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~~Structures Division~~
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20. ABSTRACT (*Continue on reverse side if necessary and identify by block number*)

It was desirable to determine the expected frequency of occurrence of lateral load factors due to aircraft ground turning maneuvers for a specified airplane service life. In order to accomplish this determination, published and unpublished ground operations data measured on a C-141-A, DC-9-15, 727-100, KC-135, and F-105D aircraft was condensed and evaluated, and used in the development of a normalized side load factor probability distribution for ground turning. The normalized distribution can be used to predict the expected lateral load factor spectrum due to ground turns for any aircraft. A subordinate analysis of —> over

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20. KC-135 and FB-111A data provided a normalized probability distribution of lateral load factor applicable to taxiing and landing.

FOREWORD

This report was prepared by John W. Rustenburg, Flight Systems Engineering, Deputy of Strategic Systems, under System 139A, B-1.

The report presents results from a study to determine the expected frequency of occurrence of lateral load factors due to ground turning maneuvers during the specific B-1 service life.

The intent of the report is to publish "lessons learned" during the B-1 program.

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LIST OF SYMBOLS

b	Constant in the analytical expression of the probability distribution; distance between nose gear station and center of gravity location.
d	Distance between nose gear and landing gear stations.
e	Distance between ground and center of gravity.
g	Gravitational constant.
m_1, m_2, m_i n_1, n_2, n_i	Number of data points in class intervals of a given population.
n_y	Lateral acceleration in g units.
n_s	Overturning side load factor.
P	Probability of reaching or exceeding a given response variable.
P_o	Intercept of the exponential curve.
t	Distance between main landing gears.
$\bar{X}$	Weighted mean value.
y	Response variable.

SECTION I

INTRODUCTION

Although the design criteria for ground turning maneuvers as specified in References 1 and 2 may have contributed in providing adequate landing gear strength, valid questions may be raised regarding its realism in comparison to actual operational usage. Use of the existing criteria in the design phase of the B-1 resulted in the prediction of excessively large design loads. This provided the impetus to study available ground turning data in an effort to establish realistic side load factor criteria which would be a function of the expected operational usage of the aircraft.

Published and unpublished ground turning data measured on C-141A, DC-9-15, 727-100, KC-135 and F-105D aircraft was available to support these efforts. The data was condensed and analyzed, and was successfully applied in the development of a normalized probability distribution which allowed prediction of the expected lateral accelerations for ground turning of the B-1. A limited amount of other ground service loads data from FB-111A aircraft and the KC-135 was also used in the derivation of a similar normalized distribution which can provide a rudimentary estimate of expected taxiing and landing side load factor occurrences. It is the purpose of this report to present the data analysis procedures and study results for application to other aircraft.

SECTION II

ANALYSIS OF GROUND TURNING DATA

References 3, 4 and 5 have provided the airplane lateral acceleration data used in this part of the study. The data in these references was measured primarily during ground turning maneuvers and is presented in various formats. In order to facilitate comparison, the data was scaled to a common baseline of frequency of occurrences of absolute lateral acceleration per 1000 flights. In certain cases this required the combination of load factors of equal magnitude regardless of direction or pre- and post-flight occurrence. Admittedly such combinations mask any assymmetry between left and right occurrences as well as differences between pre-flight and post-flight occurrences. These concerns will be discussed subsequently, however.

A. Development of a Normalized Probability Distribution

Frequency distributions of lateral accelerations during ground turning as derived from the measured data in References 3 through 5 are shown in Tables 1 through 5 for the C-141A, 727-100, DC-9-15, KC-135, and F-105D. The cumulative frequency distribution as well as the relative frequency and relative cumulative frequency are shown.

The relative cumulative frequency or cumulative probability is calculated by dividing the cumulative number of occurrences in each class interval by the cumulative number of occurrences in the lowest class interval. However, whereas the data from references 3 and 4 is based on measured acceleration peaks in all class intervals exceeding a zero acceleration level, the F-105D data from Reference 5 incorporates only acceleration larger than 0.08 "g". These accelerations were developed usually in major taxi turns having durations of 10 to 40 seconds, such as those around corners of taxi-ways. Accelerations less than 0.08 "g" associated with steering inputs of less than 10 seconds duration were omitted. The data from References 3 and 4, on the other hand, does include deliberate turn maneuvers of shorter duration associated with smaller heading changes rather than those solely measured during turns around corners of taxiways. The data for the C-141A, DC-9-15, 727-100 and KC-135 as derived from References 3 and 4 is considerably more extensive and may be more representative of the total ground turning experience. To improve the statistical reliability of the data base, it was decided to use the Reference 3 and 4 data as the primary input and consider all occurrences above 0.0 "g". The cumulative frequency of occurrence in the lower class intervals for the F-105D was inferred by other means.

In order to estimate the total number of expected acceleration peaks exceeding 0.0 "g", the available F-105D data needed to be extrapolated. This extrapolation was performed through application of a least squares fit technique.

Figures 1 through 4 present the accumulated frequencies of the C-141A, 727-100, DC-9-15 and KC-135 data plotted against the lateral acceleration squared. The figures reveal that the data, when plotted on semi-log paper, present a nearly linear relationships and least squares straight lines fitted to the data provide good approximations. As a consequence, it was assumed that the F-105D experience could be adequately described by a similar approximation. Thus, a least squares expression was determined for the available F-105D data and the predicted accumulated frequence of occurrence for $n_y = 0.0$ calculated. Figure 5 shows the data and the least squares fit. The least squares relationship does not seem to represent the data of the F-105D as accurately as it did for the other aircraft, but was nevertheless accepted.

Least squares curves fitting the cumulative probabilities of the side load factor squared for the observed data of Tables 1 through 5 are presented in Figure 6. Considerable differences are evident in the slopes of these curves. These differences cannot simply be attributed to any obvious differences in airplane type or usage. The direct application of these cumulative probability curves to predict expected lateral accelerations on other aircraft is therefore not feasible. Some form of normalization which would consolidate the available data into a single relationship applicable to all aircraft provides an alternate approach.

In Reference 7, a data normalization procedure was used which included considerations of airplane capability. The procedure contains the initial assumption that an aircraft is utilized in direct proportion to its capability. A proportionality constant or ratio could then be determined for each parameter peak by dividing the recorded value of the parameter by the maximum analytical value of that parameter. For example:

$$R_{n_y} = n_y \text{ recorded}/n_y \text{ analytical maximum} \tag{1}$$

The maximum lateral acceleration which defines the aircraft capability in ground turning is the overturning side load factor. The magnitude of the overturning side load factor is determined by the landing gear dimensional arrangement and center of gravity location of the aircraft. Figure 7 presents a generalized center of gravity-landing gear geometry diagram. Assuming an airplane to be in the static three point attitude and the ratio of side load to vertical load component equal on all gear units, the overturning side load factor will be:

$$n_s = 0.5 \frac{bt}{de} \tag{2}$$

Table 6 presents the landing gear arrangement dimensional data for the five airplanes under consideration as well as average center of gravity locations for representative taxiing conditions. Calculated overturning load factor values are also shown.

Using the overturning load factor n_s of Table 6, the observed lateral accelerations of Tables 1 through 5 were normalized according to the concept expressed by Equation 1. The cumulative probability distribution of the normalized acceleration squared is presented in Figure 8. Clearly, the normalization has resulted in a more consistent data base. As would be expected, the normalized data points also exhibit an approximately linear relationship. This relationship can be adequately described by an expression of the form:

$$P = P_o \quad e^{-y/b} \tag{3}$$

This exponential expresses a linear relationship when plotted on semilog paper where the slope of the line will be equal to -1/b.

The parameter b provides a measure of the intensity of the accelerations encountered and can be equated to twice the mean square. P_o is the intercept of the straight line at the ordinate. It represents the probability of exceeding the zero value of the normalized acceleration squared during ground turns. The least squares straight line for the data points of Figure 8 can provide the values for P_o and 1/b for use in the equation. The resulting value for P_o equals .84, while 1/b equals 1/.009. Clearly the probability of exceeding zero acceleration during turns should be 1.0. The difference can be attributed to the failure of the least squares fit to exactly represent the data. The value for b on the other hand can be accepted as an accurate description of the relative severity of the acceleration sample. The curve for the probability of exceeding the normalized acceleration squared will therefore be raised to reflect a value of $P_o = 1.0$, while retaining the slope as determined by the least squares fit. The resulting equation is thus as follows:

$$P = 1.0\, e^{-\frac{\left(n_y/n_s\right)^2}{.009}} \qquad (4)$$

B. Deletion of Low Amplitude Peaks

To gain insight into the effect of changes in data base, primarily in low amplitude accelerations where extraneous noise might exist, the data analysis discussed in the previous section was repeated for all peaks exceeding $n_y = 0.08$ "g". Thus, for the C-141A, 727-100, DC-9-15, and KC-135A, all peaks less than 0.08 "g" were deleted. In effect, this results in a data threshold at 0.08 "g" consistent with the available F-105D data, instead of the 0.0 "g" as was previously used.

Because of variation in the overturning load factor n_s for the different airplanes, the normalized threshold load factor $0.08/n_s$ value will be different for each airplane. To compare all aircraft, it was necessary to redefine the abscissa of the probability curve as $\left(n_y/n_s\right)^2 - \left(0.08/n_s\right)^2$.

The resulting data points were again fit with a least squares straight line as shown in Figure 9. Derivation of the slope of this line shows it to be nearly identical to the slope of the line for all data points above 0.0 "g" as shown in Figure 8.

It is concluded that the relative severity of the acceleration distribution as expressed by the slope of a fitted straight line is not sensitive to changes in the data base. It increases our confidence that Equation 4 will provide a reliable approximation for the prediction of lateral acceleration probabilities, supported by the largest possible data base.

C. Ground Turns Per Flight

The acceleration data from References 3, 4, and 5 represent peak readings measured at the airplane center of gravity during each ground turning maneuver. The cumulative frequency distribution of the normalized accelerations thus reflects the probability of exceeding a given maximum normalized acceleration peak when executing a ground turning maneuver. It can be envisioned as the fraction of ground turning maneuvers which exceed a given acceleration value out of all turning maneuvers being considered.

For the probability distribution to be meaningful, it is necessary to have a knowledge of the total number of turning maneuvers to be expected during a given flight. The number of turns will be primarily dependent on the physical layout and orientation of runways, taxiways, ramps and aircraft parking areas. It can be expected that significant variations in the number of turns per individual arrival or departure exists. However, the average number of turns over many arrivals and departures on a variety of airfields should approach a constant value. For purposes of this study, the average number of turns will be determined on a per flight basis, where a flight consists of a departure and arrival. The distribution of these turns between arrivals and departures will be discussed subsequently. Table 7 presents the number of turns per 1000 flights exceeding $n_y = 0.0$ "g" as derived from Figures 1 through 5. Clearly considerable variation is present. The values for the KC-135 and F-105D experience in particular appear to represent extremes wher compared with other aircraft. The data for the C-141, DC-9-15 and 727-100 is based on arrivals and departures from 31 U.S. Military and U.S. Commercial, and 13 foreign military or commercial airports. In contrast, the data for the KC-135 and F-105D was obtained at a single, albeit in each case a different U.S. military base. Futhermore, as shown in

Table 7, the occurrences for each aircraft are also based on a different number of flights. Half flights are the result of missing data in some arrivals or departures. The weighted mean of the combined data of Table 7 considering the number of airports and the number of flights for each airplane was computed as 9881 ground turns per 1000 flights using the following relationship:

$$\bar{X} = \frac{n_1 m_1 x_1 + n_2 m_2 x_2 + n_i m_i x_i}{n_1 m_1 + n_2 m_2 + n_i m_i} \qquad (5)$$

Table 8 presents the relative distribution of ground turns between arrivals and departures and between left hand and right hand turns for the C-141A, DC-9-15, 727-100, and F-105D. As shown, the ground turns are about equally divided between arrivals and departures with slightly fewer turns occurring during arrivals than departures. Although no large differences exist, more left hand than right hand turns are evident. It is possible that a pilot may prefer left hand turns if given a choice. Insufficient information exists to analyze the differences other than to note their existence.

SECTION III

ANALYSIS OF GROUND HANDLING AND LANDING DATA

The lateral accelerations studied so far were based exclusively on measurements made during ground turns. The data in Reference 6 for the FB-111A is representative of "ground handling." Ground handling is defined in Reference 6 as "All ground static operations and all low speed (essentially zero lift) taxi operations, including operations on taxiways, and ramps and in parking areas." Lateral accelerations during take-off, landing transition, and landing roll-out were specifically omitted.

This definition allows inclusions of lateral acceleration measurements other than during major ground turns such as short duration heading changes and steering corrections during low speed roll-out after landing. Such additional accelerations would have contaminated the comparison with the C-141A, DC-9-15, 727-100, KC-135 and F-105D aircraft and therefore this data was not included in the previously discussed study.

A. Development of a Normalized Probability Distribution

Table 9 presents the lateral acceleration data for "ground handling" of the FB-111A. This data was extrapolated and the cumulative probability distribution of the normalized lateral acceleration squared was determined using the same methods previously applied to the F-105D data. Figure 10 shows the results for the FB-111A ground handling data with a comparison to the general curve for ground turns derived for the previously studied aircraft. As anticipated, the FB-111A "ground handling" data does not appear to be from the same population as the earlier data, and may include measurements other than from ground turns only. To further test the assumption that other lateral accelerations are included, the landing and high speed landing roll-out accelerations were added to the "ground handling" data for the FB-111A and compared to the summation of turning and landing accelerations for the KC-135.

Table 10 presents the frequency distribution of lateral accelerations measured during KC-135 landings and ground turns as derived from Reference 4. Table 11 presents corresponding data for the FB-111A as derived from

Reference 6. The FB-111A landing data, however, includes only measurements for the landing transition and landing roll out to start of zero lift speed.

Summation of the frequencies for landings and ground turns for the KC-135 and landings and "ground handling" for the FB-111A essentially provide the lateral accelerations frequencies which might be expected during the entire landing phase and subsequent taxiing until the following take-off. Figure 10 shows the summations for both aircraft as a function of the acceleration squared. These summations are subsequently normalized and the cumulative probability determined. Figure 11 presents the results for the KC-135 and FB-111A.

The agreement between the KC-135 and FB-111A data is good. Although this agreement cannot be taken as proof, it does lend credence to the assumption that the FB-111A "ground handling" data includes additional lateral accelerations possibly associated with the low speed portion of the landing roll-out. It suggests possible application of Figure 11 to the entire landing and taxiing phases. A least squares straight line fit to the data exhibits a slope of $-1/b = -1/.025$ and a zero intercept P_o equal to 1.0 provides the relationship for the probability of exceeding the normalized acceleration squared as follows:

$$P = e^{-\frac{\left(n_y/n_s\right)^2}{.025}} \qquad (6)$$

B. Lateral Acceleration Per Flight

As in the previous study for ground turning maneuvers, it is now necessary to determine the average number of lateral accelerations per flight due to the landing and taxiing. Table 12 presents the number of accelerations exceeding 0.0 "g" as derived from the least squares curves fitted to the data in Figure 10. The data for the KC-135 was measured during operation of a single airbase. Over 90% of the FB-111A data analyzed was obtained during operation at a single base. For purposes of this study, all FB-111A data will be assumed from a single base. The weighted mean calculated from the data of Table 12 equals 19224 lateral accelerations per 1000 flights.

SECTION IV

APPLICATION OF STUDY RESULTS TO DESIGN CRITERIA

Varied lateral acceleration frequency distributions for several aircraft configurations have been normalized into a single cumulative probability distribution. This successful normalization suggests that the determination of future design criteria for ground maneuvering should include consideration of the expected landing gear dimensional data and predicted aircraft center of gravity locations. Results from this study may be combined to form a procedure for establishing ground turning criteria which includes such considerations. The resulting criteria will be applicable to a particular aircraft and will be different from aircraft to aircraft depending on the aircraft's landing gear dimensional arrangements and center of gravity location.

A. Ground Turning

To apply the study results in the definition of design criteria for ground turning, it is first necessary to compute the overturning side load factor. This is accomplished through application of Equation 2 and will be a function of the known or specified landing gear dimensional arrangement and center of gravity location. The center of gravity location can be based on pre and post flight gross weight conditions, if desired. However, center of gravity locations for average taxi gross weight considerations were used in the original normalization and therefore would be more appropriate. Using the predicted overturning side load factor, the cumulative probability of lateral acceleration can be determined through application of Equation 4. It was determined in Section II that an average of 9881 ground turns per 1000 flights occur. For convenience, this will be rounded off to 10,000 occurrences per 1000 flights. These ground turns will be distributed in accordance with the relative frequency distribution derived from Equation 4.

It has been shown that the ground turns are almost equally divided between departures and arrivals or pre and post flight. For practical engineering application, the small difference can be neglected. The ground turn frequency distribution will, therefore, be equally divided between pre and post flight gross weight conditions. For USAF aircraft these gross weight conditions are best represented by the maximum design weight and land plane landing weight as defined in Reference 8.

The difference between left and right hand turns was found to be somewhat larger as evidenced in Table 8. Data for ground handling activities of the FB-111 (not shown in Table 8) indicates a relative frequency of approximately 60 percent for accelerations which would result from left turns to 40 percent for right turns. Reference 2 requires an acceleration distribution of 60 percent to the right (left turn) versus 40 percent to the left (right turn). Based on the data of Table 8 and the FB-111A, it seems appropriate to retain the 60/40 distribution as specified in Reference 8.

B. Landing and Taxiing

The procedures discussed to define criteria for ground turning are equally applicable to the combined landing and taxiing data. Unfortunately, this data base is extremely limited and the procedure should, therefore, be applied with caution. It may perhaps best be used in conjunction with existing criteria and as a guide to further understanding and future developments of new criteria.

When using the procedure, the cumulative probability distribution is obtained from Equation 6. For convenience, the 19,794 lateral accelerations per 1000 flights is rounded off to 20,000 accelerations per 1000 flights or twice the number of accelerations defined for ground turning. For right (left turn steering command) versus left (right turn steering command) acceleration, the 60/40 distribution is applicable.

SECTION V

CONCLUSIONS

The lateral accelerations measured during ground turning at the center of gravity of a C-141A, DC-9-15, 727-100, KC-135 and a F-105D have been successfully normalized into a single cumulative probability distribution. The normalization factor used was the overturning side load factor for each of the airplanes. This overturning side load factor is a function of the airplane's landing gear dimensional arrangement as well as the center of gravity location. In addition, the average number of turns per 1000 flights and the relative distributions of lateral accelerations between pre and post flight, and left hand versus right hand turns were determined. The study results have been used to form a procedure for the prediction of expected lateral acceleration distribution resulting from ground turning of any aircraft.

The data base used in the development of the normalized distribution which forms the basis of the prediction procedure is not large. However, the considerable spread in the original lateral acceleration data and the normalization factors of the subject aircraft provides confidence that the approach is practicable.

The results from the procedure are primarily useful to the definition of repeated load criteria. However, it was used to support a reduction in the specified maximum discrete side load for ground turning of the B-1. The approach may be applied to the definition of discrete static design criteria for ground turning of other aircraft by establishing an acceptable probability of failure.

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TABLE 1

Frequency Distribution of Lateral Acceleration During Ground Turn Maneuvers of a C-141A

LATERAL ACCELERATION g	FREQUENCY PER 1000 FLIGHTS	CUMULATIVE FREQUENCY PER 1000 FLIGHTS	RELATIVE FREQUENCY	RELATIVE CUMULATIVE FREQUENCY
0 - 0.02	1085	9846	.1102	1.0
0.02 - 0.04	2759	8761	.2803	.89
0.04 - 0.06	2837	6001	.2882	.61
0.06 - 0.08	1705	3164	.1732	.32
0.08 - 0.10	946	1459	.0961	.15
0.10 - 0.12	264	513	.0268	.052
0.12 - 0.14	202	249	.0205	.025
0.14 - 0.16	31	47	.0031	.0047
0.16 - 0.18	16	16	.0016	.0016

TABLE 2

Frequency Distribution of Lateral Acceleration

During Ground Turn Maneuvers of a DC-9-15

LATERAL ACCELERATION	FREQUENCY PER 1000 FLIGHTS	CUMULATIVE FREQUENCY PER 1000 FLIGHTS	RELATIVE FREQUENCY	RELATIVE CUMULATIVE FREQUENCY
0.0 - 0.3	1733	10400	.1667	1.0
.03 - .06	2533	8667	.2463	.83
.06 - .09	4667	6134	.4487	.59
.09 - .12	667	1467	.0461	.141
.12 - .15	800	800	.0769	.0769
.15 - .18	-	-	-	-

TABLE 3

Frequency Distribution of Lateral Acceleration

During Ground Turn Maneuvers of a 727-100

LATERAL ACCELERATION	FREQUENCY PER 1000 FLIGHTS	CUMULATIVE FREQUENCY PER 1000 FLIGHTS	RELATIVE FREQUENCY	RELATIVE CUMULATIVE FREQUENCY
0.0 - .03	3200	12800	.25	1.0
.03 - .06	3467	9600	.27	.75
.06 - .09	2800	5133	.22	.4892
.09 - .12	2133	3333	.17	.2604
.12 - .15	1067	1200	.083	.0937
.15 - .18	133	133	.01	.0104

TABLE 4

Frequency Distribution of Lateral Acceleration During Ground Turn Maneuvers of a KC-135

LATERAL ACCELERATION	FREQUENCY PER 1000 FLIGHTS	CUMULATIVE FREQUENCY PER 1000 FLIGHTS	RELATIVE FREQUENCY	RELATIVE CUMULATIVE FREQUENCY
0.0 - 0.5	731	2423	.502	1.0
.05 - .10	692	1692	.286	.698
.10 - .15	615	1000	.254	.413
.15 - .20	270	385	.111	.159
.20 - .25	115	115	.047	.048

TABLE 5

Frequency Distribution of Lateral Acceleration

During Ground Turn Maneuvers of a F-105D

LATERAL ACCELERATION	FREQUENCY PER 1000 FLIGHTS	CUMULATIVE FREQUENCY PER 1000 FLIGHTS	RELATIVE FREQUENCY	RELATIVE CUMULATIVE FREQUENCY
0.0 - .02	-	-	-	-
.02 - .04	-	-	-	-
.04 - .06	-	-	-	-
.06 - .08	-	-	-	-
.08 - .10	1533	5533	.28	.35
.10 - .12	1267	4000	.23	.25
.12 - .14	1067	2733	.19	.17
.14 - .16	800	1667	.145	.105
.16 - .18	533	867	.095	.055
.18 - .20	267	333	.05	.021
.20 - .22	67	67	.01	.0042

TABLE 6

Landing Gear Geometry Data

AIRPLANE	DIMENSIONS				$0.5 \frac{bt}{de}$
	b	d	e	t	
C-141A	48.29	53.25	11.92	17.5	.666
727-100	49.5	53.25	9.58	18.75	.910
DC-9-15	39.69	43.71	8.56	16.4	.870
KC-135	42.95	45.67	8.13	22.1	1.28
F-105D	18.75	21.08	8.4	17.27	.919
FB-111A	19.72	24.44	6.75	10.03	.599

TABLE 7

Total Number of Ground Turns per 1000 Flights for Five Aircraft

AIRCRAFT	OCCURRENCES EXCEEDING $n_y = 0.0$ "g" PER 1000 FLIGHTS	NUMBER OF SAMPLES	
		AIRFIELDS	FLIGHTS
C-141A	9846	42	64.5
DC-9-15	10400	8	7.5
727-100	12800	8	7.5
KC-135	2423	1	26
F-105D	15835	1	15

TABLE 8

Relative Frequency of Ground Turns for Arrivals vs Departures, and for Left Hand vs Right Hand Turns

AIRCRAFT	RELATIVE FREQUENCY			
	ARRIVALS	DEPARTURES	LEFT HAND	RIGHT HAND
C-141A	.487	.513	.52	.48
DC-9-15	.495	.505		
727-100	.497	.503		
F-105D	.47	.53	-	-
KC-135			.55	.45

TABLE 9

Frequency Distribution of Lateral Acceleration

During Ground Handling of a FB-111A

LATERAL ACCELERATION	FREQUENCY PER 1000 FLIGHTS	CUMULATIVE FREQUENCY PER 1000 FLIGHTS	RELATIVE FREQUENCY	RELATIVE CUMULATIVE FREQUENCY
0 - .06	-	-	-	-
.06 - .13	-	-	-	-
.13 - .19	2822	3108	.908	1.0
.19 - .25	261	286	.084	.092
.25 - .31	25	25	.008	.00804

TABLE 10

Frequency Distributions of Lateral Acceleration

During Landing and Turning of a KC-135

LATERAL ACCELERATION	ACCUMULATED FREQUENCY PER 1000 FLIGHTS		
	LANDING	GROUND TURNS	1 + 2
0.0 - .10	4615	2423	7038
.10 - .20	3865	1000	4865
.20 - .30	2385	115	2500
.30 - .40	981		981
.40 - .50	173		173

TABLE 11

Frequency Distributions of Lateral Acceleration During Landing, Landing Transition and Ground Handling of a FB-111A

LATERAL ACCELERATION	ACCUMULATED FREQUENCY PER 1000 FLIGHTS		
	LANDING & LANDING TRANSITION	GROUND HANDLING	1 + 2
0 - .06			
.06 - .13			
.13 - .19	1050	3108	4158
.19 - .25	200	286	486
.25 - .31		25	25

TABLE 12

Total Number of Lateral Accelerations Per 1000 Flights Due to the Landing and Ground Maneuvering of a KC-135 and a FB-111A

AIRCRAFT	OCCURRENCES EXCEEDING n_y = 0.0 "g" PER 1000 FLIGHTS	NUMBER OF SAMPLES	
		AIRFIELDS	FLIGHTS
KC-135	6568	1.	26
FB-111A	28001	1.	38

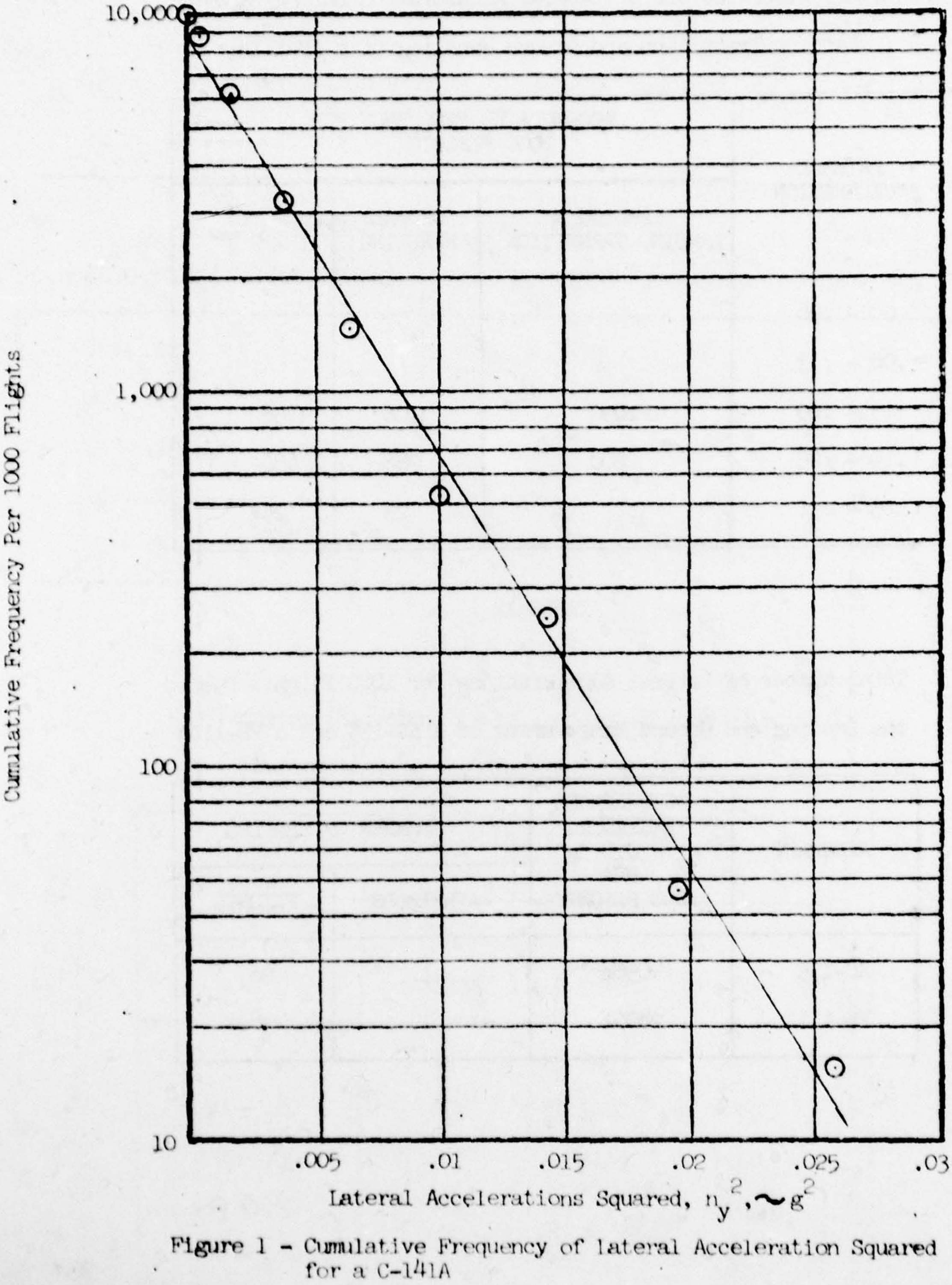


Figure 1 - Cumulative Frequency of lateral Acceleration Squared for a C-141A

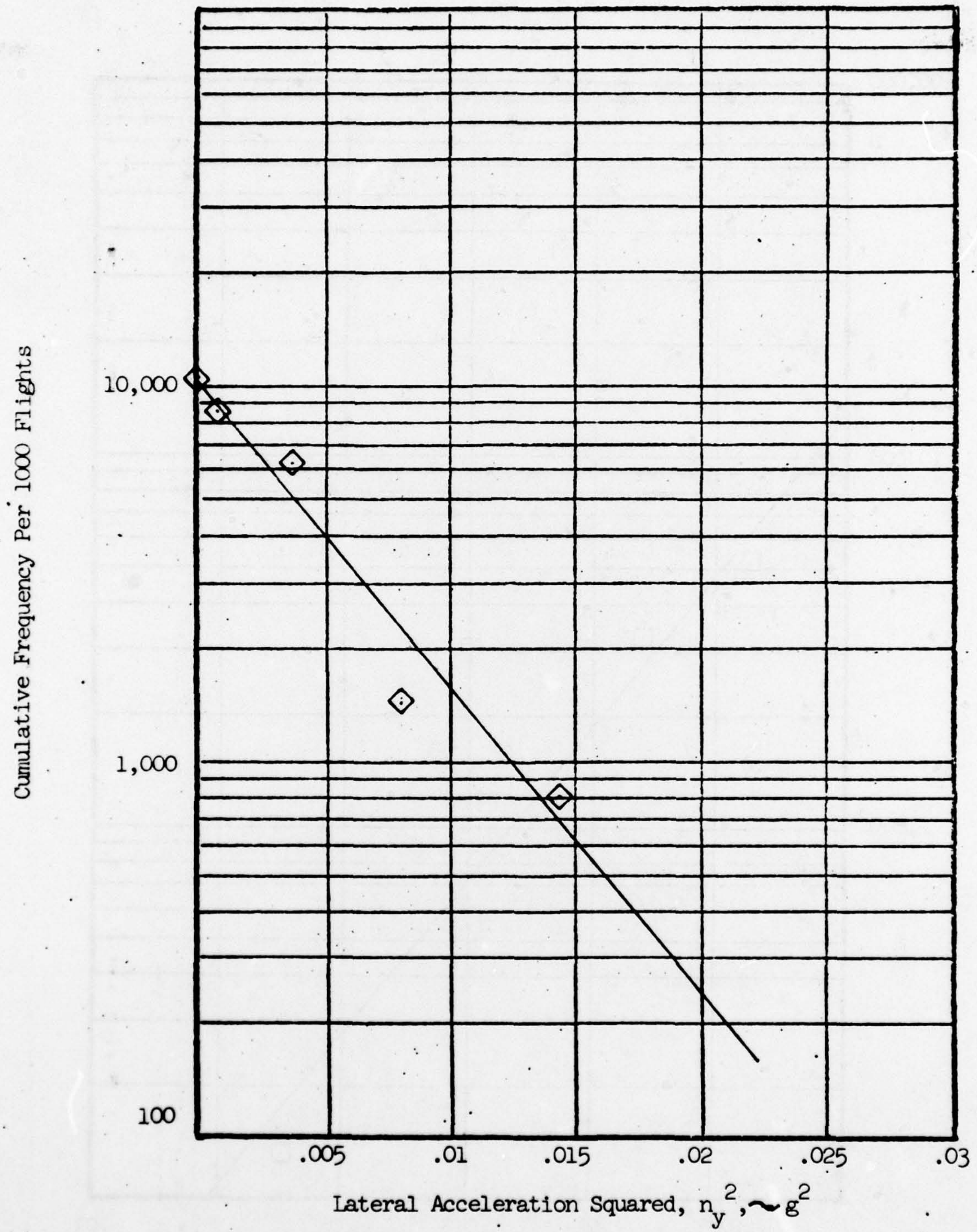


Figure 2 - Cumulative Frequency of Lateral Acceleration Squared for a DC-9-15

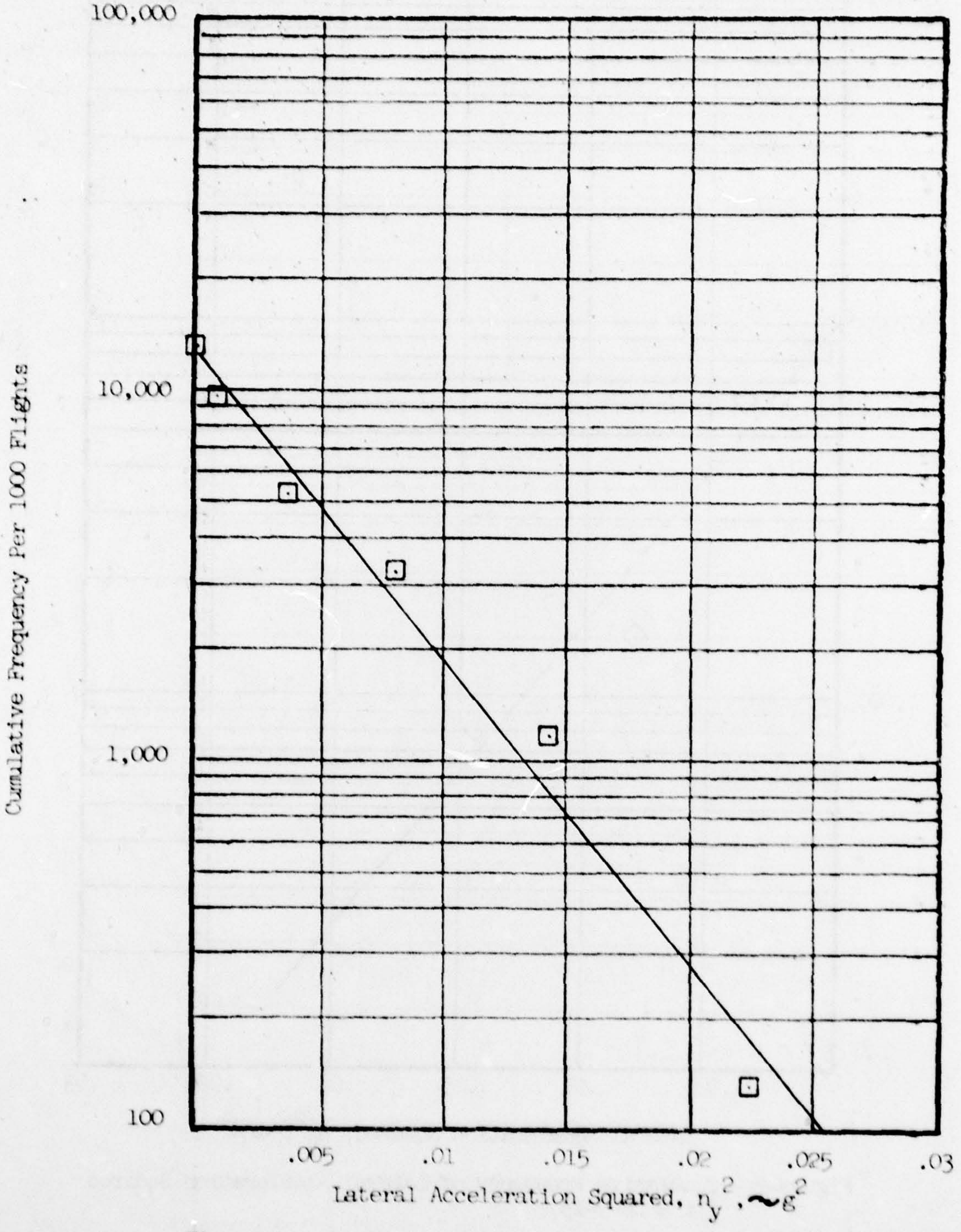


Figure 3 - Cumulative Frequency of Lateral Accelerations Squared for a 727-100

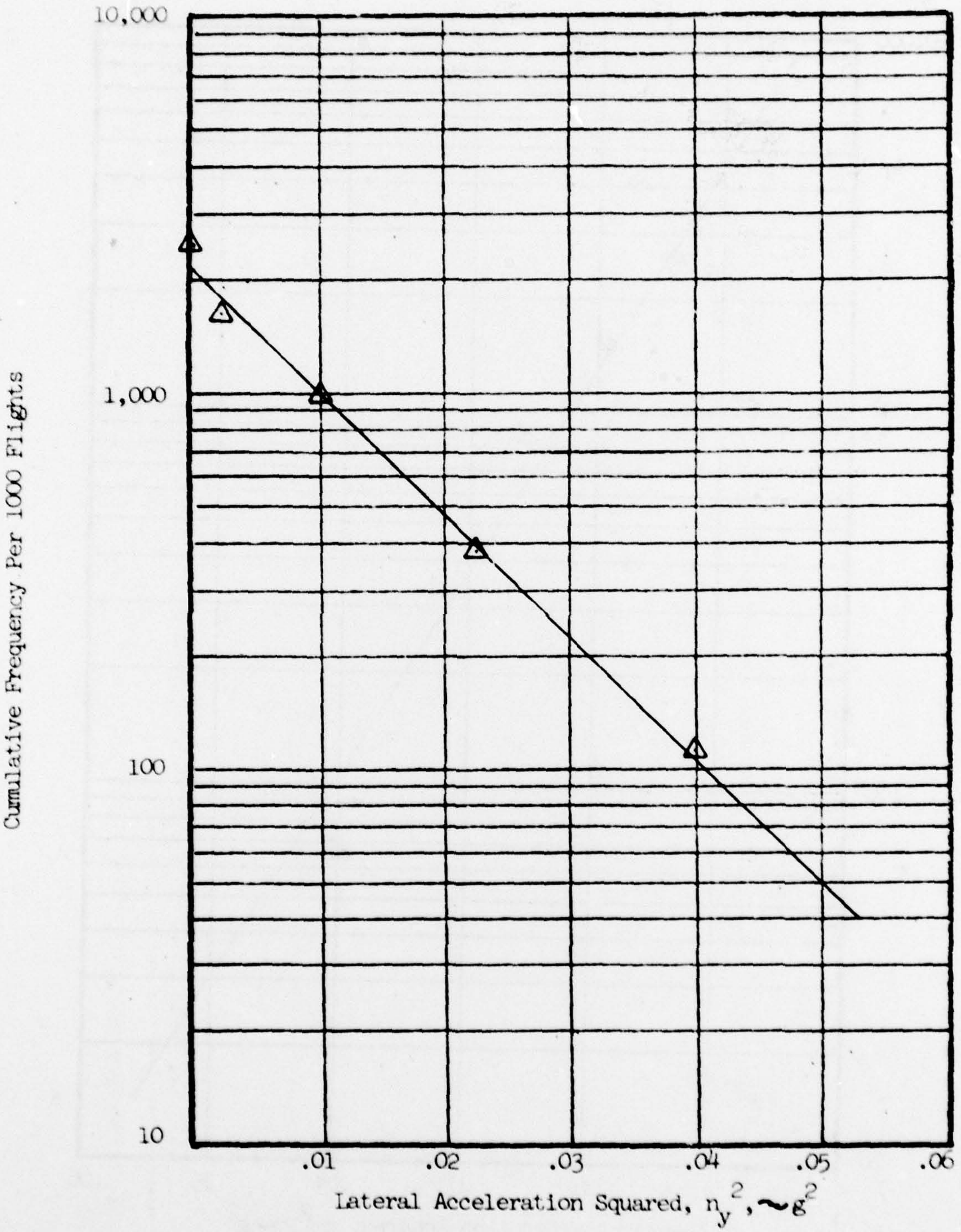


Figure 4 - Cumulative Frequency of Lateral Accelerations Squared for a KC-135

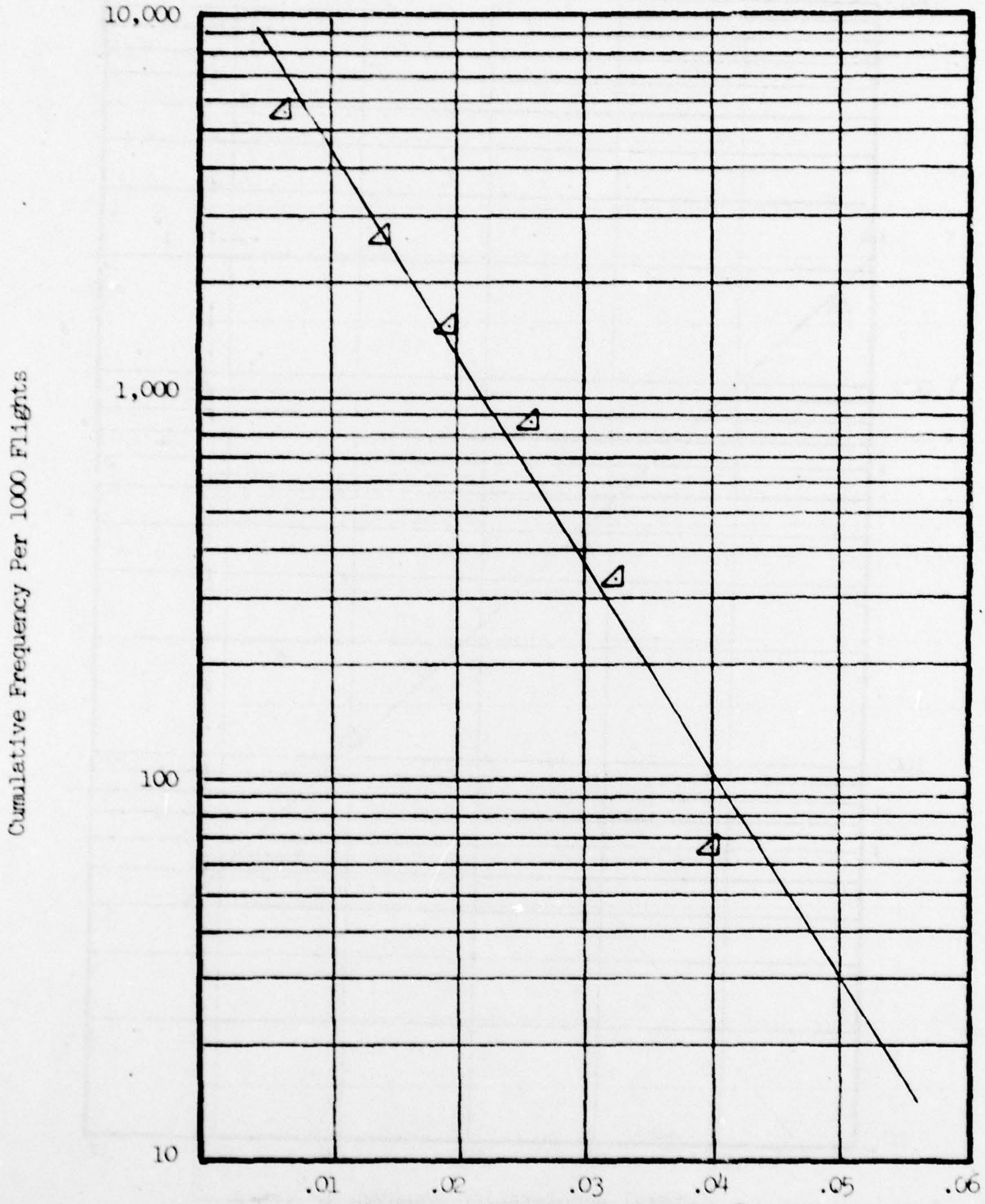


Figure 5 - Cumulative Frequency of Lateral Accelerations Squared for a F-105D

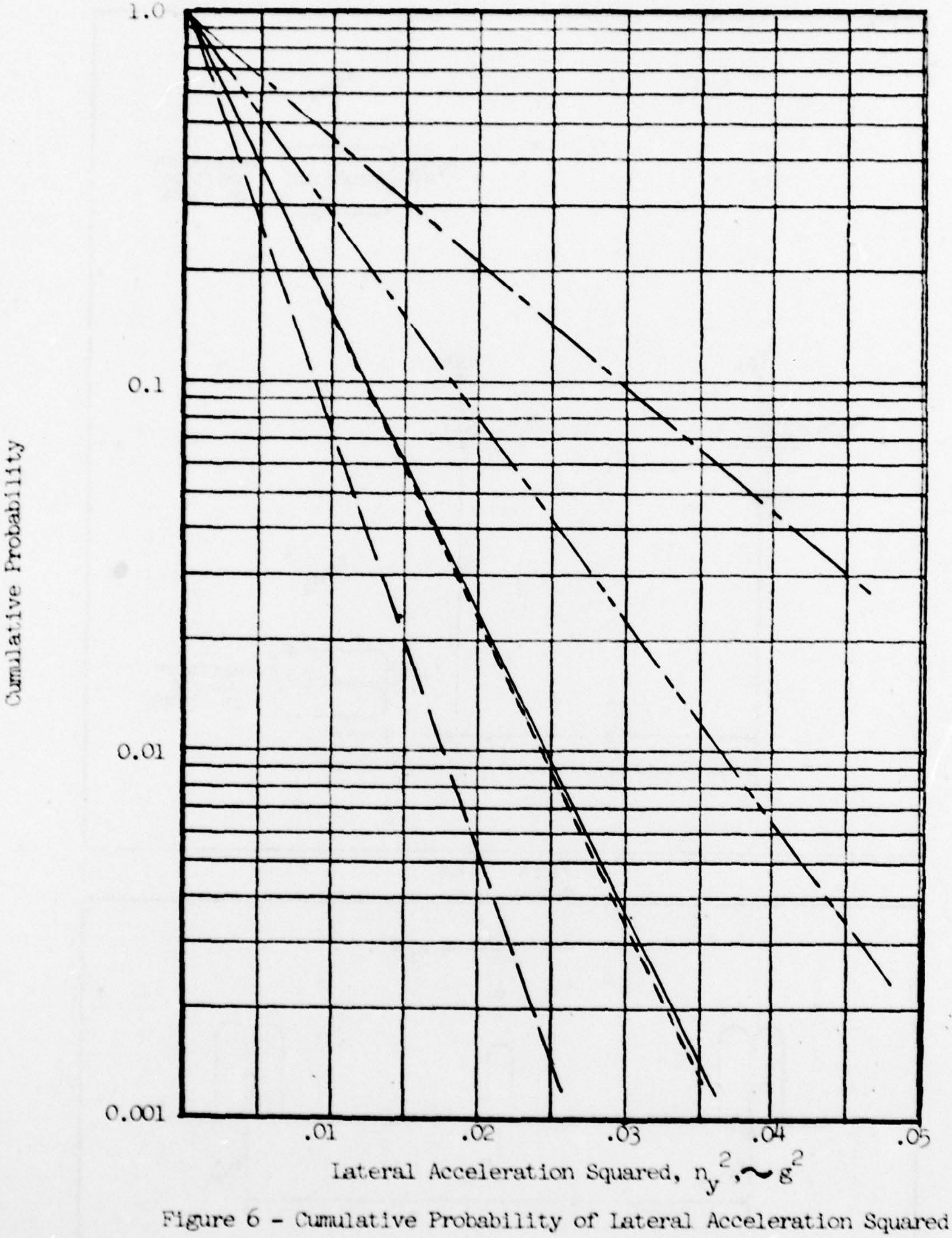
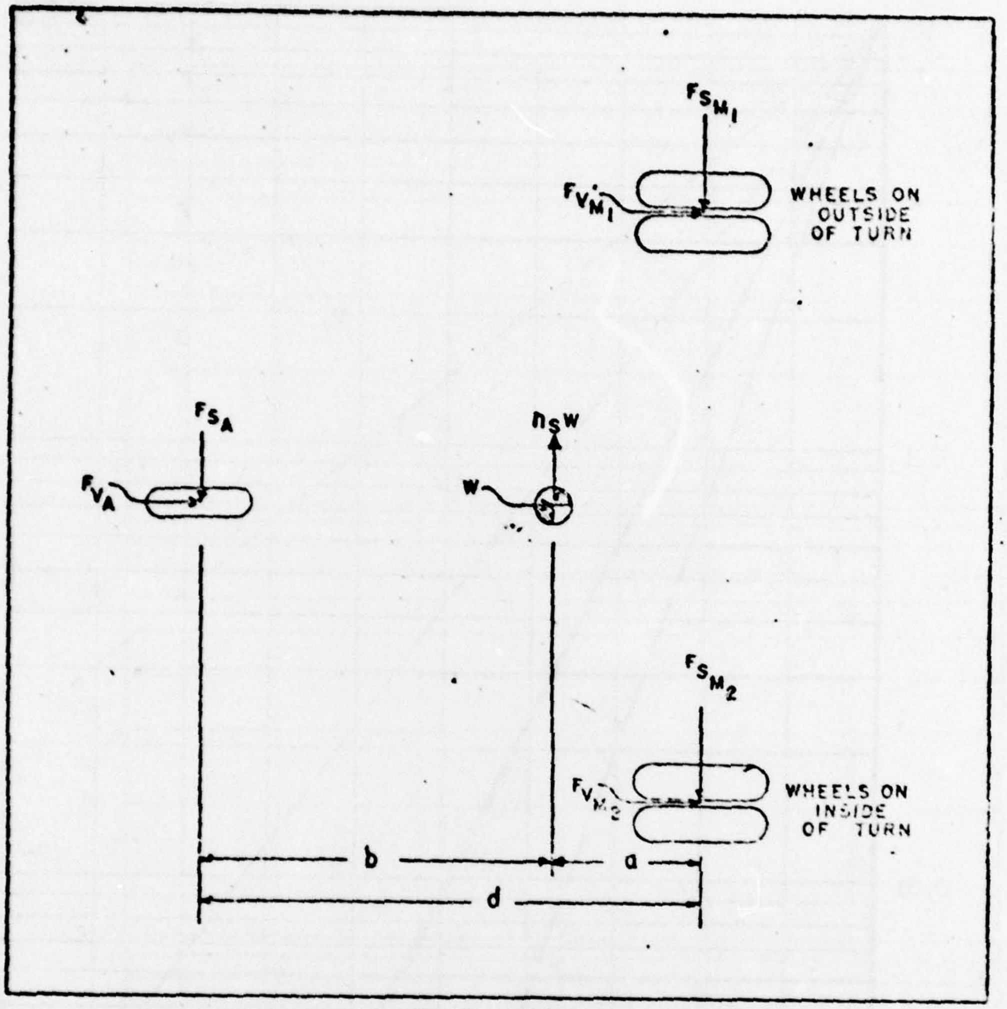
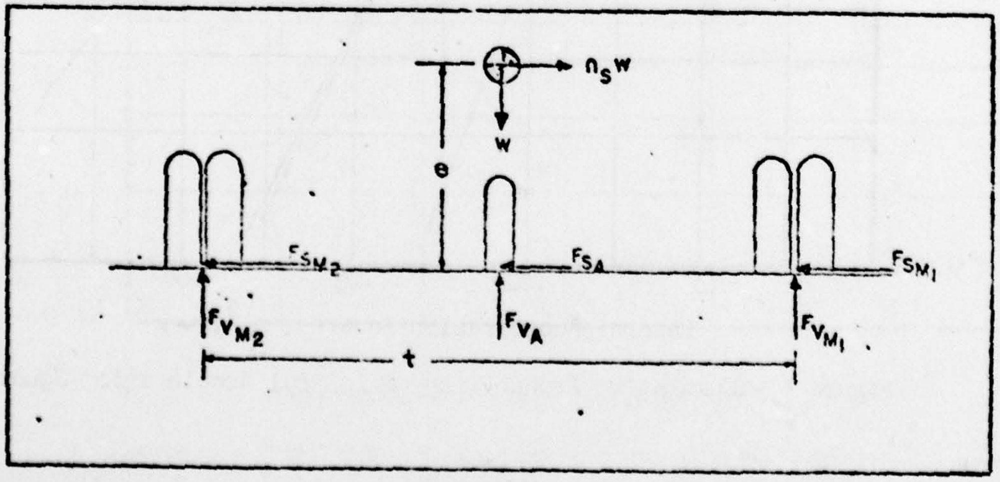


Figure 6 - Cumulative Probability of Lateral Acceleration Squared



PLAN VIEW



END VIEW

Figure 7 - Landing Gear Geometry

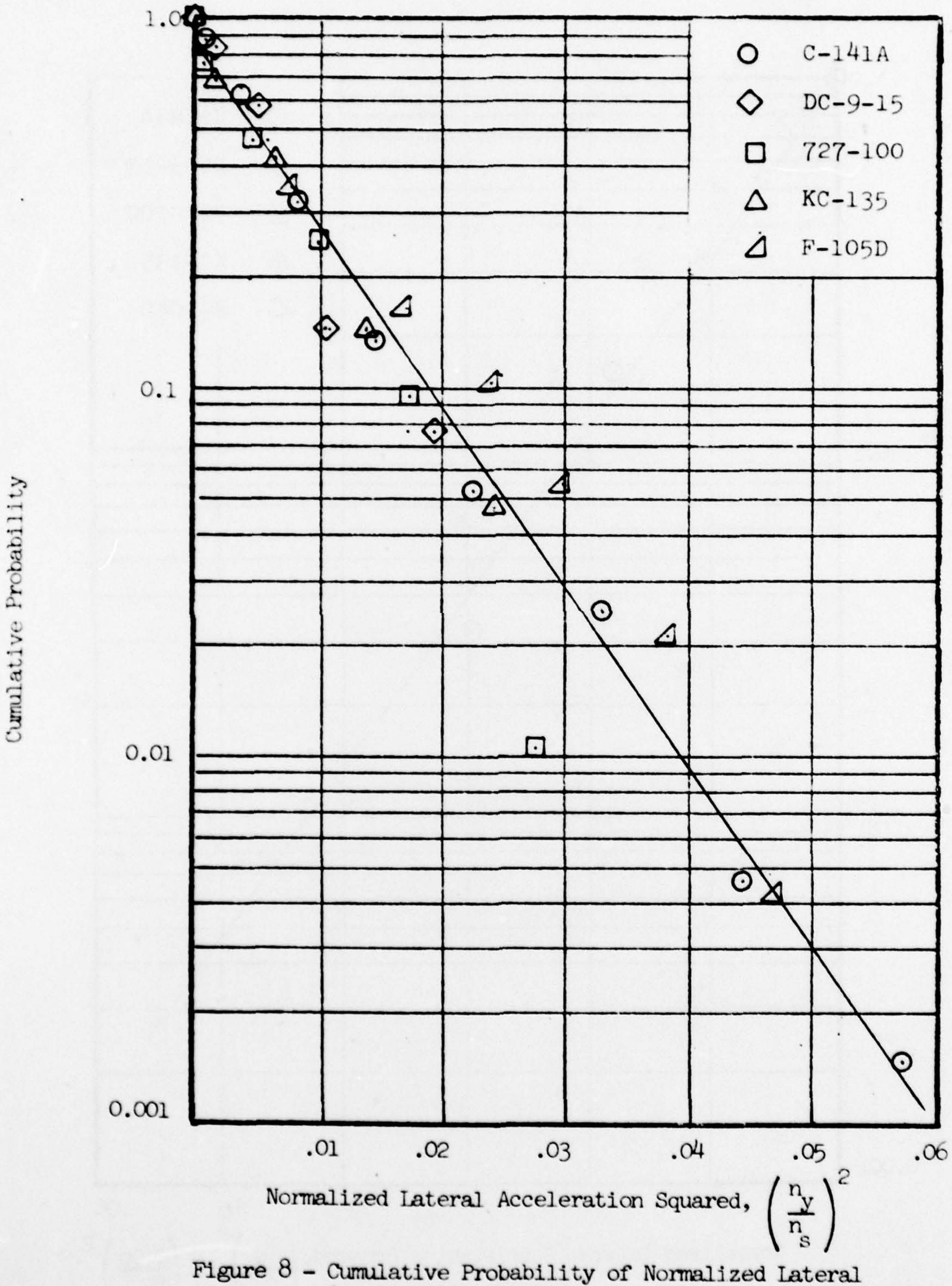


Figure 8 - Cumulative Probability of Normalized Lateral Acceleration Squared

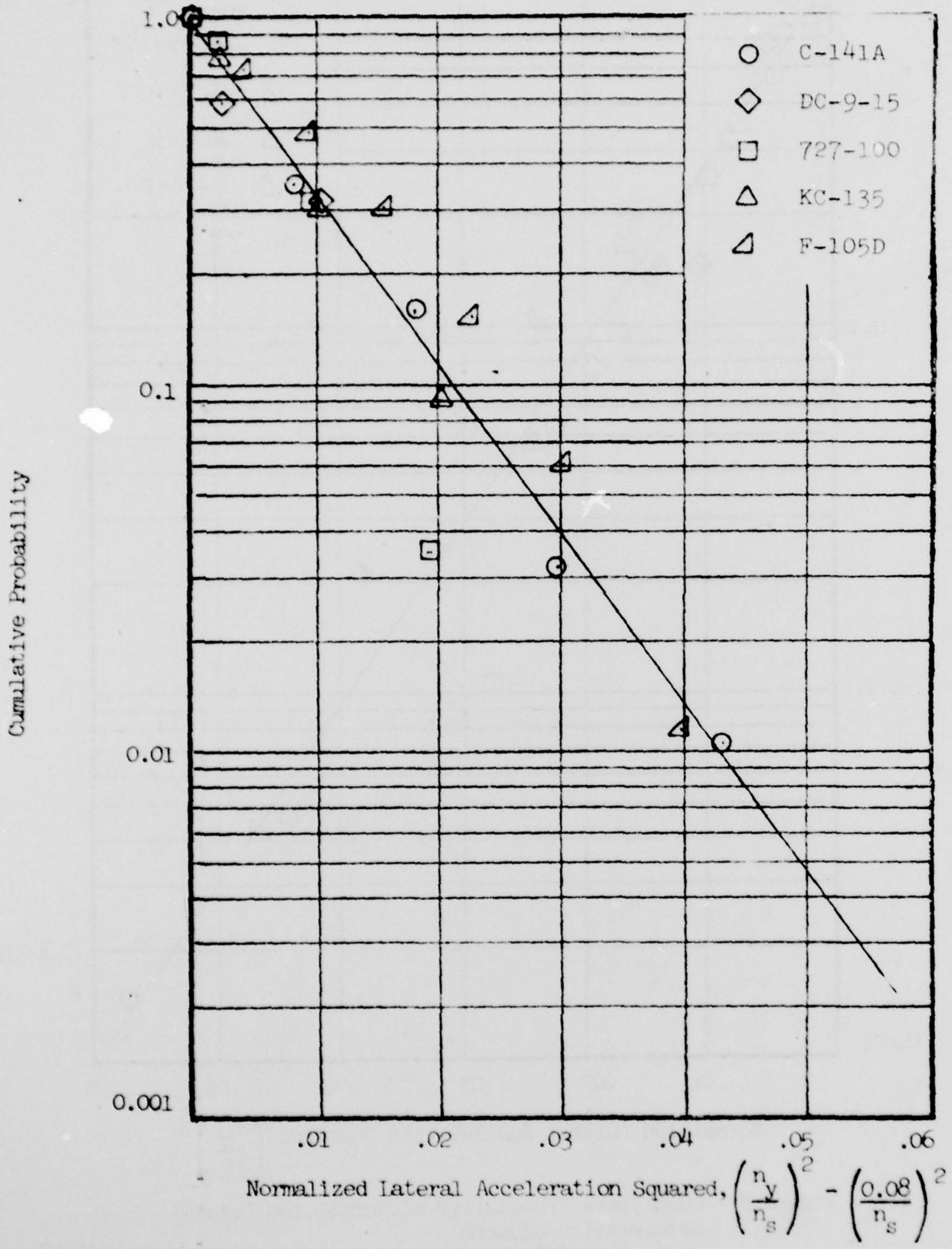


Figure 9 - Cumulative Probability of Normalized Lateral Acceleration Squared for Data Threshold $n_y = 0.08$

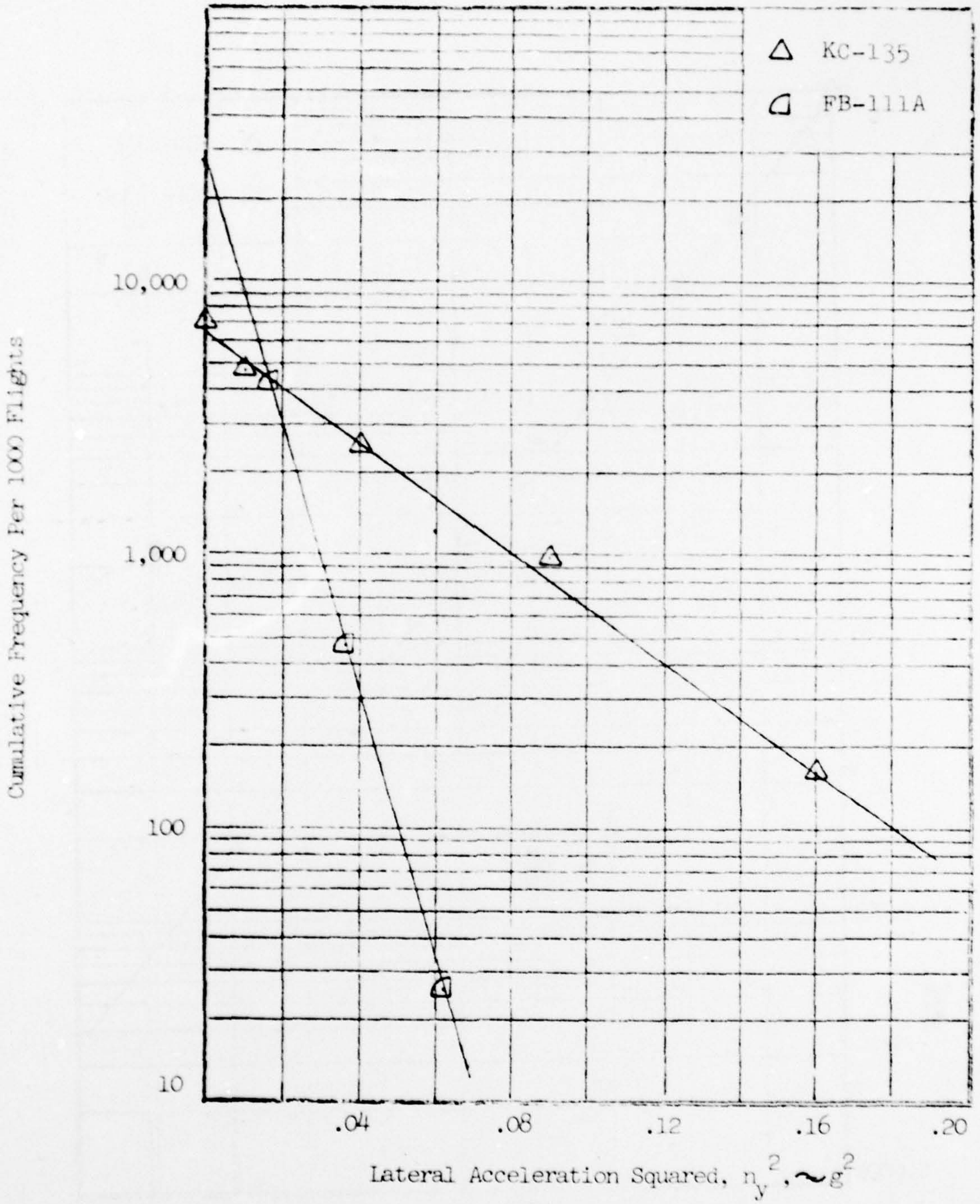


Figure 10 - Cumulative Frequency of Lateral Acceleration Squared for a KC-135 and FB-111A During Landing and Taxiing Operations

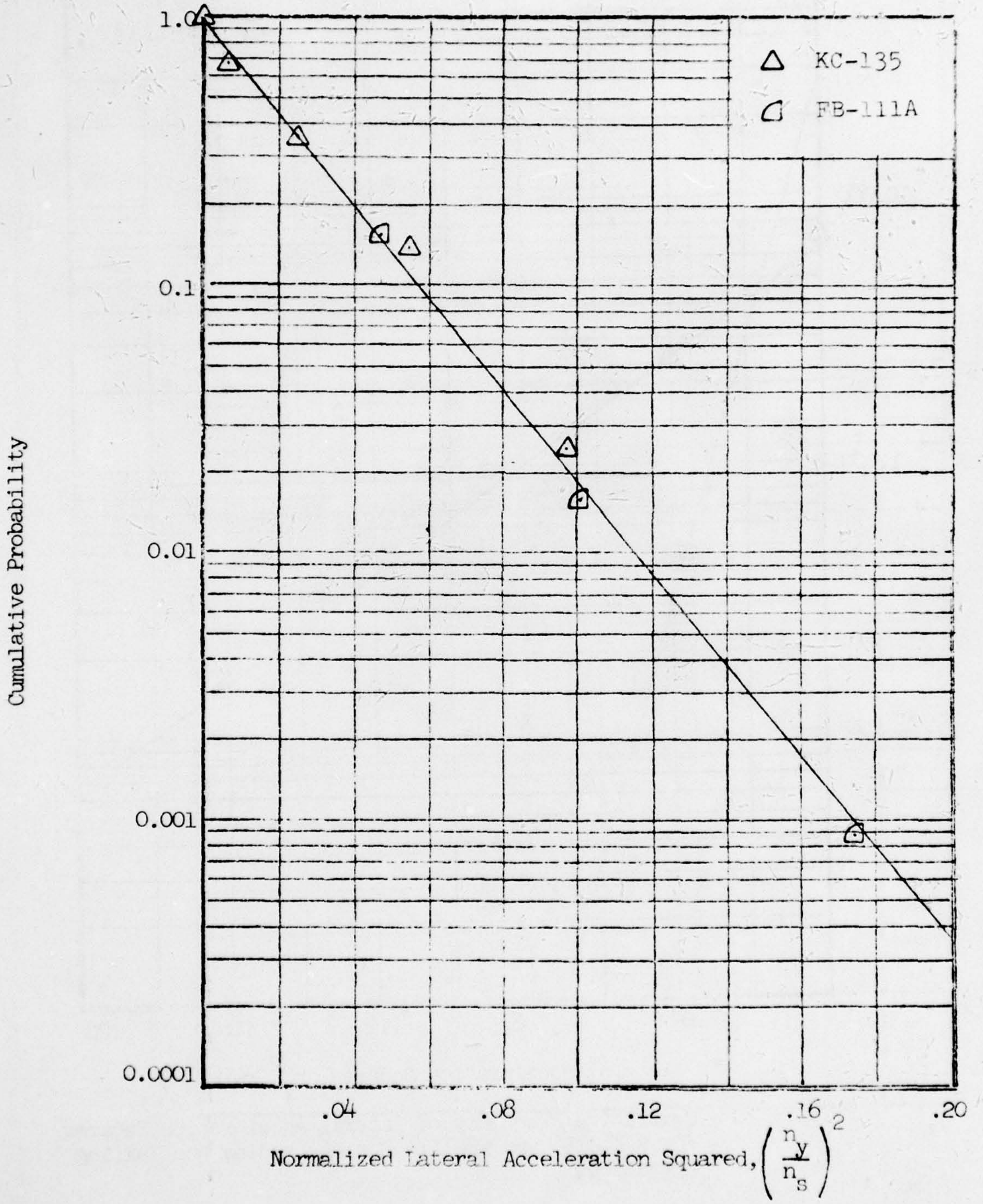


Figure 11 - Cumulative Probability of Normalized Lateral Acceleration Squared for Landing and Taxiing Operations