NASA TECHNICAL MEMORANDUM

NASA TM X-72660

NASA TM X-72660

EFFECTS OF EXPOSURE TIME DURING FLIGHT MANEUVERS ON PASSENGER SUBJECTIVE COMFORT RATING

By Valerie J. Brown

April 1975

RECEIVED
NASA STI FACILITY
INPUT BRANCH
APR 1975

This informal documentation medium is used to provide accelerated or special release of technical information to selected users. The contents may not meet NASA formal editing and publication standards, may be revised, or may be incorporated in another publication.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER, HAMPTON, VIRGINIA 23665

(NASA-TM-X-72660) EFFECTS OF EXPOSURE TIME DURING FLIGHT MANEUVERS ON PASSENGER SUBJECTIVE COMFORT RATING (NASA) 28 p HC $3.75 CSCL 05E

N75-21029

Unclas

G3/54 14756

1. Report No. NASA TM X-72660	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Effects of Exposure Time During Flight Maneuvers On Passenger Subjective Comfort Rating		5. Report Date April 1975
		6. Performing Organization Code
7. Author(s) Valerie J. Brown		8. Performing Organization Report No.
		10. Work Unit No.
9. Performing Organization Name and Address NASA Langley Research Center Hampton, Virginia 23665		11. Contract or Grant No.
		13. Type of Report and Period Covered Technical Memorandum
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D.C. 20546		14. Sponsoring Agency Code

15. Supplementary Notes

Final release of special information not suitable for formal publication.

16. Abstract

A study has been carried out to determine the effects of length of exposure time to a flight maneuver environment on subjective passenger evaluation of ride comfort. The results indicate that, for over 95 percent of the segments, there is no significant change in the test subjects' comfort ratings of identical segments spaced one hour apart.

17. Key Words (Suggested by Author(s)) (STAR category underlined) Ride-quality, passenger comfort, flight maneuvers, time effects Aircraft	18. Distribution Statement Unclassified - Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	25	$3.25

*Available from The National Technical Information Service, Springfield, Virginia 22151
STIF/NASA Scientific and Technical Information Facility, P.O. Box 33, College Park, MD 20740

ABSTRACT

A study has been carried out to determine the effects of length of exposure time to a flight maneuver environment on subjective passenger evaluation of ride comfort. The results indicate that, for over 95 percent of the segments, there is no significant change in the test subjects' comfort ratings of identical segments space one hour apart.

EFFECTS OF EXPOSURE TIME DURING FLIGHT MANEUVERS ON PASSENGER SUBJECTIVE COMFORT RATING

by Valerie J. Brown

Langley Research Center

SUMMARY

A study has been carried out to determine the effects of length of exposure time to a flight maneuver environment on subjective passenger evaluation of ride comfort. Four statistical analysis tests have been performed on ride comfort ratings obtained during one two-hour test flight wherein eleven test subjects were exposed to two identical programmed sequences of twenty four flight segments which covered a wide range of maneuver conditions. The results of the analysis indicate that, for over ninety five percent of the segments, there is no significant change in the test subjects' comfort ratings of identical segments spaced one hour apart. These results are in contrast to those found in previous studies involving a vibration environment, rather than flight maneuver environment, where increased exposure-time was found to cause a degradation of ride comfort ratings.

INTRODUCTION

In the design of an aircraft (or other vehicle) both human and technical factors must be considered. The development of the jet transport has tended to set an improved standard in both common carrier service and passenger ride comfort. However, several new concepts developed in recent years for advanced air, land, and water vehicles (e.g. STOL transports, air cushion vehicles, high-speed rail vehicles, etc.) may have inferior ride quality. In some instances, this degradation has been so severe that the ride is very close to being unacceptable. Therefore, to be able to accurately formulate and/or evaluate any new vehicle design, the relationship between the vehicle ride environment characteristics and passenger acceptance of that ride environment must be established.

Passenger acceptance is subjective and is affected by many factors (e.g. comfort, time savings, cost, safety, convenience, reliability, etc.). In a study by the University of Virginia (ref. 1), passenger comfort and trip cost were identified as being equally important factors in air travel satisfaction. Factors upon which comfort itself is dependent include motions, vibrations, temperature, noise, pressure changes, etc. Prior studies have indicated that exposure time to a vibratory ride environment can be significant. An example is found in University of Virginia ride quality studies aboard a passenger hovercraft (ref. 2). The data of Figure 1 show that at approximately twenty minutes into the ride, the mean subjective response became noticeably more "uncomfortable" even though the ride environment remained unchanged. Also, in a recommended standard entitled "Guide for the Evaluation of Human Exposure to Whole

Body Vibration" (ref. 3), the International Organization for Standardization (ISO) postulates a decrease in comfort with increased exposure time. However, there is some question as to the exact relation between exposure time and comfort as offered in these standards. The effects on ride comfort of exposure time to an environment of flight maneuvers rather than vibration has not been addressed previously.

The present study was performed to gain an insight into the effects on ride comfort of the duration of exposure to flight maneuvers. Statistical analyses were carried out on subjective data obtained during one test flight of a ride quality flight study conducted at the Langley Research Center. Data obtained during the test flight are considered sufficient to provide results which are statistically significant.

SYMBOLS

A	total number of reverse arrangements
A_i	individual reverse arrangement
$\bar{d}$	difference between two sample means
d_i	difference between two individual ratings
g	acceleration of gravity (9.8 m/sec^2)
H_o	null hypothesis
H_1	alternate hypothesis
N	size of each sample
N_o	total sample size ($n_1 + n_2$)
n_1	size of first sample
n_2	size of second sample
n_x	longitudinal acceleration (g-units)
P	pitch rate (deg/sec)
r	total number of runs
t	statistical value for use with "t" Test
Δt	change in time (sec)
u	statistical value for use with Wilcoxon Two-Sample Test
U	critical value for use in Wilcoxon Two-Sample Test
V_i	indicated airspeed (m/sec)
W_1	sum of ranks
$\bar{X}_1$, $\bar{X}_2$	sample means
x_i, x_j	individual values for use in Trend Test
α	probability of rejecting the null hypothesis when it is true (type I error)

γ	flight path angle (deg)
θ	pitch attitude (deg)
ϕ	roll attitude (deg)

subscripts

i,j	integer values
m	maximum

TEST EQUIPMENT, SUBJECTS, AND PROCEDURES

Test Aircraft

The USAF Total In-Flight Simulator (TIFS) aircraft utilized is basically a Convair-580 aircraft modified into a variable-stability research aircraft through incorporation of side-force generating surfaces, a second test cockpit, and an on-board analog computer and fly-by-wire control system. For the ride quality flight tests, the test cockpit was removed and a nose cover fairing installed. The computer system, located in the rear portion of the aircraft, was directed by a magnetic drive tape to regulate the aircraft motions in all six degrees of freedom (vertical, lateral, and longitudinal accelerations, and roll, pitch, and yaw attitude). Magnetic drive tapes were prepared in advance by flying the aircraft through prescribed series of maneuvers and recording the various motion parameter time histories. Aircraft motions during the test were then computer controlled through the side-force surfaces, servo-driven throttle, direct lift flaps, ailerons, elevators, and rudder. The principle advantage of using the TIFS for in-flight ride quality research is that the motions which the aircraft is to undergo are programmable and therefore repeatable.

For the test flight, the pilot flew the TIFS to the desired altitude and then engaged the computer. For certain maneuvers the pilot deflected the fowler flaps and lowered the landing gear. Between maneuvers the pilot could trim the aircraft if required. It should be noted that the computer would automatically disengage and the pilot take direct control of the aircraft if at any time a hazardous flight condition developed.

After the test was completed, the pilot disengaged the computer and landed the TIFS.

Aircraft Interior

The front section of the TIFS cabin was modified for the ride quality test program. Twelve commercial airline seats were installed in the positions indicated by Figure 2. The hydraulic system for the actuators was enclosed within wood paneling (Enclosures A & C). Within Enclosure B, as shown on Figure 2, a videotape camera was installed, facing Seat 7. The control and monitoring equipment for the videotape was located in front of Seat 12. Carpeting was installed and curtains were installed so that the test subjects would not be able to see either the pilot or the computer. As shown in Figure 3, the cabin interior was equipped to look like the interior of a commercial commuter aircraft. The aircraft was unpressurized and the test altitude was limited to a maximum value of 10,000 feet.

Test Subjects

Eleven test subjects were used for the flight of the present study. They were randomly selected, and varied in age, profession, and previous flight experience (See Table 1). Prior to the test, the subjects were instructed to evaluate overall comfort rather than attempt to isolate individual motions and/or feelings. Also, they were instructed that if at any time during the test an individual test subject did not wish to continue to experience the programmed motions, he should raise his hand, and the test would be terminated. The subjects were only given general descriptions of the kind of motion which the aircraft would undergo.

Test Procedure

The test flight lasted approximately two and one quarter hours. It included two 45 minute test periods, each containing 24 separate maneuvers (segments) each up to fifty seconds in duration, followed by a period of steady flight. In both test periods, the aircraft was controlled by the same drive tape; therefore, the sequence of maneuvers was identical. The maneuvers consisted of simple turns, longitudinal decelerations (with and without pitchover), steady descents, curved decelerations and turns, either alone or in combination. The maneuvers were typical of those encountered or under consideration for terminal-area operations of transport aircraft, and are described in Table 2.

The subjects were notified of the beginning and end of each test segment through the use of the public address system on the aircraft. Immediately following the completion of a segment, each subject independently evaluated the comfort of the ride segment. The evaluation made use of a seven-point rating scale; with a rating of one being very comfortable, a rating of four being neutral, and a rating of seven being very uncomfortable. The range of comfort ratings for the 24 segments spanned the entire seven-point scale.

Upon completion of the first test period (i.e. the first 24 segments), there was a fifteen-minute rest period where subjects were allowed to get out of their seats and walk around. Also during this break, the subjects were asked to change their seating positions so that they were in different seats for the second test period. Each subject was asked if he had any objection to continuing the flight and conducting the second test. All

After the break, the same 24 segments were repeated. Since the first test period and break together were approximately one hour in duration, the same maneuvers were repeated at about a one-hour interval.

ANALYSIS PROCEDURE

A linear regression analysis and four different statistical tests were performed on the ride comfort ratings obtained (Table 3). The strength of each statistical test is discussed. Since each of the 24 programmed maneuvers was a unique combination of environmental inputs, it was expected that ratings for all 24 maneuvers would not be normally distributed. This presumption was verified by the Chi-Squared Goodness of Fit Test for the normal distribution (ref. 4).

Linear Regression Analysis

The least-square-error linear relationship between subjective responses given during the first test period and corresponding responses during the second test period is shown in Figure 4. The linear correlation coefficient for these data is 0.90.

Wilcoxon Two-Sample Test

The first statistical test which was carried out was the Wilcoxon Two-Sample Test (ref. 4), which is a non-parametric statistical test (i.e., it assumes no knowledge about the distribution and parameters of the population). It is valid for both normal and non-normal populations.

"t" Test

The most powerful test used was the "t" Test of Significance Between Two Sample Means ($\bar{x}_1$ and $\bar{x}_2$) (ref. 6). This test was performed for paired variates (i.e., each rating given by each subject during the first test period was paired with the corresponding rating given by the same subject in the second test period).

Run Test

The Run Test, which is another non-parametric test, was performed on the mean values of the ratings from each of the 48 segments. This test was used to determine whether or not a trend existed in the data (i.e. if the ratings are independent or not).

Trend Test

The final test which was performed was also a non-parametric test, the Trend Test. Generally, it is more powerful than the Run Test for detecting monotonic trends in a given sequence of observations.

RESULTS AND DISCUSSION

Wilcoxon Two-Sample Test

The Wilcoxon Two-Sample Test was performed on each paired segment. Table 4 presents a summary of the sum of the ranks (w_1) and the u values. This test was performed at the $\alpha = 0.05$ level of significance; at this level, the critical value of U is 34. All of the segments have u values within the acceptance region; therefore, the null hypothesis is accepted (i.e. ratings in the second test period were not significantly less comfortable than those in the first period).

"t" Test

The "t" Test of Significance Between Two Sample Means was also performed on each of the paired segments. Inspection of Table 5, indicates high probability that the differences between the sample means were indeed random. With no real differences in test subject populations and flight maneuvers between the first and second test periods, one would expect that significant ($\alpha = .10$) differences in corresponding ratings would occur by chance alone in 2 or 3 of the 24 maneuvers. Note that only 4 mean rating differences exceed 0.5; i.e. 20 out of 24 mean rating pairs agree within half a response unit.

Run Test

The Run Test was carried out for the mean values of the ratings which were given by all eleven subjects, for each segment. The median of the entire sample of 48 ratings was 3.7. Thus, as may be seen in Table 6, the total number of runs (r) is 19. This test was performed for a level of significance of $\alpha = 0.05$. Therefore, the acceptance interval is $17.2 < r < 31.8$. Since $r = 19$, it is within the interval and H_o may be accepted. These results indicate that no significant trend with time is present in the comfort ratings.

Trend Test

The Trend Test was also carried out for the mean values of the ratings which were given by all eleven subjects for each segment. As indicated in Table 7, the sum of all of the reverse arrangements (A) is 478. As in the Run Test, this test was carried out on a level of significance $\alpha = 0.05$. Thus, the acceptance region is $457 < A < 678$. The value for A falls within this interval; therefore, H_o is accepted. The test indicates that no significant monotonic trend with time exists in the comfort ratings.

CONCLUDING REMARKS

Analyses have been carried out on ride quality subjective response data to aid in the quantification of the relationship between exposure time to ride environment and passenger subjective evaluation of ride comfort. Four different tests performed to determine statistical significance indicate that, for over ninety-five percent of the segments, there is no significant change in the test subjects' comfort ratings of identical segments. The results suggest that there is no statistically notable change in a person's comfort for numerous maneuvers of significant magnitude over an exposure time of approximately two hours. The results of this study are at variance with those found in previous studies involving a vibratory rather than flight maneuver environment.

REFERENCES

1. Jacobson, I.D.; and Kuhlthau, A.R.: Determining STOL Ride Quality Criteria - Passenger Acceptance. Journal of Aircraft, vol. 10, no.3, March 1973, pp. 163-166.
2. McClurken, Eugene W., Jr.: Preliminary Ride-Quality Evaluation of the HM.2 Hoverferry. Mem. Rep. 403216, Univ. of Virginia, December 1974.
3. International Organization for Standardization (ISO): Guide for the Evaluation of Human Exposure to Whole-Body Vibration. Draft International Standard ISO/DIS 2631, Geneva, 1972.
4. Walpole, Ronald E.; and Myers, Raymond H.: Probability and Statistics for Engineers and Scientists. The Macmillan Company, 1972.
5. Beyer, William H., Ph.D., ed.: CRC Handbook of Tables for Probability and Statistics. Second ed. The Chemical Rubber Co., 1968.
6. Hodgman, Charles D., ed.: CRC Standard Mathematical Tables. Twelfth ed. Chemical Rubber Publishing Company, 1959.
7. Bendat, Julius S.; and Piersol, Allan G.: Measurement and Analysis of Random Data. John Wiley & Sons, Inc., 1966.

Table 1: Test Subjects

AGE	SEX	PROFESSION	ESTIMATED FLIGHT EXPERIENCE
32	M	engineer	36/yr.
43	F	housewife	none
55	F	stenographer	2 previous
20	F	student	12/yr.
38	M	engineer	100+/yr.
33	F	housewife	1/yr.
25	M	student	12/yr.
21	M	student	2/yr.
32	M	engineer	12/yr.
35	F	computer programmer	6/yr.
20	M	student	4/yr.

Table 2: Flight Maneuvers of Present Study

Segment	Maneuver	γ(deg)	θ(deg)	ϕ(deg)	P_m(deg/sec)	V_i(m/sec)	Δt(sec)	n_x(g's)
1	steady descent	-4.	+2.	-	-	-	-	-
2	steady turn	-	-	+15.	-	102.9	-	-
3	longitudinal deceleration	-	-4.	-	-	-	-	-.20
4	S-turn	-	-	+25.	-	-	20.	-
5	steady descent	-8.	-2.	-	-	-	-	-
6	curved deceleration	-	-4.	+25.	-	-	-	-.20
7	steady turn	-	-	+25.	-	82.3	-	-
8	longitudinal deceleration	-	-4.	-	-	-	-	-.10
9	turn entry	-	-	+45.	20.	82.3	-	-
10	steady descent	0.	-2.	-	-	-	-	-
11	steady turn	-	-	+45.	-	102.9	-	-
12	longitudinal deceleration	-	0.	-	-	-	-	-.25
13	s-turn	-	-	+45.	-	-	0.	-
14	Steady turn	-8.	-10.	-	-	-	-	-
15	steady turn	-	-	+25.	-	61.7	-	-
16	longitudinal deceleration	-	-8.	-	-	-	-	-.15
17	turn entry	-	-	+25.	20.	82.3	-	-
18	curved deceleration	-	-4.	+45.	-	-	-	-.20
19	steady descent	0.	+6.	-	-	-	-	-
20	steady turn	-	-	+45.	-	82.3	-	-
21	longitudinal deceleration	-	-8.	-	-	-	-	-.20
22	S-turn	-	-	+25.	-	-	10.	-
23	steady descent	-4.	-2.	-	-	-	-	-
24	steady descent	-	-	+25.	-	102.9	-	-

TABLE 3. - SUBJECTIVE RIDE RATING RESPONSE

(a). Test Period 1

Seat Number	1	2	3	4	5	6	7	8	9	10	Mean Ride Rating
Subject Number	23	27	19	4	2	22	10	1	30	25	
Segment Number											
1	4	3	2	1	3	1	1	2	2	2	2.100
2	4	5	3	1	3	2	2	2	2	2	2.600
3	4	5	6	3	3	4	4	3	3	3	3.800
4	4	5	3	4	4	5	2	3	2	3	3.500
5	4	6	2	3	3	3	2	5	3	2	3.300
6	4	5	2	5	3	5	3	3	2	3	3.500
7	4	4	3	4	4	5	2	5	2	2	3.500
8	5	3	5	6	2	3	3	3	2	2	3.400
9	5	5	3	5	4	6	4	4	3	5	4.400
10	5	5	2	3	3	3	2	4	2	2	3.100
11	5	5	5	4	4	5	5	4	4	5	4.600
12	6	5	5	6	4	5	4	5	3	4	4.700
13	5	6	5	5	5	6	4	5	4	6	5.100
14	5	5	4	4	3	5	4	5	4	4	4.300
15	4	5	4	4	4	5	3	5	2	2	3.800
16	6	5	6	6	4	5	5	6	3	3	4.900
17	6	5	4	3	4	2	3	3	2	2	3.400
18	5	5	6	5	5	5	4	5	2	3	4.500
19	5	3	2	5	4	1	2	2	2	2	2.800
20	5	5	5	3	5	5	3	5	3	5	4.400
21	5	5	6	5	4	5	4	5	4	3	4.600
22	5	3	4	4	5	2	3	4	2	2	3.400
23	5	3	2	4	4	2	2	4	2	3	3.100
24	5	3	4	3	4	3	2	3	2	2	3.100

TABLE 3. - SUBJECTIVE RIDE RATING RESPONSE

(b). Test Period 2

Seat Number	1	2	3	4	5	6	7	8	9	10	Mean Ride Rating
Subject Number	10	30	22	1	25	19	4	23	27	2	
Segment Number											
1	1	2	1	2	1	2	2	2	2	2	1.700
2	3	2	2	3	3	4	2	2	5	3	2.900
3	3	3	5	5	4	5	5	4	5	3	4.200
4	4	2	4	5	2	5	3	3	5	4	3.700
5	4	3	2	5	2	2	2	3	5	4	3.200
6	4	2	3	5	2	4	4	4	5	4	3.700
7	3	2	3	4	2	5	3	4	4	4	3.400
8	3	3	2	4	3	5	2	3	5	4	3.400
9	5	3	6	6	5	6	3	5	5	4	4.800
10	4	3	5	5	2	3	3	4	3	5	3.700
11	4	5	6	7	6	7	4	5	5	5	5.400
12	5	4	5	5	5	6	5	5	5	4	4.900
13	5	5	5	6	6	7	5	4	5	5	5.300
14	4	5	5	5	5	3	4	5	5	5	4.600
15	3	4	4	5	3	5	4	5	5	5	4.300
16	5	5	5	6	4	7	5	5	5	4	5.100
17	3	2	4	4	2	5	4	4	4	4	3.600
18	5	4	6	4	3	3	5	5	5	5	4.500
19	3	2	1	2	1	2	3	2	2	2	2.000
20	5	5	6	4	5	5	5	5	5	5	5.000
21	5	4	5	5	2	5	4	5	5	5	4.500
22	3	2	2	4	2	4	4	4	3	3	3.100
23	3	2	3	4	2	5	4	4	5	3	3.500
24	3	2	2	3	2	4	3	4	4	3	3.000

Table 4: Wilcoxon Two-Sample Test for significance of change in individual subjective response to each maneuver when repeated one hour later.

null hypotheses (H_o)	significance level	acceptance region
no change exists	.05	$u \geq 34$

Maneuver	Sum of ranks (w_1)	u
1	133.	67.
2	106.5	40.5
3	113.5	47.5
4	121.	55.
5	129.	63.
6	106.5	40.5
7	129.5	63.5
8	128.	62.
9	114.5	48.5
10	109.	43.
11	104.5	38.5
12	119.5	53.5
13	121.5	55.5
14	113.	47.
15	112.5	46.5
16	125.	59.
17	116.5	50.5
18	126.	60.
19	143.	77.
20	115.5	49.5
21	126.5	60.5
22	134.	68.
23	115.	49.
24	124.	58.

Table 5: The probability (P) that change in mean subjective response ($\bar{d}$) for each maneuver (when repeated one hour later) is random.

"t" Test with Paired Variates

Maneuver	$\bar{d}$	t	P*
1	.4	1.451	.182
2	-.3	1.074	.310
3	-.4	1.291	.229
4	-.2	.530	.608
5	.1	.351	.734
6	-.2	.530	.608
7	.1	.275	.789
8	0.	0.	1.0
9	-.4	1.191	.261
10	-.6	1.537	.163
11	-.8	2.082	.068
12	-.2	.656	.528
13	-.2	.731	.483
14	-.3	.901	.390
15	-.5	1.151	.279
16	-.2	.615	.554
17	-.2	.325	.753
18	0.	0.	1.0
19	.8	1.865	.094
20	-.6	2.457	.037
21	.1	.318	.758
22	.3	.640	.540
23	-.4	.759	.467
24	.1	.223	.837

*Note: P is the probability that the given value of t is equaled or exceeded by chance.

Table 6: Run Test for significant trend in mean subjective response to each maneuver when repeated one hour later.

null hypothesis (H_o)	significance level	acceptance region	median
no trend	.05	$17.2<r\leq 31.8$	3.7
	.10	$18.2<r\leq 30.8$	

Period	Maneuver	Mean Response	Run(r)	
1	1	2.1	-	1
	2	2.6	-	
	3	3.8	+	2
	4	3.5	-	
	5	3.3	-	
	6	3.5	-	3
	7	3.5	-	
	8	3.4	-	
	9	4.4	+	4
	10	3.1	-	5
	11	4.6	+	
	12	4.7	+	
	13	5.1	+	6
	14	4.3	+	
	15	3.8	+	
	16	4.9	+	
	17	3.4	-	7
	18	4.5	+	8
	19	2.8	-	9
	20	4.4	+	10
	21	4.6	+	
	22	3.4	-	
	23	3.1	-	
	24	3.1	-	11
2	25	1.7	-	
	26	2.9	-	
	27	4.2	+	12
	28	3.7	+	
	29	3.2	-	
	30	3.7	-	13
	31	3.4	-	
	32	3.4	-	
	33	4.8	+	
	34	3.7	+	
	35	5.4	+	
	36	4.9	+	
	37	5.3	+	14
	38	4.6	+	
	39	4.3	+	
	40	5.1	+	
	41	3.6	-	15
	42	4.5	+	16
	43	2.0	-	17
	44	5.0	+	18
	45	4.5	+	
	46	3.1	-	
	47	3.5	-	19
	48	3.0	-	

Table 7: Trend Test for significant monotonic trend in mean subjective response to each maneuver when repeated one hour later.

null hypothesis (H_o)	significance level	acceptance region
no trend	.05	$457<A<678$
	.10	$475<A\leq 660$

i	A_i	i	A_i
1	2	25	0
2	2	26	1
3	24	27	11
4	16	28	8
5	10	29	3
6	15	30	7
7	15	31	3
8	10	32	3
9	22	33	10
10	5	34	5
11	26	35	13
12	28	36	9
13	32	37	11
14	20	38	8
15	18	39	5
16	27	40	8
17	9	41	4
18	20	42	4
19	1	43	0
20	18	44	4
21	20	45	3
22	8	46	1
23	4	47	1
24	4	A	= 478

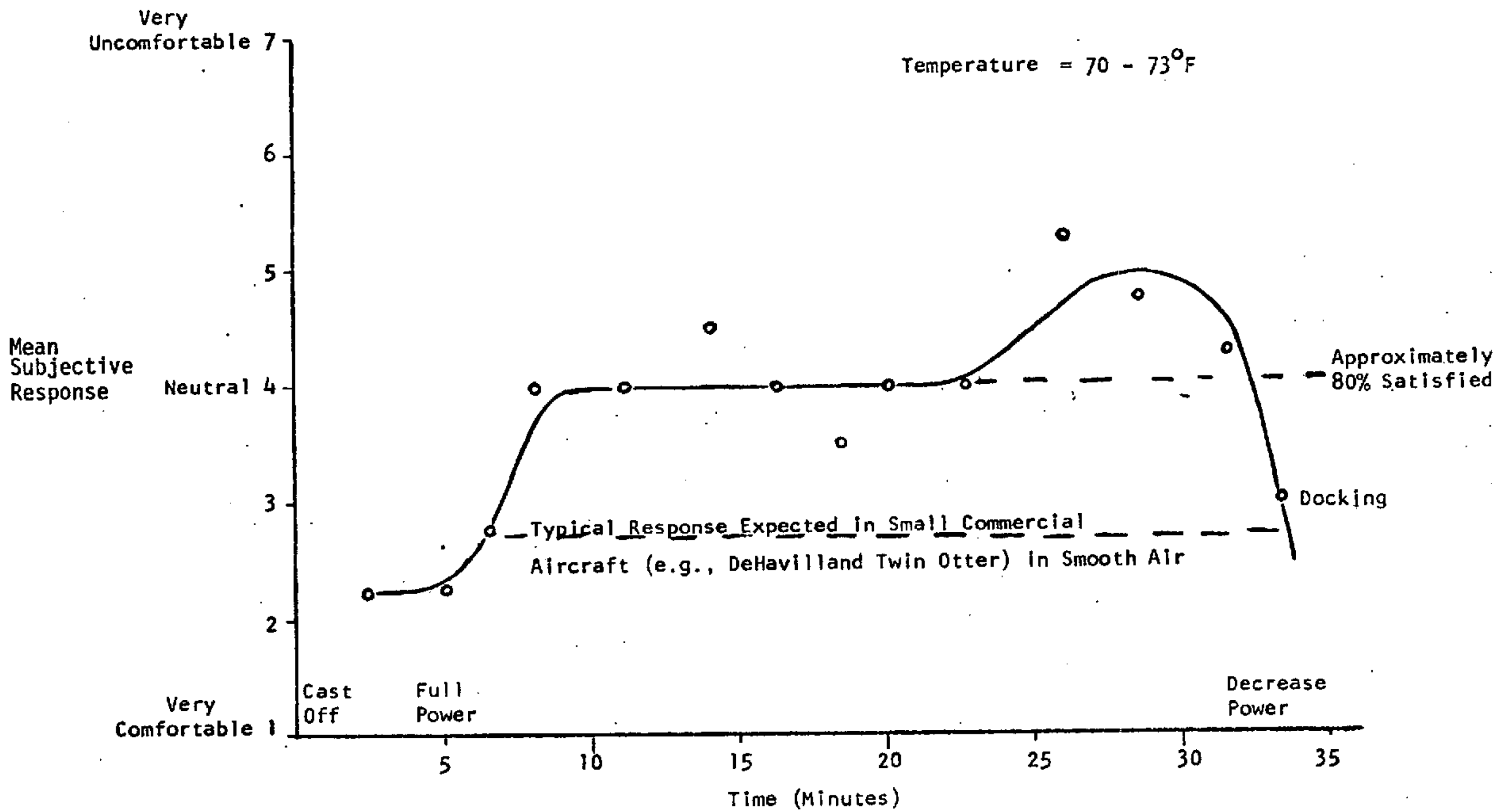
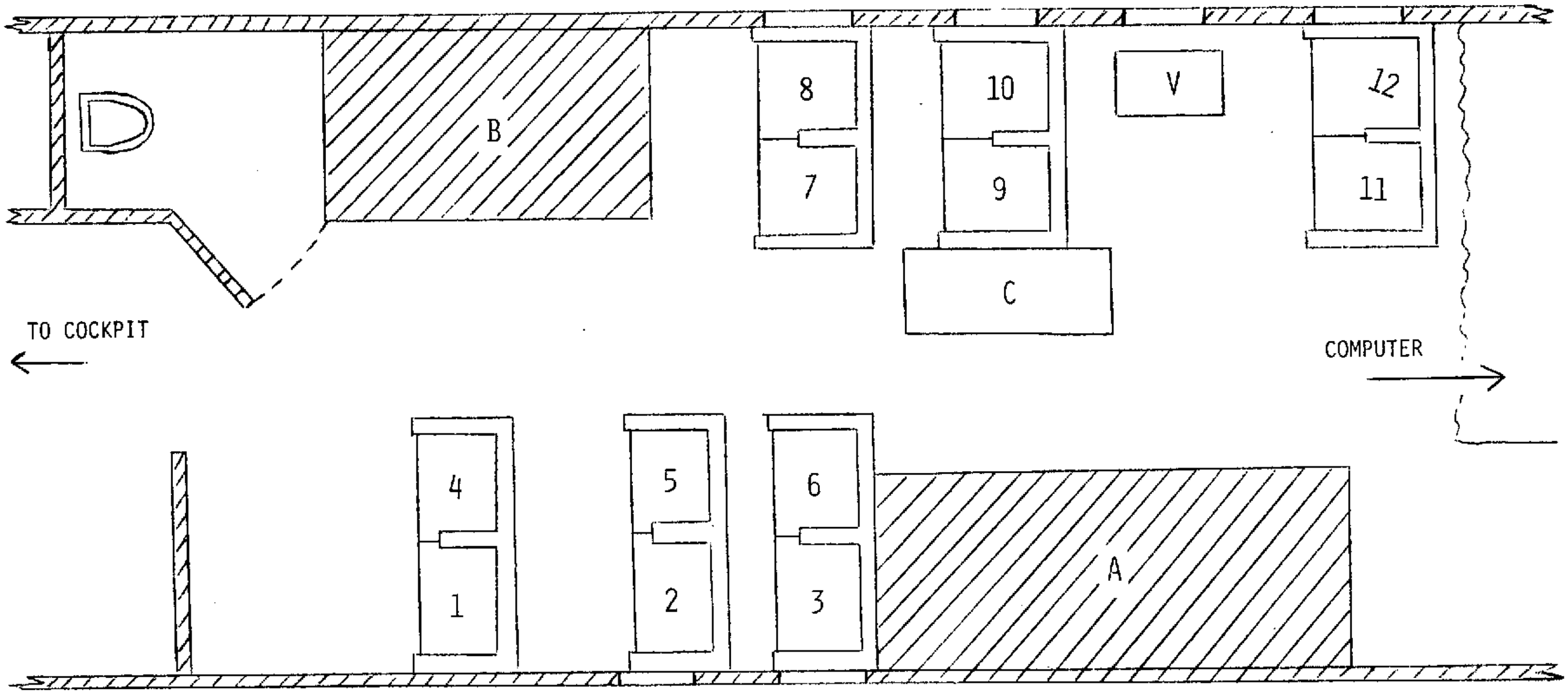


FIGURE 1. - SUBJECTIVE RESPONSE VS. EXPOSURE TIME for hovercraft (see ref. 2)



seats numbered 1 to 12
equipment enclosures labeled A,B,C
videocamera monitor labeled V

Figure 2. - TIFS aircraft interior as modified for ride quality experiments.

NASA
L-74-5271

Figure 3. - Interior view of TIFS aircraft looking aft.

27

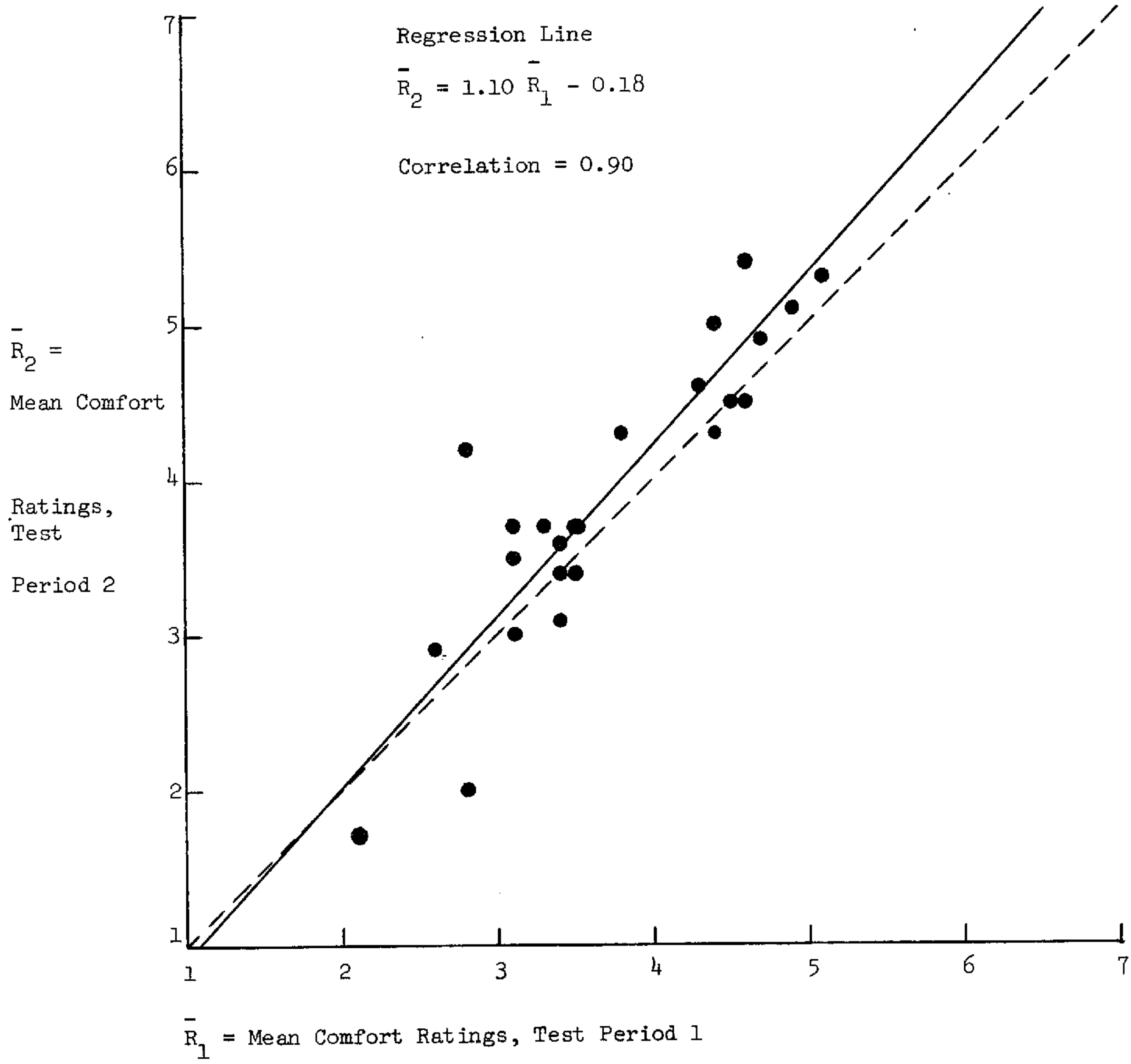


Figure 4.- Relationship between Mean Comfort Ratings During During First Test Period and Corresponding Ratings During Second Test Period