staff assistant), Mr. Kitazawa (Japan), Mr. Yoshioka (Japan), Mr. Masue (Japan), and Rowena Cross-Najafi (US staff assistant). Back row, left to right: Maryalice Locke (US), Dennis Levanduski (US staff assistant), Jean Marze (France), Vital Ferry (France), John Wesler (US), Tony Pike (UK), Dr. John Powers (US), Peter Kearsey (UK), Steve Newman (US), Ken Adams (UK), John Fennell (UK), Larry Plaster (US), Richard Tedrick (US), and Sharon Daboin-Yoshikami (US).

Figure 1.0.A

2.0 BACKGROUND AND HISTORY OF THE HNMRP

2.1 PREDECESSORS

The HNMRP evolved from two previous multinational programs sponsored by ICAO during the years 1980 through 1986.

The first program was an international "round-robin" helicopter noise analysis program (Ref 1) conducted under the auspices of the ICAO Committee on Aircraft Noise (CAN) WG B (the predecessor to WG II). The program was formulated under WG B Rapporteur Vitale Ferry, of the French Direction Generale de l'Aviation Civile (DGAC), and Program Coordinator Edward J. Rickley, of the US Department of Transportation (DOT) Transportation Systems Center (TSC). From the analysis of identical analog tapes of helicopter noise, this program provided a quantitative comparison of data reduction and analysis systems. The results showed a standard deviation (of differences) on the order 0.5 dB and a range of differences approaching 1.5 dB (3 standard deviations).

The second program was an examination, by a three nation panel, of the test to test variability of noise data from the A109-A helicopter using ICAO Annex 16 noise certification procedures (Ref 2). The A109-A study examined two separate field tests, conducted at different locations, by two different teams--but with the same model aircraft. The purpose of the program was to develop greater confidence and understanding of the application of the ICAO noise standards. The A109-A study also strived to bring to light problems, if any, regarding test repeatability, test procedures, flight procedures or any other test or data reduction factors.

The A109-A study concluded:

> "The approach mode requires further examination due to the apparent variability in noise levels as seen in the A109-A case which was also observed in the case of the earlier individual campaigns carried out by the French, German and the FAA teams."

It was also recommended that further studies be conducted to acquire a better statistical knowledge of:

1. aircraft-to-aircraft variability;
2. pilot-to-pilot variability;
3. effect of wind on uneven blade loading;
4. the human dynamics of verbal flight path guidance and influence on noise data variability; and
5. the use of stability augmentation techniques verses manual control.

In addition, the report stated:

> "It is important to investigate the above factors and explain such test to test variability in order to remove uncertainties and to provide the confidence required in the application of the proposed standards. Should the result of such a thorough investigation still be negative it might be necessary to consider specifying an additional degree of tolerance about the prescribed noise limits for the approach case in order to allow for 'undefinable' factors."

These conclusions and recommendations along with the "round robin" experience provided the basis for the development of the Helicopter Noise Measurement Repeatability Program.

2.2 WORKING GROUP II ACTIVITIES and THE HNMRP

The Rapporteur of ICAO CAEP Working Group II (1983-1986), Dr. John O. Powers, provided the following synopsis of WG II and HNMRP activities in his report to CAEP/1 (June 1986) (Ref 3). (Dr. John O. Powers retired as the Chief Scientist of the US FAA, Office of Environment and Energy in January of 1987.)

> "Working Group II was established under the Committee on Aviation Environmental Protection (CAEP) to consider (along with other topics) the further development of noise standards for helicopters during the Seventh Meeting of the Committee on Aircraft Noise (CAN)(in 1983). The Working Group responded with the establishment (of a program) dealing with possible refinements of the ICAO Annex 16, Chapter 8 Helicopter Noise Standards....
>
> "The first Working Group meeting was held on October 26-28, 1983, in Amsterdam, The Netherlands. During the meeting, Working Group members recognized and addressed the complexity and implications of conducting a helicopter noise repeatability test program. After a review of the potential difficulties, the Group decided that such a program would provide broad experience and an opportunity to evaluate the problems which could arise during the implementation of the Annex 16, Chapter 8 Helicopter Noise Standards....
>
> "The second meeting of the Working Group was held in Boston, Massachusetts, USA, May 21-23, 1984.... The discussions... related to the helicopter program, predominantly addressed the structured repeatability test program and noise abatement operational procedures.... It was reported during the meeting that seven member nations were actively participating in the helicopter noise repeatability program. (After the meeting the number of participating nations increased to nine.) Many unique measurement techniques were discussed and early indications implied that meaningful recommendations would result from the program for presentation to CAEP/1....
>
> "Working Group II held its third meeting in Tokyo, Japan, March 25-27, 1985.... (At that meeting the status of the HNMRP) was reviewed and specific recommendations, were either accepted or tentatively accepted dealing with takeoff flight-path definition, overflight airspeeds, maximum operational rotor speed, atmospheric absorption adjustments for takeoff, generalized source noise adjustments, and specifications for data analysis systems.... Plans were made...for a Helicopter Noise Measurement Repeatability Program (HNMRP) subgroup meeting for final analysis of test results and formulation of additional Chapter 8 recommendations...."

The last meeting of Working Group II prior to CAEP/1 was held in Ottawa, Canada, October 9-11, 1985. At this meeting a report was presented by the HNMRP Program Coordinator detailing the findings of the HNMRP Subgroup from their "Program Evaluation Meeting" (in Washington, DC, USA, October 1-4, 1985). Several additional Chapter 8 modifications proposed by the HNMRP

Subgroup were included in the Working Group II report to CAEP.

In addition to the HNMRP subgroup meeting held in Washington DC, another HNMRP evaluation meeting was held in Paris, France (April 21 to 25, 1986). This meeting was held to finalize regulatory language for the proposed amendments and refinements to the ICAO international helicopter noise certification standards.

The work of the HNMRP and Working Group II reached a significant milestone at the meeting of the first full ICAO Committee on Aviation Environmental Protection (CAEP/1) meeting, in Montreal, Canada during June of 1986. At that meeting the recommendations of Working Group II (based on Paris HNMRP agreements) were agreed to as proposed amendments to the international standard.

2.3 PROGRAM REFERENCE DOCUMENTATION

In this section the primary HNMRP source documentation is listed. These documents are highlighted here, in the text of the report, since they played such an important role in the program. The HNMRP was conducted in accordance with the procedures set out in these documents.

All of the source documentation material discussed here are also formally referenced in the customary manner immediately prior to the appendices.

1) Test Plan for the ICAO Helicopter Noise Measurement Repeatability Program, November 1983, Revised December 15, 1983. (Ref 4)

2) Helicopter Noise Measurement Repeatability Program Mid-Program Review Advance Phases Protocol, October 1, 1984. (Ref 5)

While general test program provisions were specified in the references cited above, the ultimate reference and focus of the program was the following document:

3) ICAO Annex 16 (Ref 6)

Within ICAO Annex 16, helicopter noise certification is addressed in Chapter 8, with many cross references to Appendices 2 and 4.

Other valuable reference documents were:

4) Bell 206L-1 Long Ranger II Flight Manual, Bell Helicopter Textron, May 18, 1978. (Ref 7)

5) ICAO Working Group II Background Information Paper on Agenda Item 3A, Compendium of Comments on Test Plan, May 1984 (presented by the US representative). (Ref 8)

6) "An Examination of Test to Test Variability for the A109-A Helicopter Using ICAO Annex 16 Noise Certification Procedures", ICAO Committee on Aircraft Noise (CAN) Working Group B, joint German, Italian, U.S. member paper, January 1983. (Ref 2)

The formal reference section, just prior to the appendices, includes a more extensive list of HNMRP references and is subdivided into four parts: General References, Participants' Submittals, HNMRP Papers, and ICAO WG II Meeting Working and Background Information Papers.

2.4 REFERENCE CONDITIONS

The specific reference conditions to which data adjustments were to be made were stated in the "HNMRP Mid Program Review" document. Those reference values are repeated below:

Helicopter reference point -

For the HNMRP, the helicopter skid was the helicopter reference point for photo altitude determination.

Takeoff reference profile-

Vy = 57 knots
Rate of climb = 463.3 meters per minute (1520 ft/min)
Climb angle = 15.26 degrees
Altitude over centerline center = 156.4 meters (513 ft)
CPA over centerline center = 150.9 meters (495 ft)
CPA to the sideline sites = 192 meters (630 ft)

Approach reference profile-

Reference approach over centerline center = 120 meters (394 ft)
Reference CPA over centerline center = 120 meters (394 ft)
Reference CPA to the sideline sites = 192 meters (630 ft)

Level flyover reference profile-

Reference altitude over centerline center = 150 meters (492 ft)
Reference CPA to the sideline sites = 212 meters (696 ft)

3.0 TEST PLAN

The HNMRP test plan was intended to be a guideline for the program participants. Detailed below are the flight operations and other important information included in the test plan.

Many of the participants' flight test programs also included some flight operations that were not mentioned in the test plan. These additional operations are noted in this section as well as in Section 5.

3.1 TEST HELICOPTERS: BELL MODELS 206L-1 and 206L-3

Participants in the HNMRP had the option of testing either the Bell 206L-1 (Long Ranger II) or the Bell 206L-3 (Long Ranger III) helicopter. These helicopters are considered acoustically identical, although, there are some differences in installed power and performance. The Bell 206L-1 (or 206L-3) helicopter was selected as the test vehicle because of its world wide availability. Bell 206L-1 helicopters were used in all but the Japanese flight test program, in which a 206L-3 was used.

There exist three basic models of the Bell 206 helicopter. The first version, referred to as the 206-L Long Ranger, is the earliest production model and is acoustically different (smaller tail rotor) from derivative models 206L-1 and 206L-3. Table 3.1.A is a summary of the prominent features each of the three models.

In the Japanese test program, the takeoff mass of the Bell 206L-3 was adjusted from 1882 Kg to 1796 Kg in order to achieve the same rate of climb as the Bell 206L-1. With this modification the takeoff reference altitudes of the two helicopters become, in theory, the same.

Figures 3.1.A and 3.1.B are schematic line diagrams of the Bell 206L-1 test helicopter.

Figure 3.1.A

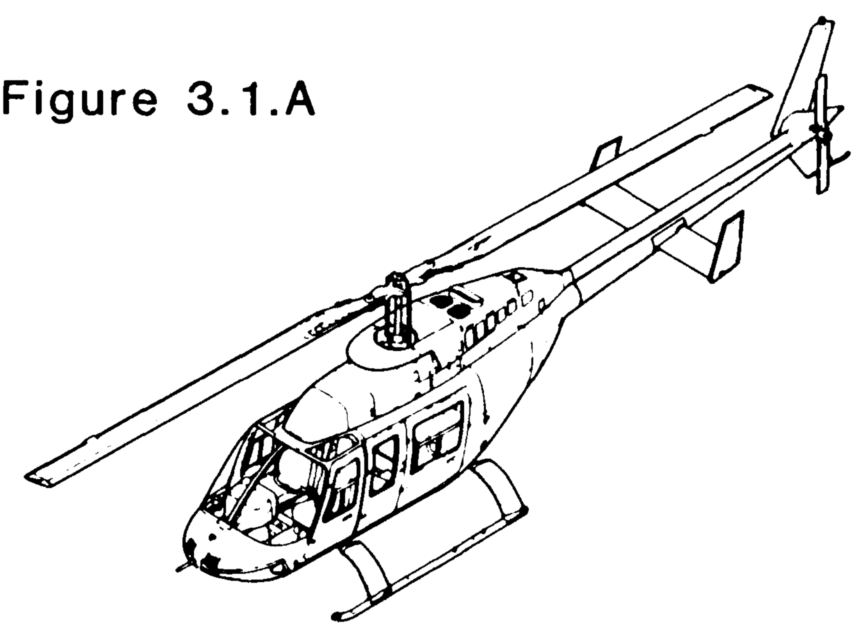


Table 3.1.A

BELL MODEL 206 "FAMILY" CHARACTERISTICS

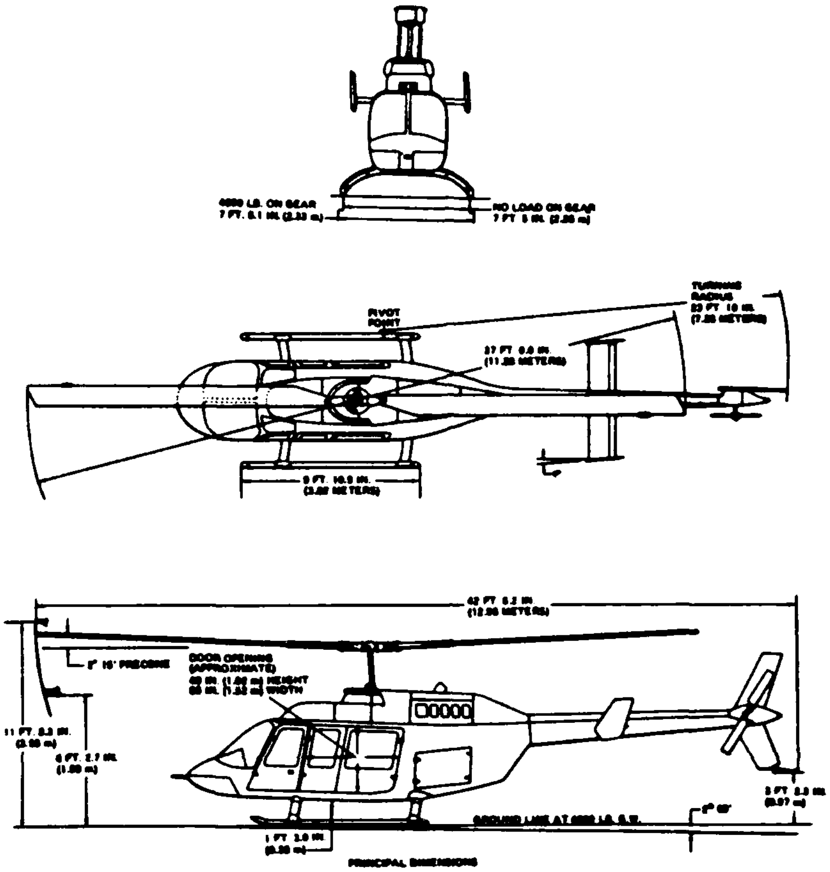
Model	Bell 206-L	Bell 206L-1	Bell 206L-3
Common Name	Long Ranger	Long Ranger II	Long Ranger III
Mass (Kg)	1814	1837	1796 ***
Mass (Pounds)	4000	4050	3960
Engine	Allison 250-C20B	Allison 250-C28B	Allison 150-C30P
Installed HP	NA	500	650
Takeoff HP	420	435	435
Transmission HP	428	435	435
BRC (FPM)	1600	1520	1520
BRC (FPS)	26.67	25.33	25.33
BRC SP. Vy (Kt)	52	57	57
Vy (FPS)	87.78	96.22	96.22
BRC Climb Angle	17.68	15.26	15.26
ICAO T/O Alt.(Meters)	179.41	156.46	156.46
ICAO T/O Alt.(Feet)	588.61	513.32	513.32
Main Rotor RPM	394	394	394
Tail Rotor RPM	2550	2550	2550
Main Dia.(Meters)	11.28	11.28	11.28
Main Dia.(Feet)	37.01	37.01	37.01
Tail Dia.(Meters)	1.58	1.65	1.65
Tail Dia.(Feet)	5.17	5.42	5.42
Main R-Vel (FPS)	763	763	763
Tail R-Vel (FPS)	692	722	722
VNE (Knots)	130	130	130
VNE (MPH)	150	150	150
VNE (Km/Hr)	241	241	241

NOTE: VNE = VH; (.45 VNE) + 65 = 123 knots; and (.9 VNE) = 117 knots. (.9 VNE) = 117 knots is the value specified as the reference speed for the HNMRP level flyover test.

*** For test purposes the takeoff mass of the Bell 206L-3 was adjusted from 1882 Kg to 1796 Kg in order to achieve the same rate of climb as the Bell 206L-1.

REFERENCE: Bell Helicopter rotorcraft flight manual information via a telephone-conference with Bell Helicopter.

Figure 3.1.B



3.2 CORE FLIGHT OPERATIONS

The following operations are the ICAO Annex 16 noise certification reference procedures (Chapter 8, Section 8.6). Participants were requested to include these operations in their flight programs. It was also requested that six "good" runs be acquired for each operation.

3.2.1 Flyover Test Series

The overflight reference procedure, as stated in ICAO Annex 16, Chapter 8, Section 8.6.3, is as follows:

a) the helicopter shall be stabilized in level flight overhead the flight path reference point at a height of 150 meters (492 ft);

b) a speed of 0.9 VH or 0.9 VNE or 0.45 VH + 120 km/h (0.45 VH + 65 kt) or 0.45 VNE + 120 km/h (0.45 VNE + 65 kt), whichever is the least, shall be maintained throughout the overflight reference procedure;

(Note: VH is the maximum speed in level flight at power not exceeding maximum continuous power. VNE is the never exceed speed.)

c) the overflight shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for level flight;

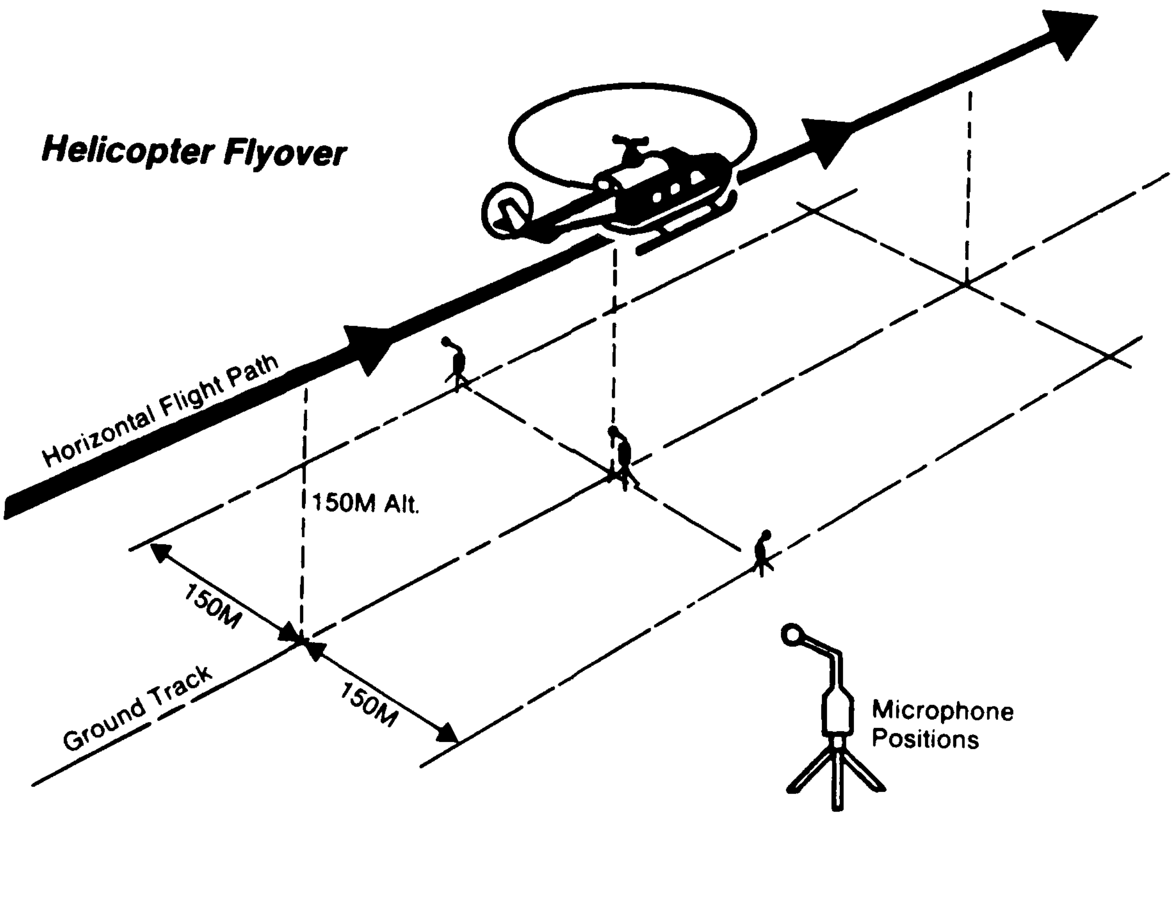
d) the helicopter shall be in cruise configuration; and

e) the mass of the helicopter shall be the maximum takeoff mass at which noise certification is requested.

The reference airspeed selected for the level flyover operation was 117 knots, which is 0.9 Vh.

This flyover operation is depicted graphically in Figure 3.2.A.

Figure 3.2.A



3.2.2 Takeoff Test Series

The takeoff reference flight procedure, as stated in ICAO Annex 16, Chapter 8, Section 8.6.2, is as follows:

a) the helicopter shall be stabilized at the maximum take-off power and at the best rate of climb along a path starting from a point located 500 m forward of the flight path reference point, at 20 m (65 ft) above the ground;

b) the best rate of climb speed Vy, or the lowest approved speed for the climb after take-off, whichever is the greater, shall be maintained throughout the take-off reference procedure;

c) the steady climb shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for take-off;

d) a constant take-off configuration selected by the applicant shall be maintained throughout the take-off reference procedure except that the landing gear may be retracted; and

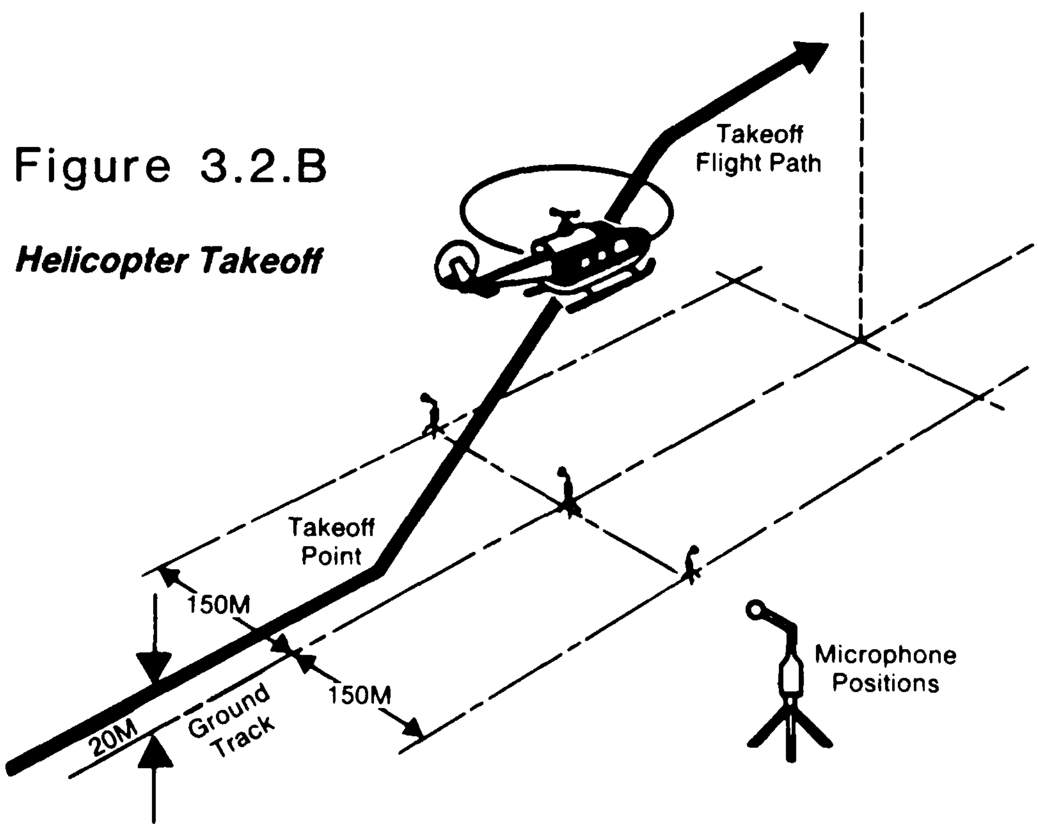
e) the mass of the helicopter shall be the maximum take-off mass at which noise certification is requested.

The pilots were asked to anticipate the rotation marker and apply maximum takeoff power early so that the helicopter would intercept a direct climb path, projecting from the 500 meter rotation point, 20 meters above the ground.

This takeoff operation is graphically depicted in Figure 3.2.B.

Figure 3.2.B

Helicopter Takeoff



3.2.3 Approach Test Series

The approach reference procedure, as stated in ICAO Annex 16, Chapter 8, Section 8.6.4, is as follows:

a) the helicopter shall be stabilized and following a 6 degree approach path;

b) the approach shall be made at a stabilized airspeed equal to the best rate of climb speed Vy, or the lowest approved speed for the approach, whichever is the greater, with power stabilized during the approach and over the flight path reference point, and continued to a normal touchdown;

c) the approach shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for approach;

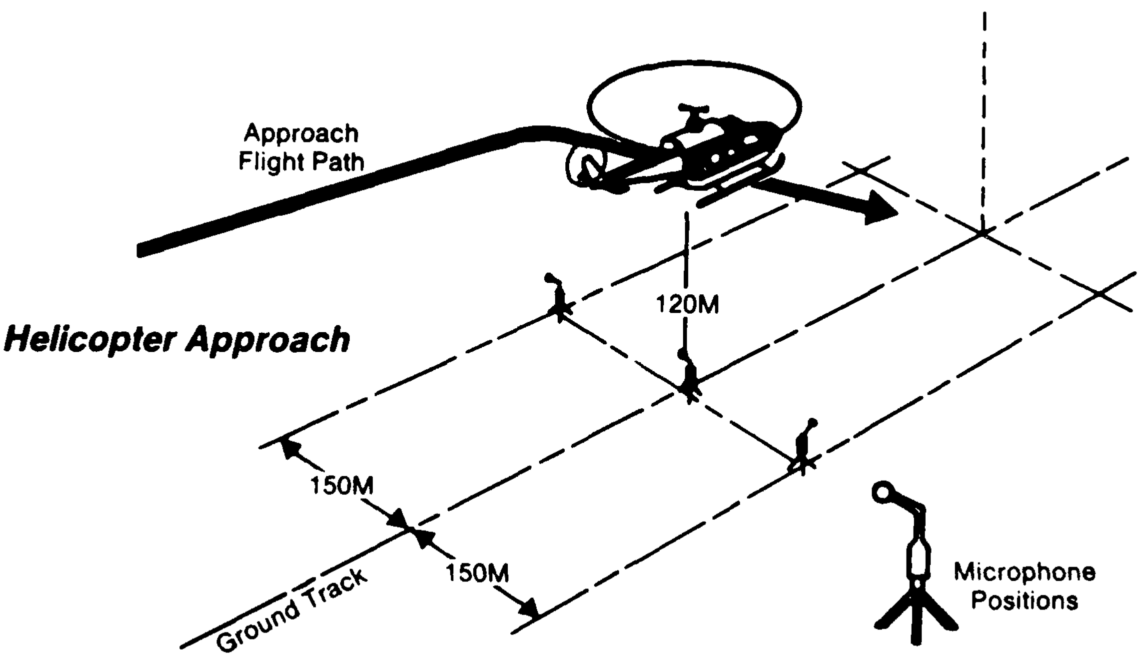
d) the constant approach configuration used in airworthiness certification tests, with the landing gear extended, shall be maintained throughout the approach reference procedure; and

e) the mass of the helicopter at touchdown shall be the maximum landing mass at which noise certification is requested.

An airspeed of 57 knots was established as Vy for approach operations.

This approach operation is graphically depicted in Figure 3.2.C.

Figure 3.2.C



3.3 ELECTIVE OPERATIONS

The following operations were conducted at the option of the participants. Some of these test scenarios were delineated in the test plan, while others were selected by the test participants for the enhancement of their own programs.

3.3.1 Higher Altitude Level Flyover Operations

In some programs additional flyover tests were conducted at 250, 300, and 350 meters following the procedures otherwise detailed for the certification flyover test.

3.3.2 Speed Trials

Additional flyover test series were conducted at a variety of airspeeds (57, 83, 91, 94, 98, 104, 105, 110, 118, and 130 knots) following the procedures otherwise detailed for the certification flyover test.

3.3.3 Bell Recommended Approach

This operation was conducted following a procedure developed by Bell Helicopter:

1. Commence approach from a level flight altitude of 750 feet AGL (above ground level). Follow a descent profile as if to land at the reference 6 degree target point, such that the central microphone is overflown at 400 feet AGL. Terminate the descent at 100 feet AGL.

2. Start descent at 80 to 100 knots and reduce collective pitch to 10 to 20% main rotor torque.

3. Bleed off airspeed during the descent down to an altitude of 200 to 300 feet.

Note: The reduction in collective pitch to the 10 to 20% torque range will result in a higher than normal rate of descent. To offset this higher rate of descent, if desired, the approach may be started at 10 to 20% torque. This procedure should be practiced so that the pilot familiarizes himself with the variation in collective and cyclic controls necessary to tune out the main rotor's impulsive sound.

Presented in Section 8.2.6 is an analysis of Bell approach data versus ICAO 6 degree approach data.

3.3.4 Six Degree Approach - No Guidance

This operation was intended to evaluate the potential problem of "over controlling" when following visual and verbal flight path guidance inputs.

The target operational procedures established in the US/Canadian program were as follows:

1. Maintain a stabilized rate of descent of 600 feet per minute.

2. Stabilize airspeed at Vy (57 knots).

3. Stabilize rotor speed at maximum (top of green arc) normal operating RPM (394 RPM).

4. Commence the descent at 750 feet AGL. Proceed with 6 degree descent such that the central microphone is overflown at 400 feet AGL. Continue down to 100 feet AGL.

Results from the six degree approach - no guidance operations are compared to the ICAO six degree approach results in Section 8.2.5.

3.3.5 Core Repeated by a Second Pilot

In several of the programs, the core test program was conducted by two different pilots. This established the means to assess the influence of pilot technique. This comparison is discussed in Section 8.2.2.

3.3.6 ICAO Takeoff Variations

ICAO takeoff variation operations were flown in two of the flight test programs. In the French/Italian test an "early rotation" operation was tested and in the Japanese test a "power climb" as well as an early rotation operation were included.

3.3.7 Other Approach Operations

A variety of approach operations were included in the various flight test programs. Those not previously mentioned are:

Six degree Vy + 20	Nine degree Vy	Twelve degree Vy
Six degree Vy - 20	Nine degree Vy + 20	
Six degree Vy - 17	Nine degree Vy - 17	

The results of some of these operations are examined in Section 8.2.6.

3.3.8 Static Operations

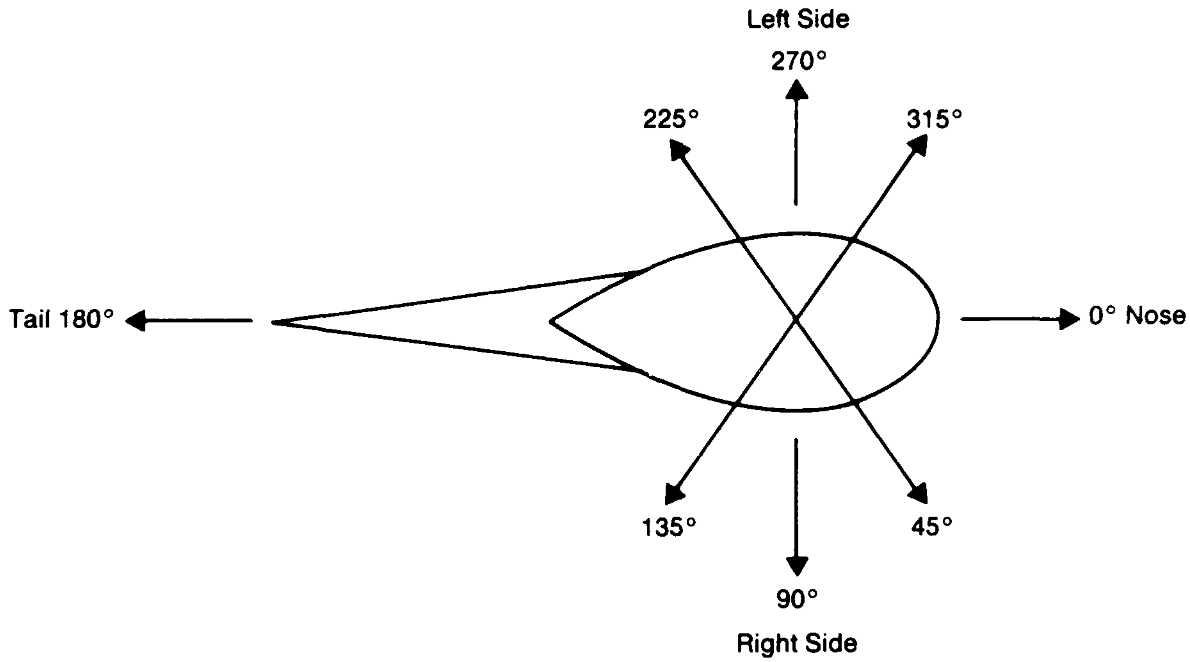
The static operational test series described below were intended to provide a test-to-test check on the similarity in acoustical emission characteristics with the effects of: pilot technique, forward flight, winds aloft, and propagation path anomalies removed.

During all static operations the helicopter was positioned at a designated point on a runway or taxiway. The measurement teams recorded a one minute (or longer) sample of sound for each of the eight directivity angles.

The acoustical emission angle convention for the HNMRP test was given as: zero degrees at the nose, 90 degrees off of the right side, 180 degrees at the tail, and 270 degrees off of the left side of the helicopter. Figure 3.3.A is a diagram of the acoustical emission angle convention.

Figure 3.3.A

Acoustical Emission Angle Convention



The eight directivity angles were intended to provide an additional check on the helicopter source characteristics by allowing a direct comparison of directivity patterns. The requested 60 second sampling period was intended, in part, to smooth out effects of micro-meteorology.

Participants were encouraged, if possible, to include a second measurement site for all static operations conducted, the first site being located 150 m away from the helicopter over a hard propagation path. This second site was to be located 150 m away from the helicopter over a soft propagation path.

3.3.8.1 Static Flight Idle

For the static flight idle operation, the helicopter skids are on the ground and the rotor RPM is stabilized throughout the recording period at 100 percent RPM. The results of the static flight idle test series are discussed in Section 8.2.9.

3.3.8.2 Static Ground Idle

The static ground idle test target procedures are the same as those followed in the static flight idle, except that the target RPM is 67 percent.

3.3.8.3 Static Hover-In-Ground-Effect

The static hover-in-ground-effect (HIGE) test series is conducted such that the skid height is five feet above ground level (see Figure 3.3.B). All other target procedures are the same as for the flight idle static operations.

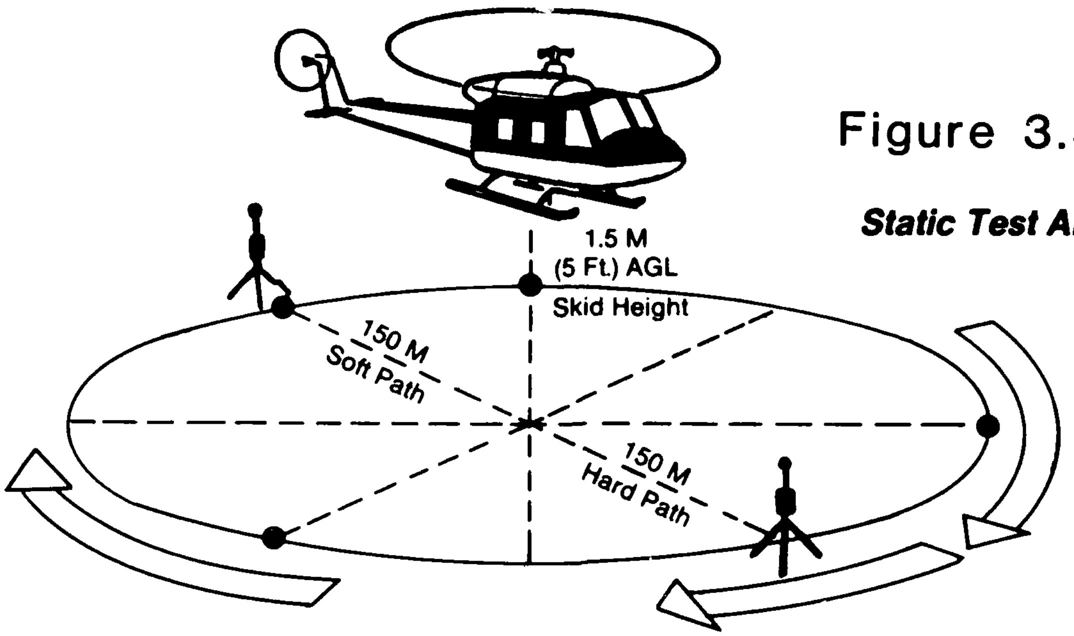


Figure 3.3.B

Static Test Array

Helicopter Rotates In 45° Steps

3.4 DATA ANALYSIS SYSTEM CALIBRATION TEST TAPE

Inclusion of data analysis system calibration test tapes in the HNMRP came as an outgrowth of an earlier ICAO CAN WG B program. In 1980 and 1981, an international "round-robin" helicopter noise analysis program was conducted (ref 1) which performed a quantitative comparison of data reduction and analysis systems using analog tapes of helicopter noise. The program found that, on average, organization to organization differences were small. In the context of the repeatability program, however, analysis system test tapes were used to attempt to prepare a normalization process which would compensate, to the greatest extent possible, for the known (or knowable) sources of data reduction and analysis system variation. With this in mind, system comparison tapes were devised along the lines of the "round-robin" program tapes.

Identical test tapes were prepared by the US Department of Transportation (DOT) Transportation Systems Center (TSC). All of the tapes were recorded on a Nagra IV-SJ instrumentation tape recorder at a speed of 19 cps, and contained helicopter noise data and reference signals. Noise data were recorded on both channels 1 and 2, and an IRIG-B time code signal was recorded on the cue track.

The helicopter noise data on the tapes were measured at a centerline-center microphone location and had been modified by accentuating the high frequencies and by adding artificial high frequency noise to ensure a good signal-to-noise ratio from 10-dB-down-point to 10-dB-down-point. After analysis on the US system, the calibration tapes were distributed and analyzed by the ten laboratories participating in the program. The findings and results of these analyses are presented in Section 9.2.

4.0 IMPLEMENTATION OF THE PROGRAM PLAN: TECHNICAL ISSUES AND DISCUSSIONS

The following section addresses a cross section of practical concerns, identified during the HNMRP, which arise when an individual or an organization actually goes into the field to implement a flight test program. As such, this section provides an excellent starting point for future ICAO efforts to develop a technical manual or guidance document for the implementation of the Annex 16 noise certification standards.

This section is organized by subject areas, pulling together information from the HNMRP test plan and combining it with comments and suggestions which were put forth by the program participants. These discussions include comments from the program test planning period and specifically detail noise certification test program implementation and data reduction concerns.

4.1 GROUND SURFACE CHARACTERISTICS

Within the context of noise measurement repeatability, the question of ground surface characteristics has in the past been cited as a possible source of variability. This issue was addressed by the HNMRP by each team deploying a ground plane microphone at the centerline-center measurement site to complement the 1.2-meter microphone. (The data from these ground microphones are compared to the 1.2 meter microphone data in Section 8.2.8).

The observed differences in the noise levels between the microphones provide a measure of the impedance characterizing the ground surface. The difference, between the value measured at the ground and the value measured at the 1.2 meter microphone level,--at a fixed incidence angle--should be a qualitative indication of the acoustic reflective properties of the ground surface.

One participant, however, commented that the difference (ground minus 1.2 meter) could be misleading: "It was observed that the difference depended heavily upon the frequencies at which the tones were generated, as well as upon the ground surface impedance."

In response to this observation it should be noted that the object of assessing the differences between the 1.2 meter and the ground microphone sound levels is explicitly to quantify the aggregate influences of surface impedance and source spectral content. The object is not to suppress these effects, but to "let them operate," thereby documenting (to a degree) the test site impedance characteristics.

4.2 TRACKING

It was specified in the test plan that each test use a tracking system capable of providing time-coded helicopter position information. It was also recommended that ground speed and climb and descent angles be identified for each event as an analytical aid.

When sophisticated continuous tracking systems prove to be unavailable the following two suggestions were proposed.

1. Equip the test helicopter with a radar altimeter (much more accurate than standard barometric altimeter).

2. Utilize photographic scaling techniques to quantify the helicopter altitude at three sites along ground track.

The specific tracking systems used in each test program are identified in Section 5.

4.2.1 Photo Scaling

For the HNMRP, skid width--rather than rotor diameter--was taken to be the helicopter reference position for photo scaling. Previous experience has shown that the combined effects of the rotor blade conning and the rotor tilting create a foreshortened image of the rotor diameter. Referencing the skid width eliminates this problem.

For those using photo-scaling techniques, it was recommended that an electronic signal, activated by a camera shutter (or other) mechanism, be noted on the cue or auxiliary channel of the relevant acoustical recorder. This signal, assuming a constant airspeed, permits precise calculation of the PNLTm noise record.

When the electronic shutter signal technique was not used, the angle of the helicopter position at the time of PNLTm was assumed.

4.3 COCKPIT INSTRUMENT READINGS

The test plan specified that some method be used to record the flight instrument readings for each event. Targeted parameters specified were: torque, indicated airspeed, rotor RPM, rate of climb or descent, time over the centerline-center site, and the radar altimeter reading (barometric altitude, if no radar).

Given time and space limitations for this report, and the irregular reporting of this information, the cockpit observer's log data have not been examined and are not included in this report. These data, however, do provide a possible stepping stone for future studies concerning variations in the multi-nation results.

4.4 WIND DATA

At the outset of the program, it was suggested that if possible wind data at the test flight altitudes be acquired to supplement the usual 10 meter (33 foot) temperature and relative humidity readings. Recommended wind data acquisition techniques included tethered balloons, meteorological radiosondes, or acoustical sounding devices.

It was further recommended that temperature, relative humidity, wind speed, and wind direction data be acquired at increments of 30.5 meters (100 ft) between the ground and an altitude of 305 meters (1000 ft) above the ground.

Concerning wind conditions, one program participant commented that testing should be carried out at low wind speeds and suggested that specific limits should be defined. "Assuming that pilots maintain the correct air speed and glide slope during the approach, head winds will reduce the rate of descent with possible marked changes in the noise characteristics. The effect of both wind speed and direction will, however, vary with helicopter type and we would suggest that suitable limits be recommended."

The concern that wind be as low as possible was strongly shared among the participants; a maximum of 5 knots (total wind vector) was thus, for the purposed of the HNMRP, taken to be an acceptable limit. Although current authorities have not agreed on a "magic number" for minimum wind speed, 5 knots was used in the program because it is generally given as the maximum speed for "light and variable" wind conditions.

4.5 APPROACH GUIDANCE

The use of a Visual Approach Slope Indicator (VASI), Precision Approach Path Indicator (PAPI), or equivalent was recommended for use in assisting approach operations.

One participant commented:

> "In our experience, attempts by the pilot to fly down a very narrow PAPI beam produce a continuously varying rate of descent. Thus, while the mean flight path is maintained within a reasonable degree of test precision, the rate of descent (an important parameter connected with blade/vortex interactions) at any instant in time may vary much more than during operational flying. It is believed that in certain circumstances, precision visual guidance systems may exacerbate blade slap problems and would suggest that each organization should carry out approaches with and without visual guidance."

Following this suggestion and previous concerns, it was recommended to all participants that they include in their programs an approach operation conducted entirely "on instruments." During this operation the rate of descent and airspeed were monitored in order to achieve the reference approach path.

As discussed in later sections of this report, guidance technique was not seen as a significant factor in noise level variability for the particular test helicopter.

4.6 STATE OF MAINTENANCE

As an additional test design control, it was recommended that the participants document the general condition of the test aircraft and determine the time since its last overhaul. It was considered plausible that differences in overhaul status could influence resulting noise levels.

4.7 DATA ACQUISITION SYSTEMS

The test plan provided general guidance with respect to measurement hardware. In Section 5 of this report the equipment used by each test team is discussed in detail.

4.8 ANALYSIS SYSTEM TIME CONSTANT

During the initial program planning period, one participant commented:

> "I do not accept that (as stated in the HNMRP test plan) 'strict adherence to IEC-179, -161, -225, and -651 requirements ....' will necessarily ensure that the results will be free from hardware bias errors. WHL have presented (UK WP10, May 1981, Ref.A) results of tests showing that the presence of impulsive signals does introduce hardware related variability. These findings were confirmed by further tests carried out on three types of analyzers...(UK WP2, December 1981, Ref.B) and...(US letter report DOT-TSC-FA-253-LR-2, October 1981. Ref.C). For whatever reason, WHL have obtained differences of more than 0.5 EPNdB when analyzing the same tape recording on GEN RAD 1995 and 1921 machines. In the context of the proposed tests, I suggest that we should at least acknowledge a potential source of hardware variability and make due allowance in the interpretation of the results." (Ref 9).

The issue of system dynamic response was subsequently pursued by the HNMRP.

Participants using the GEN RAD 1995 were henceforth requested to use the "1-second exponential integration" setting, and those using the B&K 2131 to select the "2-second exponential averaging" setting each equivalent to a slow exponential dynamic response. In the case where a linear detection is utilized, participants were also requested to employ a weighted moving window function designed to achieve a response closely duplicating that of the slow exponential.

Refinements to Annex 16 concerning this issue are discussed in Section 6.5.1.

4.9 ADVANCING BLADE TIP MACH NUMBER CORRECTION

In accordance with Annex 16, the HNMRP test plan stated that participants should apply the "Delta 3" advancing blade tip Mach number correction to level flyover data. The procedure to implement airspeed-temperature source noise adjustments was outlined as follows:

a. Develop a function of PNLTM versus advancing blade tip Mach number.

b. Plot the noise data and determine a best curve fit function to the data.

c. Use the local slope of the function to correct all data back to the reference airspeed and temperature.

4.10 SPECTRAL IRREGULARITIES

Participants were reminded that tone corrections are to be computed using the acoustical spectrum extending from 50 Hertz (band 17 low edge) to 11,200 Hertz (band 40 edge) in accordance with ICAO Annex 16, Appendix 4, Sections 4.3 and 4.4. The initiation of the tone correction procedure at a lower frequency reflects recognition of the strong low frequency tonal content of the helicopter noise.

4.11 SPECTRAL SHAPING

Spectral shaping techniques were reviewed in the Mid-Program Review document as follows:

> In the event that the signal to noise ratio in a given one-third octave band is less than 3 dB, the band SPL is said to be masked. In this case it is necessary to implement the spectrum normalization procedure set out in the CAN Seven, Report on Agenda Item 3, pages 3-53 and 3-54 (Ref 10). In the event that tracking or meteorological data are unavailable, it is recommended that a slope of 3 dB per one-third octave be utilized.

This value (3 dB per one-third octave) was based on examination of preliminary 206L-1 data acquired in the US/Canadian test program.

4.12 STATIC TESTING

Static tests were included in the HNMRP test plan because static operations are typically encountered in heliport operations. The HNMRP imposed 60 second sampling period (discussed in Section 4.12) was requested in an effort to acquire a representative measure of the acoustical source characteristics--including random temporal variation.

Concerning the static test, one participant expressed concern that "Noise levels measured during hover, particularly at very low altitudes can vary tremendously--15 dB(A)--in a single 30 second period." In response to this concern it was recommended that the 60-second samples be broken down into 2-second sample periods and the LEQ be calculated for each 2-second sample. This additional measure will tend to identify source variability and provide another figure of merit for test-to-test comparisons.

The multi-nation comparison of static data is discussed in Section 8.2.9.

5.0 INDIVIDUAL TEST PROGRAM SUMMARIES

Independent programs were conducted by Australia and Japan, while joint programs were conducted by: France DGAC Service Technique de la Navigation Aerienne (STNA), France Aerospatiale and Italy; the United Kingdom (UK) and the Federal Republic of Germany (FRG); and the United States (US) and Canada. (In the listing of joint programs, the host team is listed first.)

Where possible, excerpts have been taken directly from participants' reports. Descriptions of equipment and processes utilized by each team have been included, in as much detail as possible, so that readers planning tests will benefit from the experience of the HNMRP participants. (The reports have not been reproduced in their entirety for space conservation purposes.)

In all tests problems do arise. Some of those problems are described in the following sections for the benefit of anyone planning a similar test and for those planning further analyses with the HNMRP data. The following participant test summaries cannot, however, totally replace the participants' reports for conducting in depth examination of HNMRP data.

In regards to future analyses with HNMRP data, a GREAT deal of care must be taken when examining data in the individual participants' reports. Each participant submitted a number of different papers and reports. Some of these reports present only as measured data, some concern only a portion of their program, and some include data revisions. As such, the most current data set for each participant is not necessarily in their most recent submission. A list of the participants' submittals can be found in the reference section of this report, just prior to the appendices.

In preparing this report the HNMRP Program Coordinator's Staff has gone to great lengths to attempt to get all of the numbers right. However, given the number of reports submitted, the variety of different reporting formats, language barriers, and numerous other problems there may yet be errors.

Below is a summary table of the HNMRP, Table 5.0.A. Included in the table is a list of those who participated in the HNMRP, both certificating authorities and manufacturers. This list includes Brazil which acquired certification experience by performing a practice noise test, but was unable to participate in a full repeatability noise test program.

Table 5.0.A

ICAO HELICOPTER NOISE MEASUREMENT REPEATABILITY PROGRAM

NATIONS WHICH ACQUIRED CERTIFICATION EXPERIENCE:

AUSTRALIA
BRAZIL
CANADA
FRANCE
FEDERAL REPUBLIC OF GERMANY
ITALY
JAPAN
UNITED KINGDOM
UNITED STATES

NOISE MEASUREMENT - FLIGHT TEST PROGRAMS CONDUCTED (in chronological order):

July	2- 6, 1984	UNITED KINGDOM - FEDERAL REPUBLIC OF GERMANY
August	27-29, 1984	UNITED STATES - CANADA
September	13-14, 1984	AUSTRALIA
October	16-17, 1984	FRANCE STNA - FRANCE AEROSPATIALE - ITALY
December	1- 2, 1984	JAPAN

AIRCRAFT & HELICOPTER MANUFACTURERS WHO PARTICIPATED IN TESTING & EVALUATION:

AEROSPATIALE
AGUSTA
BELL TEXTRON
BRITISH AEROSPACE
DE HAVILAND OF CANADA
KAWASAKI
SIKORSKY
WESTLAND

TOTAL NUMBER OF FLIGHT TEST RUNS CONDUCTED: 529

5.1 AUSTRALIAN TEST PROGRAM

The Australian test program was conducted by the Australian Department of Aviation, Airways Division at Mangalore Airfield in Victoria, Australia on the 13th and 14th of September 1984. Mangalore is approximately 100 km north of Melbourne. Taking into account their geographical location, the Australians found it impractical to arrange for a joint program with another nation.

5.1.1 Weather

Since the tests were scheduled for the end of the Australian winter, suitable weather was a very important concern. The 13th, however, proved to be a fine, still morning with no frost, light winds and little cloud cover. The following test day was calm and significantly colder, with visible ground frost. That day there was a delay, however, to allow the temperature to stabilize as the frost melted. All in all, the weather for the tests was fine and sunny.

5.1.2 Operations

The Australian test program included the ICAO certification level flyover, approach and takeoff as well as:

117 kts level flyover operations at 250 and 350m;
150m level flyover operations at 104 and 91 kts;
six degree approaches at 40 and 77 kts;
the Bell "Quiet" approach operation;
a six degree approach without guidance; and
a static flight idle operation

5.1.3 Pilot

Flight test operations were performed by a single test pilot.

5.1.4 Test Helicopter

The test helicopter used during the Australian test was a Bell 206L-1. Table 5.1.A is a summary of the information available concerning the particular helicopter tested.

5.1.5 Test Site Array

The Australian flight operations test site array, shown in Figure 5.1.A, consisted of the three certification measurement sites and the additional centerline site requested in the HNMRP test plan. For the static test there were the two requested sites located 150m away from the hover site, one over a hard propagation path, the other over a soft propagation path. The three photographic sites were placed in line with the centerline path at 150m intervals.

Figure 5.1.A

Australian Test Site Array

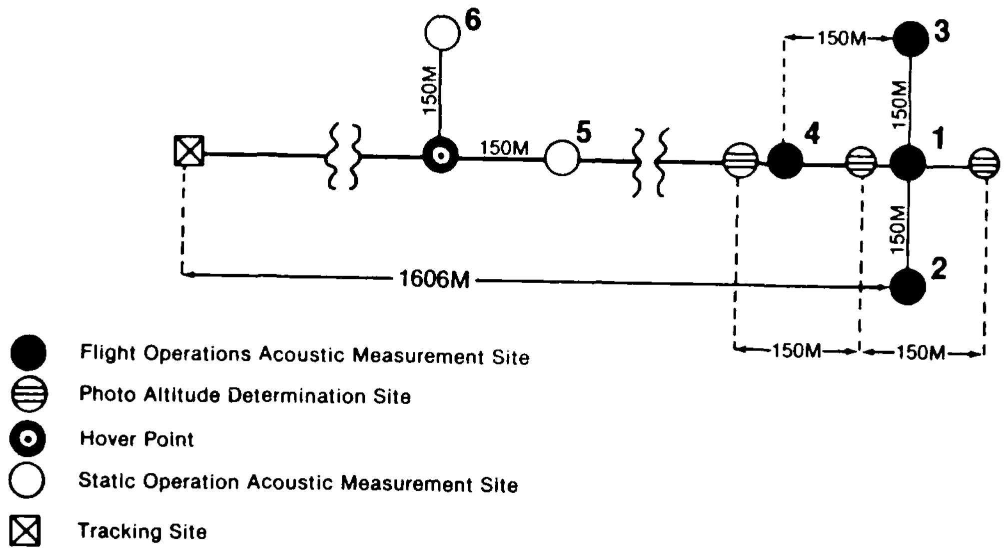


Table 5.1.A

Registration Number	VH BJY
Serial Number	45387
Engine	Allison 250-L28B

Maintenance History

Engine	1482 hours
Rotor hub	1482 hours
Rotor hub since overhaul	282 hours
Rotor	1482 hours
Transmission	1482 hours

5.1.6 Equipment

5.1.6.a Acoustic Equipment

A dual microphone system was deployed by the Australian team at their centerline-center site. This equipment, shown in Figures 5.1.B and 5.1.C, sent 1.2 m microphone data to one track of the Nagra recorder and ground microphone data to the other track. Single microphone systems were used at all of the other noise measurement sites.

All equipment used in the measurements was, whenever possible, calibrated and was tested in accordance with ISO Standard 3891 or to standards referenced in ISO 3891, principally IEC Standard 561.

Australian Noise Measurement/Recording System Instrumentation

Figure 5.1.B

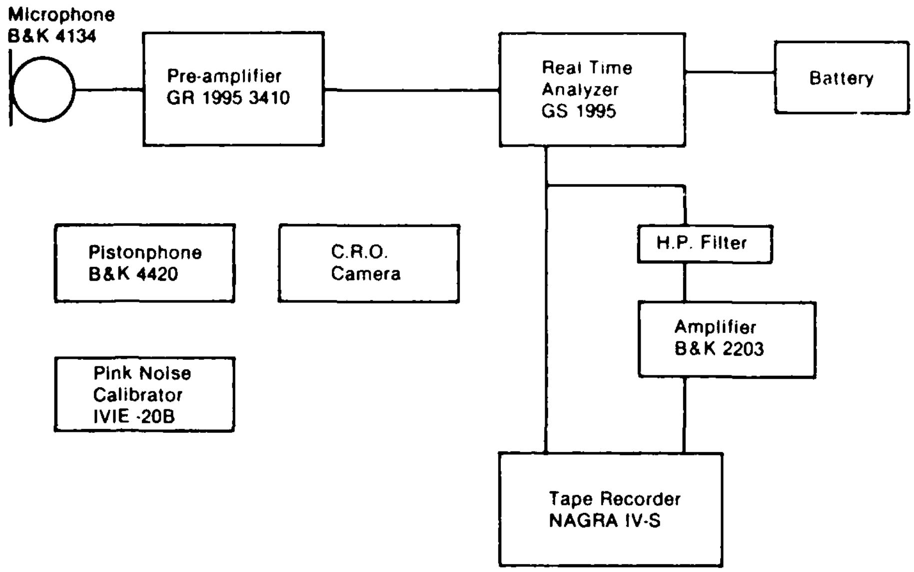
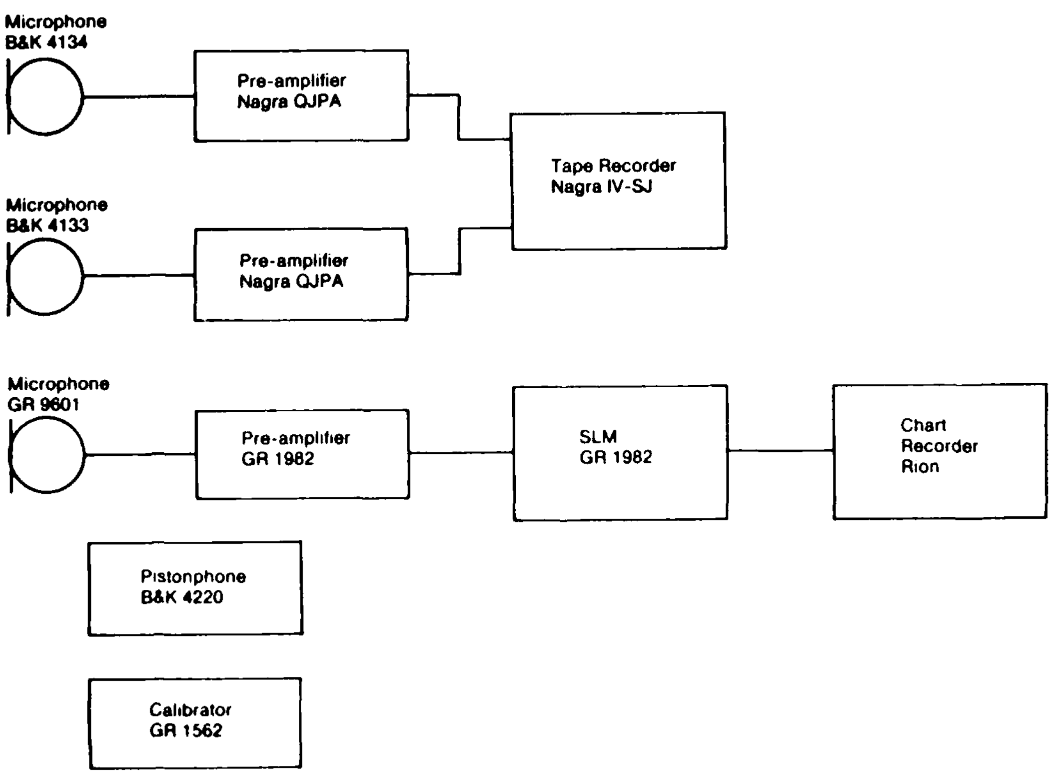


Figure 5.1.C



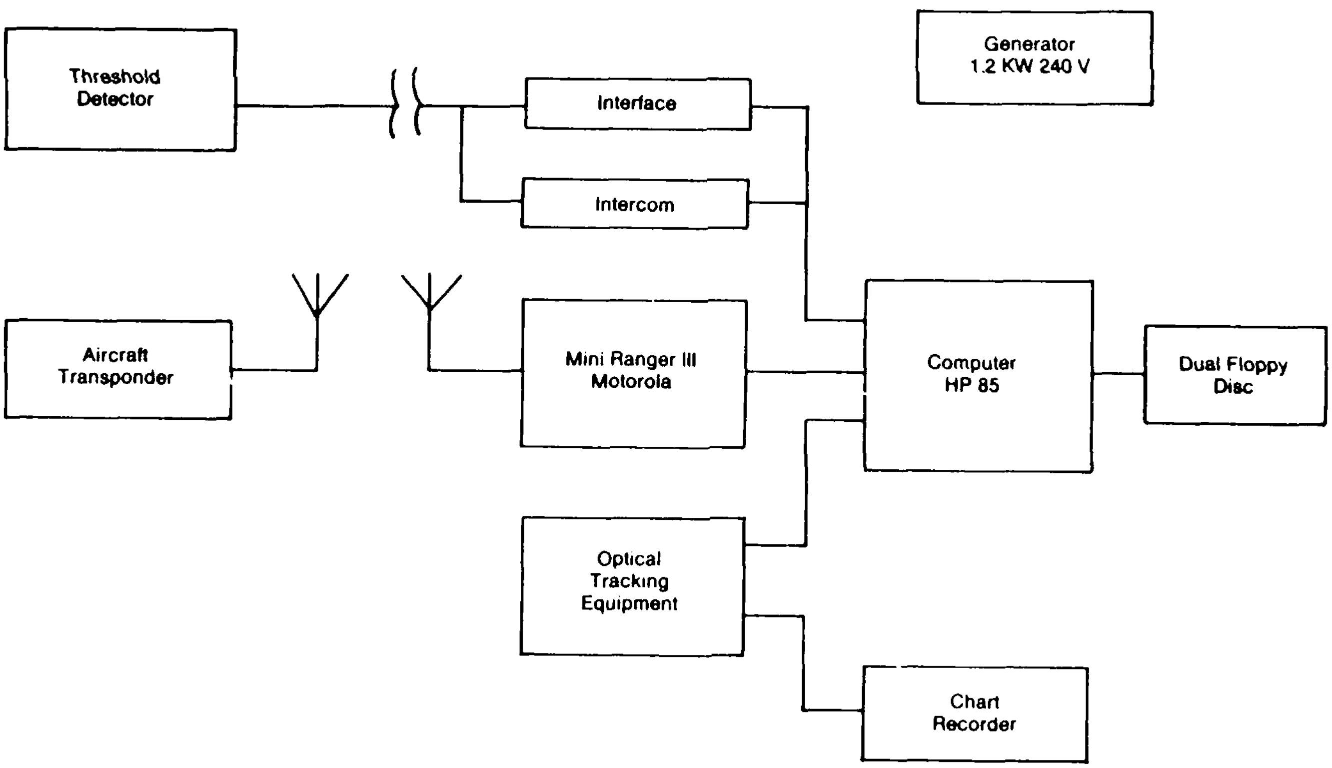
Sound level meters were tested in accordance with Australian Standard AS 1259-1982 based on IEC 651. The B&K type 2203 meters used were built to conform to a previous standard (IEC 179) and were not able to strictly conform to the detection requirements of IEC 651. The B&K 2204 meters failed to meet the noise level requirements on the lowest scale. Since the tests were not dependent on these functions of the instruments, the units were considered satisfactory for the tests.

5.1.6.b Tracking Equipment

The tracking system used during the Australian test program, shown in Figure 5.1.D, was developed by the Australian Department of Aviation, Airways Division Systems Branch and was composed entirely of existing Australian Department of Aviation equipment. The optical electronic tracking equipment used in the system was originally developed to test Instrument Landing Systems. As modified this equipment provided a readout of azimuth and elevation angles at a rate of 20 samples per second. The unit can electronically track a light mounted in the aircraft, however, during this test program it was used in the manual mode.

Figure 5.1.D

Australian Aircraft Tracking System



For tracking, a small transponder unit (part of the radar distance measuring Mini Ranger III) was placed in the aircraft and was powered by the aircraft's auxiliary supply. This unit, uses a small external antenna on the aircraft to transmit to a horn antenna on the receiver-transmitter-measuring unit located at the tracking site.

A threshold detector was also used as part of the tracking system. Situated at the centerline-center site, it put a short on the telephone line to the tracking site when the aircraft passed through the vertical fan-shaped beam. The time of this event was detected by the instrument at the tracking site and recorded. The time over centerline-center was also independently available from the distance measuring equipment at the tracking site.

5.1.6.c Photo Altitude Determination System

The tracking equipment described above was an untried system with unknown reliability in the field. It was therefore considered necessary to have a fairly good back-up system. A photo-scaling system similar to the one described in the US FAA reports on helicopter noise measurements was used.

5.1.6.d Meteorological Equipment

The Australian Bureau of Meteorology was responsible for measuring atmospheric conditions during the tests.

Continuous wind measurements were made throughout the trial period at a height of 10 meters using a Lambrecht Woelfle anemograph. This gave a continuous record of wind direction and wind run. Wind speed was derived from wind run.

At ground level, one meter, measurements of temperature and humidity were also taken.

Upper atmosphere data was obtained from instrumentation carried by a tethered balloon which was reeled up and down between the ground and 300 meters. Additional measurements up to a height of 2000 meters were made using a radio sonde. Both the tethered balloon and the radio sonde were tracked with a theodolite. The position of the tethered balloon was calculated from the theodolite angles and the length of tether line. The position of the radiosonde was calculated from the theodolite angles and height information derived from the temperature and pressure records.

5.1.6.e Cockpit Data Documentation

A color video recorder and camera were used to record the instrument readings on the pilots console during the tests. The camera was a normal commercial unit with a built-in timer which was used to synchronize the helicopter instrument readings with the tracking and noise measurement results.

5.1.7 Noise Data Reduction

The initial analysis of the Australian acoustic tapes was carried out on a system which consisted of: a GR 1925 Multifilter, a GR 1926 Multichannel RMS

Detector and a PDP11 computer. This system, however, failed several times, so an alternative system was developed using a GR1995 real time analyzer and a Hewlett Packard HP85 computer. Unfortunately, this second system gave EPNL values approximately 1dB lower than the initial system.

While investigating the cause of the discrepancy between the two systems, the initial system was restored. It was decided to continue the analysis on the initial system in the hopes that the analysis would basically remain valid and a correction factor could be applied if it was found to be in error.

Fortunately, before the next failure of the initial system occurred the normalization test tapes from the HNMRP program coordinator were analyzed. The results of this analysis confirmed the differences between the two systems and it was concluded that the fault lay with the initial system. Subsequently, the final Australian data set was obtained using the GR1995/HP85 system.

5.1.8 Final Data Summary

The data in the "Australian Final Data Summary Table" (Table 5.1.B) came from the April 1986 Australian Submittal with the exception of the Tone Correction Values which came from the Australian June 1986 Telex. The three microphone average was calculated for all metrics and operations by the Program Coordinator's Staff using individual event data reported in the April 1986 Submittal.

Table 5.1.B

FINAL CORRECTED AUSTRALIAN DATA

	LEFT	CENTER	RIGHT	3MIC	STD.DEV.	90% CI
APPROACH						
EPNL	87.46	93.82	91.51	90.93	0.98	0.66
PNLTm	86.47	93.83	91.39	90.57	1.11	0.74
ALm	71.95	80.80	77.99	76.92	1.11	0.74
SEL	NA	NA	NA	NA	NA	NA
LEVEL FLYOVER						
EPNL	88.82	89.69	87.42	88.65	0.72	0.39
PNLTm	90.16	92.22	88.30	90.23	0.61	0.33
ALm	75.69	78.27	74.74	76.24	0.56	0.31
SEL	NA	NA	NA	NA	NA	NA
TAKEOFF						
EPNL	87.89	89.55	87.63	88.35	0.39	0.17
PNLTm	88.97	90.39	88.21	89.18	0.48	0.21
ALm	73.72	75.90	74.14	74.58	0.62	0.27
SEL	NA	NA	NA	NA	NA	NA
DURATION P						
APPROACH	33.69	22.19	24.50			
LEVEL FLYOVER	20.86	14.27	23.18			
TAKEOFF	21.44	17.66	23.44			
DURATION A						
APPROACH	38.38	24.12	31.25			
LEVEL FLYOVER	22.59	15.04	24.05			
TAKEOFF	26.09	21.88	25.84			
TONE CORRECTION VALUE						
APPROACH	1.54	0.96	1.65			
LEVEL FLYOVER	1.55	1.54	1.47			
TAKEOFF	2.53	2.01	2.47			
TONE CORRECTION BAND		NA				
MAX NOY BANDS		NA				

STATIC FLIGHT IDLE

	0	45	90	135	180	225	270	315
HARD	72.2	72.00	74.50	72.20	NA	NA	NA	NA
SOFT	66.8	70.80	67.00	63.90	64.80	64.20	70.20	71.2

DATA CAME FROM THE APRIL 1986 PARTICIPANT SUBMITTAL WITH THE EXCEPTION OF THE TONE CORRECTION VALUES WHICH CAME FROM A JUNE 1986 TELEX.
THE 3 MIC AVERAGE WAS CALCULATED FOR ALL METRICS AND OPERATIONS BY THE PCG USING INDIVIDUAL EVENT DATA REPORTED IN THE APRIL 1986 SUBMITTAL.

5.2 JAPANESE TEST PROGRAM

The Japanese flight tests took place on the 1st and 2nd of December, 1984 at Utsunomiya Airport, 100 km north of Tokyo. The program was planned and coordinated by the Aircraft Nuisance Prevention Association of Japan.

5.2.1 Weather

The weather was generally cloudy both test days, with temperatures ranging from 7.8 to 14.9 degrees Celsius.

5.2.2 Operations

The Japanese flight test program consisted of 96 flights and 4 ground static noise measurements. Table 5.2.A is a list of the operations conducted.

Table 5.2.A

Japanese Test Program Flight Operations

Operation	Pilot	ID	Operation	Pilot	ID
ICAO Flyover	A	C1	ICAO Takeoff	A	A1
ICAO Flyover	B	C2	ICAO Takeoff	B	A2
ICAO Flyover Repeated	A	D1	ICAO 6 Approach	A	B1
ICAO Flyover Repeated	B	D2	ICAO 6 Approach	B	B2
0.8 Vne Flyover	A	F1	6 degree Approach No Guidance	B	E2
0.7 Vne Flyover	A	G1			
80m Vh Flyover	A	J1	Static Ground Idle		K
80m Vh Flyover	B	J2	Static Flight Idle		L
300m Vh Flyover	B	H2			

It should be noted that although the target flyover procedure called for 0.9 Vne (117 KIAS) and maximum continuous rpm (100%), the helicopter speed during the flyover operations were conducted at Maximum Continuous Power (85%) because the torque would have exceeded the airworthiness limitation (85%) (which has no time limitation).

5.2.3 Pilots

The core test program was performed by two pilots. Pilot A had 6,240 hours of flight time, while Pilot B had 1,810 hours. Included in Table 5.2.A are notations as to which pilot performed each operation.

5.2.4 Test Helicopter

The Japanese test helicopter was a Bell 206L-3. The Japanese were the only team to test the L-3 variation. Details of the particular helicopter tested appear in Table 5.2.B. A comparison of the general specifications of the Bell 206L-1 and L-3 appears in Table 3.1.A. As discussed in Section 3.0, the two helicopters are acoustically identical.

Before each event, the weight of the helicopter was adjusted to the specified weight (1,796 Kg ± 5%). During the flight test, fuel was supplied after each 100 Kg fuel consumption and at the same time the weight of the helicopter was re-adjusted using ballast.

Table 5.2.B
HELICOPTER DETAILS

Helicopter Model	Bell 206L-3
Registration Number	JA9361
Serial Number	51028
Engine	Allison 250-C30P

Maintenance Status	Cycle	Time Since Last Maintenance
Track & Balance of Rotor System	100 Hr X 1	4.10
Power Plant	100 Hr X 1	4.10
Rotor Hub	100 Hr X 1	4.10
Transmission	100 Hr X 1	4.10

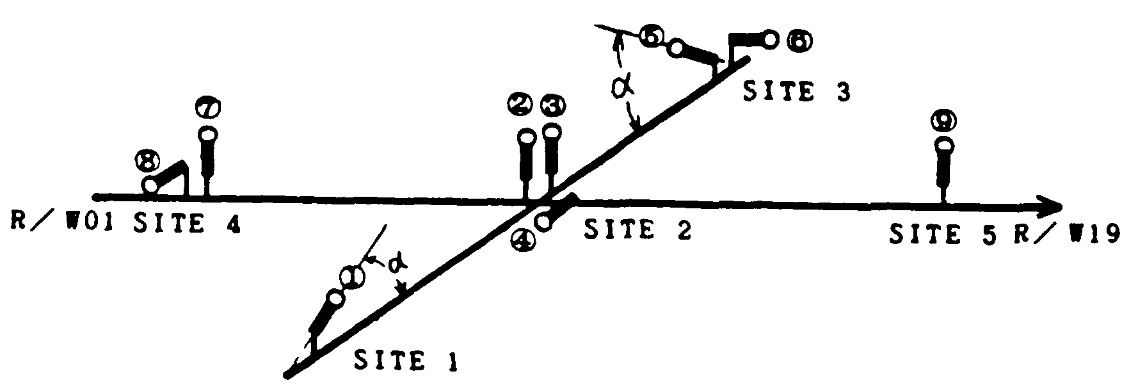
Hours of Use (as of Dec. 1, 1984)

Power Plant	94:13
Body	99:13

5.2.5 Test Site Array

Figure 5.2.A is a diagram of the Japanese test site array. The ground surface of the test area was generally flat and covered with short cropped grass.

Figure 5.2.A



The acoustical measurement sites for flight operations consisted of three centerline sites (5, 2 and 4) and two sideline sites (1 and 3). The centerline-center site was equipped with a ground and a 1.2 m microphone. Sideline site 1 and centerline site 5 were each equipped with a single 1.2 m microphone. Sideline site 3 and centerline site 4 were equipped with two 1.2 m microphones. (The microphone array and equipment used are discussed further in Section 5.2.6.f.)

The test site array for static operations consisted of hard and soft propagation path sites at a distance of 150 m from the hover site.

The takeoff rotation point was located 500m from the centerline-center site. Visual cues to define the point were provided in the form of a red "X" and white lines. To assist the pilots in maintaining the centerline flight path, red and white lines were also provided at various positions along the centerline.

5.2.6 Equipment

5.2.6.a Approach Guidance System

To provide visual guidance during the approach operations, a standard Precise Approach Path Indicator (PAPI) system was used. The PAPI was located 1,140m from the centerline-center microphone position. Due to the short distance from the PAPI lights to the helicopter during the test, only two of the PAPI's four standard light units were used. The two light units were located 2.5 m to the left and right of the centerline. The pilots saw a red or a white light depending on the helicopter's position. The system used provided vertical displacement information within ±0.25 degree of the reference approach slope.

5.2.6.b Photo Altitude Determination System

The system used was in accordance with the standard photo altitude determination systems used in the Australian HNMRP test and US FAA tests.

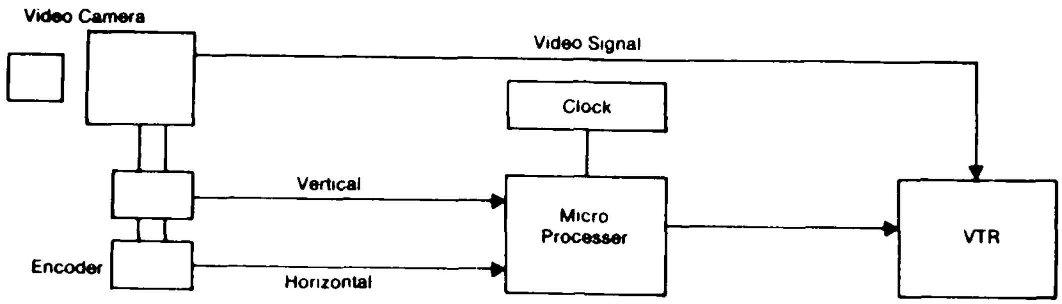
5.2.6.c Video Tracking System

Continuous tracking information was gathered using a video recording system (shown in Figure 5.2.B) that employed two video cameras. The helicopter was tracked by the cameras throughout each event and the relative helicopter position was measured by angles of elevation and azimuth from the position of each video camera unit. This information was recorded on a VTR tape at one-second intervals.

Calibration of the tracking system was performed several times using a static object of known height and distance. The accuracy of height was ±1.0% and the accuracy of location was ±0.5% to a distance of 500m. The reference position was taken to be the center of helicopter cabin.

Figure 5.2.B

Japanese Video Tracker Instrumentation



5.2.6.d Cockpit Data Documentation

Helicopter instrument performance documentation was gathered during each event using a video camera inside the helicopter to record the cockpit instruments and a calibrated watch.

5.2.6.e Meteorological Data Measurement Systems

Wind speed, wind direction, temperature and relative humidity were measured at a height of 10 m above the ground.

Temperature and relative humidity data were measured from the helicopter while it maintained level flight.

Upper air wind speed and wind direction data, from 100m to 300m AGL, were measured by sondes. The wind speed/direction instrumentation (type PR550TC) was manufactured by Ogasawara Instruments.

5.2.6.f Acoustical Measurement Instrumentation

The Japanese used RION Precision Integrating Sound Level Meters (PISLM) (types NA-60/61 and NL-11) and Kudelski NAGRA IV SJ tape recorders. With both 1/2 inch diameter "free field type" condenser microphones were used. The Japanese were obliged to use the "free field type" microphones because "pressure type" microphones were not available in Japan. As a result, the microphone type and their setting angles deviated from Annex 16 requirements.

In regards to this deviation, the Japanese sent the Program Coordinator one of the RION systems, with "free field" microphone, to examine along with background technical information.

The data concerning the RION system was examined by the Program Coordinator and the system was subsequently tested along with two GenRad PISLMs with "pressure type" microphones.

Concerning normal versus grazing response microphone settings, the examination showed that at frequencies below 100 Hz there is virtually no difference in response of the RION NA-60 system regardless of the acoustical incidence angle. For incidence angles ±45 degrees to normal the examination showed the correction factor remains zero for frequencies below 4000 Hz. At 90 and 270 degrees there may be a small correction (less than 1 dB) in the 3150 Hz region which should be considered for the duration adjustment.

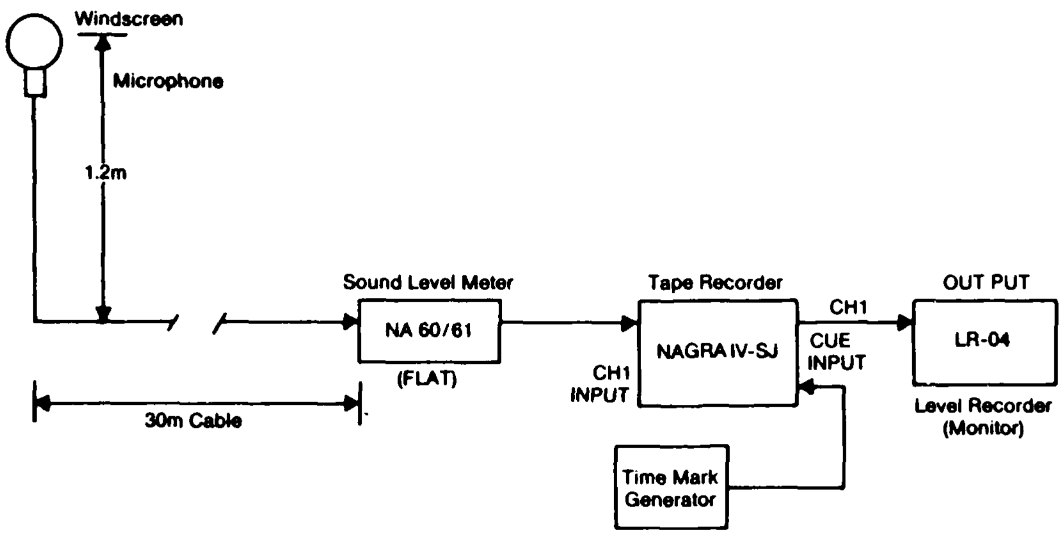
The examination further showed that considering microphone directional response characteristics, the dominant SPL Bands in the Bell 206L-1 (L-3) helicopter acoustical spectrum, and the angle of incidence for the acoustical maximum, additional corrections are not necessary to compensate for differences between the microphone used and microphones specified in Paragraph 3.2, Appendix 4, of ICAO Annex 16, Volume 1.

All of the acoustical measurement systems were calibrated by recording the standard noise produced by a pistonphone (250 Hz, 114 dB) for 30 seconds. This procedure was performed before the first flight and after the last flight for each test day.

The Japanese noise measurement instrumentation is shown in Figure 5.2.C.

Figure 5.2.C

Japanese Noise Measurement/Recording System Instrumentation



5.2.7 Noise Data Reduction

Reduction and correction of the recorded noise data was made in accordance with Annex 16 (as amended at CAN/7) and the "HNMRP Mid-Program Review-Advanced Phase Protocol" document.

5.2.8 Final Data Summary

The data which appears in Table 5.2.C, the Japanese "Final Corrected Data Summary," was derived from the Japanese May 1986 Participant Submittal. The only exception being the static data, which came from the Japanese September 1985 Report.

The three-microphone average for PNLTm approach, takeoff, and level flyover was calculated by the program coordinator's staff using individual event data reported in the May 1986 submittal. Delta 3 corrections were applied by the program coordinator staff to PNLTM level flyover data using individual event data reported with the May 1986 EPNL data tables.

Table 5.2.C

JAPAN FINAL CORRECTED DATA

PILOT 1	LEFT	CENTER	RIGHT	3MIC	STD. DEV.	90% CI
APPROACH						
EPNL	89.10	93.50	90.70	91.20	0.80	0.60
PNLTm	88.50	94.30	90.00	91.11	0.38	0.29
ALm	NA	NA	NA	NA	NA	NA
SEL	NA	NA	NA	NA	NA	NA
LEVEL FLYOVER P1-1						
EPNL	90.10	89.10	88.40	89.20	0.40	0.50
PNLTm	91.04	91.44	88.79	90.42	0.14	0.16
ALm	NA	NA	NA	NA	NA	NA
SEL	NA	NA	NA	NA	NA	NA
LEVEL FLYOVER P1-2						
EPNL	90.60	88.20	86.80	88.60	0.40	0.70
PNLTm	91.33	90.99	87.63	89.98	0.31	0.52
ALm	NA	NA	NA	NA	NA	NA
SEL	NA	NA	NA	NA	NA	NA
TAKEOFF						
EPNL	88.50	88.90	88.90	88.90	0.30	0.20
PNLTm	89.30	89.70	88.90	89.29	0.72	0.20
ALm	NA	NA	NA	NA	NA	NA
SEL	NA	NA	NA	NA	NA	NA

PILOT 2	LEFT	CENTER	RIGHT	3MIC	STD. DEV.	90% CI
APPROACH						
EPNL	89.70	93.70	91.50	91.60	0.80	0.50
PNLTm	88.00	95.40	91.20	91.55	0.64	0.39
ALm	NA	NA	NA	NA	NA	NA
SEL	NA	NA	NA	NA	NA	NA
LEVEL FLYOVER P2-1						
EPNL	90.40	88.40	87.90	88.90	0.60	0.70
PNLTm	91.93	91.87	89.01	90.93	0.38	0.44
ALm	NA	NA	NA	NA	NA	NA
SEL	NA	NA	NA	NA	NA	NA
LEVEL FLYOVER P2-2						
EPNL	91.50	89.10	87.70	89.40	0.40	0.50
PNLTm	91.87	91.50	88.35	90.57	0.16	0.19
ALm	NA	NA	NA	NA	NA	NA
SEL	NA	NA	NA	NA	NA	NA
TAKEOFF						
EPNL	88.10	90.00	88.70	88.90	0.50	0.30
PNLTm	88.70	91.40	89.30	89.80	0.56	0.35
ALm	NA	NA	NA	NA	NA	NA
SEL	NA	NA	NA	NA	NA	NA

Pilot 1				Pilot 2			
DURATION P	NA			DURATION P	NA		
DURATION A	NA			DURATION A	NA		
MAX NOY BANDS	NA			MAX NOY BANDS	NA		
TONE CORRECTION VALUE				TONE CORRECTION VALUE			
APPROACH	0.90	0.65	0.77	APPROACH	1.11	0.75	1.11
LEVEL FLYOVER P1-1	1.35	1.28	1.27	LEVEL FLYOVER P2-1	1.53	1.64	0.95
LEVEL FLYOVER P1-2	1.72	1.27	1.09	LEVEL FLYOVER P2-2	1.28	1.47	1.29
TAKEOFF	2.41	2.10	2.41	TAKEOFF	2.27	2.11	2.26
TONE CORRECTION BAND				TONE CORRECTION BAND			
APPROACH	24	25	26	APPROACH	27	25	27
LEVEL FLYOVER P1-1	23	23	22	LEVEL FLYOVER P2-1	20	23	22
LEVEL FLYOVER P1-2	20	23	22	LEVEL FLYOVER P2-2	20	23	22
TAKEOFF	22	22	22	TAKEOFF	22	22	22

STATIC FLIGHT IDLE

	0	45	90	135	180	225	270	315
HARD	71.70	77.80	77.90	77.30	73.90	75.20	75.00	75.50
SOFT	65.10	65.60	65.80	70.20	69.70	77.50	70.70	68.50

5.3 French - Italian Test Program

The French - Italian test program was conducted on October 16th and 17th of 1984 at la Fare-les-Oliviers aerodrome 40 Km northwest of Marignane, France. The primary measurement teams participating in the program were Service Technique de la Navigation Aerienne (STNA) and Aerospatiale from France, and Costruzioni Aeronautiche G. Agusta from Italy. The US also deployed one microphone system at the centerline-center location.

5.3.1 Weather

For the certification events the temperature ranged from 17 to 18 degrees Celsius, while the relative humidity ranged from 68 to 78.5 percent. For some events, there was some difficulty with the wind exceeding the test plan proposed limitations.

5.3.2 Operations

Table 5.3.A is a list of the operations conducted during the French-Italian test program.

Table 5.3.A

ICAO Flyover 150m, 0.9Vh (105kts)	Approach 12 degrees
Flyover 150m, 0.8Vh (94kts)	Approach 9 degrees
Flyover 150m, 0.7Vh (82.6kts)	ICAO Approach 6 degrees
Flyover 150m, Vh (118kts)	Approach 6 degrees Vy-20
Flyover 150m, Vy (57kts)	Approach 6 degrees Vy+20
Flyover 250m, 0.9 Vh (105kts)	Static Flight Idle
ICAO Takeoff 500m	Takeoff 600m

5.3.3 Pilot

Flight test operations were performed by a single test pilot.

5.3.4 Test Helicopter

The test helicopter was a Bell 206L-1 leased from la Societe Heli-Air-Monaco (registration number 3AM SX).

5.3.5 Test Site Array

The test site array varied in number and location of sites depending on the operation conducted. Figures 5.3.A, 5.3.B, and 5.3.C depict the test site arrays for the takeoff, level flyover and 6 degree approach operations, as presented in the Aerospatiale submittals. Throughout the program each of the primary measurement teams operated measurement systems at the noise certification sites.

Figure 5.3.A

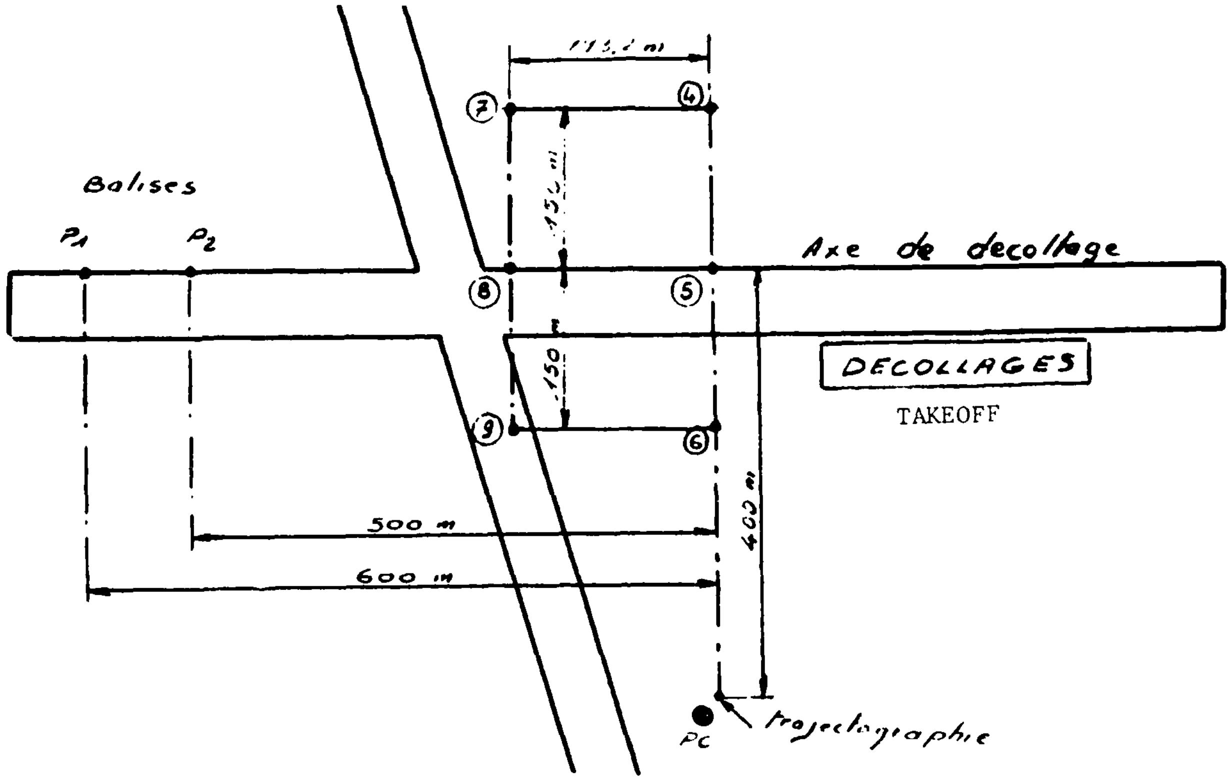


Figure 5.3.B

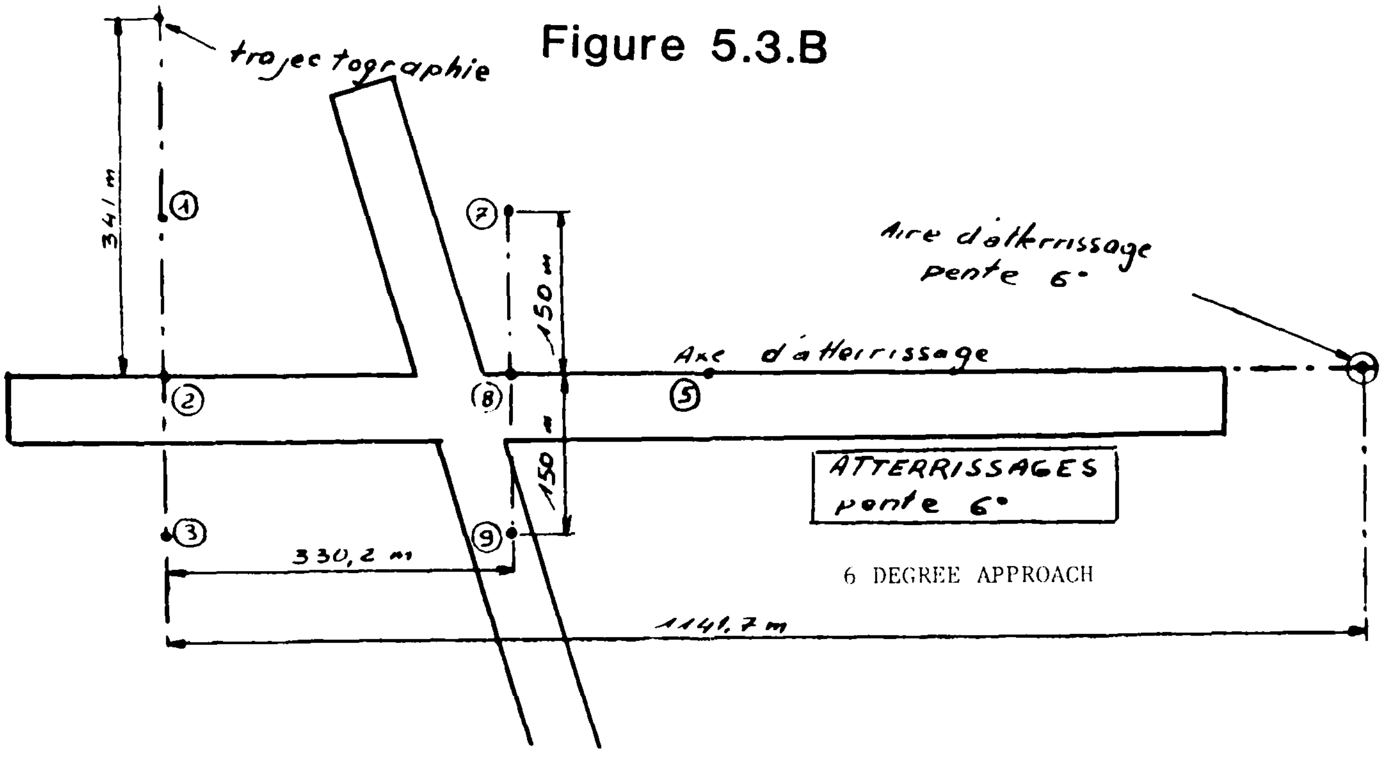
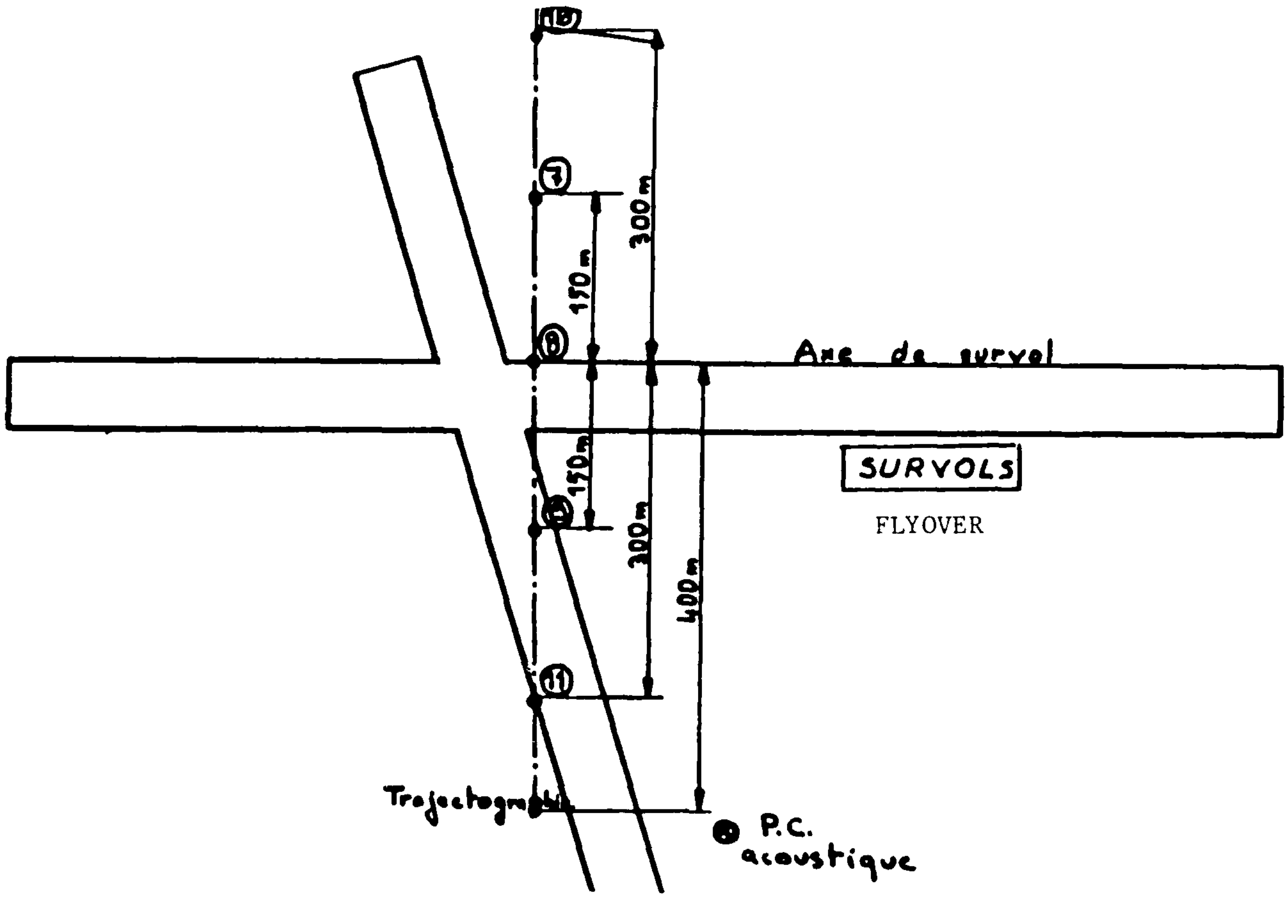


Figure 5.3.C



The ground surface of the test site area was composed of sparse grass on a clay base, which provided a very flat and homogeneous surface.

5.3.6 Joint Program Features

5.3.6.a Cockpit Data Documentation

Helicopter performance characteristics were documented during the French-Italian test by use of a cockpit videotape system similar to those used in other HNMRP flight test programs.

5.3.6.b Tracking System

Tracking data was acquired during the French-Italian test by STNA using a time-code-synchronized camera system composed of three cameras. The first camera was positioned at the centerline-center site to give altitude (within 3 meters). The second camera, located at the far end of flight path, monitored deviation from the reference flight track by the operator shooting the picture when the aircraft was orthogonal to the centerline-center site. The third camera, essentially a photo-theodolite, was positioned on the sideline and provided helicopter azimuth and elevation.

5.3.6.c Meteorological Data Measurement Systems

During the French-Italian flight test program a 10 meter meteorological tower was used to measure: temperature, relative humidity, wind speed and wind direction.

5.3.6.d Approach Guidance System

A theodolite system was used during the tests for approach guidance.

5.3.7 Italian Test Team

Although the Italian Costruzioni Aeronautiche G. Agusta team was one of the primary independent measurement teams, they had a series of unfortunate equipment failures which resulted in the loss of their independently acquired noise data. As such, Italian data does not appear in the analyses presented in this report. They did, however, analyze a copy of the Aerospatiale noise tapes. A comparison of the Aerospatiale and Agusta data reduction results would be very interesting, providing insight into the data reduction and processing differences between the Aerospatiale and Agusta laboratories.

5.3.8 Aerospatiale Test Team

The Aerospatiale team, while performing all of the HNMRP requirements, included a variety of different enhancements in their test program. First of all, they deployed several measurement systems where two separate microphones fed data into a single Nagra recorder. Secondly, they deployed an additional set of measurement sites (a centerline and two sideline sites) for the takeoff and approach operations--see Figures 5.3.A and 5.3.B. Thirdly, they analyzed their data by both the ICAO Annex 16 procedures and an alternative method. This report presents only the data requested by the HNMRP. Examination of the Aerospatiale enhancement exercises would be a very worthwhile future work item.

5.3.8.a Aerospatiale Final Summary Data

Table 5.3.A is a presentation of the Aerospatiale final summary data. This data was derived from a facsimile communication with Aerospatiale dated March 24, 1987 and from the April 1986 submittals.

5.3.8.b Aerospatiale Program Notes

The following are notes which the Aerospatiale requested be included in the final HNMRP report.

The French-Italian ICAO 6 degree approach flights were performed under wind conditions which exceeded the 5 kts maximum specified by the HNMRP. It is the feeling of Aerospatiale that, "These weather conditions considerably disturbed the paths followed and subsequently the pulse noise generation, which is the characteristic feature of this phase of flight....If these approach phase measurements had been made for a helicopter certification instead of an acoustic repeatability program study, they would not have been presented by Aerospatiale."

They further went on to state, "We believe that the approach measurement results obtained by Aerospatiale in 'outside standards' conditions for a helicopter displaying particular characteristics in this flight phase cannot be integrally included in the HNMRP comparisons without introducing in the statistic study a variance that might alter the repeatability conclusions. So in order to prevent the effects of these variations and to provide measurement results representative of the ICAO reference conditions: 6 degree slope, selection was made among all the available measurement points. Hence: flights 100-101-103, microphones 1/2/3."

Concerning the Aerospatiale submittals: The April 1986 data submittals are a complete presentation of as-measured data adjusted for ambient noise levels. The "Summary Report" presents corrected data with an "average correction" method. Aerospatiale Annex 16, Chapter 8, Appendix 4 corrected results are unpublished, but were transmitted to the HNMRP Program Coordinator in a March 24, 1987 telex. For flyover and takeoff the 3-microphone average noise levels are the same for the Annex 16 correction and for the simplified method.

5.3.9 STNA Test Team

The STNA team deployed Nagra measurement systems at the certification test sites. Recorded noise data reduction was made in compliance with the procedures detailed in the HNMRP reference documentation.

Table 5.3.B is a presentation of the STNA final summary data as confirmed by a November 26, 1986 telex.

5.3.10 Additional Information

The information used to prepare this chapter was derived from the STNA, Aerospatiale, and Agusta participant submittals, as well as from an audio tape made by the HNMRP Program Coordinator during the actual test.

Table 5.3.B

FRANCE AEROSPATIALE FINAL CORRECTED DATA

	LEFT	CENTER	RIGHT	CMID	STD DEV	90% CI
APPROACH						
EPNL	86.10	92.20	89.40	89.20	0.84	1.42
PNLTm	88.60	94.70	9[illegible].10	9[illegible].50	1.22	[illegible]
ALm	NA	NA	NA	NA	NA	NA
SEL	NA	NA	NA	NA	NA	NA
LEVEL FLYOVER						
EPNL	87.90	88.40	86.30	87.70	0.36	0.42
PNLTm	90.70	91.20	89.00	90.20	0.64	0.75
ALm	NA	NA	NA	NA	NA	NA
SEL	NA	NA	NA	NA	NA	NA
TAKEOFF						
EPNL	85.70	88.40	87.40	87.20	0.64	0.52
PNLTm	85.50	89.90	88.80	88.00	0.86	0.71
ALm	NA	NA	NA	NA	NA	NA
SEL	NA	NA	NA	NA	NA	NA

DURATION P			
APPROACH	25.30	17.80	23.20
LEVEL FLYOVER	15.10	12.90	16.90
TAKEOFF	25.80	15.10	21.50
DURATION A			
APPROACH	27.50	19.00	23.30
LEVEL FLYOVER	16.40	12.00	15.90
TAKEOFF	29.40	20.80	26.10
TONE CORRECTION VALUE			
APPROACH	1.30	1.00	1.00
LEVEL FLYOVER	2.10	1.30	1.40
TAKEOFF	2.50	2.20	2.50
TONE CORRECTION BAND			
APPROACH	27.7	25	22
LEVEL FLYOVER	22	22	22
TAKEOFF	22	22	22

MAX NOY BAND NA

STATIC
HARD

0	45	90	135	180	225	270	315
70.9	71.4	71.9	69.7	67.9	68.2	70.[illegible]	72.[illegible]

*FOR STATIC 270 DEGREE ANGLE THE NUMBERS SHOWN ARE AVERAGES OF TWO 270 DEGREE EVENTS

Table 5.3.C

FRANCE STVA FINAL CORRECTED DATA

	LEFT	CENTER	RIGHT	CMID	STD DEV	90% CI
APPROACH						
EPNL	85.[illegible]	91.4[illegible]	88.7[illegible]	88.[illegible]	[illegible]	1.4[illegible]
PNLTm	85.[illegible]	92.4[illegible]	89.7[illegible]	89.47	1.3[illegible]	1.3[illegible]
ALm	71.5[illegible]	75.9[illegible]	76.5	76.[illegible]	1.2[illegible]	[illegible].9[illegible]
SEL	81.7[illegible]	88.2[illegible]	86.7[illegible]	85.41	[illegible]	[illegible].5[illegible]
LEVEL FLYOVER						
EPNL	85.7[illegible]	87.5[illegible]	87.9[illegible]	85.6[illegible]	[illegible].4[illegible]	0.5[illegible]
PNLTm	89.2[illegible]	91.[illegible]	86.80	89.[illegible]	[illegible]	[illegible].80
ALm	73.70	77.[illegible]	73.[illegible]	74.27	[illegible].50	[illegible].50
SEL	81.3[illegible]	87.80	80.30	81.97	0.7	[illegible]
TAKEOFF						
EPNL	84.7[illegible]	87.[illegible]	84.50	85.50	[illegible].40	0.[illegible]
PNLTm	85.[illegible]	89.[illegible]	85.9[illegible]	85.57	0.5[illegible]	0.40
ALm	71.9[illegible]	74.00	71.40	72.47	[illegible]	[illegible]
SEL	82.1[illegible]	87.50	81.[illegible]	82.[illegible]	0.70	[illegible].20

DURATION P			
APPROACH	26.70	19.1[illegible]	21.[illegible]
LEVEL FLYOVER	10.90	17.10	16.[illegible]
TAKEOFF	22.10	11.60	19.[illegible]
DURATION A			
APPROACH	29.10	19.60	23.40
LEVEL FLYOVER	15.00	11.80	12.00
TAKEOFF	23.70	14.90	21.00
TONE CORRECTION VALUE			
APPROACH	1.20	1.00	1.00
LEVEL FLYOVER	2.40	1.70	1.60
TAKEOFF	2.40	2.40	2.50
TONE CORRECTION BAND			
APPROACH	27	22	25
LEVEL FLYOVER	22	22	22
TAKEOFF	22	22	22
MAX NOY BANDS			
APPROACH	24,25,25	26,25,25	25,25,27
LEVEL FLYOVER	23,27,29	25,25,25	24,25,27
TAKEOFF	31,32,32	27,25,25	25,27,32

5.4 United Kingdom - Federal Republic of Germany Test Program

This section describes the joint United Kingdom / Federal Republic of Germany (UK/FRG) noise measurement flight test program carried out between July 2nd and 6th of 1984 at the British Aerospace Dunsfold Airfield in Surrey, England.

The overall UK/FRG program coordinator was from the UK Civil Aviation Organization (CAA). UK involvement was funded by the UK Department of Trade and Industry, and measurement teams were deployed by Westland Helicopters Limited (WHL) and British Aerospace (BAe). FRG participation came from the German Aerospace Research Establishment (DFVLR). The HNMRP program-coordinator was also present during the flight tests.

5.4.1 Weather

The flight tests were carried out in exceptionally good weather conditions, with sunny and warm weather throughout the test period. Cross winds during the early part of the flight tests, however, often exceeded the permitted range leading to aborted test runs. As a consequence, it was necessary to shift the measuring sites to another runway location during the program.

5.4.2 Operations

Table 5.4.A is a list of the operations conducted during the UK/FRG flight test program. Due to time constraints, the number of "good" flight events for the elective flight operations was reduced to four. Each flight condition was repeated a sufficient number of times to ensure the required 6 (or 4) "good", i.e. valid, runs.

The UK team was unable to measure the Pilot 2 level flyover and approach operations due to equipment problems.

It should also be noted that all of the level flyover tests series were performed at an airspeed significantly lower than the target airspeed. Under the prevailing conditions, the maximum speed in level flight VH (which is equivalent to the "Never Exceed Speed" VNE for the subject helicopter) could not be flown due to turbine outlet temperature limitations. Therefore, it was quite important to apply source noise adjustments.

5.4.3 Pilots

The pilots flying the test operations were: Pilot 1 from the UK CAA and Pilot 2 from Air Hanson Ltd of Weybridge, Surrey, England.

5.4.4 Test Helicopter

The helicopter tested was a Bell 206L-1 from Air Hanson Limited of Weybridge, Surrey, England.

Table 5.4.A

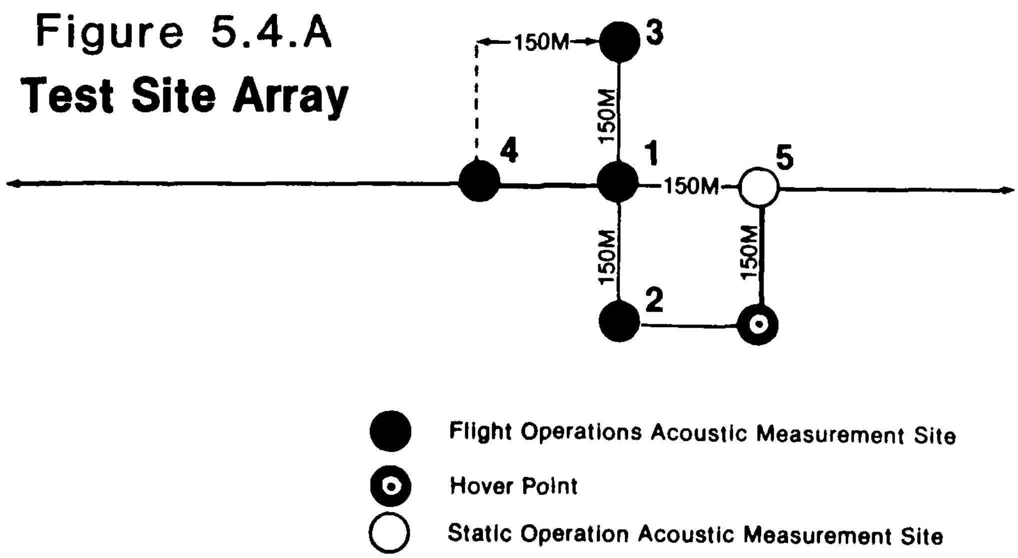
UK-FRG FLIGHT TEST PROGRAM

ID	PILOT	OPERATION	ID	PILOT	OPERATION
A1	1	TAKEOFF Vy	C1	1	6 DEGREE APPROACH Vy
A2	2	TAKEOFF Vy	C2	2	6 DEGREE APPROACH Vy
B1	1	FLYOVER 0.9 Vh	J1	1	6 DEGREE APPROACH Vy+20
B2	2	FLYOVER 0.9 Vh	J2	2	6 DEGREE APPROACH Vy+20
F	1	FLYOVER 0.7 Vh	K1	1	6 DEGREE APPROACH Vy-17
G	1	FLYOVER 0.8 Vh	K2	2	6 DEGREE APPROACH Vy-17
H	1	FLYOVER 0.9 Vh			
D	1	STATIC	P1	1	BELL REC. APPROACH
E	1	STATIC	P2	2	BELL REC. APPROACH
L1	1	9 DEGREE APPROACH Vy	R1	1	6 DEG. APP. NO GUIDANCE
L2	2	9 DEGREE APPROACH Vy	R2	2	6 DEG. APP. NO GUIDANCE
M1	1	9 DEGREE APPROACH Vy+20	N1	1	9 DEGREE APPROACH Vy-17
M2	2	9 DEGREE APPROACH Vy+20	N2	2	9 DEGREE APPROACH Vy-17

5.4.5 Test Site Array

The British Aerospace (BAe) airfield at Dunsfold, Surrey, England was selected as the location for the field test. The airfield included one operational and two unused runways, which allowed for five possible microphone array variations. As mentioned above, due to cross winds during the early part of the flight test it was necessary to shift the test site array to avoid continued problems. The relationship of sites to one another, shown in the general site array--Figure 5.4.A, was basically held constant throughout the test. (For takeoff and approach measurements site 4 was positioned at the low altitude centerline position.)

Figure 5.4.A
Test Site Array



Due to the number of measurement systems deployed, the layout around each acoustical measurement site (particularly the central measurement site) had to be carefully thought out such as to incorporate all of the different microphone configurations and cameras. Each microphone system was generally separated by a distance of 4 meters for the 1.2m microphones and 6 meters for the ground microphones. Care was also necessary for a proper electric cabling around each measurement site to accommodate the multi-channel FM system which was deployed by the FRG team. (This system was operated and powered from a central van and required long lengths of cables across the airfield.)

Synchronization between the different measuring teams and positions was provided by portable radios and referenced to IRIG B time standard.

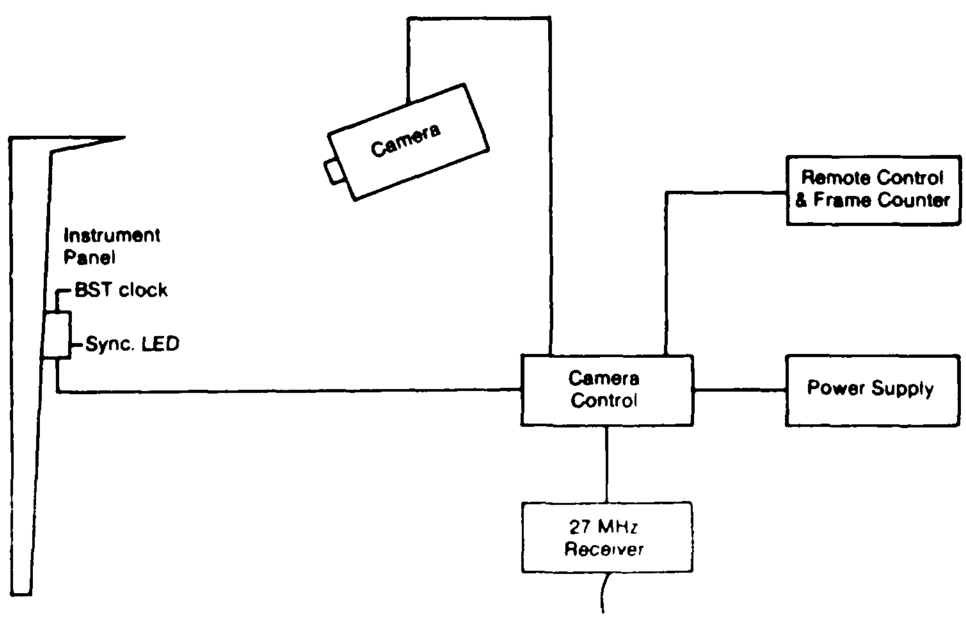
5.4.6 Joint Program Features

5.4.6.a Cockpit Data Documentation

A requirement introduced by the CAA, and strongly supported by the HNMPP Program Coordinator, was to record the cockpit instrument readings, at a rate of one-per-second, throughout each test flight. This requirement was fulfilled by the WHL team using a Vinten Scientic 16mm cine camera and associated equipment (operated from a 24 volt DC battery power supply). Figure 5.4.B is a schematic depiction of this system. The camera was mounted on the cockpit fire extinguisher mounting points, such that the entire instrument panel was in view. Film cassettes containing approximately 2000 frames could be fitted into the camera in situ under normal day light conditions. Each run was identified by holding a note pad, with the run number inscribed on it, in the camera field of view at the start of the run.

Figure 5.4.B

UK/FRG Cockpit Instrument Recording System



The cockpit photographs were synchronized to the acoustical measurements and tracking data using 27 MHz radio transmissions. When the ground cameras were operated they triggered a radio transmission which was picked up on the acoustical tapes and also caused a light mounted on the cockpit instrument panel to flash which was recorded by the camera.

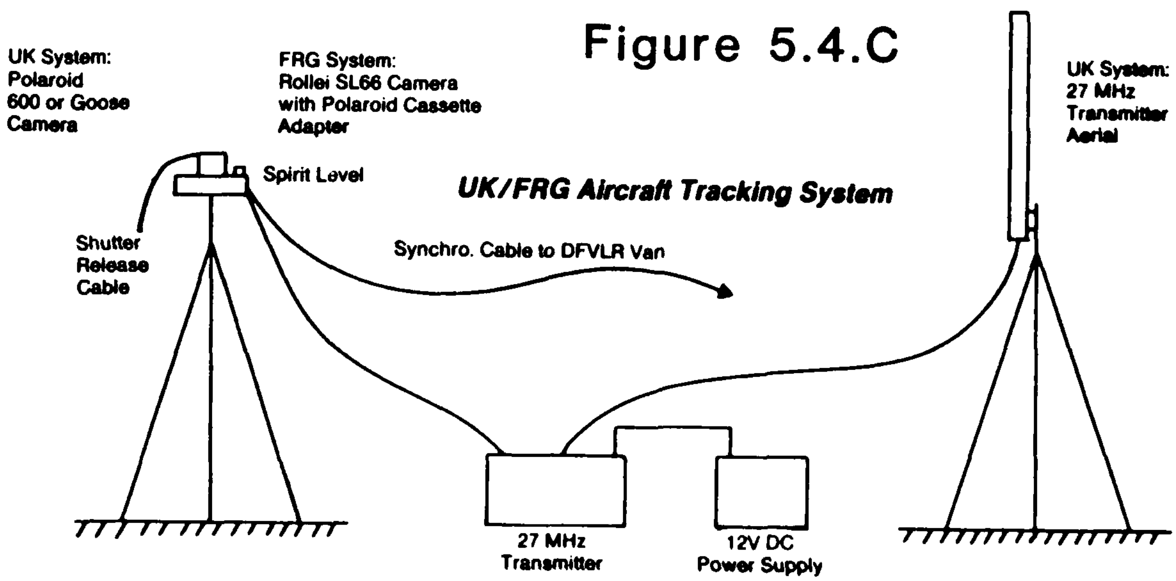
A video camera was also employed during the tests as a back-up for the cine camera. During each event, the flight observer also kept a record of the most important cockpit instrument readings. It should be noted that the cockpit IAS readings were in units of statute miles per hour (mph) instead of nautical miles per hour (kts).

5.4.6.b Tracking System

Tracking data was acquired for the UK/FRG test via a sophisticated photo altitude determination system, depicted in Figure 5.4.C. The system was synchronized (as mentioned above) to the other data measurement instrumentation systems with 27 MHz radio transmissions. The photometric scaling techniques utilized were applied separately by both teams; the FRG and UK teams operated two and three cameras, respectively.

All of the five camera stations were positioned along the flight track such that the "long edge" of the photographs would be parallel to the flight track. The exact positions of the two outboard UK-WHL stations depended upon the flight track used, but the two FRG-DFVLR stations--along with the central UK-BAe station--were always at fixed positions, namely 21 m uptrack, and 200 m and 15 m downtrack, respectively. The cameras were focussed at infinity and set at maximum shutter speed (1/500 sec) with the aperture adjusted to suit ambient light conditions. During a flight event, each camera when operated triggered a synchronization impulse which was transmitted to the recording stations. A photographic print was available shortly after the photographs were taken. Aircraft altitude and lateral and longitudinal displacement from the ideal flight path could thus be determined at each camera station by photo-scaling techniques. Images were measured using either an episcope or a travelling microscope. This unique on-site photo-scaling ability allowed timely track keeping verification.

Figure 5.4.C



Although the two teams informed one another of their results, each team used only their own results for the reduction and correction of their noise data; thus maintaining the policy of acquiring two independent sets of data.

5.4.6.c Approach Guidance System

The approach guidance system used for the UK/FRG flight test was a semi-portable Precision Approach Path Indicator (PAPI) supplied and operated by the UK team. The PAPI system used is essentially a two color light projector consisting of a lamp, red filter and lens positioned so as to project a beam of light, the upper half of which is white, the lower red. The system is comprised of two units, each of which has two lamps. The units were arranged at 90 degrees to the approach path centerline ground track, approximately 5 m to either side of the approach path origin. One unit was set such that the red/white boundary was at the lower limit of the desired approach angle, the other unit at the higher limit. Thus, the approaching pilot saw one red light and one white light if he was within the required glide slope limits, two whites if he was too high or two reds if he was too low.

Each unit was mounted on a rigid 't' frame which, for the purposes of this relatively short test, was placed firmly onto a flattened ground surface. This type of installation requires frequent checking of the set angles since the stability of a grass surface is questionable. It was found during the test that one unit did in fact move significantly during a long unattended period of several hours (reasons unknown). From then on the units were checked frequently at convenient intervals during testing.

5.4.7 Federal Republic of Germany Team

5.4.7.a Photo Determination System Equipment

The FRG-DFVLR ground tracking system employed two identical stations, each comprised of a Rollei SL 66 camera with 150 mm focal length lens and a Polaroid cassette adapter attached to the camera, all of which was mounted on a heavy tripod. Each camera was connected, via an electric cable, to the central noise measurement station in the acoustic van, where the synchronizing trigger signals were recorded.

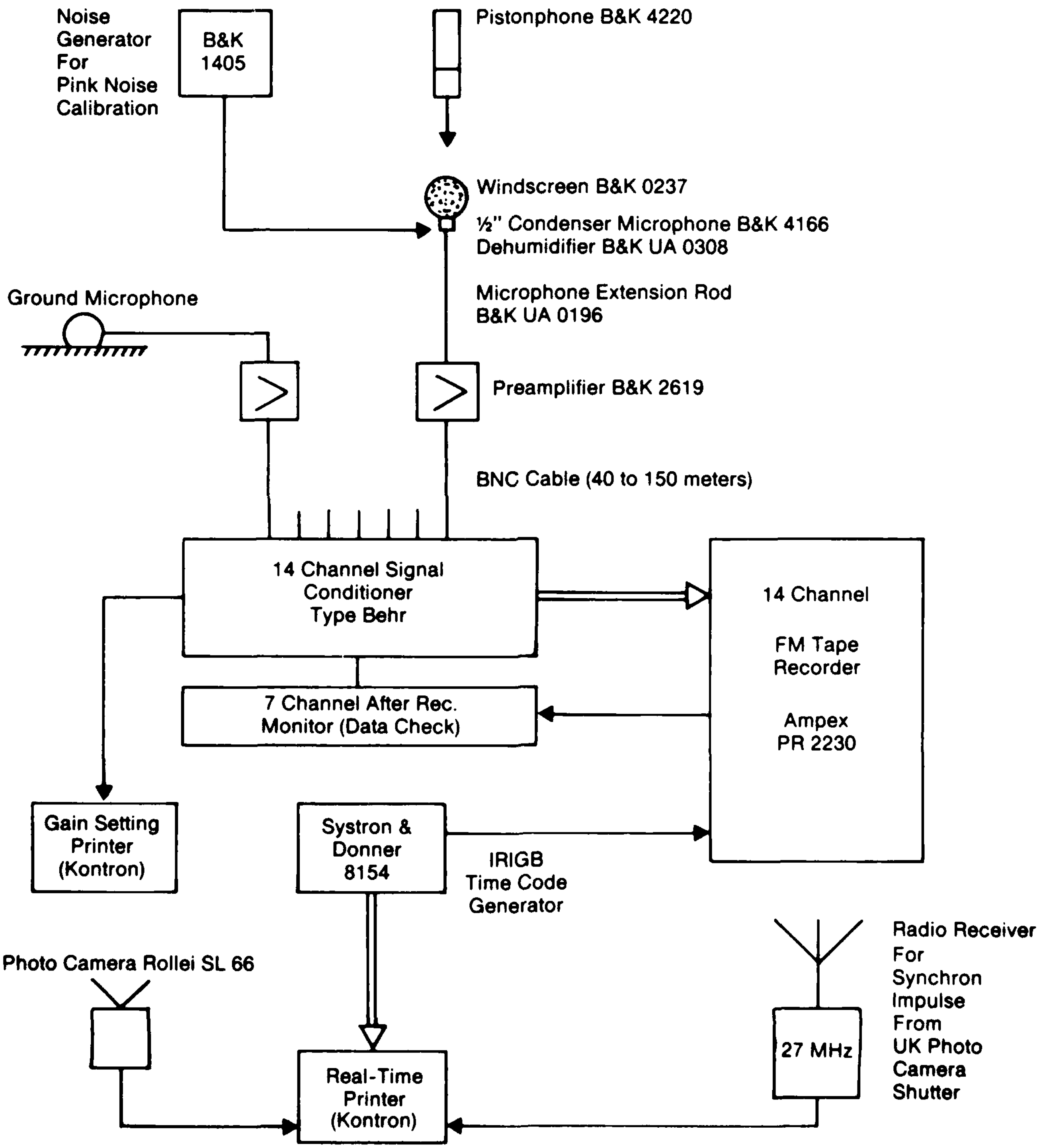
5.4.7.b Acoustic Data Acquisition

During the test the FRG team employed a central noise recording station to record the noise data from each of the FRG sites. This system, located in the DFVLR Acoustic Van, is comprised of a 14-track FM magnetic tape recorder, a 14-channel signal conditioning-and-monitoring unit (with automatic gain setting printer), and an IRIG B time-code generator. Figure 5.4.D. is a schematic diagram of the FRG acoustic data acquisition instrumentation.

For flight operations, the FRG-DFVLR team deployed a total of eight microphones. The centerline-center site was equipped with two 1.2 m and one ground microphone. The two sideline sites were each equipped with a 1.2 m and a ground microphone. A 1.2 m PISLM system was also at the centerline-center

Figure 5.4.D

FRG Acoustic Data Acquistion Instrumentation

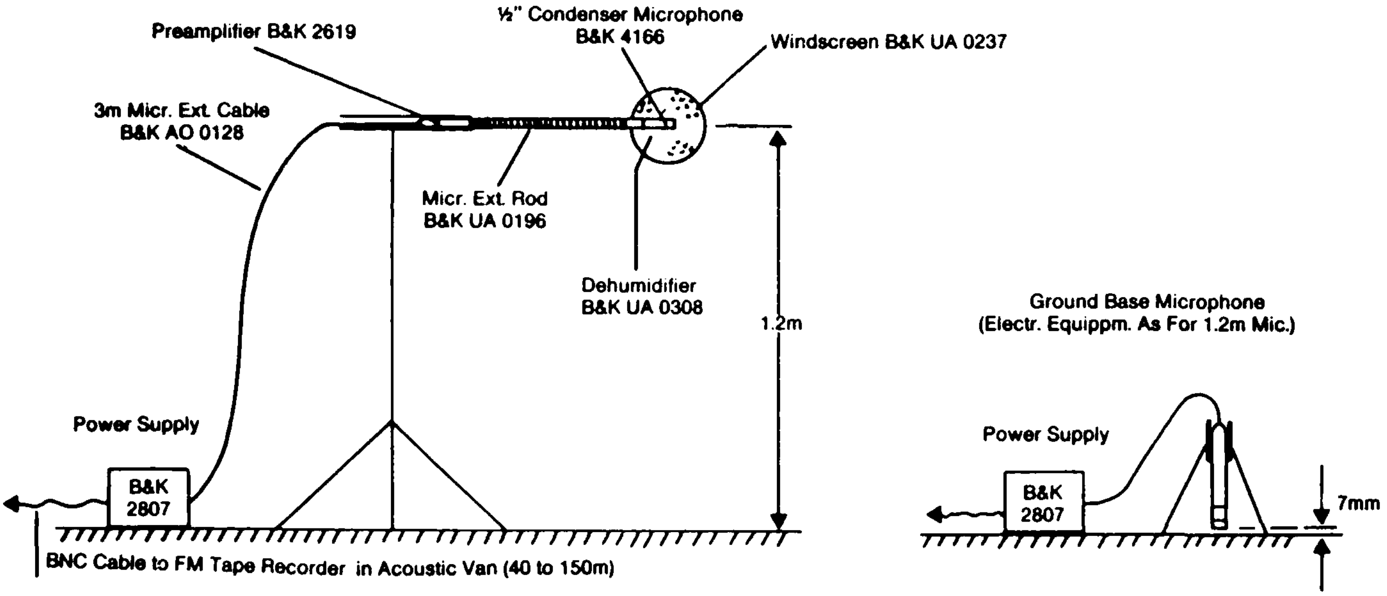


site. The final 1.2 m microphone was deployed at the additional centerline site--4. Data from each of these microphones fed into separate channels of the Ampex PR 2230 tape recorder contained in the DFVLR Acoustic Van. Figure 5.4.E depicts a typical FRG noise measurement station.

For static operations, 1.2 m recording system microphones were deployed at the 150 m soft and hard propagation path sites.

Figure 5.4.E

Typical FRG Noise Measuring Station



5.4.7.c Noise Data Reduction

Processing and analysis of the acoustic recordings were performed using the DFVLR Technical Acoustics Laboratory's data analysis system. This system is controlled by a LSI 11/25 micro processor which is linked by a 16-bit parallel interface to the local DFVLR computer center's VAX 11750. The VAX in turn is linked to the DFVLR IBM 4381 main computer, allowing access to output plotter and laser printer facilities. A schematic of the system and hardware used is shown in Figure 5.4.F.

Included in the FRG report was the following foot note:

> "Care should be taken when ALM and OASPLM results are compared between different laboratories. It should be noted how many one-third octave bands have been included in the calculation, since it was found that differences in level of approximately 2 dB(A) can occur for ALM and more than 6 dB for OASPLM, if all of the 42 bands of the one-third octave band analyzer instead of the recommended 24 bands are being used."

5.4.7.d Final Data Summary

The data which appears in the FRG "Final Corrected Data Summary", Table 5.4.B, was derived from the FRG December 1985 Report, with the exception of the static data and corrections to the approach data which came from a September 1986 Submittal.

Figure 5.4.F

FRG Data Analysis And Processing System

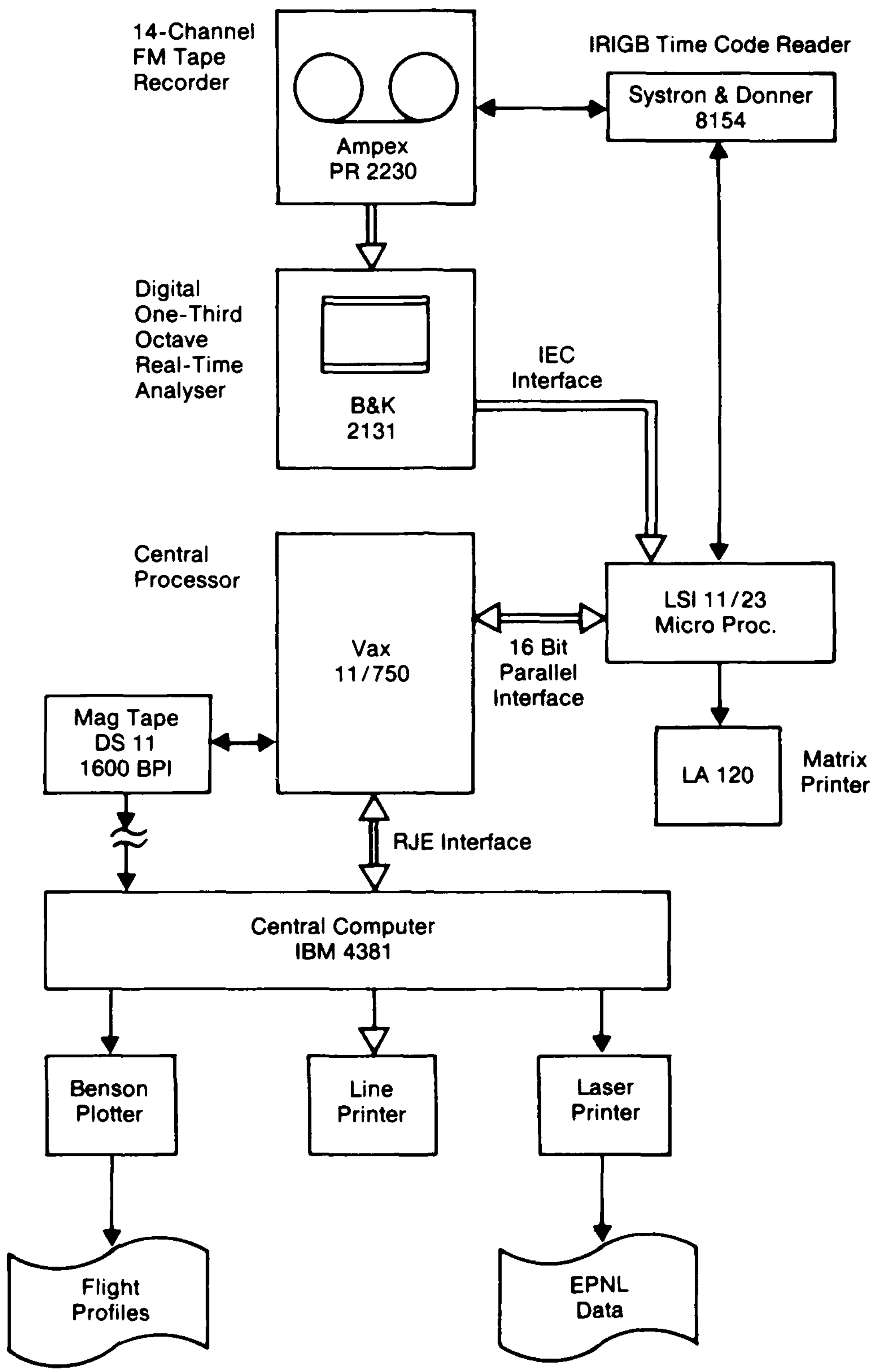


Table 5.4.B

FINAL CORRECTED DATA FEDERAL REPUBLIC OF GERMANY

PILOT 1	LEFT	CENTER	RIGHT	3MIC	STD. DEV.	90% CI
APPROACH						
EPNL	86.90	92.30	89.10	89.50	0.60	0.40
PNLTm	85.30	93.60	87.90	88.90	0.60	0.40
ALm	71.20	80.90	75.10	75.70	0.50	0.30
SEL	83.30	89.30	85.70	86.10	0.80	0.50
LEVEL FLYOVER						
EPNL	86.60	88.20	84.90	86.60	0.30	0.20
PNLTm	88.00	90.50	86.10	88.20	0.20	0.20
ALm	71.50	74.00	71.10	72.20	0.30	0.30
SEL	80.40	81.50	80.10	80.70	0.20	0.20
TAKEOFF						
EPNL	85.50	86.60	86.10	86.10	0.30	0.30
PNLTm	86.50	87.60	86.50	86.90	0.30	0.30
ALm	71.30	72.60	72.00	72.00	0.30	0.30
SEL	81.80	82.80	82.70	82.40	0.30	0.30
DURATION P						
APPROACH	39.40	19.50	39.40			
LEVEL FLYOVER	20.30	15.30	19.60			
TAKEOFF	22.30	18.20	22.40			
DURATION A						
APPROACH	42.10	17.20	36.70			
LEVEL FLYOVER	21.20	15.10	18.30			
TAKEOFF	27.00	21.80	24.50			
TONE CORRECTION VALUE						
APPROACH	1.10	0.70	1.30			
LEVEL FLYOVER	1.90	1.00	1.30			
TAKEOFF	2.80	2.20	2.30			
TONE CORRECTION BAND						
APPROACH	22	25	27			
LEVEL FLYOVER	22	23	23			
TAKEOFF	22	22	22			
MAX NOY BAND						
APPROACH	24,27,25		25,24,26		24,23,24	
LEVEL FLYOVER	22,29,32		24,26,27		22,32,25	
TAKEOFF	22,24,32		22,34,35		24,22,29	

PILOT 2	LEFT	CENTER	RIGHT	3MIC	STD. DEV.	90% CI
APPROACH						
EPNL	86.30	92.60	89.90	89.60	0.50	0.40
PNLTm	85.30	93.40	89.50	89.40	0.80	0.70
ALm	71.40	80.70	76.40	76.10	0.50	0.40
SEL	83.00	89.40	87.30	86.60	0.30	0.30
LEVEL FLYOVER						
EPNL	86.30	89.70	85.60	87.20	0.30	0.30
PNLTm	87.80	91.60	86.70	88.70	0.30	0.30
ALm	71.90	75.20	71.80	73.00	0.80	0.70
SEL	81.00	83.00	80.70	81.60	0.60	0.50
TAKEOFF						
EPNL	86.30	85.70	86.20	86.00	0.10	0.00
PNLTm	87.40	86.90	86.40	86.90	0.20	0.10
ALm	72.30	71.80	71.20	71.80	0.40	0.40
SEL	82.70	82.20	82.60	82.50	0.20	0.20
DURATION P						
APPROACH	36.80	25.20	32.30			
LEVEL FLYOVER	17.50	15.20	18.10			
TAKEOFF	22.20	15.30	19.60			
DURATION A						
APPROACH	39.70	20.30	34.40			
LEVEL FLYOVER	18.20	15.30	17.70			
TAKEOFF	25.80	23.80	27.00			
TONE CORRECTION VALUE						
APPROACH	1.00	0.70	1.30			
LEVEL FLYOVER	1.70	0.80	1.40			
TAKEOFF	2.90	2.30	2.40			
TONE CORRECTION BAND						
APPROACH	22	25	27			
LEVEL FLYOVER	22	23	27			
TAKEOFF	22	22	22			
MAX NOY BAND						
APPROACH	23,24,26		25,26,26		24,23,26	
LEVEL FLYOVER	22,32,NA		23,26,22		22,24.NA	
TAKEOFF	22.24.29		22,NA,26		22,24,29	

STATIC FLIGHT IDLE

	0	45	90	135	180	225	270	315
HARD	64.80	65.80	65.60	68.90	65.30	66.30	67.60	66.10
SOFT	54.00	59.20	59.40	63.70	57.50	59.80	59.50	56.10

THE DATA WHICH APPEARS IN THIS TABLE WAS DERIVED FROM THE FRG DECEMBER 1985 REPORT, WITH THE EXCEPTION OF THE STATIC DATA AND CORRECTIONS TO THE APPROACH DATA WHICH CAME FROM A SEPTEMBER 1986 SUBMITTAL.

5.4.8 United Kingdom Team

5.4.8.a Tracking Equipment

The UK ground tracking stations employed Polaroid 600 (or 600SE) cameras with 127mm lenses mounted on photographic tripods. Each camera was equipped with a 27 MHz radio transmitter, which when triggered produced an amplitude modulated carrier at 1kHz for approximately 1 second. This signal was picked up by 27 Mhz receivers connected to the auxiliary channel of the Nagra tape recorders at the adjacent acoustical measurement sites and within the helicopter.

5.4.8.b Acoustical Data Acquisition Instrumentation

For the UK participant, noise recordings were made by teams from Westland Helicopter Ltd., while direct read measurements (and weather data) were obtained by British Aerospace. For the purposes of this report, only the noise recorded measurements are discussed.

The UK measuring systems at the centerline-center measurement site consisted of a 1.2 m microphone system and a ground surface system, which fed into separate channels of the site's 2-channel Nagra tape recorder. The ground microphone was inverted with its diaphragm 7mm above a closely cropped grass surface. The three other noise measurements sites were each equipped with a single 1.2 microphone system. Figure 5.4.G is a schematic diagram of a the UK acoustical data acquisition instrumentation; included in the figure are the systems equipment specifications.

5.4.8.c Noise Data Reduction

Processing of the tape recorded acoustic signals was carried out using the Westland Acoustics Laboratory's analysis system, which consists of the following equipment:

- Gen Rad 1995 Integrated 1/3 Octave Real Time Analyzer
- Nicolet 660A dual channel FFT analyzer
- Hewlett Packard 9845 B desktop computer including:
    - 578 k bytes RAM
    - 2 - 9885 flexible disk drives
    - 9872 B A3 plotter
- Hewlett Packard 7045 B A3 X-Y plotter

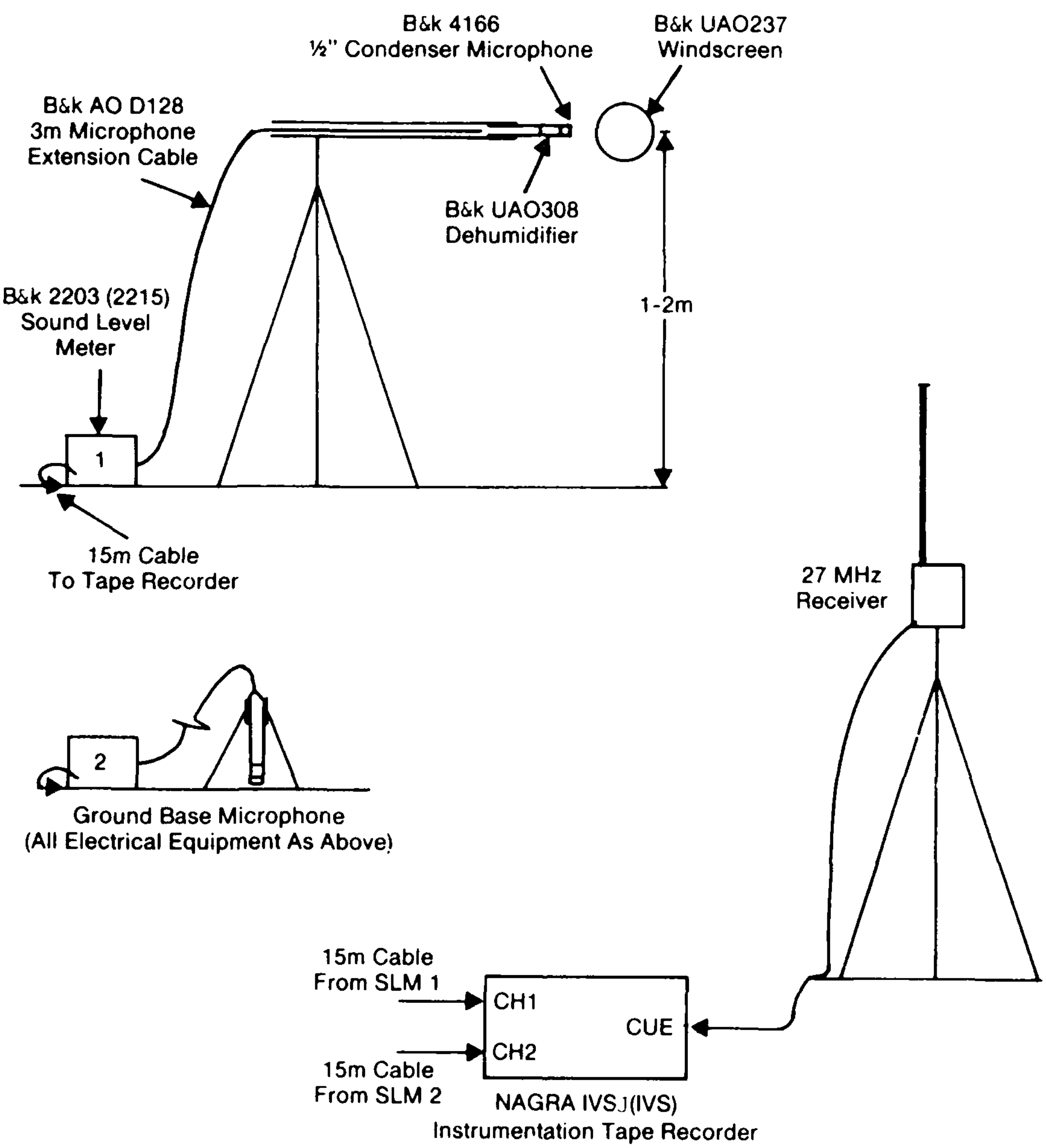
The two spectrum analyzers are linked to the computer via HP-IB (IEEE -488, 1978) and 16-bit parallel interfaces (Nicolet only) providing an extremely flexible facility.

5.4.8.d Final Summary Data

The data in the UK final corrected data summary table, Table 5.4.C, uses data from the UK December 1985 submittal, with corrections to the level flyover data coming from the September 1986 submittal.

Figure 5.4.G

UK Noise Measurement/Recording System Instrumentation



NOTES: 1. Ground Based Microphone at Position 1 Only
2. Equipment Types in Parentheses at Microphone 4

Table 5.4.C

UNITED KINGDOM FINAL CORRECTED DATA

PILOT 1

	LEFT	CENTER	RIGHT	3MIC	STD DEV	90% CI
APPROACH						
EPNL	86.20	92.30	89.90	89.50	0.50	0.40
PNLTm	85.60	93.80	99.60	89.70	0.80	0.70
ALm	71.90	81.20	76.50	76.60	0.90	0.70
SEL	82.90	89.60	87.40	86.60	0.50	0.40
LEVEL FLYOVER						
EPNL	89.10	89.00	85.20	87.80	NA	NA
PNLTm	90.40	92.20	86.90	89.90	NA	NA
ALm	72.80	75.40	72.30	73.50	0.30	0.20
SEL	81.50	82.50	80.70	81.70	0.20	0.20
TAKEOFF						
EPNL	86.00	87.30	86.60	86.60	0.40	0.30
PNLTm	86.70	88.50	86.80	87.30	0.30	0.30
ALm	72.00	73.90	72.90	72.90	0.30	0.30
SEL	82.50	83.70	83.50	83.20	0.30	0.30
DURATION P						
APPROACH	27.00	17.70	26.20			
LEVEL FLYOVER	19.90	12.20	16.30			
TAKEOFF	23.00	15.20	22.80			
DURATION A						
APPROACH	38.80	17.20	32.60			
LEVEL FLYOVER	21.00	12.80	13.80			
TAKEOFF	28.20	19.30	23.80			
TONE CORRECTION VALUE						
APPROACH	0.90	0.90	1.00			
LEVEL FLYOVER	1.30	1.20	1.20			
TAKEOFF	2.70	2.20	2.70			
TONE CORRECTION BAND						
APPROACH	24	24	26			
LEVEL FLYOVER	22	23	23			
TAKEOFF	22	22	23			
MAX NOY BANDS						
APPROACH	24,23,24	25,25,25	26,25,25			
LEVEL FLYOVER	22,27,26	24,24,26	22,31,27			
TAKEOFF	22,24,31	22,27,32	22,23,27			

PILOT 2

	LEFT	CENTER	RIGHT	3MIC	STD DEV	90% CI
APPROACH						
EPNL	NA	NA	NA	NA	NA	NA
PNLTm	NA	NA	NA	NA	NA	NA
ALm	NA	NA	NA	NA	NA	NA
SEL	NA	NA	NA	NA	NA	NA
LEVEL FLYOVER						
EPNL	NA	NA	NA	NA	NA	NA
PNLTm	NA	NA	NA	NA	NA	NA
ALm	NA	NA	NA	NA	NA	NA
SEL	NA	NA	NA	NA	NA	NA
TAKEOFF						
EPNL	86.40	86.60	87.20	86.80	0.20	0.20
PNLTm	87.30	87.70	87.20	87.40	0.30	0.20
ALm	72.80	72.80	73.20	72.90	0.50	0.50
SEL	82.90	83.00	84.10	83.30	0.20	0.20
DURATION P						
APPROACH	NA	NA	NA			
LEVEL FLYOVER	NA	NA	NA			
TAKEOFF	22.30	17.30	25.30			
DURATION A						
APPROACH	NA	NA	NA			
LEVEL FLYOVER	NA	NA	NA			
TAKEOFF	22.80	22.80	26.10			
TONE CORRECTION VALUE						
APPROACH	NA	NA	NA			
LEVEL FLYOVER	NA	NA	NA			
TAKEOFF	2.70	2.10	2.60			
TONE CORRECTION BAND						
APPROACH	NA	NA	NA			
LEVEL FLYOVER	NA	NA	NA			
TAKEOFF	[illegible]	[illegible]	[illegible]			
MAX NOY BANDS						
APPROACH	NA,NA,NA	NA,NA,NA	NA,NA,NA			
LEVEL FLYOVER	NA,NA,NA	NA,NA,NA	NA,NA,NA			
TAKEOFF	[illegible],24,19	[illegible],28,[illegible]	[illegible]			

STATIC FLIGHT IDLE

	0	45	90	135	180	225	270	315
HARD	67.0	67.2	65.[illegible]	68.[illegible]	67.9	64.2	65.[illegible]	67.[illegible]
SOFT	54.9	58.[illegible]	59.[illegible]	67.[illegible]	58.2	61.[illegible]	55.9	5[illegible]

THE DATA WHICH APPEARS IN THIS TABLE IS FROM THE U.K. DECEMBER 1985 SUBMITTAL WITH CORRECTIONS TO THE LEVEL FLYOVER DATA COMING FROM THE SEPTEMBER 1985 SUBMITTAL.

UK delta 3 calculated at 15°C

5.5 UNITED STATES - CANADIAN TEST

The joint United States/Canadian noise measurement flight test was held August 27th through 29th, 1984 at Dulles International Airport near Washington, DC, USA. The United States (US) test team was comprised of US Department of Transportation (DOT) personnel from the Federal Aviation Administration (FAA) and the Transportation Systems Center (TSC). The Canadian team was comprised of personnel from the Canadian Ministry of Transport.

5.5.1 Weather

The weather for the US/Canadian noise measurement flight test was clear and sunny. Core program test events occurred from 8:00 am to 1:00 pm EST, during which time temperatures ranged from 18 degrees Celsius to 27 degrees Celsius.

5.5.2 Operations

The static and flight operations conducted as part of the US/Canadian flight test program are outlined in Table 5.5.A. The core test program (detailed in Section 3.2) was conducted twice by two different pilots, thus establishing a data base of four complete core tests within this single flight test program.

Table 5.5.A

US-CANADIAN FLIGHT TEST PROGRAM

ID	** OCRN	PILOT	OPERATION	ID	** OCRN	PILOT	OPERATION
A	1	1	Level Flyover 0.9Vh	AZ	2	1	Level Flyover 0.9Vh
AA	1	2	Level Flyover 0.9Vh	AY	2	2	Level Flyover 0.9Vh
B	1	1	ICAO Takeoff, Vy	BZ	2	1	ICAO Takeoff, Vy
BB	1	2	ICAO Takeoff, Vy	BY	2	2	ICAO Takeoff, Vy
C	1	1	Six Degree Approach	CZ	2	1	Six Degree Approach
CC	1	2	Six Degree Approach	CY	2	2	Six Degree Approach
D	1	1	Static FI	DZ	2	1	Static FI
E	1	1	Static GI	EZ	2	1	Static GI
F	1	1	Static HIGE	FZ	2	1	Static HIGE
M	1	1	Bell Quiet Approach	MM	2	1	Bell Quiet Approach
K	1	1	Six Degree Approach No Guidance	KK	2	1	Six Degree Approach No Guidance
G	1	1	Level Flyover 0.9Vh (300m)				
H	1	1	Level Flyover 1.0Vh (150m)				
I	1	1	Level Flyover 0.8Vh (150m)				
J	1	1	Level Flyover 0.7Vh (150m)				

** OCCURRENCE - First or second time pilot flew operation.

5.5.3 Pilots

The US/Canadian flight test program pilots were: Pilot 1 from Omniflight Airways (Baltimore, Maryland, USA) and Pilot 2 from the FAA. As mentioned above, the core test program was flown twice by each pilot. Included in Table 5.5.A are notations as to which pilot flew which event.

5.5.4 Test Helicopter

The Bell 206L-1 used during the US/Canadian test program was leased by Bell Helicopter, Textron from Omniflight Airways (Baltimore, Maryland, USA).

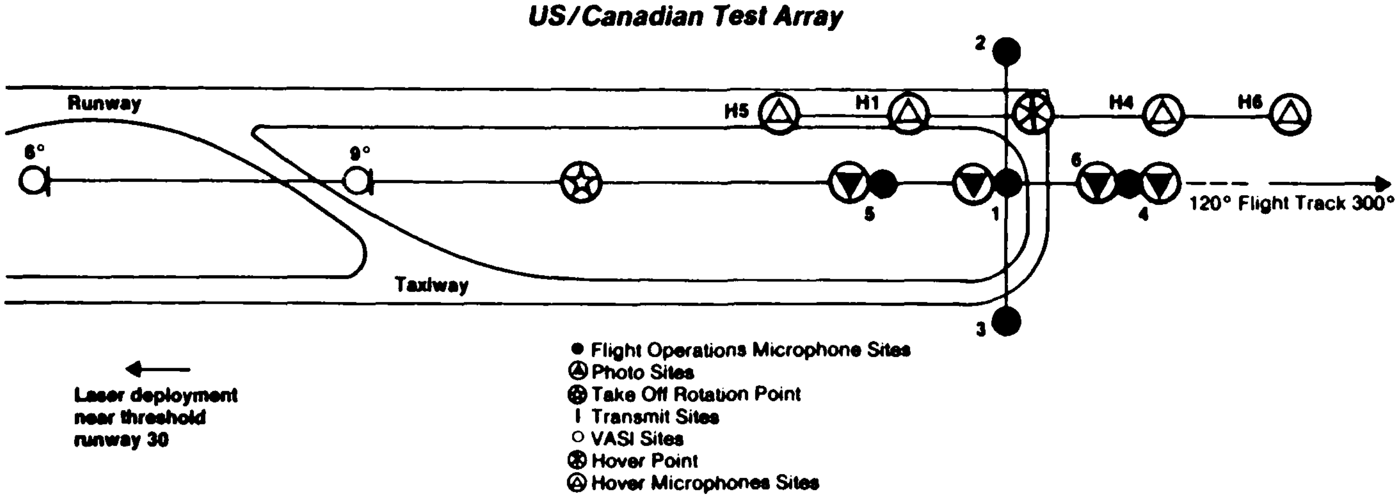
Prior to the test, a laser retro-reflector was mounted on the underside of the test helicopter for tracking purposes. The retro-reflector constitutes the only external modification to the US test helicopter.

5.5.5 Test Site Array

The US/Canadian test site array was an enhancement of the HNMRP test plan specifications. The flight operation test site array consisted of the certification sites (a centerline-center and two sideline sites), the HNMRP recommended down-range centerline site, and an additional centerline site, located 150 meters up-range from the centerline-center site (for a total of three centerline sites). The test site array for static operations included the requested 150 m hard and soft propagation path sites plus two additional sites, one hard and one soft propagation located 300 meters from the hover point. Figure 5.5.A is a schematic diagram of the test site array.

Figure 5.5.A

US/Canadian Test Array



The noise measurement testing area was nominally flat, with a ground cover of short, clipped grass. It was bordered on the north, south, and west by woods, which provided a low ambient noise level. The runway adjacent to the test area was closed during the test, so there was minimum interference from commercial or general aviation.

5.5.6 Joint Program Features

5.5.6.a Approach Guidance System

Approach guidance was provided to the pilots by means of a Visual Approach Slope Indicator (VASI). The VASI was located at the point where the approach path intercepted the ground, at a distance of 1128 meters (3701 feet) from the centerline-center site. The system used in the test was a three-light arrangement giving vertical displacement information within ±0.5 degrees of the reference approach slope. The pilot observed a green light if the helicopter was within 0.5 degrees of the approach slope, red if below the approach slope, white if above.

In the case of verbal guidance approaches, FAA personnel operating a surveying theodolite advised the flight crew of deviations (exceeding 0.5 degrees) from the reference six degree flight path.

5.5.6.b Tracking Systems

During the US/Canadian HNMRP flight test three separate tracking systems (laser, radar and photographic) were used in order compare the systems and to assure complete acquisition of tracking data. Below is a description of each tracking system. Measurement and reduction of tracking data was the responsibility of the US team with the resulting tracking data used by both teams to reduce their noise data.

Laser - The laser precision automated tracking system used during the US/Canadian HNMRP flight test is a semi-mobile facility which uses an invisible laser beam to automatically track aircraft equipped with a retro-reflector.

The tracking portion of the system consists of a laser transmitter and an optical receiver. Short bursts of infrared laser energy are generated in a narrow beam toward the target and are returned to a receiving telescope. The receiving telescope's optical output is then directed to a 4-quadrant photo detector. When the telescope axis is pointed precisely at the tracked target, all quadrants of the photo detector receive an equal portion of the target return image, and the detector outputs are equal. An optical automatic gain control system operates a filter wheel in conjunction with the laser transmitter optical attenuators to maintain constant average optical signal levels at the quadrant photo detector. When the target is off of the telescope axis, detector outputs are unequal and a function of the magnitude and direction of the pointing error; the necessary adjustments are then made automatically to maintain target tracking.

Initial locking of the laser transmitter onto the aircraft's retro-reflector is made with video-optical sighting equipment which is linked to a television camera mounted below the receiving telescope and aligned with the tracking optical axis. After the camera sights the aircraft, the system begins tracking automatically.

Range is obtained by measuring the time interval between transmitted and received optical pulses. The range computer is initialized each time the laser is fired. If no target return pulse is received and automatic and manual operations fail to acquire the target the computer disregards the data sample. Range to the tracked target is measured and displayed with a resolution of 1 foot in 5 miles.

The data processing portion of the laser system consists of a Digital Equipment Corporation PDP-11/35 processor and related equipment. The accuracy for both azimuth and elevation is 20 arc seconds. During tracking, the data processing system exercises control over the tracking system and formats the tracking data for recording and display. After tracking is completed, tracking data are recorded on magnetic tape.

Radar - The radar system deployed during the US/Canadian flight test is a semi-mobile 9.1 GigaHertz radar system. The radar locates the target with the assistance of a video camera which is mounted below the radar transmitting/receiving antenna. Once the operator controlled video system has the target in an acquisition window, the radar system locks on.

The radar determines the range of the helicopter by analyzing the reflected electromagnetic pulse from the aircraft. The target's spherical coordinates, range, elevation and azimuth are outputted, along with IRIG-B time code, to a Kennedy one inch magnetic tape drive. The magnetic tape was subsequently reduced in the FAA acoustical laboratory using a PDP-11-35 computer system. Raw data were then converted to Cartesian coordinates, and the required position information was computed, tabulated and plotted.

Photo Altitude Determination System - Helicopter position data were also acquired by using the photo altitude determination system, which is described in the Society of Automotive Engineers report AIR-902 (Ref 11) and which was used by several other HNMRP participants.

Problems were encountered with each of the three tracking systems throughout the program. The laser system's problems included failure of the diesel electric generator power supply and difficulty locking onto the retro-reflector during some operations. The radar system experienced data drop-out when the tracking antenna would lock-up on strong stationary electromagnetic targets. There were also problems with the radar's recording tape drive transport mechanism. The photographic crew universally experienced difficulty during the test in their attempts to provide time synchronized photographs through use of time indexed data backs, or range code synchronized stop watches. Fortunately, with three systems, tracking data were available on most of the events.

Laser data were used as <u>the</u> tracking data, when available, because it is the most accurate of the three systems (1 foot in 5 miles). Laser data, however, were only available for approximately one-third of the total number of program events (both core and elective operations). As such, in cases where laser data were unavailable, photo data were used together with radar data, creating Photo Adjusted Radar data (PAR). PAR data were generated in the following manner:

$$\text{CPA(PAR)} = \text{photo CPA} \qquad \text{SR(PAR)} = \frac{\text{Photo CPA} * \text{Radar SR}}{\text{Radar CPA}}$$

5.5.6.c Meteorological Systems

For the US/Canadian HNMRP flight test a Doppler Sodar was used to acquire a detailed description of the wind structure in the immediate vicinity of the noise measurement sites. The Sodar measures wind speed and direction by sending an acoustical pulse into the atmosphere, via three large conically shaped antenna, and measuring the intensity of the returning pulse echo. The frequency shift of the echo varies according to the wind speed (doppler effect), while the echo intensity varies according to thermal turbulence and structure. A DEC PDP-1103 computer processed the information received from the pulse echoes and stored the output on magnetic tape. The accuracy of the Remtech Doppler Sodar system is 0.3 meters per second for wind speed and 3 degrees for wind direction.

A ten meter meteorological tower was used to measure: temperature, relative humidity, wind speed and wind direction during the test. Both meteorological systems were deployed and operated by the US team and the subsequent data was shared by the two teams.

5.5.6.d Cockpit Data Documentation

During the US/Canadian noise measurement flight test, helicopter performance characteristics were documented by the use of a cockpit videotape system similar to those used in the other HNMRP flight test programs. A flight observer's log of the average instrument readings for each event was also kept.

5.5.7 Canadian Team

5.5.7.a Acoustical Acquisition Systems

The Canadian acoustical acquisition systems consisted of both analog and digital magnetic recording systems. The analog systems were deployed at the sideline sites, while the digital systems were deployed at the three centerline sites. An inverted (ground-plane) microphone, using a digital magnetic recording system, was also deployed at the centerline-center site.

Both the analog and the digital systems included condenser microphones with preamps operated by battery driven B&K 2804 power supplies.

For the analog systems, the power supplies were modified to provide 30 dB extra gain (via an internal toggle switch). Fifty meter cables were used to connect the power supplies to the B&K 7003 four channel magnetic tape recorders. The four recorder channels (Ch) were used as follows:

Ch-1 cue channel
Ch-2 acoustic data were recorded as linear or flat weighting
Ch-3 acoustic data were passed through an A-weighted filter
Ch-4 Inter Range Instrumentation Group-B (IRIG-B) synchronized time code

The A-weighted filter was employed in case the dynamic range of the tape recorder (approximately 40-50 dB) was inadequate for the large level

Figure 5.5.B

Canadian Analog Acoustical Data Acquisition System

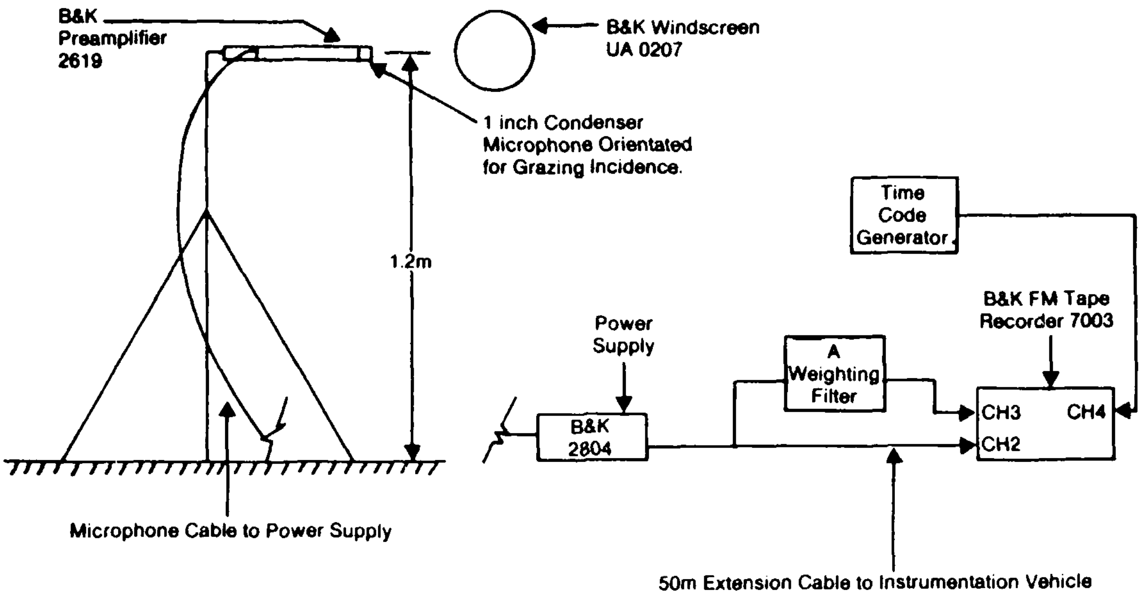
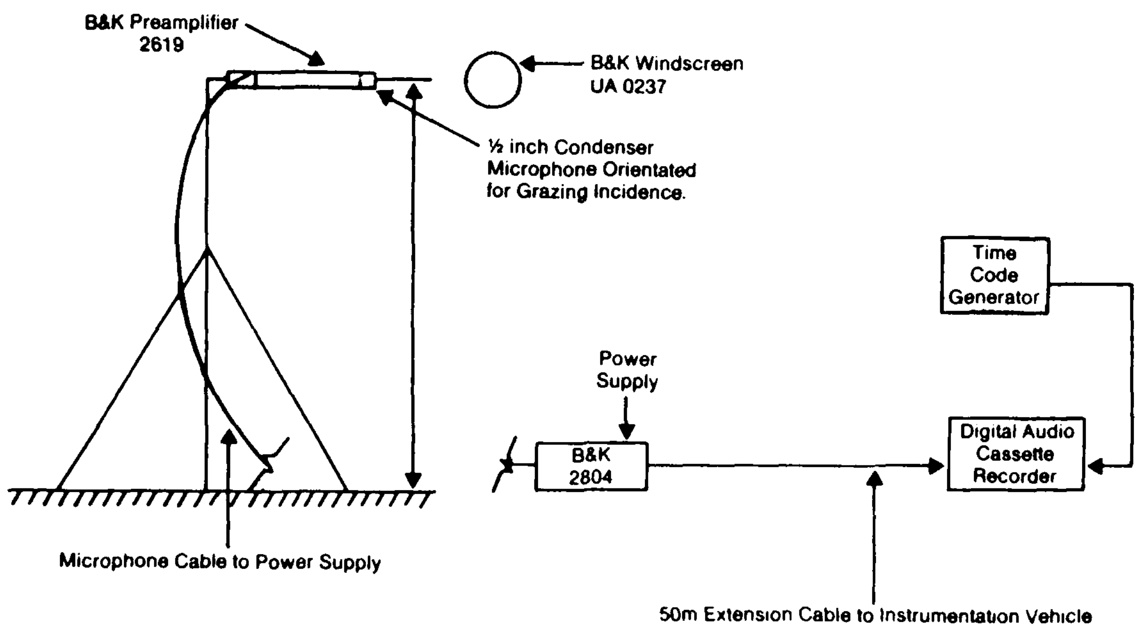
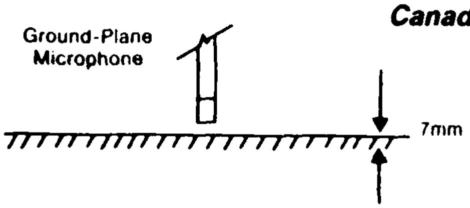


Figure 5.5.C



Canadian Digital Acoustical Data Acquisition System



differences (30 to 60 dB) between the high and low frequencies which characterize helicopter acoustic signals. Recording gains were set so that the optimal signal-to-noise ratio would be achieved while allowing sufficient "head-room" to avoid distortion of the peak levels.

The digital systems employed were Panasonic and Technics Digital Audio Cassette Recorders, types SVP-100 and SV-100, for the ground-plane and conventional microphone systems respectively. 14 Bit AD-DA converters and Pulse Code Modulation (PCM) Encoder/Decoders were used with both, and acoustic data were recorded on VHS video cassettes. These systems have a wide dynamic range, approximately 85 dB, and thus no high frequency pre-emphasis was necessary. AC power was provided by means of 12 Volt DC batteries and a static invertor.

The analog and digital systems are shown in Figures 5.5.B and 5.5.C, respectively.

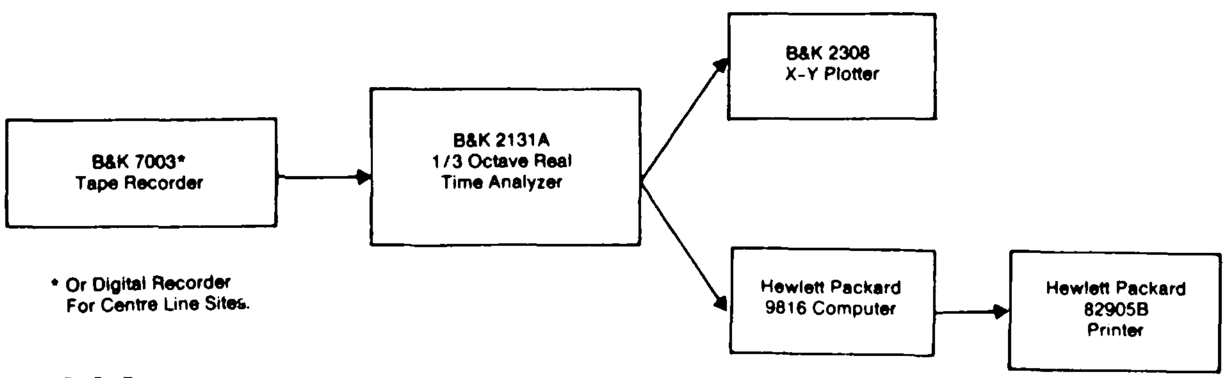
5.5.7.b Acoustic Data Reduction and Processing

The magnetic tape recording field data were reduced and processed at De Havilland of Canada, Toronto Division. Additional processing was performed at Transport Canada. Figure 5.5.D is a schematic of the data reduction and analysis system used.

Corrections were applied to the data to account for non-standard acoustical day conditions, source noise characteristics and aircraft deviations from the reference flight track and speed. These corrections, as well as the prior data reduction and analysis were conducted in accordance with the procedures detailed in the HNMRP reference documentation. Included in these corrections were the Annex 16 Delta 1, 2, and 3 corrections.

Figure 5.5.D

Canadian Acoustic Data Reduction and Analysis System



5.5.7.c Final Data Summary

The data which appears in the Canada "Final Corrected Data Summary", Tables 5.5.B and 5.5.C, were derived from the Canadian April 1986 "ICAO HNMRP US/CANADA JOINT PROGRAM, CANADIAN TEST REPORT" (R-86-2) and from September 1986 submittals.

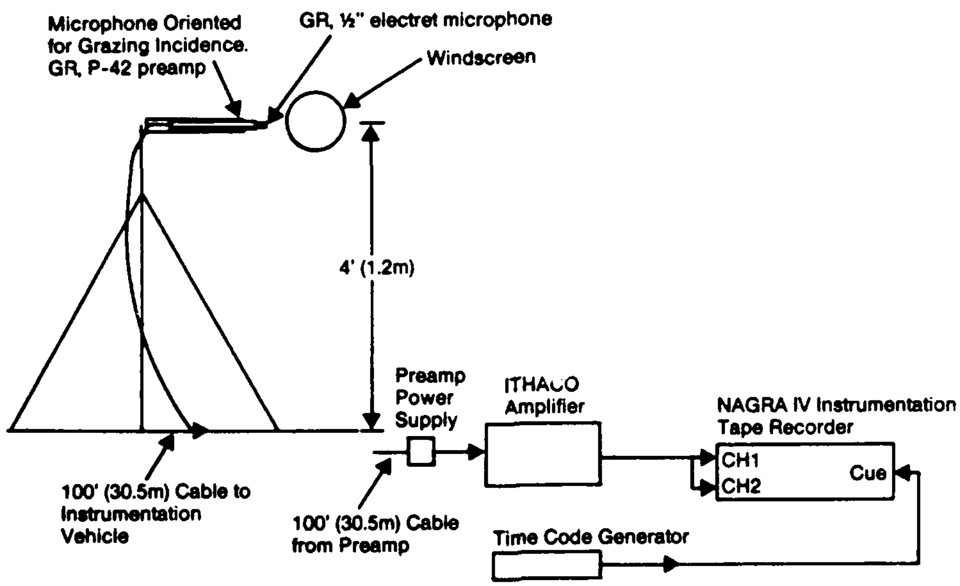
5.5.8 United States' Team

5.5.8.a Acoustic Measurement Instrumentation

Nagra two-channel direct-mode tape recorder systems, shown in Figure 5.5.E,

Figure 5.5.E

US Noise Measurement/Recording System Instrumentation



were deployed by the US team at each acoustical measurement site. On one channel the noise data were recorded with essentially flat frequency response, while on the second channel the data were first weighted and amplified using a high pass pre-emphasis filter.

Helicopter acoustical signals are characterized by large level differences (30 to 60 dB) between the high and low frequencies and as such the use of pre-emphasis was deemed necessary in order to boost the high frequency portion of the acoustical signal. The pre-emphasis network rolled off those frequencies below 10,000 Hz at 20 dB per decade. Recording gains were adjusted so that the best possible signal-to-noise ratio would be achieved while allowing enough "head room" to comply with applicable distortion avoidance requirements.

5.5.8.b Noise Data Reduction

The analog magnetic tape recordings were analyzed at the Transportation Systems Center (TSC) facility in Cambridge, Massachusetts, USA. Data reduction followed the basic procedures defined in the references outlined in Section 2.3 of this report. Delta 1 and 2 corrections were applied to all operations as per Annex 16 procedures, and in the case of the level flyover operation Delta 3 source noise corrections were also applied.

5.5.8.c Final Summary Data

The "US Test Report" is the source of the final US data presented in Tables 5.5.D and 5.5.E. The "US Test Report" was prepared before the HNMRP group agreed on the left-center-right-3 microphone data table format so the US data have been presented in Appendix C in that format.

Table 5.5.B

CANADA FINAL CORRECTED DATA

PILOT 1-1

	LEFT	CENTER	RIGHT	3MIC	STD DEV	90% CI
APPROACH						
EPNL	NA	NA	NA	NA	NA	NA
PNLTM	NA	NA	NA	NA	NA	NA
ALM	NA	NA	NA	NA	NA	NA
SEL	NA	NA	NA	NA	NA	NA
LEVEL FLYOVER						
EPNL	88.59	88.67	88.34	88.54	0.22	0.21
PNLTM	88.88	90.38	89.44	89.57	0.27	0.26
ALM	74.29	76.43	74.82	75.18	0.48	0.46
SEL	84.31	85.08	83.88	84.43	0.32	0.31
TAKEOFF						
EPNL	87.76	87.35	87.75	87.62	0.17	0.29
PNLTM	88.82	88.85	88.36	88.68	0.55	0.93
ALM	73.11	73.82	72.48	73.14	0.08	0.14
SEL	83.71	83.53	83.49	83.57	0.32	0.54
DURATION P						
APPROACH	NA	NA	NA			
LEVEL FLYOVER	22.70	16.50	17.70			
TAKEOFF	23.10	17.30	25.30			
DURATION A						
APPROACH	NA	NA	NA			
LEVEL FLYOVER	22.85	16.60	17.50			
TAKEOFF	NA	19.40	28.20			
TONE CORRECTION VALUE						
APPROACH	NA	NA	NA			
LEVEL FLYOVER	1.78	1.10	1.44			
TAKEOFF	2.60	2.20	2.40			
TONE CORRECTION BAND						
APPROACH	NA	NA	NA			
LEVEL FLYOVER	NA	23	NA			
TAKEOFF	NA	22	22			
MAX NOY BANDS						
APPROACH	NA,NA,NA	NA,NA,NA	NA,NA,NA			
LEVEL FLYOVER	NA,NA,NA	23,26,27	NA,NA,NA			
TAKEOFF	NA,NA,NA	22,34,26	22,24,34			

STATIC FLIGHT IDLE

0	45	90	135	180	225	270	315
HARD P1-1							
61.2	67.0	69.7	66.0	69.7	73.6	71.9	71.3

PILOT 1-2

	LEFT	CENTER	RIGHT	3MIC	STD DEV	90% CI
APPROACH						
EPNL	86.97	92.92	91.81	90.57	0.13	0.58
PNLTM	86.82	94.82	90.93	90.86	0.32	1.44
ALM	71.35	82.25	77.32	76.97	0.12	0.53
SEL	82.68	90.34	88.42	87.15	0.13	0.58
LEVEL FLYOVER						
EPNL	88.55	88.38	87.29	88.07	0.58	0.68
PNLTM	89.76	91.27	87.56	89.53	0.60	0.71
ALM	73.94	76.88	73.02	74.61	0.69	0.81
SEL	83.62	94.52	82.30	83.48	0.60	0.71
TAKEOFF						
EPNL	88.54	97.10	85.93	87.19	0.08	0.35
PNLTM	99.41	98.58	86.34	88.11	0.02	0.07
ALM	73.31	74.03	70.69	72.67	0.03	0.14
SEL	84.21	83.54	81.86	83.20	0.26	1.16
DURATION P						
APPROACH	25.30	17.00	27.50			
LEVEL FLYOVER	18.70	11.90	21.20			
TAKEOFF	28.10	16.50	24.30			
DURATION A						
APPROACH	20.20	16.40	26.10			
LEVEL FLYOVER	20.00	12.00	18.70			
TAKEOFF	31.80	22.70	26.10			
TONE CORRECTION VALUE						
APPROACH	1.40	1.00	1.30			
LEVEL FLYOVER	1.80	1.20	1.30			
TAKEOFF	2.70	2.30	2.50			
TONE CORRECTION BAND						
APPROACH	NA	25	NA			
LEVEL FLYOVER	NA	23	NA			
TAKEOFF	NA	22	22			
MAX NOY BANDS						
APPROACH	NA,NA,NA	25,26,26	23,NA,NA			
LEVEL FLYOVER	NA,NA,NA	23,26,22	NA,NA,34			
TAKEOFF	NA,NA,NA	22,34,35	24,22,34			

STATIC FLIGHT IDLE

0	45	90	135	180	225	270	315
HARD P1-2							
68.3	68.5	72.0	72.2	72.1	73.4	72.9	68.5

DATA CAME FROM THE APRIL 1986 & SEPTEMBER 1986 SUBMITTALS.

Table 5.5.C

CANADA FINAL CORRECTED DATA

PILOT 2-1

	LEFT	CENTER	RIGHT	3MIC	STD DEV	90% CI
APPROACH						
EPNL	87.27	93.38	91.77	90.81	0.61	1.03
PNLTm	86.78	95.85	91.54	91.39	0.26	0.43
ALm	71.76	83.52	77.65	77.64	0.47	0.79
SEL	82.76	90.80	88.36	87.31	0.50	0.84
LEVEL FLYOVER						
EPNL	87.61	88.77	88.12	88.16	0.46	2.06
PNLTm	88.17	91.41	88.25	89.28	0.47	2.09
ALm	74.02	77.24	73.71	74.99	0.14	0.61
SEL	83.68	95.41	83.77	84.26	0.44	1.95
TAKEOFF						
EPNL	87.79	88.16	86.03	87.33	0.36	1.45
PNLTm	88.68	89.99	87.44	88.71	0.79	1.34
ALm	72.74	75.34	71.56	73.21	0.82	1.38
SEL	83.28	84.63	81.84	83.25	0.91	1.53
DURATION P						
APPROACH	20.60	15.70	21.20			
LEVEL FLYOVER	20.60	12.60	19.60			
TAKEOFF	24.60	16.70	25.70			
DURATION A						
APPROACH	22.60	14.70	21.90			
LEVEL FLYOVER	22.80	13.00	17.10			
TAKEOFF	26.60	20.00	28.40			
TONE CORRECTION VALUE						
APPROACH	1.20	1.10	1.50			
LEVEL FLYOVER	1.55	1.10	1.18			
TAKEOFF	2.80	2.20	2.40			
TONE CORRECTION BAND						
APPROACH	NA	25	23			
LEVEL FLYOVER	NA	23	NA			
TAKEOFF	NA	22	22			
MAX NOY BANDS						
APPROACH	NA,NA,NA	25,25,23	23,22,NA			
LEVEL FLYOVER	NA,24,NA	23,26,27	NA,NA,24			
TAKEOFF	NA,NA,NA	22,34,35	24,22,24			

PILOT 2-2

	LEFT	CENTER	RIGHT	3MIC	STD DEV	90% CI
APPROACH						
EPNL	NA	NA	NA	NA	NA	NA
PNLTm	NA	NA	NA	NA	NA	NA
ALm	NA	NA	NA	NA	NA	NA
SEL	NA	NA	NA	NA	NA	NA
LEVEL FLYOVER						
EPNL	89.42	88.58	88.94	88.98	0.43	0.51
PNLTm	91.49	91.46	89.68	90.97	0.80	0.94
ALm	76.16	77.36	74.83	76.11	0.93	1.10
SEL	84.90	94.97	83.76	84.58	0.57	0.67
TAKEOFF						
EPNL	86.96	89.35	87.65	87.99	0.92	1.56
PNLTm	86.85	90.82	89.08	88.92	1.37	2.31
ALm	71.29	75.99	72.94	73.41	1.29	2.17
SEL	82.37	85.69	83.44	83.83	0.87	1.47
DURATION P						
APPROACH	NA	NA	NA			
LEVEL FLYOVER	20.70	14.40	17.60			
TAKEOFF	24.80	17.20	20.10			
DURATION A						
APPROACH	NA	NA	NA			
LEVEL FLYOVER	20.20	13.70	17.60			
TAKEOFF	25.60	20.20	24.60			
TONE CORRECTION VALUE						
APPROACH	NA	NA	NA			
LEVEL FLYOVER	1.54	1.30	1.36			
TAKEOFF	2.40	2.20	2.60			
TONE CORRECTION BAND						
APPROACH	NA	NA	NA			
LEVEL FLYOVER	NA	23	NA			
TAKEOFF	NA	22	22			
MAX NOY BANDS						
APPROACH	NA,NA,NA	NA,NA,NA	NA,NA,NA			
LEVEL FLYOVER	NA,NA,NA	23,26,27	23,NA,NA			
TAKEOFF	NA,NA,NA	22,34,35	24,22,24			

DATA CAME FROM THE APRIL 1986 & SEPTEMBER 1986 SUBMITTALS.

Table 5.5.D

UNITED STATES FINAL CORRECTED DATA

PILOT 1-1

	LEFT	CENTER	RIGHT	3MIC	STD DEV	90% CI
APPROACH						
EPNL	87.20	92.50	91.00	90.20	0.55	0.40
PNLTm	85.90	94.10	90.90	90.60	0.87	0.58
ALm	72.50	81.70	77.60	77.30	0.82	0.55
SEL	83.40	89.70	88.20	87.10	0.53	0.35
LEVEL FLYOVER						
EPNL	87.30	86.30	86.30	86.80	0.29	0.21
PNLTm	88.00	89.10	87.30	88.10	0.27	0.20
ALm	73.90	75.60	73.90	74.50	0.26	0.19
SEL	83.80	83.60	82.90	83.40	0.23	0.17
TAKEOFF						
EPNL	86.90	86.70	86.20	86.60	0.31	0.21
PNLTm	87.90	88.30	87.50	87.90	0.55	0.37
ALm	73.10	73.50	71.80	72.90	0.45	0.30
SEL	83.40	82.80	82.60	82.90	0.25	0.17

DURATION P			
APPROACH	32.10	17.10	25.90
LEVEL FLYOVER	20.00	12.60	16.90
TAKEOFF	20.90	16.00	21.50
DURATION A			
APPROACH	33.40	17.00	26.80
LEVEL FLYOVER	21.70	13.70	17.10
TAKEOFF	24.10	19.70	25.90
TONE CORRECTION VALUE			
APPROACH	1.50	1.00	1.60
LEVEL FLYOVER	1.70	1.10	1.30
TAKEOFF	2.60	2.10	2.50
TONE CORRECTION BAND			
APPROACH	27	25	27
LEVEL FLYOVER	20	22	22
TAKEOFF	22	22	22

MAX NOY BANDS	LEFT	CENTER	RIGHT
APPROACH	23,24,25	25,26,23	24,27,NA
LEVEL FLYOVER	23,33,32	23,26,27	24,34,35
TAKEOFF	22,24,32	22,25,34	24,22,34

STATIC DATA

	0	45	90	135	180	225	270	315
HARD	61.9	71.2	71.7	74.1	72.6	66.5	70.6	63.0
SOFT	62.9	62.5	63.6	60.9	62.0	63.0	64.5	61.7

PILOT 1-2

	LEFT	CENTER	RIGHT	3MIC	STD DEV	90% CI
APPROACH						
EPNL	86.90	92.70	90.40	90.00	0.41	0.39
PNLTm	86.30	94.00	90.20	90.20	0.38	0.36
ALm	72.20	81.50	76.80	76.80	0.49	0.46
SEL	83.60	90.10	87.70	87.10	0.36	0.34
LEVEL FLYOVER						
EPNL	87.70	87.70	86.30	87.20	0.16	0.19
PNLTm	89.70	90.60	87.60	89.30	0.14	0.16
ALm	75.30	76.80	74.70	75.60	0.17	0.20
SEL	84.00	84.30	83.10	83.80	0.23	0.27
TAKEOFF						
EPNL	87.40	86.40	85.90	86.60	0.25	0.23
PNLTm	88.70	87.70	87.20	87.90	0.18	0.17
ALm	73.40	73.10	71.70	72.70	0.43	0.41
SEL	83.70	82.90	82.40	83.00	0.24	0.23

DURATION P			
APPROACH	27.00	19.00	24.60
LEVEL FLYOVER	17.30	11.70	16.60
TAKEOFF	19.50	18.10	22.10
DURATION A			
APPROACH	34.20	18.80	26.70
LEVEL FLYOVER	18.80	12.60	16.00
TAKEOFF	29.60	25.70	26.40
TONE CORRECTION			
APPROACH	1.20	0.90	1.30
LEVEL FLYOVER	1.50	1.20	0.90
TAKEOFF	2.70	2.10	2.50
TONE CORRECTION BAND			
APPROACH	NA	25	27
LEVEL FLYOVER	22	23	22
TAKEOFF	22	22	22

MAX NOY BANDS	LEFT	CENTER	RIGHT
APPROACH	22,24,24	25,NA,25	24,27,26
LEVEL FLYOVER	22,34,33	23,26,27	24,35,NA
TAKEOFF	22,24,34	22,35,34	24,22,34

STATIC DATA

	0	45	90	135	180	225	270	315
HARD	69.8	69.4	72.5	74.7	70.8	71.3	73.1	70.3
SOFT	65.5	64.5	65.6	62.9	62.5	61.5	58.8	67.4

Table 5.5.E

UNITED STATES FINAL CORRECTED DATA

PILOT 2-1	LEFT	CENTER	RIGHT	3MIC	STD DEV	90% CI
APPROACH						
EPNL	86.40	92.40	90.80	90.10	0.71	0.52
PNLTm	86.30	94.50	91.10	90.80	0.58	0.42
ALm	71.60	81.90	78.10	77.30	0.54	0.40
SEL	82.80	89.70	88.20	87.10	0.63	0.46
LEVEL FLYOVER						
EPNL	87.30	87.50	86.20	87.00	0.30	0.25
PNLTm	89.00	89.90	87.80	88.90	0.23	0.19
ALm	74.80	76.40	74.50	75.20	0.36	0.30
SEL	83.90	84.20	83.10	83.70	0.27	0.22
TAKEOFF						
EPNL	87.30	87.70	86.50	87.20	0.59	0.44
PNLTm	88.70	89.10	88.20	88.70	0.49	0.36
ALm	73.40	74.50	72.70	73.60	0.62	0.45
SEL	83.40	84.10	82.80	83.40	0.65	0.48
DURATION P						
APPROACH	28.30	14.10	22.70			
LEVEL FLYOVER	16.50	12.90	16.20			
TAKEOFF	21.10	17.60	21.90			
DURATION A						
APPROACH	34.60	14.40	24.20			
LEVEL FLYOVER	18.80	13.90	16.60			
TAKEOFF	25.90	20.50	26.00			
TONE CORRECTION VALUE						
APPROACH	1.40	0.90	1.80			
LEVEL FLYOVER	1.90	1.10	1.20			
TAKEOFF	2.70	2.00	2.60			
TONE CORRECTION BAND						
APPROACH	27	25	27			
LEVEL FLYOVER	22	23	22			
TAKEOFF	22	19	22			
MAX NOY BANDS	LEFT	CENTER	RIGHT			
APPROACH	23.24.NA	25.24.26	24,27.27			
LEVEL FLYOVER	23.NA.33	23,26,27	24,23,26			
TAKEOFF	22.24.34	22,35.34	24,22,26			

PILOT 2-2	LEFT	CENTER	RIGHT	3MIC	STD DEV	90% CI
APPROACH						
EPNL	87.10	92.80	91.40	90.50	0.52	0.35
PNLTm	86.70	94.20	92.00	91.30	0.47	0.26
ALm	72.60	81.60	76.40	77.50	0.58	0.36
SEL	83.70	90.00	88.50	87.40	0.44	0.27
LEVEL FLYOVER						
EPNL	88.60	87.00	87.30	87.60	0.45	0.30
PNLTm	90.50	89.70	88.80	89.70	0.46	0.29
ALm	76.20	75.10	75.50	75.90	0.59	0.36
SEL	85.00	83.60	83.90	84.10	0.43	0.27
TAKEOFF						
EPNL	89.00	99.40	87.30	88.60	0.63	0.52
PNLTm	90.20	90.70	89.30	90.10	0.36	0.71
ALm	74.80	76.20	73.70	74.90	0.73	0.60
SEL	84.80	85.80	83.50	84.80	0.58	0.43
DURATION P						
APPROACH	27.60	15.00	20.80			
LEVEL FLYOVER	16.90	12.60	18.70			
TAKEOFF	19.60	16.80	18.70			
DURATION A						
APPROACH	34.80	15.70	22.70			
LEVEL FLYOVER	19.10	13.40	18.40			
TAKEOFF	24.00	19.80	23.20			
TONE CORRECTION						
APPROACH	1.40	0.80	1.80			
LEVEL FLYOVER	1.70	1.20	1.20			
TAKEOFF	2.70	2.00	2.40			
TONE CORRECTION BAND						
APPROACH	27	27	27			
LEVEL FLYOVER	22	23	22			
TAKEOFF	22	22	22			
MAX NOY BANDS	LEFT	CENTER	RIGHT			
APPROACH	23,24,25	25.27,23	24,27,23			
LEVEL FLYOVER	23,33,22	23,26,27	23.34.NA			
TAKEOFF	22.24.34	22.35,34	24,22.34			

6.0 THE HNMRP AND THE AMENDMENTS TO THE NOISE CERTIFICATION STANDARD

The proposed amendments to the existing ICAO Annex 16, Chapter 8 and Appendix 4 requirements (ratified at CAEP/1) are outlined below in Section 6.1. The CAEP ratified amendments will be forwarded "as advice from a committee of experts" to the ICAO Council for action. The time-frame for the ICAO Council approval process historically has been 18 months to two years after committee ratification. Subsequent to their approval these amendments will officially be incorporated into Annex 16.

The HNMRP played an active role in the development of each of these amendments/refinements. A detailed discussion of each issue is provided in Sections 6.2--Takeoff Issues, 6.3--Level Flyover Issues, 6.4--Approach Issues, and 6.5--Other Issues.

6.1 SUMMARY OF THE RATIFIED PROPOSED AMENDMENTS

6.1.1 Takeoff Operation Amendments

- Clarify the takeoff reference procedure
- Designate takeoff power as requiring minimum specification engine power
- Modify the takeoff profile
- Limit data adjustment requirements on takeoff to a total of 2dB for distance related deviations from the reference path

In addition to the above, the group agreed to study the feasibility of modifications to takeoff requirements in the future.

6.1.2 Level Flyover Operation Amendments

- Establish a clear definition of the level flyover test speed for certification purposes
- Establish RPM test window
- Refine the source noise adjustment requirement

A great deal of time was also devoted to discussing the standardization of reference temperatures for the level flyover operation.

6.1.3 Approach Operation Issues

- Establish test window

CAEP/1 also recommended as a future work topic: the "completion of a study on the issue of speed control on approach."

6.1.4 Other Amendments

- Establish a more rigorous detector dynamic response criteria for representing SLOW response by incorporating "4-Gates" in the detector onset criteria curve

- Incorporate a note to discourage further use of older technology noise analyzers with comparatively slow sampling rates, which yield higher noise levels
- Eliminate the "no correction window"
- Establish test windows (previously included in the "no correction window")
- Establish a requirement to quantify and limit, within reason, the deviation in the sideline elevation angle Psi
- Incorporate a provision to allow more extensive use of sensitivity curves in implementing data adjustments.

CAEP/1 also recommended continuation of helicopter technical work by Working Group II.

6.2 TAKEOFF OPERATION ISSUES

6.2.1 Takeoff Reference Procedure

To clarify the definition of the reference takeoff flight path (presented in ICAO Annex 16, Chapter 8, Section 8.6.2.1.a and 8.6.2.1.f) it was agreed that the first segment--level flight path, and the second segment--takeoff climb, should be represented as two straight lines intersecting 500 meters prior to the takeoff measurement point. It was also noted that the best rate of climb (BRC) and the speed for best rate of climb (Vy) should be certificated values based on a minimum performance scenario (i.e., variable torque engine, hot-day cooling requirements, etc.).

The CAEP/1 Chapter 8, Section 8.6.2.1 ratified amendments are as follows:

a) the helicopter shall be stabilized at the maximum takeoff power corresponding to minimum installed engine(s) specification power available for the reference ambient conditions or gearbox torque limit, whichever is lower, and along a path starting from a point located 500 m (1640 ft) prior to the flight path reference point, at 20 m (65 ft) above the ground.

f) the reference takeoff path is defined as a straight line segment inclined from the starting point (500 m prior to the center microphone location and 20 m above ground level) at an angle defined by Best Rate of Climb (BRC) and Vy for minimum specification engine performance.

6.2.2 Takeoff Power

Revision of the takeoff procedure, to specify the use of minimum specification takeoff power, was an issue raised during the HNMRP. As stated in PC Paper #5 (Ref. 12), presented at the Paris HNMRP meeting:

This revision should achieve a greater consistency in "test results for rotorcraft of the same design type tested with different engines at different ambient conditions. The minimum specification torque available at a specified ambient condition is a known power that will not be affected by engine condition or actual ambient condition. If the reference power condition is stated as maximum takeoff power or maximum continuous power, the actual power of use may vary by as much as 20 percent between two helicopters of the same design type tested at different ambient conditions. Such variation in power available used for testing and resulting variation in test day airspeeds and rates of climb could result in a particular type design showing compliance with noise requirements in one country, but not in others."

At CAEP/1 takeoff power was defined as requiring minimum specification engine power. Chapter 8, Section 8.6.2.1.a) was revised as noted above in Section 6.2.1.

6.2.3 Takeoff Procedures

During the HNMRP, a new method of performing the takeoff operation was proposed which would link noise test requirements more closely with takeoff airworthiness requirements. This proposed method is in contrast to the current takeoff requirements, which are linked with en-route climb performance airworthiness certification requirements.

The following discussion and recommendation were abstracted from a paper (Ref. 13) prepared by US FAA helicopter airworthiness expert Larry Plaster (a technical advisor to the HNMRP Program Coordinator). The paper delineated the reasons for considering the proposed regulatory refinements.

"1. The current Annex 16, Chapter 8, takeoff performance requirements are linked to the airworthiness en-route climb-out performance demonstration. These airworthiness tests establish Vy and the best rate of climb.

"There exists another set of airworthiness testing requirements pertaining to takeoff and landing. These requirements quantify (and certificate) different performance characteristics.

This "second set of performance requirements may be a better, or more representative set of airworthiness requirements to utilize as the basis for the takeoff noise certification test.

"2. An abrupt or rapid application of takeoff power at the 500 meter point (rotation point) may result in an excessive nose-down attitude for some higher powered models. This problem (would) be avoided by a scheme using a takeoff power defined as hover power plus some percentile as expressed in the takeoff demonstration airworthiness requirement....

"Newer multi-engine helicopter designs such as the Bell 412, Bell 214ST, and Sikorsky S-76B cannot apply full takeoff power during the acceleration without achieving excessive nose down pitch attitudes to remain outside the height-velocity (H-V) diagram. To eliminate this problem, manufacturers have been limiting the maximum power that can be used for takeoff to the power required to hover in-ground-effect (HIGE) plus a delta percent torque maximum that may be added to the required hover for takeoff acceleration for takeoff acceleration. (For example, the Bell 214ST uses HIGE hover power plus 10 percent torque maximum for takeoff.) Therefore, the power actually being used for takeoff is significantly less than rated takeoff which is approved for use based on structural and drive system considerations. However, the current noise regulation specifies the use of maximum takeoff power which has historically been interpreted as the drive system rated takeoff power and not the takeoff power used to establish takeoff distances for airworthiness certification.

"An additional factor which contributes to the current takeoff reference profile not being representative of actual takeoff procedures is the requirement to use Vy airspeed. Transport category helicopters establish a takeoff safety speed (Vtoss), for Category A takeoff performance and/or a takeoff climb out speed (Vtocs), for Category B takeoff performance. The rotorcraft Flight Manual (RFM) takeoff performance distances are based on the use of these reference speeds not Vy. Vtoss and Vtocs are typically 15 to 20 knots less than Vy.

"The combination of the two factors described above result in the actual takeoff profile for helicopters in this category being much shallower than the profile currently being used as a takeoff reference.

"Recommendation: Therefore it is recommended that WG II study the practicality of a future amendment to ICAO Annex 16, Chapter 8, paragraph 8.6.2, which requires:

"1. The helicopter shall be stabilized at -

(a) For helicopters for which the determination of takeoff performance is required by airworthiness regulations, the torque used to establish the takeoff distance for sea level, 25 degrees Celsius ambient conditions;

(b) For all other helicopters, the torque corresponding to the minimum installed power available for sea level, 25 degrees Celsius ambient conditions;

and at the best rate of climb....

"2. The helicopter speed shall be maintained throughout the takeoff reference procedure at -

(a) For helicopters for which the determination of takeoff performance is required by airworthiness regulations, the speed used to establish takeoff distance for sea level, 25 degrees Celsius ambient conditions;

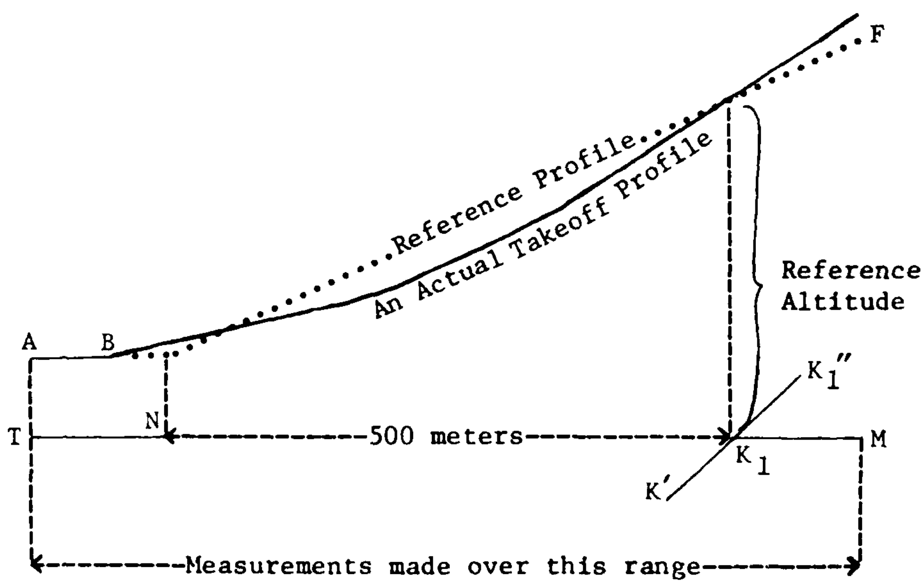
(b) For all other helicopters, the best rate of climb speed Vy, or the lowest approved speed for climb after takeoff, whichever is the greater, for sea level, 25 degrees Celsius ambient conditions.

It was agreed at CAEP/1 that this concept would be examined as part of the future WG II agenda.

6.2.4 Takeoff Profile

It was recommended at the Paris HNMRP meeting that the takeoff operation diagram be modified to extend from point B along a curved path not co-linear with the reference path. The CAEP/1 ratified amendment to ICAO Annex 16, Appendix 4 is as follows:

9.2.1 Takeoff Profile Note.- Figure 4-1 illustrates the reference and a typical takeoff profile.



a) during actual testing the helicopter is initially stabilized in level flight at the best rate of climb speed, Vy, at a point A and continues to a point B where takeoff power is applied and a steady climb is initiated. A steady climb shall be maintained throughout the 10 dB-down period and beyond to the end of the certification flight path (point F).

6.2.5 Implementation of the Takeoff Operation

At the Paris HNMRP meeting, it was proposed that point "B" of the reference takeoff profile above be adjustable, as required, to stay within the required reference window.

At CAEP/1 it was agreed that a new note be added to the end of Appendix 4, section 9.2.1 as follows:

> Note.- The position of point B may vary within the limits allowed by the certificating authorities.

6.2.6 Test to Reference Position Adjustment Limitations

At the Paris meeting, there was considerable discussion concerning the issue of minimizing the adjustments from the test day takeoff flight path to the reference takeoff flight path.

The CAEP/1 ratified amendment to Chapter 8, Section 8.7.5 is as follows:

> Adjustments for differences between test and reference flight procedures shall not exceed:
>
> a) for takeoff 4.0 EPNdB, of which the arithmetic sum of delta 1 and the term -7.5 log (QK/QrKr) from delta 2 shall not in total exceed 2.0 EPNdB.
>
> b) for overflight or approach 2.0 EPNdB.

It was also suggested, at the Paris HNMRP meeting, that a follow-on study be conducted (with HNMRP data) which would develop guidance techniques for determining when the 2 dB limit window is achieved during an actual flight test.

6.3 LEVEL FLYOVER OPERATION ISSUES

6.3.1 Flyover Reference Procedure: Vh Defined

The goal of establishing a rigorous and identifiable level flyover test speed for certification purposes arose early in the HNMRP. Previously there did not exist an airworthiness referenced Vh in the Annex. The test speed was in essence established by manufacturer selection. Since VNE is often not related to overflights, it was suggested that the value Vh, maximum speed in level flight, was a more appropriate reference value to use. Difficulties were identified with the specific definition of Vh and regulatory language was suggested for the purpose of noise certification testing.

The agreed CAEP/1 proposed amendment to Chapter 8, Section 8.6.3.1 reads as follows:

Note.- For noise certification purposes, Vh is defined as the airspeed in level flight obtained using the torque corresponding to minimum installed, maximum continuous power available for sea level pressure (1013.25 hPa), 25 degree Celsius ambient conditions unless a lower airworthiness limit is imposed by the manufacturer and approved by the certificating authority.

6.3.2 Test Window Established

With the elimination of the old Appendix 4, Section 9.1 "no correction window," (see 6.5.3) certain operational envelopes were established as test windows, specifically allowable RPM deviation. Below is the agreed CAEP/1 proposed amendment to Chapter 8, Section 8.7.6.

During the test the average rotor rpm shall not vary from the normal maximum operating rpm by more than ±1.0 per cent during the 10 dB-down time period.

6.3.3 Source Noise Adjustment

Early HNMRP evaluation of the source noise adjustment indicated that the appropriate acoustical metric for source intensity should be PNLTm, rather than EPNL as required by Annex 16 (CAN 7). The use of this metric would avoid possible confusion in adjustments related to duration effects.

HNMRP consideration of "Source Noise Correction" began at the (March 1985) Tokyo meeting with the intent of refining the CAN 7 source noise adjustment requirement to account for speed, temperature and rotor speed deviations from reference conditions. After several redrafts, the final version adopted allows the applicant the flexibility to use either advancing blade tip Mach number or another correlating parameter, whichever relates best to source noise (PNLTm).

At CAEP/1 there was still considerable debate concerning how to specify source noise correction requirements. It was acknowledged that further work was needed to understand and explain the variabilities in some of the HNMRP test results. It was also acknowledged that the blade-tip Mach number versus PNLTM relationships which were used in the repeatability tests may be improved upon. Nonetheless, many HNMRP participants found a consistent dependency between noise level and advancing blade tip Mach number.

The following is the CAEP/1 ratified amendment (Appendix 4, Section 9.5).

For overflight, if any combination of the following three factors:

1) airspeed deviations from reference,
2) rotor speed deviations from reference,
3) temperature deviations from reference,

result in an agreed noise correlating parameter whose value deviates from the reference value of this parameter, then source noise adjustments shall be determined from manufacturers data approved by the certificating authorities. This correction should normally be made using a sensitivity curve of PNLTM versus advancing blade tip Mach number; however, the correction may be made using an alternative parameter, or parameters, approved by the certificating authority.

Note 1.- If it is not possible to attain the reference value of advancing blade tip Mach number or the agreed reference noise correlating parameter then an extrapolation of the sensitivity curve is permitted providing that the data cover a range of noise correlating parameters agreed by the certificating authorities between test and reference conditions. The advancing blade tip Mach number or agreed noise correlating parameter shall be computed from measured data. A separate curve of source noise versus advancing blade tip Mach number or another agreed noise correlating parameter shall be derived for each of the three certification microphone locations, centerline, sideline left, and sideline right, defined relative to the direction of flight on each test run.

Note 2.- When using advancing blade tip Mach number it should be computed using true airspeed, on-board outside air temperature (OAT), and rotor speed.

CAEP/1 further agreed that research into the parameters influencing and varying helicopter noise during level overflight is an appropriate item for the future work program of the CAEP.

6.3.4 Speed Duration Adjustment Through the Use of Sensitivity Curves

It was recommended at the October 1985 WG II meeting that sensitivity curves be developed to adjust for ground speed duration corrections using the same data from which source corrections were developed. The proposal essentially stated that sensitivity curves should be used when the necessary data is available, rather than using the algorithm 10 log Vt/Vr for ground speed duration correction.

This proposed amendment was eventually tabled at the Paris HNMRP meeting, but is a topic for further study.

6.3.5 Level Flyover Reference Temperature

In order to achieve a consistent set of reference temperatures for all corrections and adjustments (including reference performance, source noise corrections and atmospheric absorption), it was recommended (during the Washington HNMRP meeting) that a 15 degree Celsius temperature be adopted for all applications.

At the Paris HNMRP meeting, after much discussion, this proposal was reversed in favor of retaining the 25 degree Celsius as the reference temperature for certification testing applicable to the level flyover operation.

The current set of reference temperatures is:

Source Noise Correction:	25 degree Celsius
Absorption Adjustments:	25 degree Celsius
Level Flyover Performance:	25 degree Celsius

6.4 APPROACH OPERATION ISSUES

6.4.1 Approach Window Established

As part of the decision to drop the "no correction window", certain testing envelope constraints were introduced. A limitation of ±0.5 degrees around the six degree reference approach angle was imposed.

At CAEP/1 the following amendment was ratified as an addition to the Chapter 8, Section 8.7 test procedures.

> 8.7.9 During the approach noise demonstration the helicopter shall be stabilized and following a steady glide slope angle of 6 degrees ±0.5 degrees.

6.4.2 Blade Slap on Approach

In discussions at the Paris HNMRP meeting, French participants cited test results which showed a greater tendency for blade slap to occur when the test speed exceeded the reference speed. It was observed that while this phenomena is surely helicopter specific, it may be appropriate to incorporate a cautionary note in an appendix of Annex 16.

While no specific amendments pertaining to approach speed were ratified at CAEP/1, it was recommended that the "completion of a study on the issue of speed control on approach" be taken up as a future work topic.

6.5 OTHER ISSUES

6.5.1 Analysis System Detector/Integrator Response Criteria

It was found during the HNMRP data evaluation that the need existed for the establishment of a more rigorous criteria defining SLOW dynamic response.

A requirement was adopted for a rigorous onset and decay performance test easily attainable by modern equipment. This requirement specifies 4 response test points rather than the two required by IEC-179.

For scenarios in which a SLOW dynamic response is simulated from discrete one-half second sound level samples, use of a finite set of retrospective weighting coefficients is mandatory.

The following proposed amendments, which address both topics, were ratified at CAEP/1.

Appendix 4, Section 3.4.1:

> The requirements relating to the analysis system are those of Appendix 2, Section 3.4, except for the response characteristics which are defined in Appendix 4, 3.4.2.

Appendix 4, Section 3.4.2

> For each detector/integrator, the response to a sudden onset or interruption of a constant sinusoidal signal at the respective 1/3-octave band center frequency shall be measured at sampling instants 0.5s, 1s, 1.5s and 2.0s after the onset and 0.5s and 1.0s after interruption. The rising response at 0.5s shall be -4 ±1 dB, and at 1s -1.75 ±0.5 dB, at 1.5s -1.0 ±0.5 dB, and at 2s -0.5 ±0.25, relative to the steady-state level. The falling response shall be such that the sum of the decibel readings (below initial steady-state level) and the corresponding rising response reading is 6.5 ±1 dB, at both 0.5s and 1s and on subsequent records the sum of the onset plus decay must be greater than 7.5 decibels.
>
> Note 1.- For analyzers with linear detection an approximation of this response would be given by:
>
> Weighting Coefficients for Simulation of SLOW Response

Current	(Li)	one-half second record:	33%
Previous	(Li-1)	one-half second record:	24%
Second	(Li-2)	one-half second record:	21%
Third	(Li-3)	one-half second record:	17%

$$\text{Where: } SPL = 10\log\left[(0.17\,(10^{0.1Li-3}) + 0.21\,(10^{0.1Li-2}) + 0.24\,(10^{0.1Li-1}) + 0.33\,(10^{0.1Li})\right]$$

> It should be noted that when this approximation is used the calibration signal should be established without this weighting.

One member suggested that the International Electrotechnical Commission (IEC) should be asked to adopt these characteristics. The proposed rewording would alter the rising response characteristics and provide two falling response requirements.

6.5.2 Dated Noise Analyzers

It was observed during the HNMRP testing that differences in the measured values on the order of 0.5 to 0.7 dB could result from differences in the response characteristics of the analysis system used. Since all of the analyzers used could meet the Annex 16, Appendix 4, Section 3.4 dynamic response characteristics, it was agreed that the detector/integrator characteristics should be redefined to eliminate this source of variability. As such, the incorporation of a note to discourage further use of older technology noise analyzers with comparatively slow sampling rates, which yield higher noise levels, was agreed to.

The proposed amendment to Appendix 4, Section 3.4.2 below was ratified at CAEP/1.

> Note 2.- Some analyzers have been shown to have signal sampling rates that are insufficiently accurate to detect signals with crest factor ratios greater than three (common to helicopter noise). Preferably such analyzers should not be used for helicopter certification. Use of analysis systems with high signal sampling rates (greater than 40 KHz) or those with analog detectors prior to digitalization at the output of each 1/3-octave filter is encouraged.

6.5.3 "No Correction Window" Deleted

Discussions at the Paris HNMRP meeting focused on some structural problems within the existing Annex 16 test and no correction window requirements. These provisions specified the permissible testing envelope and certain combinations of environmental and flight conditions for which data adjustments were unnecessary.

At Paris, and subsequently at CAEP/1, there was considerable debate concerning adjustments to flight test results. The following are excerpts from the CAEP/1 report.

> "Working Group II previously recommended deletion of the so-called "no correction window" which allowed completion of flight tests within certain tolerances in mass, flight path, airspeed, rotor RPM, and ambient temperature and humidity without requiring adjustment from test to reference conditions. Some members advocated retention of the "no correction window", based on their contention that sensitivity curves would otherwise have to be developed, flight time requirements for noise certification would increase appreciably, and costs would rise significantly. Other members disputed the validity of the predicted cost increases, stating that costs would only increase on the order of 5 to 10% and held that the benefits justified added costs of that magnitude.

The perspective that dominated the CAEP/1 thinking was that the "no correction window" really was in fact a set of conditions that should have been specified as test window boundaries. The sentiment was therefore to eliminate the no correction window and transfer appropriate boundary conditions to a newly established test window.

6.5.4 Test Windows Established

At Paris, and again at CAEP/1, it was suggested that Chapter 8 lacked certain essential test constraints which could reduce possible sources of variability in noise levels. After debating the issue, the Committee agreed to specify limitations on helicopter mass, flight path and rotor RPM for noise certification.

These limitations, contained in Chapter 8, Sections 8.7.6 through 8.7.10, were ratified at CAEP/1. Proposed sections 8.7.8 and 8.7.10 are described below. Sections 8.7.6 and 8.7.9 are detailed above in the level flyover and approach sections.

8.7.8 The helicopter shall fly within ±10 degrees from the vertical above the reference track through the center reference noise measurement position throughout the 10 dB-down time period.

8.7.10 Tests shall be conducted at a helicopter mass not less than 90 per cent of the relevant maximum certificated mass and may be conducted at a mass not exceeding 105 per cent of the relevant maximum certificated mass.

6.5.5 Allowable Deviation in Sideline Elevation Angle Psi

This issue essentially embraces another type of source noise correction, the change in acoustical intensity with the direction of radiation.

During discussions at the Paris HNMRP meeting, the group agreed that the noise emission directivity angle is very important and will most certainly affect final results. It was further agreed that the Paris proposed amendment to Appendix 4 (below), ratified at CAEP/1, is only a cosmetic solution and will not solve the real problem. Recognizing that the proposed amendment below does not solve the problem, it does, nevertheless, recognize officially the existence of the problem and is considered a first step toward an ultimate solution.

9.1.2 Adjustments to the measured noise data shall be made ...

9.1.2.c) the adjustment procedure described in this section shall apply to the sideline microphones in the takeoff, overflight, and approach cases. Although the noise emission is strongly dependent on the directivity pattern, variable from one helicopter type to another, the propagation angle Theta, defined in Appendix 2, 9.3.2, Figure 2.10, shall be the same for the test and reference flight paths. The elevation angle Psi shall not be constrained as in the third note of Appendix 2, 9.3.2, but must be determined and reported. The certification authority shall specify the acceptable limitations on Psi. Corrections to data obtained when these limits are exceeded shall be applied using procedures approved by the certificating authority.

As a post script on this topic, the French delegate proposed that optional sensitivity curves be developed and utilized for sideline elevation angle adjustments. It was further suggested that members experiment with techniques for acquiring the necessary information in the most efficient manner in terms of data runs and microphone location. It was hypothesized that while greater cost is involved at the onset, with future derivatives, costs will likely be recouped.

6.5.6 Optional Sensitivity Curves for Adjusting Data

Discussions at both the Washington and Paris HNMRP meetings included the topic of optional sensitivity curves as a means to implement data adjustments, rather than the current Annex 16 adjustment algorithms. The following is the proposed amendment to Appendix 4, Section 9.1.2 ratified at CAEP/1.

> Note 2.- Adjustments of noise levels for test to reference conditions may be made, subject to agreement by certificating authorities, by the methods of this section. The corrections are derived from sets of curves linking the instant at which the PNLTM is emitted for each reference procedure with appropriate parameters, for example:
>
> a) the height, average ground speed, and advancing blade tip Mach number for flyover;
> b) the glide slope and height for approach;
> c) the height, torque, and ground speed for takeoff.
>
> The sensitivity curves shall provide noise level variations as a function of the parameter for which a correction is necessary.

6.5.7 Technical Manual

At the Paris meeting, the HNMRP participants recommended to WG II that a Technical Manual Committee (or Technical Issue Group) be established to specifically follow up on residual issues from the HNMRP.

The "CAEP/1 Report on Agenda Item 1" (helicopters) charged CAEP with "continued evaluation of issues leading to and arising from the Helicopter Noise Measurement Repeatability Program."

7.0 EPNL MULTI-NATION COMPARISON DATA

This section contains EPNL multi-nation summary comparison data for the takeoff, approach and level flyover operations. A complete reporting of the multi-nation comparison data can be found in Appendix A. The information contained in this section and in Appendix A provide an important investigative tool for the exploration of why differences exist in reported data. These data, along with the potential future analyses outlined in at the end of this report, represent the primary research instruments for HNMRP follow-on Working Group II (1987-1990) activities designed to further explore questions concerning helicopter noise certification repeatability.

Please note that all UK level flyover data was corrected with a delta 3 correction referenced to 15 degrees C. All other teams used delta 3 corrections referenced to 25 degrees C.

MULTI-NATION COMPARISON ANALYSIS
TAKE-OFF EPNL DATA EXPRESSED IN DECIBELS (dB)

Table 7.0.A

PARTICIPANT	LEFT SIDELINE AVERAGE	CENTER LINE CENTER AVERAGE	RIGHT SIDELINE AVERAGE	3 MIC AVERAGE	STD DEV	90% C.I.	TEAM AVERAGE	TEST AVERAGE
AUSTRALIA	87.89	89.55	87.63	88.35	0.39	0.17	88.35	88.35
JAPAN-PILOT 1	88.80	88.90	88.90	88.90	0.30	0.20	88.90	88.90
JAPAN-PILOT 2	88.10	90.00	88.70	88.90	0.50	0.30		
FRANCE-AERO	85.70	88.40	87.40	87.20	0.64	0.53	87.20	86.35
FRANCE-STNA	84.70	87.30	84.50	85.50	0.40	0.30	85.50	
ITALY	NA	NA	NA	NA	NA	NA		
FRG-PILOT 1	85.50	86.60	86.10	86.10	0.30	0.30	86.05	86.38
FRG-PILOT 2	86.30	85.70	86.20	86.00	0.10	0.00		
UK-PILOT 1	86.00	87.30	86.60	86.60	0.40	0.30	86.70	
UK-PILOT 2	86.40	86.60	87.20	86.80	0.20	0.20		
CANADA-PILOT 1-1	87.76	87.35	87.75	87.62	0.17	0.29	87.53	87.39
CANADA-PILOT 1-2	88.54	87.10	85.93	87.19	0.08	0.35		
CANADA-PILOT 2-1	87.79	88.16	86.03	87.33	0.86	1.45		
CANADA-PILOT 2-2	86.96	89.35	87.65	87.99	0.92	1.56		
US-PILOT 1-1	86.90	86.70	86.20	86.60	0.31	0.21	87.25	
US-PILOT 1-2	87.40	86.40	85.90	86.60	0.25	0.23		
US-PILOT 2-1	87.30	87.70	86.50	87.20	0.59	0.44		
US-PILOT 2-2	89.00	89.40	87.30	88.60	0.63	0.52		
AVERAGE	87.12	87.79	86.85	87.26	0.41	0.43	87.19	87.47
STD DEV	1.22	1.28	1.11	1.02	0.25	0.42	1.12	1.15
90% C.I.	0.77	0.80	0.70	0.64	0.15	0.27	1.19	1.93

EPNL 3 MIC AVERAGE & STD DEVIATION

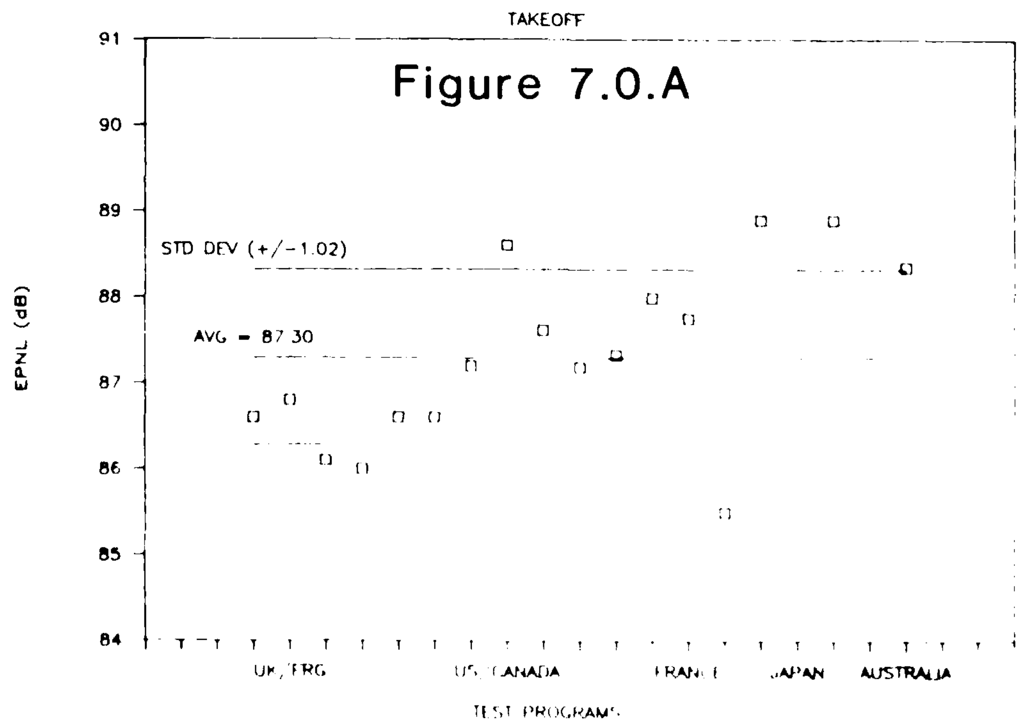


Table 7.0.B

MULTI-NATION COMPARISON ANALYSIS
APPROACH EPNL DATA EXPRESSED IN DECIBELS (dB)

PARTICIPANT	LEFT SIDELINE AVERAGE	CENTER LINE CENTER AVERAGE	RIGHT SIDELINE AVERAGE	3 MIC AVERAGE	STD DEV	90% C.I.	TEAM AVERAGE	TEST AVERAGE
AUSTRALIA	87.46	93.82	91.51	90.93	0.98	0.66	90.93	90.93
JAPAN-PILOT 1	89.30	93.50	90.70	91.20	0.80	0.60	91.40	91.40
JAPAN-PILOT 2	89.70	93.70	91.50	91.60	0.80	0.50		
FRANCE-AERO	86.10	92.30	89.40	89.30	0.84	1.42	89.30	88.84
FRANCE-STNA	85.00	91.40	88.70	88.37	0.60	0.40	88.37	
ITALY	NA	NA	NA	NA	NA	NA		
FRG-PILOT 1	85.90	92.30	89.10	89.50	0.60	0.40	89.55	89.53
FRG-PILOT 2	85.70	92.60	89.90	89.60	0.50	0.40		
UK-PILOT 1	86.30	92.30	89.90	89.50	0.50	0.40	89.50	
CANADA-PILOT 1-2	85.97	92.92	91.81	90.57	0.13	0.58	90.69	90.36
CANADA-PILOT 2-1	87.27	92.78	91.77	90.81	0.61	1.03		
US-PILOT 1-1	87.20	92.50	91.00	90.20	0.55	0.40	90.20	
US-PILOT 1-2	86.90	92.70	91.40	90.00	0.41	0.39		
US-PILOT 2-1	86.40	92.40	90.80	90.10	0.71	0.52		
US-PILOT 2-2	87.10	92.80	91.40	90.50	0.52	0.35		
AVERAGE	[illegible]	92.76	90.56	90.16	0.61	0.58	89.99	90.21
STD DEV	[illegible]	0.66	[illegible]	0.86	0.21	0.30	1.00	1.04
90% C.I.	0.86	0.47	[illegible]	0.61	0.15	0.21	1.06	1.74

EPNL 3 MIC AVERAGE & STD DEVIATION

APPROACH

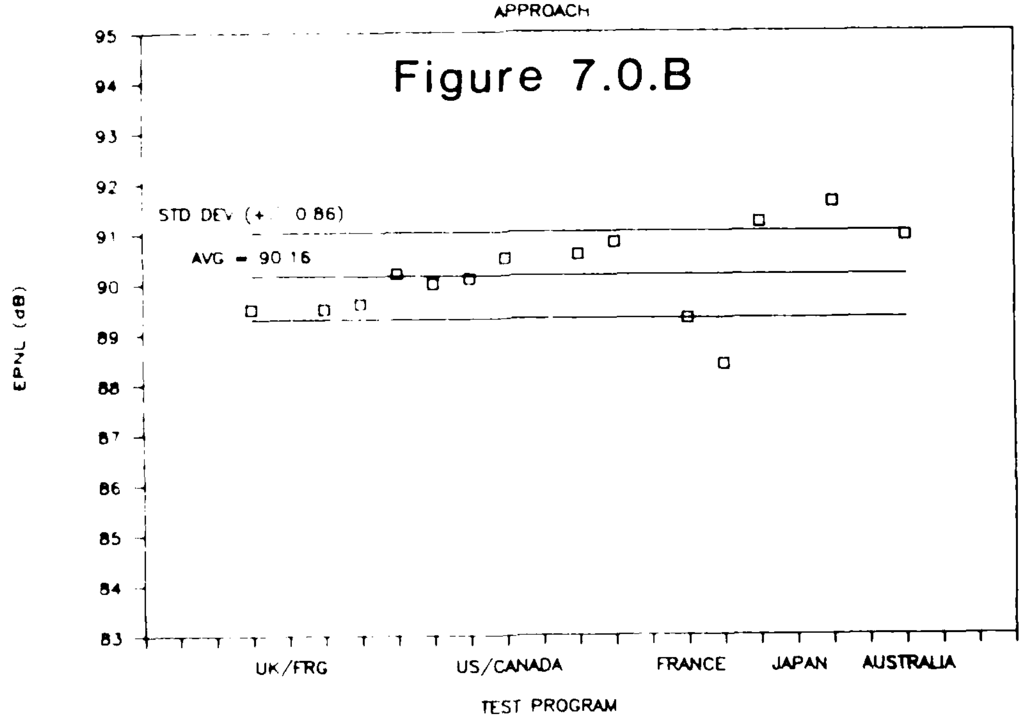
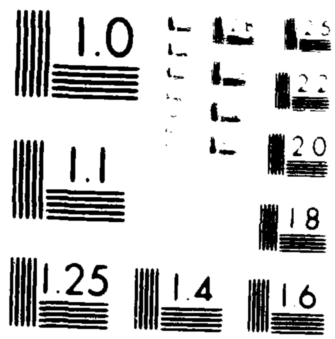


Figure 7.0.B

AD-A188 540 INTERNATIONAL CIVIL AVIATION ORGANIZATION COMMITTEE ON AVIATION ENVIRONME..(U) FEDERAL AVIATION ADMINISTRATION WASHINGTON DC OFFICE OF ENVIR.. J S NEWMAN ET AL. 2/3

UNCLASSIFIED SEP 87 FAA-EE-87-2 F/G 20/1 NL


1.0
2.2
2.0
1.1
1.8
1.25
1.4
1.6

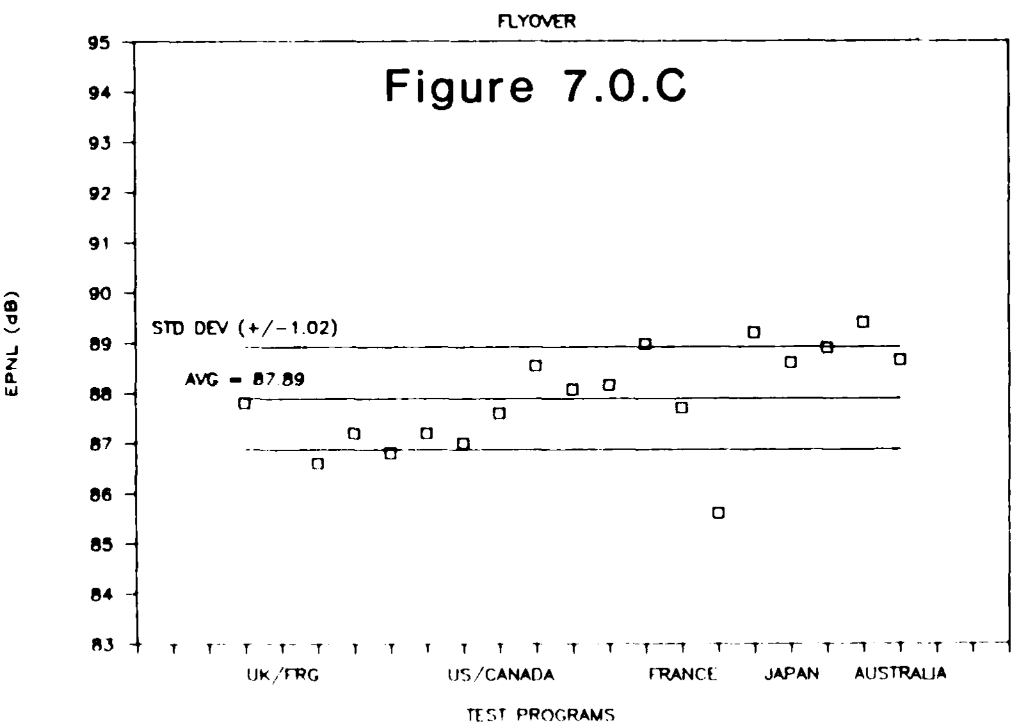
MULTI-NATION COMPARISON ANALYSIS
LEVEL FLYOVER EPNL DATA EXPRESSED IN DECIBELS (dB)

Table 7.0.C

UK delta 3 calculated at 15°C

PARTICIPANT	LEFT SIDELINE AVERAGE	CENTER LINE CENTER AVERAGE	RIGHT SIDELINE AVERAGE	3 MIC AVERAGE	STD DEV	90% C.I.	TEAM AVERAGE	TEST AVERAGE
AUSTRALIA	88.82	89.69	87.42	88.65	0.72	0.39	88.65	88.65
JAPAN-PILOT 1-1	90.10	89.10	88.40	89.20	0.40	0.50	89.03	89.03
JAPAN-PILOT 1-2	90.80	88.20	86.90	88.60	0.40	0.70		
JAPAN-PILOT 2-1	90.40	88.40	87.90	88.90	0.60	0.70		
JAPAN-PILOT 2-2	91.50	89.10	87.70	89.40	0.40	0.50		
FRANCE-AERO	87.90	88.40	86.80	87.70	0.36	0.43	87.70	86.65
FRANCE STNA	85.70	87.50	83.90	85.60	0.40	0.50	85.60	
ITALY	NA	NA	NA	NA	NA	NA		
FRG-PILOT 1	86.60	88.20	84.90	86.60	0.30	0.20	86.90	87.20
FRG-PILOT 2	86.30	89.70	85.60	87.20	0.30	0.30		
UK PILOT 1	89.10	89.00	85.20	87.90	0.25	0.21	87.80	
CANADA-PILOT 1-1	88.59	88.67	88.34	88.54	0.22	0.21	88.44	87.79
CANADA-PILOT 1-2	88.55	88.78	87.29	88.07	0.58	0.68		
CANADA-PILOT 2-1	87.61	88.77	88.12	88.16	0.46	2.06		
CANADA-PILOT 2-2	89.42	88.58	88.94	88.98	0.43	0.51		
US-PILOT 1-1	87.30	86.80	86.30	86.80	0.29	0.21	87.15	
US-PILOT 1-2	87.70	87.70	86.30	87.20	0.16	0.19		
US-PILOT 2-1	87.30	87.50	86.20	87.00	0.30	0.25		
US-PILOT 2-2	88.60	87.00	87.30	87.60	0.45	0.30		
AVERAGE	88.43	88.37	86.86	87.89	0.39	0.49	87.66	87.86
STD DEV	1.67	0.83	1.35	1.02	0.14	0.43	1.11	0.99
90% C.I.	0.99	0.50	0.82	0.62	0.09	0.26	1.17	1.65

EPNL 3 MIC AVERAGE & STD DEVIATION



8.0 MULTI-NATION COMPARISON ANALYSES

Within this section a summary of the HNMRP results and findings are presented in Section 8.1 and the "Multi-Nation Comparison Analyses" are presented in Section 8.2.

8.1 SUMMARY OF RESULTS AND FINDINGS

8.1.1 Summary of Findings

Two principle conclusions can be stated as a result of the HNMRP:

1) The requirements of ICAO Annex 16, Chapter 8 and Appendix 4 (with the incorporation of the CAEP/1 proposed changes) provide a consistent and repeatable methodology for noise certification of helicopters.

2) The random aggregate variation, resulting from numerous independent sources of variation, leads to a standard deviation of approximately 1 dB for the EPNL metric.

Other program findings include:

A Within a given test program and a given test series the acoustical data are quite repeatable and statistically well behaved. (See Section 8.2.1)

B Within a given test program pilot to pilot differences are generally insignificant. (See Section 8.2.2)

C Test day to test day differences are generally very small for the same helicopter and the same data acquisition team. (See Section 8.2.3)

D Differences do exist between measurement programs possibly suggesting that differences may exist between one helicopter and the next of the same make and model.

E For the test helicopter, approach operations are very repeatable and not apparently influenced by the degree of guidance provided. (See Section 8.2.5)

F The Bell manufacturer's "Quiet Approach" procedure results in lower noise levels (approximately 2 to 4 EPNdB) than the ICAO 6 degree approach operation. (See Section 8.2.6)

G Alternative approach operations noise levels vary from the ICAO 6 degree approach operation noise levels. (See Section 8.2.6)

H The ICAO 6 degree approach operation for the 206L-1,3 produces distinct left-right directivity patterns. (See Section 8.2.7)

I Though the approach operation appears repeatable in this program, one program participant observed that another helicopter type might exhibit greater variability if the certification flight test regime for that model encroached on a sensitive blade vortex interaction region.

8.1.2 Summary of Results

Table 8.1.A below is a summary of the overall individual operation metric multi-nation summary data comparison tables in Appendix A. In Table 8.1.A the 3-mic average multi-nation mean values are presented along with the standard deviation and 90% confidence interval (CI) values denoting the variation among the participant teams. The standard deviation and confidence interval data reveal the fundamental variability in the noise certification process as observed in the HNMRP.

TABLE 8.1.A
PROGRAM AVERAGE 3-MIC NOISE LEVELS

	APPROACH	TAKEOFF	LEVEL FLYOVER
EPNL	90.16	87.26	87.89
STD.DEV.	.61	.41	.39
90% CI	.58	.43	.49
PNLTM	90.43	88.27	89.64
STD.DEV	.73	.51	.39
90% CI	.72	.54	.50
SEL	86.79	83.20	83.15
STD.DEV.	.48	.42	.37
90% CI	.45	.56	.48
ALm	76.80	73.08	74.75
STD.DEV.	.66	.50	.47
90% CI	.56	.54	.46

8.2 MULTI-NATION COMPARISON ANALYSES

8.2.1 Statistical Stability of the Results

Within a given test program and a given test series the acoustical data are quite repeatable and statistically well behaved. The statistical repeatability of each team's 3-mic average results are shown in Tables 8.2.A through 8.2.C. These tables show the standard deviations and 90 % CI values each team arrived at in determining the averages of the 3-mic averages.

8.2.2 Pilot to Pilot Repeatability

It has been speculated that variation in measured helicopter noise may be associated with pilot technique. In order to examine pilot to pilot differences the HNMRP test plan called for identical flight operations to be flown by two different pilots.

Two pilots repeated operations in three of the test programs. (In the US/Canadian test each pilot flew a second time on a different day, for a total of four repeats of the core operations). Tables 8.2.D through 8.2.F present 3-mic average data for each pilot, the delta between pilots in a test and the average of the deltas. As seen in the tables (one for each operation), pilot to pilot differences are extremely small and in general not statistically significant.

8.2.3 Test Day to Test Day Repeatability

Another issue related to certification testing is the day to day repeatability of operations by the same pilot. The analysis of any variance between operations conducted by the same test group, at the same location, with the same helicopter and the same pilot should point out meteorological influences on noise data (if all instrument influences remained the same).

The only program able to examine this subject was the US/Canadian test program; the entire core program was conducted by two different pilots on two different days. Tables 8.2.G through 8.2.I are summaries of the relevant data.

Statistical analyses for significance were performed on this data and in general the differences from one test day to the next are not significant. However, there is an exception in the case of the second pilot second occurrence, for takeoff and level flyover. The data associated with these series--both meteorological data, flight test and noise data--are candidates for further study.

8.2.4 Program to Program Repeatability

Again, noting that there was general repeatability from program to program, the opportunity remains to investigate observed differences and explore whether or not the certification process can be further improved.

To further examine program to program repeatability one team took measurements at two test programs; the US test team participated, not only in the US/Canadian test program, but also deployed one (1.2m) measurement system at the centerline-center site during the joint French/Italian test. Unfortunately, the US data measured at the French/Italian test has not yet been fully corrected and thus cannot be compared to fully corrected US data from the US/Canadian test. This, however, would be a very interesting area for future study.

8.2.5 Guided Versus Unguided Approach

The question of whether or not the degree of guidance provided during an approach operation might influence resulting sound levels was raised during the A-109A program (a predecessor to the HNMRP). It was suggested in that program that too much guidance might result in over-controlling, which in turn would result in transient loads on the rotor system and create variation in sound levels. In order to explore this concern, the HNMRP test plan requested incorporation of guided approaches (where pilots would receive both verbal and visual flight path guidance) and unguided approaches (where pilots would be limited to an approach initiation point--altitude at a given position--,a descent rate, and an airspeed).

As shown in Table 8.2.J, guided versus unguided approach operation results show that differences in approach guidance were in general not statistically significant for the Bell 206L-1 (-3), and thus apparently not influenced by the degree of guidance provided. It should be noted, however, that the stable nature of the approach characteristics of the Bell 206L-1 (-3) may have lead to the low scatter between guidance methods and that other helicopter types, with different characteristics, may produce different results.

8.2.6 Approach Angles Examined

This section contains three tables (8.2.K, 8.2.L and 8.2.M), each comparing noise levels for the six degree ICAO approach operation with an alternative approach operation (the Bell "Quiet" approach, a nine degree approach, and a six degree Vy+20 approach). The results demonstrate that for the Bell 206L-1 (-3) helicopter the six degree ICAO operation is on average 2 to 3 dB louder than the alternative operations. These results (along with other reported noise measurement flight test data) confirm that the ICAO approach operation is, generally speaking, a worst noise case flight regime which is consistent with the intent of the authors of ICAO Annex 16. The subject of alternative approach procedures for noise certification has been recommended for further consideration by Working Group II.

8.2.7 Left Right Directivity

Source radiation "left-right" directivity patterns present a "fingerprint" of the acoustical radiation characteristics of the test helicopter for the ICAO certification operations. In theory these "fingerprints" should not differ significantly from one test to the next. However, the results of this analysis can be very useful in discovering whether one model of the test helicopter is intrinsically different from another model, or whether ambient wind conditions or other external forces are intervening creating divergence in relative left-right side noise levels, and possibly overall certification levels.

The data "fingerprint" plots and data tables are presented in Appendix A. The plots are presented overlaid on top of one another in groups which are generally similar. This format, while somewhat busy, is essential in providing a visual inter-program comparison. Legends accompany each plot identifying the program participant and/or series repetition. The plots provide a great deal of instant insight into which test program's data deviated "in form" as well as in level. That is to say, a data set which had a three microphone average on the low edge of the scatter band but had a directivity pattern very consistent with other test programs is in many ways less anomalous than a set with a mean value in the midst of the data scatter but with a distinctly different directivity pattern.

It is important to note that for the certification metric, EPNL, overall repeatability was excellent. At the same time, an important opportunity exists to examine the differences which were observed. It should be possible in future analyses of the HNMRP data to probe some of the team to team differences observed within a given test program where different measurement teams were working side-by-side.

8.2.8 Ground and 1.2 Meter Microphone Data Compared

The purpose of comparing ground and 1.2 m microphone data measured at the same site is to establish whether ground surface characteristics or microphone placement may be areas of concern in attempts to isolate variation in HNMRP data. The end product of such a comparison is to determine if similar or dissimilar ground impedance exists, in turn indicating a source of bias either does or does not exist.

Tables 8.2.N, 8.2.O, and 8.2.P provide summary comparisons of ground minus 1.2 meter microphone noise level differences for the three certification operations. The tables show that, in general the results are consistent.

8.2.9 Static Flight Idle

The objective of the static analysis is to remove the complexity of forward flight effects and examine whether gross differences in source characteristics are apparent. The discovery of significant differences in directivity and/or sound level may indicate to investigators that environmental or source emission idiosyncrasies are present in one test program or the other. The analyses in this section focus on the static flight-idle operation. Other static operations were conducted in several of the test programs and may be the topic of future WG II (1987-1990) analyses.

Acquisition of repeatable and stable static data is at times a difficult task because of the temporal and directive fluctuations in sound levels coupled with the anomalies of sound propagation along the ground plane. In order to compensates for these instabilities the test design called for measurement of the time averaged A-weighted sound level (LEQ), over a 60-second period. Data samples were to be acquired for acoustical emission directivity angles established every 45 degrees from the nose of the helicopter (zero degrees), in a clockwise fashion. In addition, it was recommended that data be acquired for two separate propagation paths, one a nominally level "soft" path (a ground surface composed of mixed grasses), the other a hard path (a ground surface which is highly reflective and uniform in composition).

Results of static tests are summarized in Table 8.2.Q and Figure 8.2.A for the "hard" propagation path scenario and in Table 8.2.R and Figure 8.2.B for the "soft" propagation path scenario. As with the left-right directivity plots, the static plots are presented overlaid in similar groups.

During the various phases of the HNMRP there were discussions concerning the acquisition of static data, below is a summary of observations made during these discussions.

1. It is evident that an isothermal condition with no wind would be the preferred condition for assessment of static data.

2. It was observed that hover in ground effect operations are prone to wide variation in levels (15 dB for certain helicopters) over a 30-second time interval.

3. It was pointed out that positioning of the aircraft, relative to the microphones,--particularly during the tail-on conditions--will need to be carried out very carefully to avoid systematic errors in mapping the directivity curves.

4. It was noted that there are several physical phenomena that influence the diminution of sound over the ground; among which spreading loss, excess ground attenuation and refraction are considered dominant in controlling propagation.

5. It was observed that the presence of temperature inversions can result in a shadow region.

6. It was noted that micrometeorlogy, the rate of surface heat loss, the specific heat of the ground surface, the rate of heating for the dissimilar surfaces and test site wind conditions may play significant roles in influencing static test results.

7. It was further noted that, as suggested in a number of working papers submitted by Poland and the USSR over the past several years, the scatter in the reported data provide some indication of the difficulty one might encounter in a sound intensity static operation certification process.

8.2.10 Meteorological Data

Figures 8.2.C through 8.2.E show the wide range of test conditions under which the noise measurement test results were achieved. Given the general repeatability of the HNMRP multi-nation comparison data, it would appear that the temperature and relative humidity data are not a significant factor when the data are corrected to the "standard acoustical day," 77% RH, 25 degrees Celsius.

A more thorough presentation of meteorological data is given in Appendix B where the specific meteorological conditions under which each test was conducted are identified.

Section 8.2

Tables and Figures

UK delta 3 calculated at 15^{o}C

Table 8.2.A

STATISTICAL REPEATABILITY OF 3-MIC AVERAGES
TAKE-OFF DATA EXPRESSED IN DECIBELS (dB)

PARTICIPANT	EPNL STD DEV	EPNL 90% C.I.	PNLTm STD DEV	PNLTm 90% C.I.	SEL STD DEV	SEL 90% C.I.	ALm STD DEV	ALm 90% C.I.
AUSTRALIA	0.39	0.17	0.48	0.21	NA	NA	0.62	0.27
JAPAN-PILOT 1	0.30	0.20	0.32	0.20	NA	NA	NA	NA
JAPAN-PILOT 2	0.50	0.30	0.56	0.35	NA	NA	NA	NA
FRANCE-AERO	0.64	0.53	0.86	0.71	NA	NA	NA	NA
FRANCE-STNA	0.40	0.30	0.50	0.40	0.30	0.20	0.30	0.20
ITALY	NA	NA	NA	NA	NA	NA	NA	NA
FRG-PILOT 1	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
FRG-PILOT 2	0.10	0.00	0.20	0.10	0.20	0.20	0.40	0.40
UK-PILOT 1	0.40	0.30	0.30	0.30	0.30	0.30	0.30	0.30
UK-PILOT 2	0.20	0.20	0.30	0.30	0.30	0.20	0.60	0.50
CANADA-PILOT 1-1	0.17	0.29	0.55	0.93	0.32	0.54	0.08	0.14
CANADA-PILOT 1-2	0.08	0.35	0.02	0.07	0.26	1.16	0.03	0.14
CANADA-PILOT 2-1	0.86	1.45	0.79	1.34	0.91	1.53	0.82	1.38
CANADA-PILOT 2-2	0.92	1.56	1.37	2.31	0.87	1.47	1.29	2.17
US-PILOT 1-1	0.31	0.21	0.55	0.37	0.25	0.17	0.45	0.30
US-PILOT 1-2	0.25	0.23	0.18	0.17	0.24	0.23	0.43	0.41
US-PILOT 2-1	0.59	0.44	0.49	0.36	0.65	0.48	0.62	0.45
US-PILOT 2-2	0.63	0.52	0.86	0.71	0.58	0.48	0.73	0.60
AVERAGE	0.41	0.43	0.51	0.54	0.42	0.56	0.50	0.54
STD DEV	0.25	0.42	0.32	0.56	0.25	0.49	0.32	0.56
90% C.I.	0.15	0.27	0.20	0.35	0.18	0.37	0.23	0.40

Table 8.2.B

STATISTICAL REPEATABILITY OF 3-MIC AVERAGED
APPROACH DATA EXPRESSED IN DECIBELS (dB)

PARTICIPANT	EPNL STD DEV	EPNL 90% C.I.	PNLTm STD DEV	PNLTm 90% C.I.	SEL STD DEV	SEL 90% C.I.	ALm STD DEV	ALm 90% C.I.
AUSTRALIA	0.98	0.66	1.11	0.74	NA	NA	1.11	0.74
JAPAN-PILOT 1	0.80	0.60	0.38	0.25	NA	NA	NA	NA
JAPAN-PILOT 2	0.80	0.50	0.64	0.39	NA	NA	NA	NA
FRANCE-AERO	0.84	1.42	1.22	2.96	NA	NA	NA	NA
FRANCE-STNA	0.60	0.40	1.80	1.30	0.60	0.50	1.20	0.90
ITALY	NA	NA	NA	NA	NA	NA	NA	NA
FRG-PILOT 1	0.60	0.40	0.60	0.40	0.80	0.50	0.50	0.30
FRG-PILOT 2	0.50	0.40	0.80	0.70	0.30	0.30	0.50	0.40
UK-PILOT 1	0.50	0.40	0.80	0.70	0.50	0.40	0.90	0.70
CANADA-PILOT 1-2	0.13	0.58	0.32	1.44	0.13	0.58	0.12	0.53
CANADA-PILOT 2-1	0.61	1.03	0.26	0.43	0.50	0.84	0.47	0.79
US-PILOT 1-1	0.55	0.40	0.87	0.58	0.53	0.35	0.82	0.55
US-PILOT 1-2	0.41	0.39	0.38	0.36	0.36	0.34	0.49	0.46
US-PILOT 2-1	0.71	0.52	0.58	0.42	0.63	0.46	0.54	0.40
US-PILOT 2-2	0.52	0.35	0.43	0.26	0.44	0.27	0.58	0.36
AVERAGE	0.61	0.58	0.73	0.78	0.48	0.45	0.66	0.56
STD DEV	0.21	0.30	0.42	0.72	0.19	0.17	0.32	0.20
90% C.I.	0.15	0.21	0.30	0.51	0.17	0.15	0.26	0.16

Table 8.2.C

STATISTICAL REPEATABILITY OF 3-MIC AVERAGES
LEVEL FLYOVER DATA EXPRESSED IN DECIBELS (dB)

PARTICIPANT	EPNL STD DEV	EPNL 90% C.I.	PNLTM STD DEV	PNLTM 90% C.I.	SEL STD DEV	SEL 90% C.I.	ALM STD DEV	ALM 90% C.I.
AUSTRALIA	[illegible]	[illegible]	[illegible]	[illegible]	NA	NA	0.56	0.31
JAPAN-PILOT 1-1	[illegible]	0.50	0.14	0.16	NA	NA	NA	NA
JAPAN-PILOT 1-2	0.40	[illegible]	[illegible]	0.52	NA	NA	NA	NA
JAPAN-PILOT 2-1	0.60	[illegible]	0.78	0.44	NA	NA	NA	NA
JAPAN-PILOT 2-2	0.40	0.50	0.16	0.19	NA	NA	NA	NA
FRANCE-AERO	0.36	0.43	0.64	0.75	NA	NA	NA	NA
FRANCE-STNA	0.40	0.50	0.60	0.80	0.30	0.30	0.50	0.50
ITALY	NA	NA	NA	NA	NA	NA	NA	NA
FRG-PILOT 1	0.30	0.20	0.20	0.20	0.20	0.20	0.30	0.30
FRG-PILOT 2	0.30	0.30	0.30	0.30	0.60	0.50	0.80	0.70
UK-PILOT 1	NA	NA	NA	NA	0.20	0.20	0.30	0.20
CANADA-PILOT 1-1	0.22	0.21	0.27	0.26	0.32	0.31	0.48	0.46
CANADA-PILOT 1-2	0.58	0.68	0.60	0.71	0.60	0.71	0.69	0.81
CANADA-PILOT 2-1	0.46	2.06	0.47	2.09	0.44	1.95	0.14	0.61
CANADA-PILOT 2-2	0.43	0.51	0.80	0.94	0.57	0.67	0.93	1.10
US-PILOT 1-1	0.29	0.21	0.27	0.20	0.23	0.17	0.26	0.19
US-PILOT 1-2	0.16	0.19	0.14	0.16	0.23	0.27	0.17	0.20
US-PILOT 2-1	0.30	0.25	0.22	0.19	0.27	0.22	0.36	0.30
US-PILOT 2-2	0.45	0.30	0.46	0.28	0.43	0.27	0.59	0.36
AVERAGE	0.40	0.51	0.39	0.50	0.37	0.48	0.47	0.46
STD DEV	0.14	0.44	0.20	0.48	0.16	0.50	0.24	0.27
90% C.I.	0.09	0.27	0.13	0.30	0.12	0.39	0.18	0.20

UK delta 3 calculated at 15°C

Table 8.2.D

PILOT TO PILOT REPEATABILITY
TAKE-OFF DATA EXPRESSED IN DECIBELS (dB)

PARTICIPANT	EPNL 3 MIC AVERAGE	PNLTm 3 MIC AVERAGE	SEL 3 MIC AVERAGE	ALm 3 MIC AVERAGE
JAPAN-PILOT 1	[illegible]	89.29	NA	NA
JAPAN-PILOT 2	88.9[illegible]	89.80	NA	NA
DELTA	[illegible]	0.51	NA	NA
FRG-PILOT 1	86.1[illegible]	86.90	83.40	72.00
FRG-PILOT 2	86.[illegible]	86.9[illegible]	82.50	71.80
DELTA	[illegible]	[illegible]	0.10	0.20
[illegible]-PILOT 1	86.6[illegible]	87.3[illegible]	83.20	72.90
[illegible]-PILOT 2	86.80	87.4[illegible]	83.30	72.90
DELTA	0.20	0.10	0.10	0.00
CANADA-PILOT [illegible]	87.6[illegible]	88.68	83.5[illegible]	73.14
CANADA-PILOT [illegible]	87.[illegible]	88.71	83.25	73.21
DELTA	[illegible]	[illegible]	[illegible]	0.07
CANADA-PILOT [illegible]	87.19	88.11	83.2[illegible]	72.67
CANADA-PILOT [illegible]	87.94	88.92	83.83	73.41
DELTA	[illegible]	.81	[illegible]	0.74
US-PILOT [illegible]	86.6[illegible]	87.90	82.90	7[illegible].90
US-PILOT [illegible]	87.[illegible]	88.7[illegible]	83.40	73.60
DELTA	[illegible]	0.80	0.50	0.70
US-PILOT [illegible]	86.50	87.90	8[illegible]	7[illegible]
US-PILOT [illegible]	88.5[illegible]	90.10	84.8[illegible]	74.90
DELTA	[illegible]	2.20	1.8[illegible]	2.20
AVG. OF DELTA	.5[illegible]	0.54	.57	0.65
STD. DEV.	.54	[illegible]	.64	0.9[illegible]
90% C.I.	.8[illegible]	.9[illegible]	0.87	1.17

Table 8.2.E

PILOT TO PILOT REPEATABILITY
APPROACH DATA EXPRESSED IN DECIBELS (dB)

PARTICIPANT	EPNL 3 MIC AVERAGE	PNLTm 3 MIC AVERAGE	SEL 3 MIC AVERAGE	ALm 3 MIC AVERAGE
JAPAN-PILOT 1	91.20	91.11	NA	NA
JAPAN-PILOT 2	91.60	91.55	NA	NA
DELTA	0.40	0.44	NA	NA
FRG-PILOT 1	89.50	88.90	86.10	75.70
FRG-PILOT 2	89.60	89.40	86.60	76.10
DELTA	0.10	0.50	0.50	0.40
CANADA-PILOT 1-2	90.57	90.86	87.15	76.97
CANADA-PILOT 2-1	90.81	91.39	87.31	77.64
DELTA	0.24	0.53	0.16	0.67
US-PILOT 1-1	90.20	90.60	87.10	77.30
US-PILOT 2-1	90.10	90.80	87.10	77.30
DELTA	0.10	0.20	0.00	0.00
US-PILOT 1-2	90.00	90.20	87.10	76.80
US-PILOT 2-2	90.50	91.00	87.40	77.50
DELTA	0.50	0.80	0.30	0.70
AVG. OF DELTA	0.25	0.45	0.24	0.44
STD. DEV.	0.21	0.31	0.21	0.32
90% C.I.	0.36	0.51	0.48	0.74

Table 8.2.F

PILOT TO PILOT REPEATABILITY
LEVEL FLYOVER DATA EXPRESSED IN DECIBELS (dB)

PARTICIPANT	EPNL 3 MIC AVERAGE	PNLTm 3 MIC AVERAGE	SEL 3 MIC AVERAGE	ALm 3 MIC AVERAGE
JAPAN-PILOT 1-1	89.20	90.42	NA	NA
JAPAN-PILOT 2-1	88.90	90.93	NA	NA
DELTA	0.30	0.51	NA	NA
JAPAN-PILOT 1-2	88.60	89.98	NA	NA
JAPAN-PILOT 2-2	89.40	90.57	NA	NA
DELTA	0.80	0.59	NA	NA
FRG-PILOT 1	86.60	88.20	80.70	72.20
FRG-PILOT 2	87.20	88.70	81.60	73.00
DELTA	0.60	0.50	0.90	0.80
CANADA-PILOT 1-1	88.54	89.57	84.43	75.18
CANADA-PILOT 2-1	88.16	89.28	84.28	74.99
DELTA	0.38	0.29	0.15	0.19
CANADA-PILOT 1-2	88.07	89.53	83.48	74.61
CANADA-PILOT 2-2	88.98	90.87	84.58	76.11
DELTA	0.91	1.34	1.10	1.50
US-FILOT 1-1	86.80	88.10	83.40	74.50
US-PILOT 2-1	87.00	88.90	83.7[illegible]	75.20
DELTA	0.20	0.80	0.30	0.70
US-PILOT 1-2	87.20	89.30	83.6[illegible]	75.6[illegible]
US-PILOT 2-2	87.60	89.70	84.3[illegible]	75.9[illegible]
DELTA	0.40	0.40	0.[illegible]	[illegible]
AVG. OF DELTA	0.51	0.62	0.55	[illegible]
STD. DEV.	0.26	0.35	0.4[illegible]	[illegible]
90% C.I.	0.21	0.4[illegible]	[illegible]	0.9[illegible]

UK delta 3 calculated at 1.5[illegible]

Table 8.2.G

TEST DAY TO TEST DAY REPEATABILITY
TAKE-OFF EPNL DATA EXPRESSED IN DECIBELS (dB)

PARTICIPANT	LEFT SIDELINE AVERAGE	CENTER LINE CENTER AVERAGE	RIGHT SIDELINE AVERAGE	1 MIC AVERAGE
CANADA-PILOT 1-1	87.[illegible]	87.[illegible]	87.75	87.6[illegible]
CANADA-PILOT 1-2	88.54	87.[illegible]	85.9[illegible]	87.19
DELTA	.78	.25	1.8[illegible]	.4[illegible]
CANADA-PILOT 2-1	87.79	88.16	86.[illegible]	87.[illegible]
CANADA-PILOT 2-2	86.96	8[illegible].25	87.65	87.99
DELTA	.8[illegible]	1.19	1.62	0.66
US-PILOT 1-1	86.9[illegible]	86.7[illegible]	86.[illegible]	86.5[illegible]
US-PILOT 1-2	87.4[illegible]	86.4[illegible]	85.9[illegible]	86.5[illegible]
DELTA	[illegible]	[illegible]	[illegible]	[illegible]
US-PILOT 2-1	87.[illegible]	87.[illegible]	86.5[illegible]	87.[illegible]
US-PILOT 2-2	89.[illegible]	89.4[illegible]	87.[illegible]	88.6[illegible]
DELTA	1.[illegible]	1.[illegible]	[illegible].8[illegible]	1.4[illegible]
AVG. OF DELTA	.95	0.85	1.1[illegible]	0.62
STD. DEV.	[illegible].52	[illegible]	[illegible]	.59
95% C.I.	[illegible]	1.61	1.6[illegible]	[illegible]

Table 8.2.H

TEST DAY TO TEST DAY REPEATABILITY
APPROACH EPNL DATA EXPRESSED IN DECIBELS (dB)

PARTICIPANT	LEFT SIDELINE AVERAGE	CENTER LINE CENTER AVERAGE	RIGHT SIDELINE AVERAGE	1 MIC AVERAGE
US-PILOT 1-1	87.[illegible]	[illegible].5	[illegible]	[illegible]
US-PILOT 1-2	86.[illegible]	[illegible]	[illegible].4	[illegible]
DELTA	[illegible]	[illegible]	.6	[illegible]
US-PILOT 2-1	86.4	[illegible].4	[illegible]	[illegible]
US-PILOT 2-2	87.[illegible]	[illegible]	[illegible].4	[illegible]
DELTA	[illegible]	.4	[illegible]	.4
AVG. OF DELTA	.5[illegible]	[illegible]	.6	[illegible]
STD. DEV.	[illegible]	.4	[illegible]	[illegible]
95% C.I.	[illegible]	[illegible]	[illegible]	[illegible]

Table 8.2.1

TEST DAY TO TEST DAY REPEATABILITY
LEVEL FLYOVER EPNL DATA EXPRESSED IN DECIBELS (dB)

PARTICIPANT	LEFT SIDELINE AVERAGE	CENTER LINE CENTER AVERAGE	RIGHT SIDELINE AVERAGE	3 MIC AVERAGE
CANADA-PILOT 1-1	88.59	88.67	88.34	88.54
CANADA-PILOT 1-2	88.55	88.38	87.29	88.07
DELTA	0.04	0.29	1.05	0.47
CANADA-PILOT 2-1	87.61	88.77	88.12	88.16
CANADA-PILOT 2-2	89.42	88.58	88.94	88.98
DELTA	1.81	0.19	0.82	0.82
US-PILOT 1-1	87.30	86.80	86.30	86.80
US-PILOT 1-2	87.70	87.70	86.30	87.20
DELTA	0.40	0.90	0.00	0.40
US-PILOT 2-1	87.30	87.50	86.20	87.00
US-PILOT 2-2	88.60	87.00	87.30	87.60
DELTA	1.30	0.50	1.10	0.60
AVG. OF DELTA	0.89	0.47	0.74	0.57
STD. DEV.	0.81	0.31	0.51	0.19
90% C.I.	1.84	0.71	1.16	0.42

Table 8.2.J

EPNL 3 MICROPHONE AVERAGE

PARTICIPANT	GUIDED APPROACH	UNGUIDED APPROACH	DELTA
JAPAN P-1	91.20	90.60	0.60
JAPAN P-2	91.60	91.20	0.40
FRG P-1	89.50	89.20	0.30
FRG P-2	89.60	NA	NA
UK P-1	89.47	90.20	0.73
UK P-2	NA	90.00	NA
US P1-1	90.20	90.40	0.20
US P2-1	90.10	89.40	0.70
AVERAGE	90.24	90.14	90.24
STD. DEV.	0.85	0.69	0.22
90% CI	0.62	0.51	0.18

Table 8.2.K

EPNL 3 MICROPHONE AVERAGE

PARTICIPANT	ICAO 6 DEGREE	BELL QUIET APPROACH	DELTA
FRG P-1	89.50	86.23	3.27
FRG P-2	89.60	NA	NA
UK P-1	89.47	86.40	3.07
UK P-2	NA	86.00	NA
US P1-1	90.20	87.53	2.67
US P2-1	90.10	87.60	2.50
AVERAGE	89.77	86.75	2.88
STD. DEV.	0.35	0.76	0.35
90% CI	0.33	0.72	0.42

Table 8.2.L

EPNL 3 MICRPHONE AVERAGE

PARTICIPANT	ICAO 6 DEGREE	9 DEGREE APPROACH	DELTA
FRANCE-AERO 1	89.30	88.37	0.93
FRANCE-STNA 1	88.37	86.60	1.77
FRG P-1	89.50	87.27	2.23
FRG P-2	89.60	87.73	1.87
UK P-1	89.47	87.60	1.87
UK P-2	NA	88.10	NA
AVERAGE	89.25	87.61	1.73
STD. DEV.	0.50	0.63	0.48
90% CI	0.48	0.52	0.46

Table 8.2.M

EPNL 3 MICROPHONE AVERAGE

PARTICIPANT	ICAO 6 DEGREE	6 DEGREE VY + 20	DELTA
FRANCE-AERO 1	89.30	88.57	0.73
FRANCE-STNA 1	88.37	87.80	0.57
FRG P-1	89.50	86.10	3.40
FRG P-2	89.60	86.10	3.50
UK P-1	89.47	89.50	0.03
UK P-2	NA	89.20	NA
AVERAGE	89.25	87.88	1.65
STD. DEV.	0.50	1.50	1.67
90% CI	0.48	1.23	1.59

Table 8.2.N

GROUND MINUS 1.2 METER MICROPHONE
TAKEOFF

COUNTRY	SAMPLE SIZE 1.2 MIC	SAMPLE SIZE GRD. MIC	DELTA dB EPNL	DELTA dB SEL	DELTA dB PNLTm	DELTA dB ALM
AUSTRALIA	NA	NA	NA	NA	NA	NA
JAPAN PILOT 1	8	8	2	NA	NA	NA
JAPAN PILOT 2	9	9	1.7	NA	NA	NA
FRANCE AERO	NA	NA	NA	NA	NA	NA
FRANCE STNA	NA	NA	NA	NA	NA	NA
ITALY	NA	NA	NA	NA	NA	NA
FRG PILOT 1	5	5	2.4	2.7	2.6	3.3
FRG PILOT 2	6	6	3	2.7	2.7	3.2
UK PILOT 1	6	6	2.5	1.7	3.1	2.5
UK PILOT 2	6	6	2.8	1.8	3.3	2.6
CANADA P1-1	NA	NA	NA	NA	NA	NA
CANADA P1-2	4	5	3.7	3.2	2.7	2.6
CANADA P2-1	7	7	3.5	2.8	3.1	2.6
CANADA P2-2	9	9	3.6	2.9	4	3
US P1-1	9	9	2.9	2.5	2.7	2.2
US P1-2	5	5	3	2.5	3	2.5
US P2-1	7	6	3.9	3.2	3.9	3.4
US P2-2	7	7	3.6	2.9	3.8	3.1

Table 8.2.O

GROUND MINUS 1.2 METER MICROPHONE
APPROACH

COUNTRY	SAMPLE SIZE 1.2 MIC	SAMPLE SIZE GRD. MIC	DELTA dB EPNL	DELTA dB SEL	DELTA dB PNLTm	DELTA dB ALM
AUSTRALIA	NA	NA				
JAPAN PILOT 1	7	7	2.4	NA	NA	NA
JAPAN PILOT 2	9	9	1.8	NA	NA	NA
FRANCE AERO	NA	NA				
FRANCE STNA	NA	NA				
ITALY	NA	NA				
FRG PILOT 1	8	8	1.9	3	1.7	2.2
FRG PILOT 2	6	6	1.8	1.9	1.7	2.1
UK PILOT 1	6	6	2.6	2.5	2	2.4
UK PILOT 2	NA	NA				
CANADA P1-1	NA	NA				
CANADA P1-2	5	5	2.9	2.8	1.8	1.7
CANADA P2-1	7	8	2.7	2.8	1.7	1.8
CANADA P2-2	9	9	2.9	2.7	2.1	2
US P1-1	10	10	2.6	2.7	2.4	2.8
US P1-2	5	5	2.5	2.7	2.5	2.7
US P2-1	8	7	2.4	2.5	2.3	2.3
US P2-2	9	9	2.7	2.7	2.5	2.8

Table 8.2.P

GROUND MINUS 1.2 METER MICROPHONE
LEVEL FLYOVER

COUNTRY	SAMPLE SIZE 1.2 MIC	SAMPLE SIZE GRD. MIC	DELTA dB EPNL	DELTA dB SEL	DELTA dB PNLTm	DELTA dB ALM
AUSTRALIA	NA	NA	NA	NA	NA	NA
JAPAN PILOT 1-1	4	4	2.5	NA	NA	NA
JAPAN PILOT 1-2	4	4	2.1	NA	NA	NA
JAPAN PILOT 2-1	3	3	1.7	NA	NA	NA
JAPAN PILOT 2-2	4	4	1.8	NA	NA	NA
FRANCE AERO	NA	NA	NA	NA	NA	NA
FRANCE STNA	NA	NA	NA	NA	NA	NA
ITALY	NA	NA	NA	NA	NA	NA
FRG PILOT 1	6	6	3.6	3.1	3.8	3.6
FRG PILOT 2	5	5	1.6	1.3	1.6	1.7
UK PILOT 1	6	6	2.5	1.8	3	2.2
UK PILOT 2	NA	NA	NA	NA	NA	NA
CANADA P1-1	NA	NA	NA	NA	NA	NA
CANADA P1-2	5	5	3.4	3.2	3.1	2.9
CANADA P2-1	7	6	3.1	3	2.8	2.9
CANADA P2-2	12	11	3.6	3.4	3.2	2.9
US P1-1	7	6	3.7	3.5	4.2	4
US P1-2	4	4	2.9	2.8	3	2.9
US P2-1	6	6	3.8	3.3	3.9	3.6
US P2-2	11	11	3.6	3.2	3.9	3.5

UK delta 3 calculated at 15°C

Table 8.2.Q

FLIGHT IDLE - HARD PATH

EMISSION ANGLE IN DEGREES

PARTICIPANT	0	45	90	135	180	225	270	315
AUSTRALIA	72.20	72.00	74.50	72.20	NA	NA	NA	NA
JAPAN	71.70	73.80	77.90	77.30	73.90	75.20	75.00	75.50
FRG	64.80	65.80	65.60	68.90	65.30	66.30	67.60	66.10
UK	63.00	67.20	65.00	68.60	63.90	64.20	65.00	67.10
CAN P1-1	61.20	67.00	69.70	66.00	69.70	73.60	71.90	71.30
US P1-1	61.90	71.20	71.70	74.10	72.60	66.50	70.60	68.00
CAN P1-2	68.30	68.50	72.00	72.20	72.10	73.40	72.80	68.50
US P1-2	68.80	69.40	72.50	74.70	72.80	71.30	73.10	70.30
AVG	66.49	69.36	71.11	71.75	70.04	70.07	70.86	69.54
STD DEV	1.64	1.05	1.63	1.40	1.61	1.77	1.41	1.30
90% CI	1.74	1.11	1.73	1.49	1.92	2.10	1.68	1.54

Table 8.2.R

FLIGHT IDLE - SOFT PATH

EMISSION ANGLE IN DEGREES

PARTICIPANT	0	45	90	135	180	225	270	315
AUSTRALIA	66.80	70.80	67.00	63.80	64.80	64.20	70.20	71.20
JAPAN	65.10	65.60	66.80	70.20	69.70	77.50	70.70	68.60
FRG	54.00	59.20	59.40	63.70	57.50	59.80	59.50	56.10
UK	54.90	58.00	59.10	63.10	58.20	61.70	59.90	56.30
US-PILOT 1-1	62.90	62.50	63.60	60.90	62.00	63.00	64.50	61.30
US-PILOT 1-2	65.50	64.50	65.60	62.90	62.50	61.50	58.80	67.40
AVG	61.53	63.43	63.58	64.10	62.45	64.62	63.93	63.48
STD DEV	2.52	2.08	1.60	1.42	2.01	2.90	2.43	2.91
90% CI	3.46	2.86	2.19	1.95	2.76	3.98	3.34	4.00

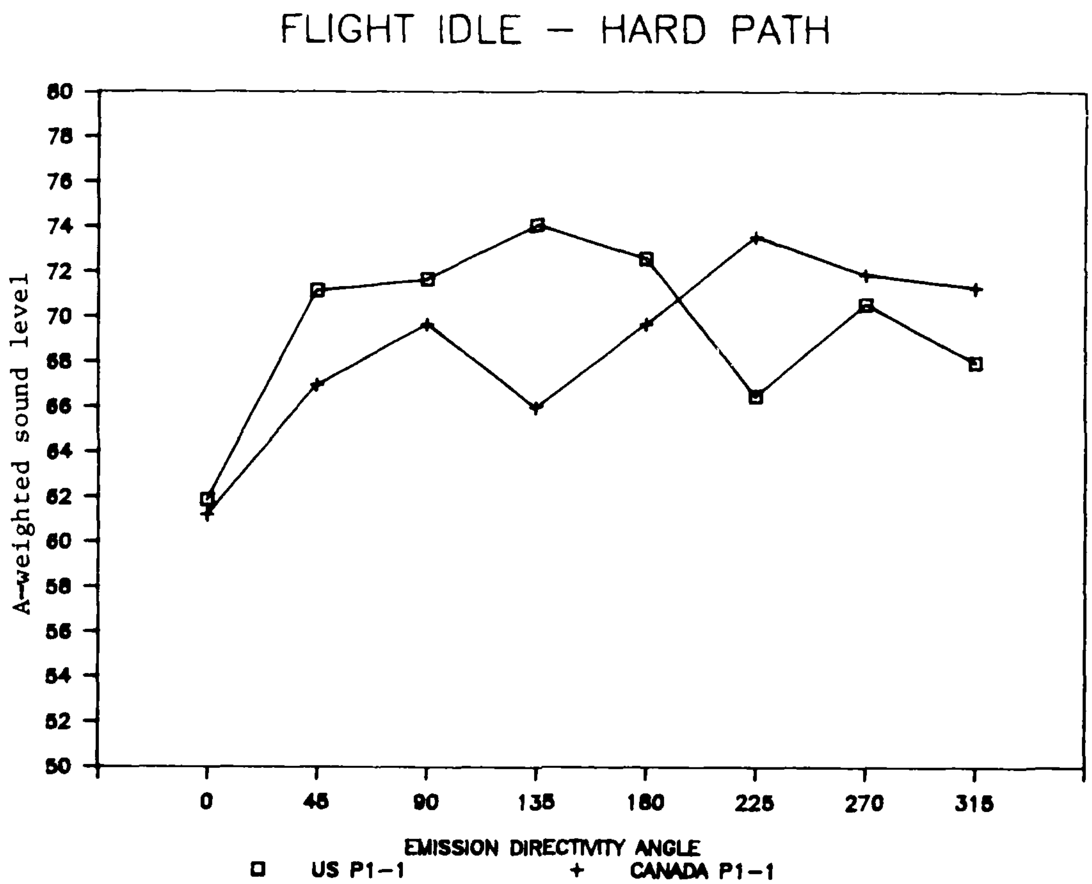
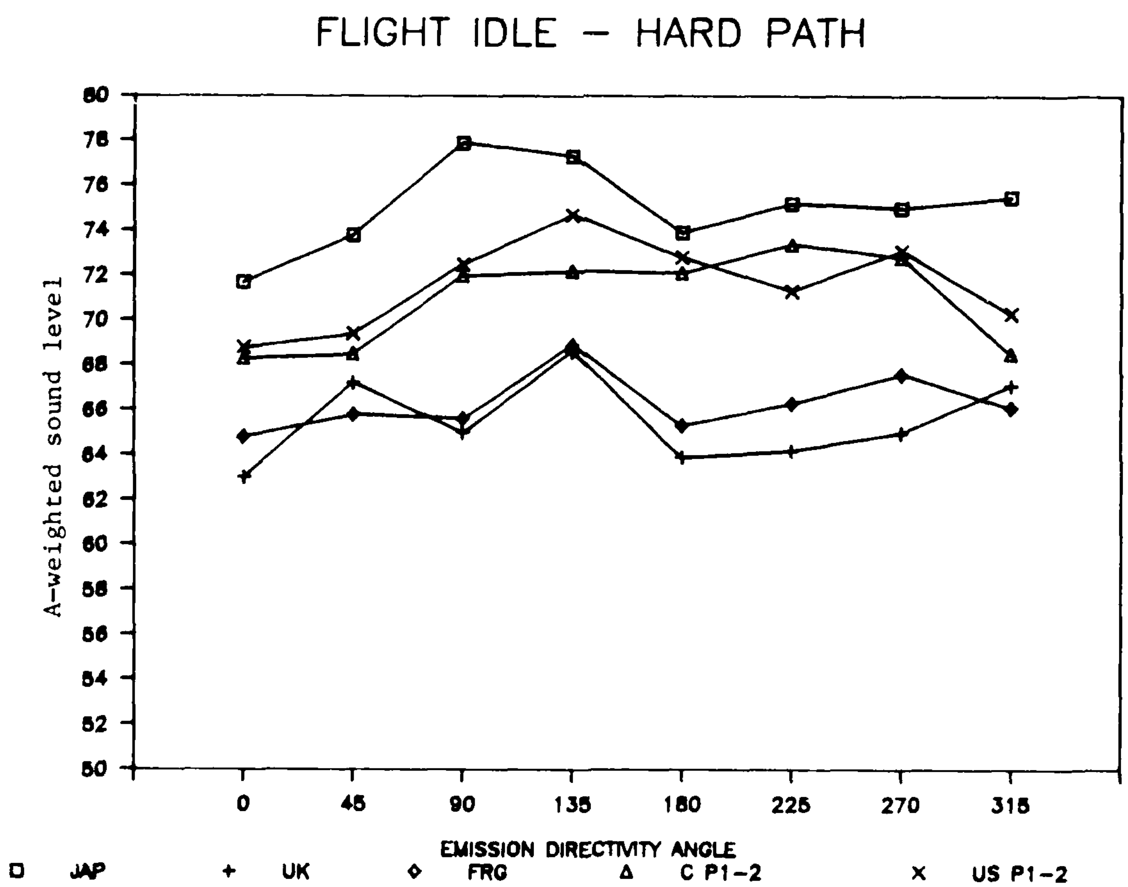

FLIGHT IDLE - HARD PATH
A-weighted sound level
80
78
76
74
72
70
68
66
64
62
60
58
56
54
52
50
0
45
90
135
180
225
270
315
EMISSION DIRECTIVITY ANGLE
US P1-1
CANADA P1-1

Figure 8.2.A


FLIGHT IDLE - HARD PATH
A-weighted sound level
80
78
76
74
72
70
68
66
64
62
60
58
56
54
52
50
0
45
90
135
180
225
270
315
EMISSION DIRECTIVITY ANGLE
JAP
UK
FRG
C P1-2
US P1-2

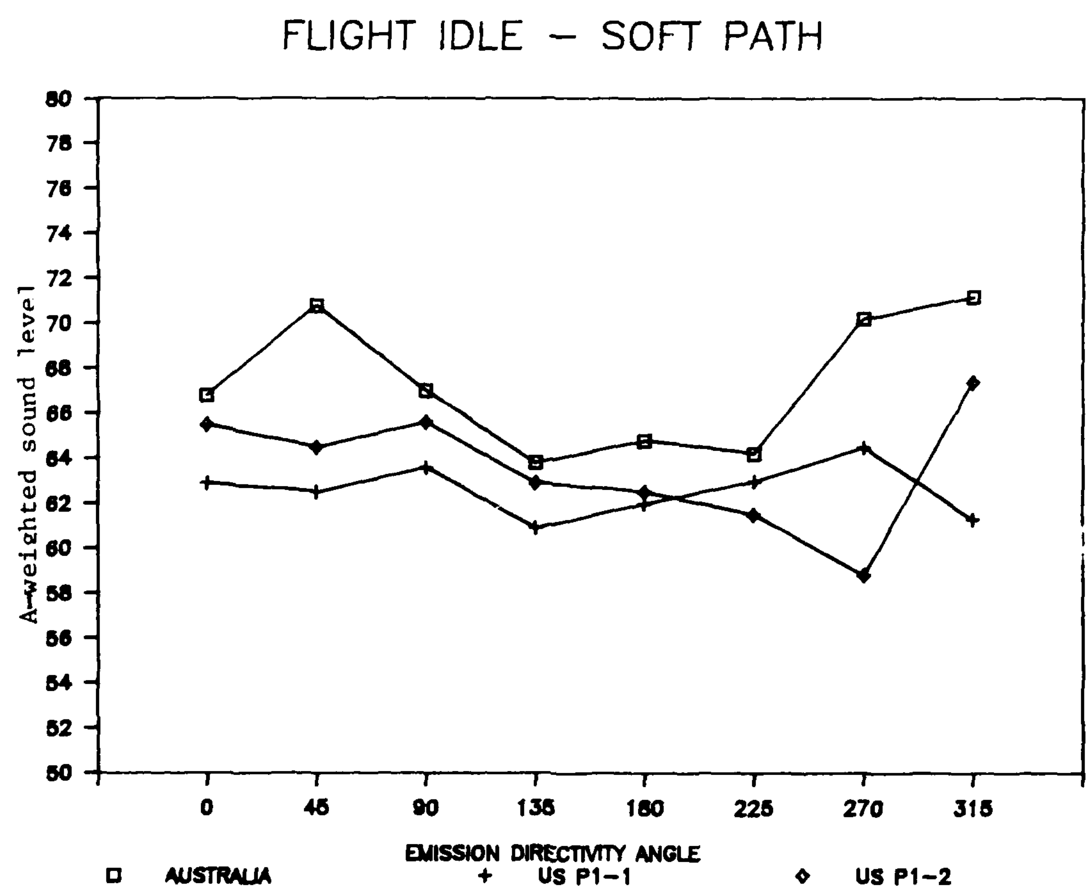

FLIGHT IDLE — SOFT PATH
A-weighted sound level
80
78
76
74
72
70
68
66
64
62
60
58
56
54
52
50
0
45
90
135
180
225
270
315
EMISSION DIRECTIVITY ANGLE
AUSTRALIA
US P1-1
US P1-2

Figure 8.2.B

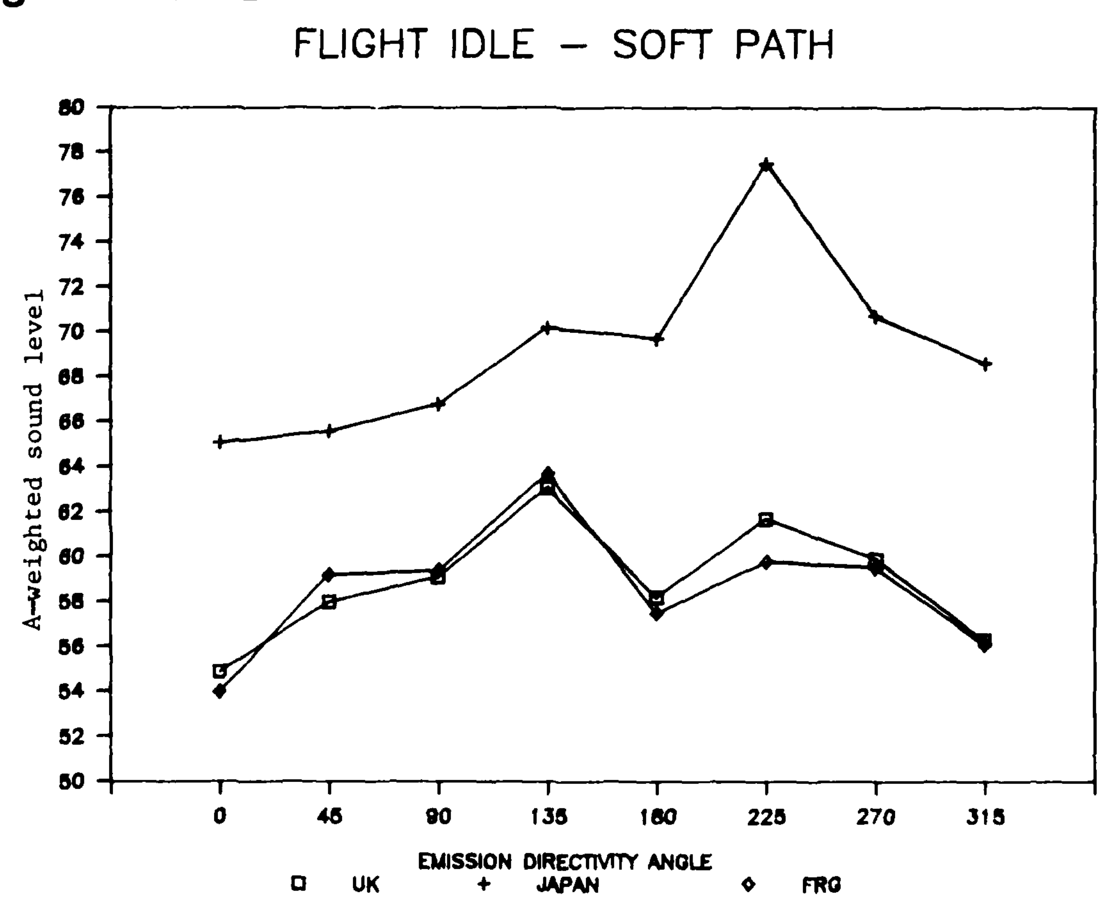
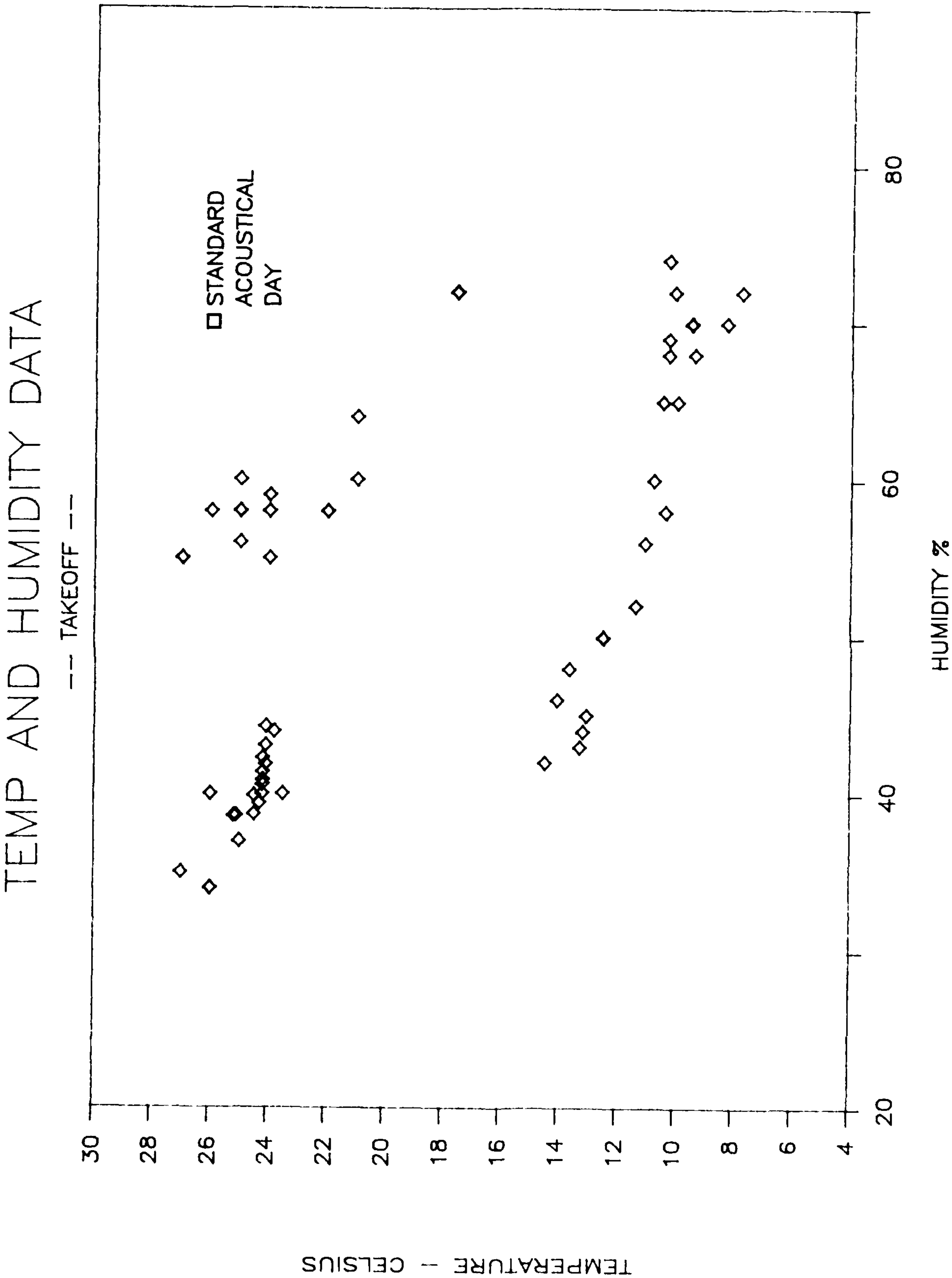

FLIGHT IDLE — SOFT PATH
A-weighted sound level
80
78
76
74
72
70
68
66
64
62
60
58
56
54
52
50
0
45
90
135
180
225
270
315
EMISSION DIRECTIVITY ANGLE
UK
JAPAN
FRG

Figure 8.2.C


TEMP AND HUMIDITY DATA
-- TAKEOFF --
STANDARD ACOUSTICAL DAY
HUMIDITY %
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40
60
80
TEMPERATURE -- CELSIUS
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28
26
24
22
20
18
16
14
12
10
8
6
4

Figure 8.2.D

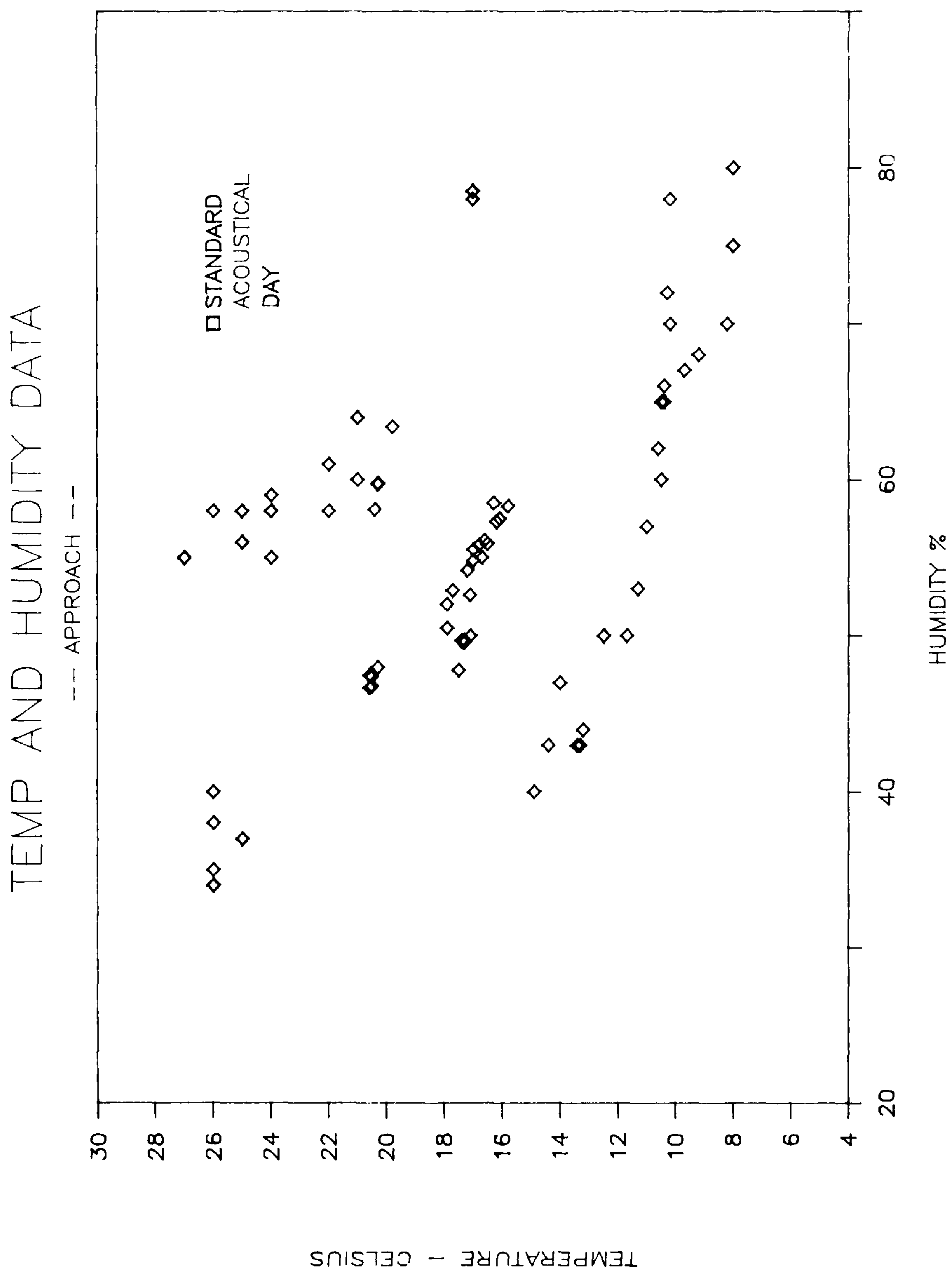
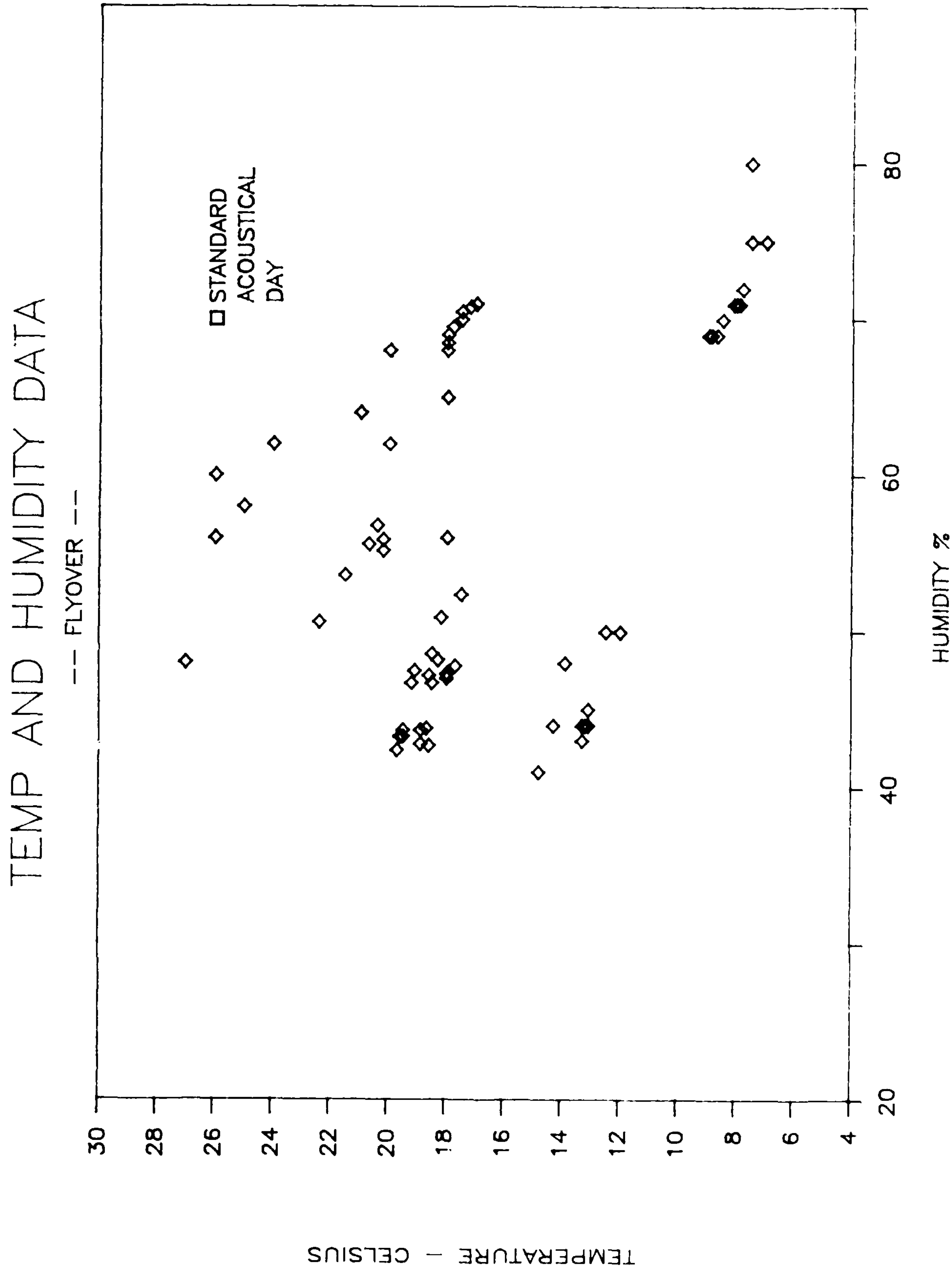

TEMP AND HUMIDITY DATA
-- APPROACH --
STANDARD ACOUSTICAL DAY
HUMIDITY %
20
40
60
80
TEMPERATURE — CELSIUS
30
28
26
24
22
20
18
16
14
12
10
8
6
4

Figure 8.2.E



TEMP AND HUMIDITY DATA
-- FLYOVER --
STANDARD ACOUSTICAL DAY
HUMIDITY %
TEMPERATURE — CELSIUS
20
40
60
80
30
28
26
24
22
20
18
16
14
12
10
8
6
4

9.0 FURTHER ANALYSIS, EVALUATION AND INVESTIGATION

The HNMRP, from inception to the completion of this report, has spanned the years 1983 through 1987. During this time the program objectives were established and refined, field tests occurred, the data were analyzed and collated, findings were examined, and amendments to Annex 16 were developed and presented to WG II and CAEP/1. The HNMRP has thus, with this report, completed its program stage. However, the question, "Why are there differences?", is yet to be quantitatively addressed.

The following sections describe a sequence of steps for the continuation of the HNMRP investigation process. Section 9.1 is an outline of the HNMRP evaluation process; Section 9.2 discusses the issue of the data analysis system calibration test tapes; and Section 9.3 discusses the statistical considerations appropriate in the further study of the HNMRP data. (A list of prospective future work topics for ICAO Working Group II are listed in Section 10.0.)

9.1 A PROCESS FOR FURTHER EVALUATION OF HNMRP DATA

Presented below is the proposed evaluation process for the continued analysis, evaluation and investigation of HNMRP data.

Step 1: Normalization

The initial step should be to decide whether or not there are distinct reduction system biases that can be accounted for based on the results of the data analysis system calibration test tapes, discussed in Section 9.2. Subsequent application of this adjustment factor to the HNMRP data should account for data reduction system biases.

Step 2: Statistical Analysis of Single Event Participant Data

Next, determination of the appropriate single event data for each participant is necessary. This single event data is important for a proper scientific evaluation of the HNMRP data. Once participant single event data is identified, the data should be entered into the appropriate statistical analysis program, as discussed in Section 9.3, to evaluate whether or not differences in HNMRP data are statistically significant.

Step 3: Further Analysis Work

Following the statistical analysis of the single event HNMRP data, further analysis investigations outlined below, and listed in Section 10.0, should be examined.

Step 4: Evaluation and Investigation

Results of the various analyses should be examined and individual test programs should be further investigated to identify possible intrinsic source differences and/or elements of the testing process which can be identified as reasons for noise level dissimilarity. Areas for consideration include:

1) Meteorological Effects
   a. temperature gradients
   b. cross wind/on-track wind components
   c. turbulence
   d. crab angle

2) Data Corrections
   a. source noise corrections
   b. groundspeed duration corrections
   c. distance duration corrections
   d. spreading and absorption

3) Helicopter Operational Characteristics
   a. Torque
   b. Approach or takeoff profile (climb/descent angle)
   c. airspeed
   d. groundspeed
   e. rotor RPM

4) Helicopter performance data resolution, acquisition, sampling and display techniques

5) Flight Control Stability Augmentation

6) Pilot Technique

7) Aircraft Specific Differences
   a. maintenance history
   b. hours on critical components

8) Methodology
   a. Calibration
   b. Gain Settings
   c. Recording Instruments
   d. Data Reduction Procedure

9) Helicopter Operational and Environmental Characteristics
   a. Adherence to Reference Operational Conditions
   b. Effects of Wind

10) Intrinsic Source Characteristics
   a. Rotor blade track and balance

9.2 COMPARISON OF THE DATA REDUCTION SYSTEM CALIBRATION TEST TAPES

A calibration test tape exercise was incorporated in the HNMRP as a means to isolate data reduction system bias. Through normalizing reported data for the unique response of each participating analysis system one would expect to see more clearly the other sources of variation. Full implementation of this normalization process remains as an activity for the ICAO CAEP WG II (1987-1990).

The HNMRP was fortunate to have the assistance of Mr. E.J. Rickley (of the US DOT TSC), the coordinator of the 1980-1981 ICAO CAN Round-Robin Noise Analyzer Comparison Program, to serve as the focal point for the calibration tape exercise. The following paragraphs are abstracted, in part, from a summary paper prepared by Mr. Rickley for the Paris 1986 HNMRP evaluation meeting.

Calibration tapes, containing helicopter noise data events, were analyzed by the eight nations (ten laboratories) participating in the ICAO Helicopter Noise Measurement Repeatability Program (HNMRP). Identical tapes containing helicopter noise data events and calibration signals were prepared for use on Nagra instrumentation tape recorders. The tapes, after analysis on the U.S. system, were sent to the eight participating nations (ten laboratories) for analysis. The purpose of the exercise was to determine if biases due to instrumentation or calibration technique could be "calibrated out" when comparing individual results of the multi-nation helicopter noise measurement program.

The results indicate a natural grouping of the data by the type of analysis system used, with 0.28, 0.32, 0.32 dB standard deviations for the EPNL metric for the flyover, takeoff and approach events respectively. The standard deviations for the PNLTm metric were 0.26, 0.36, 0.32 dB, respectively.

These results generally agree with the results of the 1981 ICAO sponsored Helicopter Round Robin Test where data submitted by the ten participants produced standard deviations of 0.28, 0.32, 0.31 dB for the EPNL metric and 0.66, 0.57, 0.4 dB for the PNLTm metric for the flyover, takeoff and approach events, respectively.

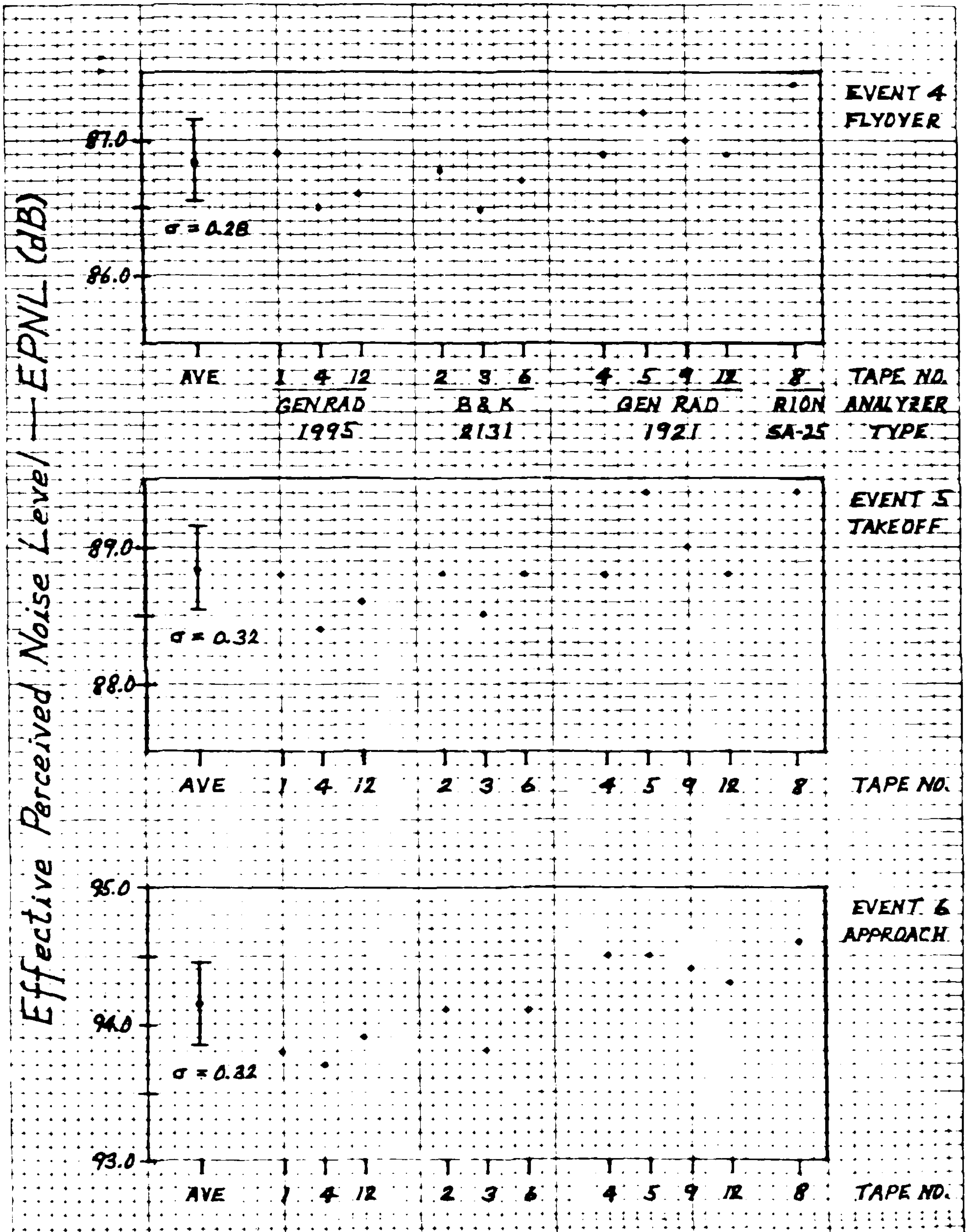
The current data shown in Figures 9.2.A and 9.2.B have been grouped by type of analysis system used. It is noted that laboratories using the GR 1995 and B&K 2131 systems, with internal exponential averaging, produced results lower than the average, while those laboratories using the GR 1921 analyzer with external computer smoothing produced results higher than the average. The exception was with the laboratory that used the Rion SA-25 analysis system with internal exponential averaging which produced results higher than the average. This grouping by analyzer type was not obvious in the 1981 data for the EPNL metric but did show up in the PNLTm metric.

Several nations expressed concern with the "quality" (unsteady reference signal) of the calibration signal recorded on the test tapes. According to the recorder manufacturer, the cyclic amplitude fluctuations noted can be attributed to one or more of the following: worn or misaligned heads, improper tape hold-back tension, defective or worn tape guides, worn tension rollers or capstan pinch wheel, and/or defective capstan.

The two US recorders were completely overhauled by the manufacturer and aligned to the recommended 3m brand 177 tape prior to producing the test tapes. Amplitude fluctuations of less than 0.1 dB were noted for the calibration signed on these recorders.

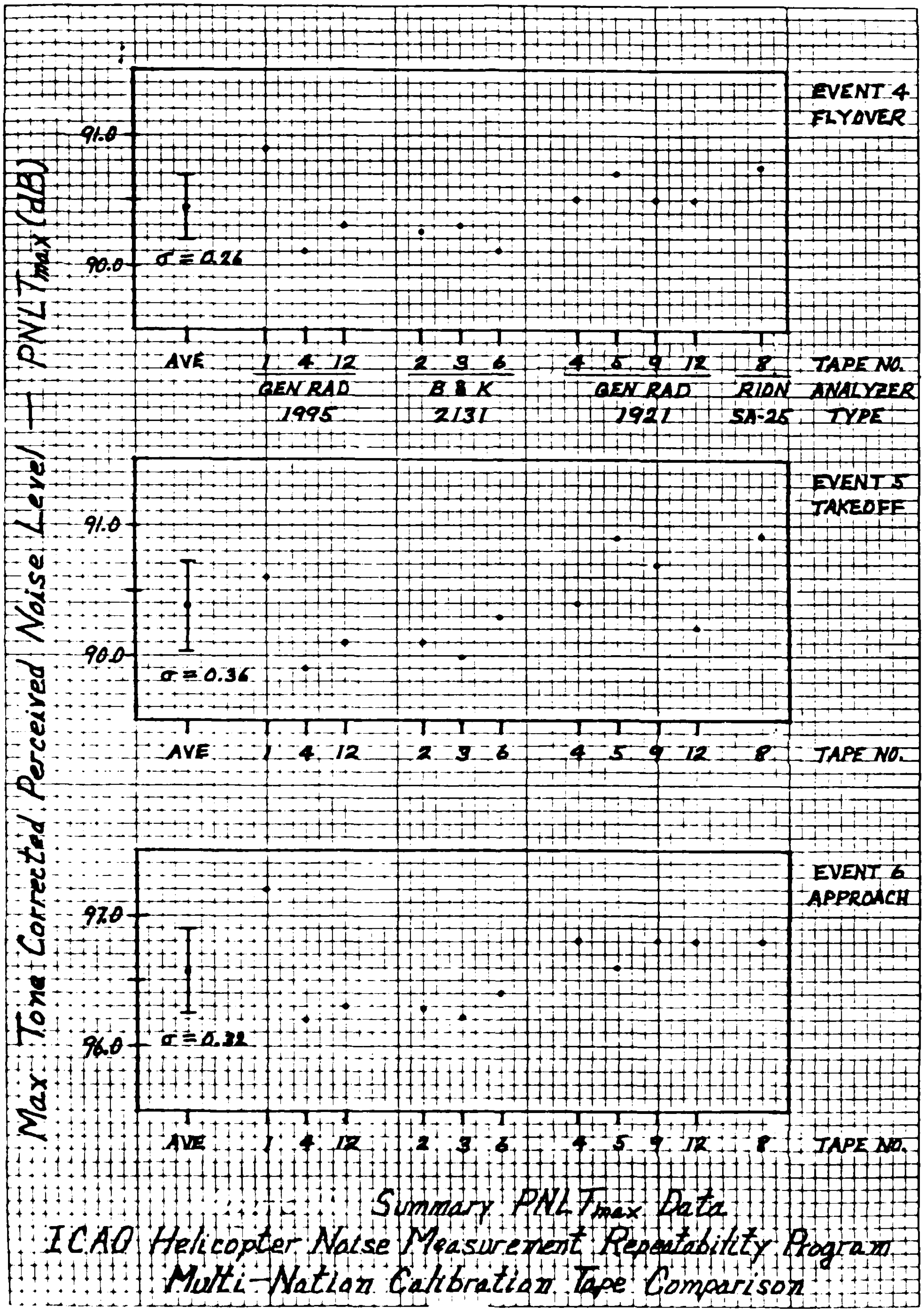
A subsequent test of one nation's "suspect" test tape on the US recorder exhibited amplitude fluctuations of less than 0.1 dB; further, the results of a re-analysis of the helicopter events on the US system agreed within

Figure 9.2.A



Summary EPNL Data
ICAO Helicopter Noise Measurement Repeatability Program
Multi-Nation Calibration Tape Comparison

Figure 9.2.B


Max Tone Corrected Perceived Noise Level — PNLTmax (dB)
EVENT 4
FLYOVER
91.0
90.0
σ = 0.26
AVE
1 4 12
2 3 6
4 5 9 12
8
TAPE NO.
GEN RAD
1995
B & K
2131
GEN RAD
1921
RION
SA-25
ANALYZER
TYPE
EVENT 5
TAKEOFF
91.0
90.0
σ = 0.36
AVE
1 4 12
2 3 6
4 5 9 12
8
TAPE NO.
EVENT 6
APPROACH
97.0
96.0
σ = 0.32
AVE
1 4 12
2 3 6
4 5 9 12
8
TAPE NO.
Summary PNLTmax Data
ICAO Helicopter Noise Measurement Repeatability Program
Multi-Nation Calibration Tape Comparison

±0.1 dB of the previous test of this tape by the US prior to shipment to the participant.

The US test tape (No. 12) was re-analyzed using five recorders including the two most recently overhauled and aligned Nagra recorders. The poorest reproduction of tape number 12 showed amplitude fluctuations of the calibration signal of ± 0.3 dB on one recorder. The amplitude fluctuations on the remaining four recorders was under ±0.2 dB. Analysis of the helicopter events on tape number 12 on the US system using these five recorders, 3 reproductions each, produced a standard deviation of 0.1 dB in the EPNL and PNLTm metrics.

Observations

The natural grouping of the data by type of analysis system suggests a bias does exist between analysis system types. The GR 1921 system with external computer smoothing produced levels on the average 0.4 dB higher than those obtained from the GR 1995 and B&K 2131 systems with internal exponential averaging. The Rion SA-25 analyzer with internal exponential averaging produced levels on the average 0.6 dB higher than the GR 1995 and B&K 2131 systems.

Recommendations:

1. The HNRMP participants may consider adjusting final reported data by the following amounts to normalize for analysis system differences:

    a) -0.4 dB should be applied to the GR-1921 produced data

    b) -0.6 dB adjustment applied to the Rion SA-25 produced data.

2. Several participants raised the point that the higher levels from the GR-1921 system are an unexplained characteristic of this system. It is noted that this system has been declared obsolete by the manufacturer (last system sold in 1978). It is worth noting that much of the worldwide helicopter noise data base was established using the GR-1921. It may be prudent at this point, given the present high technology systems available, to recommend that the GR-1921 no longer be used.

3. It is further recommended that more stringent detector characteristics be imposed to insure slow scale exponential characteristics are applied especially when linear data is smoothed by external means.

At the CAEP 1 meeting in Montreal both recommendations 2 and 3 were adopted. Data adjustments, Recommendation 1, have been reserved as a future WG II (1987-1990) activity. At the Washington HNMRP evaluation meeting, the Program Coordinator's Staff had implemented data adjustments based on early Calibration Tape results. After a great deal of discussion, it was decided to proceed without implementing any adjustment until accord could be reached on the appropriateness of the corrections. Based in part, on that early controversy concerning amplitude instabilities of the calibration signal on some test tapes, an additional test was proposed by the U.K. delegation. E. J. Rickley's synopsis of that second exercise, is abstracted in part, below:

It was suggested by WG II in Ottawa (1985) that more could be learned and a more accurate normalization could be achieved if participants in the HNMRP would submit actual magnetic tape recordings of measured noise data from different flight operations for re-analysis on a single playback and reduction system in the US. A single participant, the UK, submitted an optional calibration tape with four helicopter noise data events.

The results of the UK and US processing of this tape is tabulated in Table 9.2.A. A comparison of the data, both processed with a GR-1995 analyzer, shows agreement within 0.2 dB or less for all metrics shown with the exception of the flyover, Event 2. Here a 0.4 dB difference in the tone correction calculation coupled with a 0.9 dB difference in PNLTm (which is being examined) results in a 0.3 dB difference in the EPNL metric. These results are in good agreement with a comparison of the UK and US data reduction of the multi-nation calibration tape where differences of 0.2 dB or less were observed for the EPNL and PNLTm metric measured with the GR-1995 analyzer.

Data processed by the US using the GR-1921 analyzer are provided in Table 9.2.A and show the GR-1921 data to be consistently higher than the data from the GR-1995 analyzer.

An interesting observation was made during the analysis of the UK optional calibration tape. Annex 16 specifies that a ripple of up to 0.5 dB is allowed in the pass band of a 1/3-octave filter (appendix 2, paragraph 3.4.2). A 0.3 dB ripple was measured for the 250 Hz filter in the GR-1995 analyzer. When the tape was processed using two different recorders a 0.3 dB bias was observed in the results using the GR-1995 analyzer. This was traced to the difference in speeds of the tape recorders (under 1%) which resulted in a change of 2 Hz in the 250 Hz calibration signal. This frequency shift was sufficient to move the calibration signal from the flat portion of the pass band to a peak and resulted in a 0.3 dB bias in all the data output.

Conclusions:

1. Comparison of the UK and US results using the GR-1995 analyzer are in excellent agreement both on the multi-nation calibration comparison and using the UK produced optional calibration tape. The bias of the GR-1921 system was again confirmed.

2. Subtle frequency changes coupled with filter pass band characteristics can account for up to 0.5 dB bias in data. This suggests that a closer than normal examination and/or adjustment of the 1/3-octave filter used for calibration of analyzers should be made.

The observations concerning calibration signal recording give one cause to consider a more rigorous requirement for the stability of signals in one-third octave bands, especially, the band in which the single frequency calibration signal is applied. The present 0.5 dB ripple allowance can, as demonstrated above translate to a 0.5 dB bias error in reported data. This topic is recommended for study and possible regulatory action at CAEP II, in 1990.

Table 9.2.A

EPNL and $PNLT_{max}$ Data
ICAO Helicopter Noise Measurement Repeatability Program
Multi-Nation Calibration Tape Comparison

TAPE NO.	PARTICIPANT	ANALYZER TYPE	EPNL(dB)	$PNLT_{max}$(dB)
	Flyover Event No. 4			
1	Australia	GEN RAD 1995	86.9	90.9
4	UK-WHL	" "	86.5	90.1
12	USA	" "	86.6	90.3
2	Canada	B & K 2131	86.77	90.26
3	Italy	" "	86.48	90.31
6	FRG	" "	86.7	90.1
4	UK-BAe	GEN RAD 1921	86.9	90.5
5	F-Aerospatiale	" "	87.2	90.7
9	F-STNA	B&K 5090	87.0	90.5
12	USA	GEN RAD 1921	86.9	90.5
8	Japan	RION SA-25	87.37	90.73
		AVE.	86.85	90.45
		STD. DEV.	0.28	0.26
	Takeoff Event No. 5			
1	Australia	GEN RAD 1995	88.8	90.6
4	UK-WHL	" "	88.4	89.9
12	USA	" "	88.6	90.1
2	Canada	B & K 2131	88.81	90.09
3	Italy	" "	88.51	89.98
6	FRG	" "	88.8	90.3
4	UK-BAe	GEN RAD 1921	88.8	90.4
5	F-Aerospatiale	" "	89.4	90.9
9	F-STNA	B&K 5090	89.0	90.7
12	USA	GEN RAD 1921	88.8	90.2
8	Japan	RION SA-25	89.43	90.93
		AVE.	88.85	90.37
		STD. DEV.	0.32	0.36
	Approach Event No. 6			
1	Australia	GEN RAD 1995	93.8	97.2
4	UK-WHL	" "	93.7	96.2
12	USA	" "	93.9	96.3
2	Canada	B & K 2131	94.11	96.28
3	Italy	" "	93.80	96.22
6	FRG	" "	94.2	96.4
4	UK-BAe	GEN RAD 1921	94.5	96.8
5	F-Aerospatiale	" "	94.5	96.6
9	F-STNA	B&K 5090	94.4	96.8
12	USA	GEN RAD 1921	94.3	96.8
8	Japan	RION SA-25	94.60	96.67
		AVE.	94.16	96.57
		STD. DEV.	0.32	0.32

9.3 STATISTICAL CONSIDERATIONS

9.3.1 Statistical Treatment of Individual Team Results

For each mode of operation it was requested that at least six good flights be conducted. In each case, ICAO Annex 16 requires that the sample 90% confidence interval of the "three microphone average" must be less than 1.5 EPNdB.

The data tables submitted by participants displayed left, center, right, and "three-mic averaged" noise data, with arithmetic averages, standard deviation and 90% confidence intervals computed. (The "three-mic average" is the certification metric.) The left, center and right average values, along with the "3-mic" certification metric values, are summarized for each test team in Section 5 of this report.

9.3.2 Statistical Analysis of Overall HNMRP Results

Determination of the statistical significance of all of the possible variance factors is an important part of the HNMRP process. One of the basic objectives of this structured repeatability test program was to define the intrinsic variability associated with the measurement of helicopter noise, related to the implementation of noise certification standards. It was anticipated that many random variables (difficult to compensate for when conducting helicopter certification noise programs) could contribute to variations in certification noise-level measurements. It was also anticipated that biases, if identified, may be amenable to adjustment, and if appropriately addressed could result in improved accuracy in certification measurement capabilities. Identification and quantification of both random and non-random sources of variation represent the ultimate objective in the HNMRP evaluation process.

Controllable variables which were identified included:

1. noise data acquisition system characteristics,
2. ground surface characteristics,
3. variable meteorological conditions, and
4. helicopter maintenance.

Other unconstrained variables included:

1. production line factors (i.e., manufacturing tolerances, instrument accuracy, etc.)
2. pilot technique (i.e., consistency of helicopter attitude, smoothness of control)
3. micro-meteorological influences (i.e., temperature-humidity variation, small scale turbulence)

9.3.3 Statistical Procedures

The statistical procedures briefly identified below were those discussed and accepted by HNMRP participants as being appropriate for evaluating similarity of HNMRP sample means and variances. A detailed description of each technique along with examples was provided in the "Helicopter Noise Measurement Repeatability Program Mid-Program Review--Advance Phases Protocol" (Ref 5).

TEST FOR EQUIVALENCY OF VARIANCES: BARTLETT'S TEST

This test examines the equivalency of **variances** of **multiple** samples. It is a prerequisite for using the standard "Analysis of Variance" test (below). If this test determines that the variances are not statistically similar then a test more complicated than the "Analysis of Variance" test is required.

TEST FOR EQUIVALENCY OF MEANS: ANALYSIS OF VARIANCE

This test examines the equivalency of **means** for **multiple** samples.

TEST FOR EQUIVALENCY OF TWO VARIANCES: F TEST

This test examines the equivalency of **variances** for **samples of two**. This test is a prerequisite for using the "Students-t" test (below). If this determines that the variances are not statistically similar, a test more complicated than the "Students-t" test is required.

TEST FOR EQUIVALENCY OF TWO MEANS: STUDENTS "T" TEST (or just "t-Test")

This test examines the equivalency of **means** for **two independent samples**.

In order to implement these statistical tests it is necessary to use the actual individual event data from each test program. To test the similarity of the multi-nation takeoff PNLTm variances, for example, it is necessary to include PNLTm for each event measured by each team, a minimum of 48 (eight teams times 6 runs each) values. It is evident that the sheer volume of data and time required to sort individual event data (not to mention the difficulty in pulling data from different formats) precluded the implementation of "significance testing" at this time.

A methodology, however, was developed which allows the reader some insight into the statistical significance of differences. This procedure estimates whether or not a difference in means is significant for any given paired comparison. The procedure involves the use of the nomograph shown in Figure 9.3.A, which was developed through interactively exercising the Students-t test. It is important to note, however, that the standard deviations of the two samples to be compared must be approximately equal. If this condition is met, all that is necessary is to locate the difference in means on the ordinate of the graph and then move right to the point intersecting the appropriate standard deviation value. If the point of intersection is above the line then the null hypothesis is rejected, i.e., the difference in means is considered statistically significant.

10.0 FUTURE WORK TOPICS

This section lists future work items which have been identified during the HNMRP. They are natural follow-on work topics for consideration by ICAO Working Group II and the ICAO Technical Manual Committee. These lists represent a compendium of possible activity areas identified by HNMRP participants and do not represent proposed policy of the FAA or any other certificating authority.

10.1 FUTURE ANALYSIS OF HNMRP DATA

This first group of future work topics are analyses which involve further study of HNMRP data. It is anticipated that these analyses will provide more knowledge concerning the individual sources of variation associated with the noise certification process.

1 Perform statistical analysis of results - implement paired and group comparisons of sample variance and means as discussed in Section 9.3, Statistical Considerations. The results of these analyses should be examined in reference to the pilot to pilot, test day to test day, and other repeatability questions.

2 Investigate wind influences - analyze the relationship between wind speed and direction and changes in sample variance.

3 Quantify and compare the magnitude of the Delta 1, 2, and 3 correction values in the various test programs and investigate why reference trajectory conditions were not attained in some cases.

4 Study differences in reported source noise adjustment functions.

5 Investigate overflight noise level variability - specifically whether level flyover data variability is related to test procedures or some other factor.

6 Examine the time between overhaul status of the HNMRP test vehicles - analyze possible intrinsic source differences, that is the variation from one serial helicopter to the next.

7 Investigate and resolve various inter-program team to team differences, including a more thorough investigation of the France-Italy-US program and an investigation of the UK-FRG tracking data results (where the same type of tracking system was used by each team).

8 Explore differences between RION analyzer calibration tape results and the others reported.

9 Examine the results attained with the normal incidence microphones (used in the Japanese test program) as compared to the pressure-sensitive type microphones, specifically reviewing the ground versus 1.2m microphone data.

SECTION 10.2 FUTURE TOPICS FOR REGULATORY REFINEMENT AND IMPLEMENTATION GUIDANCE

The following are proposed analyses which step beyond the HNMRP data.

1. Examine the variation in sideline elevation angle Psi.

2. Study speed control on approach and the influence of speed variation on noise levels.

3. Examine the use of the following method to compensate for pressure altitude variations from the sound level reference condition.

$$Cp' = \frac{P'\text{measured}}{(\rho_o a_o^2)\text{measured}} = \frac{P'\text{norm}}{(\rho_o a_o^2)\text{norm}}$$

$$P'\text{norm} = \frac{(\rho_o a_o^2)\text{norm}}{(\rho_o a_o^2)\text{measured}} \times P'\text{measured}$$

$$P'\text{norm} = \frac{(P_o)\text{norm}}{(P_o)\text{measured}} \times P'\text{measured}$$

Cp' = nondimensional acoustic pressure coefficient

ρ_o = ambient density

P_o = ambient pressure

P' = acoustic pressure

a_o = ambient speed of sound

norm = normalized to standard day s.l.

4. Investigate use of parameter "carpets", multi-parameter sensitivity curves.

5. Further explore noise analyzer standardization especially in view of the B&K detector response differences recently observed in Europe.

6. Explore total revision of the takeoff test to achieve greater compatibility with airworthiness requirements for takeoff rather than the existing climbout tie-in. This would involve a direct climb takeoff from a hover operation. Acquire a data base for this operation at a variety of measurement sites.

7. Determine whether or not a better correlate exists for implementing source noise adjustments than advancing blade tip Mach number.

8. Conduct a cost analysis of the proposed experimental 3-6-9 degree approach certification scheme.

9. Re-examine A-109 differences within the context of "lessons learned" in the HNMRP.

10. Open up the repeatability "questions" to other repeat test helicopters for which good documentation is available (S-76, Dauphin SA 365N, Twin Star SA 355, Bell 222, Bell 206L).

11. Develop realistic and reasonable no correction window constraints for future Appendix 4 amendments.

12. Re-evaluate regulatory stringency - which should involve tracking the progress of NASA, DFVLR and other research organizations working on helicopter noise prediction.

13 Consider a "small helicopter" simplified certification testing procedures.

14 Examine cross referencing in Chapter 8 with Appendix 4 - review structural consistency within certification scheme and attempt to simplify the format.

15 Introduce a sensitivity curve requirement for ground speed duration correction for level flyover.

16 Revise reference temperature structure for each operation - ambient air temperature of 15 degrees Celsius, i.e., ISA or ISA + 10 degrees Celsius, as specified by the reference operation procedures in Sections 8.6.2, 8.6.3, and 8.6.4.

17 Review and restructure the WC II "Summary of Helicopter Noise Data", data base - develop an "electronic spreadsheet" or computer data base format.

18 Notify the IEC concerning ICAO CAEP-1 dynamic response modifications.

SECTION 10.3 NOISE CERTIFICATION HANDBOOK GUIDANCE

The following list identifies proposed topics for inclusion in a helicopter noise certification handbook.

1 Tracking systems.

2 Requirements for source noise adjustments.

3 Requirements for takeoff operation rotation point determination.

4 Determination of reference trajectory and position information.

5 Flight deck data acquisition and documentation instrumentation.

6 Approach guidance techniques.

7 Implementation of alternative approach operations (3 and 9 degree operations). Explain various techniques to deploy and redeploy approach guidance instrumentation and/or acoustical instrumentation in an efficient manner to maintain the prescribed reference altitude.

8 Develop a compendium of information which realistically describes the costs associated with helicopter noise certification testing. Analyze in-house costs verses the cost of using an acoustical consultant.

9 Incorporate information which would be useful in developing noise exposure curves (for use in noise contouring computer models) from flight test data.

10 Provide information on data stream time synchronization, identifying problems encountered in one of the HNMRP test programs.

REFERENCES

1. Helicopter Noise Analysis -- Round Robin Test
   Report FAA-EE-81-13, E.J. Rickley: US DOT, August 1981

2. "An Examination of Test to Test Variability for the A109A Helicopter Using ICAO Annex 16 Noise Certification Procedures:
   Paper presented jointly by the German, Italian, and US Working Group B (WG B) members at the January 1983 ICAO CAN WG B meeting.

3. "Report of WG II to CAEP/1"
   Paper presented by the Rapporteur of WG II at the ICAO CAEP/1 meeting June 1986, Montreal, Canada.

4. "Test Plan for the ICAO Helicopter Noise Measurement Repeatability Program"
   Paper presented by the HNMRP Program Coordinator to ICAO WG II members in November of 1983, revised and redistributed December 15, 1983.

5. "Mid-Program Review--Advanced Phase Protocol"
   Paper presented by the HNMRP Program Coordinator to HNMRP participants in October of 1984.

6. "ICAO Annex 16"
   International Standards and Recommended Practices, "Environmental Protection"
   Annex 16 to the Convention on International Civil Aviation Published by the International Civil Aviation Organization

7. Bell 206L-1 Long Ranger II Flight Manual
   Published by Bell Helicopter Textron, May 18, 1978

8. "Compendium of Comments on the HNMRP Test Plan"
   Paper presented by the HNMRP Program Coordinator at the May 1984 ICAO WG II meeting in Boston, USA.

9. Letter from UK HNMRP participant to the HNMRP Program Coordinator, January 16, 1984
   Letter references:
   A. Analysis of Helicopter Noise - An Area of Concern", May 1981 UK ICAO CAN WP 10
   B. "Specification of Noise Analysis Equipment for Helicopter Noise Certification", December 1981 UK ICAO CAN WP 2
   C. "Analyzer Crest Factor Limitations", E. Rickley, October 1981 DOT-TSC-FA-253-LR-2

10. ICAO Committee on Aircraft Noise Seventh Meeting Montreal, 2-13 May 1983 Report
    Doc 9419, CAN/7, International Civil Aviation Organization

11. "Determination of Minimum Distance from Ground Observer to Aircraft for Acoustic Tests"
SAE Reports AIR-902, May 15, 1966

12. "Paris PC Paper #5"
Paper distributed to HNMRP participants as part of the "Data and Papers for Paris" in regards to the PARIS HNMRP Evaluation Meeting in April of 1986.

13. "Paris PC Paper #6"
Paper distributed to hnmrp participants as part of the "Data and Papers for Paris" in regards to the PARIS HNMRP Evaluation Meeting in April of 1986.

Participants' Submittals
(most recent submittal listed first)

AUSTRALIA:

1. Amendments for Multi-Nation Report, June, 1986
2. Tabular results, April, 1986
3. Preliminary Report Data, January 1986
4. "Best 6" Corrected EPNL & PNLTm Data Telex, September 1985
5. Reanalyzed Calibration Tape Results Telex, August 1985
6. Book A, The Australian Report, March 1985
7. Book B, the Australian Report, March 1985
8. First Results Report, February 1985
9. Calibration Tape Data, 1985

CANADA:

1. Final Report Mark-up, September 1986
2. The Canadian Report, April 1986
3. Post October Meeting Response, November 1985
4. Corrected EPNL & PNLTm Data, September 1985
5. As Measured Data, August 1985
6. Calibration Tape #2 Results, June 1985
7. Preliminary Data Results, September 1984

FEDERAL REPUBLIC OF GERMANY:

1. Final Report Mark-up, September 1986
2. Additional Corrected DAta, July 1986
3. Post October Meeting Report, December 1985
4. The German Report, August 1985
5. As Measured Data, March 1985

Participants' Submittals Continued

FRANCE - AEROSPATIALE:

1. Final Numbers Telex, March [illegible], 1986
2. Final Report Notes, September 1986
3. Final Report, April 1986
4. Summary Report, April 1986
5. Measurement Results, April 1986
6. Preliminary Report, April 1986
7. Preliminary Synthesis Reports, March 1985

FRANCE - STNA

1. Telex Confirming Data, November 1986
2. Final Report Notes and February Cover, January 1986
3. February Cover and Letter, January 1986
4. Post October Meeting Response, December 1985
5. December Cover Page with Letter, August 1985
6. Book [illegible] Preliminary Data, August 1985
7. Book [illegible] Preliminary Data, August 1985

JAPAN:

1. Fully Corrected Data Report, May 1986
2. Japan Report, September 1985
3. Preliminary Report, March 1985

UNITED KINGDOM:

1. Final Report Notes, September 1986
2. The UK Report, September 1985
3. Calibration Tape Analysis Results, March 1985

Participants' Submittals Continued

4. Initial Data Package

5. Westland Helicopter Ltd. Report, December 1985

UNITED STATES:

1. ICAO HNMRP: US Test Report, Bell 206L-1 Noise Measurement Flight Test

   Report No. FAA-EE-85-6, September 1985

HNMRP PAPERS

(includes limited distribution data and information papers)

1. "Test Plan for the ICAO HNMRP", December 1983
   Distributed to WG II members.

2. "Compendium of Comments on the HNMRP Test Plan", May 1984
   ICAO WG II Boston Meeting BIP.

3. "Mid Program Review--Advance Phase Protocol", October 1984
   Distributed to HNMRP participants.

4. "Data in Hand Summary", July 1985
   Distributed to HNMRP participants.

5. "Second Distribution of Data", August 1985
   Distributed to HNMRP participants.

6. "Helicopter Noise Certification Test Procedures", March 1985
   ICAO WG II Tokyo Meeting WP #6.

7. "Data Processing and Analysis Topics:, March 1985
   ICAO WG II Tokyo Meeting WP #7.

8. "Phase 4 - Statistical Treatment of HNMRP Results", March 1985
   ICAO WG II Tokyo Meeting BIP #14.

9. "HNMRP Washington Evaluation Meeting Package", October 1985
   Distributed to HNMRP participants.

   Included in this package were papers presented by the Program Coordinator on the following topics:

   EVALUATION PROCESS
   CALIBRATION TAPE ANALYSIS
   STATISTICAL NOMOGRAPH
   EPNL MULTI-NATION SYNTHESIS
   OBSERVATIONS
   2 TEAM COMPARISON
   4 TEAM COMPARISON
   ONE TEAM AT TWO DIFFERENT TESTS
   LEFT RIGHT DIRECTIVITY
   PNLTm VERSUS ADVANCING BLADE TIP MACH NUMBER
   1.2 METER VERSUS GROUND MIC
   AIR TO GROUND PROPAGATION
   STATIC ANALYSIS
   PARTICIPANT REPORTS

HNMRP PAPERS CONTINUED

10. HNMRP Washington Evaluation Meeting Participant Papers:

"Beyond the Flight Tests: Suggestions for a Logical Treatment of the Noise Data:, Presented by the UK.

Papers were presented by France on the following topics:

APPROACH, SLOW RESPONSE - QUICK RESPONSE
GROUND ABSORPTION
TAKEOFF TRAJECTORY
AEROSPATIALE FLYOVER RESULTS
CALIBRATION BAND

11. "Proceedings from the ICAO HNMRP Washington Evaluation Meeting", November 1985. Distributed to HNMRP participants.

12. "Data and Papers for Paris", April 1986.
Distributed to HNMRP participants.

Included in the package were the following papers:

PC PAPER 1	TECH ADVISOR	Multinational Calibration Tape
PC PAPER 2	PC	Detector Response
PC PAPER 3	PC	Deviation in Elevation Angle PSI Viewed From Sideline Sites
PC PAPER 4	PC	Takeoff Correction Window
PC PAPER 5	TECH ADVISOR	Proposed Reference Power Setting For Takeoff and Landing
PC PAPER 6	TECH ADVISOR	Future Restructure of Takeoff Test Procedures
PC PAPER 7	PC	Evaluation of the No-correction Window
FRANCE 11-2-86	FRANCE	Proposal for an Acoustically Acceptable Method of Noise Level Adjustment Measured With Lateral Microphones for Helicopter Certification
PARIS LAST MIN ADD	UK & US	Optional Calibration Tape Comparison Data

ICAO Working Group II (WG II) Meeting
Working Papers (WP)
and
Background Information Papers (BIPS)

MEETING	PAPER	SUBMITTED BY	TITLE
WG II BOSTON	BIP	US	Compendium of Comments on Test Plan
WG II TOKYO	BIP 5	US	US/Canadian Test Program - US Status
WG II TOKYO	BIP 14	HNMRP PC	Phase 4 - Statistical Treatment of HNMRP Results
WG II TOKYO	BIP 15	JAPAN	Preliminary Report on Japanese Test Results
WG II TOKYO	BIP 20	CANADA	HNMRP Canadian Participation & Status of Data Reduction
WG II TOKYO	BIP 21	FRANCE	Helicopter Noise Measurement Repeatability
WG II TOKYO	WP 5	HNMRP PC	Multi-nation Status
WG II TOKYO	WP 6	HNMRP PC	Helicopter Noise Certification Testing Procedures Topics: Level Flyover Testing Requirements, Repeatability Program Problem Areas, Rotor Speed
WG II TOKYO	WP 7	HNMRP PC	Data Processing and Analysis Topics: Atmospheric Absorption Layering Requirements, Dynamic Response Requirements For Analyzers Source Noise Adjustments
WG II OTTAWA	BIP 1	HNMRP PC	Program Coordinator's Report
WG II OTTAWA	BIP 1	FRANCE	Comments on Amendment Proposed For CH 9,9.5: Correction of Noise at Source
WG II OTTAWA	BIP 11	UK	Revised Takeoff Procedure
WG II OTTAWA	BIP 12	UK	Dynamic Response Requirements for Analyzer

APPENDIX A

SUMMARY MULTI-NATION COMPARISON NOISE DATA

The contents of Appendix A are as follows:

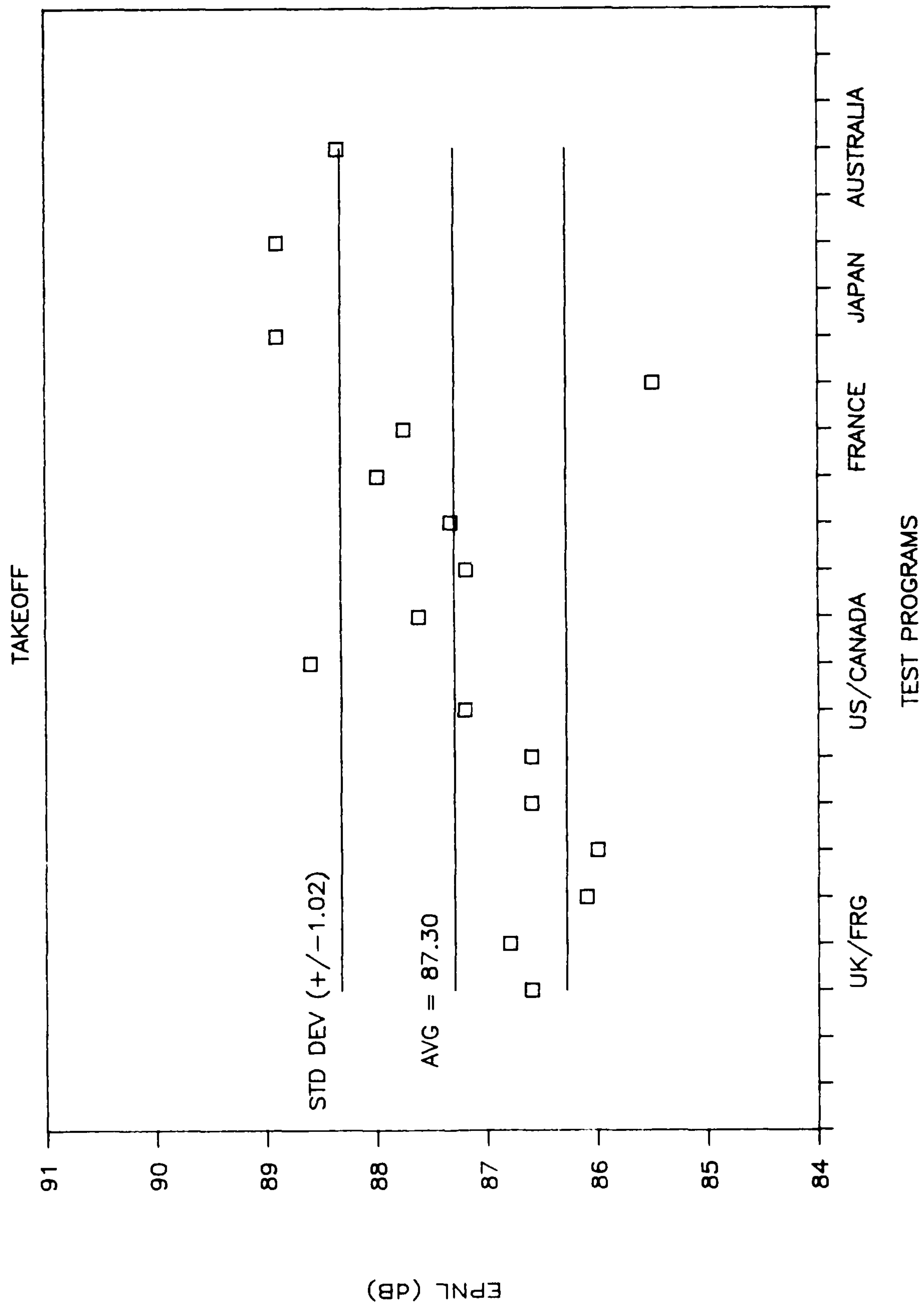
Please note that all UK level flyover data was corrected with a delta 3 correction referenced to 15 degrees C. All other teams used delta 3 corrections referenced to 25 degrees C.

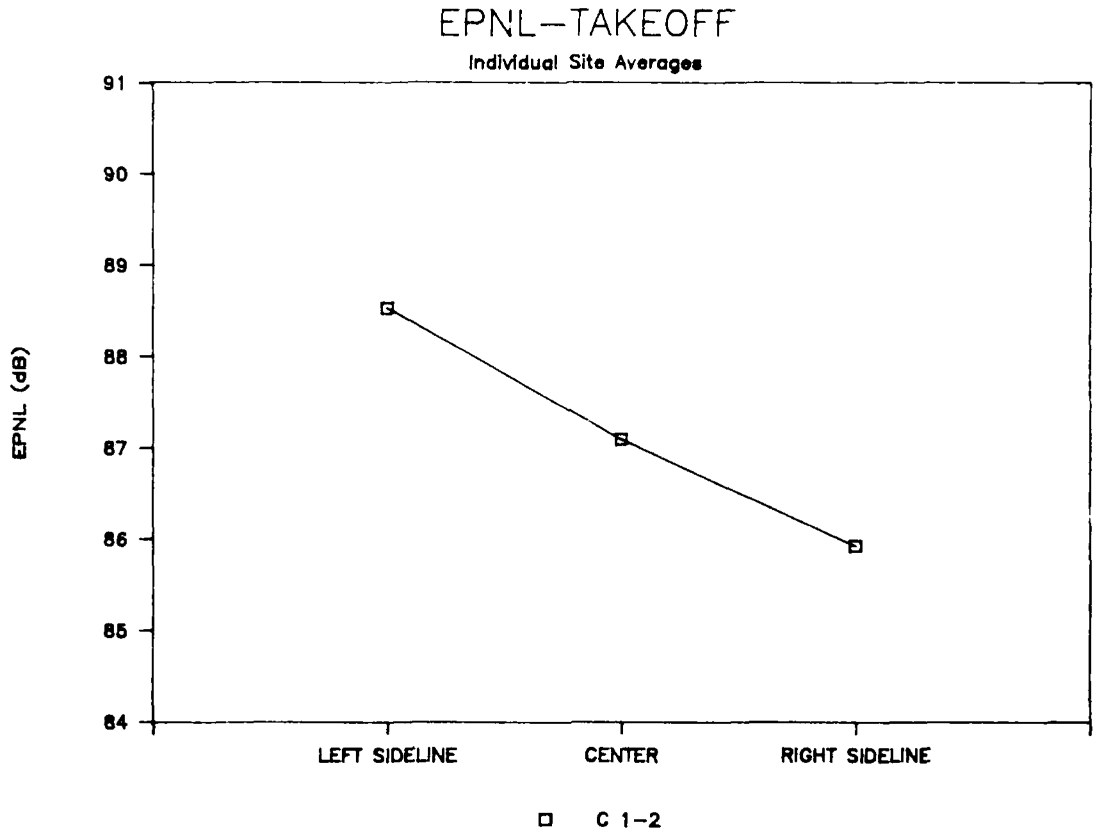
EPNL Metric Multi-nation Comparison Data

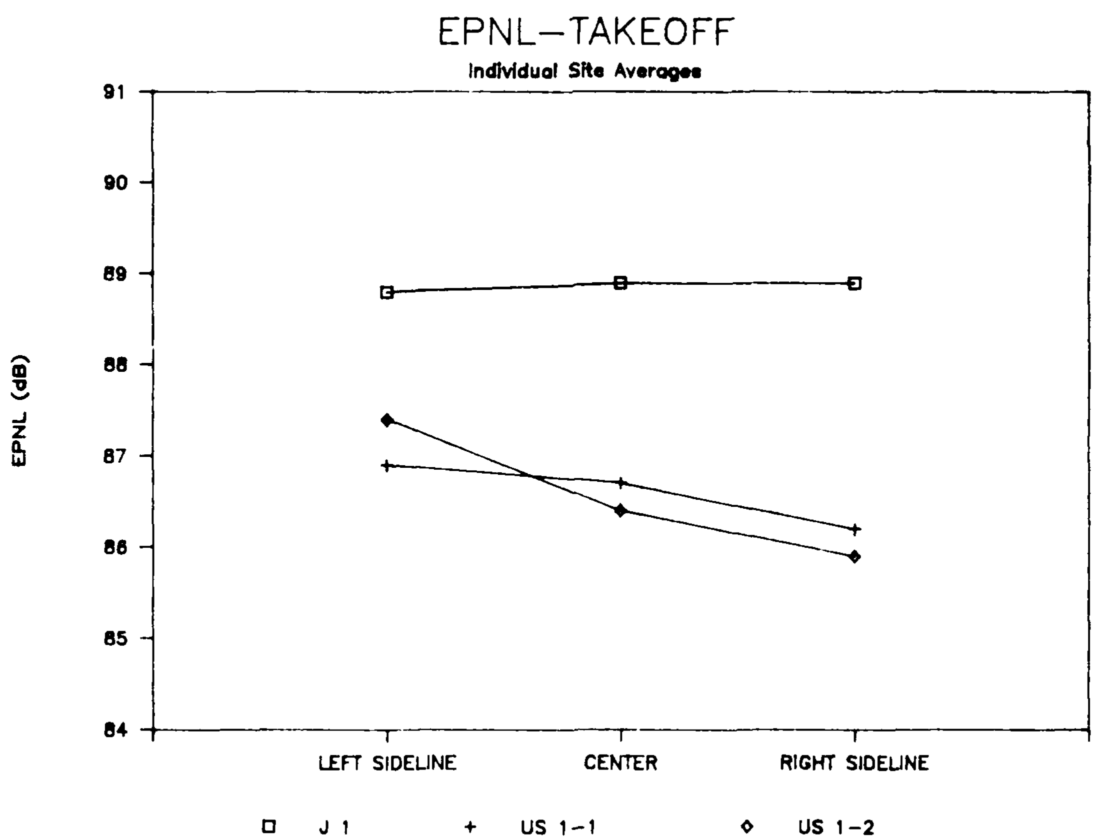
MULTI-NATION COMPARISON ANALYSIS
TAKE-OFF EPNL DATA EXPRESSED IN DECIBELS (dB)

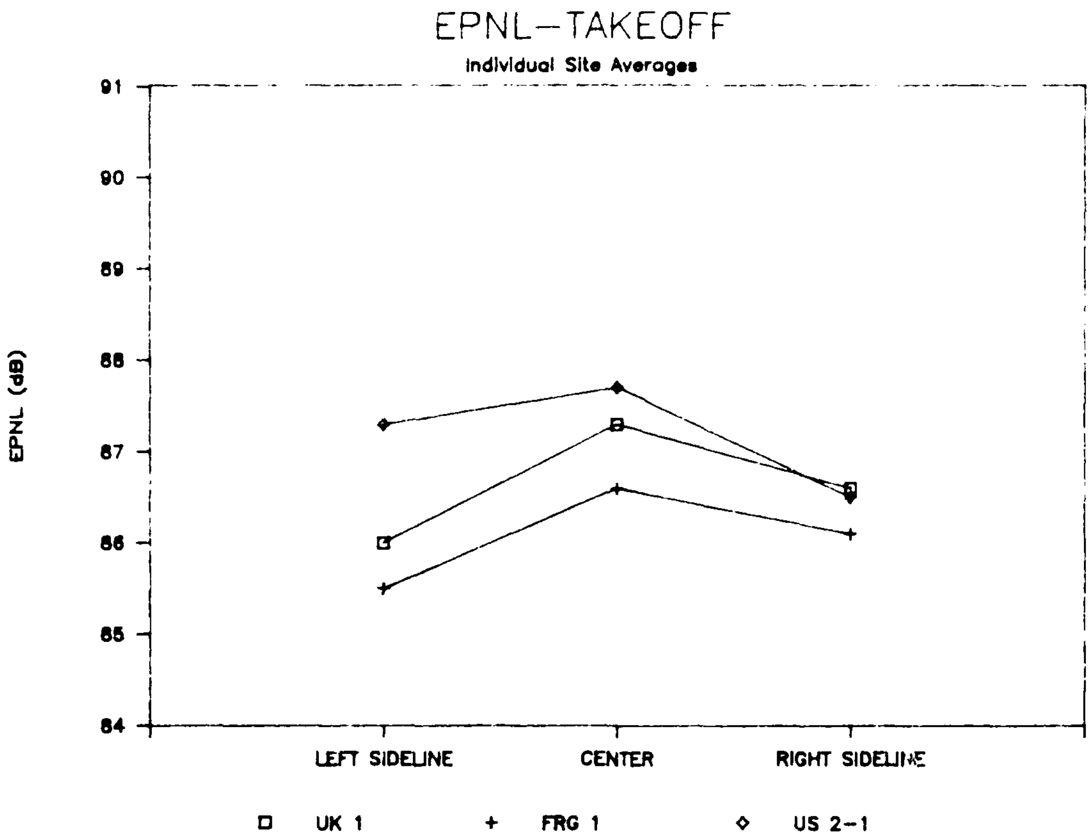
PARTICIPANT	LEFT SIDELINE AVERAGE	CENTER LINE CENTER AVERAGE	RIGHT SIDELINE AVERAGE	3 MIC AVERAGE	STD DEV	90% C.I.	TEAM AVERAGE	TEST AVERAGE
AUSTRALIA	87.89	89.55	87.63	88.35	0.39	0.17	88.35	88.35
JAPAN-PILOT 1	88.80	88.90	88.90	88.90	0.30	0.20	88.90	88.90
JAPAN-PILOT 2	88.10	90.00	88.70	88.90	0.50	0.30		
FRANCE-AERO	85.70	88.40	87.40	87.20	0.64	0.53	87.20	86.35
FRANCE-STNA	84.70	87.30	84.50	85.50	0.40	0.30	85.50	
ITALY	NA	NA	NA	NA	NA	NA		
FRG-PILOT 1	85.50	86.60	86.10	86.10	0.30	0.30	86.05	86.38
FRG-PILOT 2	86.30	85.70	86.20	86.00	0.10	0.00		
UK-PILOT 1	86.00	87.30	86.60	86.60	0.40	0.30	86.70	
UK-PILOT 2	86.40	86.60	87.20	86.80	0.20	0.20		
CANADA-PILOT 1-1	87.76	87.35	87.75	87.62	0.17	0.29	87.53	87.39
CANADA-PILOT 1-2	88.54	87.10	85.93	87.19	0.08	0.35		
CANADA-PILOT 2-1	87.79	88.16	86.03	87.33	0.86	1.45		
CANADA-PILOT 2-2	86.96	89.35	87.65	87.99	0.92	1.56		
US-PILOT 1-1	86.90	86.70	86.20	86.60	0.31	0.21	87.25	
US-PILOT 1-2	87.40	86.40	85.90	86.60	0.25	0.23		
US-PILOT 2-1	87.30	87.70	86.50	87.20	0.59	0.44		
US-PILOT 2-2	89.00	89.40	87.30	88.60	0.63	0.52		
AVERAGE	87.12	87.79	86.85	87.26	0.41	0.43	87.19	87.47
STD DEV	1.22	1.28	1.11	1.02	0.25	0.42	1.12	1.15
90% C.I.	0.77	0.80	0.70	0.64	0.15	0.27	1.19	1.93

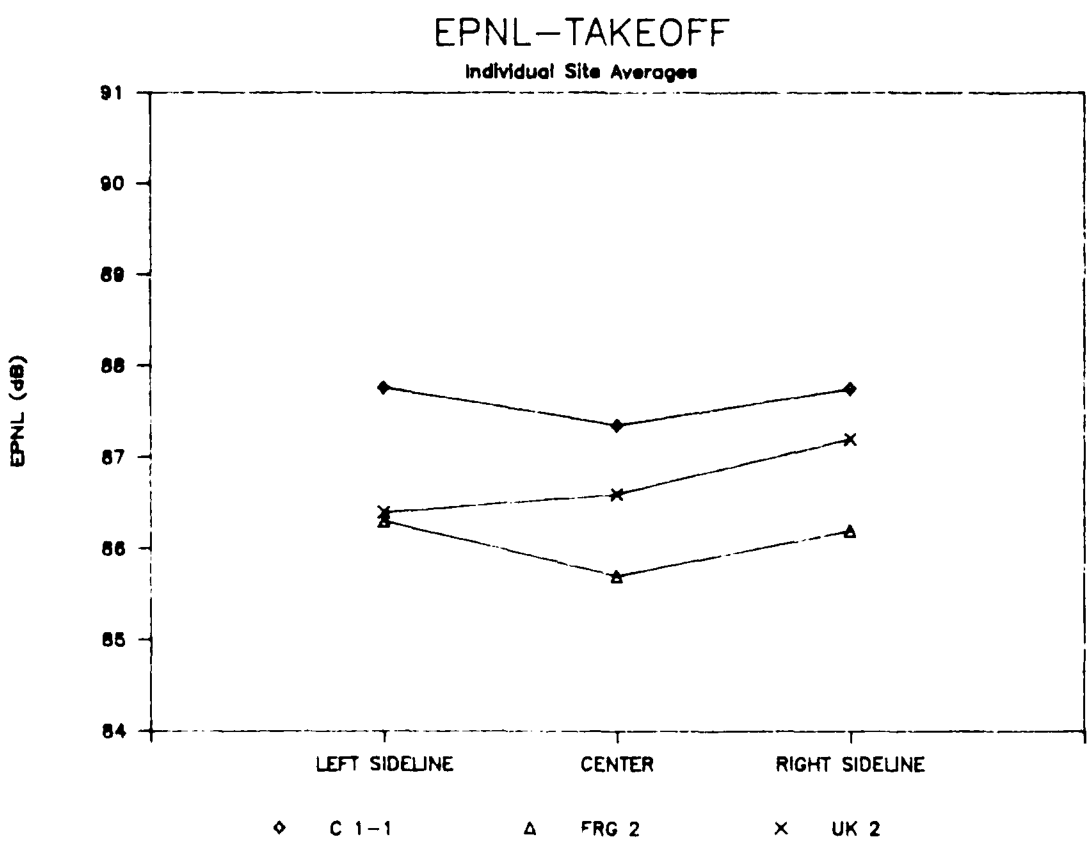
EPNL 3 MIC AVERAGE & STD DEVIATION

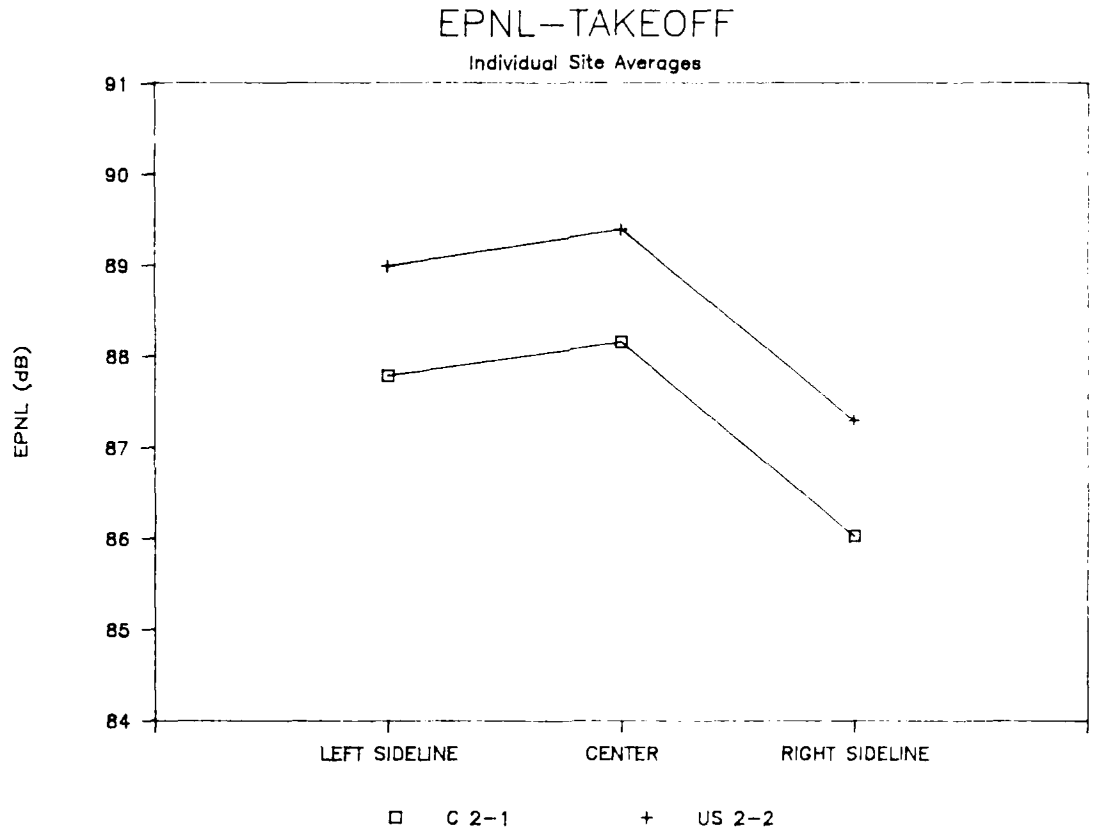


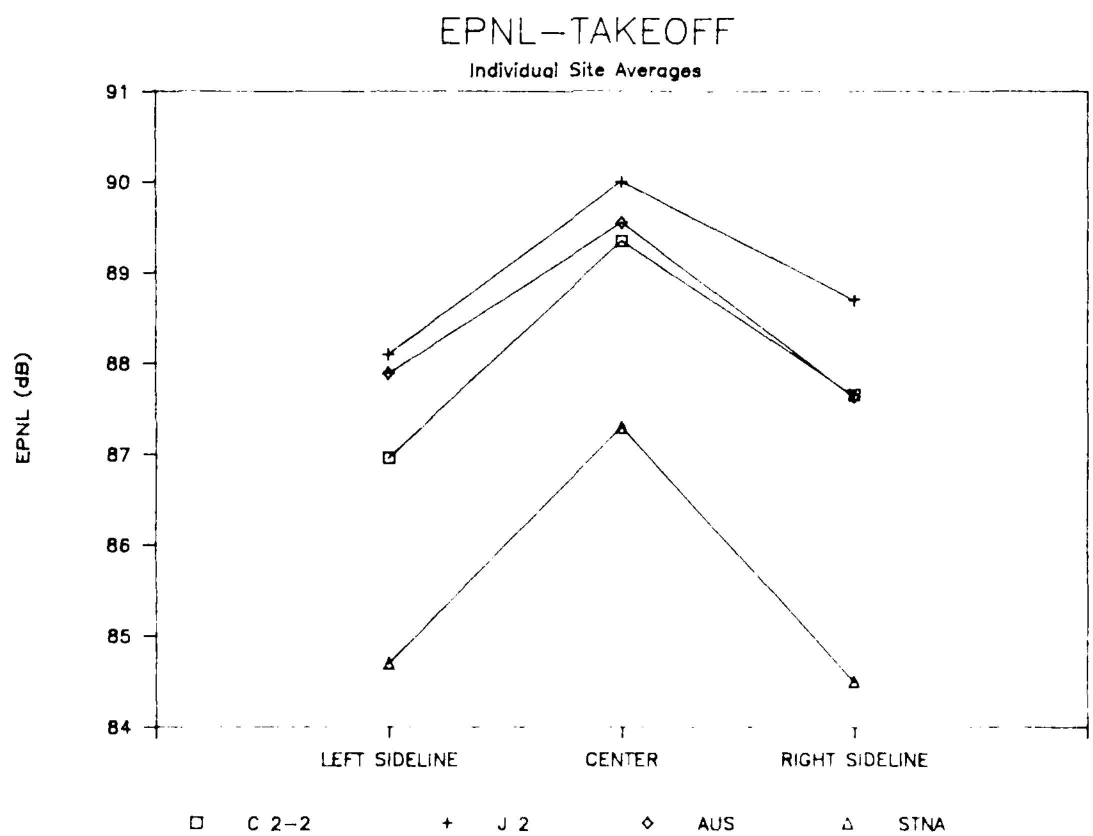

EPNL–TAKEOFF
Individual Site Averages
91
90
89
88
87
86
85
84
EPNL (dB)
LEFT SIDELINE
CENTER
RIGHT SIDELINE
C 1–2


EPNL–TAKEOFF
Individual Site Averages
91
90
89
88
87
86
85
84
EPNL (dB)
LEFT SIDELINE
CENTER
RIGHT SIDELINE
J 1
US 1–1
US 1–2


EPNL—TAKEOFF
Individual Site Averages
91
90
89
88
87
86
85
84
EPNL (dB)
LEFT SIDELINE
CENTER
RIGHT SIDELINE
UK 1
FRG 1
US 2-1

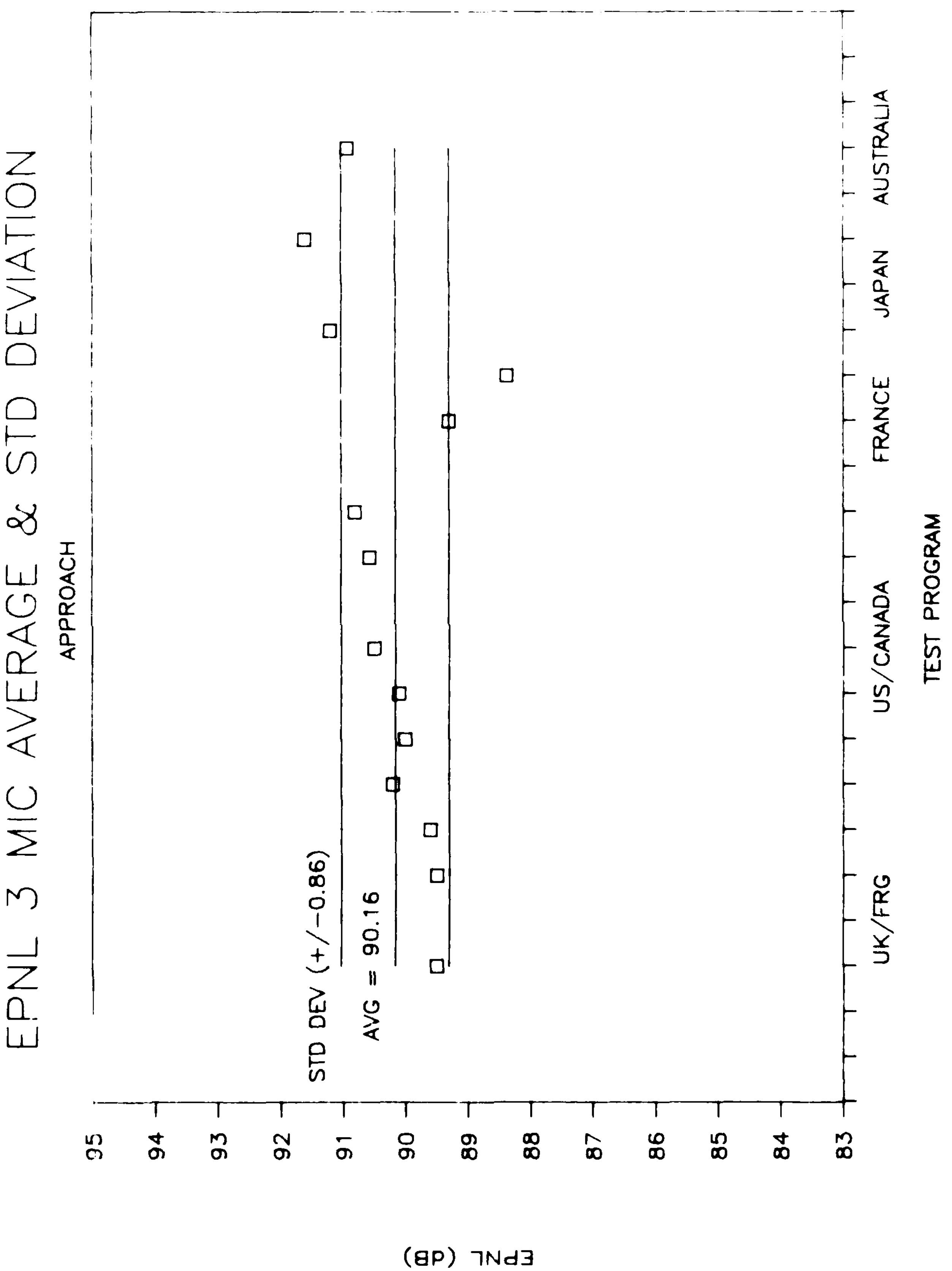

EPNL—TAKEOFF
Individual Site Averages
91
90
89
88
87
86
85
84
EPNL (dB)
LEFT SIDELINE
CENTER
RIGHT SIDELINE
C 1-1
FRG 2
UK 2


EPNL-TAKEOFF
Individual Site Averages
91
90
89
88
87
86
85
84
EPNL (dB)
LEFT SIDELINE
CENTER
RIGHT SIDELINE
C 2-1
US 2-2


EPNL-TAKEOFF
Individual Site Averages
91
90
89
88
87
86
85
84
EPNL (dB)
LEFT SIDELINE
CENTER
RIGHT SIDELINE
C 2-2
J 2
AUS
STNA

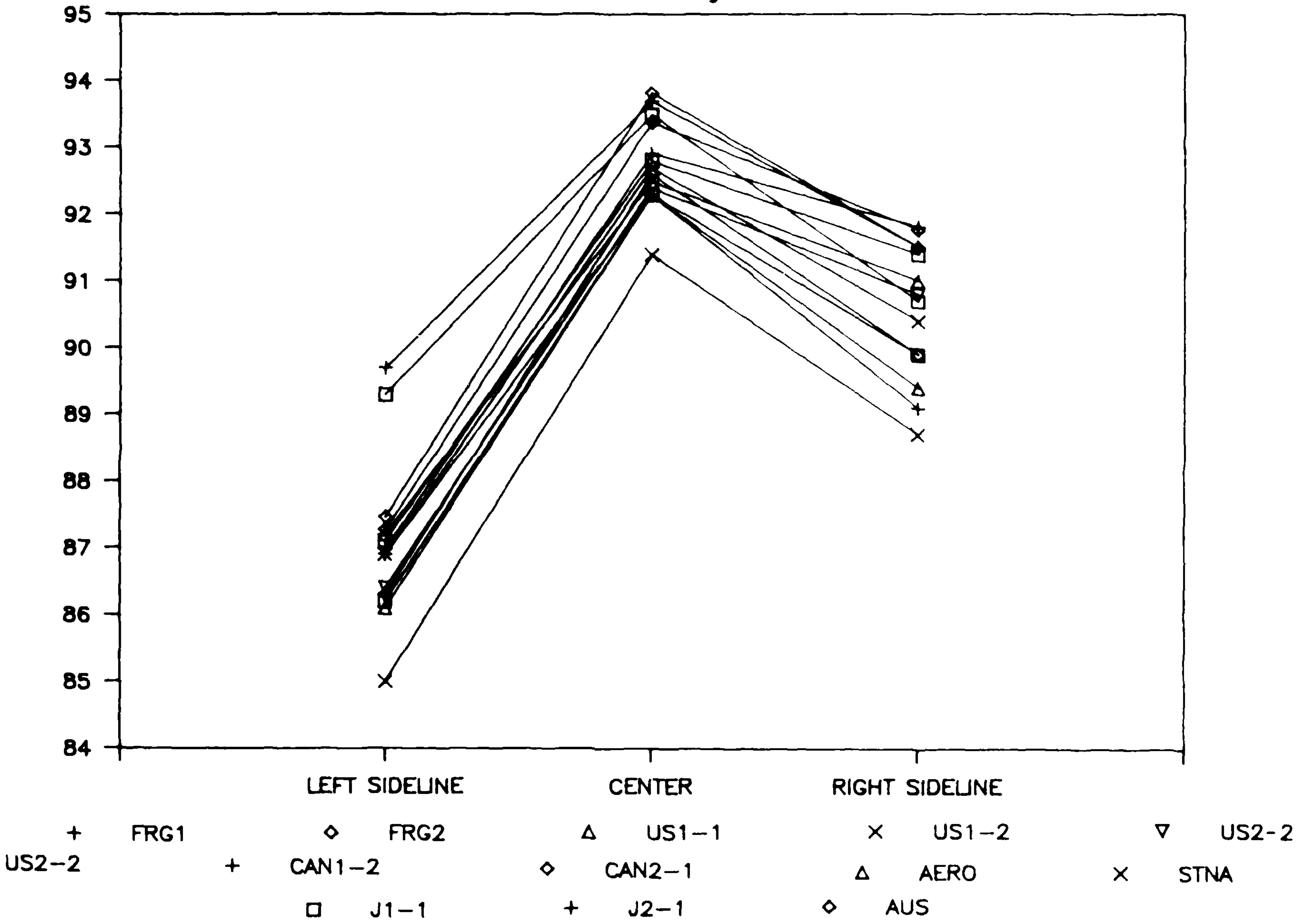
MULTI-NATION COMPARISON ANALYSIS
APPROACH EPNL DATA EXPRESSED IN DECIBELS (dB)

PARTICIPANT	LEFT SIDELINE AVERAGE	CENTER LINE CENTER AVERAGE	RIGHT SIDELINE AVERAGE	3 MIC AVERAGE	STD DEV	90% C.I.	TEAM AVERAGE	TEST AVERAGE
AUSTRALIA	87.46	93.82	91.51	90.93	0.99	[illegible]	[illegible]	[illegible]
JAPAN-PILOT 1	89.30	93.50	90.70	91.20	[illegible]	[illegible]	[illegible]	[illegible]
JAPAN-PILOT 2	89.70	93.70	91.50	91.50	[illegible]	[illegible]		
FRANCE-AERO	86.10	92.30	89.40	89.30	0.84	[illegible]	[illegible]	88.84
FRANCE-STNA	85.00	91.40	88.70	[illegible]	[illegible]	[illegible]	[illegible]	
ITALY	NA	NA	NA	NA	NA	NA		
FRG-PILOT 1	86.90	92.30	89.10	89.50	0.60	0.40	89.55	[illegible]
FRG-PILOT 2	86.30	92.60	89.90	89.60	0.50	0.40		
UK-PILOT 1	86.20	92.30	89.90	89.50	0.50	0.40	[illegible]	
CANADA-PILOT 1-2	86.97	92.92	91.81	90.57	[illegible]	0.58	[illegible]	[illegible]
CANADA-PILOT 2-1	87.27	93.38	91.77	90.81	0.61	1.03		
US-PILOT 1-1	87.20	92.50	91.00	90.20	0.55	0.40	90.20	
US-PILOT 1-2	86.90	92.70	90.40	90.00	0.41	0.39		
US-PILOT 2-1	86.40	92.40	90.80	90.10	0.71	0.52		
US-PILOT 2-2	87.10	92.80	91.40	90.50	0.52	0.35		
AVERAGE	87.06	92.76	90.56	90.16	0.61	0.58	89.99	90.21
STD DEV	1.21	0.66	1.02	0.86	0.21	0.20	1.00	1.04
90% C.I.	0.86	0.47	0.73	0.61	0.15	0.21	1.06	1.74


EPNL 3 MIC AVERAGE & STD DEVIATION
APPROACH
STD DEV (+/-0.86)
AVG = 90.16
95
94
93
92
91
90
89
88
87
86
85
84
83
EPNL (dB)
UK/FRG
US/CANADA
FRANCE
JAPAN
AUSTRALIA
TEST PROGRAM

EPNL-APPROACH

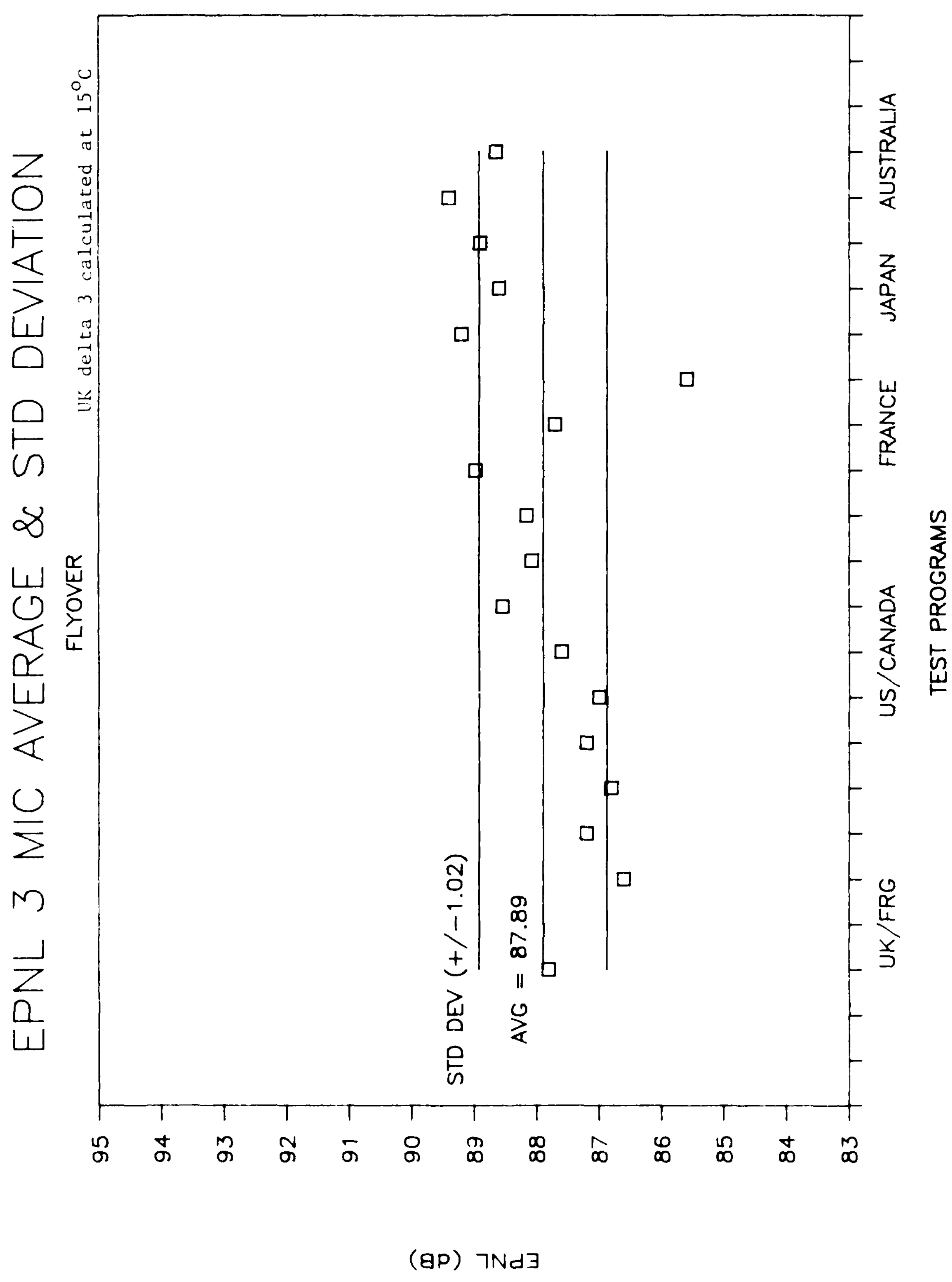
Individual Site Averages

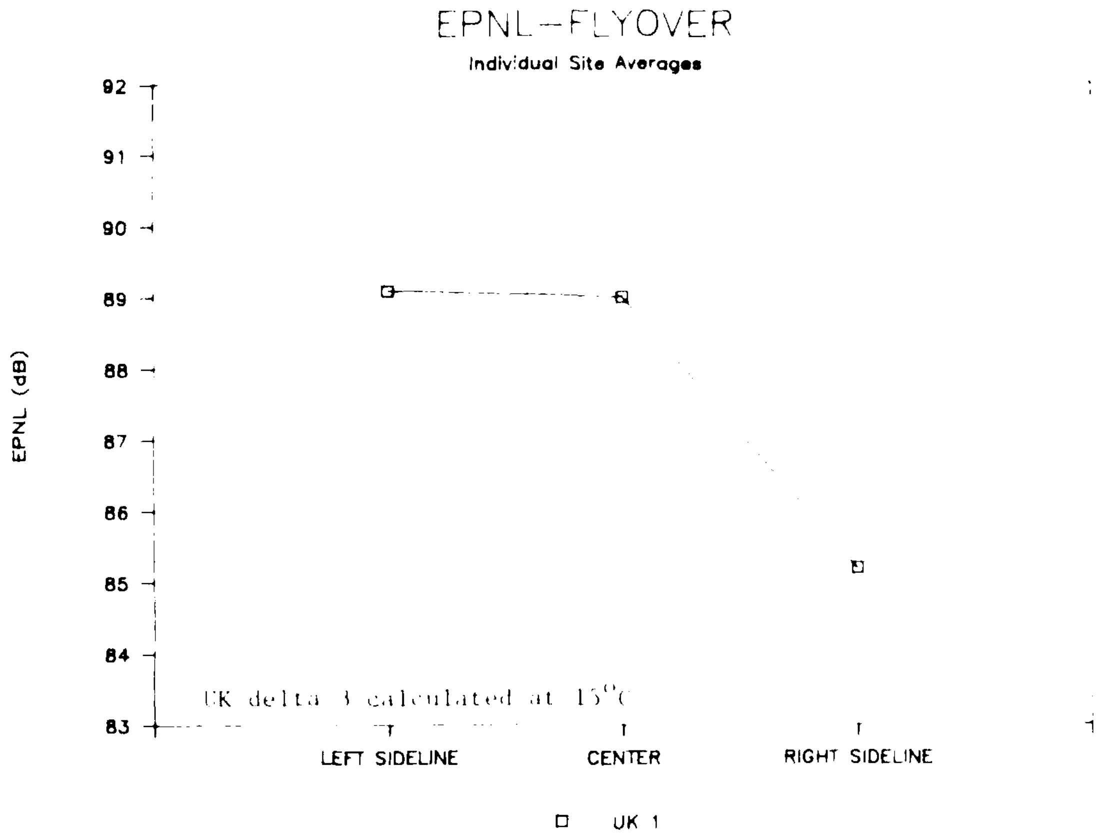


MULTI-NATION COMPARISON ANALYSIS
LEVEL FLYOVER EPNL DATA EXPRESSED IN DECIBELS (dB)

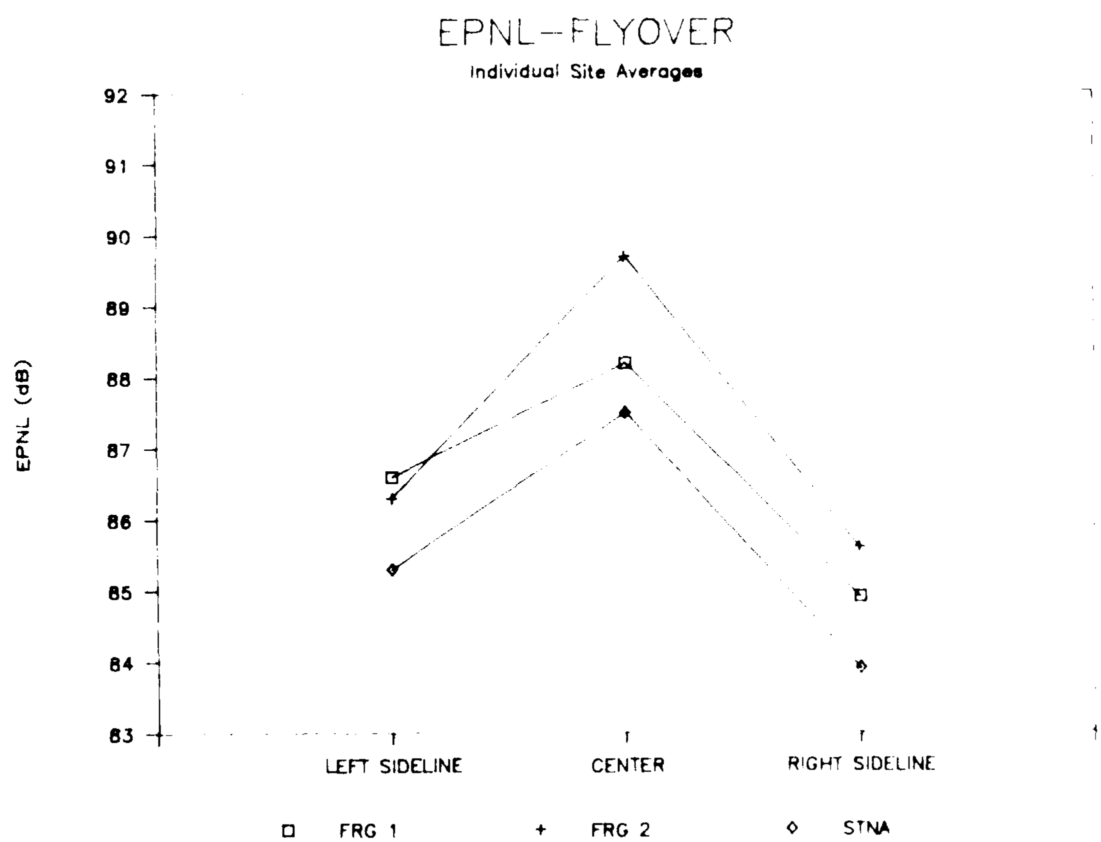
PARTICIPANT	LEFT SIDELINE AVERAGE	CENTER LINE CENTER AVERAGE	RIGHT SIDELINE AVERAGE	3 MIC AVERAGE	STD DEV	90% C.I.	TEAM AVERAGE	TEST AVERAGE
AUSTRALIA	88.82	89.69	87.42	88.65	0.72	0.39	88.65	88.65
JAPAN-PILOT 1-1	90.10	89.10	88.40	89.20	0.40	0.50	89.03	89.03
JAPAN-PILOT 1-2	90.80	88.20	86.80	88.60	0.40	0.70		
JAPAN-PILOT 2-1	90.40	88.40	87.90	88.90	0.60	0.70		
JAPAN-PILOT 2-2	91.50	89.10	87.70	89.40	0.40	0.50		
FRANCE-AERO	87.80	88.40	86.80	87.70	0.36	0.43	87.70	86.65
FRANCE-STNA	85.30	87.50	83.90	85.60	0.40	0.50	85.60	
ITALY	NA	NA	NA	NA	NA	NA		
FRG-PILOT 1	86.60	88.20	84.90	86.60	0.30	0.20	86.90	87.20
FRG-PILOT 2	86.30	89.70	85.60	87.20	0.30	0.30		
UK-PILOT 1	89.10	89.00	85.20	87.80	0.25	0.21	87.80	
CANADA-PILOT 1-1	88.59	88.67	88.34	88.54	0.22	0.21	88.44	87.79
CANADA-PILOT 1-2	88.55	88.38	87.29	88.07	0.58	0.68		
CANADA-PILOT 2-1	87.61	88.77	88.12	88.16	0.46	2.06		
CANADA-PILOT 2-2	89.42	88.58	88.94	88.98	0.43	0.51		
US-PILOT 1-1	87.30	86.80	86.30	86.80	0.29	0.21	87.15	
US-PILOT 1-2	87.70	87.70	86.30	87.20	0.16	0.19		
US-PILOT 2-1	87.30	87.50	86.20	87.00	0.30	0.25		
US-PILOT 2-2	88.60	87.00	87.30	87.60	0.45	0.30		
AVERAGE	88.43	88.37	86.86	87.89	0.39	0.49	87.66	87.86
STD DEV	1.63	0.83	1.35	1.02	0.14	0.43	1.11	0.99
90% C.I.	0.99	0.50	0.82	0.62	0.09	0.26	1.17	1.65

UK delta 3 calculated at 15°C

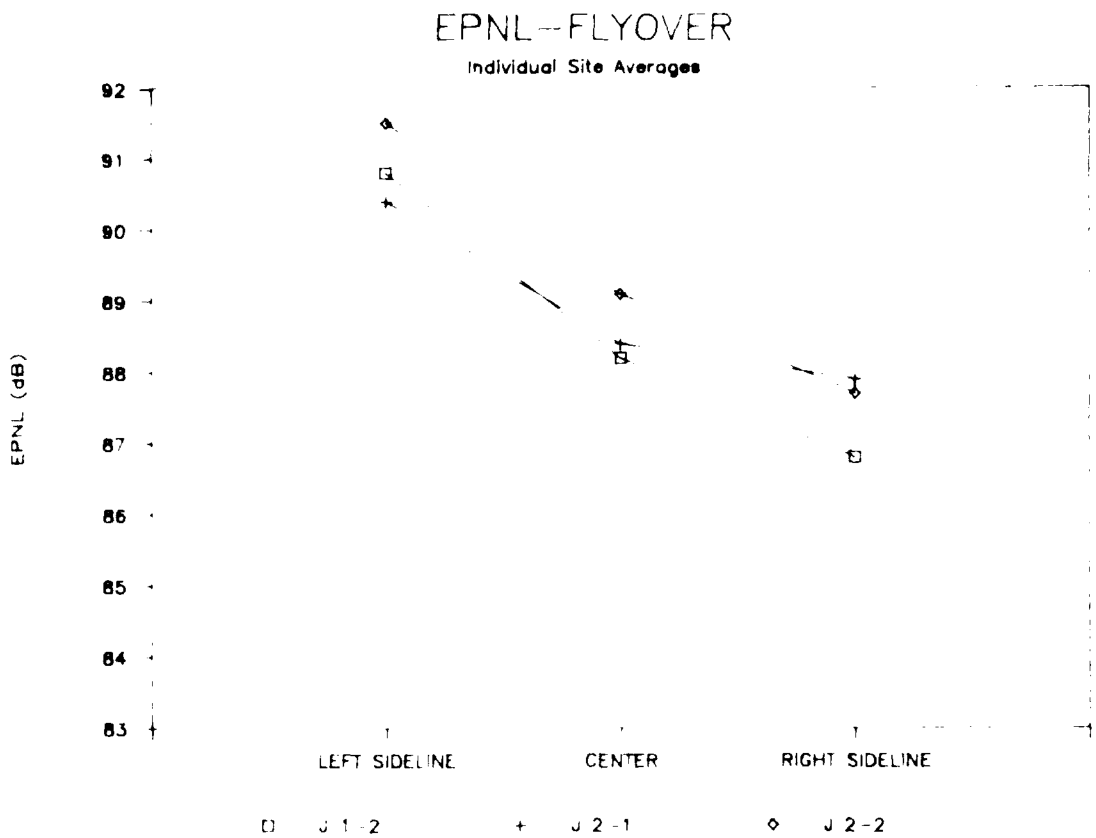

EPNL 3 MIC AVERAGE & STD DEVIATION
FLYOVER
UK delta 3 calculated at 15°C
STD DEV (+/-1.02)
AVG = 87.89
95
94
93
92
91
90
89
88
87
86
85
84
83
EPNL (dB)
UK/FRG
US/CANADA
FRANCE
JAPAN
AUSTRALIA
TEST PROGRAMS

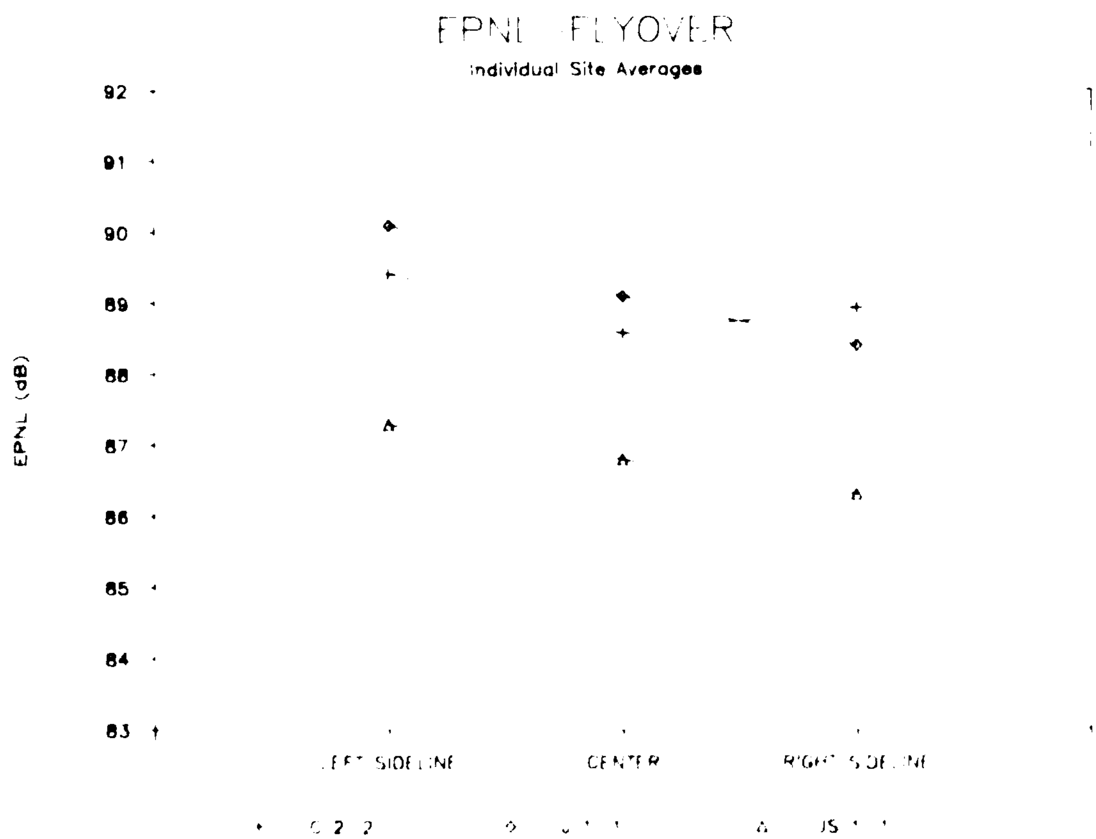


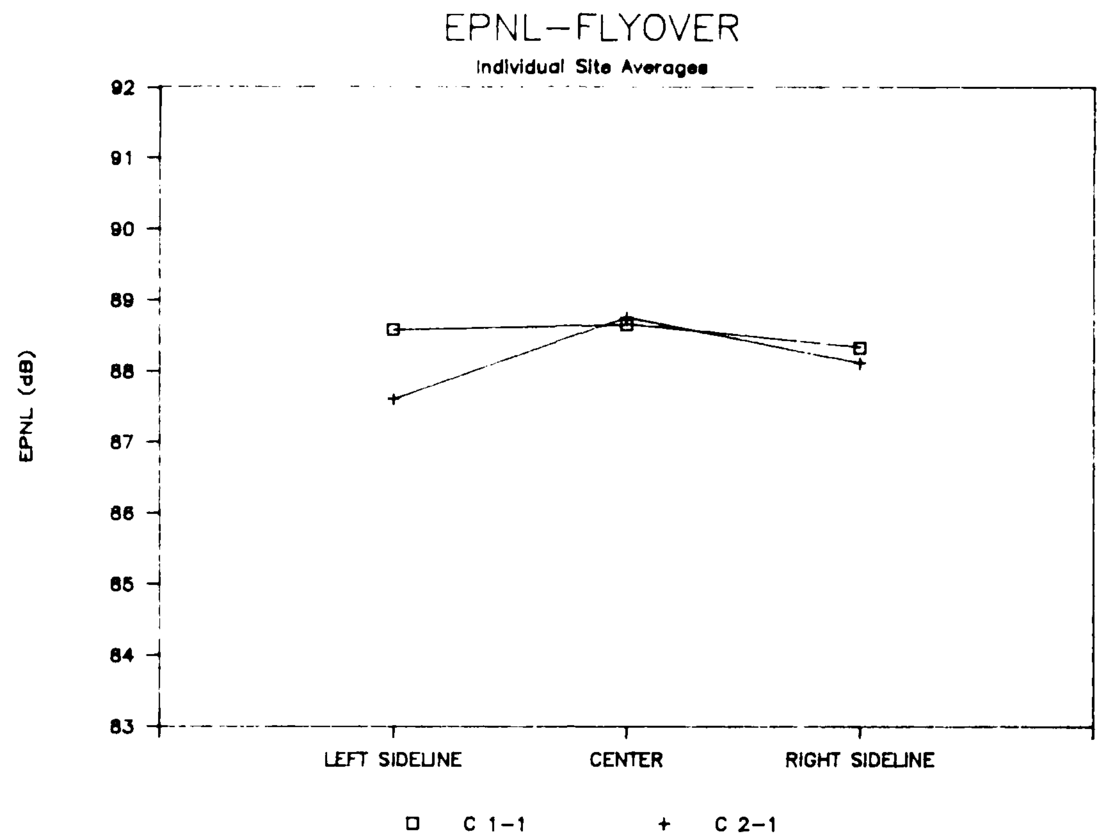
EPNL-FLYOVER
Individual Site Averages
EPNL (dB)
92
91
90
89
88
87
86
85
84
83
UK delta 3 calculated at 15°C
LEFT SIDELINE
CENTER
RIGHT SIDELINE
UK 1

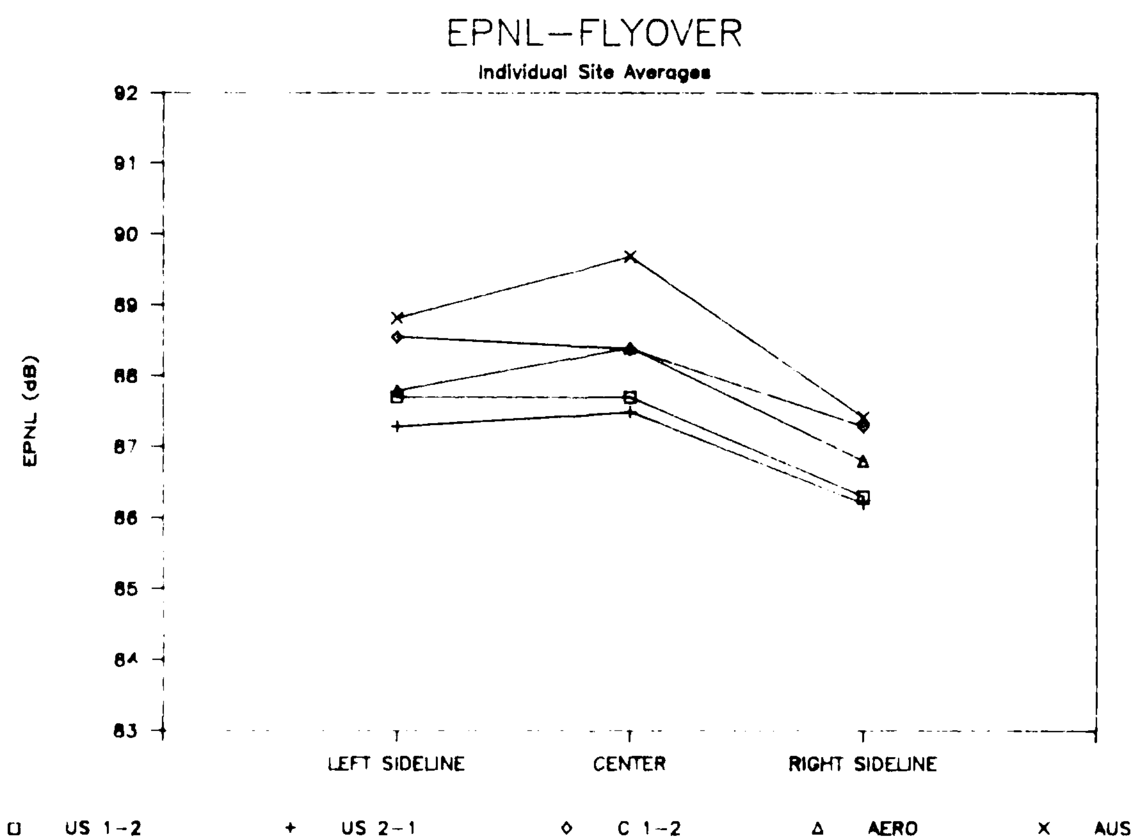


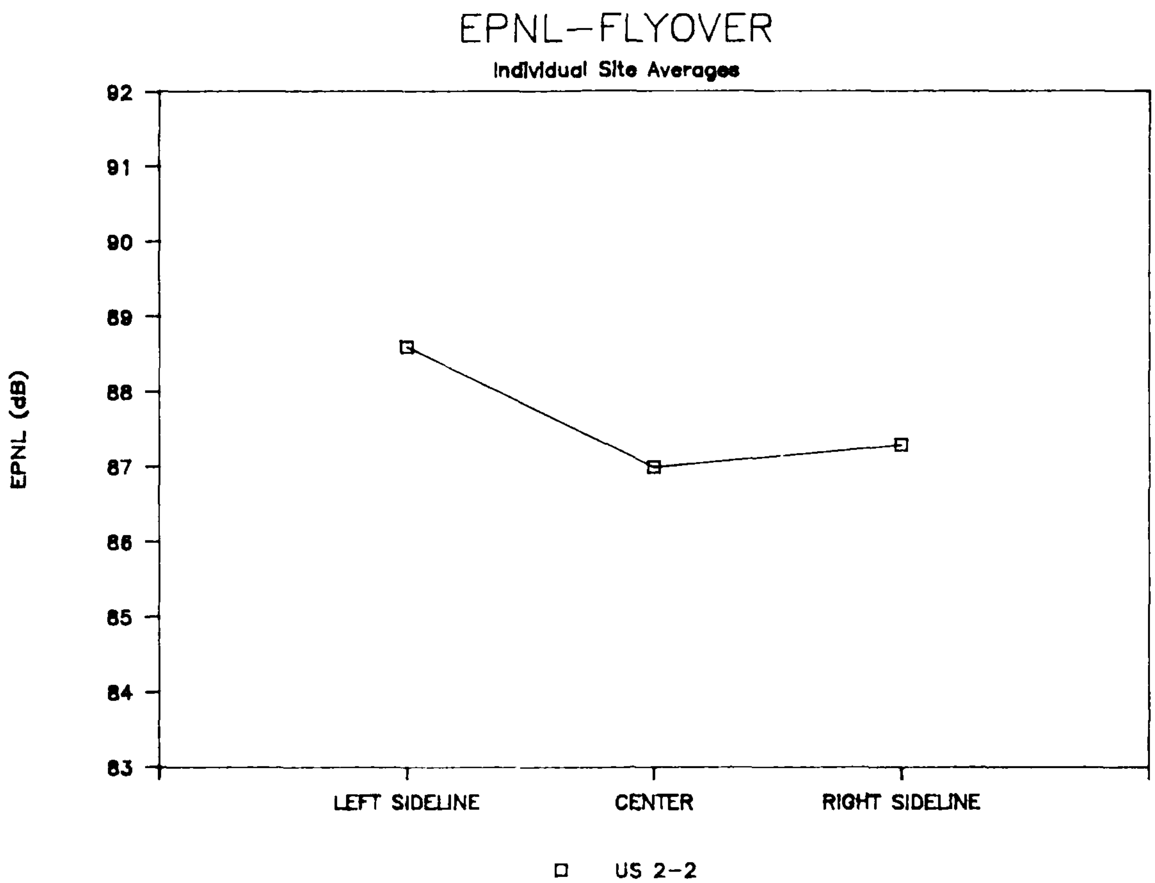
EPNL-FLYOVER
Individual Site Averages
EPNL (dB)
92
91
90
89
88
87
86
85
84
83
LEFT SIDELINE
CENTER
RIGHT SIDELINE
FRG 1
FRG 2
STNA


EPNL—FLYOVER
Individual Site Averages
EPNL (dB)
92
91
90
89
88
87
86
85
84
83
LEFT SIDELINE
CENTER
RIGHT SIDELINE
J 1-2
J 2-1
J 2-2


EPNL FLYOVER
Individual Site Averages
EPNL (dB)
92
91
90
89
88
87
86
85
84
83
CENTER


EPNL-FLYOVER
Individual Site Averages
EPNL (dB)
92
91
90
89
88
87
86
85
84
83
LEFT SIDELINE
CENTER
RIGHT SIDELINE
C 1-1
C 2-1

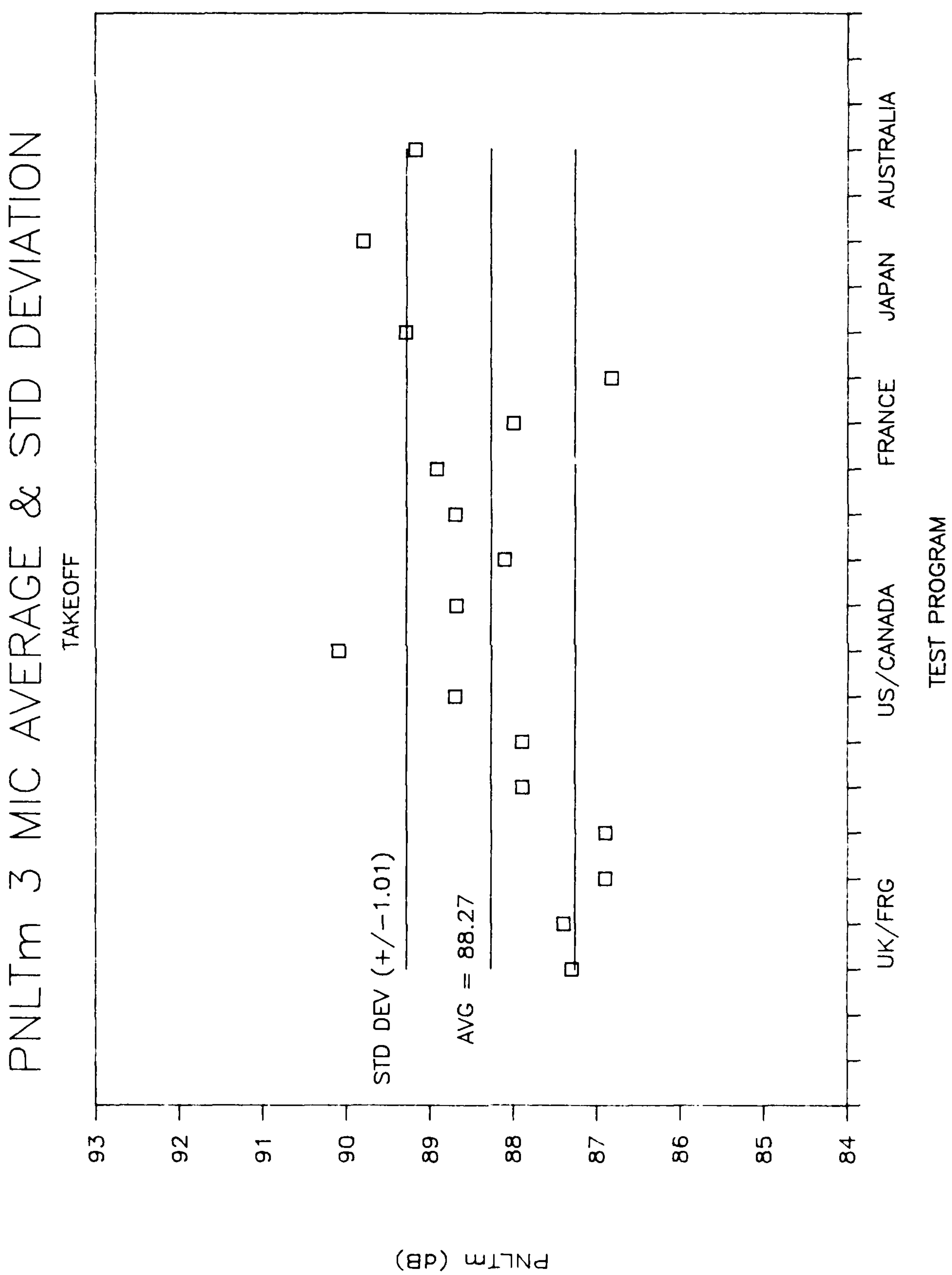

EPNL-FLYOVER
Individual Site Averages
EPNL (dB)
92
91
90
89
88
87
86
85
84
83
LEFT SIDELINE
CENTER
RIGHT SIDELINE
US 1-2
US 2-1
C 1-2
AERO
AUS

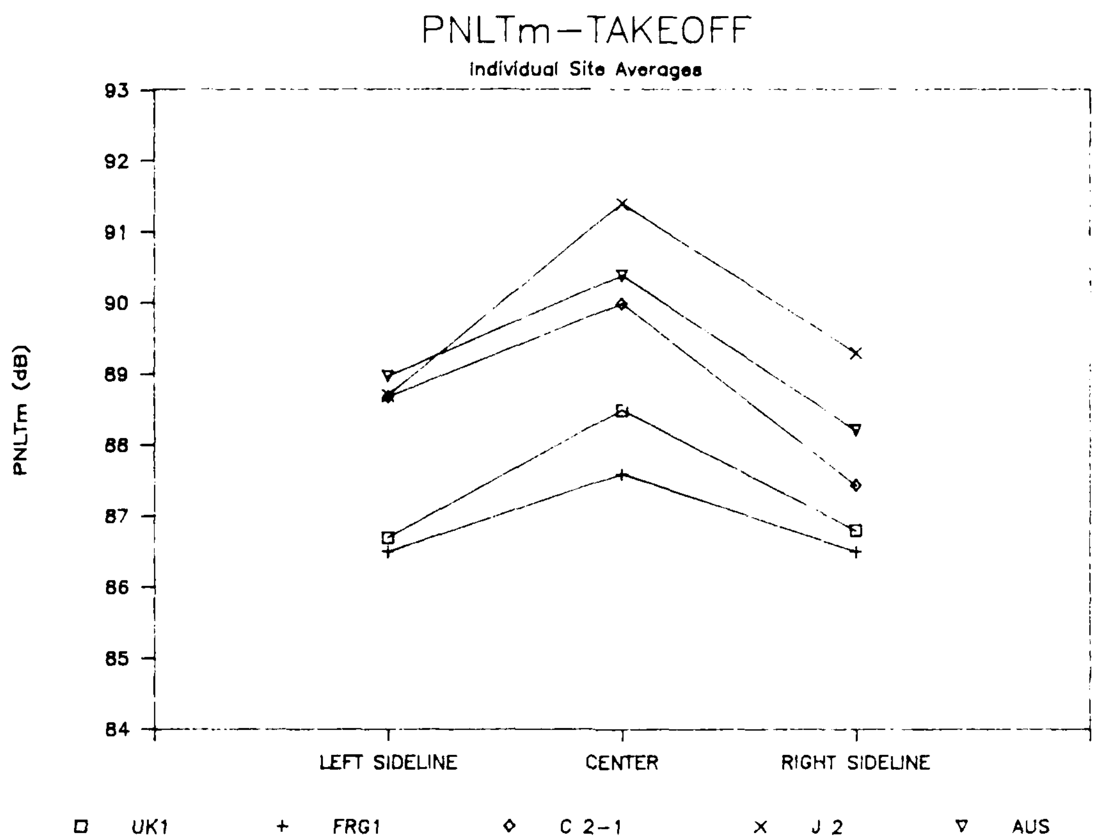

EPNL-FLYOVER
Individual Site Averages
EPNL (dB)
92
91
90
89
88
87
86
85
84
83
LEFT SIDELINE
CENTER
RIGHT SIDELINE
US 2-2

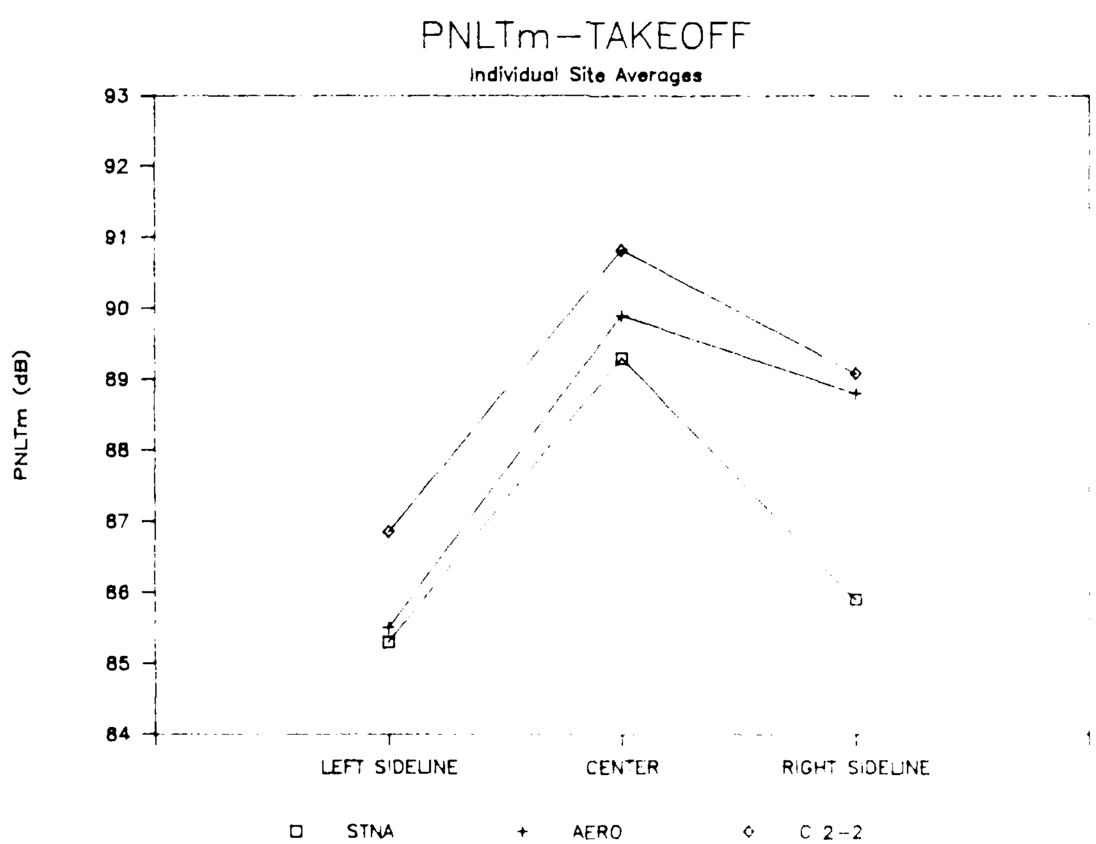
PNLTm Metric Multi-nation Comparison Data

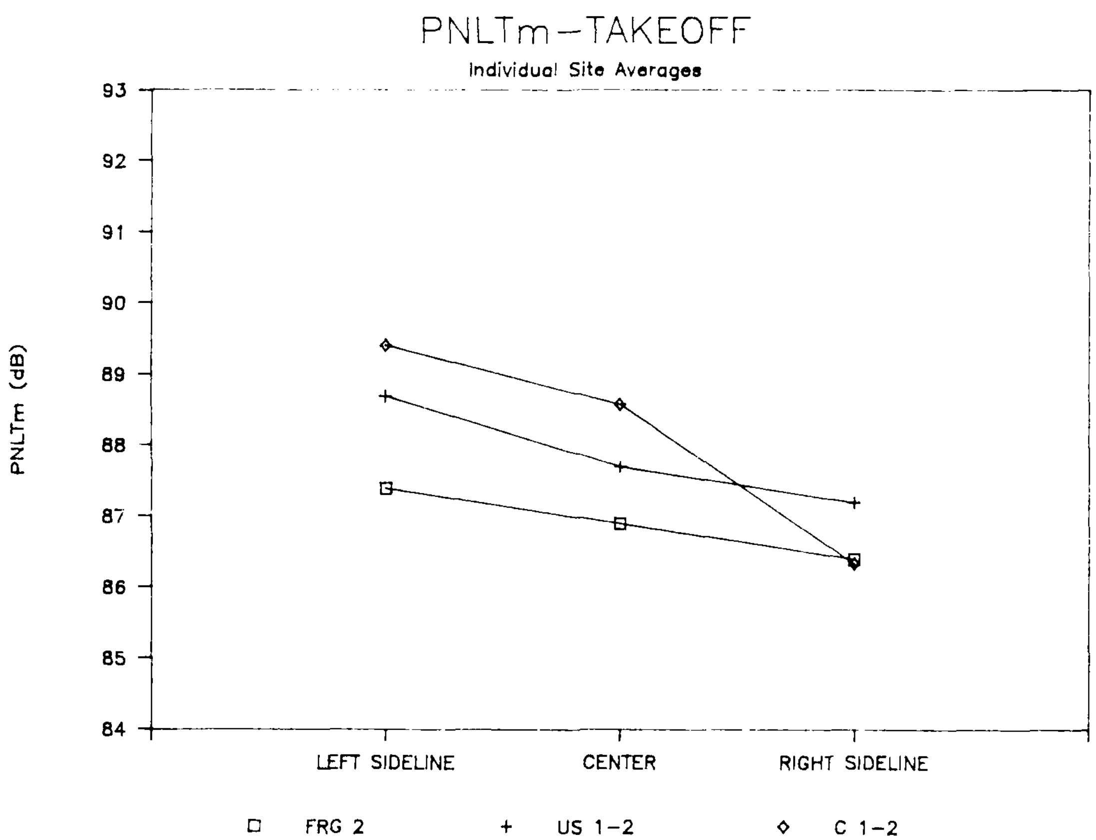
MULTI-NATION COMPARISON ANALYSIS
TAKE-OFF PNLTm DATA EXPRESSED IN DECIBELS (dB)

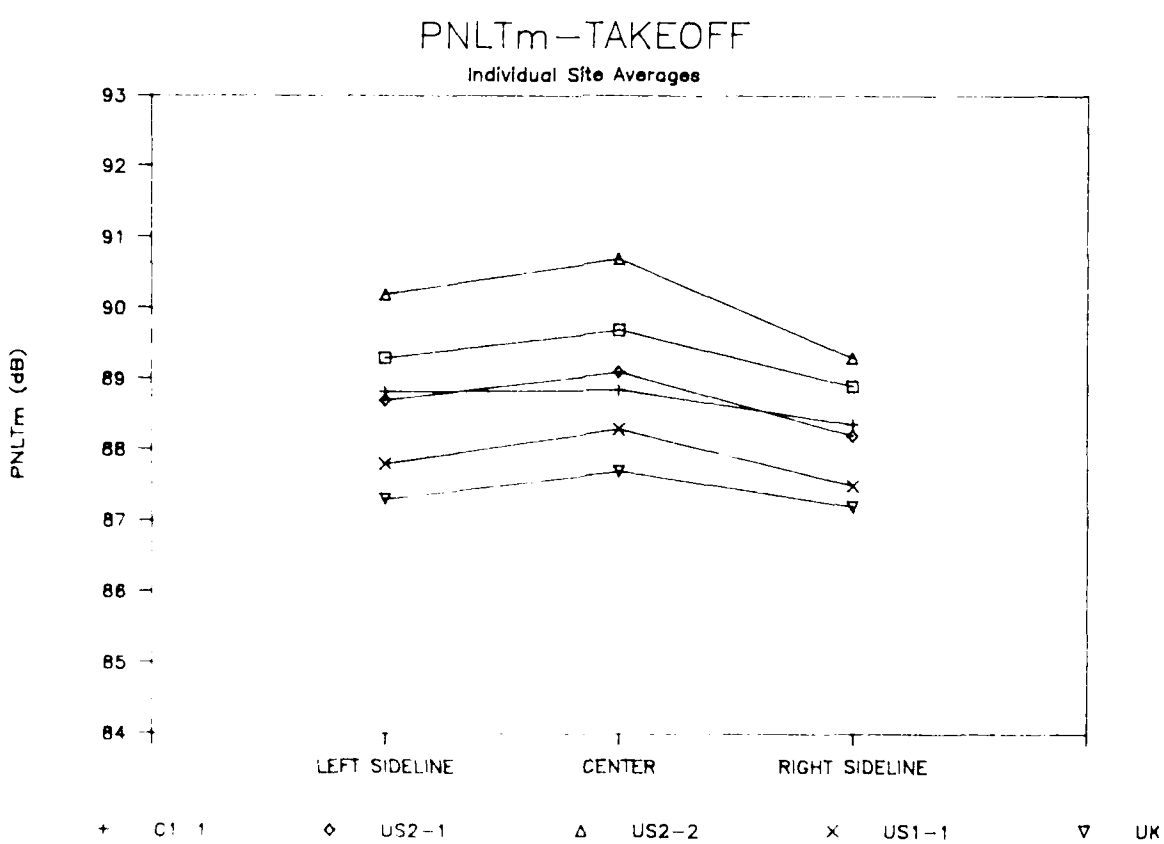
PARTICIPANT	LEFT SIDELINE AVERAGE	CENTER LINE CENTER AVERAGE	RIGHT SIDELINE AVERAGE	3 MIC AVERAGE	STD	90% C.I.	TEAM AVERAGE	TEST AVERAGE
AUSTRALIA	88.97	90.39	88.21	89.18	0.48	0.21	89.18	89.18
JAPAN-PILOT 1	89.30	89.70	88.90	89.29	0.32	0.20	89.55	89.55
JAPAN-PILOT 2	88.70	91.40	89.30	89.80	0.56	0.35		
FRANCE-AERO	85.50	89.90	88.80	88.00	0.86	0.71	88.00	87.42
FRANCE-STNA	85.30	89.30	85.90	86.83	0.50	0.40	86.83	
ITALY	NA	NA	NA	NA	NA	NA		
FRG-PILOT 1	86.50	87.60	86.50	86.90	0.30	0.30	86.90	87.13
FRG-PILOT 2	87.40	86.90	86.40	86.90	0.20	0.10		
UK-PILOT 1	86.70	88.50	86.80	87.30	0.30	0.30	87.35	
UK-PILOT 2	87.30	87.70	87.20	87.40	0.30	0.30		
CANADA-PILOT 1-1	88.82	88.85	88.36	88.68	0.55	0.93	88.61	88.63
CANADA-PILOT 1-2	89.41	88.58	86.34	88.11	0.02	0.07		
CANADA-PILOT 2-1	88.68	89.99	87.44	88.71	0.79	1.34		
CANADA-PILOT 2-2	86.85	90.82	89.08	88.92	1.37	2.31		
US-PILOT 1-1	87.80	88.30	87.50	87.90	0.55	0.37	88.65	
US-PILOT 1-2	88.70	87.70	87.20	87.90	0.18	0.17		
US-PILOT 2-1	88.70	89.10	88.20	88.70	0.49	0.36		
US-PILOT 2-2	90.20	90.70	89.30	90.10	0.86	0.71		
AVERAGE	87.93	89.14	87.73	88.27	0.51	0.54	88.13	88.38
STD DEV	1.41	1.29	1.12	1.01	0.32	0.56	1.03	1.07
90% C.I.	0.88	0.81	0.70	0.63	0.20	0.35	1.09	1.79


PNLTm 3 MIC AVERAGE & STD DEVIATION
TAKEOFF
STD DEV (+/−1.01)
AVG = 88.27
93
92
91
90
89
88
87
86
85
84
PNLTm (dB)
UK/FRG
US/CANADA
FRANCE
JAPAN
AUSTRALIA
TEST PROGRAM


PNLTm—TAKEOFF
Individual Site Averages
PNLTm (dB)
93
92
91
90
89
88
87
86
85
84
LEFT SIDELINE
CENTER
RIGHT SIDELINE
UK1
FRG1
C 2-1
J 2
AUS


PNLTm—TAKEOFF
Individual Site Averages
PNLTm (dB)
93
92
91
90
89
88
87
86
85
84
LEFT SIDELINE
CENTER
RIGHT SIDELINE
STNA
AERO
C 2-2


PNLTm-TAKEOFF
Individual Site Averages
PNLTm (dB)
93
92
91
90
89
88
87
86
85
84
LEFT SIDELINE
CENTER
RIGHT SIDELINE
FRG 2
US 1-2
C 1-2

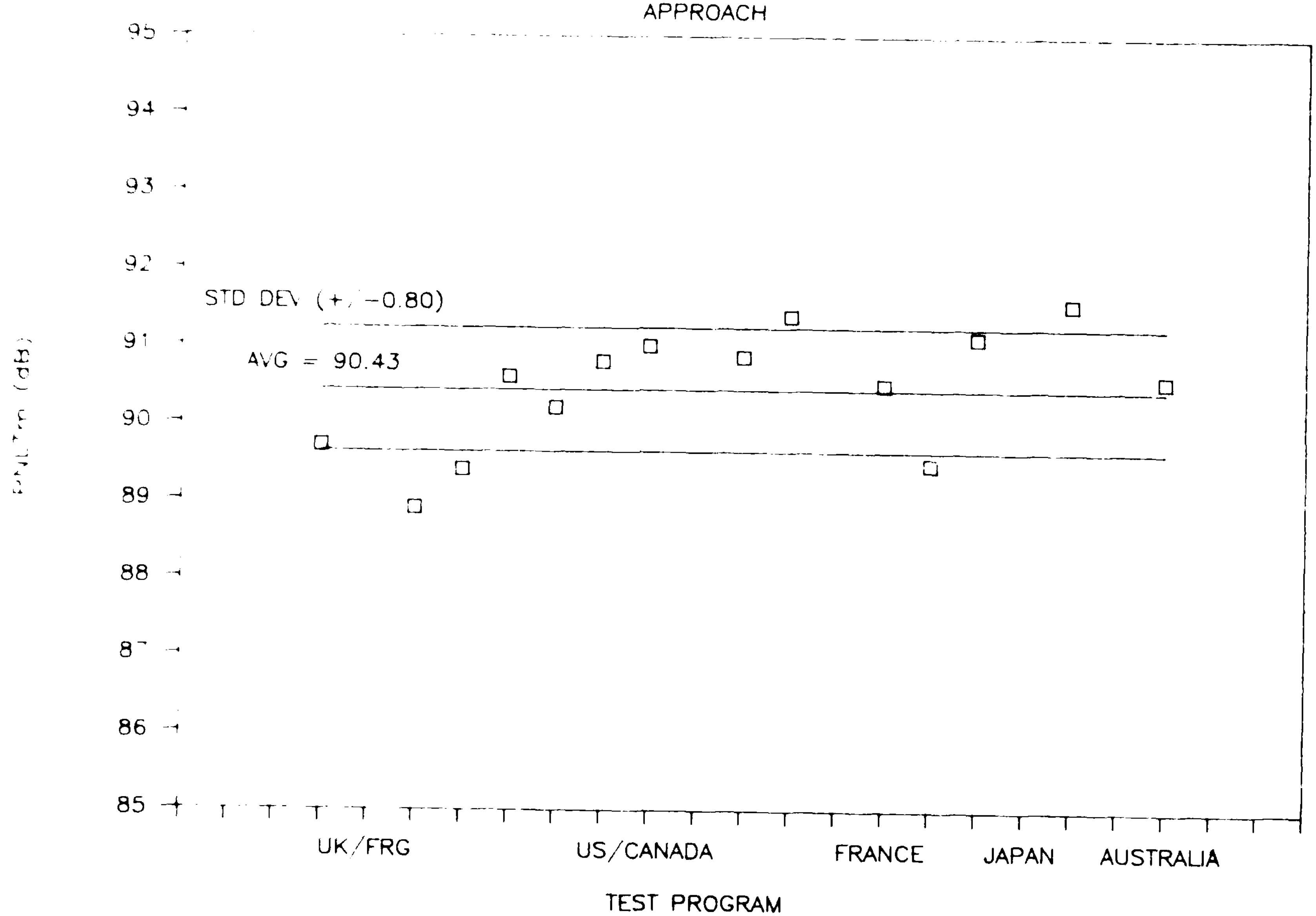

PNLTm-TAKEOFF
Individual Site Averages
PNLTm (dB)
93
92
91
90
89
88
87
86
85
84
LEFT SIDELINE
CENTER
RIGHT SIDELINE
US2-1
US2-2
US1-1
UK

MULTI-NATION COMPARISON ANALYSIS
APPROACH PNLTm DATA EXPRESSED IN DECIBELS (dB)

PARTICIPANT	LEFT SIDELINE AVERAGE	CENTER LINE CENTER AVERAGE	RIGHT SIDELINE AVERAGE	3 MIC AVERAGE	STD DEV	90% C.I.	TEAM AVERAGE	TEST AVERAGE
AUSTRALIA	86.47	93.83	91.39	90.57	1.11	0.74	90.57	90.57
JAPAN-PILOT 1	88.50	94.80	90.00	91.11	0.38	0.28	91.33	91.33
JAPAN-PILOT 2	88.00	95.40	91.20	91.55	0.64	0.39		
FRANCE-AERO	86.60	94.70	90.10	90.50	1.22	2.06	91.47	90.47
FRANCE-STNA	85.30	93.40	89.70	89.47	1.80	1.30	89.47	
ITALY	NA	NA	NA	NA	NA	NA		
FRG-PILOT 1	85.30	93.60	87.90	88.90	0.60	0.40	89.15	89.33
FRG-PILOT 2	85.30	93.40	89.50	89.40	0.80	0.70		
UK-PILOT 1	85.60	93.80	89.60	89.70	0.80	0.70	89.70	
CANADA-PILOT 1-2	86.82	94.82	90.93	90.86	0.32	1.44	91.13	90.81
CANADA-PILOT 2-1	86.78	95.85	91.54	91.39	0.26	0.43		
US-PILOT 1-1	86.90	94.10	90.90	90.60	0.87	0.58	90.65	
US-PILOT 1-2	86.30	94.00	90.20	90.20	0.38	0.36		
US-PILOT 2-1	86.30	94.50	91.10	90.80	0.58	0.42		
US-PILOT 2-2	86.70	94.20	92.00	91.00	0.43	0.26		
AVERAGE	86.49	94.31	90.43	90.43	0.73	0.72	90.43	90.53
STD DEV	0.95	0.74	1.07	0.80	0.42	0.53	0.89	[illegible]
90% C.I.	0.68	0.52	0.76	0.56	0.30	0.37	0.94	[illegible]

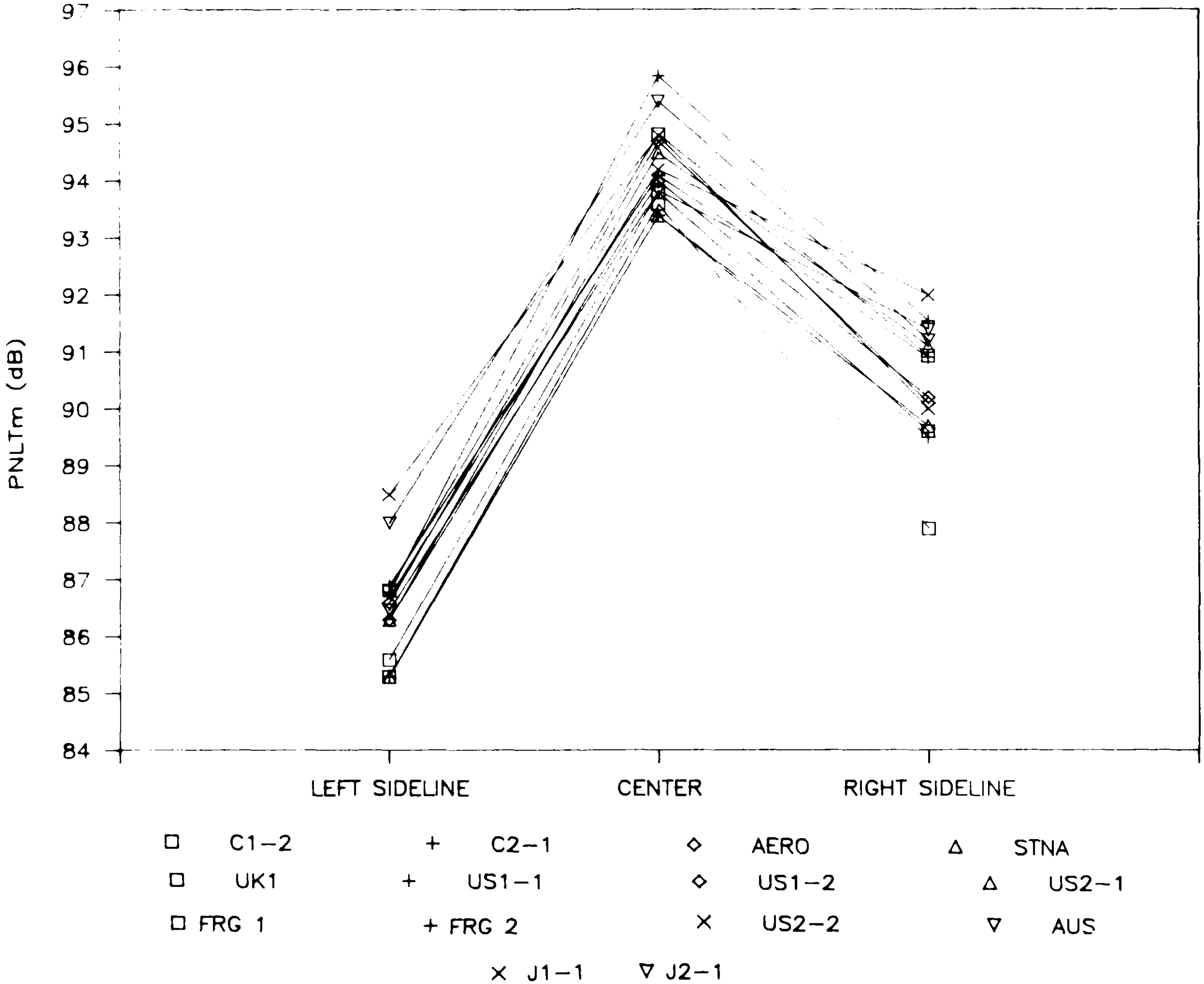
PNLTm 3 MIC AVERAGE & STD DEVIATION

APPROACH



PNLTm—APPROACH

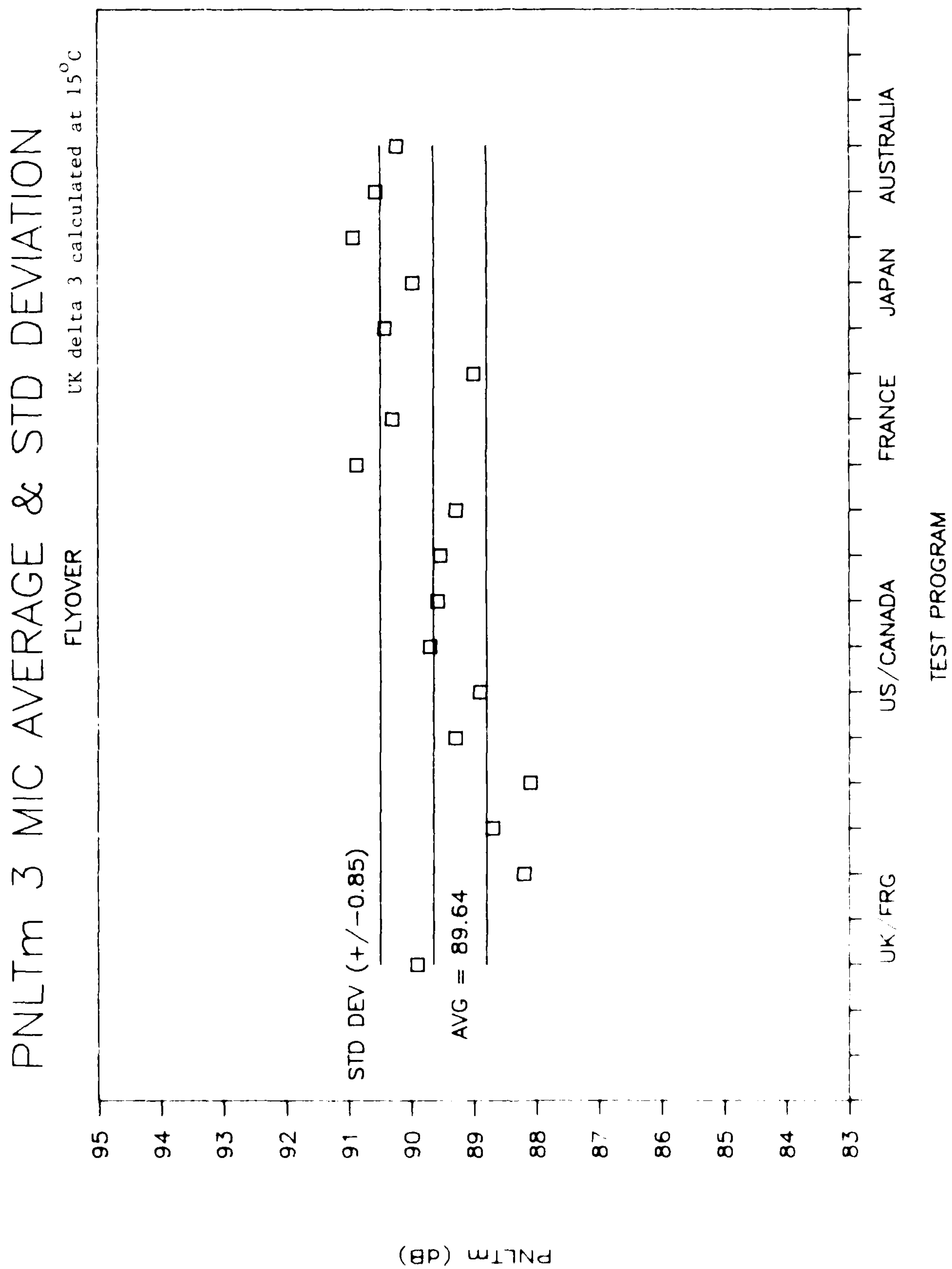
Individual Site Averages



MULTI-NATION COMPARISON ANALYSIS
LEVEL FLYOVER PNLTm DATA EXPRESSED IN DECIBELS (dB)

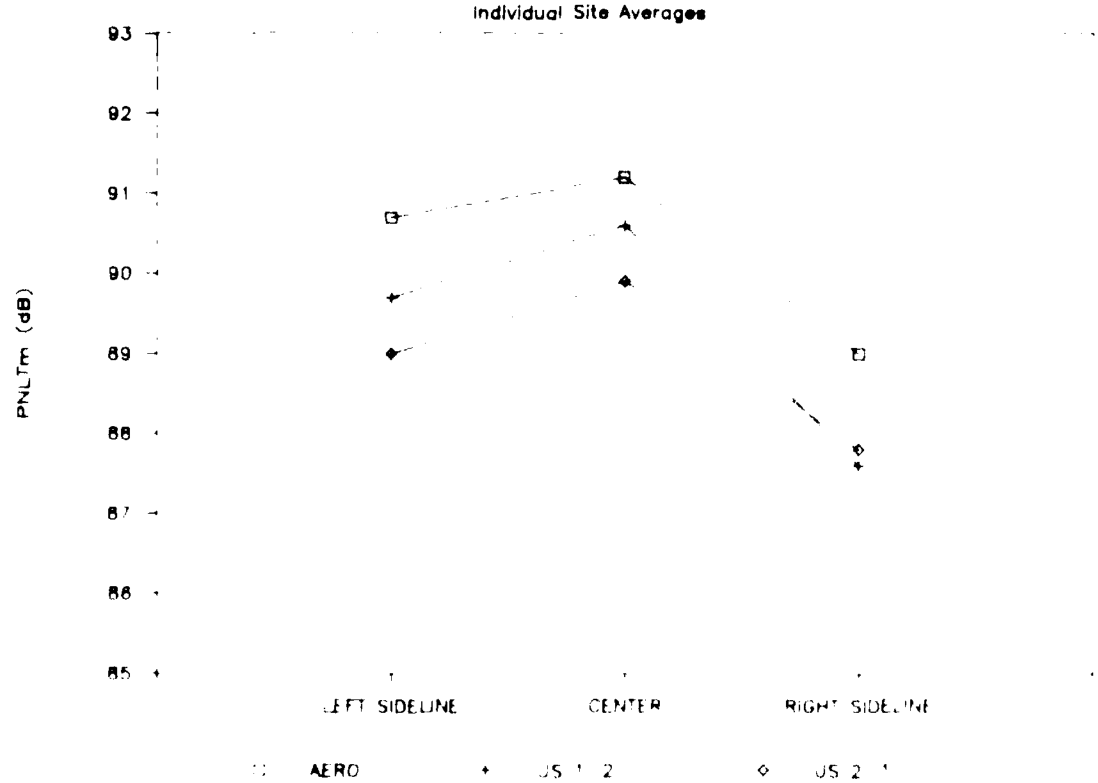
PARTICIPANT	LEFT SIDELINE AVERAGE	CENTER LINE CENTER AVERAGE	RIGHT SIDELINE AVERAGE	3 MIC AVERAGE	STD DEV	90% C.I.	TEAM AVERAGE	TEST AVERAGE
AUSTRALIA	90.16	92.22	88.30	90.23	0.61	0.33	90.23	90.23
JAPAN-PILOT 1-1	91.04	91.44	88.79	90.42	0.14	0.16	90.48	90.48
JAPAN-PILOT 1-2	91.33	90.99	87.63	89.98	0.31	0.52		
JAPAN-PILOT 2-1	91.93	91.87	89.01	90.93	0.38	0.44		
JAPAN-PILOT 2-2	91.87	91.50	88.35	90.57	0.16	0.19		
FRANCE-AERO	90.70	91.20	89.00	90.30	0.64	0.75	90.30	89.65
FRANCE-STNA	89.30	91.00	86.80	89.00	0.60	0.80	89.00	
ITALY	NA	NA	NA	NA	NA	NA		
FRG-PILOT 1	88.00	90.50	86.10	88.20	0.20	0.20	88.45	88.97
FRG-PILOT 2	87.80	91.60	86.70	88.70	0.30	0.30		
UK-PILOT 1	90.40	92.20	86.90	89.90	NA	NA	89.90	
CANADA-PILOT 1-1	88.88	90.38	89.44	89.57	0.27	0.26	89.81	89.41
CANADA-PILOT 1-2	89.76	91.27	87.56	89.53	0.60	0.71		
CANADA-PILOT 2-1	88.17	91.41	88.25	89.28	0.47	1.09		
CANADA-PILOT 2-2	91.49	91.46	89.68	90.87	0.80	0.94		
US-PILOT 1-1	88.00	89.10	87.30	88.10	0.27	0.20	89.00	
US-PILOT 1-2	89.70	90.60	87.60	89.30	0.14	0.16		
US-PILOT 2-1	89.00	89.90	87.80	86.90	0.23	0.19		
US-PILOT 2-2	90.50	89.70	88.80	89.70	0.46	0.28		
AVERAGE	89.89	91.02	88.00	89.64	0.39	0.50	89.65	89.74
STD DEV	1.37	0.85	1.01	0.85	0.20	0.48	0.74	0.62
90% C.I.	0.83	0.51	0.61	0.51	0.13	0.30	0.78	1.04

UK delta 3 calculated at 15^{o}C

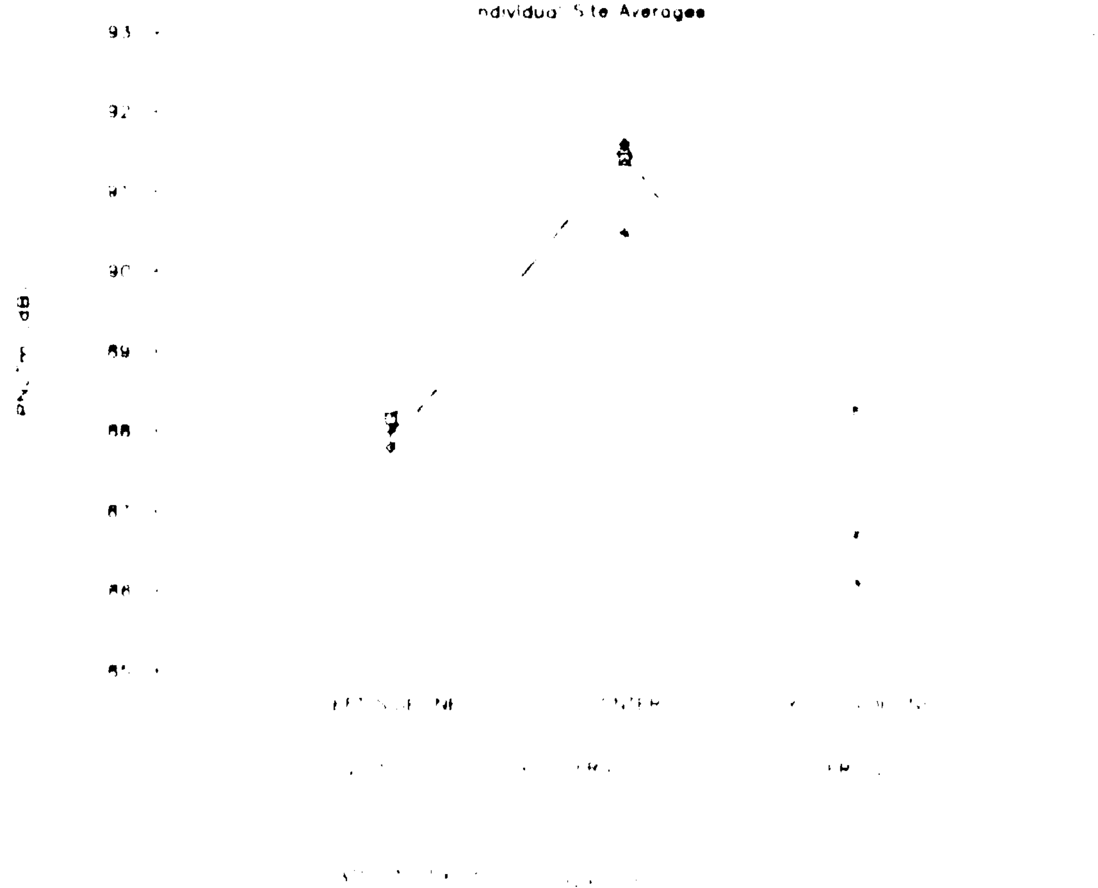

PNLTm 3 MIC AVERAGE & STD DEVIATION
FLYOVER
UK delta 3 calculated at 15°C
STD DEV (+/−0.85)
AVG = 89.64
UK/FRG
US/CANADA
FRANCE
JAPAN
AUSTRALIA
TEST PROGRAM
PNLTm (dB)
95
94
93
92
91
90
89
88
87
86
85
84
83

PNLTm—LEVEL FLYOVER

Individual Site Averages

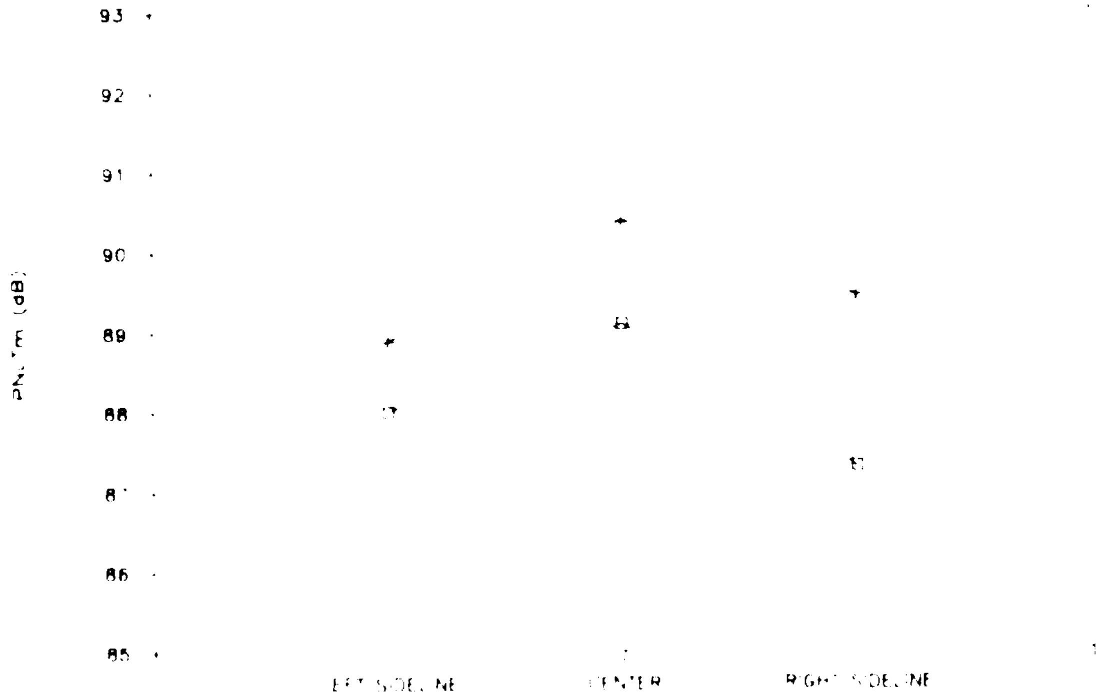


Individual Site Averages

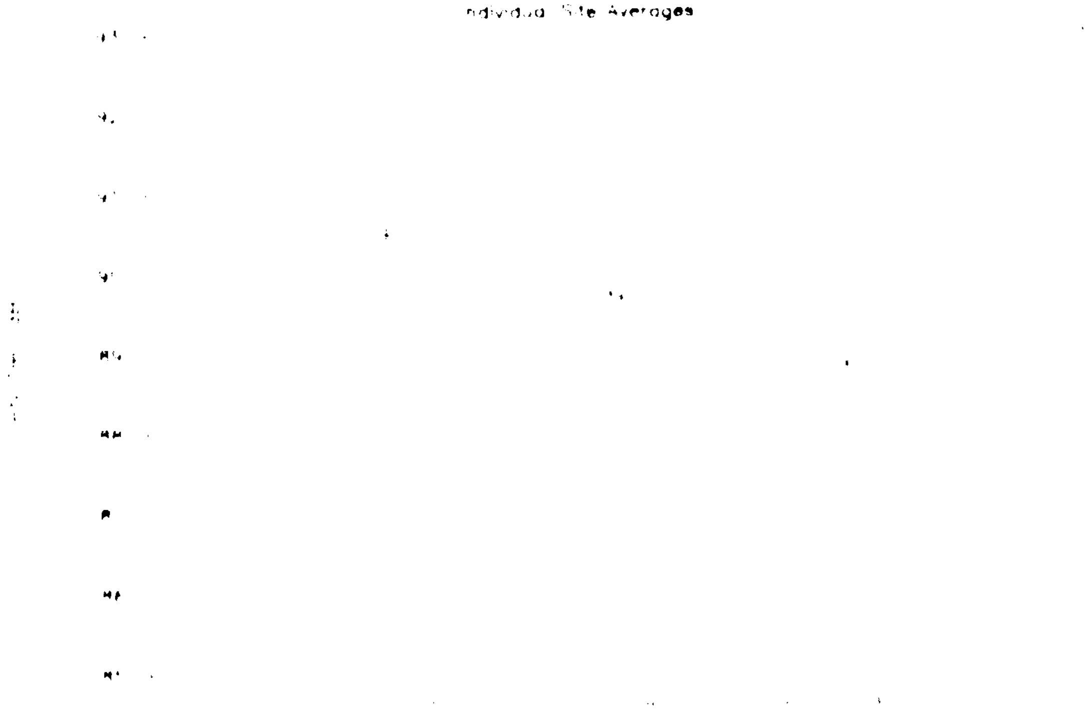


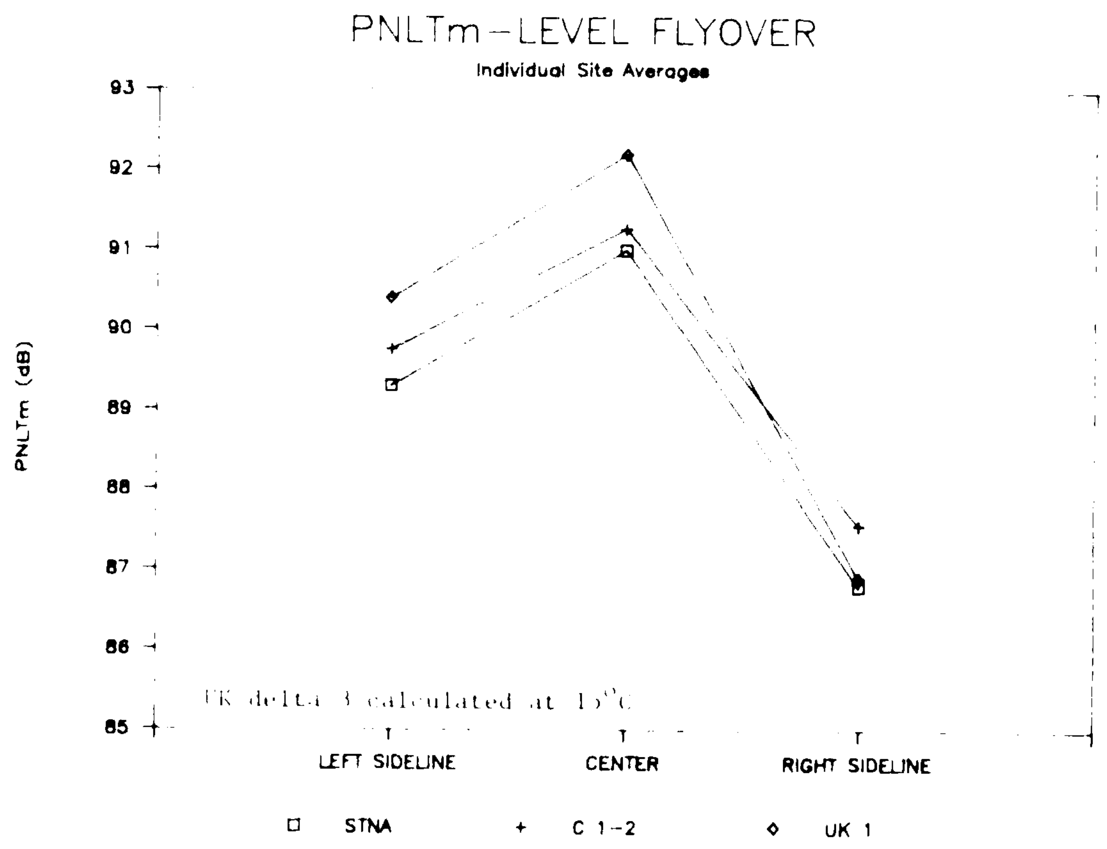
PNLTm - LEVEL FLYOVER

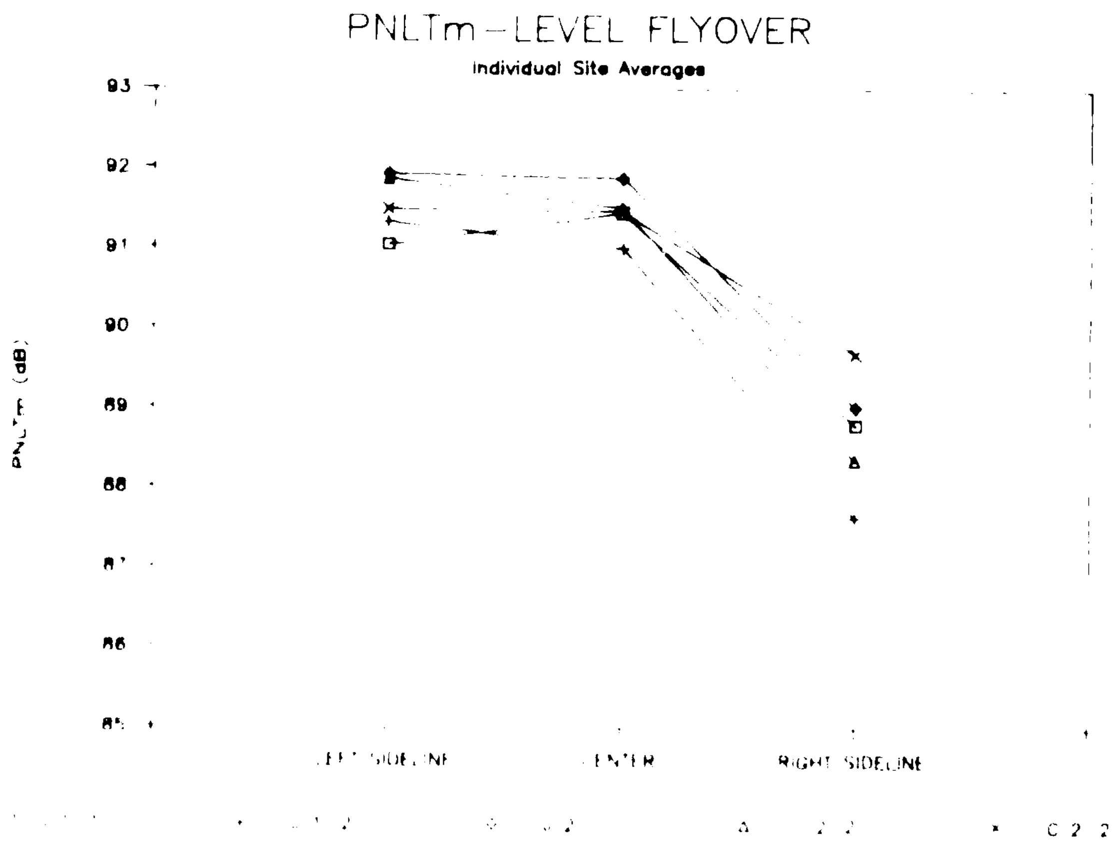
Individual Site Averages

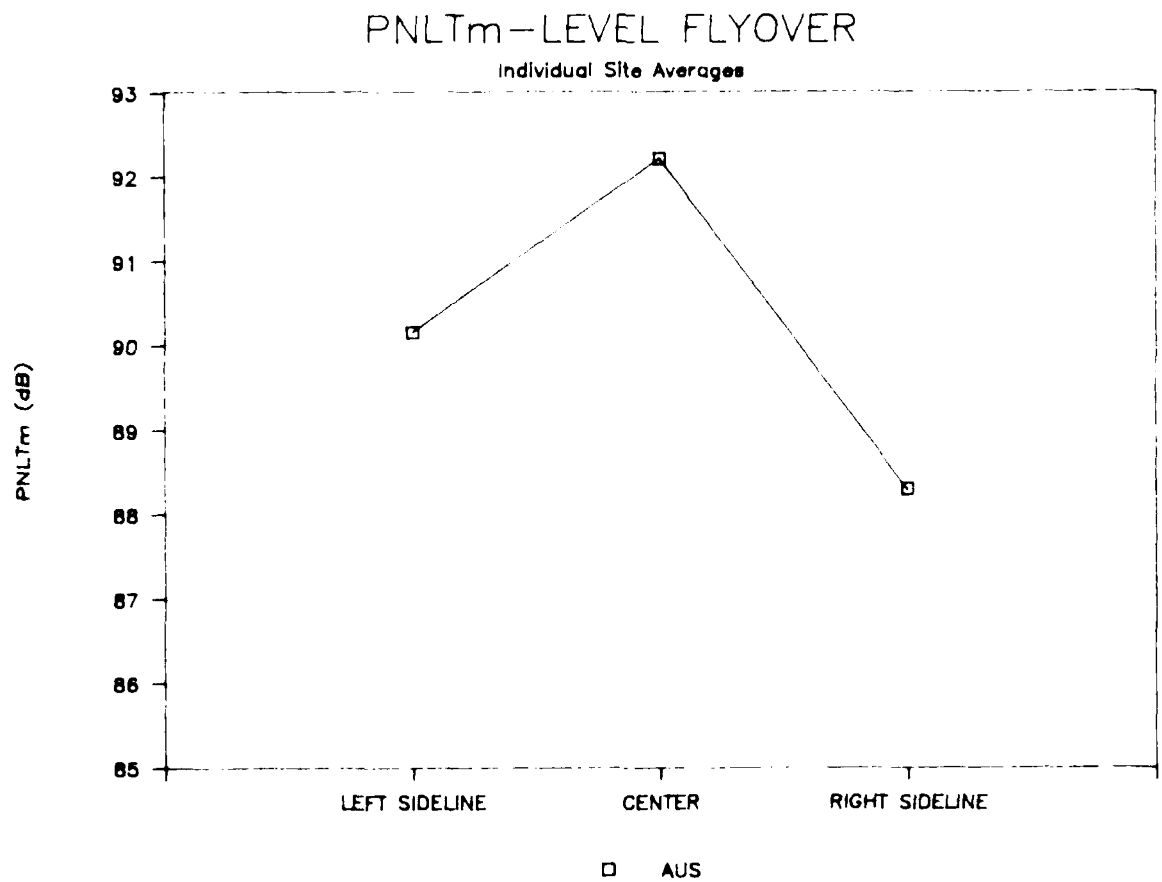


Individual Site Averages




PNLTm - LEVEL FLYOVER
Individual Site Averages
PNLTm (dB)
93
92
91
90
89
88
87
86
85
UK delta 3 calculated at 15°C
LEFT SIDELINE
CENTER
RIGHT SIDELINE
STNA
C 1-2
UK 1

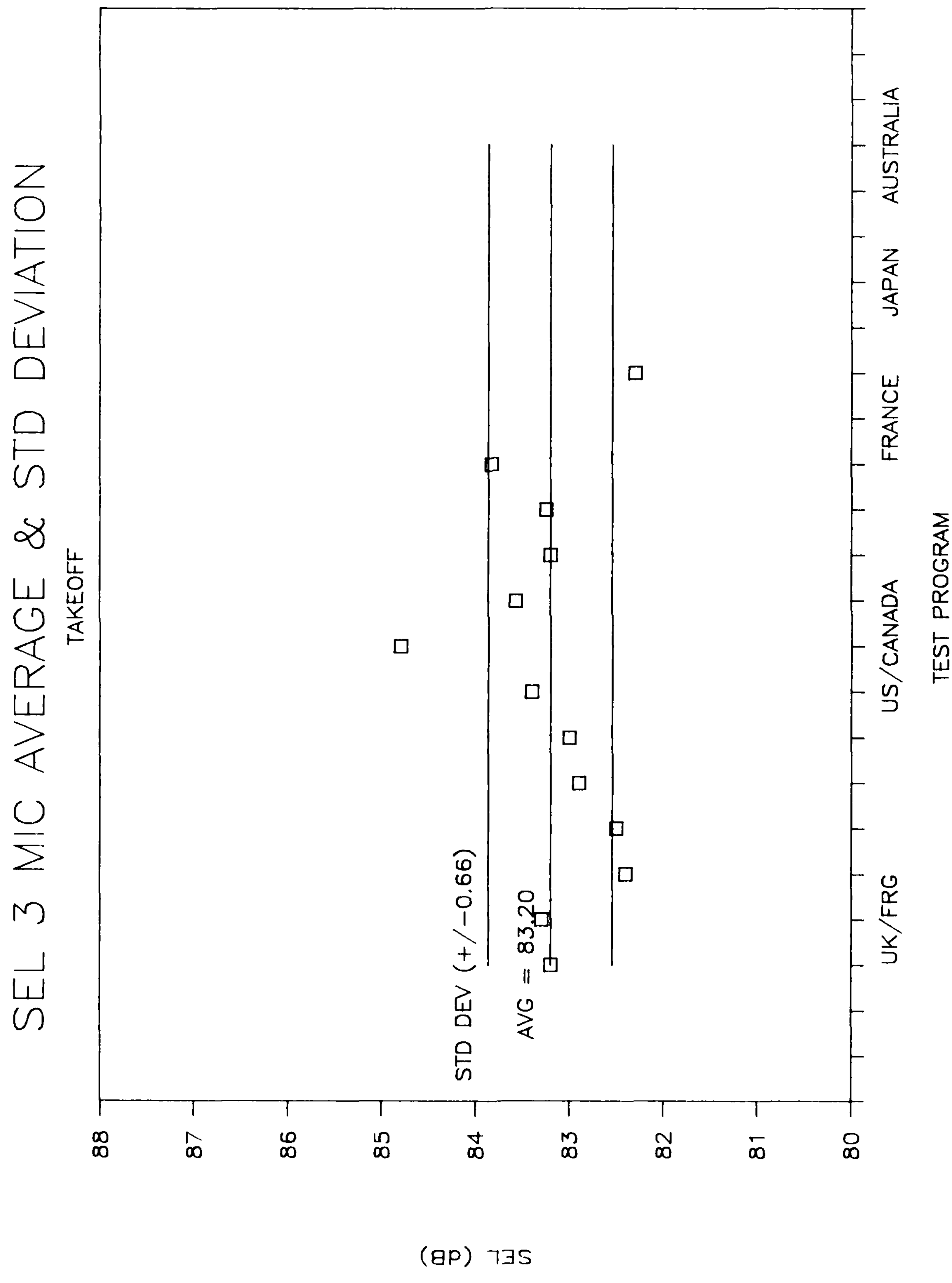

PNLTm - LEVEL FLYOVER
Individual Site Averages
93
92
91
90
89
88
86
RIGHT SIDELINE
C 2 2


PNLTm-LEVEL FLYOVER
Individual Site Averages
93
92
91
90
89
88
87
86
85
PNLTm (dB)
LEFT SIDELINE
CENTER
RIGHT SIDELINE
AUS

SEL Metric Multi-nation Comparison Data

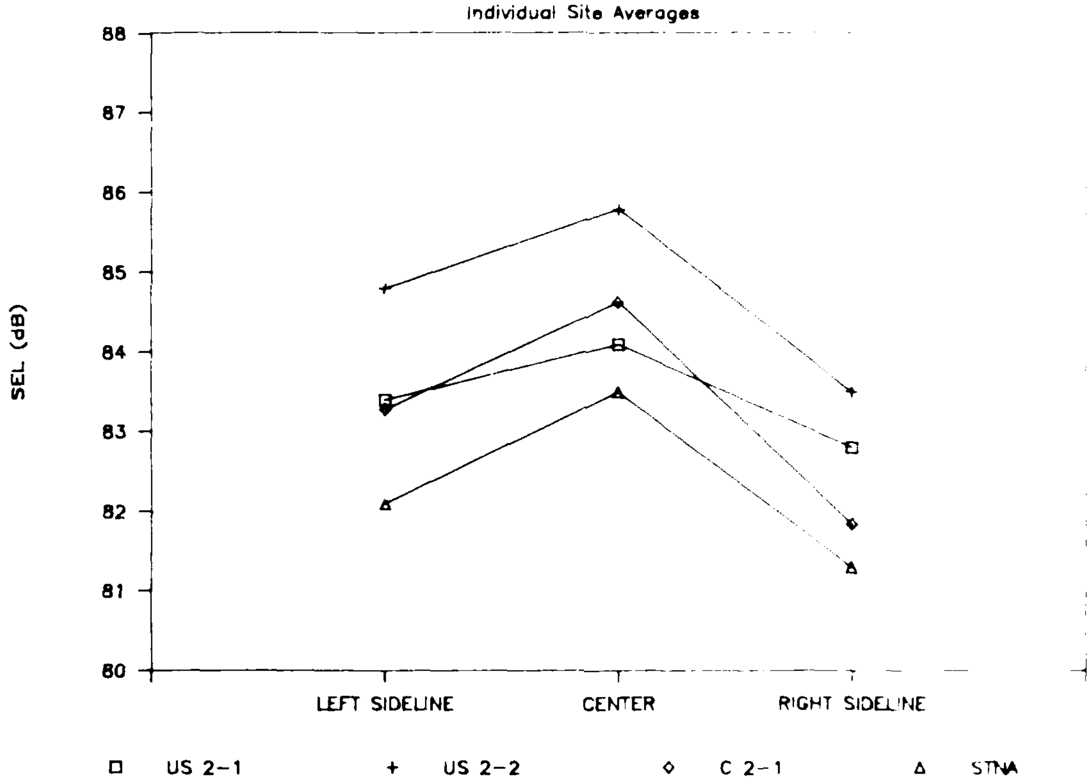
MULTI-NATION COMPARISON ANALYSIS
TAKE-OFF SEL DATA EXPRESSED IN DECIBELS (dB)

PARTICIPANT	LEFT SIDELINE AVERAGE	CENTER LINE CENTER AVERAGE	RIGHT SIDELINE AVERAGE	3 MIC AVERAGE	STD DEV	90% C.I.	TEAM AVERAGE	TEST AVERAGE
AUSTRALIA	NA	NA	NA	NA	NA	NA		
JAPAN-PILOT 1	NA	NA	NA	NA	NA	NA		
JAPAN PILOT 2	NA	NA	NA	NA	NA	NA		
FRANCE-AERO	NA	NA	NA	NA	NA	NA		
FRANCE-STNA	82.10	83.50	81.30	82.30	[illegible]	0.20	82.[illegible]	
ITALY	NA	NA	NA	NA	NA	NA		
FRG-PILOT 1	81.80	82.80	82.70	82.40	0.30	0.30	82.45	82.65
FRG-PILOT 2	82.7[illegible]	82.20	82.6[illegible]	82.50	0.20	0.20		
UK-PILOT 1	82.50	83.70	83.50	83.20	0.70	0.30	83.25	
UK-PILOT 2	82.90	83.00	84.10	83.30	0.39	0.20		
CANADA-PILOT 1-1	83.71	82.52	83.49	83.57	0.32	0.54	83.46	82.49
CANADA-PILOT 1-2	84.21	82.54	81.86	83.27	0.26	1.16		
CANADA-PILOT 2-1	83.28	84.62	81.84	83.25	0.91	1.52		
CANADA-PILOT 2-2	82.77	85.69	83.44	83.82	0.87	1.47		
US-PILOT 1-1	83.40	82.80	82.50	82.90	0.25	0.17	83.52	
US-PILOT 1-2	81.90	82.90	82.40	82.30	0.24	0.22		
US-PILOT 2-1	83.40	84.10	81.80	83.40	0.65	0.48		
US-PILOT 2-2	84.80	85.80	83.50	84.60	0.58	0.46		
AVERAGE	83.14	83.71	82.78	83.2[illegible]	0.42	0.56	[illegible]	83.17
STD DEV	.86	1.1[illegible]	0.81	.66	.25	0.49	.56	0.46
90% C.I.	0.54	0.82	0.50	0.4[illegible]	0.16	0.3[illegible]	0.[illegible]	1.25


SEL 3 MIC AVERAGE & STD DEVIATION
TAKEOFF
STD DEV (+/-0.66)
AVG = 83.20
SEL (dB)
88
87
86
85
84
83
82
81
80
UK/FRG
US/CANADA
FRANCE
JAPAN
AUSTRALIA
TEST PROGRAM

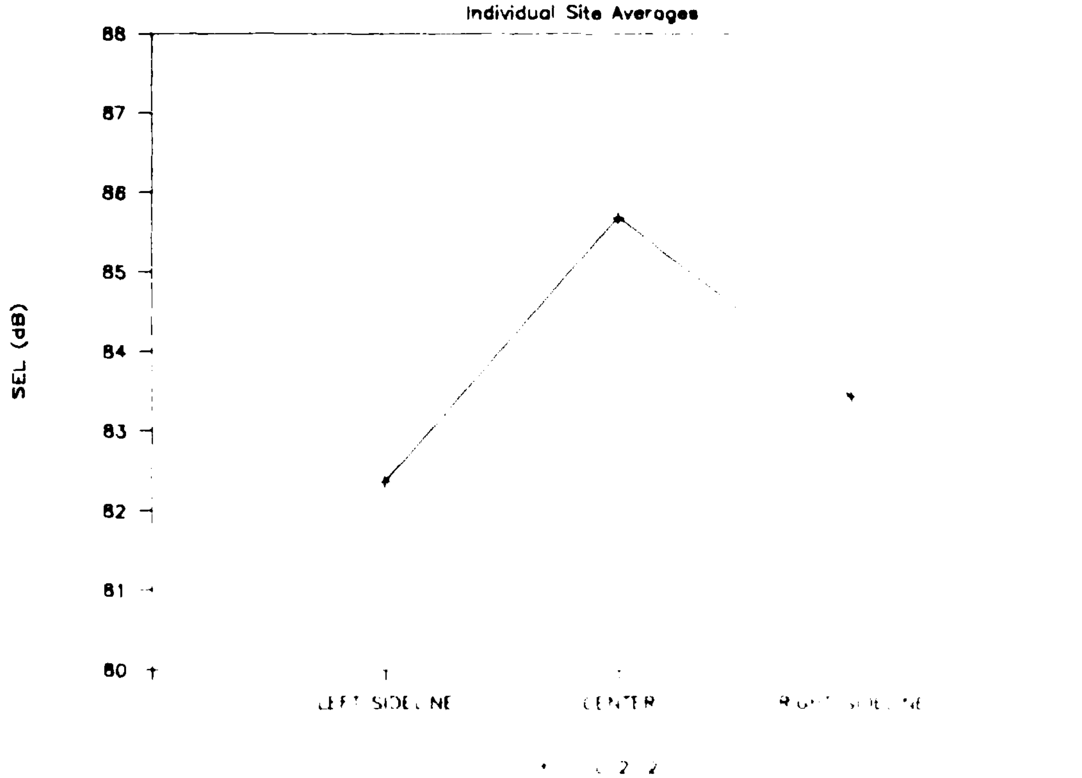
SEL—TAKEOFF

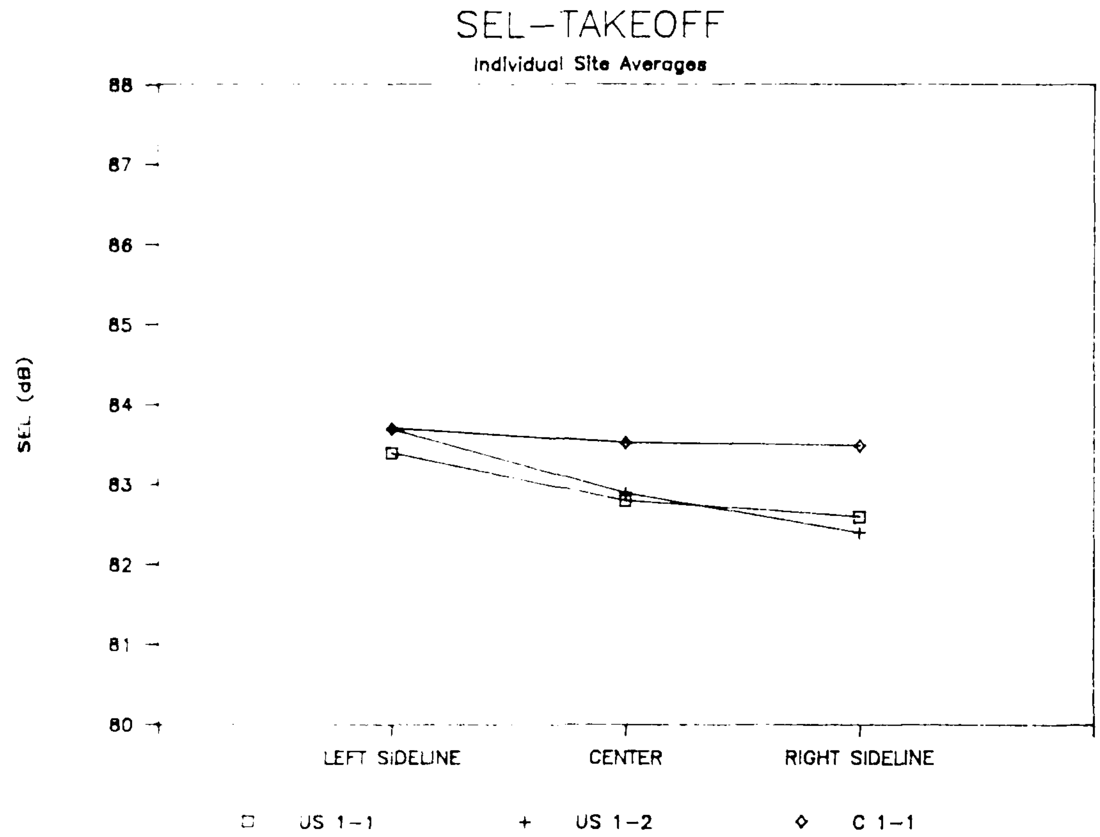
Individual Site Averages

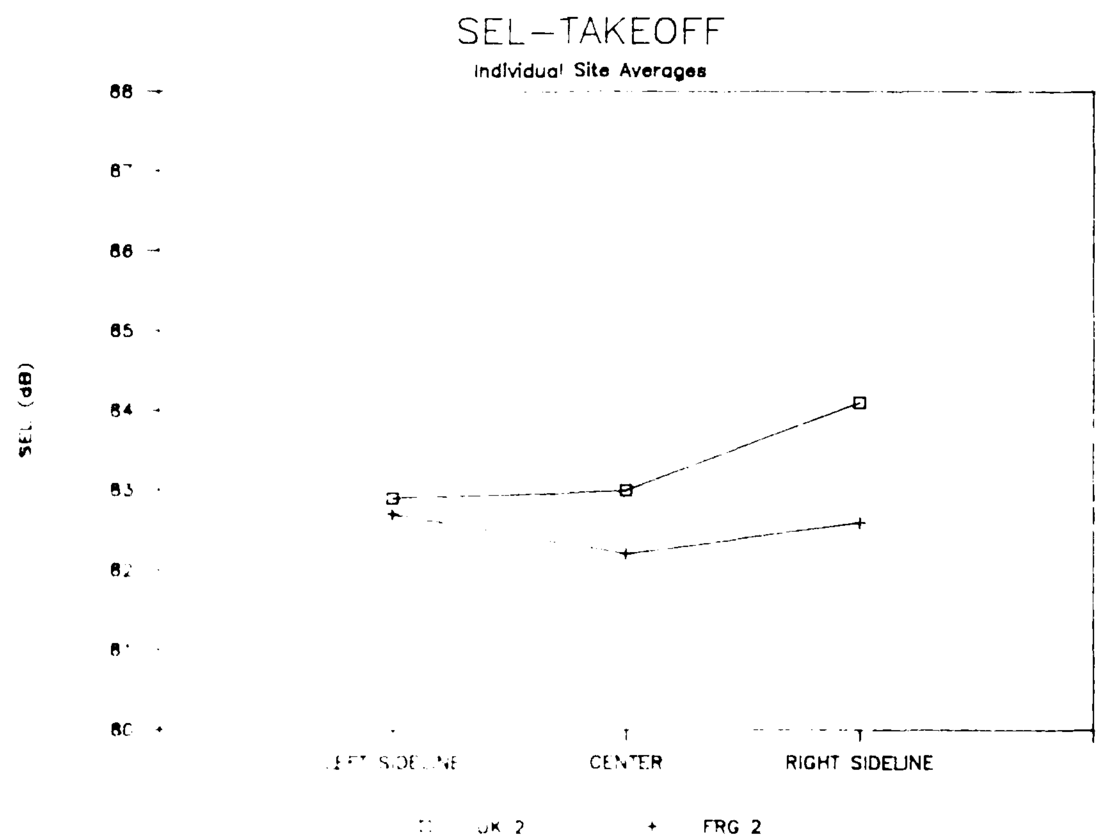


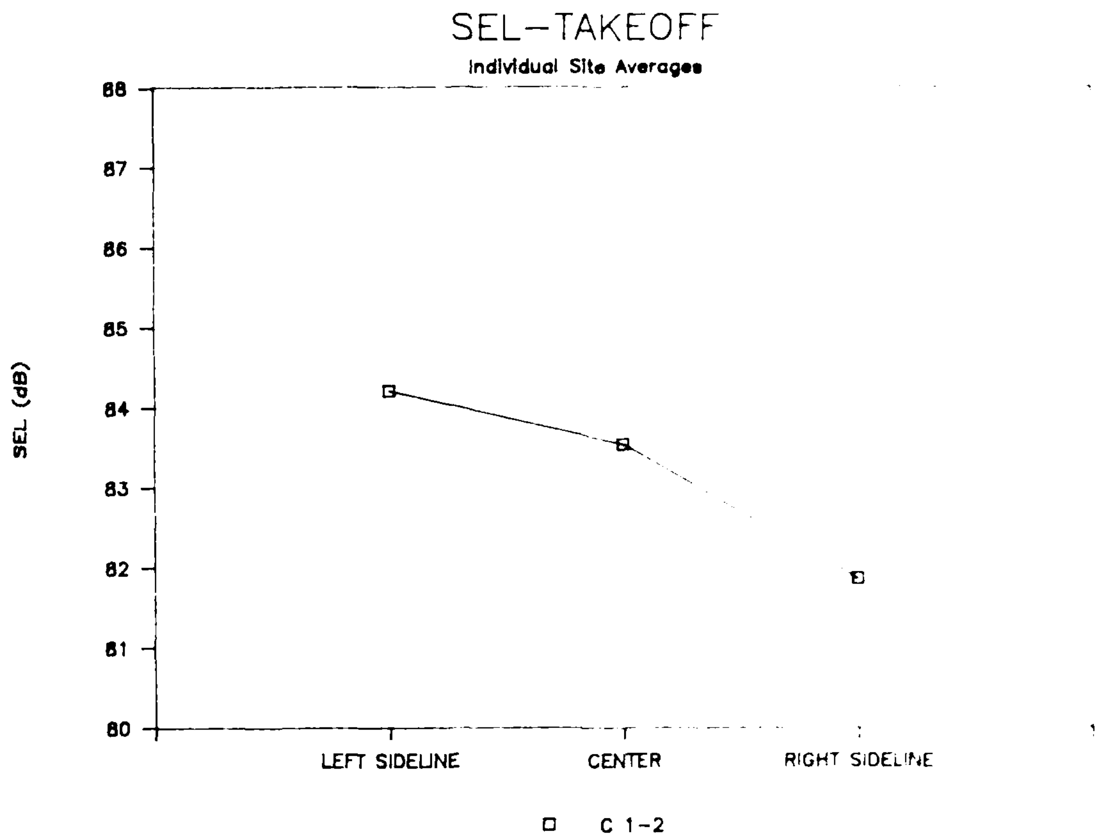
SEL—TAKEOFF

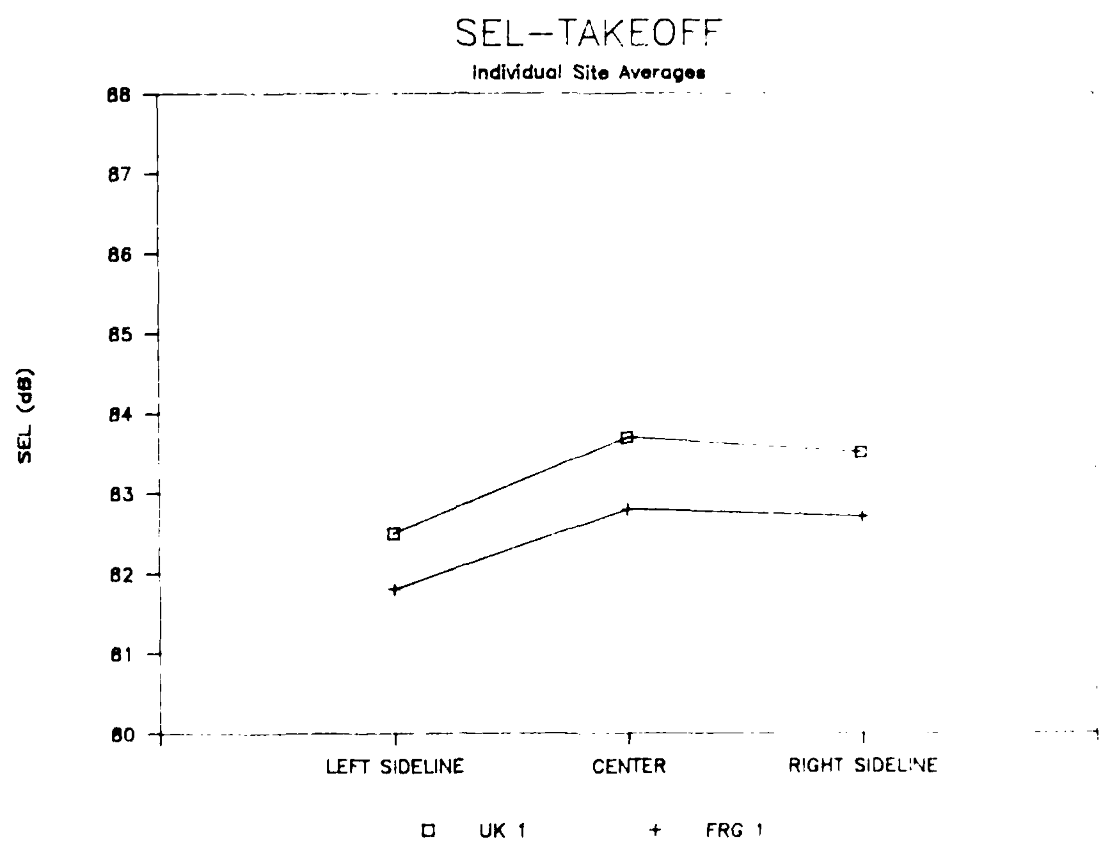
Individual Site Averages

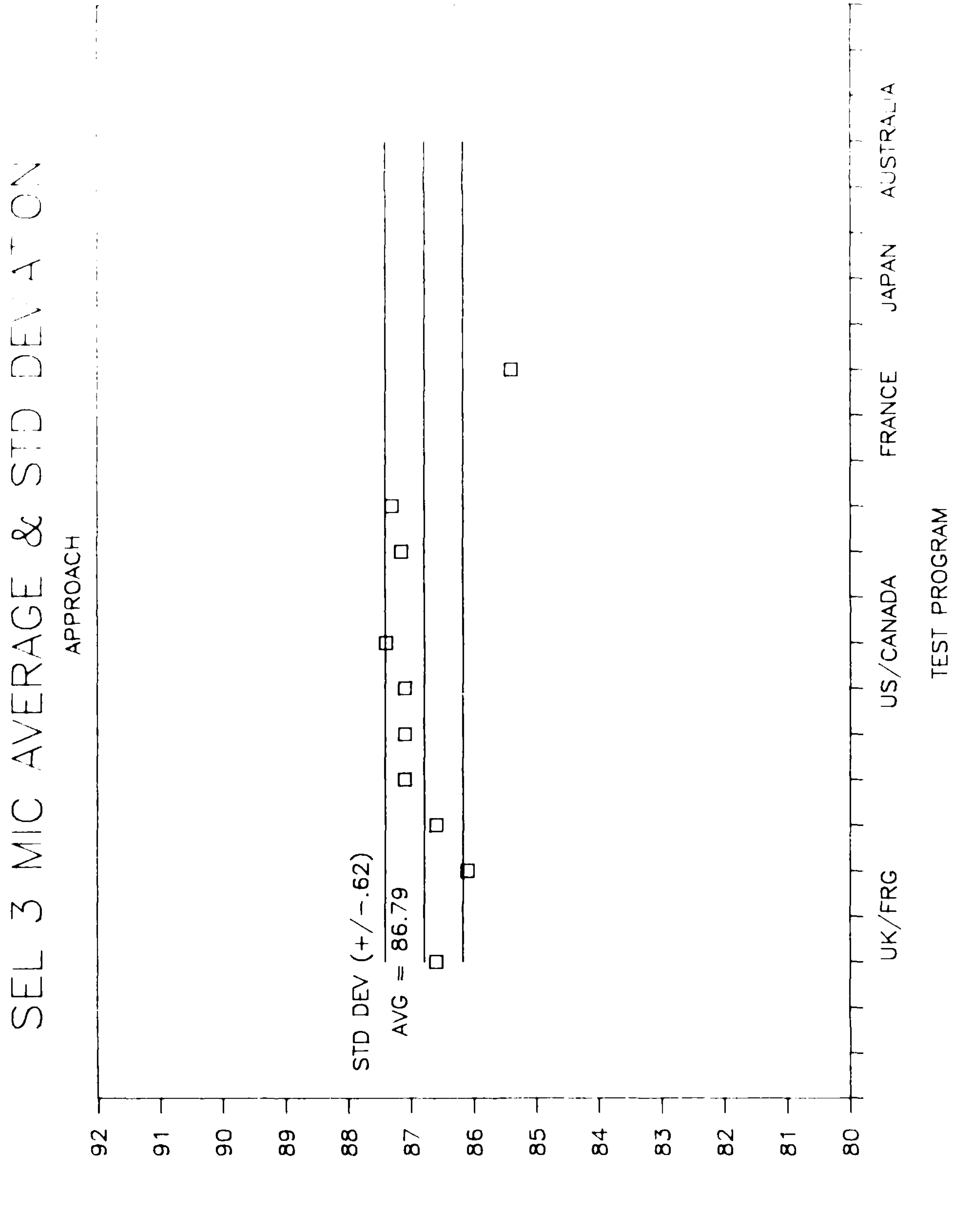



SEL-TAKEOFF
Individual Site Averages
88
87
86
85
84
83
82
81
80
SEL (dB)
LEFT SIDELINE
CENTER
RIGHT SIDELINE
US 1-1
US 1-2
C 1-1

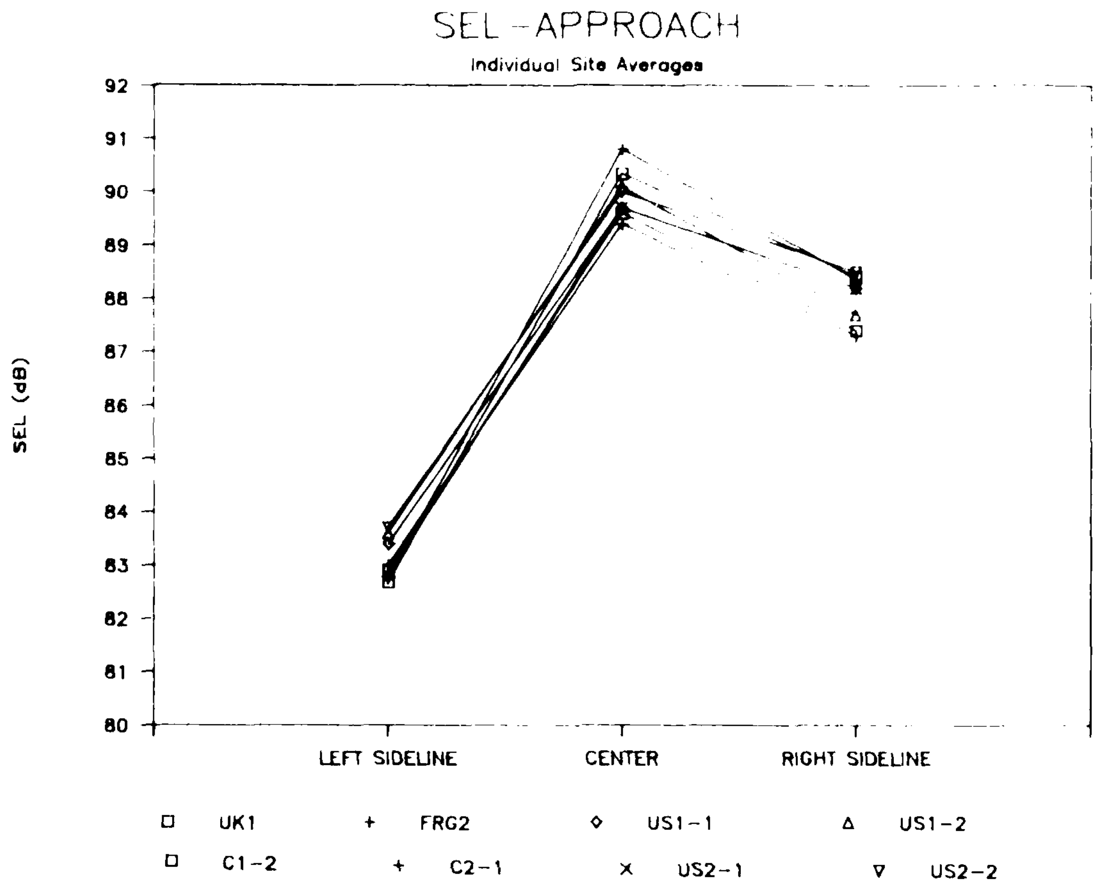

SEL-TAKEOFF
Individual Site Averages
88
86
85
84
80
SEL (dB)
CENTER
RIGHT SIDELINE
FRG 2

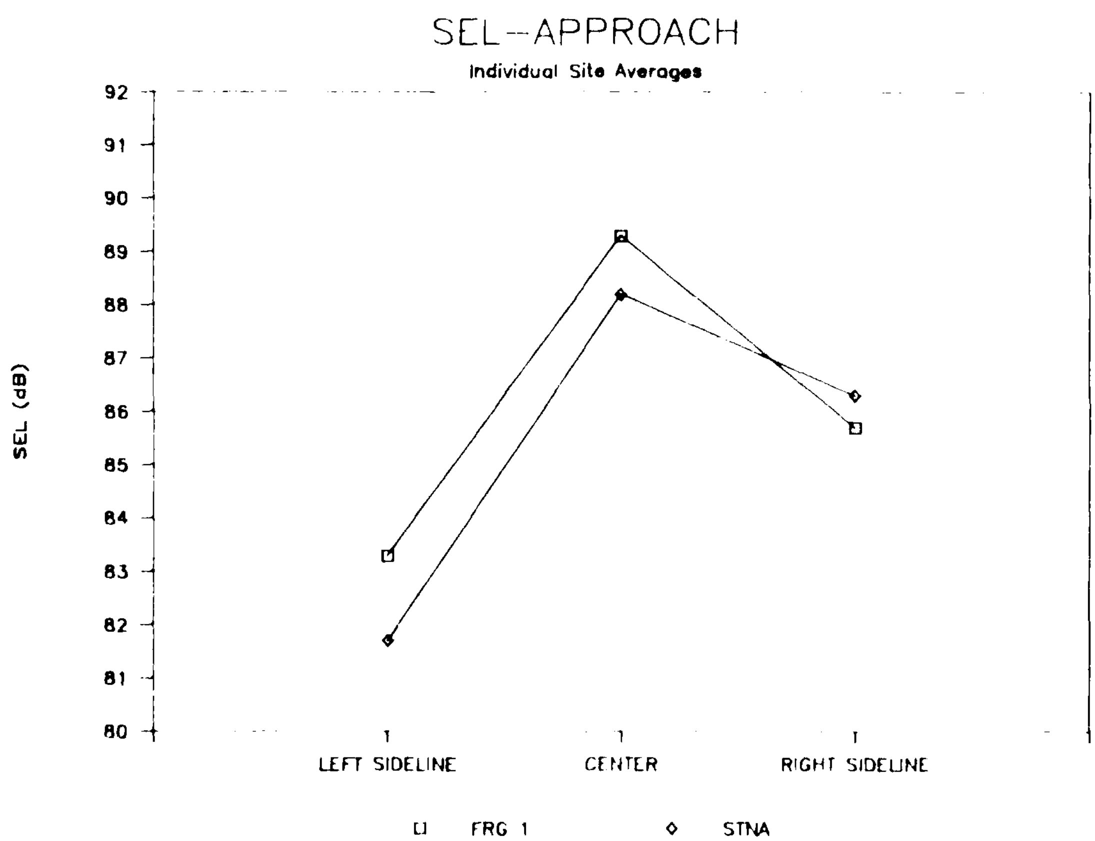

SEL-TAKEOFF
Individual Site Averages
88
87
86
85
84
83
82
81
80
SEL (dB)
LEFT SIDELINE
CENTER
RIGHT SIDELINE
C 1-2


SEL-TAKEOFF
Individual Site Averages
88
87
86
85
84
83
82
81
80
SEL (dB)
LEFT SIDELINE
CENTER
RIGHT SIDELINE
UK 1
+ FRG 1



SEL 3 MIC AVERAGE & STD DEV A T ON
APPROACH
STD DEV (+/-.62)
AVG = 86.79
92
91
90
89
88
87
86
85
84
83
82
81
80
SEL (dB)
UK/FRG
US/CANADA
FRANCE
JAPAN
AUSTRA IA
TEST PROGRAM


SEL-APPROACH
Individual Site Averages
SEL (dB)
92
91
90
89
88
87
86
85
84
83
82
81
80
LEFT SIDELINE
CENTER
RIGHT SIDELINE
UK1
FRG2
US1-1
US1-2
C1-2
C2-1
US2-1
US2-2

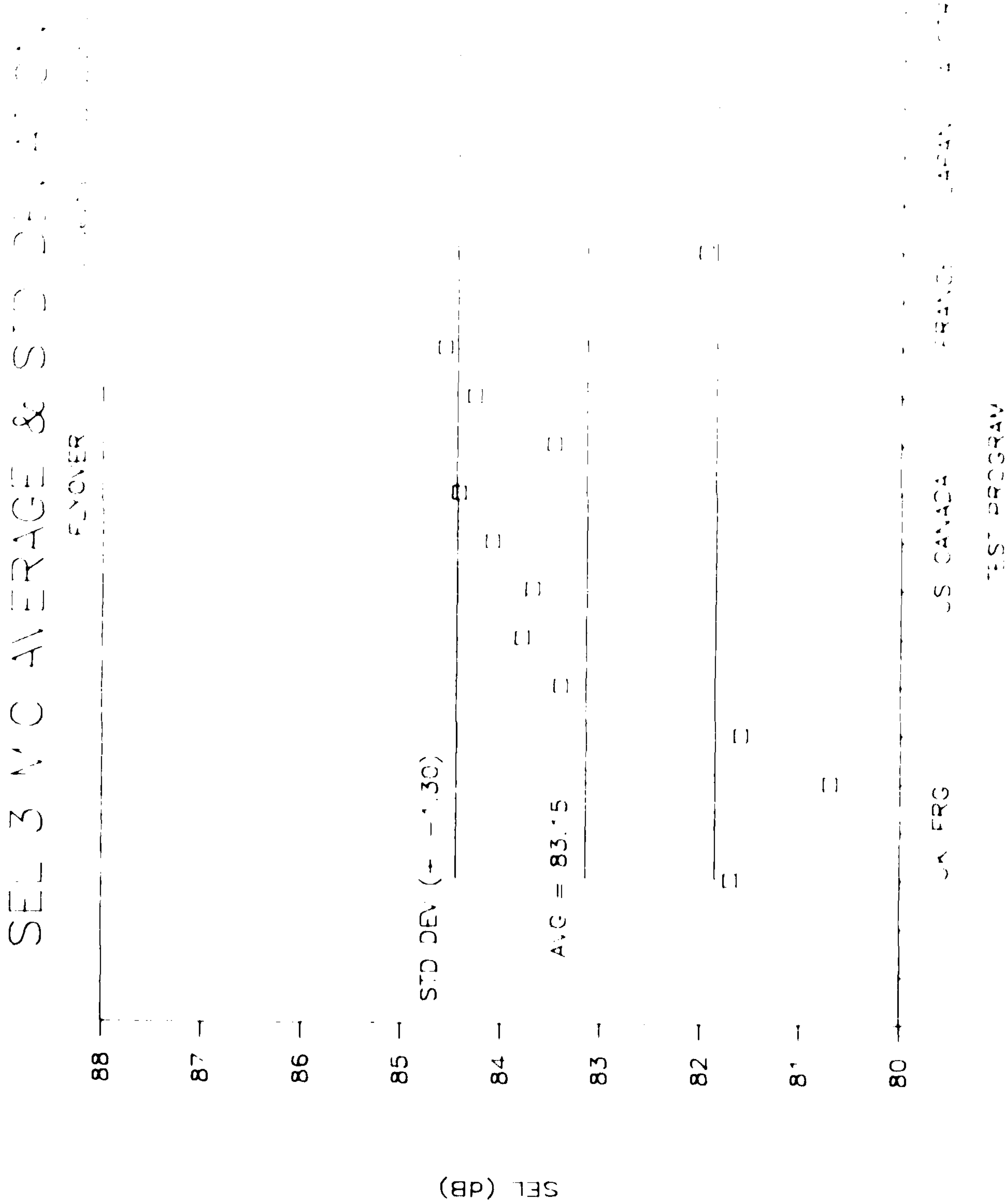

SEL-APPROACH
Individual Site Averages
SEL (dB)
92
91
90
89
88
87
86
85
84
83
82
81
80
LEFT SIDELINE
CENTER
RIGHT SIDELINE
FRG 1
STNA

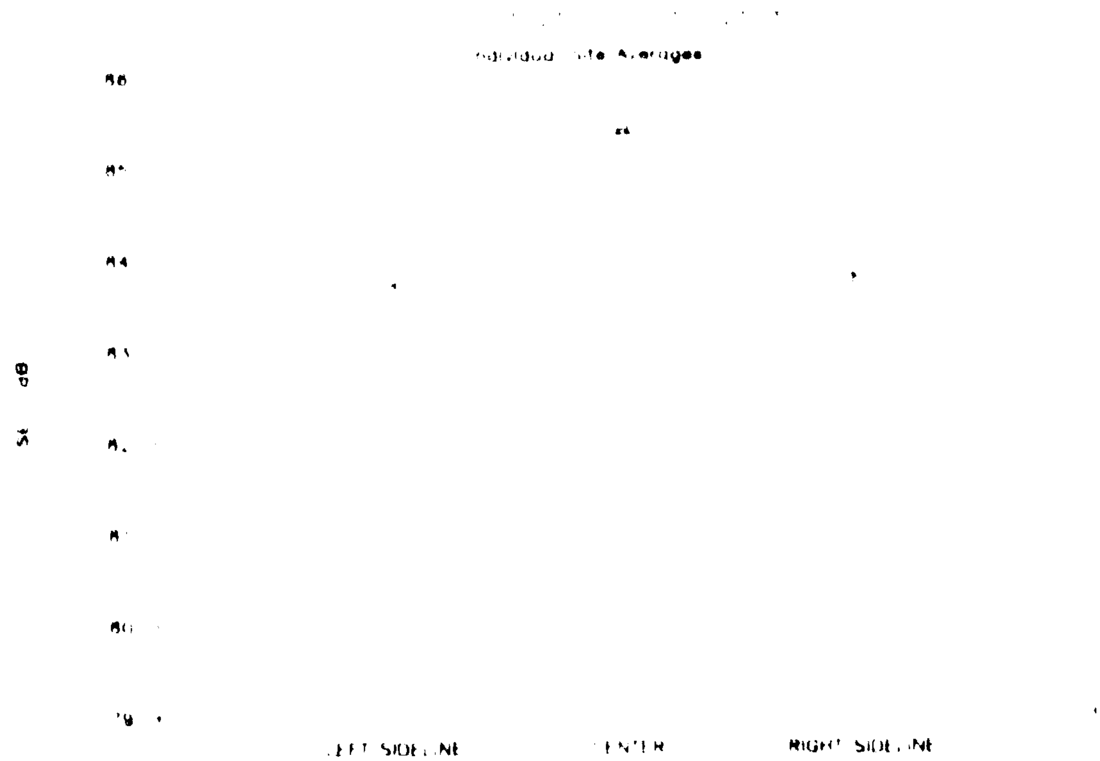
[illegible]

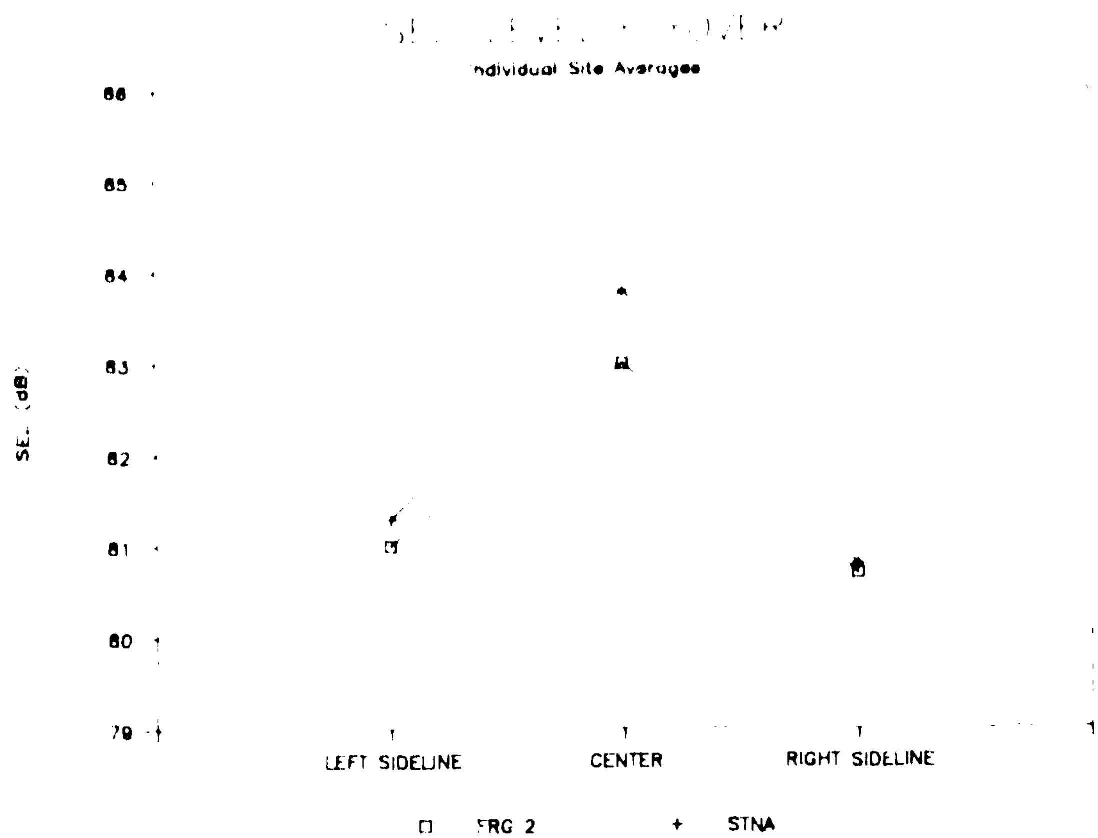
[illegible]

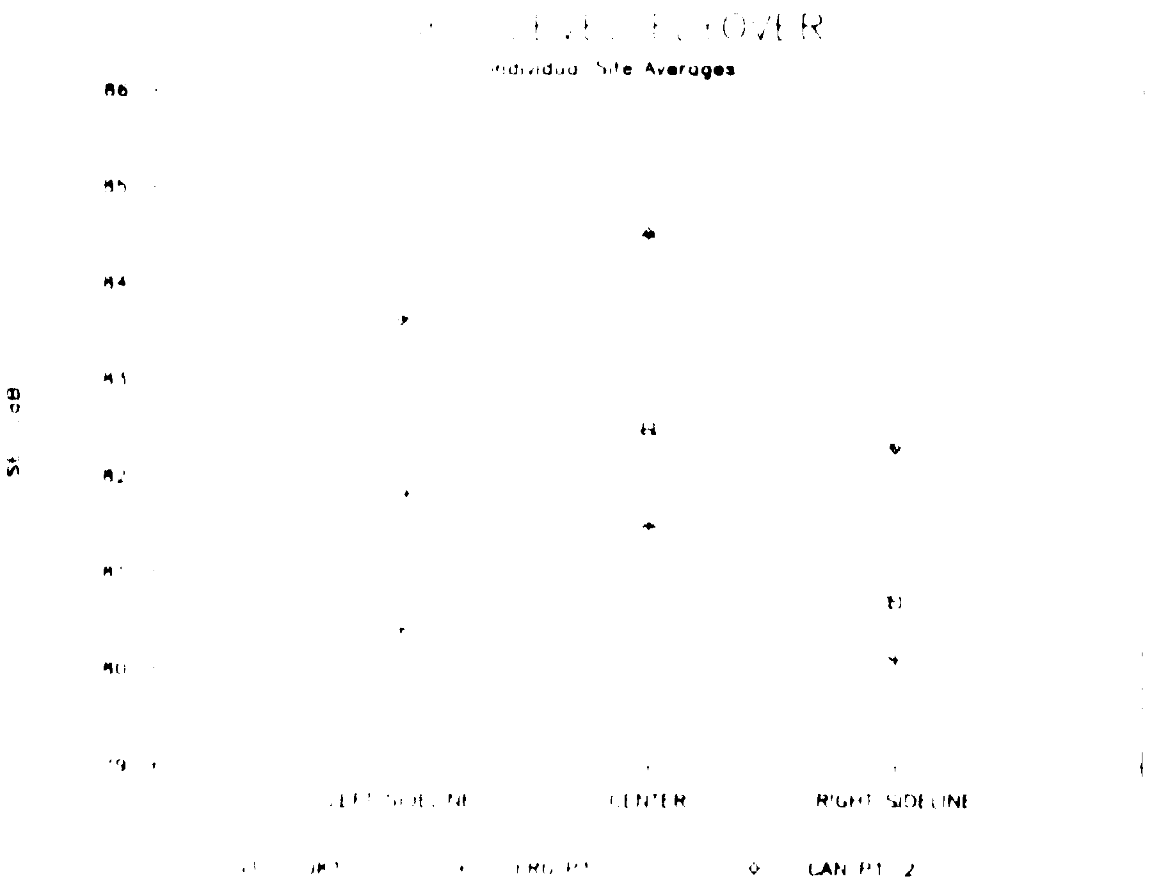
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.44	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

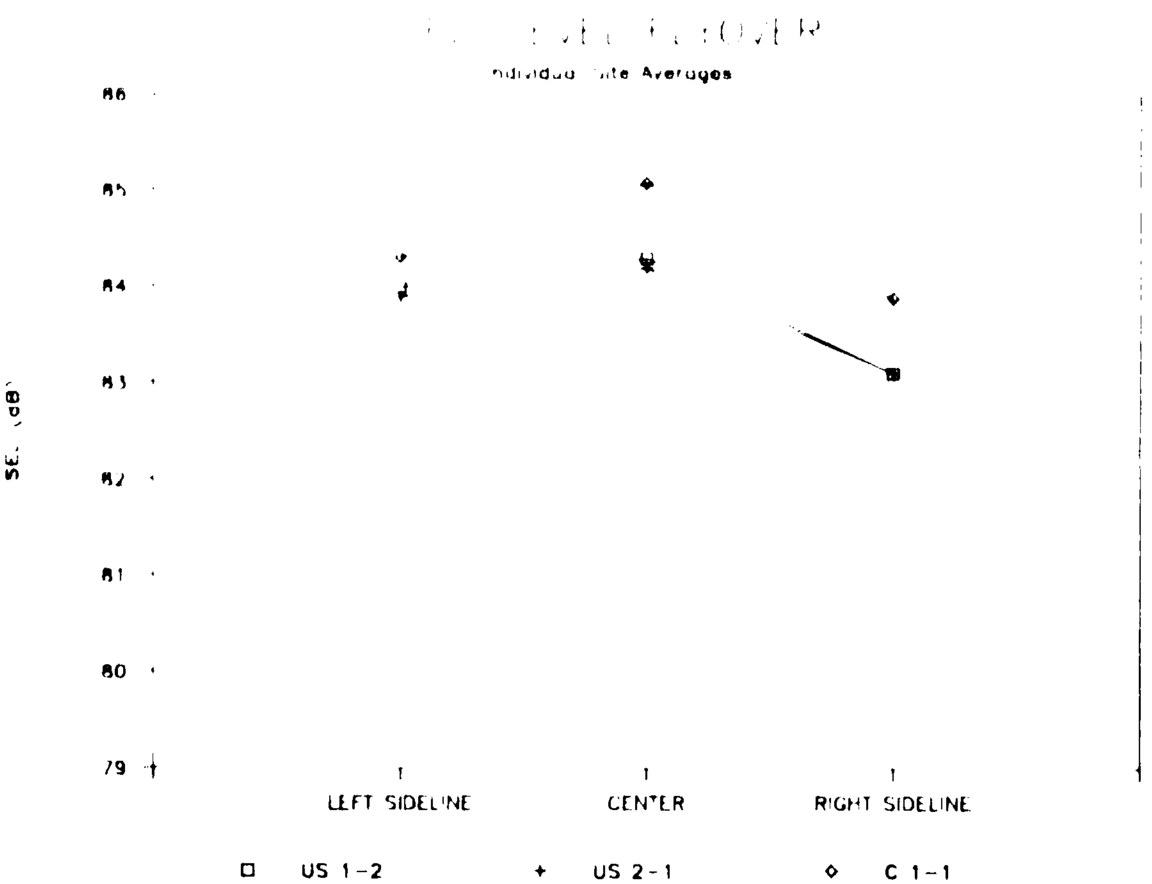
[illegible] delta 3 calculated at 15°C

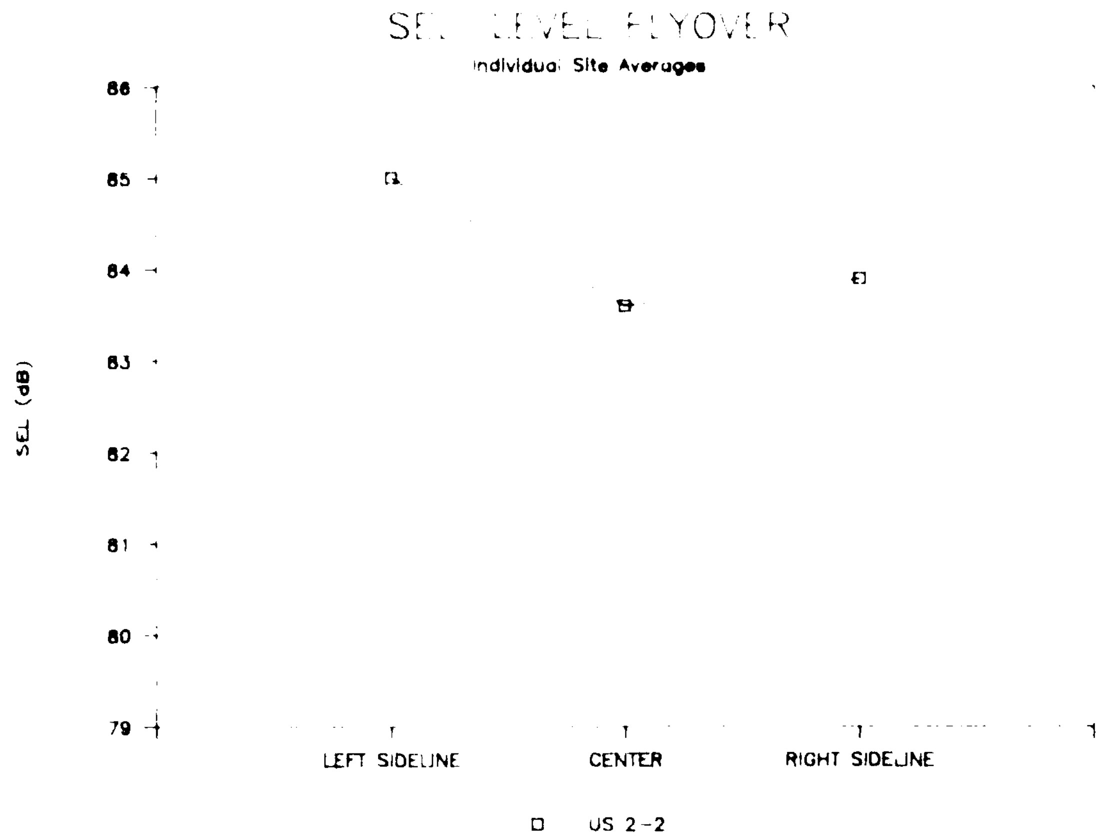

FLYOVER
STD DEV
AVG =
TEST PROGRAM
US CANADA
FRG
SEL (dB)
88
87
86
85
84
83
82
80



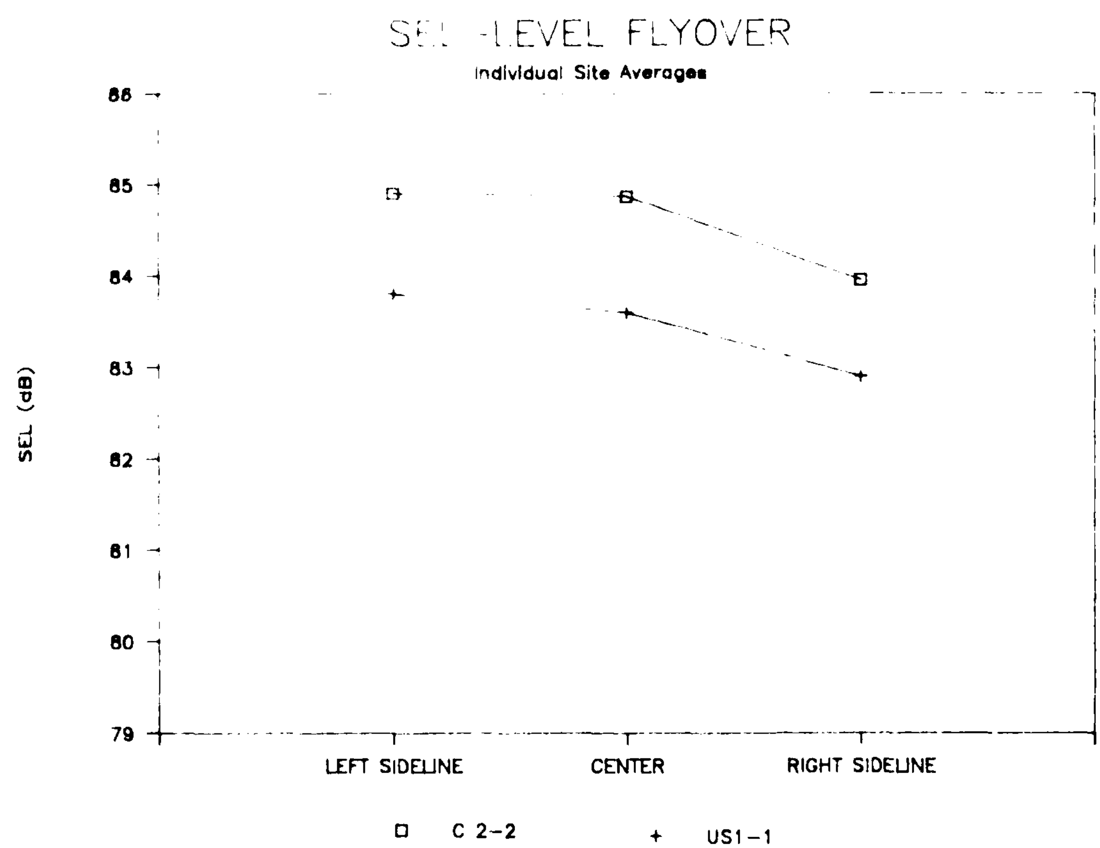

Individual Site Averages
86
85
84
83
82
81
80
79
SEL (dB)
LEFT SIDELINE
CENTER
RIGHT SIDELINE
FRG 2
STNA


Individual Site Averages
LEFT SIDELINE
CENTER
RIGHT SIDELINE
CAN PT 2


Site Averages
86
85
84
83
82
81
80
79
SEL (dB)
LEFT SIDELINE
CENTER
RIGHT SIDELINE
US 1-2
US 2-1
C 1-1



Individual Site Averages
86
85
84
83
82
81
80
79
SEL (dB)
LEFT SIDELINE
CENTER
RIGHT SIDELINE
US 2-2

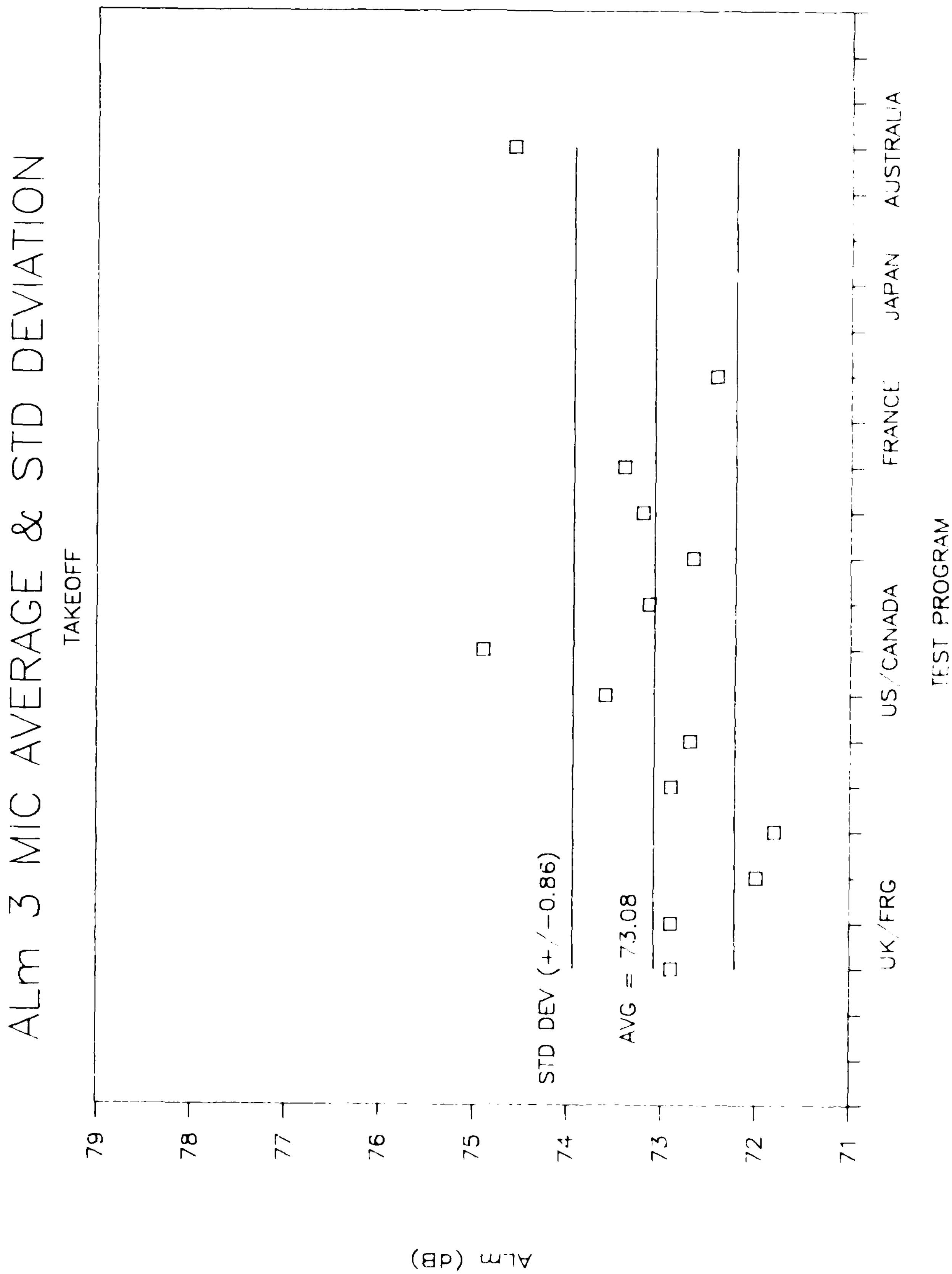


SEL -LEVEL FLYOVER
Individual Site Averages
86
85
84
83
82
81
80
79
SEL (dB)
LEFT SIDELINE
CENTER
RIGHT SIDELINE
C 2-2
US1-1

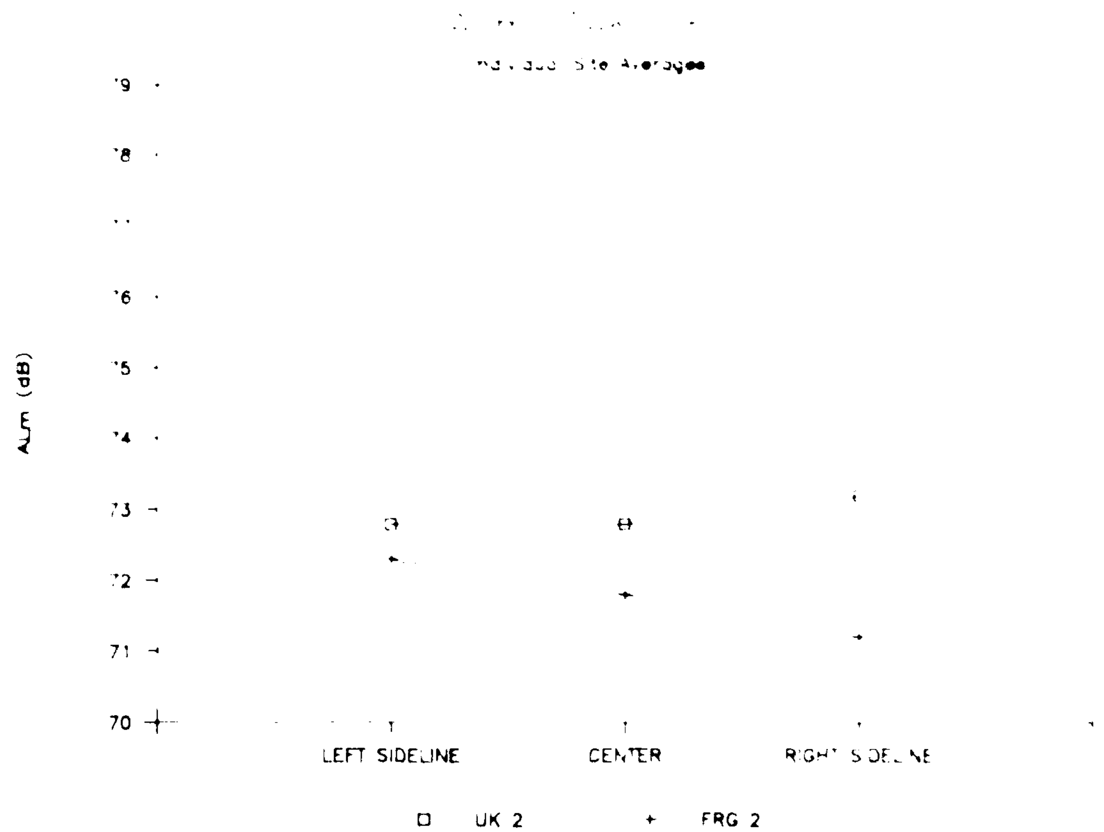
ALm Metric Multi-nation Comparison Data

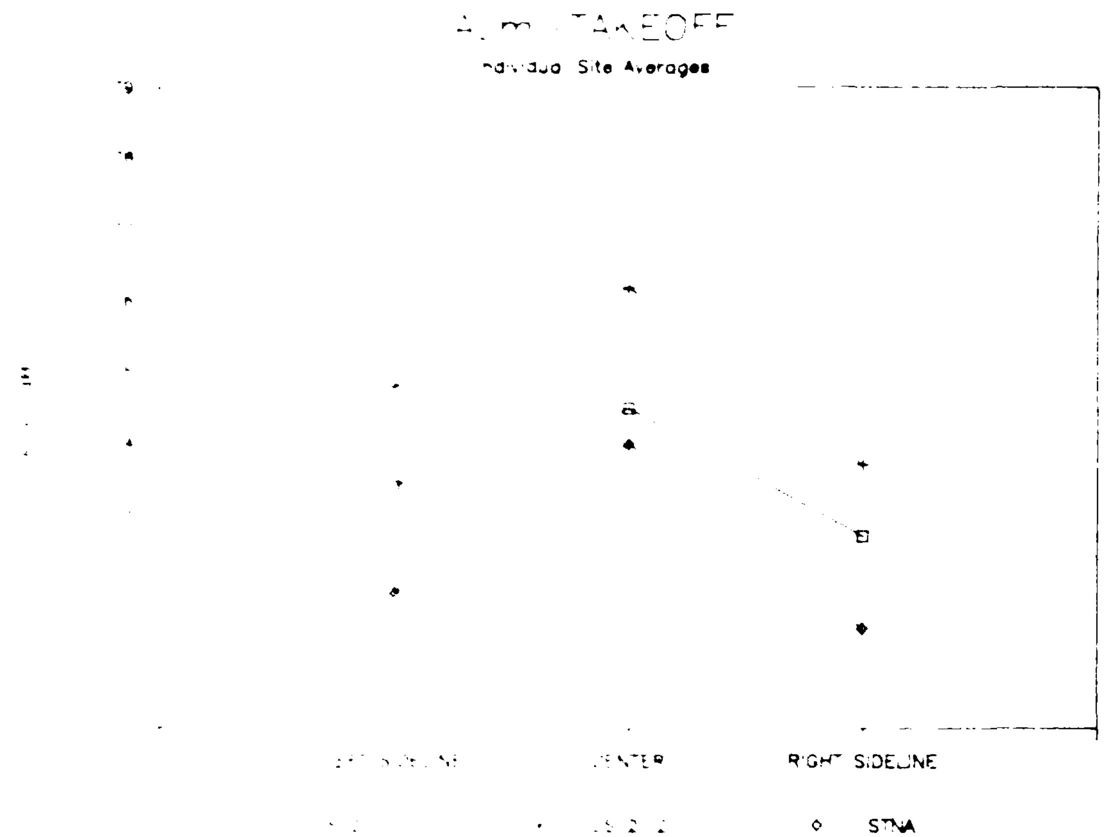
MULTI NATION COMPARISON ANALYSIS
TAKE OFF [illegible] DATA EXPRESSED IN DECIBELS [illegible]

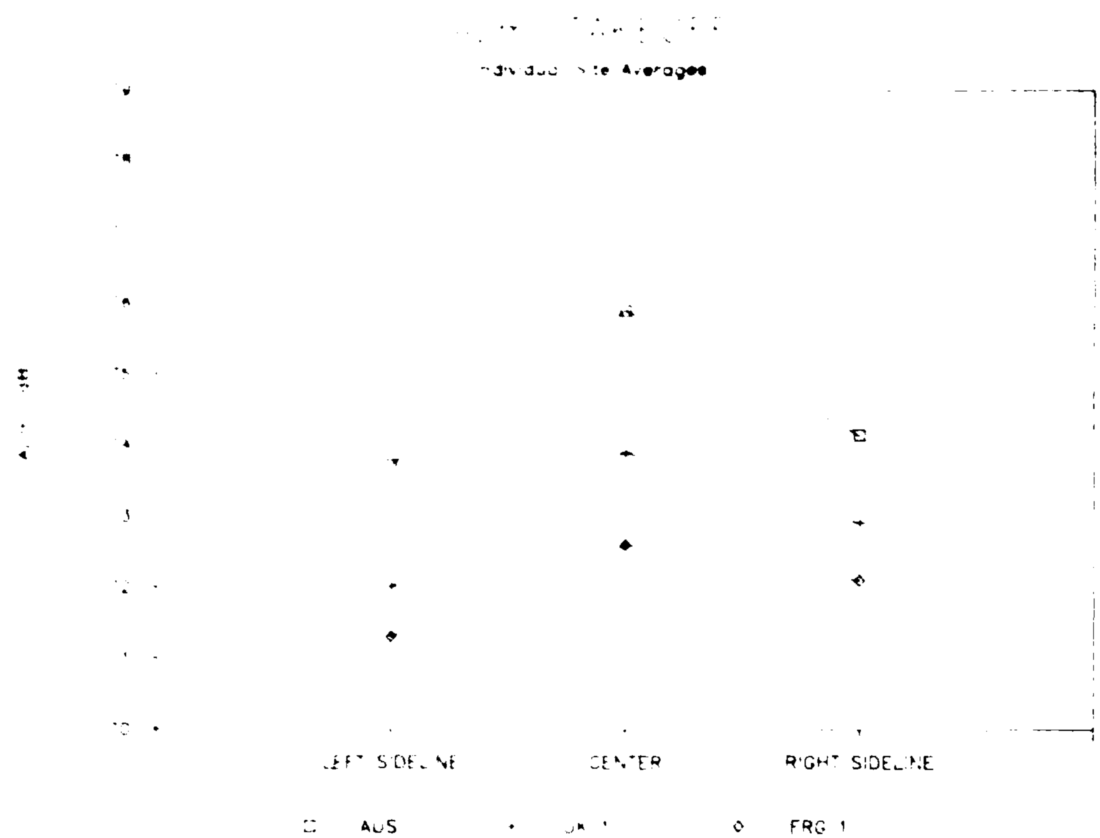
PARTICIPANT	LEFT SIDELINE AVERAGE	CENTER LINE CENTER AVERAGE	RIGHT SIDELINE AVERAGE	[illegible] AVERAGE	[illegible] DEV	[illegible]	TEAM AVERAGE	TEST AVERAGE
AUSTRALIA	[illegible]	[illegible]	74.14	4.58	[illegible]	[illegible]	74.5[illegible]	74.5[illegible]
JAPAN PILOT [illegible]	NA	NA	NA	NA	NA	NA		
JAPAN PILOT [illegible]	NA	NA	NA	NA	NA	NA		
FRANCE AER	NA	NA	NA	NA	NA	NA		
FRANCE [illegible]NA	[illegible]	[illegible]	[illegible].4	[illegible]	[illegible]	[illegible]	[illegible]	
ITALY	NA	NA	NA	NA	NA	NA		
FRG PILOT [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FRG PILOT [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.40	[illegible]		
UK PILOT [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
UK PILOT [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
CANADA PILOT [illegible]	[illegible]	[illegible]	[illegible]46	[illegible].14	[illegible]	[illegible].14	[illegible]	[illegible]
CANADA PILOT [illegible]	[illegible]	74.[illegible]	[illegible]	[illegible]	[illegible]	0.14		
CANADA-PILOT [illegible]	[illegible]74	[illegible]74	[illegible]36	[illegible]	0.82	1.36		
CANADA-PILOT [illegible]	[illegible]	75.99	[illegible]44	[illegible]41	1.29	[illegible]		
US-PILOT [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]45	[illegible]	[illegible]	
US PILOT [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.41		
US-PILOT [illegible]	[illegible]	74.5[illegible]	[illegible]	[illegible]	0.62	0.45		
US-PILOT [illegible]	74.8[illegible]	[illegible]	[illegible]	74.9[illegible]	[illegible]	[illegible]		
AVERAGE	[illegible]	74.11	[illegible]	[illegible]08	[illegible]	0.54	[illegible]	[illegible]
STD DEV	[illegible]	1.35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
90% [illegible]	[illegible]	0.96	[illegible]	0.61	[illegible]	[illegible]	[illegible]	4.4[illegible]


ALm 3 MIC AVERAGE & STD DEVIATION
TAKEOFF
STD DEV (+/-0.86)
AVG = 73.08
79
78
77
76
75
74
73
72
71
ALm (dB)
UK/FRG
US/CANADA
FRANCE
JAPAN
AUSTRALIA
TEST PROGRAM


Site Averages
(dB)
LEFT SIDELINE

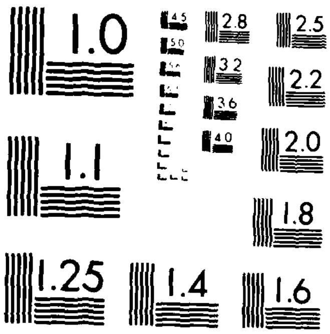

Site Averages
ALm (dB)
73
72
71
70
LEFT SIDELINE
CENTER
UK 2
FRG 2


Individual Site Averages
RIGHT SIDELINE
CENTER
STNA

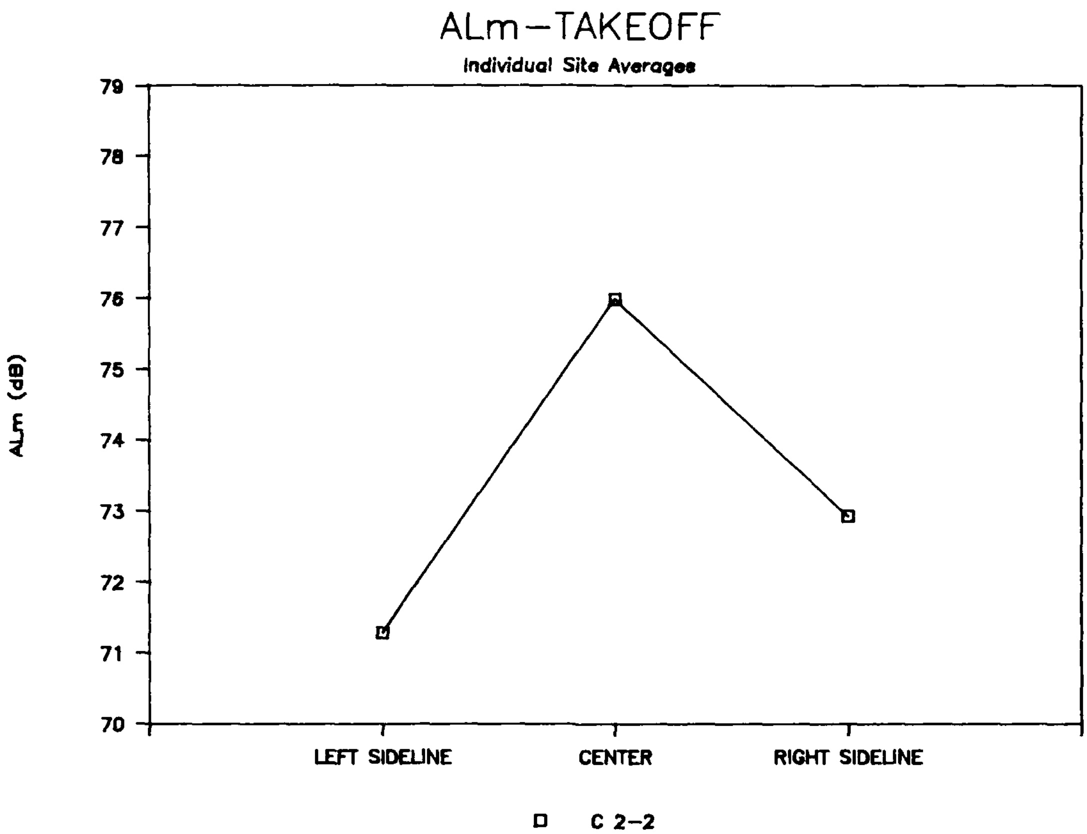

Individual Site Averages
LEFT SIDELINE
CENTER
RIGHT SIDELINE
AUS
FRG 1

AD-A180 540 INTERNATIONAL CIVIL AVIATION ORGANIZATION COMMITTEE ON AVIATION ENVIRONME..(U) FEDERAL AVIATION ADMINISTRATION WASHINGTON DC OFFICE OF ENVIR.. J S NEWMAN ET AL. 3/3

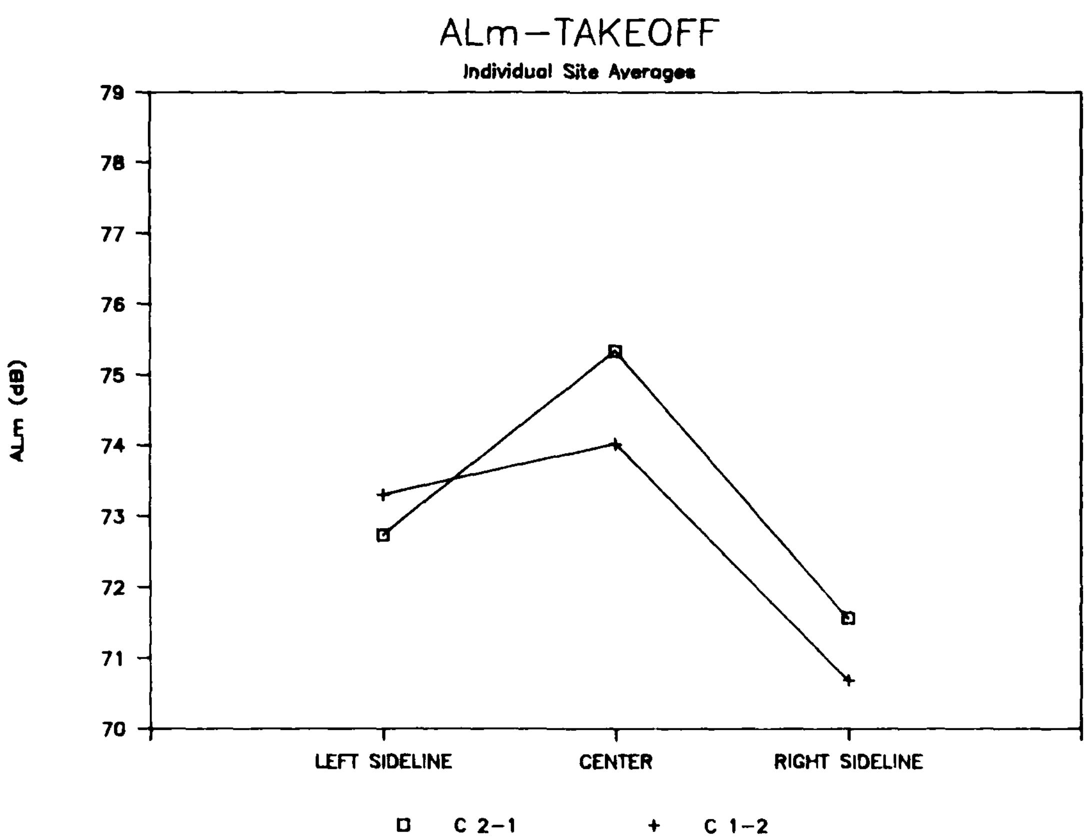
UNCLASSIFIED SEP 87 FAA-EE-87-2 F/G 20/1 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A



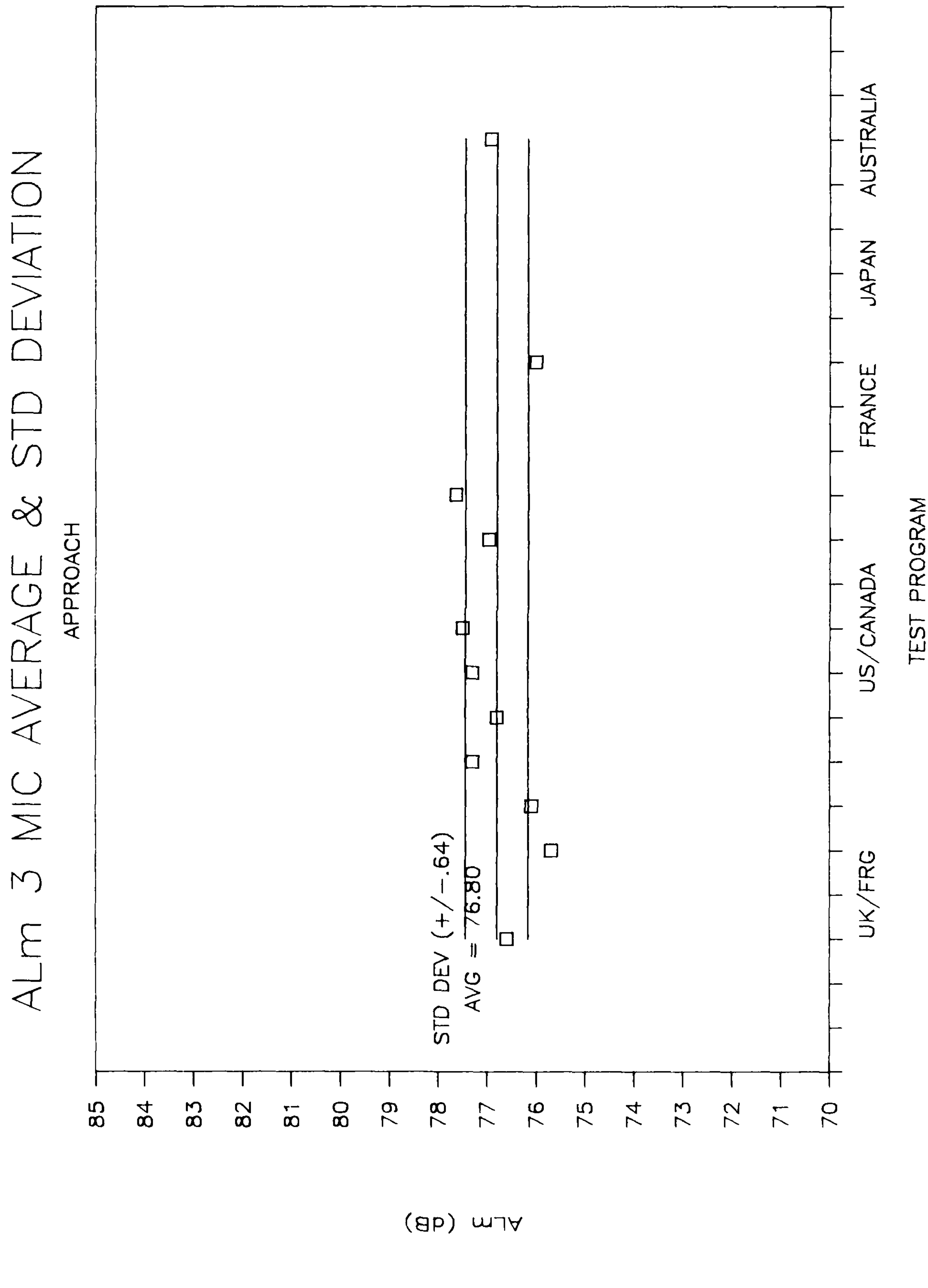
ALm-TAKEOFF
Individual Site Averages
79
78
77
76
75
74
73
72
71
70
ALm (dB)
LEFT SIDELINE
CENTER
RIGHT SIDELINE
C 2-2



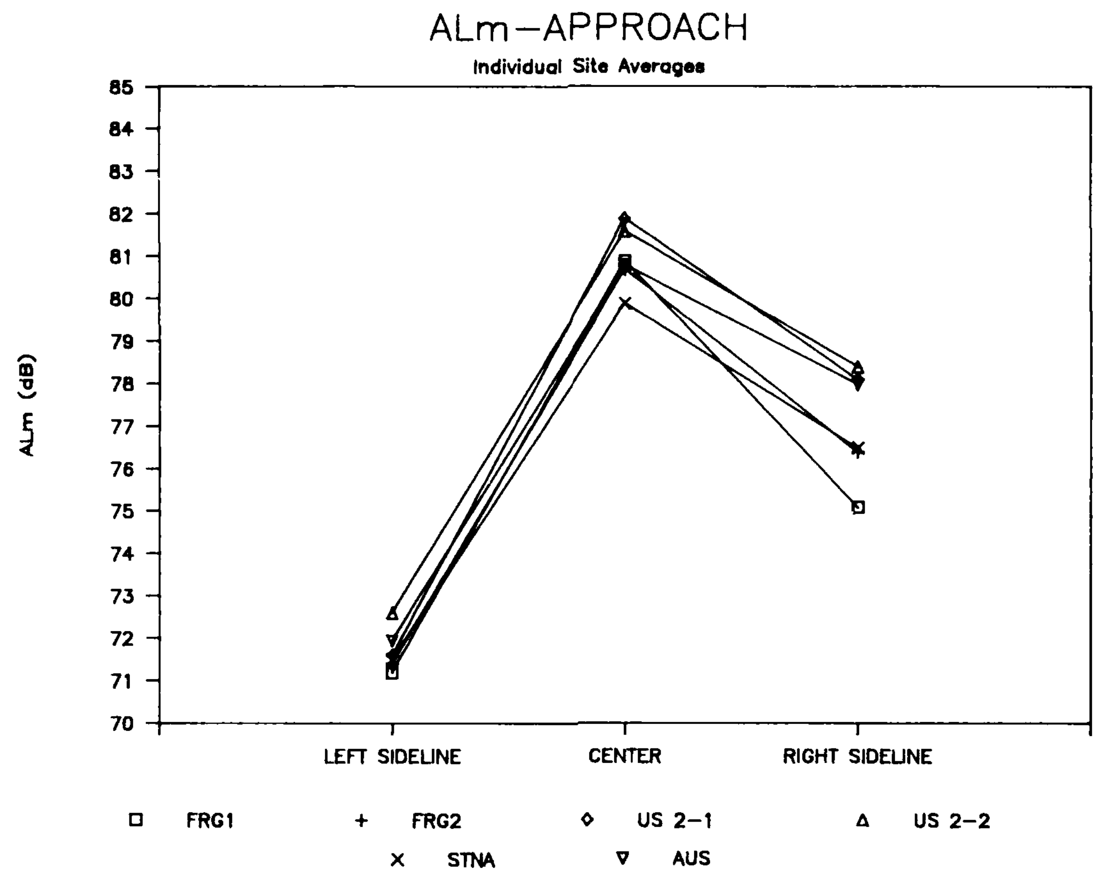
ALm-TAKEOFF
Individual Site Averages
79
78
77
76
75
74
73
72
71
70
ALm (dB)
LEFT SIDELINE
CENTER
RIGHT SIDELINE
C 2-1
C 1-2

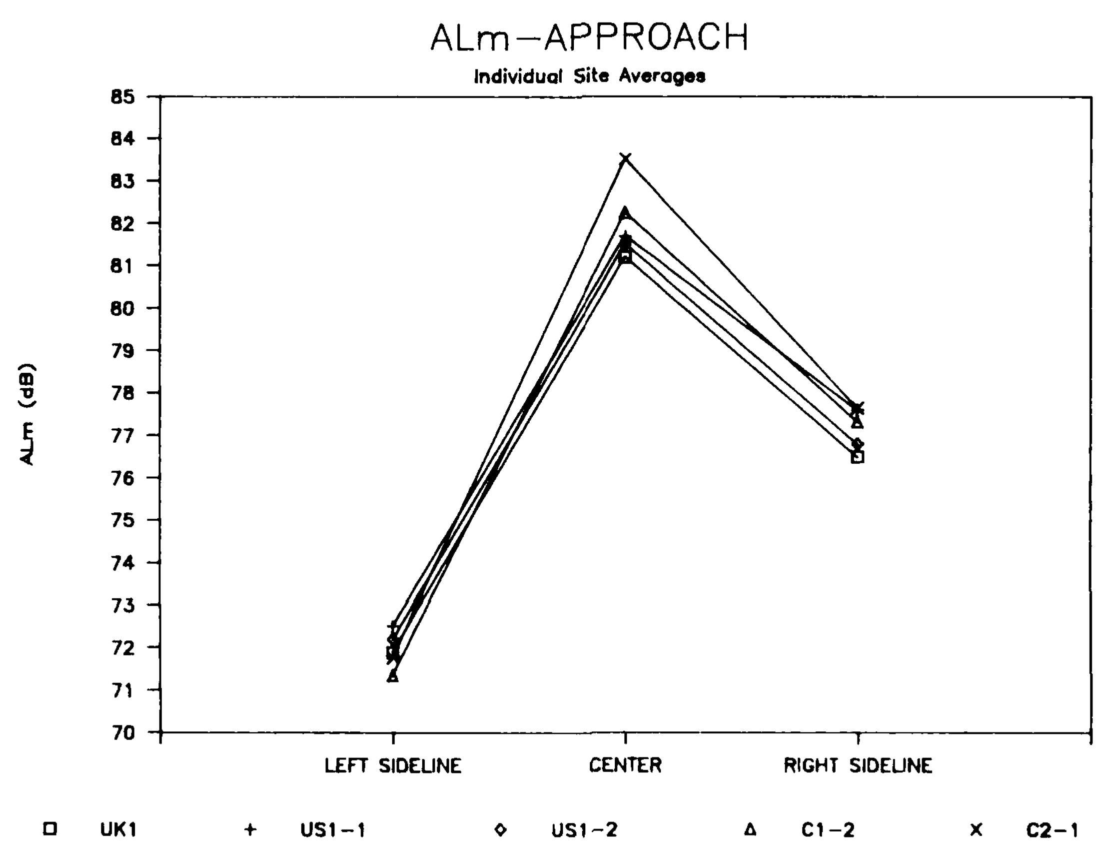
MULTI-NATION COMPARISON ANALYSIS
APPROACH ALm DATA EXPRESSED IN DECIBELS (dB)

PARTICIPANT	LEFT SIDELINE AVERAGE	CENTER LINE CENTER AVERAGE	RIGHT SIDELINE AVERAGE	3 MIC AVERAGE	STD DEV	90% C.I.	TEAM AVERAGE	TEST AVERAGE
AUSTRALIA	71.95	80.80	77.99	76.92	1.11	0.74	76.92	76.92
JAPAN-PILOT 1	NA	NA	NA	NA	NA	NA		
JAPAN-PILOT 2	NA	NA	NA	NA	NA	NA		
FRANCE-AERO	NA	NA	NA	NA	NA	NA		
FRANCE-STNA	71.50	79.90	76.50	76.00	1.20	0.90	76.00	
ITALY	NA	NA	NA	NA	NA	NA		
FRG-PILOT 1	71.20	80.90	75.10	75.70	0.50	0.30	75.90	76.13
FRG-PILOT 2	71.40	80.70	76.40	76.10	0.50	0.40		
UK-PILOT 1	71.90	81.20	76.50	76.60	0.90	0.70	76.60	
CANADA-PILOT 1-2	71.35	82.25	77.32	76.97	0.12	0.53	77.31	77.25
CANADA-PILOT 2-1	71.76	83.52	77.65	77.64	0.47	0.79		
US-PILOT 1-1	72.50	81.70	77.60	77.30	0.82	0.55	77.23	
US-PILOT 1-2	72.20	81.50	76.80	76.80	0.49	0.46		
US-PILOT 2-1	71.60	81.90	78.10	77.30	0.54	0.40		
US-PILOT 2-2	72.60	81.60	78.40	77.50	0.58	0.36		
AVERAGE	71.81	81.45	77.12	76.80	0.66	0.56	76.66	76.77
STD DEV	0.47	0.95	0.97	0.64	0.32	0.20	0.60	0.57
90% C.I.	0.39	0.79	0.81	0.53	0.26	0.16	0.83	2.31



ALm 3 MIC AVERAGE & STD DEVIATION
APPROACH
STD DEV (+/-.64)
AVG = 76.80
UK/FRG
US/CANADA
FRANCE
JAPAN
AUSTRALIA
TEST PROGRAM
85
84
83
82
81
80
79
78
77
76
75
74
73
72
71
70
ALm (dB)

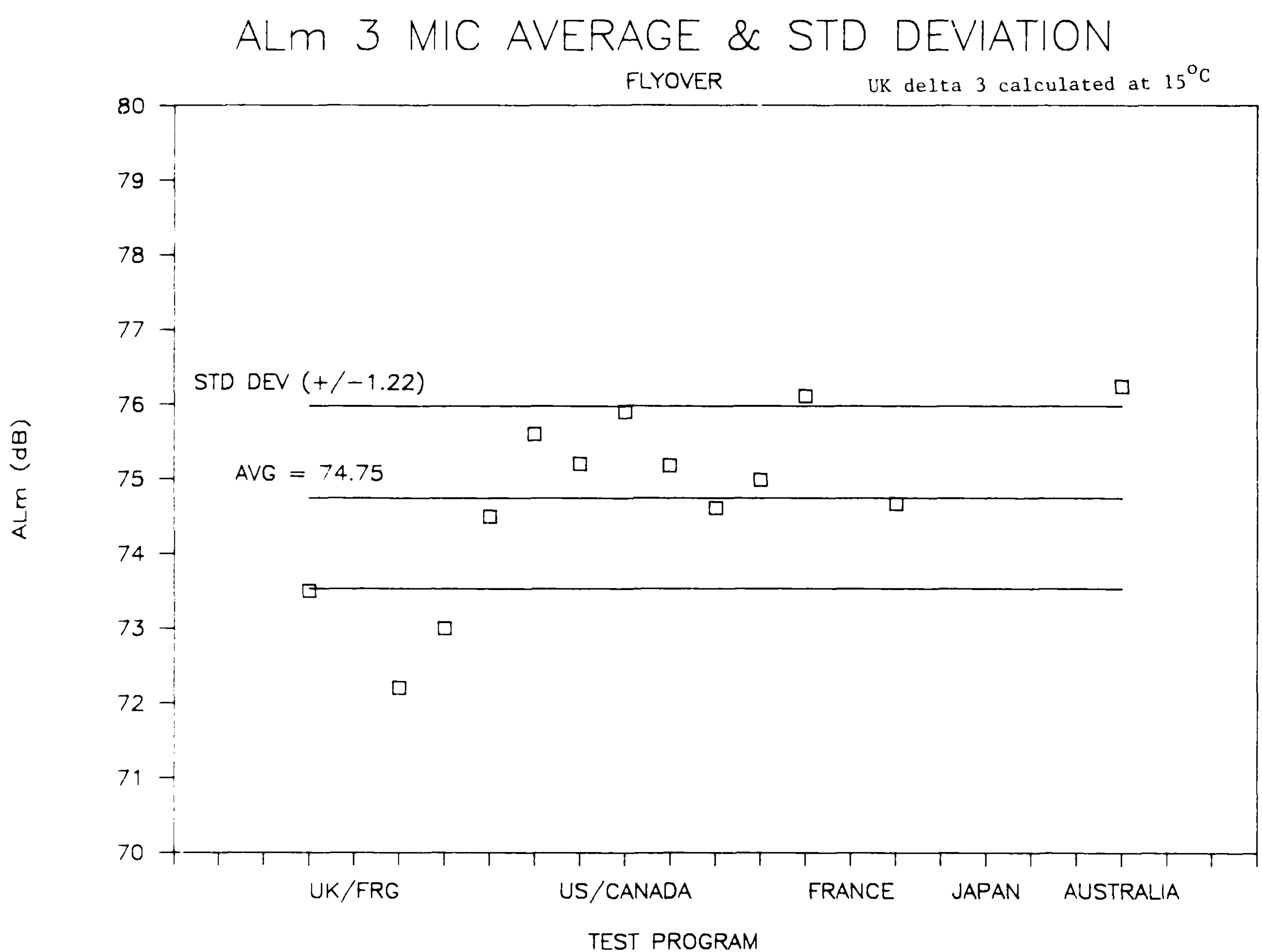

ALm—APPROACH
Individual Site Averages
ALm (dB)
85
84
83
82
81
80
79
78
77
76
75
74
73
72
71
70
LEFT SIDELINE
CENTER
RIGHT SIDELINE
FRG1
FRG2
US 2-1
US 2-2
STNA
AUS

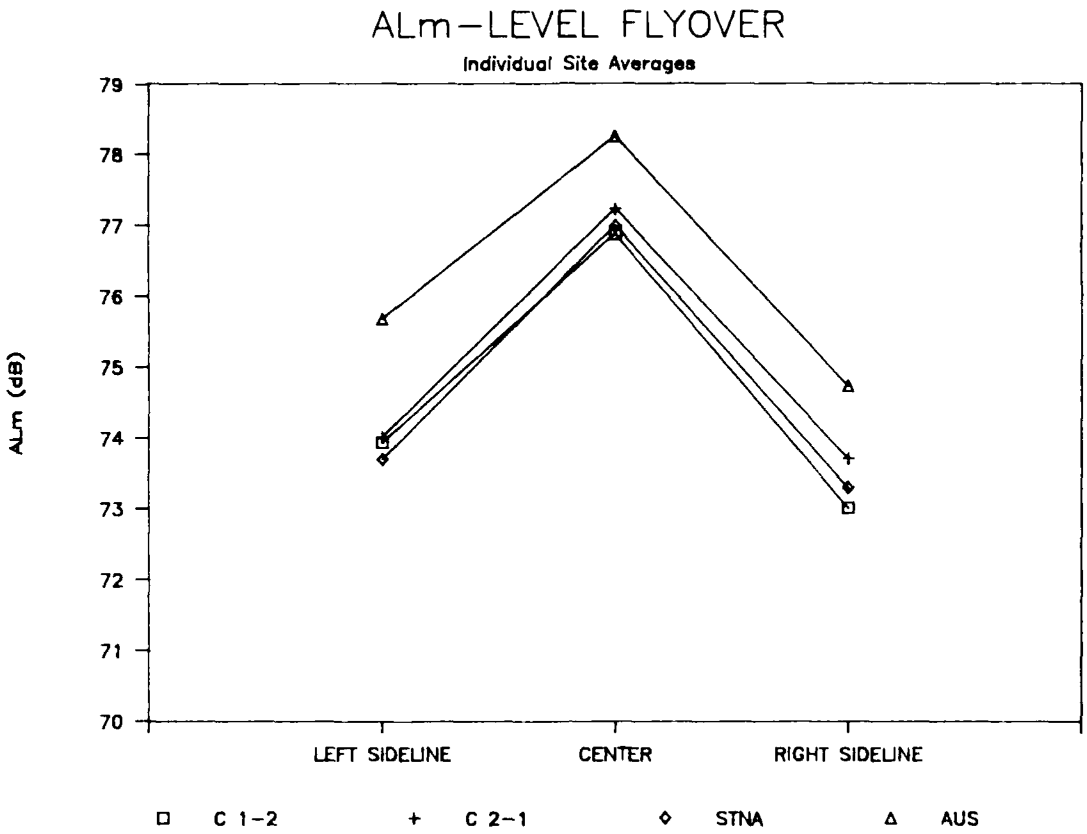

ALm—APPROACH
Individual Site Averages
ALm (dB)
85
84
83
82
81
80
79
78
77
76
75
74
73
72
71
70
LEFT SIDELINE
CENTER
RIGHT SIDELINE
UK1
US1-1
US1-2
C1-2
C2-1

MULTI-NATION COMPARISON ANALYSIS
LEVEL FLYOVER ALm DATA EXPRESSED IN DECIBELS (dB)

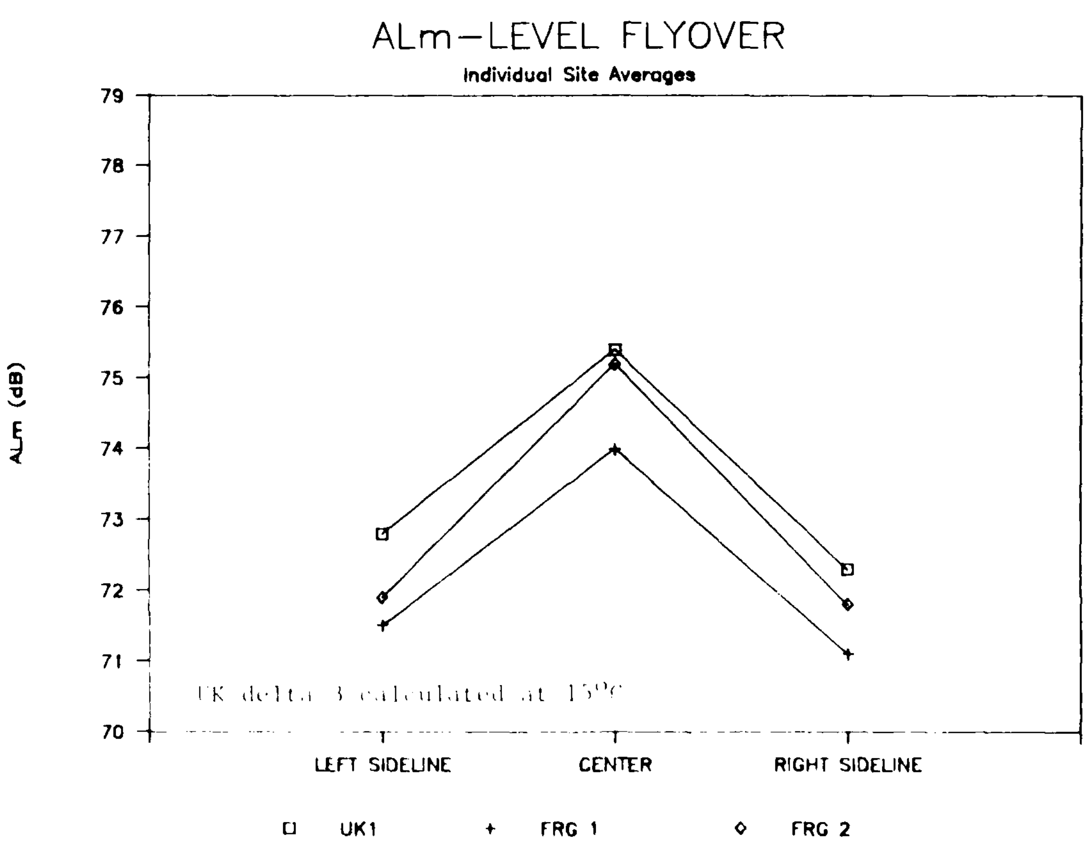
PARTICIPANT	LEFT SIDELINE AVERAGE	CENTER LINE CENTER AVERAGE	RIGHT SIDELINE AVERAGE	3 MIC AVERAGE	STD DEV	90% C.I.	TEAM AVERAGE	TEST AVERAGE
AUSTRALIA	75.69	78.26	74.74	76.24	0.56	0.31	76.24	76.24
JAPAN-PILOT 1-1	NA	NA	NA	NA	NA	NA		
JAPAN-PILOT 1-2	NA	NA	NA	NA	NA	NA		
JAPAN-PILOT 2-1	NA	NA	NA	NA	NA	NA		
JAPAN-PILOT 2-2	NA	NA	NA	NA	NA	NA		
FRANCE-AERO	NA	NA	NA	NA	NA	NA		
FRANCE-STNA	73.70	77.00	73.30	74.67	0.50	0.50	74.67	
ITALY	NA	NA	NA	NA	NA	NA		
FRG-PILOT 1	71.50	74.00	71.10	72.20	0.30	0.30	72.60	72.90
FRG-PILOT 2	71.90	75.20	71.80	73.00	0.80	0.70		
UK-PILOT 1	72.80	75.40	72.30	73.50	0.30	0.20	73.50	
CANADA-PILOT 1-1	74.29	76.43	74.82	75.18	0.48	0.46	75.22	75.26
CANADA-PILOT 1-2	73.94	76.88	73.02	74.61	0.69	0.81		
CANADA-PILOT 2-1	74.02	77.24	73.71	74.99	0.14	0.61		
CANADA-PILOT 2-2	76.16	77.36	74.83	76.11	0.93	1.10		
US-PILOT 1-1	73.90	75.60	73.90	74.50	0.26	0.19	75.30	
US-PILOT 1-2	75.30	76.80	74.70	75.60	0.17	0.20		
US-PILOT 2-1	74.90	76.40	74.50	75.20	0.36	0.30		
US-PILOT 2-2	76.20	76.10	75.50	75.90	0.59	0.36		
AVERAGE	74.18	76.36	73.71	74.75	0.47	0.46	74.59	74.80
STD DEV	1.49	1.11	1.34	1.22	0.24	0.27	1.33	1.72
90% C.I.	1.11	0.82	0.99	0.90	0.18	0.20	1.82	6.90

UK delta 3 calculated at 15°C

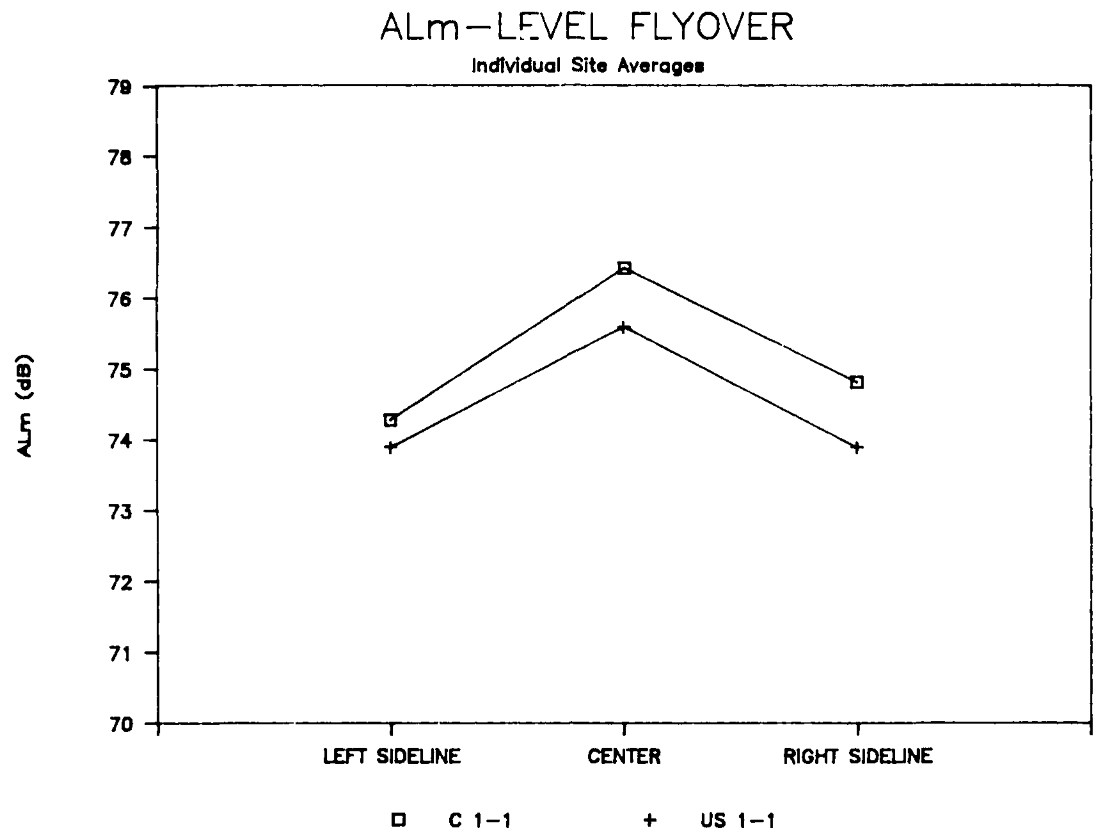

ALm 3 MIC AVERAGE & STD DEVIATION
FLYOVER
UK delta 3 calculated at 15°C
80
79
78
77
76
75
74
73
72
71
70
ALm (dB)
STD DEV (+/-1.22)
AVG = 74.75
UK/FRG
US/CANADA
FRANCE
JAPAN
AUSTRALIA
TEST PROGRAM

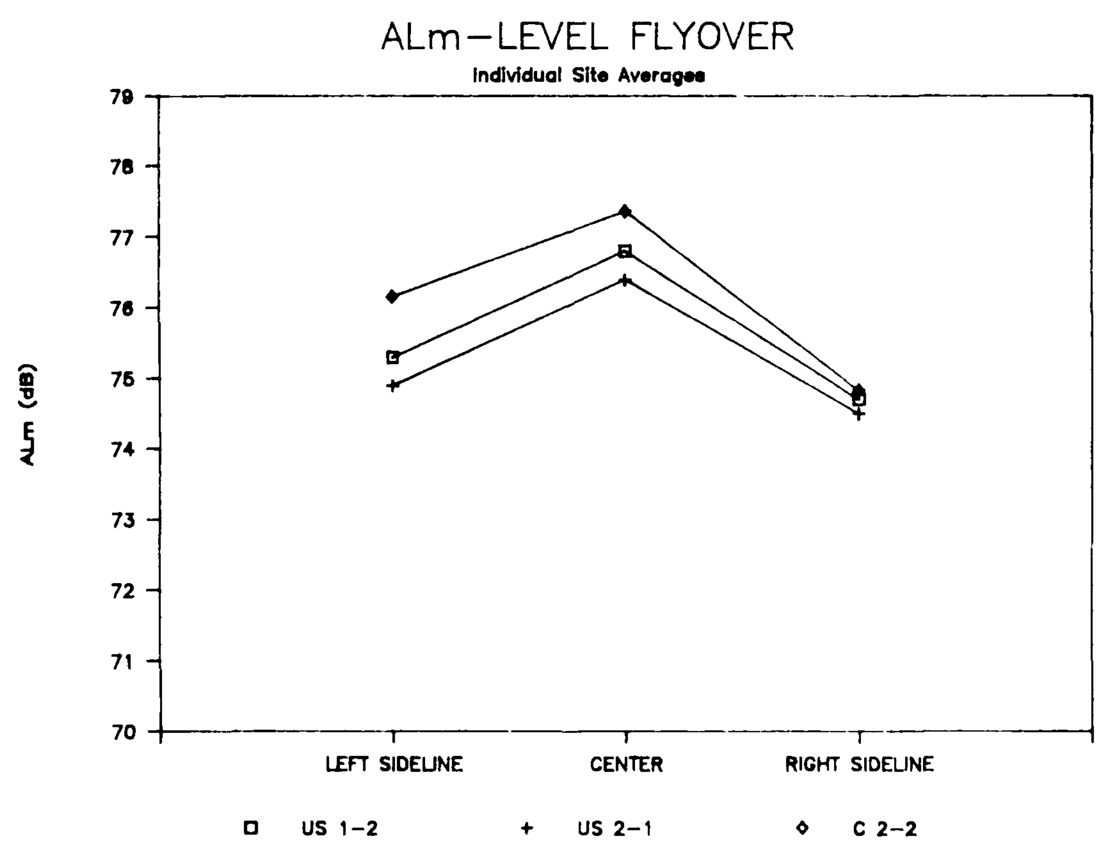


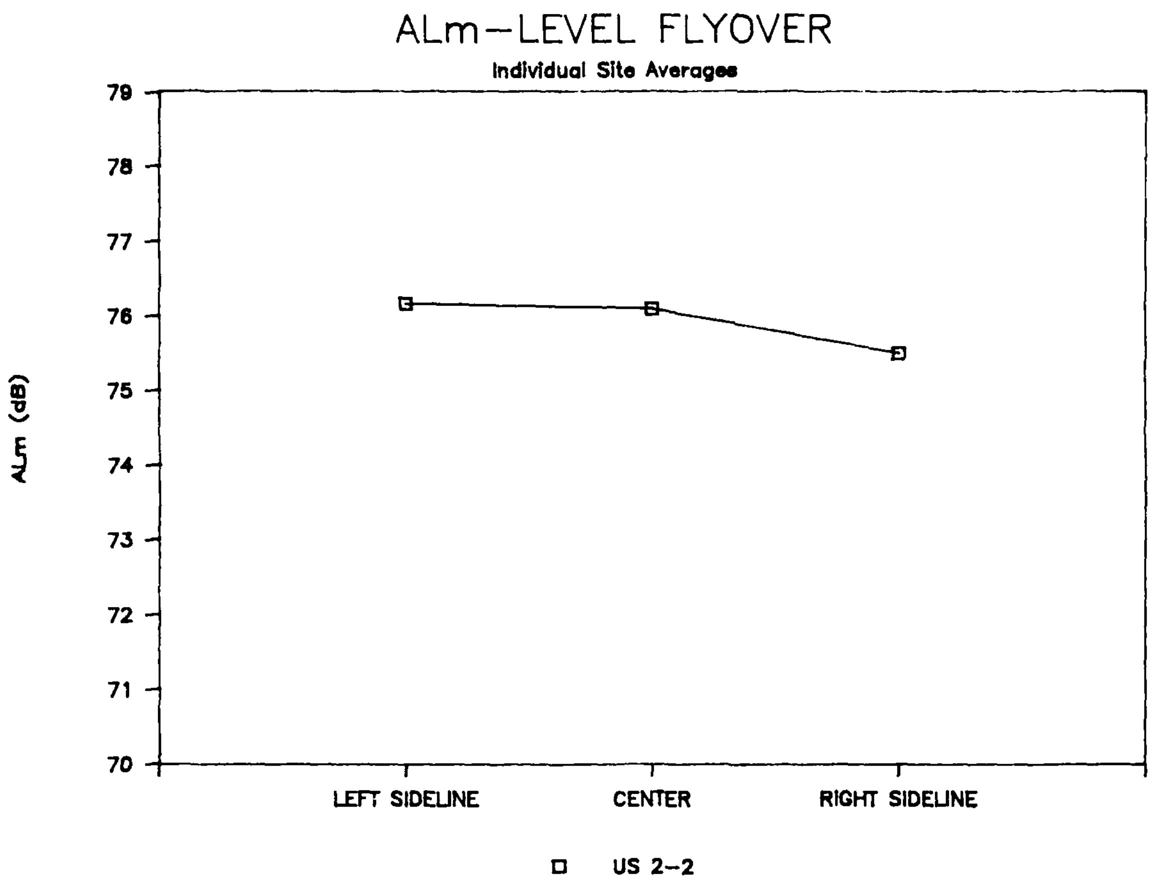
ALm-LEVEL FLYOVER
Individual Site Averages
ALm (dB)
79
78
77
76
75
74
73
72
71
70
LEFT SIDELINE
CENTER
RIGHT SIDELINE
C 1-2
C 2-1
STNA
AUS



ALm-LEVEL FLYOVER
Individual Site Averages
ALm (dB)
79
78
77
76
75
74
73
72
71
70
UK delta 3 calculated at 15°C
LEFT SIDELINE
CENTER
RIGHT SIDELINE
UK1
FRG 1
FRG 2

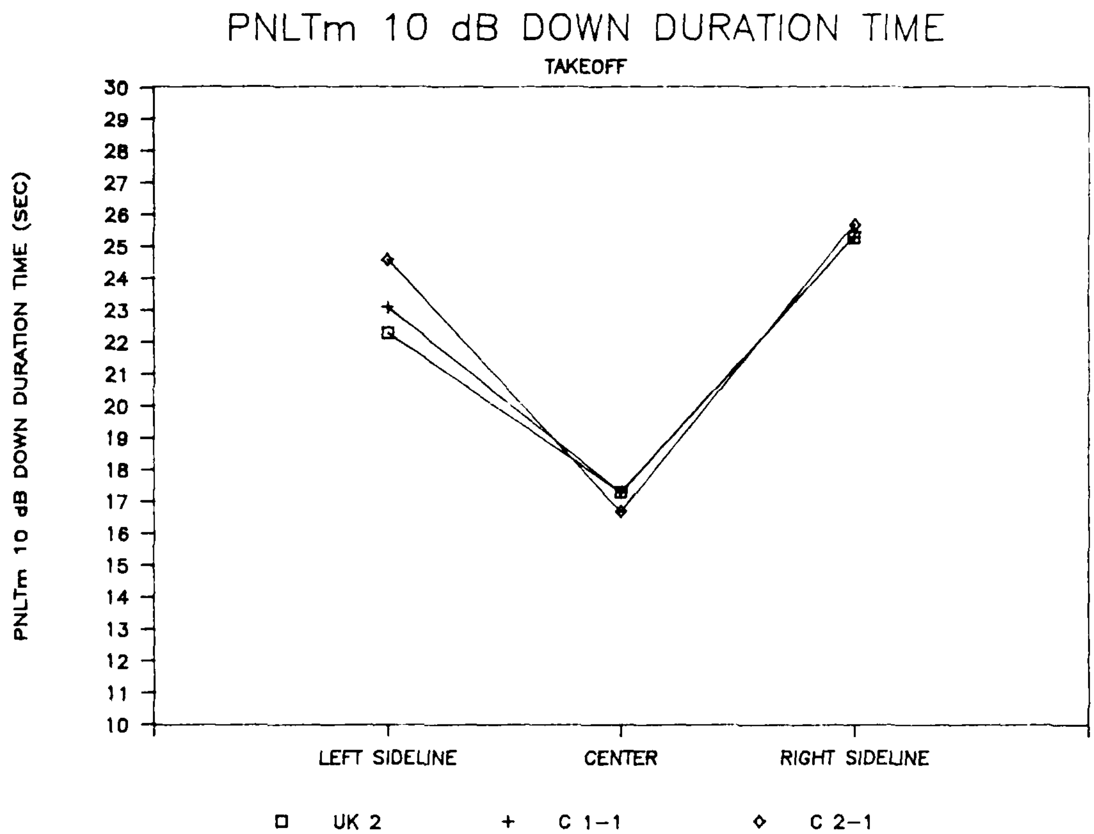

ALm-LEVEL FLYOVER
Individual Site Averages
79
78
77
76
75
74
73
72
71
70
ALm (dB)
LEFT SIDELINE
CENTER
RIGHT SIDELINE
C 1-1
US 1-1

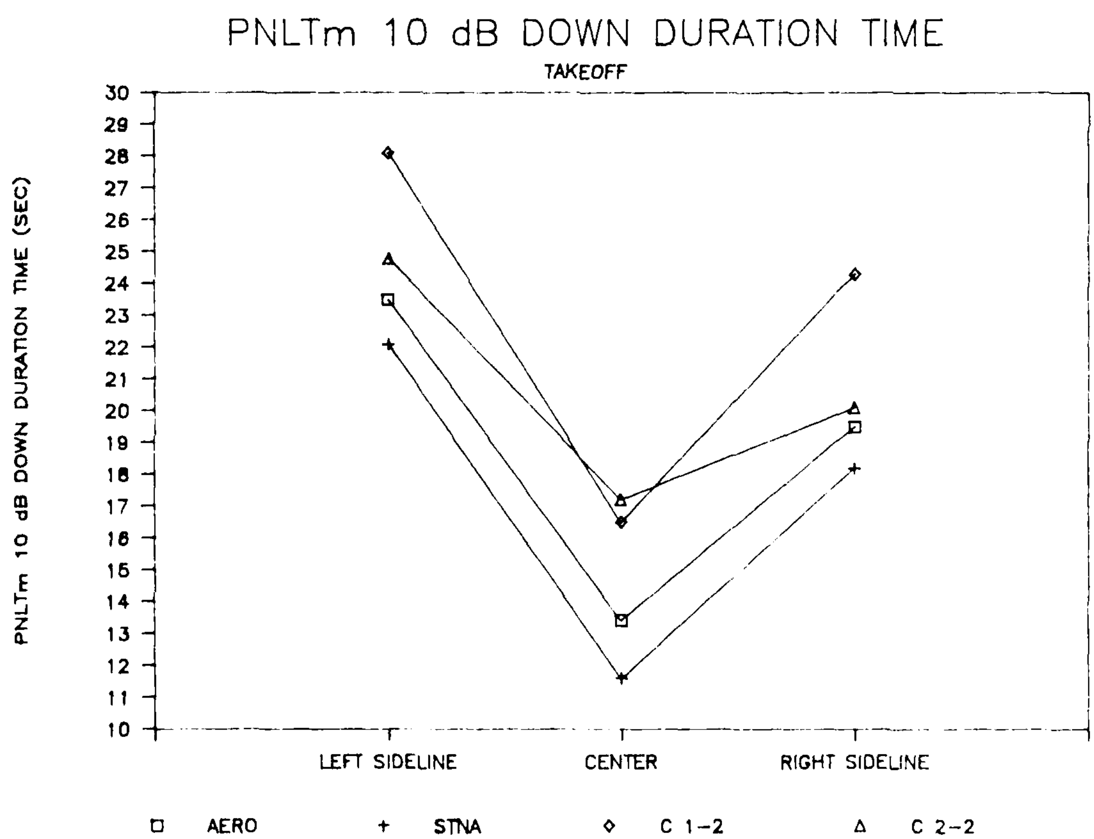

ALm-LEVEL FLYOVER
Individual Site Averages
79
78
77
76
75
74
73
72
71
70
ALm (dB)
LEFT SIDELINE
CENTER
RIGHT SIDELINE
US 1-2
US 2-1
C 2-2

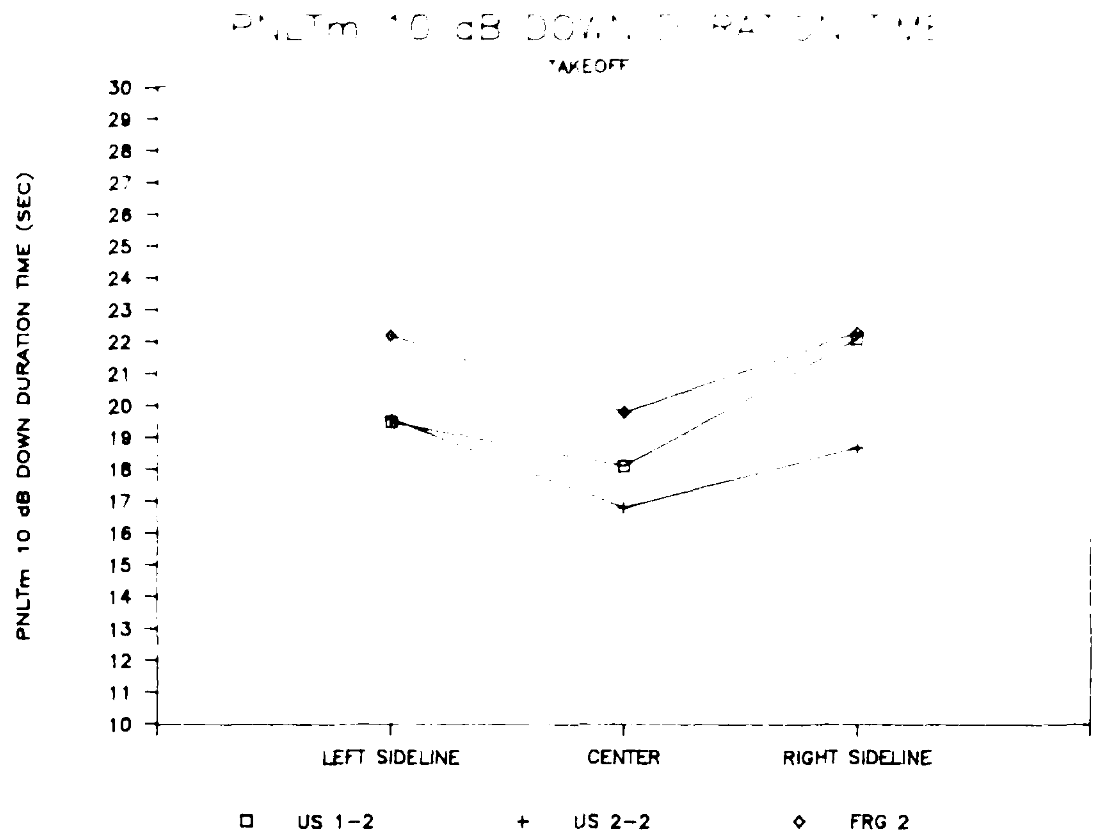


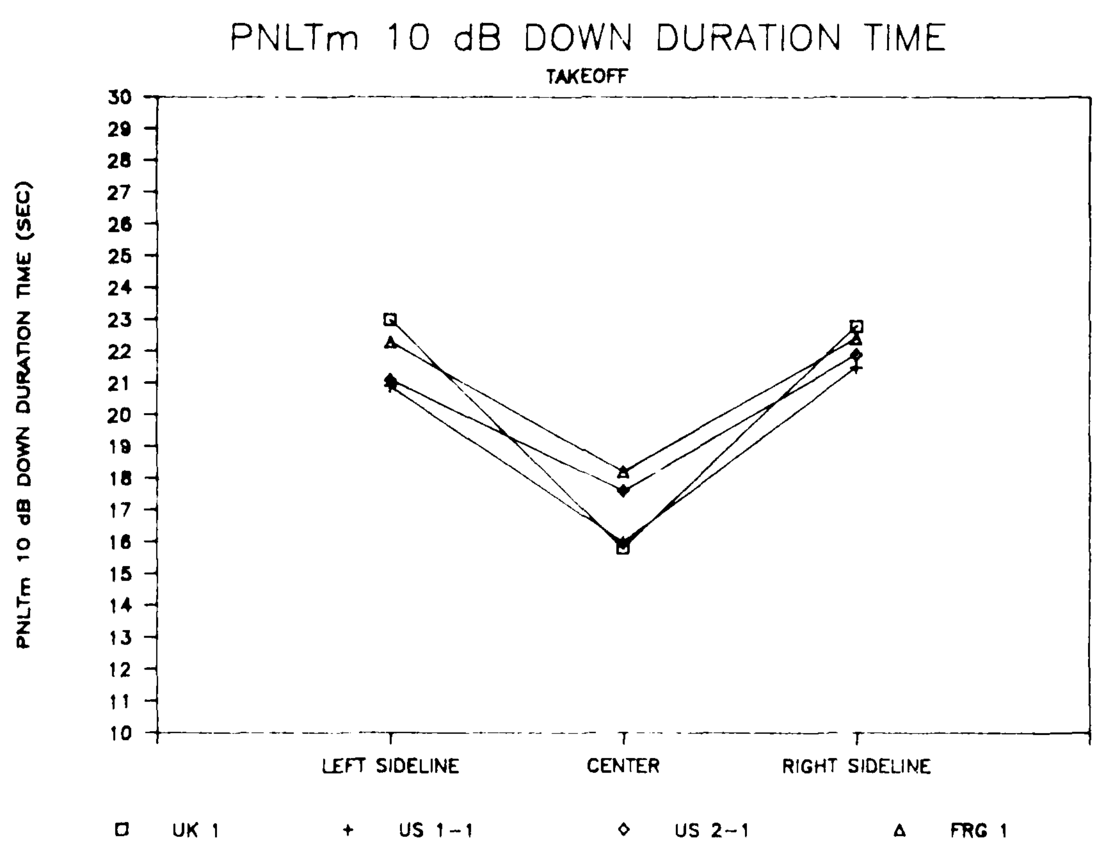
ALm-LEVEL FLYOVER
Individual Site Averages
ALm (dB)
79
78
77
76
75
74
73
72
71
70
LEFT SIDELINE
CENTER
RIGHT SIDELINE
US 2-2

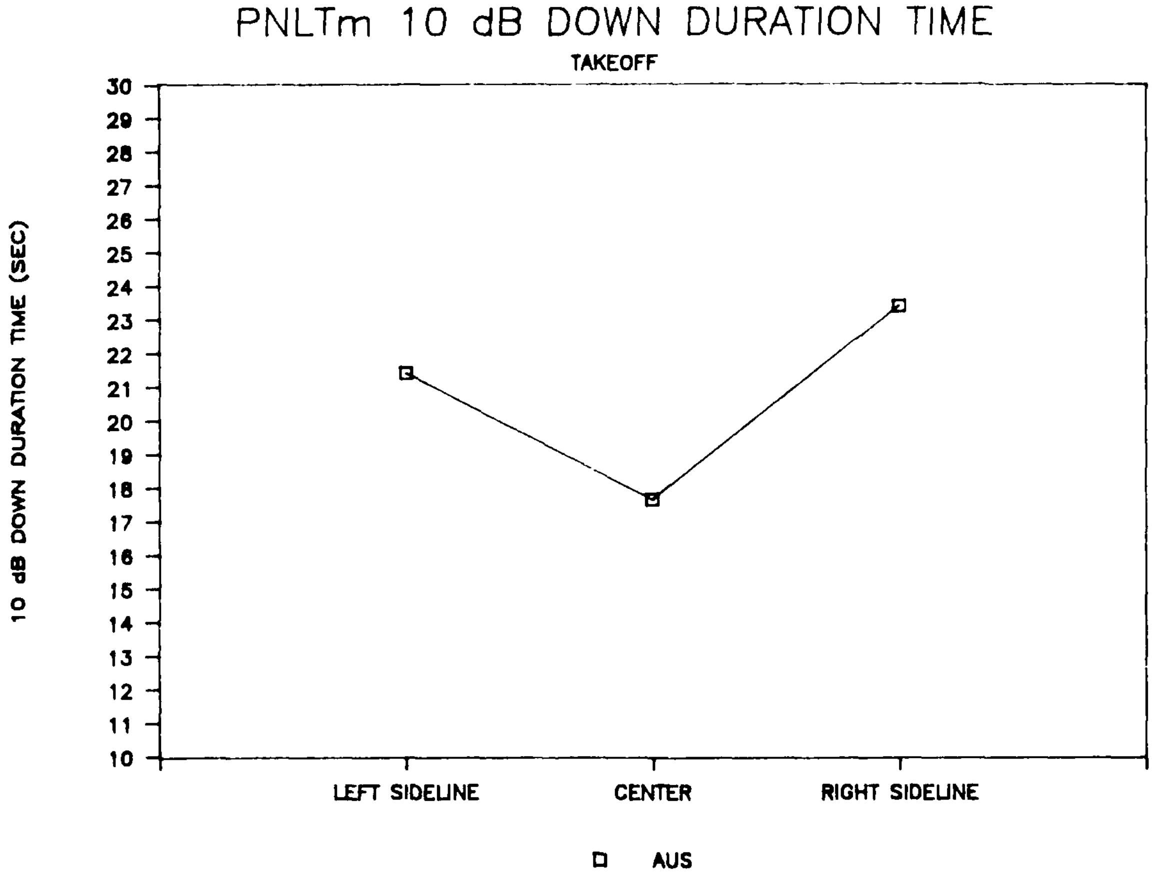
Duration Time Data


PNLTm 10 dB DOWN DURATION TIME
TAKEOFF
PNLTm 10 dB DOWN DURATION TIME (SEC)
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
LEFT SIDELINE
CENTER
RIGHT SIDELINE
UK 2
C 1-1
C 2-1

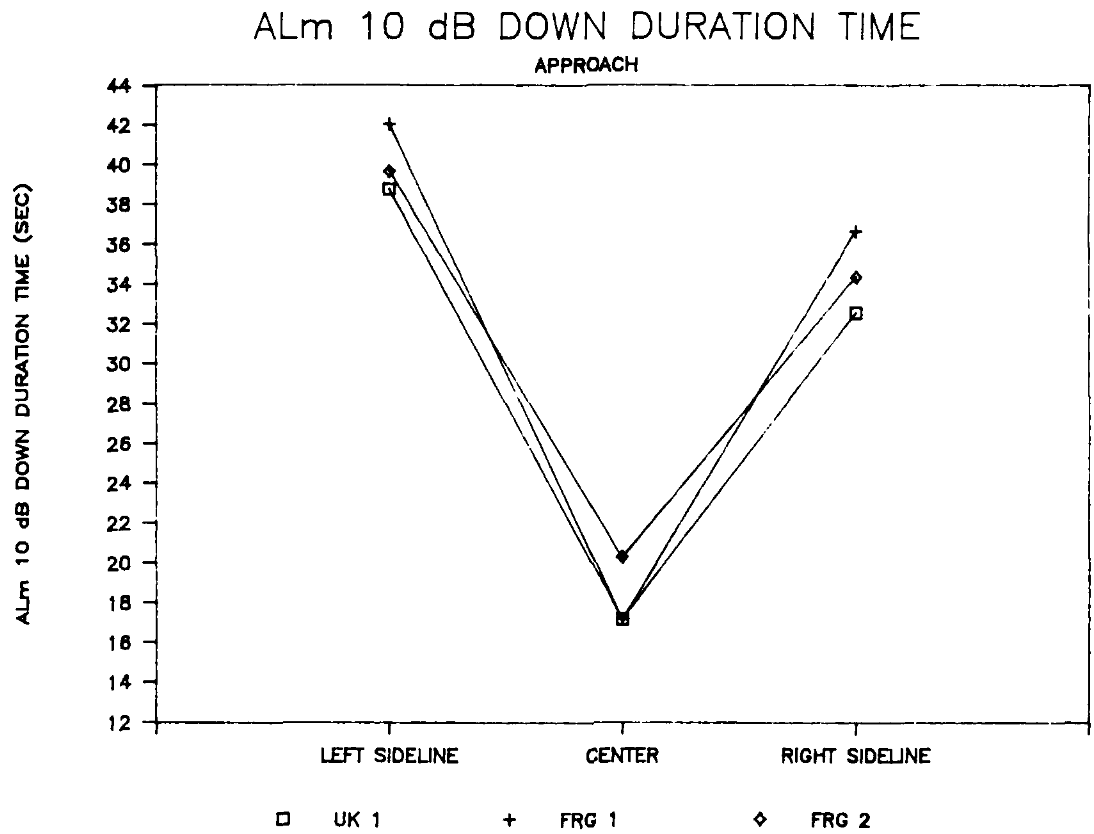

PNLTm 10 dB DOWN DURATION TIME
TAKEOFF
PNLTm 10 dB DOWN DURATION TIME (SEC)
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
LEFT SIDELINE
CENTER
RIGHT SIDELINE
AERO
STNA
C 1-2
C 2-2

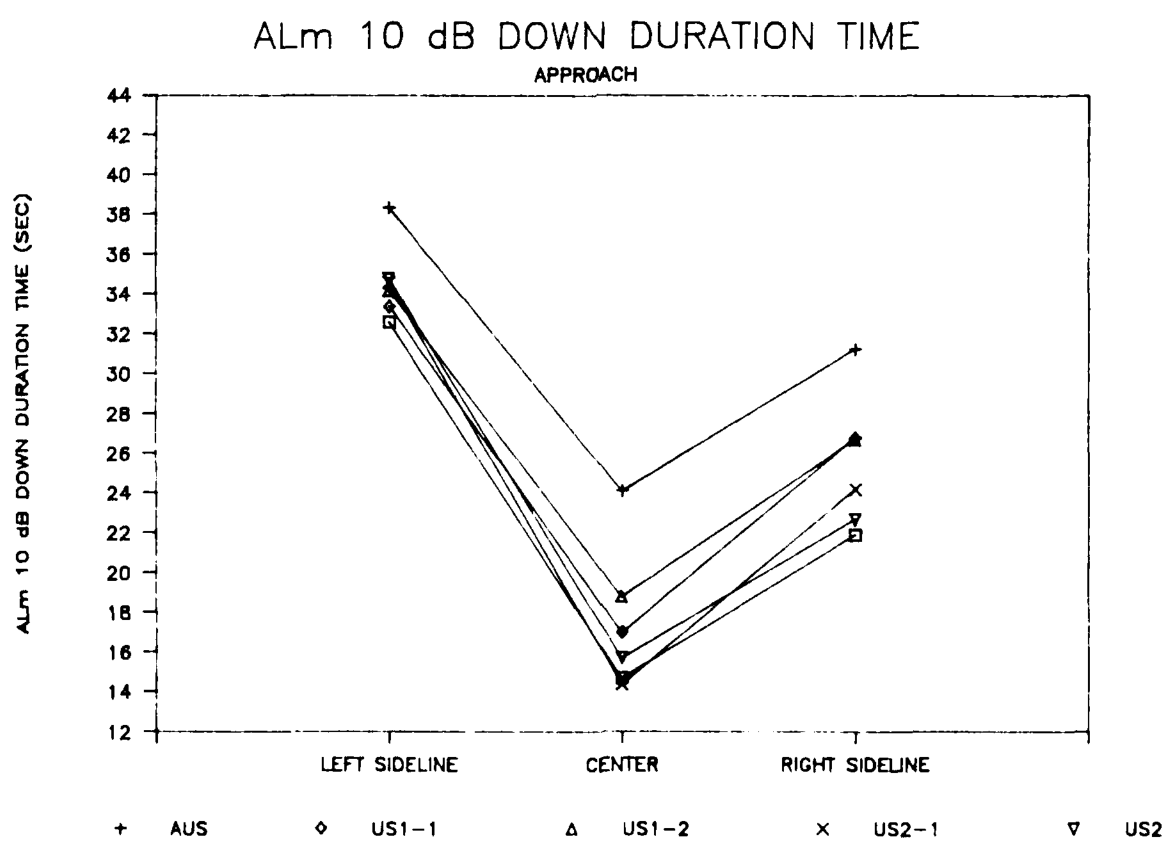

TAKEOFF
PNLTm 10 dB DOWN DURATION TIME (SEC)
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
LEFT SIDELINE
CENTER
RIGHT SIDELINE
US 1-2
US 2-2
FRG 2

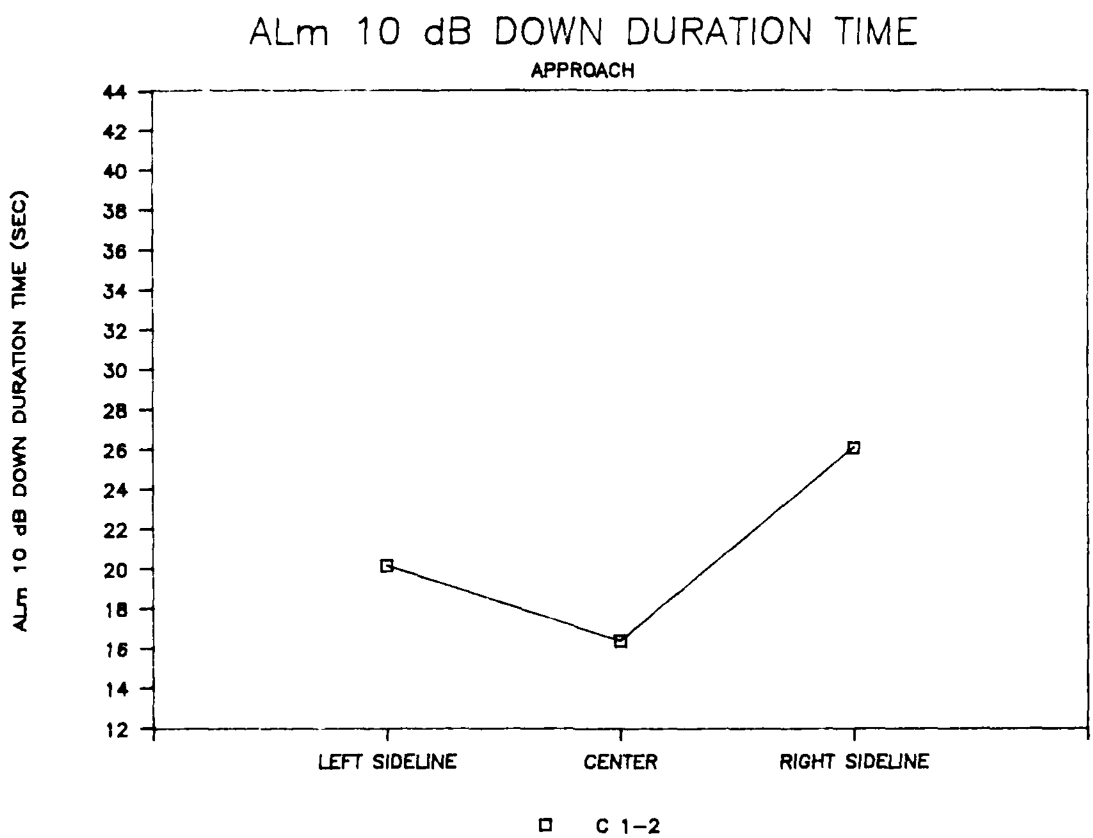

PNLTm 10 dB DOWN DURATION TIME
TAKEOFF
PNLTm 10 dB DOWN DURATION TIME (SEC)
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
LEFT SIDELINE
CENTER
RIGHT SIDELINE
UK 1
US 1-1
US 2-1
FRG 1



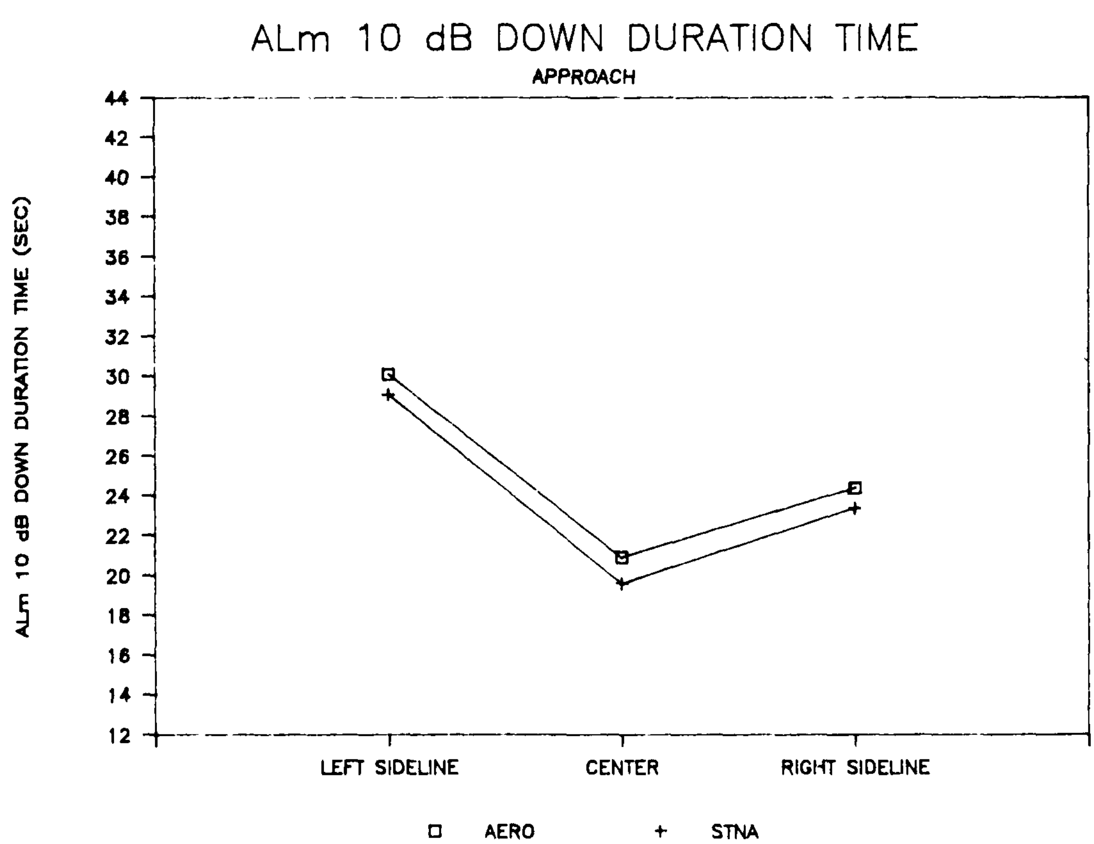
PNLTm 10 dB DOWN DURATION TIME
TAKEOFF
10 dB DOWN DURATION TIME (SEC)
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
LEFT SIDELINE
CENTER
RIGHT SIDELINE
AUS


ALm 10 dB DOWN DURATION TIME
APPROACH
ALm 10 dB DOWN DURATION TIME (SEC)
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
LEFT SIDELINE
CENTER
RIGHT SIDELINE
UK 1
FRG 1
FRG 2

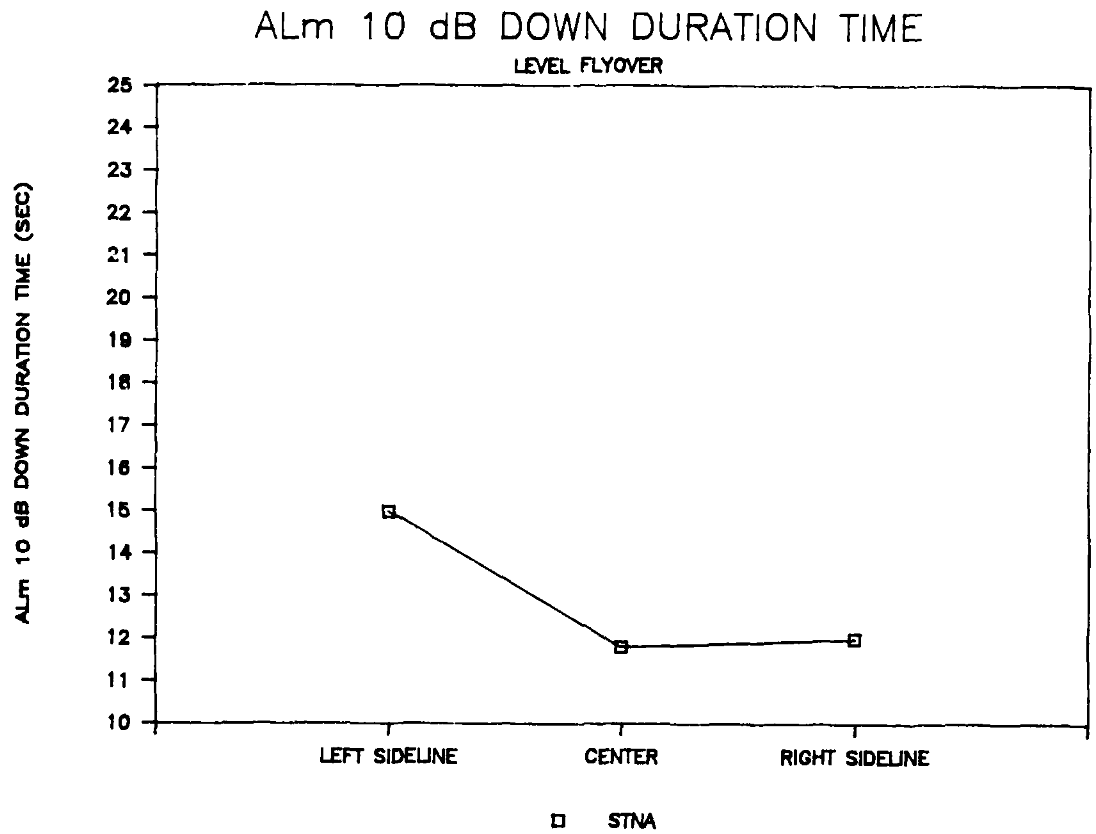

ALm 10 dB DOWN DURATION TIME
APPROACH
ALm 10 dB DOWN DURATION TIME (SEC)
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
LEFT SIDELINE
CENTER
RIGHT SIDELINE
AUS
US1-1
US1-2
US2-1
US2

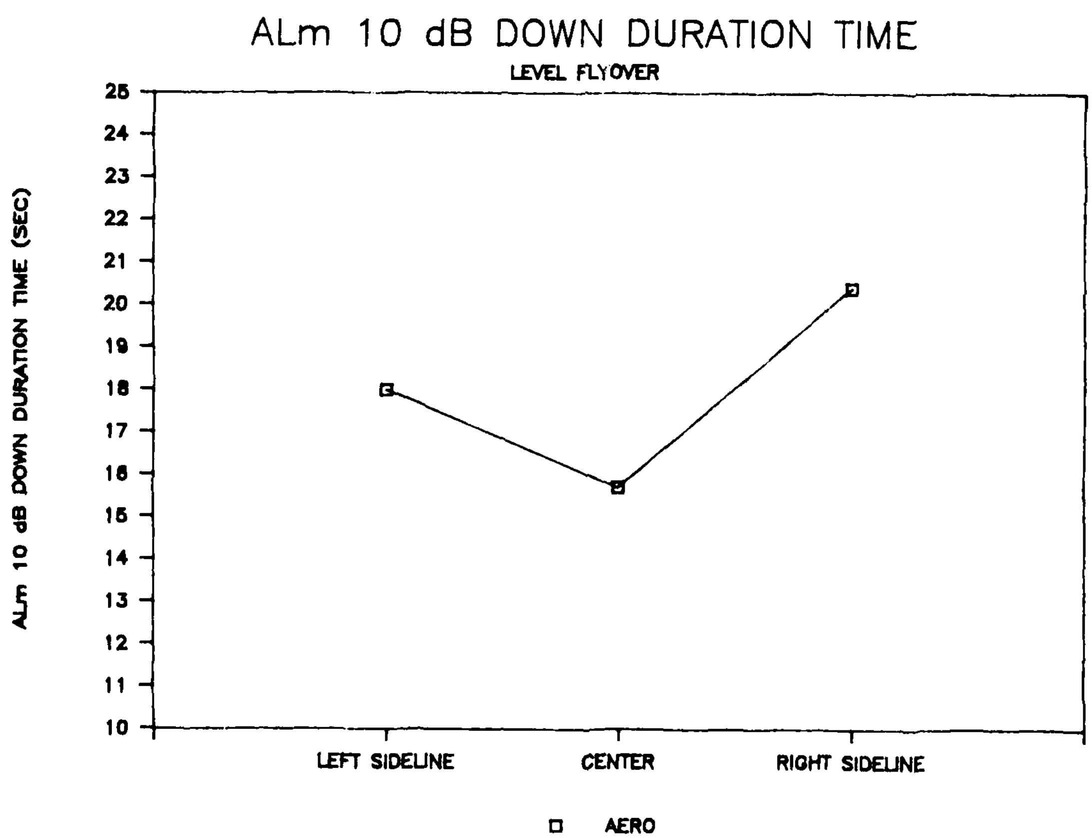


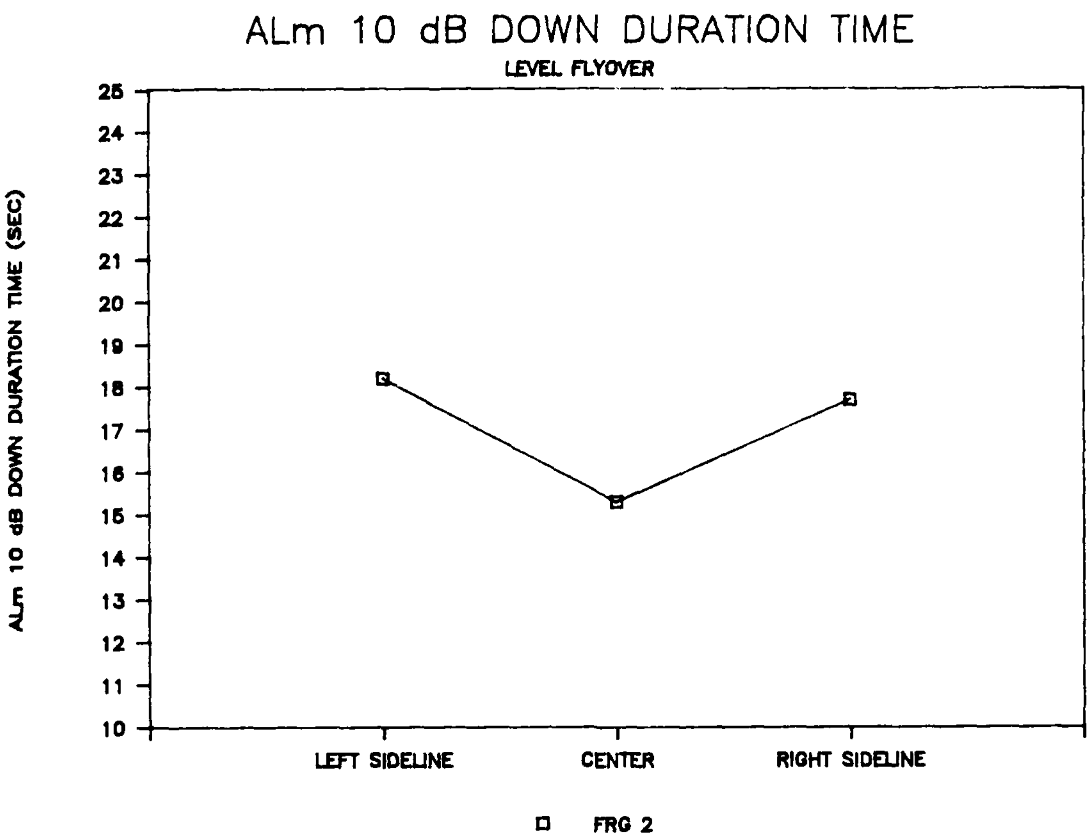
ALm 10 dB DOWN DURATION TIME
APPROACH
ALm 10 dB DOWN DURATION TIME (SEC)
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
LEFT SIDELINE
CENTER
RIGHT SIDELINE
C 1-2

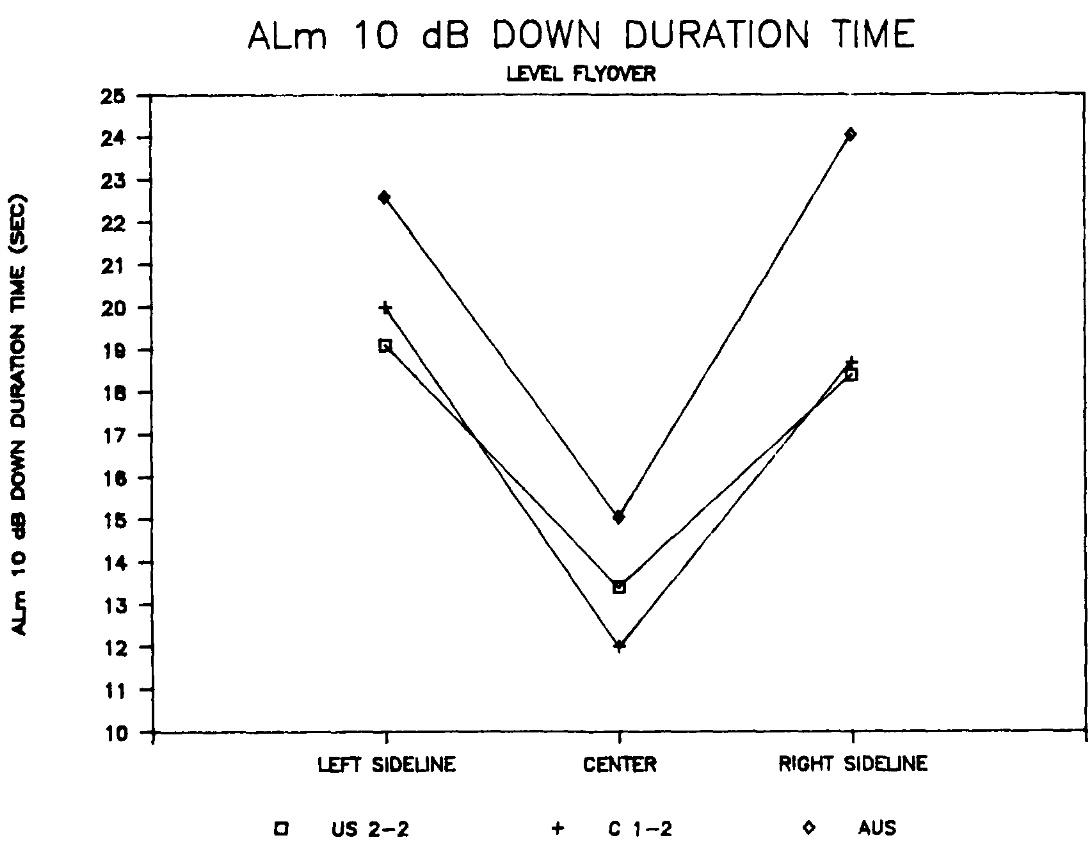


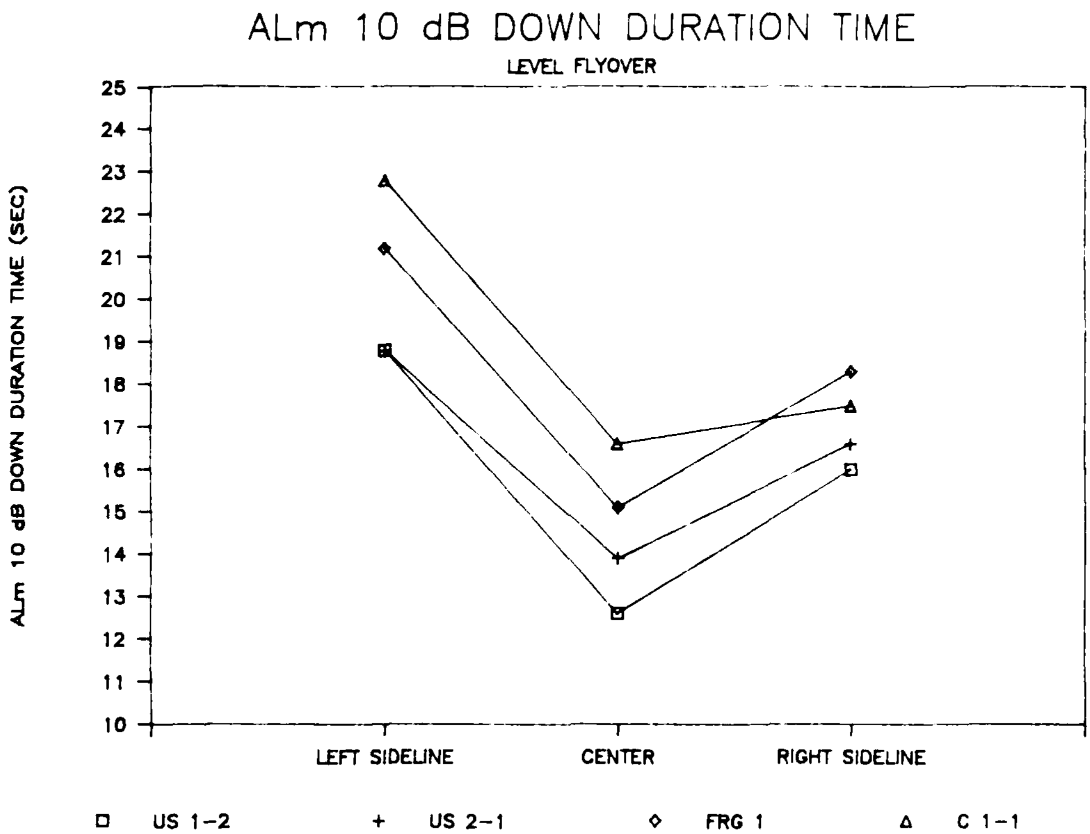
ALm 10 dB DOWN DURATION TIME
APPROACH
ALm 10 dB DOWN DURATION TIME (SEC)
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
LEFT SIDELINE
CENTER
RIGHT SIDELINE
AERO
STNA

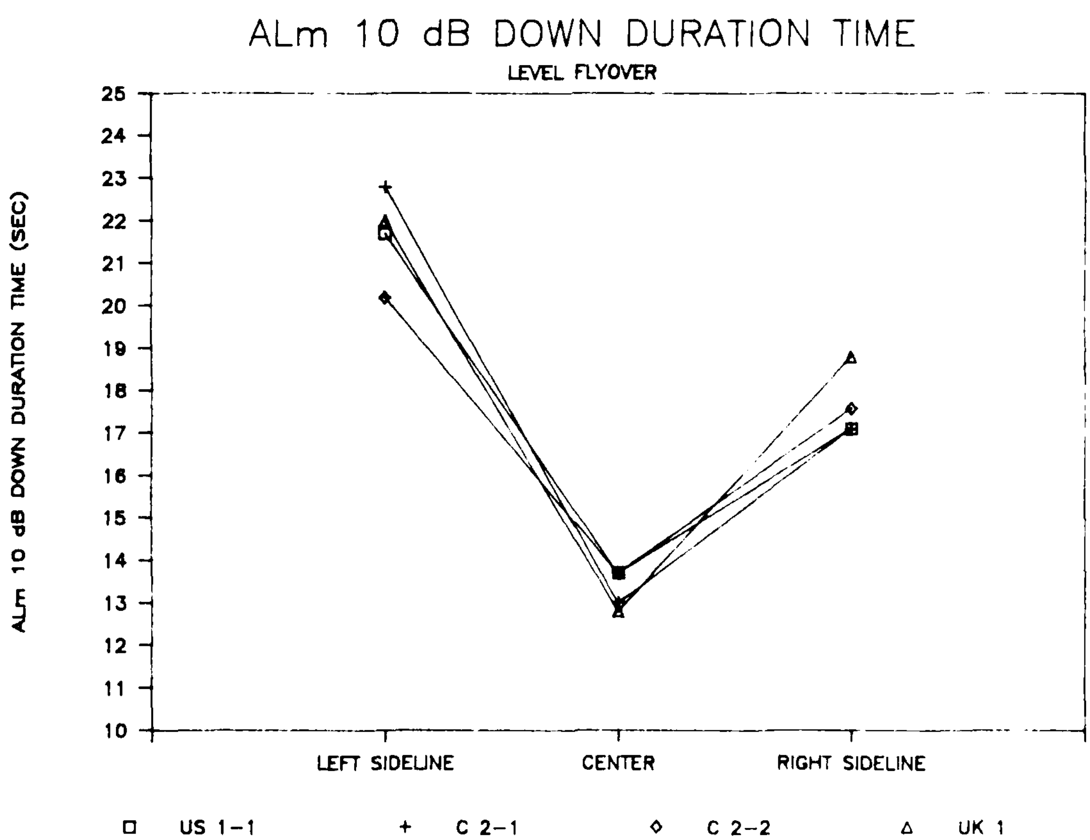

ALm 10 dB DOWN DURATION TIME
LEVEL FLYOVER
ALm 10 dB DOWN DURATION TIME (SEC)
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
LEFT SIDELINE
CENTER
RIGHT SIDELINE
STNA

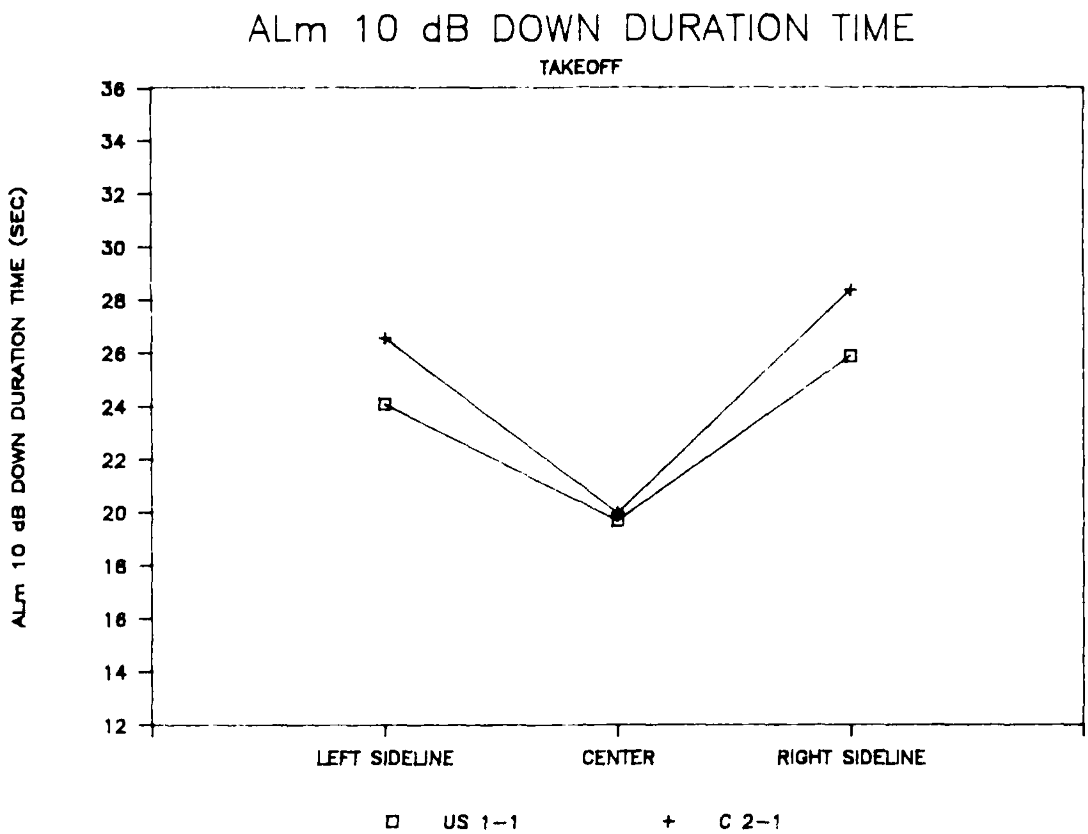

ALm 10 dB DOWN DURATION TIME
LEVEL FLYOVER
ALm 10 dB DOWN DURATION TIME (SEC)
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
LEFT SIDELINE
CENTER
RIGHT SIDELINE
AERO

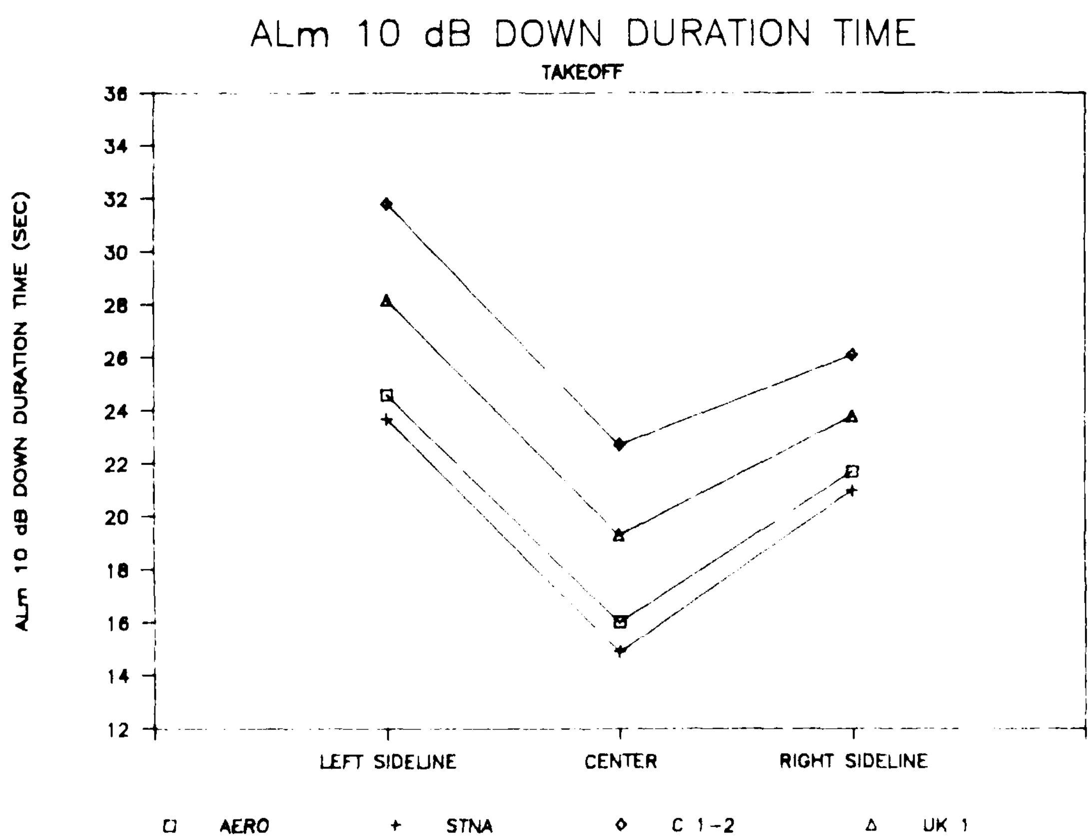

ALm 10 dB DOWN DURATION TIME
LEVEL FLYOVER
ALm 10 dB DOWN DURATION TIME (SEC)
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
LEFT SIDELINE
CENTER
RIGHT SIDELINE
FRG 2

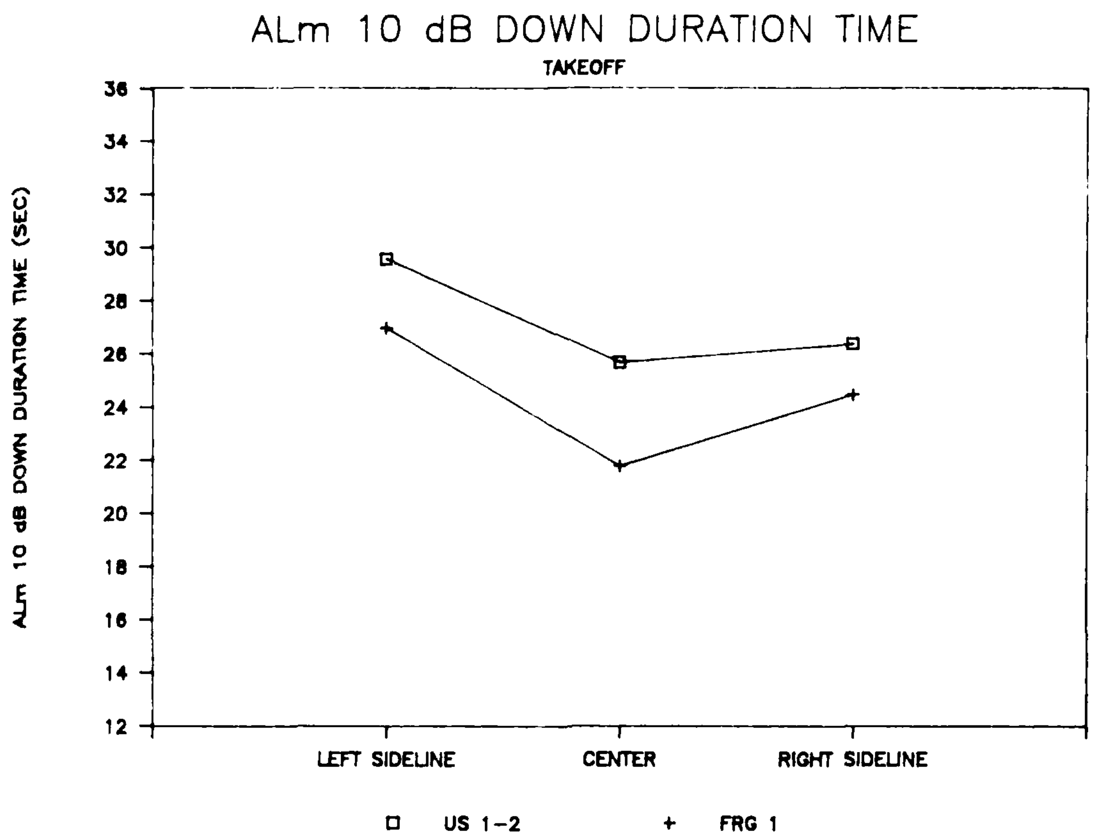

ALm 10 dB DOWN DURATION TIME
LEVEL FLYOVER
ALm 10 dB DOWN DURATION TIME (SEC)
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
LEFT SIDELINE
CENTER
RIGHT SIDELINE
US 2-2
C 1-2
AUS

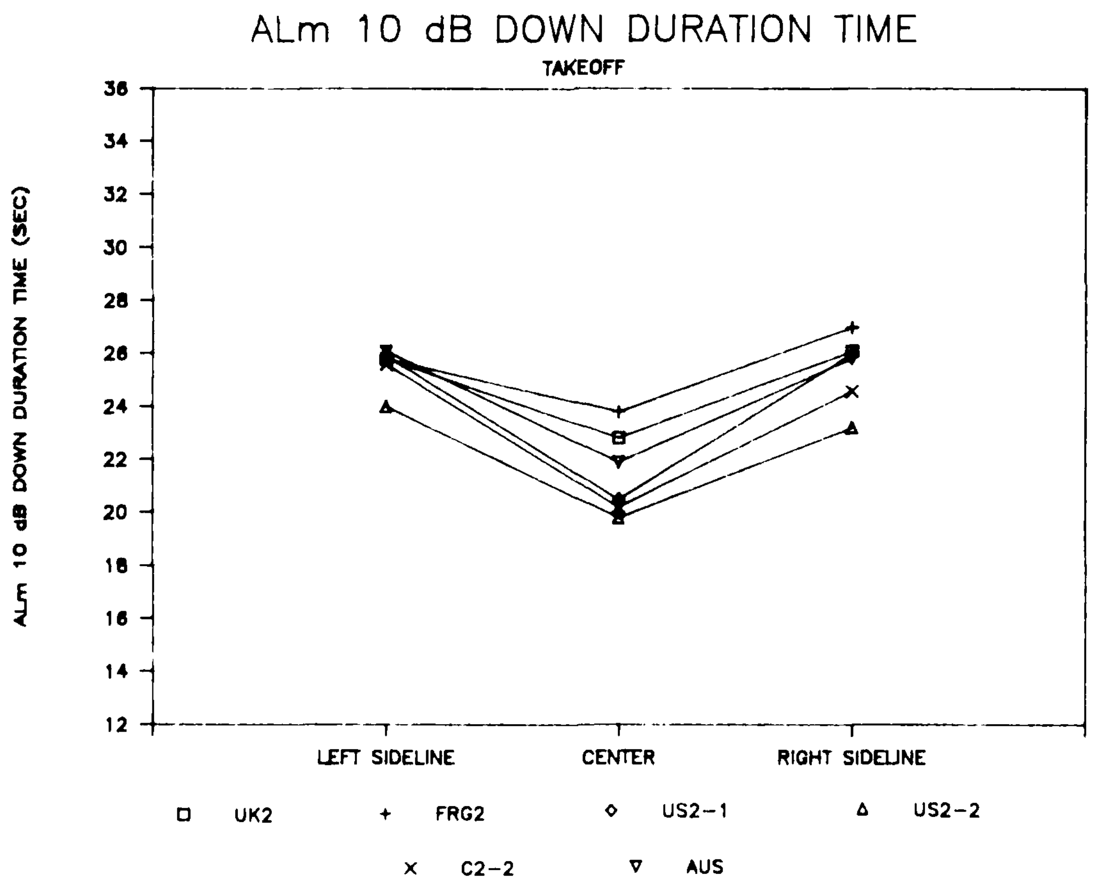

ALm 10 dB DOWN DURATION TIME
LEVEL FLYOVER
ALm 10 dB DOWN DURATION TIME (SEC)
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
LEFT SIDELINE
CENTER
RIGHT SIDELINE
□ US 1-2
+ US 2-1
◇ FRG 1
Δ C 1-1

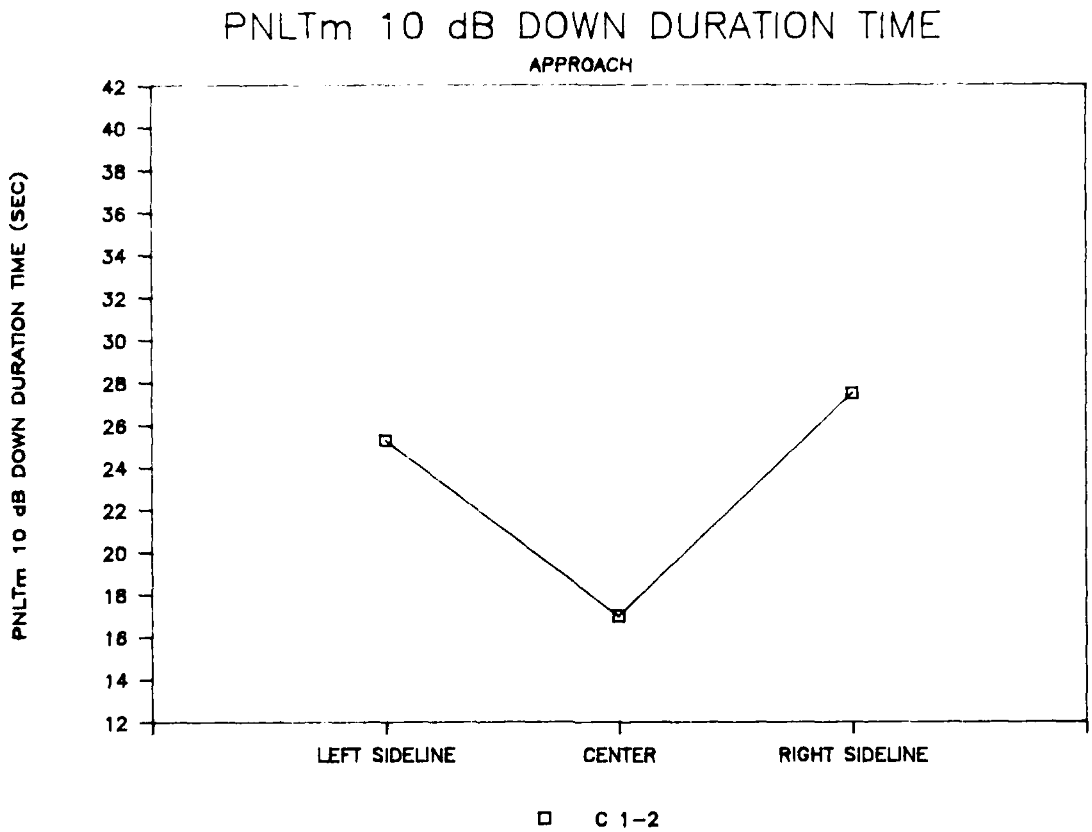

ALm 10 dB DOWN DURATION TIME
LEVEL FLYOVER
ALm 10 dB DOWN DURATION TIME (SEC)
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
LEFT SIDELINE
CENTER
RIGHT SIDELINE
□ US 1-1
+ C 2-1
◇ C 2-2
Δ UK 1


ALm 10 dB DOWN DURATION TIME
TAKEOFF
ALm 10 dB DOWN DURATION TIME (SEC)
36
34
32
30
28
26
24
22
20
18
16
14
12
LEFT SIDELINE
CENTER
RIGHT SIDELINE
US 1-1
C 2-1

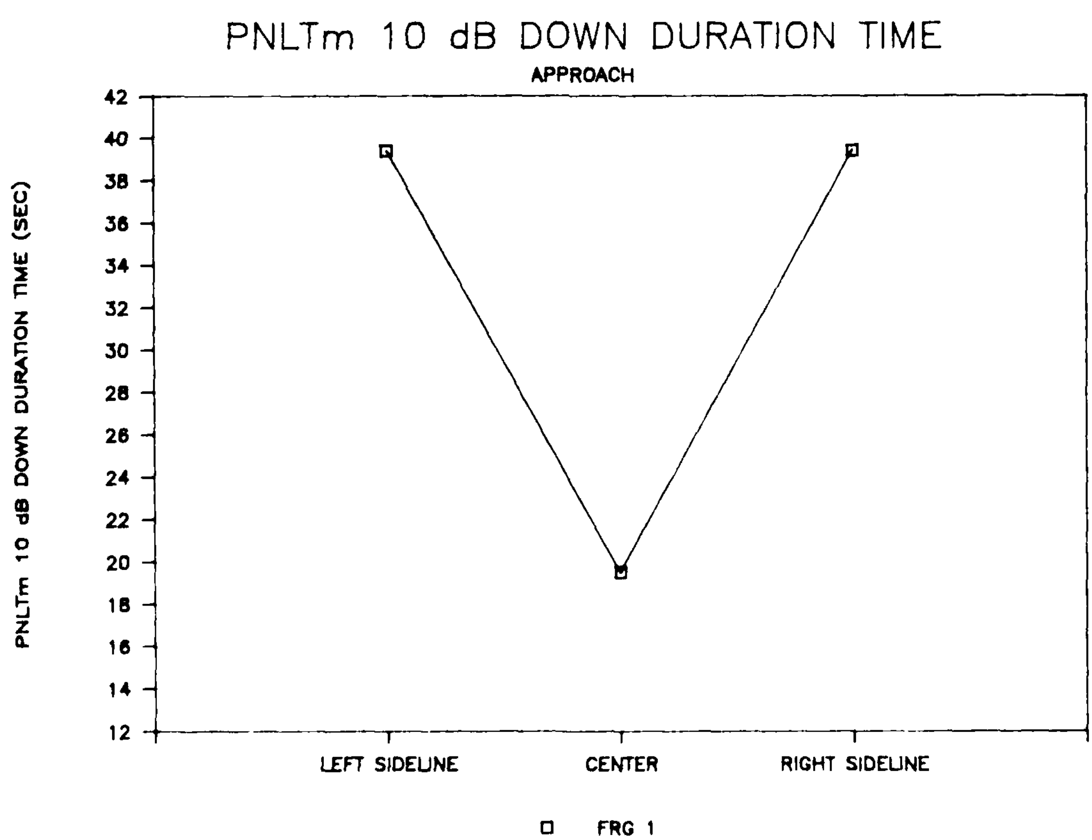

ALm 10 dB DOWN DURATION TIME
TAKEOFF
ALm 10 dB DOWN DURATION TIME (SEC)
36
34
32
30
28
26
24
22
20
18
16
14
12
LEFT SIDELINE
CENTER
RIGHT SIDELINE
AERO
STNA
C 1-2
UK 1


ALm 10 dB DOWN DURATION TIME
TAKEOFF
ALm 10 dB DOWN DURATION TIME (SEC)
36
34
32
30
28
26
24
22
20
18
16
14
12
LEFT SIDELINE
CENTER
RIGHT SIDELINE
US 1-2
FRG 1

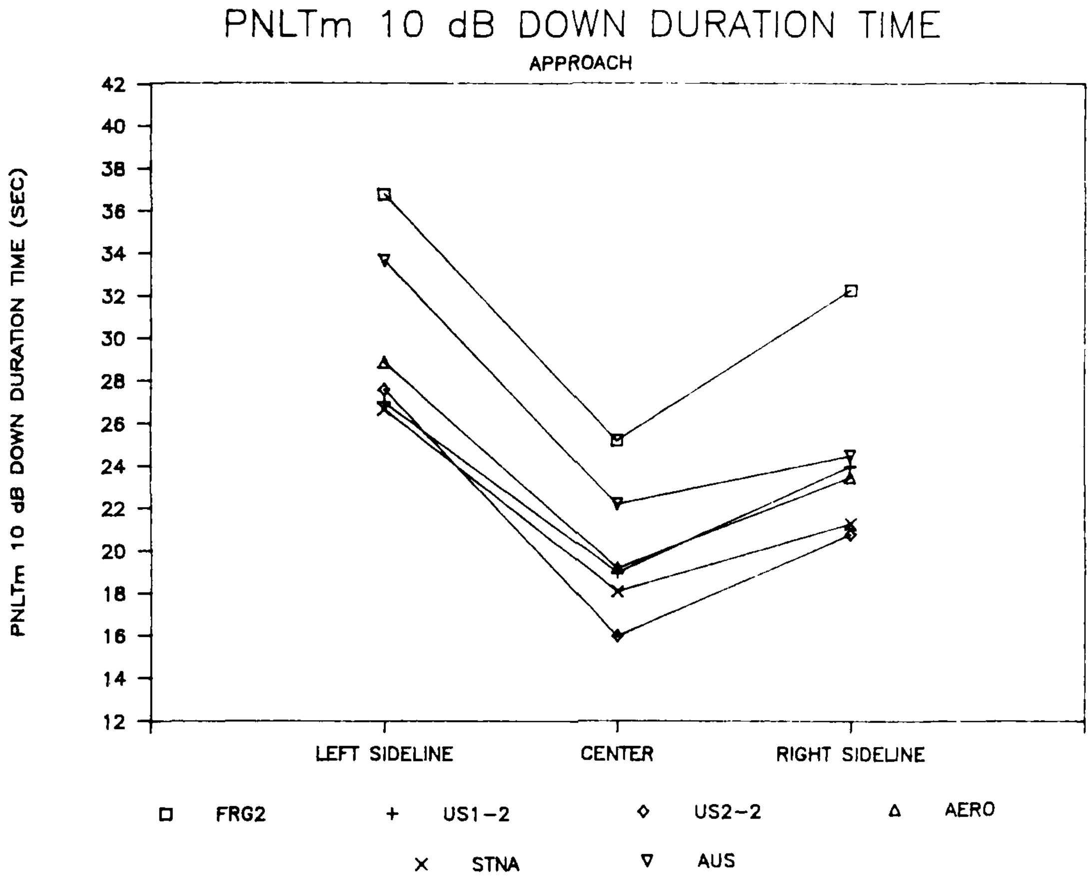

ALm 10 dB DOWN DURATION TIME
TAKEOFF
ALm 10 dB DOWN DURATION TIME (SEC)
36
34
32
30
28
26
24
22
20
18
16
14
12
LEFT SIDELINE
CENTER
RIGHT SIDELINE
UK2
FRG2
US2-1
US2-2
C2-2
AUS

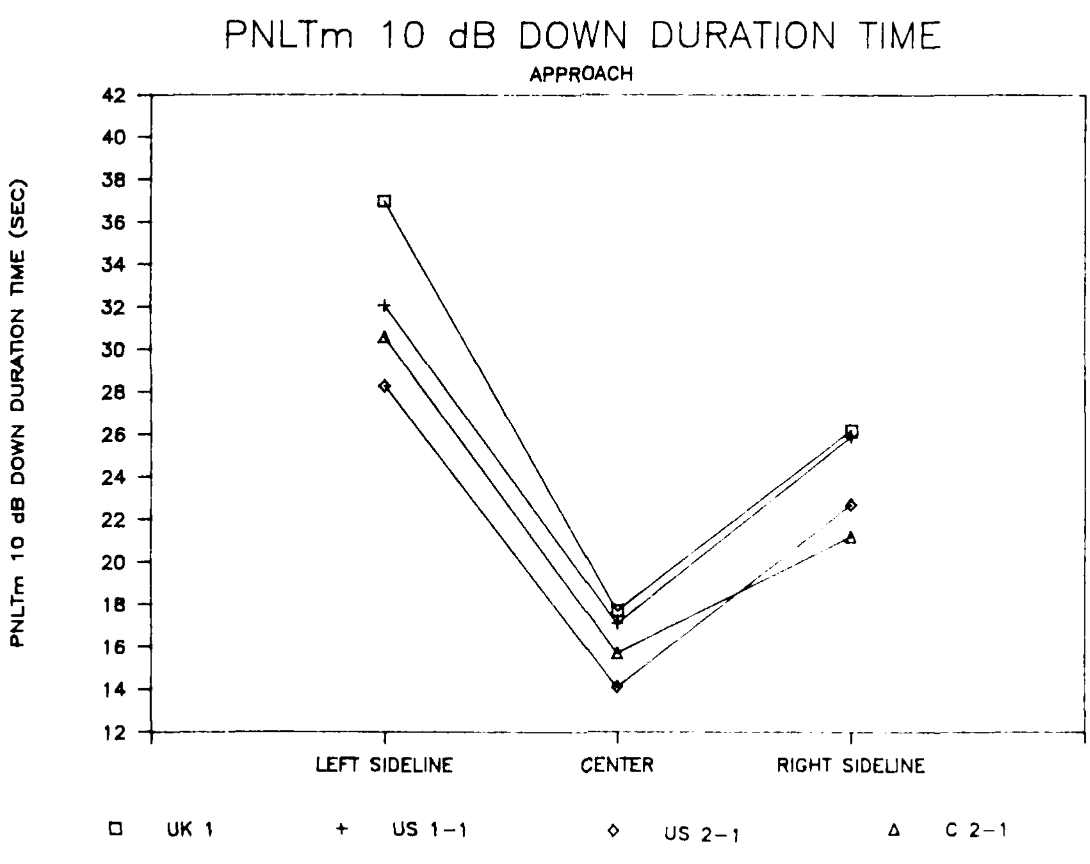


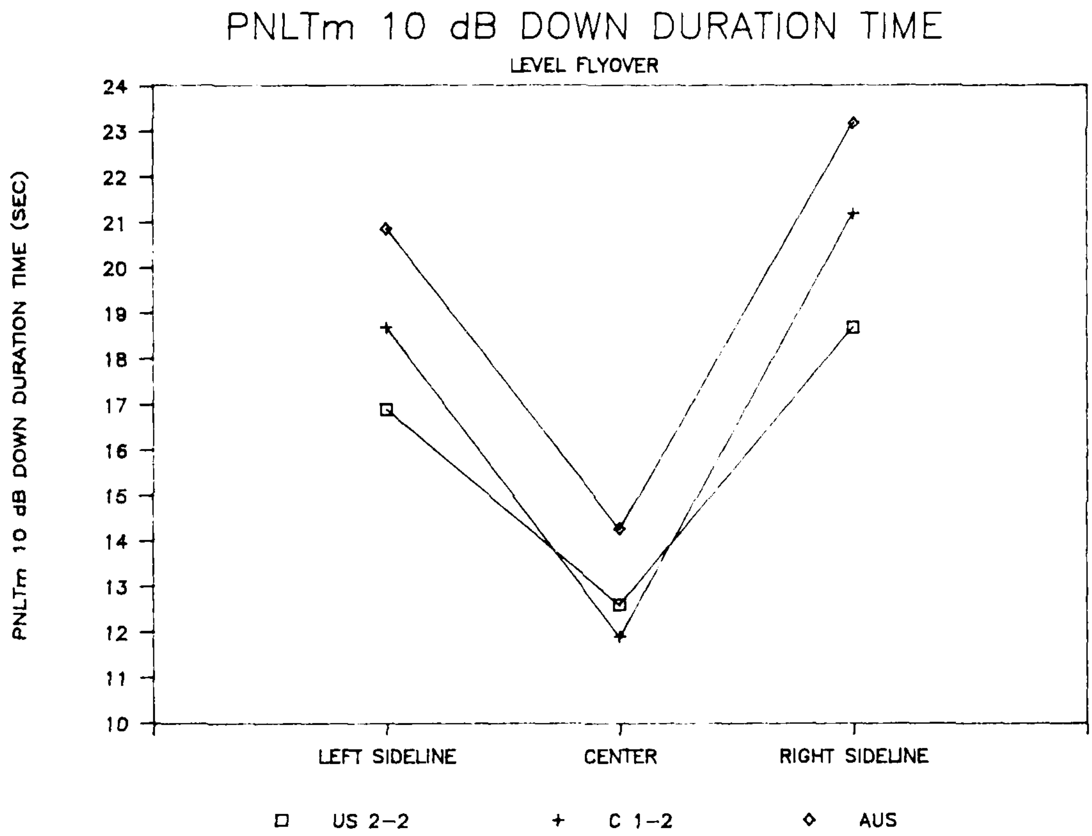
PNLTm 10 dB DOWN DURATION TIME
APPROACH
PNLTm 10 dB DOWN DURATION TIME (SEC)
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
LEFT SIDELINE
CENTER
RIGHT SIDELINE
C 1-2

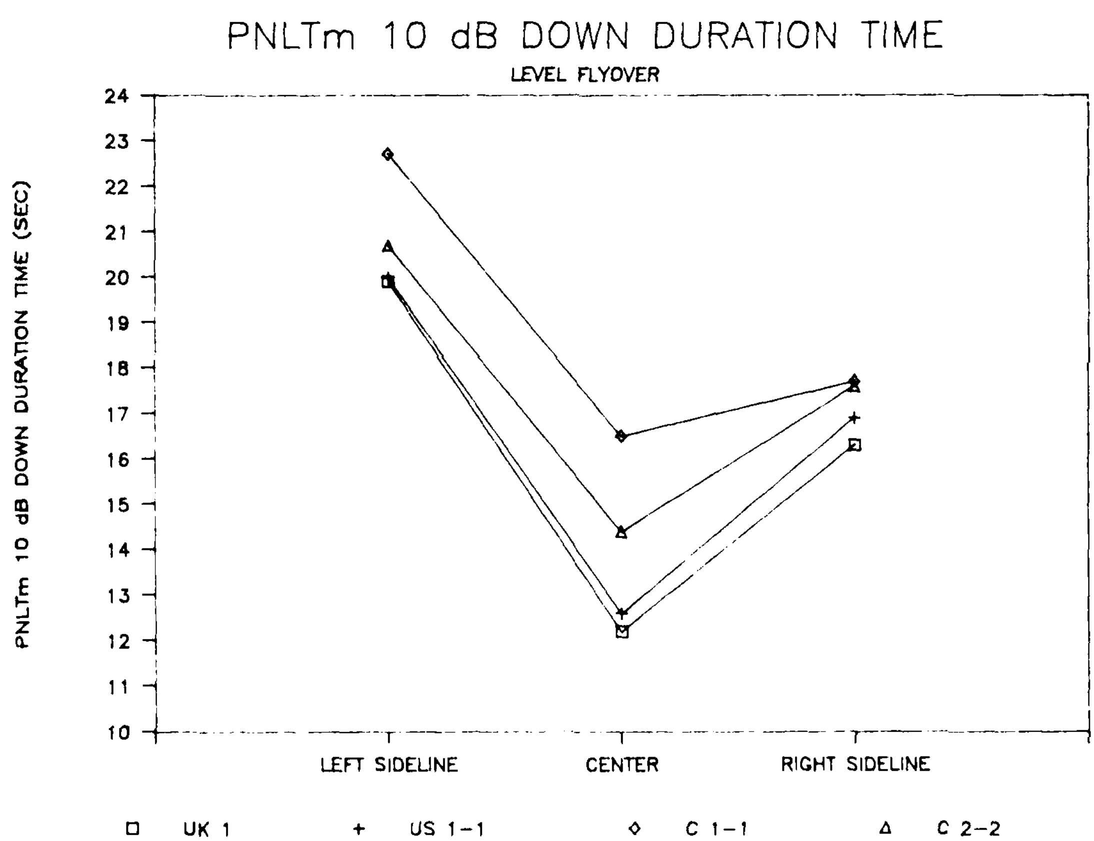


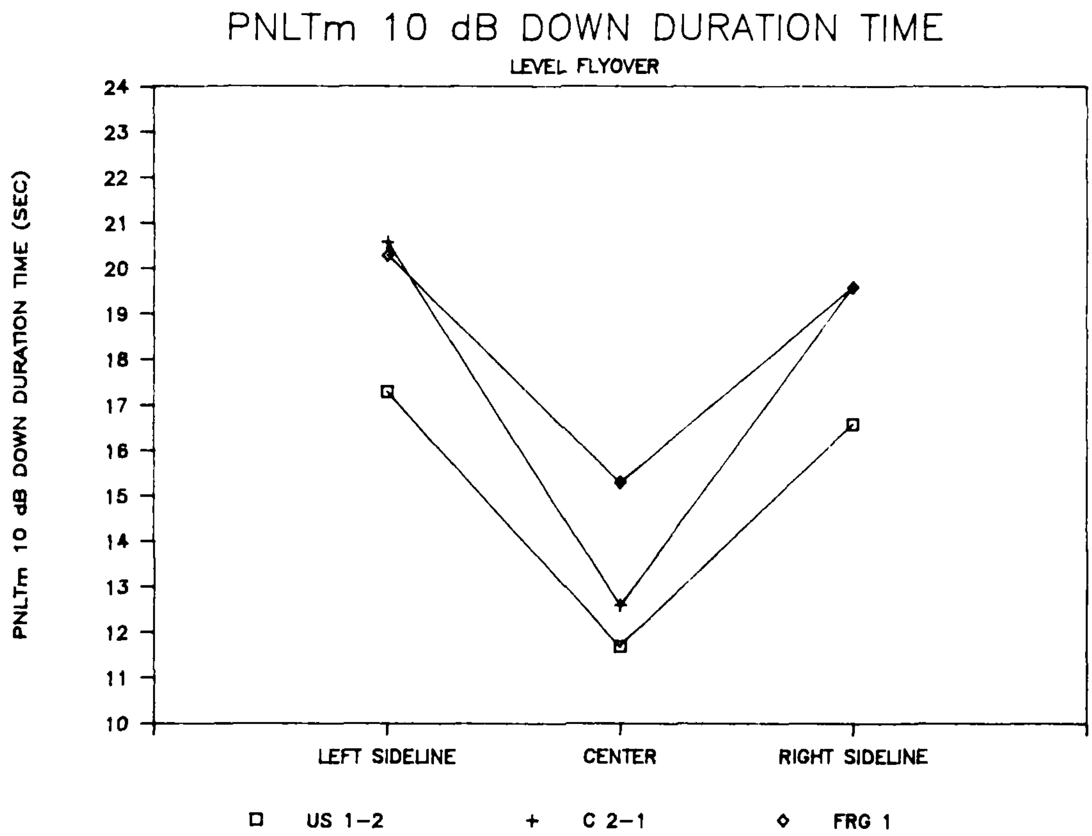
PNLTm 10 dB DOWN DURATION TIME
APPROACH
PNLTm 10 dB DOWN DURATION TIME (SEC)
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
LEFT SIDELINE
CENTER
RIGHT SIDELINE
FRG 1

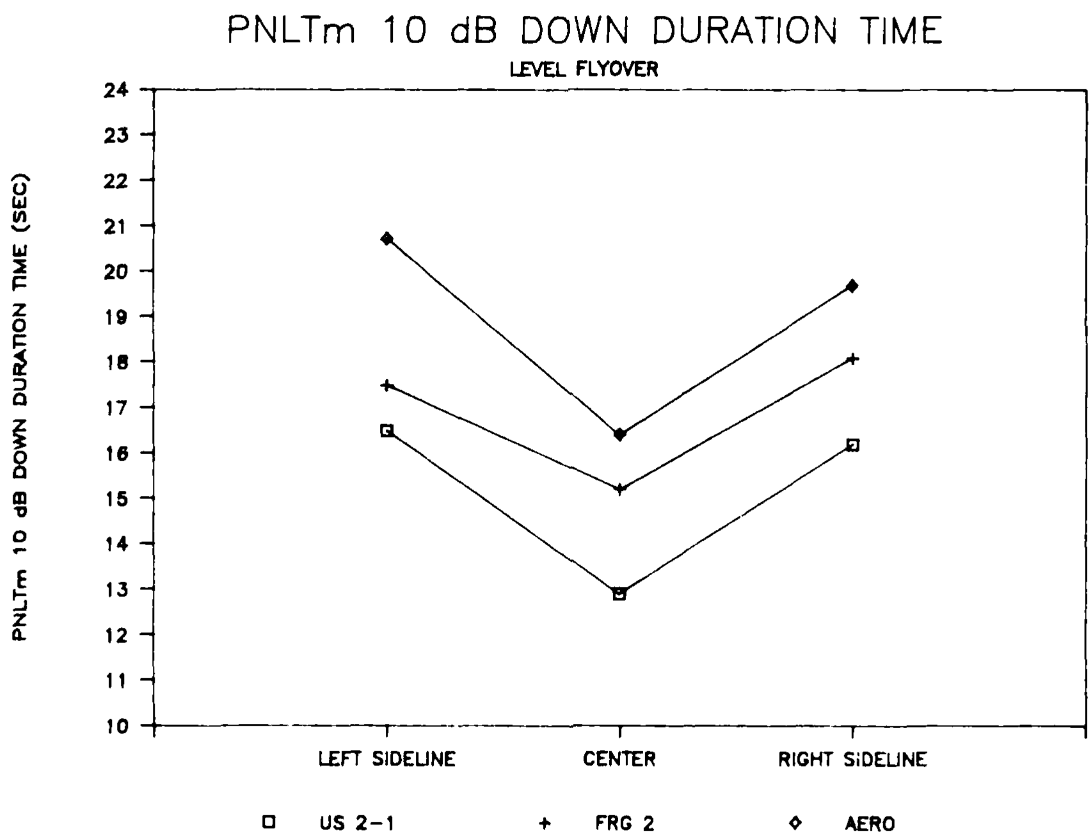

PNLTm 10 dB DOWN DURATION TIME
APPROACH
PNLTm 10 dB DOWN DURATION TIME (SEC)
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
LEFT SIDELINE
CENTER
RIGHT SIDELINE
FRG2
US1-2
US2-2
AERO
STNA
AUS

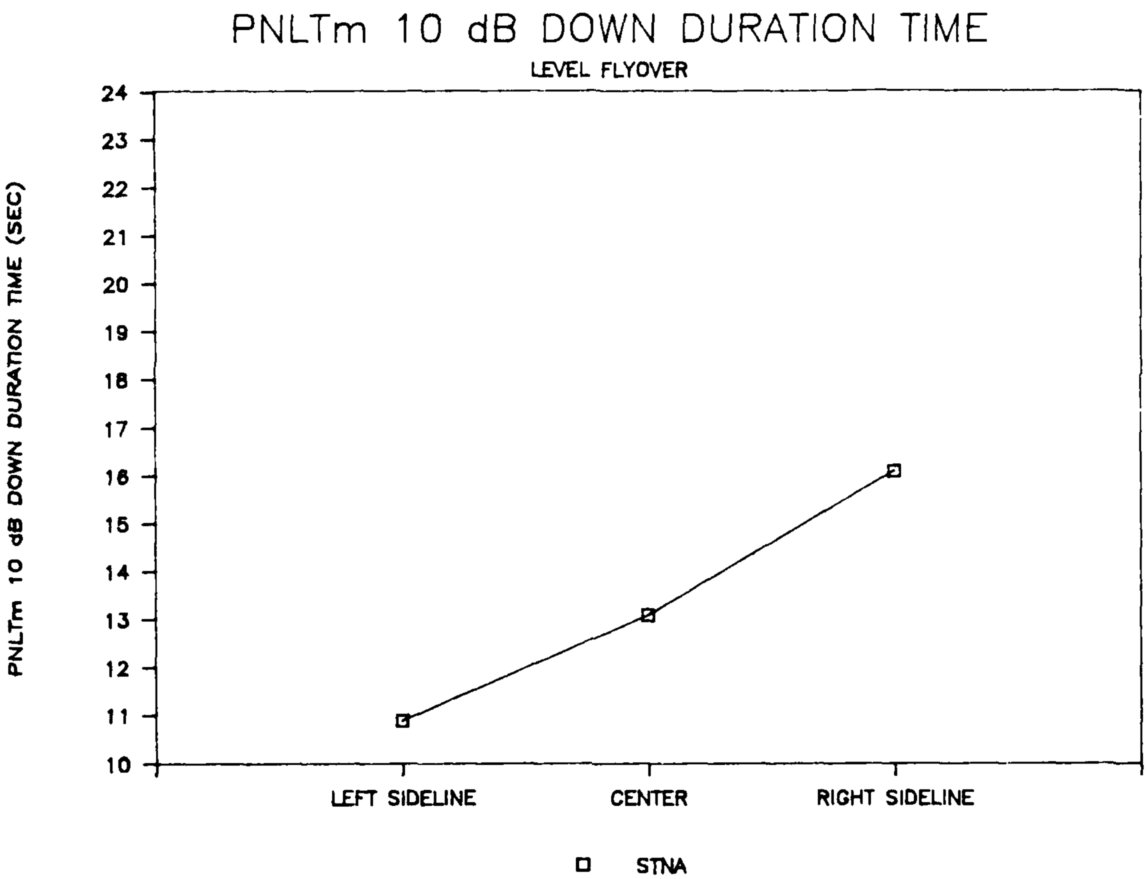

PNLTm 10 dB DOWN DURATION TIME
APPROACH
PNLTm 10 dB DOWN DURATION TIME (SEC)
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
LEFT SIDELINE
CENTER
RIGHT SIDELINE
UK 1
US 1-1
US 2-1
C 2-1


PNLTm 10 dB DOWN DURATION TIME
LEVEL FLYOVER
PNLTm 10 dB DOWN DURATION TIME (SEC)
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
LEFT SIDELINE
CENTER
RIGHT SIDELINE
US 2-2
C 1-2
AUS


PNLTm 10 dB DOWN DURATION TIME
LEVEL FLYOVER
PNLTm 10 dB DOWN DURATION TIME (SEC)
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
LEFT SIDELINE
CENTER
RIGHT SIDELINE
UK 1
US 1-1
C 1-1
C 2-2


PNLTm 10 dB DOWN DURATION TIME
LEVEL FLYOVER
PNLTm 10 dB DOWN DURATION TIME (SEC)
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
LEFT SIDELINE
CENTER
RIGHT SIDELINE
US 1-2
C 2-1
FRG 1


PNLTm 10 dB DOWN DURATION TIME
LEVEL FLYOVER
PNLTm 10 dB DOWN DURATION TIME (SEC)
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
LEFT SIDELINE
CENTER
RIGHT SIDELINE
US 2-1
FRG 2
AERO


PNLTm 10 dB DOWN DURATION TIME
LEVEL FLYOVER
PNLTm 10 dB DOWN DURATION TIME (SEC)
24
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16
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14
13
12
11
10
LEFT SIDELINE
CENTER
RIGHT SIDELINE
STNA

Appendix B

Meteorological Data

Wind Data

Australian Test

OPERATION: APPROACH TIME	EVENT	FLIGHT DIRECTION (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (LEFT/RIGHT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
9.03	8	180	1.94	285	RIGHT	1.88	TAIL	0.50
9.08	9	180	1.94	285	RIGHT	1.88	TAIL	0.50
9.15	10	180	1.94	280	RIGHT	1.91	TAIL	0.34
9.20	11	180	1.94	280	RIGHT	1.91	TAIL	0.34
11.08	22	180	1.94	280	RIGHT	1.91	TAIL	0.34
11.12	23	180	3.88	360	NO X-WIND	0.00	TAIL	3.89
14.18	30	180	3.88	360	NO X-WIND	0.00	TAIL	3.89
15.39	37	180	5.82	020	LEFT	1.99	TAIL	5.48

OPERATION: FLYOVER TIME	EVENT	FLIGHT DIRECTION (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (LEFT/RIGHT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
8.25	1	360	1.94	295	LEFT	1.76	HEAD	0.82
8.28	2	180	1.94	295	RIGHT	1.76	TAIL	0.82
8.32	3	360	1.94	295	LEFT	1.76	HEAD	0.82
8.35	4	180	1.94	295	RIGHT	1.76	TAIL	0.82
8.39	5	360	1.94	295	LEFT	1.76	HEAD	0.82
8.42	6	180	1.94	295	RIGHT	1.76	TAIL	0.82
8.45	7	360	1.94	300	LEFT	1.68	HEAD	0.97
14.50	31	180	3.88	020	LEFT	1.33	TAIL	3.65
14.53	32	360	3.88	020	RIGHT	1.33	HEAD	3.65
14.56	33	180	3.88	020	LEFT	1.33	TAIL	3.65
14.58	34	360	3.88	340	LEFT	1.33	HEAD	3.65
15.32	35	180	3.88	020	LEFT	1.33	TAIL	3.65
15.35	36	360	5.82	020	RIGHT	1.99	HEAD	5.48

OPERATION: TAKEOFF TIME	EVENT	FLIGHT DIRECTION (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (LEFT/RIGHT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
10.21	12	180	3.88	325	RIGHT	2.23	TAIL	3.18
10.24	13	180	3.88	325	RIGHT	2.23	TAIL	3.18
10.28	14	180	3.88	325	RIGHT	2.23	TAIL	3.18
10.31	15	180	3.88	325	RIGHT	2.23	TAIL	3.18
10.34	16	180	3.88	330	RIGHT	1.94	TAIL	3.37
10.36	17	180	3.88	330	RIGHT	1.94	TAIL	3.37
10.39	18	180	3.88	330	RIGHT	1.94	TAIL	3.37
10.42	19	180	3.88	330	RIGHT	1.94	TAIL	3.37
10.45	20	180	3.88	360	NO X-WIND	0.00	TAIL	3.89
11.04	21	180	3.88	360	NO X-WIND	0.00	TAIL	3.89
14.00	24	180	3.88	005	LEFT	0.34	TAIL	3.87
10.03	25	180	3.88	005	LEFT	0.34	TAIL	3.87
14.07	26	180	3.88	005	LEFT	0.34	TAIL	3.87
14.10	27	180	3.88	360	NO X-WIND	0.00	TAIL	3.89
14.13	28	180	3.88	360	NO X-WIND	0.00	TAIL	3.89
14.16	29	180	3.88	360	NO X-WIND	0.00	TAIL	3.89

Wind Data

French-Italian Test

OPERATION: APPROACH TIME	EVENT	FLIGHT DIRECTION (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (LEFT/RIGHT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
16.00	98	089	6.0	180	RIGHT	6.00	TAIL	0.10
16.04	99	089	6.5	160	RIGHT	6.15	HEAD	2.12
16.08	100	089	6.0	160	RIGHT	5.67	HEAD	1.95
16.11	101	089	11.0	180	RIGHT	11.00	TAIL	0.19
16.18	103	089	5.5	160	RIGHT	5.20	HEAD	1.79
16.25	104	089	6.0	180	RIGHT	6.00	TAIL	0.10
16.28	105	089	4.0	140	RIGHT	3.11	HEAD	2.52

OPERATION: FLYOVER TIME	EVENT	FLIGHT DIRECTION (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (LEFT/RIGHT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
11.42	5	269	1.0	255	LEFT	0.24	HEAD	0.97
11.45	6	089	0.0	260	NO X-WIND	0.00	NO H/T WIND	0.00
11.47	7	269	1.0	272	RIGHT	0.05	HEAD	1.00
11.50	8	089	1.0	280	LEFT	0.19	TAIL	0.98
11.55	9	269	1.0	300	RIGHT	0.52	HEAD	0.86
11.59	10	089	1.0	280	LEFT	0.19	TAIL	0.95
12.02	11	269	1.0	280	RIGHT	0.19	HEAD	0.98
12.04	12	089	1.0	280	LEFT	0.19	TAIL	0.98
12.09	13	089	NA	NA	NO X-WIND	NA	NO H/T WIND	NA
12.12	14	269	NA	NA	NO X-WIND	NA	NO H/T WIND	NA

OPERATION: TAKEOFF TIME	EVENT	FLIGHT DIRECTION (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (LEFT/RIGHT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
12.21	88	089	7.0	220	RIGHT	5.28	TAIL	4.59
12.23	89	089	7.0	220	RIGHT	5.28	TAIL	4.59
12.26	90	089	4.0	220	RIGHT	3.02	TAIL	2.62
12.29	91	089	7.0	220	RIGHT	5.28	TAIL	4.59
12.32	92	089	7.0	220	RIGHT	5.28	TAIL	4.59
12.34	93	089	6.0	240	RIGHT	2.91	TAIL	5.25
12.37	94	089	3.0	220	RIGHT	2.26	TAIL	1.97

Wind Data

Japanese Test

OPERATION: APPROACH TIME	EVENT	FLIGHT DIRECTION (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (LEFT/RIGHT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
14.10	B1-8	190	2.7	270	RIGHT	2.66	HEAD	0.47
14.21	B1-12	190	2.7	315	RIGHT	2.21	TAIL	1.55
14.31	B1-16	190	4.7	190	NO X-WIND	0.00	HEAD	4.70
9.23	B1-36	190	3.1	248	RIGHT	2.63	HEAD	1.64
9.37	B1-40	190	3.3	113	LEFT	3.22	HEAD	0.74
9.48	B1-44	190	4.3	135	LEFT	3.52	HEAD	2.47
10.21	B1-48	190	6.4	135	LEFT	5.24	HEAD	3.67
10.30	B1-52	190	5.2	135	LEFT	4.26	HEAD	2.98
10.40	B1-56	190	4.3	113	LEFT	4.19	HEAD	0.97
14.44	B2-20	190	5.8	338	RIGHT	3.07	TAIL	4.92
14.48	B2-20-1	190	4.9	315	RIGHT	4.01	TAIL	2.81
15.18	B2-24	190	1.9	090	LEFT	1.87	TAIL	0.33
15.29	B2-28	190	2.1	113	LEFT	2.05	HEAD	0.47
15.40	B2-32	190	1.9	090	LEFT	1.87	TAIL	0.33
11.18	B2-60	190	6.6	135	LEFT	5.41	HEAD	3.79
11.11	B2-64	190	8.6	158	LEFT	4.56	HEAD	7.29
11.39	B2-68	190	3.9	113	LEFT	3.80	HEAD	0.88
12.07	B2-72	190	6.6	158	LEFT	3.50	HEAD	5.60
12.17	B2-76	190	6.2	180	LEFT	1.08	HEAD	6.11
12.28	B2-80	190	8.2	158	LEFT	4.35	HEAD	6.95

OPERATION: FLYOVER TIME	EVENT	FLIGHT DIRECTION (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (LEFT/RIGHT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
9.17	C1-35	010	[illegible]	248	LEFT	1.95	TAIL	1.22
9.21	C1-35-1	010	2.5	248	LEFT	2.12	TAIL	1.32
9.30	C1-39	010	2.3	203	LEFT	0.52	TAIL	2.24
9.34	C1-39-1	010	1.9	180	RIGHT	0.33	TAIL	1.87
11.16	C2-59	010	6.2	135	RIGHT	5.08	TAIL	3.56
11.25	C2-63	010	4.9	158	RIGHT	2.60	TAIL	4.16
12.15	C2-74	010	7.4	158	RIGHT	3.92	TAIL	6.28
12.25	C2-78	010	5.8	225	LEFT	3.33	TAIL	4.75
9.15	D1-34	190	2.1	248	RIGHT	1.78	HEAD	1.11
9.19	D1-34-1	190	3.1	203	RIGHT	0.70	HEAD	3.02
9.28	D1-38	190	1.9	203	RIGHT	0.43	HEAD	1.85
9.33	D1-38-1	190	2.5	180	LEFT	0.43	HEAD	2.46
11.13	D2-58	190	6.8	158	LEFT	3.60	HEAD	5.77
11.23	D2-62	190	5.2	113	LEFT	5.07	HEAD	1.17
11.33	D2-66	190	9.7	156	LEFT	5.14	HEAD	8.23
12.02	D2-70	190	8.0	180	LEFT	1.39	HEAD	7.88

Wind Data

Japanese Test

OPERATION: TIME	TAKEOFF EVENT	FLIGHT DIRECTION (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (LEFT/RIGHT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
13.03	A1-1	010	2.9	248	LEFT	2.46	TAIL	1.54
13.05	A1-2	190	2.7	270	RIGHT	2.66	HEAD	0.47
13.07	A1-3	010	2.3	315	LEFT	1.65	HEAD	1.32
13.09	A1-4	190	2.7	315	RIGHT	2.21	TAIL	1.55
14.02	A1-5	010	2.9	248	LEFT	2.46	TAIL	1.54
14.05	A1-6	190	2.9	248	RIGHT	2.46	HEAD	1.54
14.08	A1-7	010	2.1	270	LEFT	2.07	TAIL	0.36
14.14	A1-9	010	1.2	270	LEFT	1.18	TAIL	0.21
14.16	A1-10	190	1.9	293	RIGHT	1.85	TAIL	0.43
14.18	A1-11	010	2.3	315	LEFT	1.88	HEAD	1.32
14.24	A1-13	010	3.1	338	LEFT	1.64	HEAD	2.63
14.26	A1-14	190	3.7	315	RIGHT	3.03	TAIL	2.12
14.28	A1-15	010	4.7	315	LEFT	3.65	HEAD	2.70
9.13	A1-33	010	1.4	248	LEFT	1.19	TAIL	0.74
9.26	A1-37	010	2.3	230	LEFT	1.48	TAIL	1.76
9.40	A1-41	010	4.1	135	RIGHT	3.36	TAIL	2.35
10.16	A1-45	010	5.1	113	RIGHT	4.97	TAIL	1.15
10.24	A1-49	010	4.3	135	RIGHT	3.52	TAIL	2.47
10.34	A1-53	010	4.3	113	RIGHT	4.19	TAIL	0.97
13.59	A1-85	010	5.1	315	LEFT	4.18	HEAD	2.93
14.12	A1-89	010	7.8	315	LEFT	6.39	HEAD	4.47
14.26	A1-93	010	10.1	270	LEFT	9.95	TAIL	1.75
14.38	A2-17	010	5.1	315	LEFT	4.18	HEAD	2.93
14.40	A2-18	190	5.1	315	RIGHT	4.18	TAIL	2.93
14.42	A2-19	010	5.4	338	LEFT	2.86	HEAD	4.58
14.46	A2-17-1	010	5.2	315	LEFT	4.26	HEAD	2.98
15.12	A2-21	010	1.2	045	RIGHT	0.69	HEAD	0.98
15.14	A2-22	190	1.0	068	LEFT	0.85	TAIL	0.53
15.15	A2-23	010	0.8	068	RIGHT	0.68	HEAD	0.42
15.20	A2-25	010	2.3	068	RIGHT	1.95	HEAD	1.22
15.23	A2-26	190	0.8	090	LEFT	0.79	TAIL	0.14
15.25	A2-27	010	1.0	068	RIGHT	0.85	HEAD	0.53
15.32	A2-29	010	1.9	090	RIGHT	1.67	HEAD	0.33
15.35	A2-30	190	3.5	090	LEFT	3.45	TAIL	0.61
15.37	A2-31	010	3.5	068	RIGHT	2.97	HEAD	1.85
11.11	A2-57	010	4.9	135	RIGHT	4.01	TAIL	2.81
11.21	A2-61	010	7.8	158	RIGHT	4.13	TAIL	6.61
11.30	A2-65	010	6.8	180	RIGHT	1.18	TAIL	6.70
12.00	A2-69	010	7.0	203	LEFT	1.57	TAIL	6.82
12.10	A2-73	010	6.5	180	RIGHT	1.15	TAIL	6.50
12.20	A2-77	010	5.8	180	RIGHT	1.01	TAIL	5.71
13.45	A2-81	010	3.7	248	LEFT	3.14	TAIL	1.96

Wind Data

UK-FRG Test

OPERATION: APPROACH TIME	EVENT	FLIGHT DIRECTION (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (LEFT/RIGHT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
9.58	C.1.1	301	7.0	330	RIGHT	3.39	HEAD	6.12
10.08	C.1.2	301	9.0	292	LEFT	1.41	HEAD	8.89
10.12	C.1.3	301	8.4	314	RIGHT	1.89	HEAD	8.18
10.15	C.1.4	301	6.6	318	RIGHT	1.93	HEAD	6.31
10.18	C.1.5	301	2.3	297	LEFT	0.16	HEAD	2.29
10.22	C.1.6	301	0.7	181	LEFT	0.61	TAIL	0.35
13.37	C.1.7	301	7.5	047	RIGHT	7.21	TAIL	2.07
13.40	C.1.8	301	4.3	054	RIGHT	3.96	TAIL	1.68
13.43	C.1.9	301	5.0	020	RIGHT	4.91	HEAD	0.95
13.46	C.1.10	301	4.9	052	RIGHT	4.57	TAIL	1.76
13.50	C.1.11	301	5.4	045	RIGHT	5.24	TAIL	1.31
15.11	C.1.12	301	7.1	219	LEFT	7.03	HEAD	0.99
16.18	C.1.13	301	6.3	231	LEFT	5.92	HEAD	2.15
16.24	C.1.14	301	4.0	245	LEFT	3.32	HEAD	2.24
16.27	C.1.15	301	4.1	249	LEFT	3.23	HEAD	2.52
12.27	C.2.1	301	12.3	299	LEFT	0.43	HEAD	12.29
12.35	C.2.2	301	8.7	298	LEFT	0.46	HEAD	8.69
12.41	C.2.3	301	13.3	304	RIGHT	0.70	HEAD	13.28
10.29	C.2.4	301	6.8	293	LEFT	0.95	HEAD	6.73
10.35	C.2.5	301	6.1	289	LEFT	1.27	HEAD	5.97
10.39	C.2.6	301	8.4	300	LEFT	0.15	HEAD	8.40
11.36	C.2.7	301	8.3	341	RIGHT	5.34	HEAD	6.36
11.39	C.2.8	301	7.2	319	RIGHT	2.22	HEAD	6.85
11.42	C.2.9	301	6.5	317	RIGHT	1.79	HEAD	6.25
11.48	C.2.10	301	NA	NA	NO X-WIND	NA	NO H/T WIND	NA
11.49	C.2.11	301	7.1	304	RIGHT	0.37	HEAD	7.09
11.55	C.2.12	301	7.3	281	LEFT	2.50	HEAD	6.86
12.20	C.2.13	301	9.4	308	RIGHT	1.15	HEAD	9.33
12.23	C.2.14	301	10.4	297	LEFT	0.73	HEAD	10.37
NA	C.2.15	301	NA	NA	NO X-WIND	NA	NO H/T WIND	NA
12.29	C.2.16	301	8.1	284	LEFT	2.37	HEAD	7.75
12.33	C.2.17	301	7.3	295	LEFT	0.76	HEAD	7.26

Wind Data

UK-FRG Test

OPERATION: TIME	LFO EVENT	FLIGHT DIRECTION (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (LEFT/RIGHT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
13.54	B.1.1	121	5.8	283	RIGHT	1.79	TAIL	5.52
13.56	B.1.2	301	2.8	291	LEFT	0.49	HEAD	2.76
13.58	B.1.3	121	4.6	295	RIGHT	0.48	TAIL	4.57
14.00	B.1.4	301	7.2	275	LEFT	3.16	HEAD	6.47
14.01	B.1.5	121	8.6	253	RIGHT	6.39	TAIL	5.75
14.03	B.1.6	301	9.0	254	LEFT	6.58	HEAD	6.14
14.16	B.1.7	121	4.0	296	RIGHT	0.35	TAIL	3.98
14.18	B.1.8	301	3.5	301	NO X-WIND	0.00	HEAD	3.50
9.37	B.1.9	207	3.6	240	RIGHT	1.96	HEAD	3.02
9.43	B.1.10	027	3.5	210	LEFT	0.18	TAIL	3.50
9.45	B.1.11	207	2.6	206	LEFT	0.05	HEAD	2.60
9.47	B.1.12	027	1.9	182	RIGHT	0.80	TAIL	1.72
9.53	B.1.13	207	2.4	230	RIGHT	0.94	HEAD	2.21
9.55	B.1.14	027	1.6	168	RIGHT	1.01	TAIL	1.24
9.59	B.1.15	027	0.9	203	RIGHT	0.06	TAIL	0.90
12.47	B.2.1	301	11.6	305	RIGHT	0.81	HEAD	11.57
12.50	B.2.2	301	10.8	312	RIGHT	2.06	HEAD	10.60
12.42	B.2.3	301	3.3	299	LEFT	0.12	HEAD	3.30
12.45	B.2.4	121	6.7	313	LEFT	1.39	TAIL	6.55
12.49	B.2.5	301	5.8	249	LEFT	4.57	HEAD	3.57
12.51	B.2.6	121	8.7	315	LEFT	2.10	TAIL	8.44
13.02	B.2.7	121	7.8	330	LEFT	3.78	TAIL	6.82
13.05	B.2.8	301	8.2	360	RIGHT	7.03	HEAD	4.22
13.06	B.2.9	121	7.0	360	LEFT	6.00	TAIL	3.61
13.09	B.2.10	301	7.8	360	RIGHT	6.69	HEAD	4.02
13.15	B.2.11	301	9.4	319	RIGHT	2.90	HEAD	8.94
13.17	B.2.12	121	11.0	317	LEFT	3.03	TAIL	10.57
13.19	B.2.13	301	7.4	304	RIGHT	0.39	HEAD	7.39

OPERATION: TIME	TAKEOFF EVENT	FLIGHT DIRECTION (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (LEFT/RIGHT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
17.11	A.1.1	207	6.0	205	LEFT	0.21	HEAD	6.00
17.13	A.1.2	207	7.1	307	RIGHT	6.99	TAIL	1.23
17.16	A.1.3	207	6.2	310	RIGHT	6.04	TAIL	1.39
17.18	A.1.4	207	6.4	306	RIGHT	6.32	TAIL	1.00
17.26	A.1.5	207	4.5	320	RIGHT	4.14	TAIL	1.76
17.28	A.1.6	207	4.5	284	RIGHT	4.38	HEAD	1.01
17.40	A.1.7	207	3.1	206	LEFT	0.05	HEAD	3.10
17.42	A.1.8	207	3.2	201	LEFT	0.33	HEAD	3.18
17.45	A.1.9	207	2.8	283	RIGHT	2.72	HEAD	0.68
11.15	A.2.1	207	2.2	287	RIGHT	2.17	HEAD	0.38
11.18	A.2.2	207	2.9	287	RIGHT	2.86	HEAD	0.50
11.20	A.2.3	207	3.2	312	RIGHT	3.09	TAIL	0.83
11.22	A.2.4	207	4.3	294	RIGHT	4.29	HEAD	0.23
11.25	A.2.5	207	3.5	274	RIGHT	3.22	HEAD	1.37
11.27	A.2.6	207	5.6	242	RIGHT	3.21	HEAD	4.59

Wind Data

US-Canadian Test

APPROACH

TIME	EVENT	AIRCRAFT HEADING (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (RIGHT/LEFT) DIRECTION	CROSS WIND COMPONET (RIGHT/LEFT) (KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	ON TRACK COMPONET (HEAD/TAIL) (KNOTS)
11:26	C-32	120	3.90	250	RIGHT	2.99	TAIL	2.51
11:33	C-34	120	4.30	165	RIGHT	3.04	HEAD	3.04
11:41	C-36	120	4.30	165	RIGHT	3.04	HEAD	3.04
11:56	C-38	120	4.30	160	RIGHT	2.76	HEAD	3.29
12:03	C-40	120	2.60	160	RIGHT	1.67	HEAD	1.99
12:09	C-42	120	2.60	160	RIGHT	1.67	HEAD	1.99
12:16	C-44	120	3.90	220	RIGHT	3.84	TAIL	0.68
12:25	C-46	120	3.90	220	RIGHT	3.84	TAIL	0.68
12:31	C-48	120	3.90	250	RIGHT	2.99	TAIL	2.51
12:39	C-50	120	3.90	250	RIGHT	2.99	TAIL	2.51

TIME	EVENT	AIRCRAFT HEADING (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (RIGHT/LEFT) DIRECTION	CROSS WIND COMPONET (RIGHT/LEFT) (KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	ON TRACK COMPONET (HEAD/TAIL) (KNOTS)
08:43	CC-10	120	2.20	130	RIGHT	0.38	HEAD	2.17
08:52	CC-12	120	3.50	170	RIGHT	2.68	HEAD	2.25
08:58	CC-14	120	3.50	170	RIGHT	2.68	HEAD	2.25
10:36	CC-16	120	2.60	190	RIGHT	2.44	HEAD	0.89
10:45	CC-18	120	2.60	180	RIGHT	2.25	HEAD	1.30
10:52	CC-20	120	2.60	180	RIGHT	2.25	HEAD	1.30
10:59	CC-22	120	2.60	180	RIGHT	2.25	HEAD	1.30
11:07	CC-24	120	4.30	230	RIGHT	4.04	TAIL	1.47

TIME	EVENT	AIRCRAFT HEADING (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (RIGHT/LEFT) DIRECTION	CROSS WIND COMPONET (RIGHT/LEFT) (KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	ON TRACK COMPONET (HEAD/TAIL) (KNOTS)
11:40	CZ-31	120	4.30	200	RIGHT	4.23	HEAD	0.75
11:54	CZ-33	120	4.30	180	RIGHT	3.72	HEAD	2.15
12:01	CZ-35	120	5.20	170	RIGHT	3.98	HEAD	3.34
12:09	CZ-37	120	5.20	170	RIGHT	3.98	HEAD	3.34
12:15	CZ-39	120	4.30	180	RIGHT	3.72	HEAD	2.15

TIME	EVENT	AIRCRAFT HEADING (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (RIGHT/LEFT) DIRECTION	CROSS WIND COMPONET (RIGHT/LEFT) (KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	ON TRACK COMPONET (HEAD/TAIL) (KNOTS)
08:16	CY- 2	120	3.90	215	RIGHT	3.89	TAIL	0.34
08:27	CY- 4	120	3.90	215	RIGHT	3.89	TAIL	0.34
08:33	CY- 6	120	3.50	210	RIGHT	3.50	NO H/T WIND	0.00
11:40	CY- 8	120	3.50	180	RIGHT	3.03	HEAD	1.75
11:47	CY-10	120	4.30	180	RIGHT	3.72	HEAD	2.15
11:52	CY-12	120	4.30	180	RIGHT	3.72	HEAD	2.15
11:58	CY-14	120	4.30	180	RIGHT	3.72	HEAD	2.15
12:04	CY-16	120	6.10	200	RIGHT	6.01	HEAD	1.06
12:10	CY-18	120	6.10	200	RIGHT	6.01	HEAD	1.06

Wind Data

US-Canadian Test

FLYOVER

TIME	EVENT	AIRCRAFT HEADING (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (RIGHT/LEFT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
08:35	A1-1	300	0.90	360	RIGHT	0.78	HEAD	0.45
08:35	A1-2	120	0.90	360	LEFT	0.78	TAIL	0.45
08:44	A1-4	120	0.90	360	LEFT	0.78	TAIL	0.45
08:46	A1-5	300	0.90	60	RIGHT	0.78	TAIL	0.45
08:49	A1-6	120	0.90	60	LEFT	0.78	HEAD	0.45
08:51	A1-7	300	0.90	60	RIGHT	0.78	TAIL	0.45
08:55	A1-8	120	0.90	60	LEFT	0.78	HEAD	0.45

TIME	EVENT	AIRCRAFT HEADING (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (RIGHT/LEFT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
08:19	AA-1	120	3.50	190	RIGHT	3.29	HEAD	1.20
08:22	AA-2	300	3.50	190	LEFT	3.29	TAIL	1.20
08:24	AA-3	120	3.50	190	RIGHT	3.29	HEAD	1.20
08:29	AA-5	120	3.50	190	RIGHT	3.29	HEAD	1.20
08:31	AA-6	300	4.30	180	LEFT	3.72	TAIL	2.15
08:34	AA-7	120	4.30	180	RIGHT	3.72	HEAD	2.15
08:36	AA-8	300	4.30	180	LEFT	3.72	TAIL	2.15

TIME	EVENT	AIRCRAFT HEADING (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (RIGHT/LEFT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
11:24	AZ-26	300	4.30	190	LEFT	4.04	TAIL	1.47
11:28	AZ-27	120	4.30	190	RIGHT	4.04	HEAD	1.47
11:30	AZ-28	300	4.30	200	LEFT	4.23	TAIL	0.75
11:33	AZ-29	120	4.30	200	RIGHT	4.23	HEAD	0.75
11:36	AZ-30	300	4.30	200	LEFT	4.23	TAIL	0.75

TIME	EVENT	AIRCRAFT HEADING (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (RIGHT/LEFT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
12:16	AY-19	300	4.30	205	LEFT	4.28	TAIL	0.37
12:20	AY-20	120	4.30	205	RIGHT	4.28	HEAD	0.37
12:23	AY-21	300	4.30	205	LEFT	4.28	TAIL	0.37
12:25	AY-22	120	4.30	205	RIGHT	4.28	HEAD	0.37
12:36	AY-23	300	5.20	170	LEFT	3.98	TAIL	3.34
12:38	AY-24	120	5.20	170	RIGHT	3.98	HEAD	3.34
12:40	AY-25	300	5.20	170	LEFT	3.98	TAIL	3.34
12:47	AY-27	300	5.60	190	LEFT	5.26	TAIL	1.92
12:51	AY-28	120	5.60	190	RIGHT	5.26	HEAD	1.92
12:54	AY-29	300	5.60	190	LEFT	5.26	TAIL	1.92
12:57	AY-30	120	5.60	190	RIGHT	5.26	HEAD	1.92

Wind Data

US-Canadian Test

TAKEOFF

TIME	EVENT	AIRCRAFT HEADING (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (RIGHT/LEFT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
11:29	B-33	300	4.30	165	LEFT	3.04	TAIL	3.04
11:52	B-37	300	4.30	160	LEFT	2.76	TAIL	3.29
11:59	B-39	300	4.30	160	LEFT	2.76	TAIL	3.29
12:06	B-41	300	2.60	160	LEFT	1.67	TAIL	1.99
12:12	B-43	300	2.60	160	LEFT	1.67	TAIL	1.99
12:21	B-45	300	3.90	220	LEFT	3.84	HEAD	0.68
12:28	B-47	300	3.90	220	LEFT	3.84	HEAD	0.68
12:34	B-49	300	3.90	250	LEFT	2.99	HEAD	2.51
12:47	B-52	300	4.30	230	LEFT	4.04	HEAD	1.47

TIME	EVENT	AIRCRAFT HEADING (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (RIGHT/LEFT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
08:47	BB-11	300	3.90	175	LEFT	3.19	TAIL	2.24
08:54	BB-13	300	3.90	175	LEFT	3.19	TAIL	2.24
10:32	BB-15	300	2.60	190	LEFT	2.44	TAIL	0.89
10:41	BB-17	300	2.60	190	LEFT	2.44	TAIL	0.89
10:48	BB-19	300	2.60	180	LEFT	2.25	TAIL	1.30
11:03	BB-23	300	4.30	230	LEFT	4.04	HEAD	1.47
11:10	BB-25	300	4.30	230	LEFT	4.04	HEAD	1.47

TIME	EVENT	AIRCRAFT HEADING (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (RIGHT/LEFT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
11:49	BZ-32	300	4.30	180	LEFT	3.72	TAIL	2.15
11:57	BZ-34	300	4.30	180	LEFT	3.72	TAIL	2.15
12:04	BZ-36	300	5.20	170	LEFT	3.98	TAIL	3.34
12:12	BZ-38	300	5.20	170	LEFT	3.98	TAIL	3.34
12:18	BZ-40	300	4.30	180	LEFT	3.72	TAIL	2.15

TIME	EVENT	AIRCRAFT HEADING (DEGREES)	WIND SPEED (KNOTS)	WIND DIRECTION (DEGREES)	CROSS WIND COMPONET (RIGHT/LEFT) DIRECTION	(KNOTS)	ON TRACK COMPONET (HEAD/TAIL) DIRECTION	(KNOTS)
08:24	BY- 3	300	3.90	215	LEFT	3.89	HEAD	0.34
08:30	BY- 5	300	3.50	210	LEFT	3.50	NO H/T WIND	0.00
11:44	BY- 9	300	4.30	180	LEFT	3.72	TAIL	2.15
11:49	BY-11	300	4.30	180	LEFT	3.72	TAIL	2.15
11:51	BY-13	300	4.30	180	LEFT	3.72	TAIL	2.15
12:01	BY-15	300	6.10	200	LEFT	6.01	TAIL	1.06
12:06	BY-17	300	6.10	200	LEFT	6.01	TAIL	1.06

TEMPERATURE & RELATIVE HUMIDITY
METEOROLOGICAL DATA SUMMARY TABLE

COUNTRY : AUSTRALIA
OPERATION : TAKEOFF

EVENT	TIME	TEMPERATURE (DEGREES C)	RELATIVE HUMIDITY (%)
12	10:21	9.5	70
13	10:24	9.5	70
14	10:28	9.5	70
15	10:31	9.5	70
16	10:34	9.5	70
17	10:36	9.5	70
18	10:39	9.5	70
19	10:42	9.5	70
20	10:45	10.0	65
21	11:04	10.5	65
24	14:00	12.5	50
25	14:03	12.5	50
26	14:07	12.5	50
27	14:10	12.5	50
28	14:13	12.5	50
29	14:16	12.5	50

COUNTRY : AUSTRALIA
OPERATION : APPROACH

EVENT	TIME	TEMPERATURE (DEGREES C)	RELATIVE HUMIDITY (%)
8	09:03	8.0	80
9	09:08	8.0	80
10	09:15	8.0	75
11	09:20	8.0	75
22	11:08	10.5	65
23	11:12	10.5	60
30	14:18	12.5	50
37	15:39	12.5	50

COUNTRY : AUSTRALIA
OPERATION : LEVEL FLYOVER

EVENT	TIME	TEMPERATURE (DEGREES C)	RELATIVE HUMIDITY (%)
1	08:25	7.0	75
2	08:28	7.0	75
3	08:32	7.0	75
4	08:35	7.5	75
5	08:39	7.5	75
6	08:42	7.5	75
7	08:45	7.5	80
31	14:50	12.0	50
32	14:53	12.0	50
33	14:56	12.0	50
34	14:58	12.0	50
35	15:32	12.5	50
36	15:35	12.5	50

TEMPERATURE & RELATIVE HUMIDITY
METEOROLOGICAL DATA SUMMARY TABLE

COUNTRY : JAPAN
OPERATION : TAKEOFF

EVENT	TIME	DATE	TEMPERATURE (DEGREES C)	RELATIVE HUMIDITY (%)
A1- 5	14:02	DEC 1	10.4	58
A1- 9	14:14	DEC 1	10.3	68
A1-13	14:24	DEC 1	10.3	74
A1-33	09:13	DEC 2	7.8	72
A1-37	09:26	DEC 2	8.3	70
A1-41	09:40	DEC 2	9.4	68
A1-45	10;16	DEC 2	10.8	60
A1-49	10:24	DEC 2	11.1	56
A1-53	10:34	DEC 2	11.4	52
A2-21	15:12	DEC 1	10.1	72
A2-25	15:20	DEC 1	10.3	69
A2-29	15:32	DEC 1	10.5	65
A2-57	11:11	DEC 2	13.1	45
A2-61	11:21	DEC 2	13.2	44
A2-65	11:30	DEC 2	13.3	43
A2-69	12:00	DEC 2	13.7	48
A2-73	12:10	DEC 2	14.1	46
A2-77	12:20	DEC 2	14.5	42

COUNTRY : JAPAN
OPERATION : APPROACH

EVENT	TIME	DATE	TEMPERATURE (DEGREES C)	RELATIVE HUMIDITY (%)
B1- 8	14:10	DEC 1	10.4	65
B1-12	14:21	DEC 1	10.3	72
B1-16	14:31	DEC 1	10.2	78
B1-36	09:23	DEC 2	8.2	70
B1-40	09:37	DEC 2	9.2	68
B1-44	09:48	DEC 2	9.7	67
B1-48	10:21	DEC 2	11.0	57
B1-52	10:30	DEC 2	11.3	53
B1-56	10:40	DEC 2	11.7	50
B2-24	15:18	DEC 1	10.2	70
B2-28	15:29	DEC 1	10.4	66
B2-32	15:40	DEC 1	10.6	62
B2-60	11:18	DEC 2	13.2	44
B2-64	11:28	DEC 2	13.3	43
B2-68	11:39	DEC 2	13.4	43
B2-72	12:07	DEC 2	14.0	47
B2-76	12:17	DEC 2	14.4	43
B2-80	12:28	DEC 2	14.9	40

TEMPERATURE & RELATIVE HUMIDITY
METEOROLOGICAL DATA SUMMARY TABLE

COUNTRY : JAPAN
OPERATION : LEVEL FLYOVER

EVENT	TIME	DATE	TEMPERATURE (DEGREES C)	RELATIVE HUMIDITY (%)
C1-39.1	09:34	DEC 2	9.0	69
C1-39	09:30	DEC 2	8.7	69
C1-35	09:17	DEC 2	7.9	71
C1-35.1	09:21	DEC 2	8.1	71
C2-74	12:15	DEC 2	14.3	44
C2-78	12:25	DEC 2	14.8	41
C2-59	11:16	DEC 2	13.1	44
C2-63	11:25	DEC 2	13.3	44
D1-34	09:15	DEC 2	7.8	72
D1-38	09:28	DEC 2	8.5	70
D1-34.1	09:19	DEC 2	8.0	71
D1-38.1	09:33	DEC 2	8.9	69
D2-58	11:13	DEC 2	13.1	45
D2-62	11:23	DEC 2	13.2	44
D2-66	11:33	DEC 2	13.3	43
D2-70	12:02	DEC 2	13.9	48

TEMPERATURE & RELATIVE HUMIDITY
METEOROLOGICAL DATA SUMMARY TABLE

COUNTRY : FRANCE AERO/STNA
OPERATION : TAKEOFF

EVENT	START TIME	DATE	TEMPERATURE (DEGREES C)	RELATIVE HUMIDITY (%)
88.00	12:21	OCT 17	17.6	72
89.00	12:23	OCT 17	17.6	72
90.00	12:26	OCT 17	17.6	72
91.00	12:29	OCT 17	17.6	72
92.00	12:32	OCT 17	17.6	72
93.00	12:34	OCT 17	17.6	72
94.00	12:37	OCT 17	17.6	72

COUNTRY : FRANCE AERO/STNA
OPERATION : APPROACH

EVENT	START TIME	DATE	TEMPERATURE (DEGREES C)	RELATIVE HUMIDITY (%)
98	16:00	OCT 17	17	78.5
99	16:04	OCT 17	17	78.5
100	16:08	OCT 17	17	78.5
101	16:11	OCT 17	17	78.5
103	16:18	OCT 17	17	78.5
104	16:25	OCT 17	17	78.0
105	16:28	OCT 17	17	78.0

COUNTRY : FRANCE AERO/STNA
OPERATION : LEVEL FLYOVER

EVENT	START TIME	DATE	TEMPERATURE (DEGREES C)	RELATIVE HUMIDITY (%)
5	11:42	OCT 16	17.0	71.0
6	11:45	OCT 16	17.0	71.0
7	11:47	OCT 16	17.0	71.0
8	11:50	OCT 16	17.2	70.8
9	11:55	OCT 16	17.5	70.5
10	11:59	OCT 16	17.5	70.0
11	12:02	OCT 16	17.8	69.5
12	12:04	OCT 16	18.0	69.0
13	12:09	OCT 16	18.0	68.5
14	12:12	OCT 16	18.0	68.0

TEMPERATURE & RELATIVE HUMIDITY
METEOROLOGICAL DATA SUMMARY TABLE

COUNTRY : UK/FRG
OPERATION : TAKEOFF

EVENT	TIME	DATE	TEMPERATURE (DEGREES C)	RELATIVE HUMIDITY (%)
A1-1	17:11	JULY 5	24.5	38.7
A1-2	17:13	JULY 5	24.3	39.4
A1-3	17:16	JULY 5	24.2	40.9
A1-4	17:18	JULY 5	24.2	40.6
A1-5	17:26	JULY 5	24.2	41.4
A1-6	17:28	JULY 5	24.5	39.9
A1-7	17:40	JULY 5	24.2	40.0
A1-8	17:42	JULY 5	25.2	38.6
A1-9	17:45	JULY 5	25.1	38.6
A2-1	11:15	JULY 6	24.1	44.3
A2-2	11:18	JULY 6	24.1	41.9
A2-3	11:20	JULY 6	24.2	42.3
A2-4	11:22	JULY 6	24.1	43.1
A2-5	11:25	JULY 6	23.8	44.0
A2-6	11:27	JULY 6	23.5	40.0

COUNTRY : UK/FRG
OPERATION : APPROACH

EVENT	TIME	DATE	TEMPERATURE (DEGREES C)	RELATIVE HUMIDITY (%)
C1- 1	09:58	JULY 3	16.3	58.5
C1- 2	10:08	JULY 3	17.0	55.5
C1- 3	10:12	JULY 3	15.8	58.3
C1- 4	10:15	JULY 3	16.1	57.5
C1- 5	10:18	JULY 3	16.2	57.3
C1- 6	10:22	JULY 3	16.6	56.1
C1- 7	13:37	JULY 4	20.6	46.7
C1- 8	13:40	JULY 4	20.5	47.4
C1- 9	13:43	JULY 4	20.3	48.0
C1-10	13:46	JULY 4	20.6	47.5
C1-11	13:50	JULY 4	20.5	46.8
C1-12	15:11	JULY 4	19.8	63.4
C1-13	16:18	JULY 4	20.4	58.1
C1-14	16:24	JULY 4	20.3	59.8
C1-15	16:27	JULY 4	20.3	59.7
C2- 1	12:27	JULY 2	16.7	55.0
C2- 2	12:35	JULY 2	17.0	54.8
C3- 3	12:41	JULY 2	17.7	52.9
C2- 4	10:29	JULY 3	16.8	55.8
C2- 5	10:35	JULY 3	17.2	54.2
C2- 6	10:39	JULY 3	16.5	55.9
C2- 7	11:36	JULY 3	17.1	52.6
C2- 8	11:39	JULY 3	17.9	52.0
C2- 9	11:42	JULY 3	17.5	47.8
C2-11	11:49	JULY 3	17.1	50.0
C2-12	11:55	JULY 3	17.9	50.5
C2-14	12:23	JULY 3	17.4	49.7
C2-16	12:29	JULY 3	17.3	49.7
C2-17	12:33	JULY 3	17.3	49.6

TEMPERATURE & RELATIVE HUMIDITY
METEOROLOGICAL DATA SUMMARY TABLE

COUNTRY : UK/FRG
OPERATION : LEVEL FLYOVER

EVENT	TIME	DATE	TEMPERATURE (DEGREES C)	RELATIVE HUMIDITY (%)
B1- 1	13:54	JULY 3	18.9	43.7
B1- 2	13:56	JULY 3	18.7	43.8
B1- 3	13:58	JULY 3	18.6	42.7
B1- 4	14:00	JULY 3	19.6	43.3
B1- 5	14:01	JULY 3	19.5	43.7
B1- 6	14:03	JULY 3	19.7	42.4
B1- 7	14:16	JULY 3	18.9	42.8
B1- 8	14:18	JULY 3	19.5	43.3
B1- 9	09:37	JULY 6	20.7	55.6
B1-10	09:43	JULY 6	20.2	55.9
B1-11	09:45	JULY 6	20.2	55.2
B1-13	09:53	JULY 6	21.5	53.6
B1-14	09:55	JULY 6	20.4	56.8
B1-15	09:59	JULY 6	22.4	50.6
B2- 1	12:47	JULY 2	17.5	52.4
B2- 2	12:50	JULY 2	18.2	50.9
B2- 3	12:42	JULY 3	18.0	47.0
B2- 4	12:45	JULY 3	19.2	46.7
B2- 5	12:49	JULY 3	17.7	47.8
B2- 7	13:02	JULY 3	19.1	47.5
B2- 8	13:05	JULY 3	18.5	48.6
B2- 9	13:0?	JULY 3	18.3	48.2
B2-10	13:09	JULY 3	18.3	48.2
B2-11	13:15	JULY 3	18.5	46.7
B2-12	13:17	JULY 3	18.0	47.3
B2-13	13:19	JULY 3	18.6	47.2

TEMPERATURE & RELATIVE HUMIDITY
METEOROLOGICAL DATA SUMMARY TABLE

COUNTRY : US/CANADA
OPERATION : TAKEOFF

EVENT	TIME	DATE	TEMPERATURE (DEGREES C)	RELATIVE HUMIDITY (%)
B-33	11:29	AUG 27	25	37
B-37	11:52	AUG 27	26	34
B-39	11:59	AUG 27	26	34
B-41	12:06	AUG 27	26	34
B-43	12:12	AUG 27	26	40
B-45	12:21	AUG 27	26	40
B-47	12:28	AUG 27	26	34
B-49	12:34	AUG 27	26	34
B-52	12:47	AUG 27	27	35
BB-11	08:47	AUG 28	21	60
BB-13	08:54	AUG 28	21	64
BB-15	10:32	AUG 28	24	55
BB-17	10:41	AUG 28	24	59
BB-19	10:48	AUG 28	24	59
BB-23	11:03	AUG 28	25	56
BB-25	11:10	AUG 28	25	60
BZ-32	11:49	AUG 28	26	58
BZ-34	11:57	AUG 28	27	55
BZ-36	12:04	AUG 28	27	55
BZ-38	12:12	AUG 28	27	55
BZ-40	12:18	AUG 28	27	55
BY- 3	08:24	AUG 29	22	58
BY- 5	08:30	AUG 29	22	58
BY- 9	11:44	AUG 29	24	58
BY-11	11:49	AUG 29	24	58
BY-13	11:15	AUG 29	25	58
BY-15	12:01	AUG 29	25	58
BY-17	12:06	AUG 29	25	58

TEMPERATURE & RELATIVE HUMIDITY
METEOROLOGICAL DATA SUMMARY TABLE

COUNTRY : US/CANADA
OPERATION : APPROACH

EVENT	TIME	DATE	TEMPERATURE (DEGREES C)	RELATIVE HUMIDITY (%)
C-32	11:26	AUG 27	25	37
C-34	11:33	AUG 27	25	37
C-36	11:41	AUG 27	26	38
C-38	11:56	AUG 27	26	34
C-40	12:03	AUG 27	26	34
C-42	12:09	AUG 27	26	40
C-44	12:16	AUG 27	26	40
C-46	12:25	AUG 27	26	34
C-48	12:31	AUG 27	26	34
C-50	12:39	AUG 27	26	35
CC-10	08:43	AUG 28	21	60
CC-12	08:52	AUG 28	21	64
CC-14	08:58	AUG 28	21	64
CC-16	10:36	AUG 28	24	55
CC-18	10:45	AUG 28	24	59
CC-20	10:52	AUG 28	25	56
CC-22	10:59	AUG 28	25	56
CC-24	11:07	AUG 28	25	5656
CZ-31	11:40	AUG 28	26	58
CZ-33	11:54	AUG 28	27	55
CZ-35	12:01	AUG 28	27	55
CZ-37	12:09	AUG 28	27	55
CZ-39	12:15	AUG 28	27	55
CY- 2	08:16	AUG 29	22	61
CY- 4	08:27	AUG 29	22	58
CY- 6	08:33	AUG 29	24	58
CY- 8	11:40	AUG 29	24	58
CY-10	11:47	AUG 29	24	58
CY-12	11:52	AUG 29	25	58
CY-14	11:58	AUG 29	25	58
CY-16	12:04	AUG 29	25	58
CY-18	12:10	AUG 29	25	58

TEMPERATURE & RELATIVE HUMIDITY
METEOROLOGICAL DATA SUMMARY TABLE

COUNTRY : US/CANADA
OPERATION : LEVEL FLYOVER

EVENT	TIME	DATE	TEMPERATURE (DEGREES C)	RELATIVE HUMIDITY (%)
A1-1	08:35	AUG 27	18	56
A1-2	08:35	AUG 27	18	56
A1-4	08:44	AUG 27	18	65
A1-5	08:46	AUG 27	18	65
A1-6	08:49	AUG 27	18	65
A1-7	08:51	AUG 27	18	65
A1-8	08:55	AUG 27	20	62
AA-1	08:19	AUG 28	20	68
AA-2	08:22	AUG 28	20	68
AA-3	08:24	AUG 28	21	64
AA-5	08:29	AUG 28	21	64
AA-6	08:31	AUG 28	21	64
AA-7	08:34	AUG 28	21	64
AA-8	08:36	AUG 28	21	64
AZ-26	11:24	AUG 28	26	56
AZ-27	11:28	AUG 28	26	56
AZ-28	11:30	AUG 28	26	56
AZ-29	11:33	AUG 28	26	56
AZ-30	11:36	AUG 28	26	56
AY-19	12:16	AUG 29	25	58
AY-20	12:20	AUG 29	25	58
AY-21	12:23	AUG 29	27	48
AY-22	12:25	AUG 29	27	48
AY-23	12:36	AUG 29	27	48
AY-24	12:38	AUG 29	26	60
AY-25	12:40	AUG 29	26	60
AY-27	12:47	AUG 29	26	60
AY-28	12:51	AUG 29	24	62
AY-29	12:54	AUG 29	24	62
AY-30	12:57	AUG 29	24	62

APPENDIX C
US NOISE DATA IN HNMRP FINAL FORMAT

The contents of Appendix C is as follows:

Appendix C

US Data

6 APPROACH PILOT 1-1

CENTERLINE CENTER

	EPNL	SEL	PNLTM	ALM	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
C32	91.3	88.2	94.4	81.0	14.5	12.0	1.3	18	25	26	24
C34	92.9	90.3	94.6	82.6	19.0	18.5	0.9	18	23	24	26
C36	91.9	89.0	93.9	80.9	14.5	14.5	1.0	25	25	26	24
C38	93.0	90.4	94.0	81.4	21.5	21.0	1.2	25	25	27	26
C40	93.7	91.3	95.4	84.3	13.5	15.5	0.4	28	26	24	23
C42	93.0	90.3	95.2	83.6	16.5	17.0	1.7	27	24	25	27
C44	93.0	90.5	93.3	81.5	20.0	20.5	0.7	22	22	25	21
C46	92.7	89.8	94.8	82.4	12.5	15.5	0.9	25	25	26	27
C48	90.6	87.6	91.9	78.6	20.5	19.5	0.9	25	25	22	23
C50	92.5	89.7	93.7	80.4	18.0	17.0	1.0	25	25	27	23
AVG	92.5	89.7	94.1	81.7	17.0	17.1	1.0	24	25	25	24
STD DEV	0.9	1.1	1.0	1.6	3.2	2.8	0.3				
90% CI	0.5	0.7	0.6	1.0	1.9	1.6	0.2				

SIDELINE LEFT

	EPNL	SEL	PNLTM	ALM	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
C32	NA	82.7	86.1	71.0	30.5	NA	1.5	18	23	24	22
C34	88.1	84.2	87.9	73.4	34.0	32.0	1.0	19	23	22	24
C36	NA										
C38	NA										
C40	87.9	83.8	88.6	73.2	31.0	29.0	1.8	27	23	24	27
C42	87.4	83.7	88.0	73.7	24.5	23.0	1.6	27	24	23	25
C44	87.1	83.7	85.7	72.0	39.5	38.0	1.5	27	24	23	25
C46	86.6	82.7	87.2	71.9	33.5	31.0	1.3	23	23	22	24
C48	86.5	83.3	86.4	73.0	33.5	32.0	1.6	28	25	24	26
C50	86.9	83.1	85.5	71.5	40.5	40.0	1.3	27	24	23	25
AVG	87.2	83.4	86.9	72.5	33.4	32.1	1.5	25	24	23	25
STD DEV	0.6	0.5	1.2	1.0	5.1	5.6	0.3				
90% CI	0.5	0.4	0.8	0.7	3.4	4.1	0.2				

SIDELINE RIGHT

	EPNL	SEL	PNLTM	ALM	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
C32	91.9	89.0	91.1	77.8	26.0	24.0	1.7	27	24	27	26
C34	91.1	88.3	91.9	78.2	27.0	25.5	1.9	27	24	23	27
C36	91.7	89.0	91.5	77.8	34.5	34.0	1.8	27	23	24	27
C38	91.7	88.8	91.7	78.0	22.0	21.5	1.9	27	23	27	24
C40	90.4	87.6	91.7	78.0	26.5	25.0	1.7	27	24	23	27
C42	88.9	86.0	88.4	75.7	23.5	23.5	2.0	27	24	27	23
C44	90.6	88.0	89.4	76.2	31.5	30.5	1.5	27	25	24	23
C46	92.4	89.8	91.8	79.0	28.5	27.0	0.9	23	23	24	26
C48	90.5	87.6	91.2	77.9	24.5	24.5	1.3	27	24	27	23
C50	90.8	87.9	90.4	77.6	24.0	23.5	0.7	27	24	23	26
AVG	91.0	88.2	90.9	77.6	26.8	25.9	1.6	27	24	25	25
STD DEV	1.0	1.0	1.2	1.0	3.8	3.7	0.4				
90% CI	0.6	0.6	0.7	0.6	2.2	2.2	0.2				

6 APPROACH PILOT 1-2

CENTERLINE CENTER

	EPNL	SEL	PNLTM	ALM	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
CZ31	93.0	90.4	94.3	82.2	19.5	20.0	0.7	25	25	22	23
CZ33	93.0	90.1	94.0	80.8	20.0	19.5	0.8	24	24	25	26
CZ35	93.0	90.4	93.4	81.0	17.0	18.0	1.0	25	25	26	27
CZ37	92.6	89.7	94.9	82.0	19.5	19.0	0.9	25	25	24	26
CZ39	92.1	89.7	93.6	81.5	18.0	18.5	0.8	25	25	23	26
AVG	92.7	90.1	94.0	81.5	18.8	19.0	0.9	25	25	24	26
STD DEV	0.4	0.4	0.6	0.6	1.3	0.8	0.1				
90% CI	0.4	0.3	0.6	0.6	1.2	0.8	0.1				

SIDELINE LEFT

	EPNL	SEL	PNLTM	ALM	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
CZ31	87.6	84.2	86.9	72.5	29.5	24.0	0.9	22	23	24	22
CZ33	87.0	83.4	87.6	72.3	37.5	24.5	1.3	23	23	26	24
CZ25	86.4	83.0	85.2	72.2	36.5	36.0	1.3	28	25	24	26
CZ37	85.9	82.6	84.3	70.4	36.5	29.5	0.9	26	23	22	24
CZ39	87.8	84.7	87.8	73.4	31.0	21.0	1.6	27	24	23	25
AVG	86.9	83.6	86.3	72.2	34.2	27.0	1.2	25	24	24	24
STD DEV	0.8	0.9	1.5	1.1	3.7	5.9	0.3				
90% CI	0.8	0.8	1.5	1.0	3.5	5.6	0.3				

SIDELINE RIGHT

	EPNL	SEL	PNLTM	ALM	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
CZ31	90.4	87.6	90.4	76.8	25.5	23.0	1.4	27	24	23	27
CZ33	90.8	87.9	89.9	77.1	26.5	26.0	0.7	26	23	24	26
CZ35	91.7	89.1	92.1	78.5	26.5	17.5	2.0	27	24	27	25
CZ37	90.9	88.0	91.2	78.6	23.0	23.0	0.9	24	24	23	26
CZ39	88.4	85.7	87.4	73.2	32.0	30.5	1.6	27	24	27	23
AVG	90.4	87.7	90.2	76.8	26.7	24.0	1.3	26	24	25	25
STD DEV	1.2	1.3	1.8	2.2	3.3	4.8	0.5				
90% CI	1.2	1.2	1.7	2.1	3.1	4.5	0.5				

6 APPROACH PILOT 2-1

CENTERLINE CENTER

	EPNL	SEL	PNLTM	ALM	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
CC10	92.9	90.2	94.8	81.6	15.0	14.5	1.0	28	25	24	22
CC12	92.9	90.1	96.1	83.2	13.0	13.0	1.0	25	25	24	26
CC14	90.4	87.4	93.2	80.3	14.0	13.5	1.1	25	25	26	24
CC16	90.4	87.7	93.8	81.2	13.5	14.0	0.7	25	25	24	26
CC18	93.4	91.1	94.8	82.3	13.5	13.0	1.0	25	25	27	26
CC20	92.9	90.1	94.3	81.7	14.5	14.0	0.7	25	25	24	26
CC22	93.5	90.9	94.2	82.3	16.0	16.5	0.5	25	25	23	22
CC24	93.2	90.5	95.1	82.2	16.0	14.5	1.1	25	25	26	24
AVG	92.4	89.7	94.5	81.9	14.4	14.1	0.9	25	25	25	25
STD DEV	1.3	1.4	0.9	0.9	1.1	1.1	0.2				
90% CI	0.9	0.9	0.6	0.6	0.8	0.8	0.2				

SIDELINE LEFT

	EPNL	SEL	PNLTM	ALM	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
CC10	85.7	82.2	86.9	71.6	36.0	19.0	1.3	23	23	22	26
CC12	86.1	82.3	86.5	71.8	32.5	28.0	1.3	19	23	22	24
CC14	NA										
CC16	85.0	81.8	83.7	70.0	45.5	35.0	1.3	27	23	35	24
CC18	85.8	82.5	85.5	70.8	30.5	27.5	1.5	27	23	24	25
CC20	87.0	83.2	86.2	71.3	37.5	33.0	1.4	19	23	24	33
CC22	88.7	85.0	88.4	74.2	29.5	28.5	1.9	27	24	23	25
CC24	86.4	82.6	86.8	71.6	31.0	27.0	1.4	19	23	24	26
AVG	86.4	82.8	86.3	71.6	34.6	28.3	1.4	23	23	25	26
STD DEV	1.2	1.1	1.4	1.3	5.6	5.1	0.2				
90% CI	0.9	0.8	1.1	1.0	4.1	3.7	0.1				

SIDELINE RIGHT

	EPNL	SEL	PNLTM	ALM	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
CC10	92.1	89.4	91.3	79.2	22.0	22.0	2.7	28	28	27	26
CC12	90.9	88.2	90.5	77.4	26.0	25.5	1.3	27	24	23	27
CC14	88.5	86.1	89.0	76.6	28.0	28.0	1.4	27	27	26	24
CC16	90.4	88.0	91.6	78.9	18.5	17.5	1.1	24	24	26	23
CC18	90.8	87.9	91.3	78.3	22.0	20.5	2.0	27	24	25	27
CC20	91.8	89.6	91.7	78.6	25.5	19.0	1.8	27	24	23	27
CC22	90.1	87.2	92.1	78.7	17.5	16.0	1.8	27	23	27	24
CC24	91.5	88.9	91.1	77.2	34.0	33.0	2.2	27	24	27	25
AVG	90.8	88.2	91.1	78.1	24.2	22.7	1.8	27	25	26	25
STD DEV	1.1	1.1	1.0	0.9	5.4	5.8	0.5				
90% CI	0.8	0.8	0.6	0.6	3.6	3.9	0.4				

6° APPROACH PILOT 2-2

CENTERLINE CENTER

	EPNL	SEL	PNLTm	ALm	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
CY2	92.1	89.3	94.3	81.1	12.5	12.0	1.1	25	25	26	24
CY4	92.9	90.0	93.5	80.7	15.5	16.0	0.8	22	24	22	25
CY6	92.8	90.1	93.8	81.0	15.0	15.0	0.8	25	25	23	26
CY8	92.8	89.9	93.3	81.0	15.5	15.5	0.8	25	25	23	22
CY10	93.6	90.7	94.1	81.1	18.5	18.5	0.7	25	25	24	26
CY12	92.3	89.4	94.9	82.4	14.5	15.5	0.9	27	25	27	24
CY14	92.8	90.0	94.3	81.8	17.0	17.0	0.8	25	25	26	23
CY16	93.3	90.6	94.8	82.7	15.5	17.0	0.9	27	25	27	23
CY18	92.6	90.1	95.0	82.4	17.5	17.5	0.8	25	25	27	23
AVG	92.8	90.0	94.2	81.6	15.7	16.0	0.8	25	25	25	24
STD DEV	0.4	0.5	0.6	0.7	1.8	1.9	0.1				
90% CI	0.3	0.3	0.4	0.5	1.1	1.2	0.1				

SIDELINE LEFT

	EPNL	SEL	PNLTm	ALm	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
CY2	86.1	82.6	85.8	70.9	36.0	24.5	1.2	19	23	24	35
CY4	87.2	83.9	85.4	71.7	45.5	26.5	1.4	27	33	32	24
CY6	NA	83.4	87.6	73.4	16.0	NA	1.6	27	24	23	25
CY8	87.6	84.2	87.2	73.6	36.0	32.5	0.8	27	24	23	25
CY10	86.9	83.5	85.4	71.6	42.0	30.5	1.5	27	23	24	27
CY12	86.7	83.0	86.9	71.9	36.0	29.5	1.2	19	23	22	26
CY14	87.1	83.7	86.1	72.7	42.5	34.5	1.5	28	25	24	26
CY16	87.9	84.6	88.0	73.6	31.0	23.5	1.1	19	23	24	22
CY18	87.4	84.0	88.5	74.1	28.0	19.0	1.8	27	24	23	25
AVG	87.1	83.7	86.7	72.6	34.8	27.6	1.4	24	25	24	26
STD DEV	0.6	0.6	1.1	1.1	9.0	5.1	0.3				
90% CI	0.4	0.4	0.7	0.7	5.6	3.4	0.2				

SIDELINE RIGHT

	EPNL	SEL	PNLTm	ALm	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
CY2	90.7	88.0	91.0	77.6	20.0	17.0	1.7	27	25	27	23
CY4	92.1	89.4	92.4	78.7	23.5	20.0	1.9	27	24	27	23
CY6	91.2	88.4	91.8	78.3	24.0	23.0	1.7	27	24	27	23
CY8	92.1	89.0	93.0	78.7	22.0	19.0	2.0	27	24	23	25
CY10	92.3	89.1	92.7	78.7	25.0	22.5	1.9	27	24	23	27
CY12	91.9	89.1	93.0	80.4	20.0	19.5	1.3	27	24	23	27
CY14	92.6	89.3	92.9	78.8	24.0	23.0	2.3	27	24	27	23
CY16	90.6	87.7	91.7	78.7	20.0	20.0	1.7	27	24	27	25
CY18	89.1	86.2	89.3	75.8	25.5	23.5	1.4	27	24	25	23
AVG	91.4	88.5	92.0	78.4	22.7	20.8	1.8	27	24	25	24
STD DEV	1.1	1.0	1.2	1.2	2.2	2.2	0.3				
90% CI	0.7	0.6	0.8	0.8	1.4	1.4	0.2				

APPROACH
Three Mic Averages

Pilot 1-1

	EPNL	SEL	PNLTm	ALm
C32	NA	86.6	90.5	76.6
C34	90.7	87.6	91.5	78.1
C36	NA	NA	NA	NA
C38	NA	NA	NA	NA
C40	90.7	87.6	91.9	78.5
C42	89.8	86.7	90.5	77.7
C44	90.2	87.4	89.5	76.6
C46	90.6	87.4	91.3	77.8
C48	89.2	86.2	89.8	76.5
C50	90.0	86.9	89.9	76.5
AVG	90.2	87.1	90.6	77.3
STD DEV	0.6	0.5	0.9	0.8
90% CI	0.4	0.4	0.6	0.6

Pilot 1-2

	EPNL	SEL	PNLTm	ALm
CZ31	90.3	87.4	90.5	77.2
CZ33	90.3	87.1	90.5	76.7
CZ35	90.4	87.5	90.2	77.2
CZ37	89.8	86.8	90.1	77.0
CZ39	89.4	86.7	89.6	76.0
AVG	90.0	87.1	90.2	76.8
STD DEV	0.4	0.4	0.4	0.5
90% CI	0.4	0.3	0.4	0.5

Pilot 2-1

	EPNL	SEL	PNLTm	ALm
CC10	90.2	87.3	91.0	77.5
CC12	90.0	86.9	91.0	77.5
CC14	NA	NA	NA	NA
CC16	88.6	85.8	89.7	76.7
CC18	90.0	87.2	90.5	77.1
CC20	90.6	87.6	90.7	77.2
CC22	90.8	87.7	91.6	78.4
CC24	90.4	87.3	91.0	77.0
AVG	90.1	87.1	90.8	77.3
STD DEV	0.7	0.6	0.6	0.5
90% CI	0.5	0.5	0.4	0.4

Pilot 2-2

	EPNL	SEL	PNLTm	ALm
CY2	89.6	86.7	90.4	76.5
CY4	90.7	87.8	90.4	77.0
CY6	NA	87.3	91.1	77.6
CY8	90.8	87.7	91.2	77.8
CY10	90.9	87.8	90.7	77.1
CY12	90.3	87.2	91.6	78.2
CY14	90.8	87.7	91.1	77.8
CY16	90.6	87.6	91.5	78.3
CY18	89.7	86.8	90.9	77.4
AVG	90.5	87.4	91.0	77.5
STD DEV	0.5	0.4	0.4	0.6
90% CI	0.4	0.3	0.3	0.4

LEVEL FLYOVER PILOT 1-1

CENTERLINE CENTER

	EPNL	SEL	PNLTM	ALM	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
A1	87.2	83.8	89.4	76.0	12.5	10.5	1.1	23	23	26	27
A2	87.2	83.9	89.3	75.8	14.0	13.5	1.2	23	23	26	27
A4	87.2	83.9	88.7	75.5	16.0	16.0	1.0	23	26	23	27
A5	86.6	83.2	89.4	75.5	12.0	10.0	1.3	23	23	26	27
A6	86.6	83.3	88.9	75.6	13.0	13.5	1.1	22	26	23	27
A7	86.3	83.2	88.9	75.6	13.0	10.0	1.0	23	23	26	22
A8	86.8	83.6	89.1	75.5	15.5	15.0	1.2	23	23	26	27
AVG	86.8	83.6	89.1	75.6	13.7	12.6	1.1	23	24	25	26
STD DEV	0.4	0.3	0.3	0.2	1.5	2.5	0.1				
90% CI	0.3	0.2	0.2	0.1	1.1	1.8	0.1				

SIDELINE LEFT SITE 2 & 3

	EPNL	SEL	PNLTM	ALM	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
A1	87.4	83.9	88.2	74.2	18.5	17.5	1.7	22	23	33	32
A2	87.2	83.5	87.4	73.2	24.0	22.0	1.6	20	23	33	32
A4	87.9	84.2	88.4	73.9	24.5	21.5	1.5	22	23	22	33
A5	87.1	84.0	87.6	73.9	20.0	18.5	1.8	22	33	34	32
A6	87.1	83.5	88.1	74.0	21.0	19.5	1.7	20	23	33	34
A7	87.2	83.7	88.3	74.5	20.0	19.0	1.7	20	23	34	33
A8	87.4	83.8	87.8	73.4	24.0	22.0	2.1	20	23	33	32
AVG	87.3	83.8	88.0	73.9	21.7	20.0	1.7	21	24	32	33
STD DEV	0.3	0.3	0.4	0.5	2.4	1.8	0.2				
90% CI	0.2	0.2	0.3	0.3	1.8	1.3	0.1				

SIDELINE RIGHT SITE 2 & 3

	EPNL	SEL	PNLTM	ALM	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
A1	86.6	83.1	87.6	74.2	18.0	17.5	1.1	22	24	23	35
A2	86.6	83.1	87.6	73.9	16.5	17.0	1.4	22	24	34	33
A4	86.6	83.2	87.7	74.1	18.0	16.5	1.2	24	24	34	27
A5	85.5	82.2	85.7	73.1	16.0	17.0	1.1	22	26	24	34
A6	86.3	82.8	87.3	73.9	16.5	17.0	1.3	22	24	34	35
A7	86.3	82.9	87.7	74.4	17.0	16.0	1.4	22	24	22	23
A8	86.3	83.0	87.2	73.9	17.5	17.5	1.3	22	24	35	24
AVG	86.3	82.9	87.3	73.9	17.1	16.9	1.3	22	24	29	32
STD DEV	0.4	0.3	0.7	0.4	0.8	0.5	0.1				
90% CI	0.3	0.3	0.5	0.3	0.6	0.4	0.1				

LEVEL FLYOVER PILOT 1-2
CENTERLINE CENTER

	EPNL	SEL	PNLTm	ALm	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
AZ27	87.7	84.1	90.0	76.2	13.0	12.5	1.1	23	23	26	22
AZ28	87.9	84.6	91.2	77.5	11.0	10.0	1.2	23	23	26	27
AZ29	87.7	84.3	91.3	77.1	13.0	11.5	1.4	23	23	26	27
AZ30	87.6	84.1	90.0	76.4	13.5	13.0	1.1	23	23	26	27
AVG	87.7	84.3	90.6	76.8	12.6	11.8	1.2	23	23	26	26
STD DEV	0.2	0.2	0.7	0.6	1.1	1.3	0.1				
90% CI	0.2	0.3	0.8	0.7	1.3	1.6	0.2				

SIDELINE LEFT SITE 2 & 3

	EPNL	SEL	PNLTm	ALm	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
AZ27	87.8	84.0	90.1	75.5	19.5	17.5	1.5	22	23	34	32
AZ28	87.8	84.4	89.6	75.4	20.0	18.0	1.5	22	23	34	33
AZ29	87.5	83.4	89.4	74.4	16.5	16.0	1.6	22	23	22	24
AZ30	87.7	84.3	89.6	75.8	17.5	17.0	1.4	22	23	34	33
AVG	87.7	84.0	89.7	75.3	18.8	17.1	1.5	22	23	31	31
STD DEV	0.1	0.5	0.3	0.6	1.7	0.9	0.1				
90% CI	0.2	0.5	0.4	0.7	1.9	1.0	0.1				

SIDELINE RIGHT SITE 2 & 3

	EPNL	SEL	PNLTm	ALm	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
AZ27	86.7	83.7	88.1	75.7	14.0	16.5	0.8	22	34	35	24
AZ28	86.4	83.1	86.8	74.1	18.0	18.5	1.0	22	24	22	26
AZ29	86.1	83.0	87.5	74.8	15.0	15.5	0.6	22	35	34	33
AZ30	86.0	82.5	87.8	74.2	17.0	16.0	1.2	22	24	35	22
AVG	86.3	83.1	87.6	74.7	16.0	16.6	0.9	22	29	32	26
STD DEV	0.3	0.5	0.6	0.7	1.8	1.3	0.3				
90% CI	0.4	0.6	0.7	0.9	2.2	1.6	0.3				

LEVEL FLYOVER PILOT 2-1
CENTERLINE CENTER

	EPNL	SEL	PNLTm	ALm	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
AA2	87.6	84.3	90.1	76.3	14.0	12.0	1.2	23	23	26	27
AA3	88.2	84.9	90.2	76.2	13.5	13.0	1.4	23	23	26	27
AA5	87.0	84.0	89.2	76.0	17.5	16.5	1.1	23	26	23	27
AA6	87.4	84.2	90.1	77.2	12.0	12.0	0.9	23	26	23	27
AA7	87.4	84.0	90.4	76.3	14.5	12.0	1.2	23	23	26	27
AA8	87.1	83.7	89.6	76.2	12.0	12.0	1.1	23	23	26	27
AVG	87.5	84.2	89.9	76.4	13.9	12.9	1.2	23	24	25	27
STD DEV	0.4	0.4	0.4	0.4	2.0	1.8	0.1				
90% CI	0.4	0.3	0.4	0.3	1.7	1.5	0.1				

SIDELINE LEFT SITE 2 & 3

	EPNL	SEL	PNLTm	ALm	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
AA2	87.3	84.1	88.5	74.8	18.5	16.0	1.9	20	33	23	34
AA3	87.2	83.8	88.4	74.3	21.0	19.5	2.1	20	23	32	33
AA5	87.3	83.7	89.6	74.5	22.5	16.0	1.7	22	23	22	34
AA6	87.1	83.8	89.4	75.4	15.0	14.0	2.0	20	33	34	23
AA7	87.2	83.8	88.8	74.7	21.0	19.0	1.8	22	23	32	33
AA8	87.7	84.3	89.4	75.4	15.0	14.5	1.9	22	23	22	33
AVG	87.3	83.9	89.0	74.9	18.8	16.5	1.9	21	26	28	32
STD DEV	0.2	0.2	0.5	0.5	3.2	2.3	0.1				
90% CI	0.2	0.2	0.4	0.4	2.7	1.9	0.1				

SIDELINE RIGHT SITE 2 & 3

	EPNL	SEL	PNLTm	ALm	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
AA2	86.4	83.2	87.9	74.7	16.5	16.0	1.2	22	24	23	26
AA3	86.6	83.7	87.7	74.8	16.5	16.0	1.1	22	24	22	28
AA5	85.6	82.7	87.4	74.0	18.5	17.5	1.3	22	24	34	33
AA6	86.4	83.2	88.2	75.0	16.0	16.0	1.0	27	23	27	24
AA7	85.2	82.4	86.9	74.0	15.5	15.5	1.3	22	26	22	24
AA8	86.8	83.5	88.4	74.6	16.5	16.0	1.4	22	24	23	26
AVG	86.2	83.1	87.8	74.5	16.6	16.2	1.2	23	24	25	27
STD DEV	0.6	0.5	0.6	0.4	1.0	0.7	0.1				
90% CI	0.5	0.4	0.5	0.4	0.8	0.6	0.1				

LEVEL FLYOVER PILOT 2-2
CENTERLINE CENTER

	EPNL	SEL	PNLTm	ALm	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
AY19	86.1	82.7	89.0	75.2	10.5	10.0	1.2	22	24	26	22
AY20	87.1	83.7	89.8	75.7	14.5	13.5	1.4	23	23	26	27
AY21	86.9	83.5	89.9	76.4	9.5	9.0	1.0	22	23	26	24
AY22	86.5	83.2	88.6	74.7	14.0	13.0	1.3	23	23	26	27
AY23	87.5	84.2	89.9	76.5	11.5	11.5	1.1	22	24	23	22
AY24	88.0	84.7	90.4	77.4	14.0	14.5	1.2	23	23	26	27
AY25	87.4	84.0	89.7	76.6	13.0	13.5	0.9	23	26	23	27
AY27	87.6	83.7	90.3	76.5	13.0	13.5	1.2	23	23	26	34
AY28	86.6	83.1	89.4	75.4	15.5	14.0	1.3	23	23	26	27
AY29	87.0	83.5	89.5	76.0	13.5	12.5	0.9	22	23	26	24
AY30	86.7	83.4	90.6	76.2	18.5	13.5	1.7	23	23	26	33
AVG	87.0	83.6	89.7	76.1	13.4	12.6	1.2	23	24	26	27
STD DEV	0.6	0.6	0.6	0.7	2.4	1.7	0.2				
90% CI	0.3	0.3	0.3	0.4	1.3	0.9	0.1				

SIDELINE LEFT SITE 2 & 3

	EPNL	SEL	PNLTm	ALm	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
AY19	88.4	84.9	90.0	76.4	17.0	16.5	1.8	22	32	33	34
AY20	88.3	84.6	89.4	75.2	18.0	17.5	1.6	20	23	33	32
AY21	89.0	85.6	91.0	77.2	15.0	14.0	2.1	20	32	33	34
AY22	NA	NA	NA	NA	21.5	20.0	1.7	20	23	33	32
AY23	89.0	85.6	91.4	77.4	19.0	16.0	1.4	22	23	32	22
AY24	NA	NA	NA	NA	17.5	16.0	1.6	22	23	22	32
AY25	89.0	85.3	90.5	76.1	19.5	15.0	1.6	22	23	22	33
AY27	89.0	85.5	91.0	76.8	20.0	17.0	1.4	22	23	33	34
AY28	88.3	84.4	90.5	75.6	20.0	17.0	1.8	22	23	22	33
AY29	88.0	84.2	89.9	75.6	16.0	15.5	1.6	22	23	22	33
AY30	88.4	84.6	90.6	75.2	26.0	21.5	1.8	23	23	33	32
AVG	88.6	85.0	90.5	76.2	19.1	16.9	1.7	22	25	29	32
STD DEV	0.4	0.6	0.6	0.8	0.3	2.2	0.2				
90% CI	0.3	0.3	0.4	0.5	1.6	1.2	0.1				

SIDELINE RIGHT SITE 2 & 3

	EPNL	SEL	PNLTm	ALm	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
AY19	88.8	84.8	91.3	76.9	16.0	15.0	1.6	22	24	34	35
AY20	88.0	84.1	89.3	75.4	16.5	18.0	1.4	22	24	34	27
AY21	87.7	84.1	89.8	76.0	14.5	14.5	1.6	22	24	34	27
AY22	NA	NA	NA	NA	16.5	16.0	0.3	22	24	34	26
AY23	87.6	84.2	88.9	76.1	19.0	19.0	1.3	22	26	33	24
AY24	NA	NA	NA	NA	28.5	28.5	0.7	26	23	24	26
AY25	87.6	84.1	88.7	75.6	15.5	15.5	0.9	22	23	24	22
AY27	NA	84.3	89.0	75.8	19.0	NA	0.9	22	34	22	23
AY28	85.8	82.8	87.3	74.6	18.0	20.0	1.1	22	26	22	24
AY29	87.3	83.9	88.0	75.2	17.5	18.0	0.8	28	23	26	34
AY30	85.7	82.7	86.6	73.9	21.5	22.0	1.7	27	27	25	34
AVG	87.3	83.9	88.8	75.5	18.4	18.7	1.2	23	25	28	28
STD DEV	1.1	0.7	1.4	0.9	3.9	4.2	0.4				
90% CI	0.7	0.4	0.9	0.5	2.1	2.4	0.2				

FLYOVER
Three Mic Averages

Pilot 1-1

	EPNL	SEL	PNLTm	ALm
A1	87.1	83.6	88.4	74.8
A2	87.0	83.5	88.1	74.3
A4	87.2	83.8	88.3	74.5
A5	86.4	83.1	87.6	74.2
A6	86.7	83.2	88.1	74.5
A7	86.6	83.3	88.3	74.8
A8	86.8	83.5	88.0	74.3
AVG	86.8	83.4	88.1	74.5
STD DEV	0.3	0.2	0.3	0.3
90% CI	0.2	0.2	0.2	0.2

Pilot 1-2

	EPNL	SEL	PNLTm	ALm
AZ27	87.4	83.9	89.4	75.8
AZ28	87.4	84.0	89.2	75.8
AZ29	87.1	83.6	89.4	75.4
AZ30	87.1	83.6	89.1	75.5
AVG	87.2	83.8	89.3	75.6
STD DEV	0.2	0.2	0.1	0.2
90% CI	0.2	0.3	0.2	0.2

Pilot 2-1

	EPNL	SEL	PNLTm	ALm
AA2	87.1	83.9	88.8	75.2
AA3	87.3	84.1	88.8	75.1
AA5	86.6	83.5	88.7	74.8
AA6	87.0	83.7	89.2	75.8
AA7	86.0	83.4	88.7	75.0
AA8	87.2	83.8	89.1	75.4
AVG	87.0	83.7	88.9	75.2
STD DEV	0.3	0.3	0.2	0.4
90% CI	0.3	0.2	0.2	0.3

Pilot 2-2

	EPNL	SEL	PNLTm	ALm
AY19	87.7	84.1	90.1	76.2
AY20	87.8	84.1	89.5	75.4
AY21	87.9	84.4	90.2	76.5
AY22	NA	NA	NA	NA
AY23	88.0	84.7	90.0	76.7
AY24	NA	NA	NA	NA
AY25	88.0	84.5	89.6	76.1
AY27	NA	84.5	90.1	76.0
AY28	86.9	83.4	89.0	75.2
AY29	87.4	83.9	89.1	75.6
AY30	86.9	83.6	89.2	75.1
AVG	87.6	84.1	89.7	75.9
STD DEV	0.5	0.4	0.5	0.6
90% CI	0.3	0.3	0.3	0.4

TAKEOFF PILOT 1-1
CENTERLINE CENTER

	EPNL	SEL	PNLT*	AL*	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
B33	86.5	83.0	87.9	73.5	17.0	15.5	2.1	22	22	25	35
B37	86.1	82.2	87.6	72.6	19.5	15.5	1.9	22	22	25	34
B39	86.8	82.5	88.3	73.9	19.5	16.5	1.7	22	25	35	34
B41	86.3	82.6	87.9	73.6	18.0	16.5	2.1	22	22	25	35
B43	87.4	83.4	88.1	73.3	25.5	19.0	2.2	22	22	25	24
B45	87.0	83.3	88.5	74.1	23.0	16.5	2.2	22	22	25	34
B47	87.3	82.9	89.9	74.0	19.5	14.0	2.4	22	22	25	35
B49	86.7	82.8	88.4	73.1	17.5	15.0	2.1	22	22	25	34
B52	86.2	82.4	88.0	73.5	17.5	15.5	2.2	22	22	25	34
AVG	86.7	82.8	88.3	73.5	19.7	16.0	2.1	22	22	26	33
STD DEV	0.5	0.4	0.7	0.5	2.8	1.4	0.2				
90% CI	0.3	0.3	0.4	0.3	1.8	0.9	0.1				

SIDELINE LEFT

	EPNL	SEL	PNLT*	AL*	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
B33	86.6	83.3	87.8	73.2	20.0	17.0	2.8	22	24	22	32
B37	87.1	83.8	87.7	73.1	26.0	25.0	2.4	19	22	24	34
B39	87.5	83.4	88.8	73.4	24.0	22.5	2.8	22	22	24	32
B41	86.9	83.9	88.0	74.3	21.0	19.0	2.7	22	24	32	34
B43	85.7	82.0	86.7	71.5	25.5	20.5	2.7	22	22	24	32
B45	87.0	83.5	87.9	72.8	26.0	21.0	2.7	22	22	24	32
B47	87.3	83.6	88.6	73.9	28.5	22.5	2.3	22	22	24	26
B49	87.2	83.6	87.7	73.5	22.5	21.0	2.5	22	34	33	32
B52	86.7	83.4	87.1	72.6	23.5	19.5	2.6	19	22	24	32
AVG	86.9	83.4	87.8	73.1	24.1	20.9	2.6	21	24	26	32
STD DEV	0.5	0.6	0.7	0.8	2.7	2.3	0.2				
90% CI	0.3	0.3	0.4	0.5	1.7	1.4	0.1				

SIDELINE RIGHT

	EPNL	SEL	PNLT*	AL*	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
B33	87.0	83.4	88.6	72.6	26.0	21.5	2.5	22	24	22	34
B37	NA	NA	NA	NA	26.5	21.5	2.2	22	24	22	26
B39	86.7	83.0	87.9	72.0	27.5	21.0	2.6	22	24	22	27
B41	86.0	82.6	86.9	72.0	25.0	23.5	2.6	22	24	22	34
B43	85.7	82.0	87.2	71.6	23.5	20.0	2.6	22	24	22	27
B45	85.9	82.2	87.2	71.3	28.5	21.0	2.6	22	24	22	26
B47	86.4	82.3	87.9	72.0	28.0	23.0	2.1	22	24	22	27
B49	86.5	82.9	88.2	72.2	23.0	18.5	2.6	22	24	22	34
B52	85.7	82.1	86.2	70.7	25.5	23.5	2.6	22	24	22	34
AVG	86.2	82.6	87.5	71.8	25.9	21.5	2.5	22	24	22	30
STD DEV	0.5	0.5	0.8	0.6	1.9	1.7	0.2				
90% CI	0.3	0.3	0.5	0.4	1.2	1.0	0.1				

TAKEOFF PILOT 1-2
CENTERLINE CENTER

	EPNL	SEL	PNLT*	AL*	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
BZ32	86.2	82.8	87.6	73.5	24.0	17.5	2.2	22	22	24	32
BZ34	86.3	82.9	87.2	73.5	24.5	19.5	2.0	22	22	35	34
BZ36	86.7	83.3	87.9	73.3	26.5	19.5	2.1	22	22	24	26
BZ38	86.3	82.9	88.0	72.4	34.0	17.0	2.2	22	22	25	35
BZ40	86.5	82.4	88.0	72.8	19.5	17.0	2.0	22	22	35	34
AVG	86.4	82.9	87.7	73.1	25.7	18.1	2.1	22	22	29	32
STD DEV	0.2	0.3	0.4	0.5	5.3	1.3	0.1				
90% CI	0.2	0.3	0.3	0.5	5.1	1.2	0.1				

SIDELINE LEFT

	EPNL	SEL	PNLT*	AL*	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
BZ32	87.4	83.8	88.1	73.7	27.0	21.5	2.6	22	22	24	33
BZ34	87.5	83.8	88.9	73.6	25.5	20.5	2.7	22	22	24	34
BZ36	87.7	83.9	89.3	73.8	23.5	20.0	2.7	22	22	24	34
BZ38	86.7	83.1	88.4	73.0	31.0	16.5	2.7	22	22	24	34
BZ40	87.6	83.8	88.6	72.9	41.0	19.0	2.6	22	22	34	33
AVG	87.4	83.7	88.7	73.4	29.6	19.5	2.7	22	22	26	34
STD DEV	0.4	0.3	0.5	0.4	6.9	1.9	0.0				
90% CI	0.4	0.3	0.4	0.4	6.6	1.8	0.0				

SIDELINE RIGHT

	EPNL	SEL	PNLT*	AL*	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
BZ32	86.0	82.4	87.6	72.1	25.0	22.5	2.5	22	24	22	34
BZ34	86.5	82.8	87.9	72.3	25.5	23.0	2.5	22	24	22	26
BZ36	85.9	82.6	87.2	71.5	25.0	21.5	2.5	22	24	22	34
BZ38	85.5	82.1	86.8	71.2	31.0	22.0	2.3	22	24	22	34
BZ40	85.7	82.2	86.7	71.4	25.5	21.5	2.5	22	24	22	27
AVG	85.9	82.4	87.2	71.7	26.4	22.1	2.5	22	24	22	31
STD DEV	0.4	0.3	0.5	0.5	2.6	0.7	0.1				
90% CI	0.3	0.3	0.5	0.4	2.5	0.6	0.1				

TAKEOFF PILOT 2-1

CENTERLINE CENTER

	EPNL	SEL	PNLTM	ALM	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
BB11	88.4	84.8	90.2	76.2	16.0	14.0	1.8	22	22	34	35
BB13	88.8	85.1	89.2	75.3	19.5	18.0	1.9	22	22	35	34
BB15	87.1	83.5	88.3	73.0	23.5	18.5	2.1	19	22	24	35
BB17	87.0	83.7	88.3	73.9	22.5	20.0	1.9	19	22	35	34
BB19	86.6	82.8	88.5	74.2	20.0	18.5	2.1	19	22	24	35
BB23	88.5	85.1	90.3	75.1	21.5	18.5	2.4	19	22	24	34
BB25	87.7	84.1	89.1	74.1	20.5	16.0	1.9	22	22	35	34
AVG	87.7	84.1	89.1	74.5	20.5	17.6	2.0	20	22	30	34
STD DEV	0.9	0.8	0.8	1.1	2.4	2.0	0.2				
90% CI	0.6	0.6	0.6	0.8	1.8	1.5	0.1				

SIDELINE LEFT

	EPNL	SEL	PNLTM	ALM	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
BB11	87.8	84.0	88.2	73.5	26.5	22.5	2.6	22	24	22	33
BB13	88.3	84.4	89.6	74.5	24.5	21.5	2.8	22	22	24	33
BB15	86.7	82.9	88.8	73.2	26.0	18.0	2.7	22	22	24	34
BB17	86.4	82.4	87.2	72.0	25.0	23.5	2.7	22	22	24	34
BB19	86.4	82.4	88.9	73.2	25.0	20.0	2.7	22	22	24	34
BB23	87.6	83.5	89.3	73.6	25.5	21.0	2.8	22	22	24	33
BB25	87.8	84.0	88.8	73.7	29.0	21.5	2.8	22	22	24	27
AVG	87.3	83.4	88.7	73.4	25.9	21.1	2.7	22	22	24	33
STD DEV	0.8	0.8	0.8	0.8	1.5	1.8	0.1				
90% CI	0.6	0.6	0.6	0.6	1.1	1.3	0.1				

SIDELINE RIGHT

	EPNL	SEL	PNLTM	ALM	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
BB11	86.6	82.9	88.2	73.0	22.5	20.0	2.5	22	24	22	27
BB13	86.4	82.8	89.0	73.2	24.5	17.5	2.6	22	24	22	34
BB15	87.0	83.3	87.8	72.9	24.0	22.5	2.5	22	24	22	26
BB17	86.4	82.5	87.8	71.9	26.0	23.0	2.6	22	24	22	27
BB19	85.7	81.8	88.5	72.8	28.0	25.5	2.6	22	24	22	26
BB23	86.5	82.9	86.9	72.2	29.5	25.0	2.6	22	22	24	34
BB25	87.0	83.3	88.8	73.2	27.5	19.5	2.6	22	24	22	26
AVG	86.5	82.8	88.2	72.7	26.0	21.9	2.6	22	24	22	29
STD DEV	0.5	0.5	0.7	0.5	2.5	3.0	0.1				
90% CI	0.3	0.4	0.5	0.4	1.8	2.2	0.0				

TAKEOFF PILOT 2-2

CENTERLINE CENTER

	EPNL	SEL	PNLTm	ALm	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
BY3	88.4	85.2	89.0	75.4	20.5	17.0	1.4	22	35	34	22
BY5	89.1	85.3	90.2	75.9	21.0	18.5	1.7	22	35	34	33
BY9	89.3	85.5	91.5	76.3	19.0	13.0	2.2	22	22	25	35
BY11	88.4	84.9	90.5	76.0	17.0	14.0	2.2	22	22	35	34
BY13	88.3	84.6	89.5	75.1	19.0	15.5	2.1	22	22	35	34
BY15	92.4	88.4	94.6	79.5	19.0	18.0	2.2	19	22	35	24
BY17	89.9	86.4	89.7	75.4	23.0	21.5	1.9	22	22	35	34
AVG	89.4	85.8	90.7	76.2	19.8	16.8	2.0	22	26	33	31
STD DEV	1.4	1.3	1.9	1.5	1.9	2.9	0.3				
90% CI	1.1	0.9	1.4	1.1	1.4	2.1	0.2				

SIDELINE LEFT

	EPNL	SEL	PNLTm	ALm	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
BY3	88.4	84.5	89.9	74.5	22.5	19.5	2.6	22	22	24	34
BY5	88.5	84.3	89.8	73.8	28.0	21.5	2.7	22	22	24	34
BY9	90.1	85.7	90.6	75.5	24.0	23.0	2.7	22	22	24	34
BY11	NA	NA	NA	NA	23.0	22.0	2.7	22	22	24	34
BY13	88.3	84.4	89.4	74.3	26.5	19.5	2.6	22	22	24	34
BY15	89.6	85.3	90.6	75.2	24.0	17.0	2.6	22	22	34	33
BY17	88.8	84.7	90.7	75.4	20.0	15.0	2.7	22	22	24	33
AVG	89.0	84.8	90.2	74.8	24.0	19.6	2.7	22	22	24	34
STD DEV	0.7	0.6	0.5	0.7	2.6	2.9	0.1				
90% CI	0.6	0.5	0.4	0.6	1.9	2.1	0.0				

SIDELINE RIGHT

	EPNL	SEL	PNLTm	ALm	DUR A	DUR P	TC	BAND	MAX	NOY	BANDS
BY3	87.8	83.7	89.4	73.8	22.0	20.5	2.2	22	24	22	34
BY5	87.2	83.3	89.5	73.6	26.0	20.5	2.5	22	24	22	35
BY9	87.3	83.5	90.4	74.8	19.5	14.0	2.5	22	24	22	34
BY11	87.0	83.1	89.4	73.7	23.0	18.0	2.4	22	24	22	34
BY13	87.5	83.6	88.1	72.6	24.0	20.5	2.5	22	24	22	27
BY15	87.2	83.6	88.7	73.2	23.0	17.5	2.4	22	24	22	34
BY17	87.5	83.7	89.3	73.7	25.0	20.0	2.4	22	24	22	27
AVG	87.3	83.5	89.3	73.7	23.2	18.7	2.4	22	24	22	32
STD DEV	0.3	0.2	0.7	0.7	2.1	2.4	0.1				
90% CI	0.2	0.2	0.5	0.5	1.6	1.8	0.1				

TAKE-OFF
Three Mic Averages

Pilot 1-1

	EPNL	SEL	PNLTm	ALm
B33	86.7	83.2	88.1	73.1
B37	NA	NA	NA	NA
B39	87.0	83.0	88.3	73.1
B41	86.4	83.0	87.6	73.3
B43	86.3	82.5	87.3	72.1
B45	86.6	83.0	87.9	72.7
B47	87.0	82.9	88.8	73.3
B49	86.8	83.1	88.1	72.9
B52	86.2	82.6	87.1	72.3
AVG	86.6	82.9	87.9	72.9
STD DEV	0.3	0.3	0.6	0.5
90% CI	0.2	0.2	0.4	0.3

Pilot 1-2

	EPNL	SEL	PNLTm	ALm
BZ32	86.5	83.0	87.8	73.1
BZ34	86.8	83.2	88.0	73.1
BZ36	86.8	83.3	88.1	72.9
BZ38	86.2	82.7	87.7	72.2
BZ40	86.6	82.8	87.8	72.4
AVG	86.6	83.0	87.9	72.7
STD DEV	0.3	0.2	0.2	0.4
90% CI	0.2	0.2	0.2	0.4

Pilot 2-1

	EPNL	SEL	PNLTm	ALm
BB11	87.6	83.9	88.9	74.2
BB13	87.8	84.1	89.3	74.3
BB15	86.9	83.2	88.3	73.0
BB17	86.6	82.9	87.8	72.6
BB19	86.2	82.3	88.6	73.4
BB23	87.5	82.8	88.8	73.6
BB25	87.5	83.8	88.9	73.7
AVG	87.2	83.4	88.7	73.6
STD DEV	0.6	0.7	0.5	0.6
90% CI	0.4	0.5	0.4	0.5

Pilot 2-2

	EPNL	SEL	PNLTm	ALm
BY3	88.2	84.5	89.4	74.6
BY5	88.3	84.3	89.8	74.4
BY9	88.9	84.9	90.8	75.5
BY11	NA	NA	NA	NA
BY13	88.0	84.2	89.0	74.0
BY15	89.7	85.8	91.3	76.0
BY17	88.7	84.9	89.9	74.8
AVG	88.6	84.8	90.1	74.9
STD DEV	0.6	0.6	0.9	0.7
90% CI	0.5	0.5	0.7	0.6

END

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