A STUDY OF THE SEMI-ANNUAL INSTRUMENT CHECK FOR AIRLINE PILOTS

prepared by

JOHN A. NAGAY

Report of a project conducted by the American Institute for Research, Incorporated, Pittsburgh, Pennsylvania, under the auspices of the National Research Council Committee on Aviation Psychology, with funds provided by the Civil Aeronautics Administration.

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Committee on Aviation Psychology

Executive Subcommittee

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1950

LETTER OF TRANSMITTAL

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2101 Constitution Avenue, Washington, D. C.

Division of Anthropology and Psychology

Committee on Aviation Psychology

November 13, 1950

Dr. Dean R. Brimhall
Civil Aeronautics Administration, W-2B
Department of Commerce
Washington 25, D. C.

Dear Dr. Brimhall:

The attached report, entitled A Study of the Semi-Annual Instrument Check for Airline Pilots, prepared by John A. Nagay, is submitted by the Committee on Aviation Psychology with the recommendation that it be included in the series of Technical reports of the Division of Research, Civil Aeronautics Administration.

There seems reason for the opinion that the information embodied in this report and observations concerning procedures can be useful to the Civil Aeronautics Administration in reviewing regulations pertaining to the semi-annual airline pilot instrument check, and in evaluating practices employed in its administration.

Sincerely yours,

MSV:eag

Morris S. Viteles, Chairman
Committee on Aviation Psychology
National Research Council

EDITORIAL FOREWORD

Under current Civil Air Regulations, airline pilots are required twice a year to demonstrate satisfactory proficiency in piloting and navigating by instruments. This requirement is intended to provide assurance that such pilots have maintained the information and skill necessary for the safe operation of planes, even in the case of procedures and maneuvers which are performed infrequently in the course of day-to-day flight in transport aircraft.

The study described in the attached report was designed to furnish information which could be useful to the Civil Aeronautics Administration (a) in reviewing policies pertaining to the semi-annual airline pilot instrument check, and (b) in considering techniques which could be used in most effectively checking whether information and skills needed in both day-to-day and emergency flight situations were being maintained.

The findings of the study show that there are wide differences among airline companies with respect to the requirements imposed in the six-month instrument check and in the procedures employed for assessing pilot knowledge and skill. There are also considerable differences of opinion among pilots with respect to what should be embodied in the semi-annual instrument check. Nevertheless, an analysis of replies to a questionnaire received from 944 airline pilots, representing 15 per cent of the airline membership of the Air Line Pilots Association, furnished data of significance in considering minimum requirements in the way of procedures which should be checked at specific intervals. Of equal importance are recommendations bearing upon principles and procedures involved in the administration of the six-month check, viz:

(1) Techniques employed in the objective Standard Flight Check for the Airline Transport Rating, described in earlier reports of the Committee on Aviation Psychology, can be profitably employed in setting-up precise descriptions of what is to be done and how it is to be done and in making uniform the standards for recording and evaluating pilot performance.

(2) Pilots, as mature individuals with insights into their own skill, should play an active role in the selection of those procedures to be given special attention during the limited time available for checking and practice.

(3) The training aspects of the semi-annual instrument check flight should be stressed so that full advantage can be taken of the findings in effecting improvements in skill where they are most needed.

The study described in this report was conducted by John A. Nagay, American Institute for Research, under the general supervision of John C. Flanagan with the close cooperation of Civil Aeronautics Administration personnel. Special

acknowledgement is due to the airline pilots who participated in the study and to officers of the Air Line Pilots Association, including David L. Behncke, President, Clarence N. Sayen, Executive Vice-President, W. W. Anderson, Works Progress Assistant, and others who were helpful throughout the investigation.

November 13, 1950

Morris S. Viteles, Chairman
Committee on Aviation Psychology

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The entire project was conducted under the guidance and direction of Dr. John C. Flanagan, Director of Research of the American Institute for Research. Other staff members assisted at various stages, notably Dr. Elmer D. West, Mr. Robert Fitzpatrick, Mrs. Marilyn K. Rigby, Miss Virginia Edmonds, and Mrs. Janis A. Keller.

Dr. Morris S. Viteles, Chairman of the Committee on Aviation Psychology, and the members of that committee gave valuable advice and support throughout.

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The assistance of the Air Line Pilots Association in the preparation and distribution of the questionnaire greatly facilitated the gathering of the project's basic data. Special acknowledgement is due to the organization's president, Mr. David L. Behncke, the Executive Vice President, Mr. Clarence N. Sayen, and the Works Progress Assistant, Mr. W. W. Anderson.

Finally, grateful acknowledgment is made to the several hundred airline captains and first officers who completed and returned the questionnaire forms.

SUMMARY

The purposes of the project described in this report were to provide the Civil Aeronautics Administration with information which would furnish a basis for a review of policies in the area of periodic airline pilot checking, and to make available data for the revision of current techniques for checking the maintenance of essential pilot information and skills.

The semi-annual instrument checks used by 18 of the country's major airlines were reviewed and found to vary considerably in form and content. The flight-checking techniques used do not, in most cases, provide specific standards or precise descriptions of what is to be done.

The basic data of the study were provided by airline captains and first officers in their responses to a questionnaire. The questionnaire listed 19 procedures or maneuvers and 24 unusual or emergency situations. Pilots were requested to indicate the number of times each of these were flown or experienced in the past six months, the number of times the procedures should be flown per six months period to maintain proficiency at a satisfactory level, what recent training had helped them cope with the emergencies, and what type of additional training or practice was desirable on both the procedures and emergencies.

Nine hundred and forty-four questionnaires were returned, comprising about 15% of the active membership of the Air Line Pilots Association to whom forms were sent. Of those replying, 593 were captains, 324 were first officers, and 27 did not identify themselves.

Pilot responses showed considerable variability. Many indicated that the amount of practice received on line flights in the preceding six months was adequate without further training. In general first officers expressed more need for additional training or practice than did pilots with captain ratings.

The following recommendations were made on the basis of the survey:

1. The training aspects of the semi-annual check should be stressed. The pilot should be given a more active part in the selection of those maneuvers to be given special attention and the role of the check pilot should be more that of consultant than examiner.
2. Training and checking appear to be especially needed on the following maneuvers:
   a. The ILS approach
   b. Steep turns (approaching maximum bank)
   c. Rapid descent and pull-up
   d. Recovery from unusual attitudes
   e. Minimum speed maneuvering, and approach to stall
3. Training and checking on pilot skill in coping with emergencies should be emphasized, particularly on such critical items as:
   a. Engine failure
   b. Fire
   c. Failure of ground navigational aids
   d. Excessive icing
   e. Extreme turbulence

In regard to recommendations for checking techniques, the flight-checking principles developed in earlier studies for the CAA appear applicable; i.e., uniform standards, on-the-spot recording, efficient description, and objective items. The use of simulators was suggested as an appropriate technique for checking performance on emergencies without hazard to personnel. The final recommendation was that a number of problem situations typical of the complex emergency situations which are likely to confront pilots be developed. These situations complete with approved solutions are expected to provide a valuable aid in the development of pilots' skill in anticipating and being prepared in advance to take appropriate action in emergencies.

A STUDY OF THE SEMI-ANNUAL INSTRUMENT CHECK FOR AIRLINE PILOTS

I. INTRODUCTION AND OBJECTIVES

Under existing air regulations, each pilot in command of an airline aircraft is required twice a year to demonstrate satisfactory proficiency at piloting and navigating by instruments. This program of periodic checking is in a state of flux; changes in the Civil Air Regulations pertaining to periodic checks are under consideration, and there are many opinions as to what should constitute the six-months check. At the request of the Division of Research, Civil Aeronautics Administration, the National Research Council Committee on Aviation Psychology arranged with the American Institute for Research to conduct a study designed to provide data regarding the essential information and skills which must be maintained by air line pilots. It was anticipated that such data would provide a sound basis for the review of CAA policies in the area of periodic checks and training, and for the formulation of recommendations as to techniques which could be used for checking whether information and skills needed in day-to-day flight operations were being maintained.

The purpose of this report is to describe the research program undertaken. The results of a survey of the current periodic checks of the major air carriers will be reported in the following section. This section also includes a description of the development of a questionnaire designed to obtain facts related to learning and remembering the various skills and information essential to a satisfactory level of performance in piloting transport aircraft and in meeting emergency situations. The questionnaire was directed to the group most interested in the problems of periodic checking, the pilots themselves; a group which has heretofore not been surveyed in systematic fashion.

The third section describes the sample, the questionnaire returns, and the analysis of the data.

The fourth and final section of the report lists the conclusions, the recommendations regarding periodic checking which the data support, and further recommendations regarding flight-testing techniques proved successful in earlier studies.

II. CONDUCT OF THE STUDY

1. Examination of Airline Semi-Annual Flight-Checks

Early in the study, the semi-annual instrument checks of 18 of the country's major airlines were obtained. These were then subjected to analysis, the results of which are shown in the following table.

TABLE 1

ANALYSIS OF 18 AIRLINE SEMI-ANNUAL INSTRUMENT CHECKS

	Variable	Frequency: No	Yes	Sometimes	Unknown or not Applicable
(1)	Is recording in the air specified?	16		1	1
(2)	Are instructions given for maneuvers?	11	4	2	1
(3)	Are airspeeds, power settings, etc., specified?	8	6	1	3
(4)	Are airspeeds, power settings, etc., to be filled in?	8	1	2	7
(5)	Are separate airspeeds, power settings, etc., provided for different aircraft types?	7	5		6
(6)	Are tolerances specified?	12	2	2	2
(7)	Are maneuvers broken down into items?	7	2	9	
(8)	Are pictorial or diagrammatic aids provided?	18			
(9)	Are behavioral descriptions provided?	16		2	
(10)	Is a diagram of the check ride provided?	14	4		
(11)	Method of scoring maneuvers:				2
	a. 2--5 point scale		14		
	b. Percentage scores		2		

It may be seen that airline semi-annual checks in current use are, with very few exceptions, lacking in the characteristics generally conceded to be desirable in flight tests. There is also considerable variability in content among the

different checks. In the matter of format, most of the flight-checks obtained from airline companies consisted of one or two mimeographed pages containing lists of maneuvers which are scored by having the check-pilot record his opinion with very little help in the way of suggested standards or precise descriptions of what is to be done. The specific maneuvers and procedures included in the checks, regardless of how they were measured, were, however, of particular value to this study in the development of a questionnaire for airline pilots.

2. Development of a Questionnaire

a. Statement of Essential Pilot Skills

The first step in the development of a questionnaire for airline pilots was the compilation of a list of skills essential to a satisfactory level of flying performance. Gordon[1,2] in previous studies, had already determined the critical requirements of the airline pilot's job and had developed a reliable flight-check based on these requirements.[3] This flight-check was designed as the one to be taken by candidates for their initial certification as airline pilots--for their Airline Transport Ratings. The problem in the present study was a different one; it was to determine which essential skills, information, proficiencies, etc., need to be checked periodically as required by the Civil Air Regulations. It also seemed likely that some of the critical skills might be involved in the execution of maneuvers which are accomplished many times on

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[1] Gordon, Thomas. The Airline Pilot: A Survey of the Critical Requirements on His Job and of Pilot Evaluation and Selection Procedures. Washington, D. C. CAA Division of Research, Report No. 73, November 1947.

[2] Gordon, Thomas. The Development of a Standard Flight-Check for the Airline Transport Rating Based on the Critical Requirements of the Airline Pilot's Job. Washington, D. C., CAA Division of Research, Report No. 85, April 1949.

[3] Nagay, John A. Revisions of the Standard Flight-Check for the Airline Transport Rating Based on the Airline Tryout. Washington, D. C., CAA Division of Research, Report No. 89, May 1950.

each flight. In such cases it would, of course, seem inappropriate to check experienced pilots at six-month intervals.

Several sources were reviewed for the purpose of extracting these statements of essential skills, proficiencies, etc., that pilots need to maintain. They included the semi-annual instrument checks of the major U. S. airlines, training manuals, flight-checks, civilian and military aviation handbooks and the like. Much valuable additional information was gained from conferences with pilots, check-pilots, Civil Aeronautics Board, and Civil Aeronautics Administration officials. A final list of 19 "procedures" eventually evolved from an initially rather lengthy list. The reduction of the list of procedures to this group of 19 was dictated by the need of presenting pilots with a reasonably short form to fill out, and was accomplished with the help of aviation experts.

b. Analysis of Malfunction Reports

The questionnaire was also designed to obtain information on the types of emergency or unusual situations for which training or practice would be most helpful to pilots. One of the primary sources of data of this type was the records kept by the Civil Aeronautics Administration Air Carrier Maintenance Branch. These records list the type of malfunctions occurring in scheduled flight which are reported daily to the Branch. Analyses were made of reports of this type on several transport aircraft types: the DC-3, DC-4, DC-6, the Convair, Martin 202, Constellation, and Boeing 377. The kind and frequency of breakdowns which occurred to two aircraft types, the DC-3 and Martin 202, over a period of several months, are attached to the report as Appendix A. Information of this sort, supplemented by that from other sources, provided a list of 24 "Unusual Situations" which were included in the questionnaire.

c. The Form of the Questionnaire

From the basic data described above, a tentative questionnaire form was

developed. It consisted of three main sections, headed, "PROCEDURES," "UNUSUAL SITUATIONS," AND "EXPERIENCE WITH EMERGENCIES."

The first section listed the 19 procedure items previously mentioned. Space was provided following each item for the pilots to record the following:

A. The number of times the procedure was performed on line flights during the last six months.

B. The minimum number of times it is necessary to fly the procedure on line flights during a six-month period in order to maintain proficiency at a satisfactory level.

C. A "yes--no" column to indicate whether or not additional practice was needed. If the respondent answered "yes," he was requested to indicate the amount and type of additional practice that was desirable by choosing from a list of types at the bottom of the page and writing the letter designation of the type followed by a number indicating the number of practice sessions.

The types of additional training or practice included:

a. Training flight
b. Practice on non-revenue flights
c. Practice on revenue flights
d. Practice on simulators (such as the Dehmel)
e. Practice on the Link trainer
f. Practice on mock-ups
g. Ground school
h. Home study
i. Other

The second section, headed, "UNUSUAL SITUATIONS," listed 24 types of situations with space provided for indicating:

A. Number of times experienced in the past six-months.

B. The amount and type of training received during the past six-months which aided the respondent in coping with the situations. (The type was to be chosen from the same list provided for Section I.)

C. The amount and type of additional training or practice needed. (Here again the respondent was to choose from the list on the first page if a need for additional practice was indicated by a "yes" response.)

The third section of the questionnaire requested detailed accounts of hazardous situations and comments on the applicability of training received.

There was also a series of questions on the training value of simulated emergency situations. This section involved considerable writing and later proved to be unpopular with the respondents, many of whom omitted it altogether.

d. Revision and Distribution of the Questionnaire

Two pilot groups reviewed the tentative questionnaire form: the check-pilots of American Airlines in a meeting at Ft. Worth, Texas, and representatives of the Air Line Pilots Association at Chicago. The need for additional information on which to base policies in the area of periodic checks and training was discussed by these groups. The problems connected with getting valid information from pilots on matters of this type in which they are interested parties were also discussed.

The Air Line Pilots Association had three committees within their organization review the form. The suggestions offered did much to reduce the questionnaire's length. Such suggestions and other changes were adopted and a final form prepared (Appendix B).

The Air Line Pilots Association also agreed to distribute and collect the questionnaires. Some 6200 4-page booklets, photo-offset from typed copy, were prepared and sent to the pilots' organization for transmittal to their active members. The forms were sent out in June 1950, accompanied by a letter of transmittal from the Air Line Pilots Association.

III. ANALYSIS OF RESULTS

1. Questionnaire Returns

A total of 944 questionnaires were returned. Of these, 593 were completed by airline captains and 324 by first officers; 27 pilots did not indicate their rank. The total number of respondents comprises slightly more than 15% of the Air Line Pilot Association's active membership. No attempt at follow-up was made.

Thirty-three airlines were represented in the returns. As might be expected, the largest number of questionnaires were returned by pilots representing the larger lines. Airlines from whose pilots 50 or more forms were returned include:

American Airlines
Eastern Air Lines
Pan American World Airways
Trans World Airlines
United Air Lines

Pilots from the following lines returned from 10 to 49 questionnaires:

American Overseas Airlines
Braniff Airways
Capital Airlines
Chicago and Southern Air Lines
Continental Air Lines
Delta Air Lines
Hawaiian Airlines
Mid-Continent Airlines
National Airlines
Northeast Airlines
Northwest Airlines
Pan American - Grace Airways
Western Air Lines

Airlines from whose pilots less than 10 forms were received included:

Alaska Airlines
All - American Airways
Caribbean - Atlantic Airlines
Central Airlines
Colonial Airlines
Empire Air Lines
The Flying Tiger Line
Frontier Airlines
Pacific Northern Airlines
Pioneer Air Lines

Robinson Airlines
Trans - Pacific Airlines
Trans - Texas Airways
West Coast Airlines
Wisconsin Central Airlines

2. Analysis of the Data

a. Method

The tabulation of the questionnaire data proved to be a rather extensive task. Sections I and II of each form required 138 separate responses and this number multiplied by the total returns provided over 130,000 pilot responses for tabulation. (This figure includes "omits" as a response.)

After some preliminary exploration it was decided that the most meaningful way of presenting the data was to set up class intervals for the "numerical response" sections of the questionnaire (Section IA, IB, and IIA), and to report the number of pilots whose responses fell within each interval. Sections IC, IIB, and IIC of the questionnaire, which required the pilots to state whether or not additional practice or training was required on the procedures and unusual situations, or whether or not they had received recent training which helped them cope with the situations, were tabulated to show the number of "yes or no" responses and the number of pilots who advocated the various types of additional training presented.*

b. Analysis of Captains' Responses - Questionnaire Section I - Routine Operation.

The responses of airline captains to Sections I and II of the questionnaire are shown in Tables 2, 3, 4, 5, 6, and 7. The group of 620 captains includes a few reserve captains who are qualified as captains but do not fly

*Copies of tables in which data for all the pilot respondents are classified by airlines are to be found in the files of the Committee on Aviation Psychology. Copies have also been supplied for the files of the CAA Division of Research.

regularly in that capacity. They are, however, presumed to be subject to periodic checking in the same way as are captains who always fly as aircraft commander. A group of 27 pilots who did not specify their rank is also included in this group.

Table 2 shows the percent of the sample of 620 who omitted the items or whose responses fell within certain class intervals; i.e., the percent who had not flown the listed procedures at all during the past six months; those who had flown them once, twice; from 3 to 7 times; from 8 to 12 times; 13 to 27; 28 to 42; 43 to 57; 58 to 91; and 92 or more.

Table 3 indicates the responses of captains to Part B of Section I of the questionnaire in answer to the question, "How often during a six-month period should these procedures be flown in order that proficiency can be maintained at a satisfactory level?" Like Table 2, these responses are in terms of the percent of the captain sample indicating various numbers of times that the procedures should be flown.

Table 4 is not entirely in terms of percent; it lists the percent of pilots who omitted the items or answered "yes" or "no" to the question of whether or not additional practice or training is necessary on the procedures. Where affirmative answers were given, the type of additional practice or training that the respondents advocated is also shown, in terms of the number of pilots advocating the various types of training or practice. If multiple responses were made; i.e., if a pilot felt that more than one type of additional practice or training was essential, all were recorded. Some pilots also indicated that additional practice or training was needed without specifying the type. For these reasons, the sum of the "type specified" responses will frequently be less than, or in excess of, the sum of the affirmative responses.

TABLE 2

RESPONSES OF AIRLINE CAPTAINS TO QUESTIONNAIRE SECTION I A

The distribution is in terms of the percent of the captain sample (N=620*) among the various intervals indicated. The numbers beneath each interval are the midpoints of the intervals.

Procedure	% of Omits	Number of Times Flown in Last Six Months									
		0	1	2	3-7	8-12	13-27	28-42	43-57	58-91	92+
		0	1	2	5	10	20	35	50	75	100**
(1) Take-off in low ceiling (1000 feet or less)	4	1	1	2	13	20	30	15	5	5	4
(2) Emergency climb (METO power)	6	57	15	9	10	2	1	0	0	0	0
(3) Steep turns (approach maximum bank)	5	67	6	10	8	3	0	0	0	0	0
(4) Rapid descent and pull up	5	66	11	8	8	1	0	0	0	0	0
(5) Recovery from unusual attitudes	7	84	4	1	3	1	0	0	0	0	0
(6) Minimum speed maneuvering	6	56	6	8	12	6	3	1	1	0	1
(7) Approach to stall	8	81	3	2	3	1	0	0	0	0	0
(8) Radio range orientation	6	77	5	2	4	2	2	0	0	0	1
(9) ADF tracking	17	6	1	3	10	14	17	8	7	4	12
(10) Manual loop orientation and tracking	6	57	7	7	12	7	3	1	0	0	0
(11) Standard low freq. approach instrument	5	25	8	9	25	14	8	3	2	0	1
(12) ADF approach	5	24	8	12	26	11	11	2	1	0	1
(13) ILS approach	6	10	1	4	13	16	30	11	4	3	1
(14) GCA approach	7	39	7	13	22	8	3	0	0	0	0
(15) Missed approach procedure	4	51	18	12	13	2	0	0	0	0	0
(16) Approach under 400-1 conditions	4	9	5	8	33	19	15	4	2	0	0
(17) Cross-wind landing (more than 30°) up to max. allowable for equipment	5	13	6	9	25	15	13	5	3	2	3
(18) No-flap landing	5	61	9	9	10	3	2	0	0	0	0
(19) Cross-wind take-off (more than 30°) up to max. allowable for equipment	6	16	5	9	24	15	13	5	3	1	3

*Includes 27 unidentified respondents.

**This figure more nearly approximates the mode than the midpoint. Most responses above 92 were 100.

TABLE 3

RESPONSES OF AIRLINE CAPTAINS TO QUESTIONNAIRE SECTION 1 B

The distribution is in terms of the percent of the captain sample (N=620*) among the various intervals indicated. The numbers beneath each interval are the midpoints of the intervals.

Procedure	% of Omits	Times Necessary to Fly per 6 mo. to Maintain Proficiency									
		0	1	2	3-7	8-12	13-27	28-42	43-57	58-91	92+
		0	1	2	5	10	20	35	50	75	100**
(1) Take-off in low ceiling (1000 feet or less)	14	18	10	10	30	12	5	1	0	0	0
(2) Emergency climb (METO power)	13	45	19	11	11	2	0	0	0	0	0
(3) Steep turns (approach maximum bank)	13	36	14	13	18	4	2	0	0	0	0
(4) Rapid descent and pull up	13	39	21	11	14	2	0	0	0	0	0
(5) Recovery from unusual attitudes	16	47	15	10	11	1	0	0	0	0	0
(6) Minimum speed maneuvering	15	34	18	12	13	6	1	0	0	0	0
(7) Approach to stall	16	46	16	8	10	3	0	0	0	0	0
(8) Radio range orientation	13	47	20	8	8	2	1	0	0	0	0
(9) ADF tracking	17	12	13	9	26	17	5	1	0	0	0
(10) Manual loop orientation and tracking	14	34	20	12	15	4	1	0	0	0	0
(11) Standard low freq. approach instrument	14	11	15	15	29	12	3	0	0	0	0
(12) ADF approach	13	15	16	15	31	7	2	0	0	0	0
(13) ILS approach	15	5	6	5	30	22	12	3	1	0	0
(14) GCA approach	21	25	12	10	23	6	2	0	0	0	0
(15) Missed approach procedure	14	31	23	14	16	3	0	0	0	0	0
(16) Approach under 400-1 conditions	15	11	13	11	33	12	3	1	0	0	0
(17) Cross-wind landing (more than 30°) up to max. allowable for equipment	14	22	13	12	26	8	3	0	0	0	1
(18) No-flap landing	14	42	19	11	11	2	1	0	0	0	0
(19) Cross-wind take-off (more than 30°) up to max. allowable for equipment	15	26	14	13	22	7	1	0	0	0	1

*Includes 27 unidentified respondents.

**This figure more nearly approximates the mode than the midpoint. Most responses above 92 were 100.

TABLE 4

RESPONSES OF AIRLINE CAPTAINS TO QUESTIONNAIRE SECTION I C

Percent of Captains (N=620*) Responding Under the Various Categories

a. Training flights
b. Practice on non-revenue flights
c. Practice on revenue flights
d. Practice on simulators (such as the Dehmel)
e. Practice on Link Trainer
f. Practice on mock-ups
g. Ground school
h. Home study
i. Other

Procedure	% of Omits	% No	% Yes	Type of Additional Practice or Training Specified (No. of pilots) a	b	c	d	e	f	g	h	i**
(1) Take-off in low ceiling (1000 feet or less)	10	80	10	48	2	2	0	0	0	0	0	2
(2) Emergency climb (METO power)	12	66	22	112	12	4	0	0	1	0	1	4
(3) Steep turns (approach maximum bank)	10	41	49	288	31	4	2	0	0	1	1	7
(4) Rapid descent and pull up	13	47	40	202	17	0	2	0	0	0	0	9
(5) Recovery from unusual attitudes	13	48	39	194	19	1	2	0	0	1	0	7
(6) Mini. speed maneuvering	12	48	40	206	20	3	2	1	0	0	0	8
(7) Approach to stall	13	47	40	209	22	0	1	1	0	0	1	7
(8) Radio range orientation	14	51	35	106	17	9	10	92	0	1	1	4
(9) ADF tracking	12	70	18	50	8	12	4	38	0	0	0	4
(10) Manual loop orientation and tracking	14	56	30	96	11	10	8	64	0	0	1	3
(11) Standard low freq. approach instrument	15	58	27	101	15	17	5	39	0	0	0	8
(12) ADF approach	14	58	28	119	19	21	6	44	1	0	0	4
(13) ILS approach	13	45	42	173	22	51	4	34	0	0	0	7
(14) GCA approach	17	53	30	106	21	36	5	17	0	0	0	2
(15) Missed appr. procedure	13	49	38	183	19	8	5	21	0	0	1	7
(16) Approach under 400-1 conditions	14	53	33	156	16	17	1	16	0	0	0	5
(17) Cross-wind Landing (more than 30°) up to max. allowable for equipment	14	68	18	92	10	7	1	1	0	0	0	2
(18) No-flap landing	14	57	29	134	21	9	1	0	0	0	0	2
(19) Cross-wind take-off (more than 30°) up to max. allowable for equip.	14	70	16	81	10	8	1	0	0	0	0	1

*Includes 27 unidentified respondents.
**Most "i" responses specified th[illegible]

Tables 2, 3, and 4 will be considered together inasmuch as they all deal with the "Procedures" section of the questionnaire form. For the sake of brevity in discussing the tables, reference will be made to the midpoints of the intervals rather than to the entire interval. It should be kept in mind, however, that if for example, 20% of the captains are reported as having accomplished 10 steep turns; this number, 10, actually represents a group of responses ranging from 8 to 12.

Procedure 1, "Take-off in low ceiling (1000 feet or less)," shows a considerable spread of responses in Table 2, ranging from 1% of the captains who reported not having made any low ceiling take-offs to 30% who made 20. Four percent omitted the item and 4% reported making 100 such take-offs. In Table 3, the largest number of captains falling under any one category was again 30%; this number specifying that 5 low ceiling take-offs per six months were adequate for maintaining proficiency. Eighteen percent indicated that no low ceiling take-offs need be flown; 10% indicated 1; 10% indicated 2; 12% felt that it was necessary to make 10; 5%, 20; and 1%, 35. In view of the preponderance of time actually flown to times necessary to fly the procedure, it is not surprising to find the bulk of responses negative in Table 4. When asked whether or not additional practice or training was needed on this maneuver, 10% of the captains omitted the item, 80% answered "No" and 10%, "Yes." Of the 10% who answered "Yes," 48 captains indicated that the additional practice or training should be received on training flights, 2 indicated non-revenue flights, 2 revenue flights, and 2 "other."

These data from Table 4 on Procedure 1 are typical of the responses on most of the procedures. In all cases except one, more captains answer "No" to the question of whether additional practice or training is needed than

answer in the affirmative. The one exception is the response to Procedure 3, "Steep turns (approach maximum bank)." Of those pilots who do answer "Yes," a larger number always advocate training flights as the training or practice medium in preference to any other type listed. It seems likely that this reflects an attitude on the part of pilots (supported by comments written on the questionnaire forms) that the six-month check should be more of a training session than an examination upon the results of which disciplinary action can be taken.

Procedures 2 through 8 on Table 2 are generally similar, with about the same proportion of captains omitting the items; the majority reporting not having flown the procedures, and very few reporting flying them in excess of 5 times. Table 3 shows a range of 34% to 47% indicating that these procedures need not be flown in a six-month period to maintain proficiency, and a range of 14% to 20% indicating that they should be carried out once. The number of captains indicating that these procedures should be flown 2 and 5 times is approximately equal with percents ranging from 8 to 21. The percent of captains indicating more than 5 times per six-month period diminishes rapidly after the 5 mark, with no captains represented in the 35, 50, 75 or 100 groups. With the exception of Procedure 3, as noted earlier, negative responses exceed affirmative on all these procedures in Table 4. Those answering affirmatively most frequently suggest training flights as the means of obtaining additional practice. Procedure 8, "Radio range orientation," however, shows more spread than the other procedures, with 10 pilots recommending simulator training and 92 Link trainer practice.

Procedure 9, "ADF tracking," shows considerable variability of response. In Table 2, the percent range from 1 through 17, with the highest, 17%, occurring in the "Omits" and in the "No" categories. Twelve percent of the captains

indicated having carried out ADF tracking procedures 100 times per six-month period. The highest percent in Table 3 is 26, with this number of pilots indicating that ADF tracking procedures should be carried out 5 times in a six-month period. Seventy percent of the captains indicated that no additional practice was needed on this procedure (Table 4), while 18% felt additional ADF work was desirable. Fifty preferred training flights and 38 advocated practice in the Link trainer.

Procedure 10, "Manual loop orientation and tracking," the use of which is limited to certain geographical areas, showed 57% of captains reporting not having used the manual loop during the past six months. The data in Table 3 show that 48% omitted the item or indicated that the procedure need not be practiced, while 52% felt that it should be carried out. These responses ranged from 1 to 20 with more indicating 1 than larger amounts. For the 30% who indicated that additional practice or training was desirable (Table 4), the two most popular types were (a) training flights, with 96 pilots indicating this as their preference, and (b) Link trainer, with a frequency of 64 pilots.

Three of the approach procedures; the low frequency, ADF, and GCA, have the highest percent of captains reporting in the 0 and 5 categories in Table 2. There are also substantial numbers of captains who indicated that these approaches should be carried out 5 times per six months to maintain proficiency (Table 3). In Table 4, the negative responses exceed the affirmative ones and, of those who answered "Yes," the most popular responses were again training flights and Link trainer except for GCA approaches where the numerical favorites were training flights and revenue flights.

Procedure 13, "ILS approach," is apparently flown more frequently by airline pilots than any other of the procedures listed. Here the highest frequency, 30%, reported having flown 20 in the last six months. Thirty percent

of the captains fell within the 5 category in Table 3. Almost half of the captains who completed this item in Section IC of the questionnaire indicated that additional practice or training was necessary on this approach system, with 173 preferring training flights, 51 revenue flights, 17 Link trainer, and smaller numbers in other categories.

More captains indicated that they flew no missed approach procedures, that one should be flown, and that no additional practice or training was needed, than indicated any other category.

The cross-wind landing and take-off procedures (Numbers 17 and 19) both exhibit a considerable spread of responses in Table 2. In Table 3, the highest percents fall in the 0 and 5 categories and the majority of captains feel that no additional practice or training is required.

Comparatively few captains made no-flap landings; most of them felt that the maneuver should not be practiced, and of the 29% who felt that additional practice was needed, 134 advocated training flights.

c. Analysis of Captains' Responses - Questionnaire Section II - Unusual or Emergency Situations.

Tables 5, 6, and 7 report the responses of captains to the second main section of the questionnaire which deals with unusual or emergency situations. Table 5, like Table 2, reports the percent of the captain sample who experienced the listed situations various numbers of times. The same class intervals are used.

Table 6 shows the responses of the captains to a question designed to indicate the type of training they had received which helped them cope with the various emergencies. Both Table 6 and 7 have the "Omit," "Yes," and "No" columns in terms of percent and the "type of training or practice" columns in terms of the number of captains specifying each.

TABLE 5

RESPONSES OF AIRLINE CAPTAINS TO QUESTIONNAIRE SECTION II A

The distribution is in terms of the percent of the captain sample (N=602*) among the various intervals indicated. The numbers beneath each interval are the midpoints of the intervals.

Unusual Situation	% of Omits	Number of Times Experienced in Last Six Months									
		0	1	2	3-7	8-12	13-27	28-42	43-57	58-91	92+
		0	1	2	5	10	20	35	50	75	100**
(1) Engine failure											
(a) During take-off (before normal climb est'd)	8	75	14	2	1	0	0	0	0	0	0
(b) During turns	17	78	4	1	0	0	0	0	0	0	0
(c) At altitude	9	56	21	9	4	0	0	0	0	0	0
(d) On approach	13	79	7	1	0	0	0	0	0	0	0
(2) Engine-out landing	7	57	21	10	5	0	0	0	0	0	0
(3) Propeller malfunctions	6	76	10	4	3	0	0	0	0	0	0
(4) Controls, control surfaces and cable malfunctions	8	87	4	0	0	0	0	0	0	0	0
(5) Heating and ventilating system malfunctions	9	51	10	10	14	3	2	1	0	0	0
(6) Landing gear malfunctions	6	69	18	4	2	0	0	0	0	0	0
(7) Brake failure	7	82	8	2	1	0	0	0	0	0	0
(8) Tire blowout	9	77	11	2	1	0	0	0	0	0	0
(9) Engine fire	8	87	4	1	0	0	0	0	0	0	0
(10) Other fire	7	89	3	1	0	0	0	0	0	0	0
(11) Radio equipment failure	7	50	18	15	9	1	0	0	0	0	0

TABLE 5 - Continued

Unusual Situation	% of Omits	Number of Times Experienced in Last Six Months: 0	1	2	3-7	8-12	13-27	28-42	43-57	58-91	92+
		0	1	2	5	10	20	35	50	75	100**
(12) Electrical system malfunction	7	72	13	4	4	1	0	0	0	0	0
(13) Hydraulic system malfunction	6	75	14	3	1	0	0	0	0	0	0
(14) Failure of ground navigational facilities	8	59	10	7	12	3	1	0	0	0	0
(15) Instrument malfunction	8	52	12	8	15	3	1	0	0	0	0
(16) Warning equipment failure	7	70	9	6	5	2	1	0	0	0	0
(17) Excessive icing	6	66	13	8	5	1	0	0	0	0	0
(18) Extreme turbulence	6	46	16	13	15	2	1	0	0	0	0
(19) Runway ice	8	48	5	6	17	8	4	2	0	0	1
(20) Abandoned take-off (Start-stop)	5	70	18	4	2	0	0	0	0	0	0
(21) Emergency descent	7	84	6	2	1	0	0	0	0	0	0
(22) Boost failure	9	85	3	2	1	0	0	0	0	0	0
(23) Balked landing	12	67	9	7	5	0	0	0	0	0	0
(24) Emergency evacuation of plane (Passengers and Crew)	14	84	2	0	0	0	0	0	0	0	0

*Includes 27 unidentified respondents.

**This figure more nearly approximates the mode than the midpoint. Most responses above 92 were 100.

TABLE 6

RESPONSES OF AIRLINE CAPTAINS TO QUESTIONNAIRE SECTION II B

Percent of Captains (N=620*) Responding Under the Various Categories

a. Training flights
b. Practice on non-revenue flights
c. Practice on revenue flights
d. Practice on simulators (such as the Dehmel)
e. Practice on Link Trainer
f. Practice on mock-ups
g. Ground school
h. Home study
i. Other

Unusual Situations	% of Omits	% No	% Yes	Type of Helpful Training Received in Last 6 mo. (No. of pilots) a	b	c	d	e	f	g	h	i**
(1) Engine failure												
(a) During take-off (before normal climb est'd)	28	18	54	246	6	1	4	3	1	5	7	23
(b) During turns	37	21	42	198	4	2	0	1	1	2	5	17
(c) At altitude	29	17	54	240	7	1	6	1	1	5	6	24
(d) On approach	36	18	46	200	3	0	5	1	1	2	3	17
(2) Engine-out landing	25	19	56	259	6	2	5	1	1	3	6	17
(3) Propellor malfunctions	40	42	18	57	1	1	1	1	1	25	10	10
(4) Controls, control surfaces, and cable malfunc.	44	47	9	17	1	2	0	1	1	14	7	4
(5) Heating and ventilating system malfunctions	34	40	26	34	2	3	4	1	2	62	49	12
(6) Landing gear malfunctions	37	40	23	53	2	2	6	2	1	40	23	14
(7) Brake failure	40	42	18	51	1	4	2	1	1	24	13	14
(8) Tire blowout	41	50	9	14	0	5	0	1	2	13	13	7
(9) Engine fire	39	29	32	118	2	9	5	2	2	33	15	17
(10) Other fire	40	33	26	68	8	2	4	2	2	33	17	14
(11) Radio equip. failure	35	44	21	36	0	9	3	2	1	31	35	8

TABLE 6 - Continued

Unusual Situation	% of Omits	% No	% Yes	Type of Helpful Training Received in Last 6 mo. (No. of pilots) a	b	c	d	e	f	g	h	i**
(12) Electrical system malfunction	37	40	23	32	0	4	5	1	2	51	29	13
(13) Hydraulic system malfunction	36	38	26	62	0	5	5	1	1	38	25	14
(14) Failure of ground navigational facilities	40	46	14	33	2	10	1	6	2	12	18	10
(15) Instrument malfunction	35	41	24	53	3	13	5	6	1	32	26	10
(16) Warning equipment failure	43	45	12	19	1	8	4	1	1	24	19	7
(17) Excessive icing	40	48	12	13	3	16	5	2	1	16	22	12
(18) Extreme turbulence	39	47	14	21	3	28	1	3	1	14	19	8
(19) Runway ice	39	49	12	14	4	28	2	3	2	6	13	8
(20) Abandoned take-off (start-stop)	38	44	18	64	2	10	6	1	0	7	5	13
(21) Emergency descent	41	31	27	115	3	9	4	2	1	4	7	15
(22) Boost failure	47	45	8	25	3	2	4	2	1	8	7	5
(23) Balked landing	43	40	17	70	4	12	4	2	2	5	5	7
(24) Emergency evacuation of plane (Passengers and Crew)	45	36	19	41	2	3	3	2	2	39	16	11

*Includes 27 unidentified respondents.

**Most "i" responses specified the six-month check.

TABLE 7

RESPONSES OF AIRLINE CAPTAINS TO QUESTIONNAIRE SECTION II C

Percent of Captains (N=620*) Responding Under the Various Categories

a. Training flights
b. Practice on non-revenue flights
c. Practice on revenue flights
d. Practice on simulators (such as the Dehmel)
e. Practice on Link Trainer
f. Practice on mock-ups
g. Ground school
h. Home study
i. Other

Unusual Situation	% of Omits	% No	% Yes	Type of Additional Practice Specified (No. of pilots) a	b	c	d	e	f	g	h	i**
(1) Engine failure												
(a) During take-off (before normal climb est'd)	22	42	36	183	10	0	3	1	1	4	3	4
(b) During turns	30	49	21	105	7	0	1	0	1	1	2	3
(c) At altitude	28	53	19	90	7	0	2	0	1	1	4	3
(d) On approach	28	46	26	137	5	0	4	0	1	2	3	3
(2) Engine-out landing	23	53	24	123	8	0	4	0	1	3	2	2
(3) Propeller malfunctions	31	52	17	54	4	0	5	2	3	18	10	3
(4) Controls, control surfaces, and cable malfunc.	35	53	12	29	1	2	2	1	7	17	11	2
(5) Heating and ventilating system malfunctions	30	55	15	19	0	2	3	1	13	42	19	2
(6) Landing gear malfunctions	29	53	18	33	1	2	2	0	11	37	18	2
(7) Brake failure	33	50	17	55	3	2	2	0	5	23	15	3
(8) Tire blowout	32	57	11	20	1	1	2	0	4	22	3	3
(9) Engine fire	32	42	26	86	4	2	7	0	16	41	17	4
(10) Other fire	33	42	25	69	2	3	7	0	15	49	23	5
(11) Radio equip. failure	29	54	17	23	7	2	3	1	10	45	22	2

TABLE 7 - Continued

Unusual Situation	% of Omits	% No	% Yes	Type of Additional Practice Specified (No. of pilots)							
				a	b	c	d	e	f	g	h	i**
(12) Electrical system malfunction	33	48	19	29	5	1	4	0	11	55	34	3
(13) Hydraulic system malfunction	31	47	22	42	5	1	4	0	11	55	23	3
(14) Failure of ground navigational facilities	34	58	8	18	3	1	2	1	2	12	15	1
(15) Instrument malfunction	32	55	13	32	5	2	1	3	8	21	18	1
(16) Warning equipment failure	34	54	12	13	3	2	5	0	6	26	18	2
(17) Excessive icing	31	57	12	18	2	1	2	0	4	25	20	2
(18) Extreme turbulence	30	61	9	14	1	0	2	0	2	12	15	2
(19) Runway ice	32	59	9	27	2	2	0	0	1	17	5	1
(20) Abandoned take-off (start-stop)	31	52	17	87	6	0	2	1	0	3	4	3
(21) Emergency descent	33	49	18	87	5	0	4	0	0	4	7	4
(22) Boost failure	38	53	9	27	1	0	0	0	1	12	6	2
(23) Balked landing	36	53	11	49	3	0	2	0	3	4	1	2
(24) Emergency evacuation of plane (Passengers and Crew)	36	37	27	67	7	0	3	0	29	44	18	11

*Includes 27 unidentified respondents.

**Most "i" responses specified the six-month check.

Like Table 4, Table 7 shows the captains' responses to the question of whether or not additional practice or training is essential in the listed emergency situations, and the type of training or practice specified for the affirmative responses.

In regard to Table 5, the only unusual situation which any captains reported having experienced more than 35 times was No. 19, "Runway ice," where 1% reported in the 100 category. Other situations with comparatively high frequency of occurrence are (5) "Heating and ventilating system malfunctions," (15) "Instrument malfunction," and (18) "Extreme turbulence." If items 1 a, b, c, d and 2, the items representing various conditions under which engines fail, are combined into a general situation which might be titled "Engine Failure," their frequency of occurrence becomes quite substantial.

Table 6 shows that on 21 out of the 24 emergency situations, more captains report that they have not had appropriate helpful training than report that they have had training which helped them cope with the situation. With those who report that they did receive training, "training flights" is again the most popular response (it seems quite likely that periodic checks must be included in these flights), with "ground school," "home study" and "other" the next most frequent types of training.

Despite the fact that most captains report no training on these emergencies, Table 7, like Table 4 shows that on every item, more pilots indicate that no further practice or training is required than indicate that it is. Here again, those answering in the affirmative choose training flights most frequently with considerable spread over the other choices and some bunching of responses in the f, g, and h categories, "mock-ups," "ground school" and "home study" respectively.

d. Analysis of Pilots' Responses - Questionnaire Section III - Hazardous Situations

The first question on the last page of the questionnaire form was completed

TABLE 8

HAZARDOUS SITUATIONS REPORTED BY AIRLINE PILOTS ON QUESTIONNAIRE SECTION III 1 - CLASSIFIED UNDER THE SITUATIONS LISTED IN SECTION II

Item	Captains and Reserve Captains	First Officers	Unidentified	Total
(1) Engine failure	110	50	5	165
(3) Propeller Malfunctions	11	8	1	20
(4) Controls, control surfaces, and cable malfunctions	8	3	0	11
(5) Heating and ventilating system malfunctions	4	4	0	8
(6) Landing gear malfunctions	12	5	0	17
(7) Brake failure	7	2	0	9
(8) Tire blowout	2	1	0	3
(9) Engine fire	14	3	0	17
(10) Other fire	8	8	1	17
(11) Radio equipment failure	15	3	0	18
(12) Electrical system malfunction	4	4	0	8
(13) Hydraulic system malfunction	20	10	2	32
(14) Failure of ground navigational facilities	48	12	0	60
(15) Instrument malfunction	11	1	0	12
(16) Warning equipment failure	16	4	0	20
(17) Excessive icing	48	18	2	68
(18) Extreme turbulence	48	18	2	68
(19) Runway ice	4	0	0	4
(20) Abandoned take-off (start-stop)	4	3	0	7
(21) Emergency descent	4	6	0	10
(22) Boost failure	1	0	0	1
(23) Balked landing	2	4	0	6
(24) Emergency evacuation of plane (Passengers and Crew)	1	0	0	1
Other	47	40	2	89
None Reported	184	125	12	321
TOTAL*	633	332	27	992

*These totals do not agree with the total questionnaire returns because more than one incident was occasionally reported and, in such cases, these were classified separately.

by enough pilots to permit partial analysis. The item requested pilots to describe the last time they faced a hazardous situation in scheduled flight. Table 8 shows the results of this analysis.

The incidents reported were classified, as far as possible, under the categories listed on Page 2 of the questionnaire. It will be noted that incidents classified under the separate parts of Item 2, Page 2 have been combined and that Item 2, "Engine-out landing," has been omitted from this analysis. One total for the four parts of Item 1, "Engine failure," was reported because it was not always possible to determine from the incident the phase in which the engine failure occurred. Item 2 was omitted since engine-out landings were not clearly separated from engine-failure enroute.

Engine failures were the hazardous incidents reported most frequently. "Excessive icing," "Extreme turbulence," and "Failure of ground navigational facilities" were next in frequency with a difference of about 100 incidents between them and the engine failures. About one-third of the respondents reported no hazardous incidents occurring in regular line flights. Incidents included in the "Others" category could not be classified under any of the items listed on Page 2 of the questionnaire. For the most part, they included descriptions of unfavorable weather conditions which were not clearly icing or turbulence, and hazardous encounters with other aircraft which were not under Air Traffic Control jurisdiction or which did not follow instructions issued by Air Traffic Control.

It is interesting to note that this sample of incidents fits quite well under the categories extracted from the various sources mentioned earlier. This analysis provided valuable additional data on the kinds of emergency situations which occur frequently and on which pilots need "preparedness" practice and training.

e. Analysis of First Officers' Responses - Questionnaire Section I - Routine Operations

The responses of first officers are shown in Tables 9 through 14; Tables 9, 10, and 11, which show responses to Questionnaire Section I are set up in the same way as were Tables 2, 3, and 4, except, of course, that the data are for first officers rather than captains.

The first officers' distribution of responses in Table 10 is quite similar to that of the captains in Table 2 with considerable variability of responses on Procedures 1, 9, 11, 12, 13, 14, 17, and 19.

Table 10, which indicates the number of times first officers felt that the various procedures should be flown over a six months period in order that proficiency can be maintained at a satisfactory level, shows a trend quite different from that in Table 3, which shows the same type of data for captains. For each procedure, the percent of first officers indicating that the procedures need not be flown at all during a half-year period was smaller than the similar percent for captains reporting on the same items. In other words, first officers feel that the procedures require more practice to keep up satisfactory proficiency than do captains. This was true for all items except the ILS approach, for which nearly all pilots desired additional practice and only five percent of both captains and first officers indicated that the maneuver need not be flown.

The percent of first officers who expressed a need for additional practice or training (Table 11) was higher in every case than was the percent of captains answering in the affirmative (Table 4). The percent of first officers answering "Yes" exceeds that of those answering "No" for several items, a phenomenon which occurred only once in the analysis of captains' responses. Training flights were again the most popular choice for those who indicated

TABLE 9

RESPONSES OF AIRLINE FIRST OFFICERS TO QUESTIONNAIRE SECTION I A

The distribution is in terms of the percent of the first officer sample (N=323) among the various intervals indicated. The numbers beneath each interval are the midpoints of the intervals.

Procedure	% of Omits	Number of Times Flown in Last Six Months									
		0	1	2	3-7	8-12	13-27	28-42	43-57	58-91	92+
		0	1	2	5	10	20	35	50	75	100*
(1) Take-off in low ceiling (1000 feet or less)	2	6	5	3	21	18	24	12	3	3	3
(2) Emergency climb (METO power)	17	50	16	7	8	1	0	0	0	1	0
(3) Steep turns (approach maximum bank)	17	57	7	6	10	2	1	0	0	0	0
(4) Rapid descent and pull up	8	61	10	7	11	2	1	0	0	0	0
(5) Recovery from unusual attitudes	10	86	2	1	1	0	0	0	0	0	0
(6) Minimum speed maneuvering	10	54	5	5	14	7	3	1	0	1	0
(7) Approach to stall	12	82	2	2	0	0	0	0	0	0	1
(8) Radio range orientation	8	73	3	2	6	3	3	1	1	0	0
(9) ADF tracking	9	8	1	3	14	15	17	9	10	4	10
(10) Manual loop orientation and tracking	10	59	2	8	13	4	3	0	0	0	0
(11) Standard low freq. approach instrument	5	22	7	14	27	14	8	1	1	0	0
(12) ADF approach	5	28	9	17	26	8	5	1	0	0	0
(13) ILS approach	5	14	5	5	23	19	21	5	2	2	0
(14) GCA approach	7	42	12	14	20	2	2	0	0	0	0
(15) Missed approach procedure	7	51	18	12	11	0	0	0	0	0	0
(16) Approach under 400-1 conditions	3	15	9	11	32	16	11	1	1	0	0
(17) Cross-wind landing (more than 30°) up to max. allowable for equipment	4	19	9	15	22	17	10	2	2	0	2
(18) No-flap landing	10	67	8	6	7	1	1	0	0	0	0
(19) Cross-wind take-off (more than 30°) up to max. allowable for equipment	5	19	10	12	20	16	11	3	2	0	1

*This figure more nearly approximates the mode than the midpoint. Most responses above 92 were 100.

TABLE 10

RESPONSES OF AIRLINE FIRST OFFICERS TO QUESTIONNAIRE SECTION I B

The distribution is in terms of the percent of the first officer sample (N=324) among the various intervals indicated. The numbers beneath each interval are the midpoints of the intervals.

Procedure	% of Omits	Times Necessary to Fly per 6 mo. to Maintain Proficiency									
		0	1	2	3-7	8-10	13-27	28-42	43-57	58-92	93+
		0	1	2	5	10	20	35	50	75	100*
(1) Take-off in low ceiling (1000 feet or less)	12	15	10	11	33	13	5	0	0	0	0
(2) Emergency climb (METO power)	14	36	26	11	12	0	0	0	0	0	0
(3) Steep turns (approach maximum bank)	18	27	10	13	26	7	0	0	0	0	0
(4) Rapid descent and pull up	17	29	16	14	21	2	0	0	0	0	0
(5) Recovery from unusual attitudes	19	42	14	10	15	0	0	0	0	0	0
(6) Minimum speed maneuvering	17	25	15	12	26	5	1	0	0	0	0
(7) Approach to stall	19	43	14	9	13	1	1	0	0	0	0
(8) Radio range orientation	17	35	18	10	17	3	1	0	0	0	0
(9) ADF tracking	15	9	10	7	39	13	5	0	1	0	1
(10) Manual loop orientation and tracking	15	26	17	13	26	2	1	0	0	0	0
(11) Standard low freq. approach instrument	14	10	15	13	38	9	2	0	0	0	0
(12) ADF approach	13	11	19	15	36	5	1	0	0	0	0
(13) ILS approach	13	5	6	9	38	18	9	2	0	0	0
(14) GCA approach	18	18	16	13	29	4	1	0	0	0	0
(15) Missed approach procedure	14	23	20	18	22	3	0	0	0	0	0
(16) Approach under 400-1 conditions	14	10	13	14	36	11	2	0	0	0	0
(17) Cross-wind landing (more than 30°) up to max. allowable for equipment	14	14	12	15	34	9	2	0	0	0	0
(18) No-flap landing	14	33	26	13	14	1	0	0	0	0	0
(19) Cross-wind take-off (more than 30°) up to max. allowable for equipment	14	17	14	19	25	8	2	0	0	0	0

*This figure more nearly approximates the mode than the midpoint. Most responses above 92 were 100.

TABLE 12

RESPONSES OF AIRLINE FIRST OFFICERS TO QUESTIONNAIRE SECTION I C

Percent of First Officers (N=324) Responding Under the Various Categories

a. Training flights
b. Practice on non-revenue flights
c. Practice on revenue flights
d. Practice on simulators (such as the Dehmel)
e. Practice on Link Trainer
f. Practice on mock-ups
g. Ground school
h. Home study
i. Other

	% of Omits	% No	% Yes	Type of Additional Training or Practice Specified (No. of Pilots) a	b	c	d	e	f	g	h	i*
(1) Take-off in low ceiling (1000 feet or less)	11	76	13	22	2	8	0	1	0	0	0	0
(2) Emergency climb (METO power)	15	58	27	66	15	3	1	0	0	0	0	0
(3) Steep turns (approach maximum bank)	14	27	59	154	25	2	2	1	0	0	0	0
(4) Rapid descent and pull up	15	41	44	117	21	7	2	4	0	0	0	0
(5) Recovery from unusual attitudes	14	41	45	127	9	0	1	2	0	0	0	0
(6) Mini. speed maneuvering	14	38	48	128	25	4	1	2	0	0	0	0
(7) Approach to stall	14	43	43	116	15	0	2	1	0	0	0	0
(8) Radio range orientation	13	47	40	72	9	12	9	14	1	0	0	0
(9) ADF tracking	14	64	22	37	8	9	6	26	0	0	0	0
(10) Manual loop orientation and tracking	16	45	39	67	13	19	8	51	0	1	0	0
(11) Standard low freq. approach instrument	17	42	41	80	15	17	6	39	0	0	1	0
(12) ADF approach	15	43	42	67	13	19	17	29	0	1	0	1
(13) ILS approach	14	40	46	98	15	28	9	32	0	0	0	0
(14) GCA approach	18	37	45	86	21	38	7	16	1	0	2	0
(15) Missed appr. procedure	14	40	46	114	13	8	5	23	0	0	0	0
(16) Approach under 400-1 conditions	15	47	38	96	17	15	3	12	0	0	0	0
(17) Cross-wind landing (more than 30°) up to max. allowable for equipment	14	55	31	84	13	8	2	0	1	0	0	0
(18) No-flap landing	16	44	40	106	16	12	1	0	0	0	0	0
(19) Cross-wind take-off more than 30°) up to max. allowable for equip.	16	58	26	70	10	6	1	0	0	1	0	0

*Most "i" responses specified the 6-month check.

that additional training or practice was needed.

f. Analysis of First Officers' Responses - Questionnaire Section II - Unusual and Emergency Situations.

Like Tables 5, 6, and 7, Tables 12, 13, and 14 present the responses which show frequency of occurrence of emergency or unusual situations, type of appropriate training received, and type of additional training or practice needed on these emergency situations.

As might be expected, since captains and first officers undoubtedly experience the same emergencies, Table 12 does not differ markedly from Table 5. Here the situations which occur most frequently are No. 19, "Runway ice," (18) "Extreme turbulence," (5) "Heating and ventilating system malfunctions," (15) "Instrument malfunction," and "Engine failure" if (1) a, b, c, d and 2 are combined.

As shown in Table 13, more first officers invariably report not having had appropriate training which helped them cope with the emergency situations than reported having had training. First officers also report they engage in less "home study" than do captains.

Table 14 shows first officers answering "Yes" to the question of the need for additional training in greater numbers than answering "No" on 6 items. These include several of the "Engine failure" items, "Engine fire" (they are divided almost equally on "Other fire") and "Emergency evacuation of plane." Once again training flights are by far the most popular choice for maintaining proficiency, and ground school training runs second.

TABLE 12

RESPONSES OF AIRLINE FIRST OFFICERS TO QUESTIONNAIRE SECTION II A

The distribution is in terms of the percent of the first officer sample (N=324) among the various intervals indicated. The number under the intervals are their midpoints.

Unusual Situation	% of Cmits	Number of Times Experienced in Last 6 Months									
		0	1	2	3-7	8-12	13-27	28-42	43-57	58-91	92+
		0	1	2	5	10	20	35	50	75	100*
(1) Engine failure											
a. During take-off (before normal climb established)	11	75	10	2	1	0	0	0	0	0	0
b. During turns	16	81	2	1	0	0	0	0	0	0	0
c. At altitude	11	58	20	7	4	0	0	0	0	0	0
d. On approach	16	78	4	1	0	0	0	0	0	0	0
(2) Engine-out landing	8	58	22	6	6	1	0	0	0	0	0
(3) Propeller malfunctions	9	74	13	3	2	0	0	0	0	0	0
(4) Controls, control surfaces, and cable malfunctions	12	81	6	1	0	0	0	0	0	0	0
(5) Heating and ventilating system malfunctions	11	51	9	11	15	2	2	0	0	0	0
(6) Landing gear malfunctions	11	70	14	3	1	0	0	0	0	0	0
(7) Brake failure	13	80	6	1	0	0	0	0	0	0	0
(8) Tire blowout	12	75	11	2	0	0	0	0	0	0	0
(9) Engine fire	12	83	4	0	0	0	0	0	0	0	0
(10) Other fire	12	82	5	1	0	0	0	0	0	0	0
(11) Radio equipment failure	9	54	14	10	12	1	0	0	0	0	0
(12) Electrical system malfunctions	12	73	8	3	3	0	0	0	0	0	0
(13) Hydraulic system malfunctions	12	72	12	3	1	0	0	0	0	0	0

TABLE 12 - Continued

Unusual Situation	% of Omits	Number of Times Experienced in Last 6 Months: 0	1	2	3-7	8-12	13-27	28-42	43-57	58-91	92+
		0	1	2	5	10	20	35	50	75	100*
(14) Failure of ground navigational facilities	10	60	10	10	8	2	0	0	0	0	0
(15) Instrument malfunction	12	49	15	9	14	1	0	0	0	0	0
(16) Warning equipment failure	10	70	9	5	6	1	0	0	0	0	0
(17) Excessive icing	11	67	10	6	4	1	0	0	0	0	0
(18) Extreme turbulence	8	49	17	10	12	2	1	0	0	0	0
(19) Runway ice	10	47	7	7	14	10	4	1	1	0	0
(20) Abandoned take-off (Start-stop)	11	70	14	4	2	0	0	0	0	0	0
(21) Emergency descent	12	77	8	1	1	0	0	0	0	0	0
(22) Boost failure	13	81	6	0	0	0	0	0	0	0	0
(23) Balked landing	16	66	7	5	6	0	0	0	0	0	0
(24) Emergency evacuation of plane (Passengers and Crew)	19	78	2	0	1	0	0	0	0	0	0

*This figure more nearly approximates the mode than the midpoint. Most responses above 92 were 100.

TABLE 13

RESPONSES OF AIRLINE FIRST OFFICERS TO QUESTIONNAIRE SECTION II B

Percent of First Officers (N=324) Responding Under the Various Categories

a. Training flights
b. Practice on non-revenue flights
c. Practice on revenue flights
d. Practice on simulators (such as the Dehmel)
e. Practice on Link Trainer
f. Practice on mock-ups
g. Ground school
h. Home study
i. Other

Unusual Situation	% of Omits	% No	% Yes	Type of Helpful Training Received in Last 6 mo. (No. of pilots) a	b	c	d	e	f	g	h	i*
(1) Engine failure												
(a) During take-off (before normal climb established)	32	42	26	53	7	4	3	0	0	2	4	1
(b) During turns	38	43	18	40	4	1	3	0	0	0	3	1
(c) At altitude	32	41	26	57	6	5	4	0	0	1	8	1
(d) On approach	36	44	20	42	5	1	5	9	0	0	4	0
(2) Engine-out landing	31	43	25	53	9	6	5	0	0	0	5	1
(3) Propeller malfunctions	35	53	11	9	4	2	1	0	0	7	10	1
(4) Controls, control surfaces, and cable malfunc.	38	56	5	3	0	1	1	0	0	6	5	1
(5) Heating and ventilating system malfunctions	34	45	20	6	3	7	2	0	1	21	23	2
(6) Landing gear malfunctions	38	46	16	16	3	4	2	0	0	16	11	2
(7) Brake failure	40	48	11	11	0	4	1	0	0	14	7	2
(8) Tire blowout	40	52	7	3	2	2	0	0	0	4	7	2
(9) Engine fire	40	43	16	19	3	3	5	0	1	15	11	1
(10) Other fire	39	48	13	7	0	4	4	0	0	17	12	2
(11) Radio equip. failure	34	49	16	11	3	6	1	2	0	15	14	1

TABLE 13 — Continued

	% of Omits	No	Yes	Type of Helpful Training Received in Last 6 mo. (No. of pilots) a	b	c	d	e	f	g	h	i*
(12) Electrical system malfunction	40	47	12	4	0	2	2	1	0	16	10	0
(13) Hydraulic system malfunction	39	44	17	12	2	4	3	1	2	21	9	2
(14) Failure of ground navigational facilities	35	52	13	6	1	9	0	4	0	8	8	3
(15) Instrument malfunction	37	47	16	12	1	10	4	0	0	9	11	1
(16) Warning equipment failure	40	49	10	2	2	4	4	0	4	9	9	2
(17) Excessive icing	39-	49	11	3	1	10	4	0	0	6	11	3
(18) Extreme turbulence	37	47	16	5	1	18	2	0	0	10	8	5
(19) Runway ice	35	48	16	4	3	24	2	0	0	6	10	4
(20) Abandoned take-off (start-stop)	39	50	12	16	1	5	5	0	0	3	7	1
(21) Emergency descent	39	48	12	20	2	3	5	1	0	3	4	2
(22) Boost failure	43	51	5	5	0	2	1	0	0	3	4	1
(23) Balked landing	42	46	11	16	3	8	2	0	0	2	1	1
(24) Emergency evacuation of plane (Passengers and Crew)	42	42	16	7	1	3	0	1	2	1	16	1

*Most "i" responses specified the 6-month check.

TABLE 14

RESPONSES OF AIRLINE FIRST OFFICERS TO QUESTIONNAIRE SECTION II C

Percent of First Officers (N=324) Responding Under the Various Categories

a. Training flights
b. Practice on non-revenue flights
c. Practice on revenue flights
d. Practice on simulators (such as the Dehmel)
e. Practice on Link Trainer
f. Practice on mock-ups
g. Ground school
h. Home study
i. Other

Unusual Situation	% of Omits	% No	% Yes	Type of Additional Practice Specified (number of pilots) a	b	c	d	e	f	g	h	i*
(1) Engine failure												
a. During take-off (before normal climb established)	19	20	61	171	15	2	5	0	1	1	0	1
b. During turns	27	32	41	110	11	2	3	0	0	1	0	1
c. At altitude	25	42	33	93	8	0	4	0	1	2	1	1
d. On approach	26	27	37	131	11	0	3	2	0	1	0	1
(2) Engine-out landing	20	33	47	134	13	1	2	0	0	1	0	1
(3) Propeller malfunctions	29	47	24	51	5	0	6	0	2	13	6	0
(4) Controls, control surfaces, and cable malfunctions	31	50	19	33	1	1	2	3	2	17	11	0
(5) Heating and ventilating system malfunctions	27	52	21	17	2	1	4	2	7	21	14	0
(6) Landing gear malfunctions	28	44	28	45	4	0	7	2	6	26	14	0
(7) Brake failure	31	45	24	42	5	0	0	1	4	22	9	0
(8) Tire blowout	33	53	14	14	2	0	3	1	3	9	12	0
(9) Engine fire	30	34	36	67	7	1	20	1	9	26	13	0
(10) Other fire	31	35	34	58	7	1	15	1	9	28	13	0

TABLE 14 - Continued

Unusual Situation	% of Omits	% No	% Yes	Type of Additional Practice Specified (No. of Pilots) a	b	c	d	e	f	g	h	i*
(11) Radio equipment failure	26	51	24	28	2	1	2	5	3	32	10	0
(12) Electrical system malfunction	30	41	29	30	5	1	10	3	8	39	14	1
(13) Hydraulic system malfunction	29	43	28	39	8	0	12	3	7	29	14	1
(14) Failure of ground navigational facilities	30	57	13	21	3	2	2	4	1	13	4	1
(15) Instrument malfunct.	29	46	25	37	6	1	10	4	1	20	7	0
(16) Warning equipment failure	33	50	16	18	5	0	7	1	0	26	5	0
(17) Excessive icing	31	51	18	15	1	0	8	1	0	20	7	0
(18) Extreme turbulence	28	60	11	13	3	1	3	1	0	11	5	0
(19) Runway ice	28	58	13	22	4	1	3	1	0	10	3	0
(20) Abandoned take-off (Start-stop)	30	44	25	73	3	0	2	1	0	5	0	0
(21) Emergency descent	32	46	22	60	4	2	4	1	1	5	1	0
(22) Boost failure	37	48	15	30	1	0	5	1	1	11	4	0
(23) Balked landing	37	45	18	41	4	2	2	1	5	8	1	0
(24) Emergency evacuation of plane (Passengers and crew)	35	29	36	41	3	1	4	1	25	32	6	5

*Most "i" responses specified the six-months check.

IV. SUMMARY AND CONCLUSIONS

This report has described a study of the semi-annual instrument check for airline pilots. The fundamental purposes of the study were to provide the Civil Aeronautics Administration with information which would provide a basis for a review of policies in the area of periodic checks and training, and to make available data for the revision of current techniques for checking the maintenance of essential pilot information and skills.

A review of the semi-annual checks of 18 of the major airlines revealed that there is little agreement among airlines as to what pilot skills need to be checked periodically. The flight-checking techniques used do not, in most cases, provide specific standards or precise descriptions of what is to be done.

The basic data of the study were facts and opinions provided by airline pilots by means of a questionnaire. Nine hundred and forty-four airline captains and first officers, all active members of the Air Line Pilots Association, provided data on the number of times per six-month period 19 procedures (thought by authoritative sources to be essential pilot skills) were carried out, the number of times these procedures should be flown during the same time interval to maintain proficiency at a satisfactory level, and whether or not additional training or practice was desirable. They also reported the number of times a list of 24 unusual or emergency situations had occurred to them on line flights over the past six months, what appropriate training they had had for dealing with these situations, and, again, what additional practice or training was desirable.

Pilot responses on these parts of the questionnaire form showed considerable variability, ranging in many cases from 0 to 100 or more on the section dealing with the number of times the procedures were flown per six-month period. On the section dealing with the number of times the procedures should be flown

to maintain proficiency at a satisfactory level, many of the pilots indicated that the amount of practice received on line flights during the preceding six-month period was adequate. This tendency was less noticeable among first officers than it was among the captains' responses. In this same connection, first officers indicated the necessity for additional training or practice more frequently than did captains. The obvious explanation for this finding would be, of course, that it is a function of experience or of opportunity to fly the maneuvers; the less-experienced first officers naturally being more in need of training and practice. It seems likely, however, that the tendency, particularly on the part of captains, to de-emphasize training needs might stem in part from a natural reluctance to impose requirements on themselves. It is noteworthy that in spite of this natural tendency, sizeable numbers reported a need for more practice or training.

The study has brought a wealth of data to light with the possibility of many analyses which are beyond the scope of the present study. Data for such further analyses are to be found in complete tables filed with the NRC Committee on Aviation Psychology and with the CAA Division of Research. Since the data represent to some extent the opinions of a vitally interested group, their natural biases must be kept in mind in interpreting their reports.

The results of this survey appear to justify the following recommendations regarding semi-annual checking.

Recommendations

1. The training aspects of the semi-annual checks should be stressed.
   a. The great variation among pilots in terms of opportunity to maintain proficiency on line flights and the large number indicating the need for additional training on various flight procedures indicate the importance of further practice.

b. It is suggested that line-flight experience be integrated with the periodic checks so that maximum benefit can be gained by the pilot from such special non-revenue flights.

c. As a mature individual with insight into his own skills and experiences the pilot should be given a more active part in the selection of those maneuvers to be given special attention during the limited time available for checking and practice.

d. The role of the check pilot would seem most appropriately that of a professional consultant and adviser. Perhaps a check-list should be filled in by the pilot just before his periodic check, reporting the extent of recent practice obtained on various aspects of flight including any evidences of needed practice such as missed approaches or minor procedural difficulties. On the basis of the pilots' own comments on this sheet together with information obtained from records of previous flights, the check pilot would plan a training program including a check-flight especially designed to meet the particular needs in regard to proficiency-maintenance of this pilot.

e. Certain minimal procedures would be checked at definite intervals because of their importance regardless of the opportunity of the specific pilot to practice them on regular flights.

2. <u>The analysis indicates that there are a few maneuvers on which training and checking are especially needed by these pilots</u>.

These include:

a. The ILS Approach.

b. Steep Turns (approaching maximum bank)

c. Rapid Descent and Pull-up.

d. Recovery from Unusual Attitudes.

e. Minimum Speed Maneuvering and Approach to Stall.

3. The analysis also indicates that training in the handling of emergency situations should be emphasized in the semi-annual check, particularly on frequently occurring and critical types such as:

a. Engine failure.

b. Fire engine and other.

c. Situations in which pilots are deprived of ground navigational aids.

d. Excessive icing.

e. Extreme turbulence.

Techniques

The maneuvers and procedures appearing to need special emphasis are not of a type suitable for carrying out on line flights with a load of passengers. Many appear to require special non-revenue flights. Earlier work on the development of an objective flight-check for the CAA's Airline Transport Rating [4, 5, 6] has clearly demonstrated that improved results for in-flight checking of maneuvers such as those listed can be obtained by more objective procedures.

Flight-checking in this fashion involves the use of:

a. Uniform standards of proficiency which all pilots have to meet.

b. Recording flying performance as it occurs - no reliance on memory.

c. Efficient, precise descriptions of what is to be done and how.

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[4] Gordon, Thomas, op. cit.

[5] Nagay, John A, op. cit.

[6] Civil Aeronautics Administration. Flight-Check Manual to Accompany the Pilot Flight Test Report for the Airline Transport Rating Flight Examination. Washington, D.C., April 1950.

d. Objective items, involving quantitative data and diagrammatic aids, which permit different check pilots to agree as to how well the pilot flew.

The recent development of elaborate electronic flight simulators has provided what appears to be a very appropriate technique for training and checking on the maintenance of pilot skills in meeting emergency situations without hazard to personnel or equipment.

Many of the emergency situations experienced by pilots are extremely complex in nature. The modern transport airplane is a vastly complicated mechanism and the possible combinations of things which can present problems to the pilot probably number in the thousands. The reports of hazardous situations suggest that there is a definite need for pilots to be prepared for such contingencies in advance, to anticipate them by having thought them through before they occur. It is, no doubt, the development of this sort of skill that pilots had in mind when they reported the need for "home study" on many of the emergency situations listed in the questionnaire.

The data of the survey have suggested a technique for aiding in the development of flexibility in making appropriate decisions in complex emergency situations. There are many special problem situations which could be set up with approved solutions and discussed and studied by pilots. They would be problem situations of the "What would you do if . . .?" type, extracted from accident reports and incidents reported by pilots. Examples of incidents taken from those reported in this study can be found in Appendix C.

It is believed that the preparation of a fairly extensive list of such problems with approved solutions would aid materially in the development of "anticipatory" skills in meeting emergencies and it is recommended that a program aimed at the development of such a list be instituted.

Maintenance of skills by the pilot is of key importance to aviation safety. It is hoped that the results of this study may make a small contribution toward improving the effectiveness of procedures for insuring that airline pilots are assisted in maintaining their proficiency at a uniformly high level.

APPENDIX A

TABLES SHOWING INCIDENCE OF MALFUNCTIONS IN DC- 3 AND MARTIN 202 TYPE AIR-CRAFT

TYPES OF MALFUNCTIONS

Power Plant - Rough operation, partial or complete loss of power, excessive vibration noise, cracked, missing, broken parts, smoke, fire, abnormal fuel, oil, temperature, etc. indications

Instruments - Failure to indicate, erroneous indications

Controls - Failure to operate, restricted operation, broken, cracked, jammed, or frozen surfaces or cables (elevators, rudder, aileron, wing flaps)

Propeller - Nicked, cracked, bent, activating mechanism failure or malfunction

Wing-Fuselage - Damaged surfaces or parts--covering, doors, windows, spars, rivets, etc. (includes stabilizers), icing, hail or lightening damage

Heating and Ventilating Equipment - Malfunction, failure to operate (augmentors, super chargers, and other parts of mechanism)

Hydraulic Pressure Equipment - Malfunction or failure, leakage, etc.

Warning Equipment - Lights, horns, etc. malfunction or failure

Radio Equipment - Malfunction, failure, fire, etc.--including antennae

Compartment-Cabin - Luggage or cargo compartments or cabin fire--gally, cushions, etc.

Landing Gear - Mechanism, struts, wheels, nosewheel, etc. malfunction, failure to operate, collapse

Brake System - Malfunction - failure to operate

Tires - Retread failures, blow-outs

Electrical System - General malfunction or failure

Pressurization Equipment - General malfunction or failure

Water System - General malfunction or failure

Emergency Equipment - CO_2 equipment, de-icing, fuel dump equipment, etc. malfunction of failure

DC-3 MECHANICAL MALFUNCTION
(12/16/48 - 10/15/49)

TYPES OF MALFUNCTION

Where Malfunction Occurred	Power Plant	Instruments	Control & Control Surfaces	Prop.	Wing Fusel.	Heating & Vent.	Hyd. Press.	Warning Equip.	Radio Equip.	Compartment—Cabin	Landing Gear	Brake System	Tubes Tires	Elec. System	Press. Equip.	Water System	Emerg. Equip.	TOTAL
Refueling					1													1
Prestarting	2								1					1				4
Starting	2						1				1			1				4
Taxiing	2						1				1	1						5
Run-up	5			3			1		1					1				11
Take-off	20		1	2	1		3	2			4							33
Climb	6								1									7
Descent																	1	1
In flight	71	1	4	1	1	3	7	2	6	1				9				106
Approach	3						2	1			1							7
Landing	3		2				1				2		3					11
Parking																		
Towing											1							1
Inspection	31		3	1	12						5	2		1				55
TOTAL	145	1	10	7	15	3	15	5	9	1	15	3	3	13	0	0	1	246

MARTIN M-202 MECHANICAL MALFUNCTIONS
(12/16/48 - 10/15/49)

TYPES OF MALFUNCTION

Where Malfunction Occurred	Power Plant	Instruments	Control & Control Surfaces	Prop.	Wing & Fusel.	Heating & Vent.	Hydr. Press.	Warning Equip.	Radio Equip.	Cabin Equip.	Landing Gear	Brake System	Tires	Elec. System	Press. Equip.	Water System	Emerg. Equip.	TOTAL
Refueling	2				1													3
Prestarting																		
Starting	2			1														3
Taxiing	1																	1
Run-up																		
Take-off	7		1	2		1		1						1				13
Climb	1																	1
Descent																		
In flight	21	1	1	2	3	7	1		1		2			2				41
Approach			1								1							2
Landing			1								1			1				3
Parking																		
Inspections	2		3		4						1							10
TOTAL	36	1	7	5	8	8	1	1	1		5			4				77

APPENDIX B

THE QUESTIONNAIRE FORM

AND

ALPA LETTER OF TRANSMITTAL

Affiliated with the
A. F. of L.

"Schedule With Safety"

AIR LINE PILOTS ASSOCIATION
INTERNATIONAL

3145 West Sixty-Third Street

Telephone
GRovehill 6-2200

CHICAGO 29

June 15, 1950

TO ALL ALPA MEMBERS

Dear Member:

The American Institute for Research has requested the cooperation of the air line pilots in working out some of the problems relating to pilot qualifications and the devising of methods for evaluating those qualifications. It is the desire of the American Institute, in cooperation with other interested parties, especially the air line pilots as represented by ALPA, to provide more suitable and more uniform standards for inclusion in the six month check.

The American Institute for Research, in an effort to take advantage of the experience of qualified people in the field, has subjected their work to the criticism of various interested parties, including the Air Line Pilots Association, and has cooperated in accepting the pilots' recommendations and included many of them in their drafts of such examinations.

The Institute is presently working on a study designed to establish the facts related to a satisfactory level of performance, uniform in character, in piloting air line aircraft, especially respecting various types of unusual situations in flight which may arise. The program is designed to add uniformity and to attempt to determine what is essential and what is non-essential in a six months' check, and what should be done, if anything, to revise present methods of employing this six months' evaluation. In other words, it is anticipated that a final result of this study will be an effort to devise a more adequate and standard procedure for giving the six months' pilot competency check. It will seek to eliminate dangerous or extreme maneuvers of every kind and character and replace all this with something more productive of constructive and uniform evaluation of air line piloting skill.

Opinions among aviation agencies, with respect to the semi-annual instrument check, range from the belief that it should be a brief practice period to a conviction that it should be as comprehensive as the flight check taken for the ATR. ALPA believes it should be only practical and adequate.

The Institute is soliciting the help of the air line pilots through their Association in this project. Unless the pilots

cooperate substantially in an effort of this kind, the ones who are apparently trying to do a sincere job are handicapped, and without the essential necessary information might well bring forth results way off the runway that would take many years to revise and correct. The American Institute for Research has requested that the air line pilots cooperate in this research by contributing vast background and experience in all-weather flying, provide facts about the types of unusual procedures and situations encountered in air line flying by means of the enclosed questionnaire. As an initial step, they have requested that ALPA circulate the attached questionnaire to all of the air line pilot members of the Association.

The information which is required is, how often the air line pilot carries out the procedures or experiences the situations listed in the questionnaire; how often these things have to be practiced to keep up the pilot's skill or what training the pilot has had that has helped, or what extra training or practice may seem necessary or desirable. Therefore, after consultation with the ALPA Air Safety and Airworthiness Advisory Committee of Headquarters, established by Convention action, and other interested pilot groups, and a considerable revision of the questionnaire, Headquarters agreed to circulate the questionnaire subject to the following stipulations:

1. That no pilot will be required to sign his name to the attached questionnaire.

2. That all questionnaires will be sent out by Headquarters and will be returned to Headquarters.

3. That the questionnaire will always remain the property of the Association.

4. That the Association and its members will have a full opportunity to participate in the preparation of any tests, the flying thereof, etc., for which the information gathered from this questionnaire may be utilized.

Headquarters' personnel and various pilot groups have participated in the preparation of the attached questionnaire. It is believed that the information which will be obtained will be of considerable value to the Association as well as to the American Institute for Research. The Engineering and Air Safety Department will carefully evaluate and tabulate the information contained in each questionnaire. Each questionnaire will be examined carefully to determine that the pilot has not affixed his name or included any other personal identification.

We, therefore, sincerely request that you complete each question on this questionnaire promptly, conscientiously, and to the best of your ability in accordance with the instructions contained

thereon and return it to the Headquarters Engineering and Air Safety Department not later than July 1, 1950.

Headquarters will watch the program continuously and if any dual purpose procedure becomes evident, we will immediately take proper action forthwith to cause its elimination.

Your cooperation will be appreciated.

With kind regards, I am

Sincerely yours,

AIR LINE PILOTS ASSOCIATION

David L. Behncke, President

dlb/ek

SOME QUESTIONS ON THE MAINTENANCE OF FLYING SKILL

A Questionnaire for Airline Pilots

PURPOSE OF THE QUESTIONNAIRE

This is the first step in a research project designed to assist airline pilots by establishing the facts related to learning and remembering the various skills and information essential to a satisfactory level of performance in piloting transport aircraft, and in meeting various types of unusual situations which may possibly arise.

HOW TO FILL OUT THE QUESTIONNAIRE

The next two pages consist of lists of procedures and unusual situations met in transport flying. Questions about each are listed at the top of the page. You are asked to write a number in the appropriate column to answer each question about each procedure and situation. Setting up the questionnaire in this fashion reduces the amount of writing you have to do to a minimum.

Page 1 lists procedures carried out in transport flying. The question under Column A at the top of the page asks you to indicate how many times during the past six months you have performed the procedures on line flights. You simply write the number in the column beside the appropriate procedure. Be as accurate as possible. A number of blank spaces are included in the lists where you may add additional procedures which are carried out frequently. Column B asks you to indicate the minimum number of times the procedures should be carried out on line flights in a 6-month period in order that proficiency on the procedures can be maintained. This is also answered by writing in a number. Column C is a little more complicated and special instructions have been printed at the bottom of page 1 explaining how to fill it out.

The same general principles apply to the questions concerning the unusual situations that are met in transport flying listed on page 2.

Page 3 is a little different but is self-explanatory.

* * * *

AIRLINE_____

CAPTAIN (_____) FIRST OFFICER (_____)

NUMBER OF FLYING HOURS_____

ATR: YES (_____) NO (_____)

AIRCRAFT TYPE ROUTINELY FLOWN_____

* * * *

American Institute for Research Pittsburgh 13, Pennsylvania 11 May 1950

I PROCEDURES

	A	B	C*		
	Times Performed On Line Flights During Last Six Months	Minimum Times Necessary On Line Flights In a 6-month Period In Order to Maintain Proficiency	Additional Practice Needed		
			Check Yes	Check No	Amount and Type
(1) Take-off in low ceiling (1000 feet or less)					
(2) Emergency climb (METO power)					
(3) Steep turns (approach maximum bank)					
(4) Rapid descent and pull-up					
(5) Recovery from unusual attitudes					
(6) Minimum speed maneuvering					
(7) Approach to stall					
(8) Radio range orientation					
(9) ADF tracking					
(10) Manual loop orientation and tracking					
(11) Standard low freq. approach instrument					
(12) ADF approach					
(13) ILS approach					
(14) GCA approach					
(15) Missed approach procedure					
(16) Approach under 400-1 conditions					
(17) Cross-wind landing (more than 30°) up to maximum allowable for equipment					
(18) No-flap landing					
(19) Cross-wind take-off (more than 30°) up to maximum allowable for equipment					
(20) _____					
(21) _____					
(22) _____					
(23) _____					
(24) _____					
(25) _____					

*HOW TO FILL OUT COLUMN C

If you indicated in Column C that you felt additional practice was necessary on certain procedures, choose the type of additional practice needed from one of those in the list on the right. Then indicate the number of additional practice sessions (or "flights" as the case may be) by writing in the appropriate number. For example, if you feel three additional training flights are required over a six-month period to maintain proficiency on Steep turns, write "a3" in Column C opposite No. 3, "Steep Turns."

a. Training flights
b. Practice on non-revenue flight
c. Practice on revenue flights
d. Practice on simulators (such the Dehmel)
e. Practice on Link Trainer
f. Practice on mock-ups
g. Ground school
h. Home study
i. Other

II UNUSUAL SITUATIONS

	A Times Experienced In Past Six Months	B* Training in Past Six Months Which Aided You State Amount And Type	C* Extra Practice Or Instruction Needed: Check Yes	C* Extra Practice Or Instruction Needed: Check No	C* Extra Practice Or Instruction Needed: Amount and Type
1) Engine failure a. During take-off (before normal climb established)					
b. During turns					
c. At altitude					
d. On approach					
2) Engine-out landing					
3) Propellor malfunctions					
4) Controls, control surfaces, and cable malfunctions					
5) Heating and ventilating system malfunctions					
6) Landing gear malfunctions					
7) Brake failure					
8) Tire blowout					
9) Engine fire					
10) Other fire					
11) Radio equipment failure					
12) Electrical system malfunction					
13) Hydraulic system malfunction					
14) Failure of ground navigational facilities					
15) Instrument malfunction					
16) Warning equipment failure					
17) Excessive icing					
18) Extreme turbulence					
19) Runway ice					
20) Abandoned take-off (start-stop)					
21) Emergency descent					
22) Boost failure					
23) Balked landing					
24) Emergency evacuation of plane (Passengers and Crew)					
25) _____					
26) _____					
27) _____					
28) _____					

*HOW TO FILL OUT COLUMNS B AND C

In Column B, indicate by letter the types of practice you have had in the past six months which helped you cope with each situation. Choose from the list at the bottom right of page 1. Then write the number of practice sessions you had in the past six months after the letter indicating the type -- "a2, e4", etc. Column C is filled out in the same way as Column C on page 1.

III EXPERIENCE WITH EMERGENCIES

1. List the last time you faced a hazardous situation in scheduled flight.
   (a). Approximate date _____
   (b). Incident - describe:

2. Was any difficulty experienced in completing the emergency procedures or remedial action?

   Yes _____ No _____

   Describe:

3. Did you feel you had sufficient recent training to cope efficiently with the problem? Yes _____ No _____

4. What additional training would be helpful?
   Describe:

5. Can you think of a time when an emergency or equipment failure occurred in scheduled flight, which you had never before experienced but which you had practiced in training flights by simulating the proper procedure?
   (a). Describe the most recent occasion:

   (b). Comment on the value of the training procedures involved:

   (c). How could the training procedures have been improved?

APPENDIX C

SAMPLE HAZARDOUS SITUATIONS

SAMPLE HAZARDOUS SITUATIONS

Pilot Responses to Questionnaire Section III 1,
"List the last time you faced a hazardous situation in scheduled flight."

Classification (Per item numbers on Questionnaire Section II)	Incident
1 a	Engine out on take-off in Convair, max gross load, no wind, returned and landed - no damage to aircraft or personnel.
1 b	Lost 2 out of 3 engines on go around. It wouldn't fly on one engine.
1 c	Oil pressure failed on right engine of DC-3 over _____while enroute from _____to_____. I was on instruments and picking up light ice. I proceeded to _____on one engine and made a safe landing.
1 d	Approach to airport under bad weather conditions (GCA) with #2 Eng. dead (unable to feather) and #1 Eng. low on power; also had much ice on wings and fuselage. Would have been very difficult to make go-around.
2	Double dead stick on Lockheed Electra. No emergency field available so landed in field of wheat stubble - no damage - fortunately it was daylight.
3	Prop governor failed - No. 4 Prop ran away. Made quick descent to large airport within five miles after being unable to feather.
4	Take off with elevator shift "level unlocked, longer t/o run resulted." Unnatural control "feel."
5	One cabin heater would not shut-off with main switch, emergency switch, or circuit breakers. Evidently igniting itself. Feathered #2 engine - cutting off fuel supply to heater.
6	DC-4 - gear handle stuck in the up position. 2 hrs. were required to remove cargo from upper and forward lower cargo holds in order to get into hell hold. The hand grip cable was removed and the mechanism operated by hand.
7	(1) hit by lightning over ____, later 7 _____planes hit over____ same day and I don't know how many others. Suggest lightning warning be included on CAA wx bdx and also thru co. channels. I was first that day for ___ and if warning had been sent out, some of the others could have and should have been rerouted or a/c slowed up when in the vicinity of this severe cold front. (2) <u>One brake locked on t/o. This was faulty wheel and had been reported in this condition for several prev. days. This wheel and assembly should have been changed to prevent bad accident</u>.
8	Right outboard tire blew out on take off.

9 3 cracked cylinders on #3 engine of DC-6 oil leaking on to hot exhaust manifold caused a fire to start. Feathered #3, opened cowl flaps and fire stopped. 15 minutes later landed at the next scheduled stop.

10 Plane was struck by lightning while traversing a cold front. Laison radio equipment began smoking - preparatory to burning. Upon discovery of smoke issuing forth the F/O directed F/E to cut off all radios. The captain was rather busy with the basic occupation, needle and ball. The F/O then directed the F/E to open circuitbreaker for disabled set and all other radios were restored.

11 Power failure of all radio aids and tower radio in vicinity of _____- the hazard was made by the amount of planes in _____area. Failure of adequate equipment or procedure of tower personnel caused planes to have to hold for approximately 15 to 20 minutes.

12 We had both Carburetors freeze up when we were carrying only 20° C. Carb. heat. The heads drop down to approximately 90° C and the engines started up so that the generators overheated and also we were picking up moderate ice on the wings. We were losing airspeed and altitude and made emergency descent into _____.

13 Hydraulic leak in lower side of gear retract shut causing hydraulic fluid loss and gear to drop so hard with no restriction that it tore the gear down latch away on the left main and it stayed up only due to weight distribution in relation to the wheel-no gear warning lights and it was necessary to land with no flaps, brakes or nose wheel steering.

14 Myself and Flight ___ estimated _____ one minute apart. Controller, our Co. man, did not relay this information to either pilot. He then cleared me to land down thru ____'s alt. 1000 ft. below. When I checked over ___ he told me to stay out of area. We both landed within 30 seconds of each other. (I broken contact by luck) I did not know the position of ____ but overheard a radio conversation at the last minute indicating he was over ____. (This man is not connected with the Co. now.)

15 Failure of horizon while in holding pattern following a 5 hr. flight during which the instrument had performed O.K. I felt if such conditions could be simulated in training - I would have recognized what was malfunctioning much sooner.

16 All indications of a Fuselage fire -- bells ringing - horns blowing and all fire warning lights come on.
CO^2 flooded passenger cabin instead of baggage bin - later established cause to be faulty smoke detectors.

17 Airplane picked up a hell of a load of ice and rubber de-izer boots were of very little value in this severe icing condition. Also windshield was covered with ice with no satisfactory method available to remove it.

Engines were run wide open for one hour and 30 minutes to keep the airplane aloft until we could reach a warmer temperature to melt the ice.

18 I try never to let a situation become hazardous. However, I entered a line squall which didn't look bad at all but shortly thereafter the aircraft started a rapid descent. With the airspeed 105 and using METO Power the aircraft stopped its descent at 800 ft. above the terrain. Later I learned there had been a tornado in the vicinity where I encountered the downdraft.

19 Landing N at then under 400-1 S with wind NNW 45 and runway covered 2" slush. Wind slid the airplane sideways across the runway.
As soon as I realized that the left cross wind coupled with slight power used from left engine was pushing me sideways to the right, I retarded the left throttle, allowing the airplane to weathervane to the left, and slid cockeyed, the track then being down the runway.

20 Power failure on port engine in attempted take off.
Abandoned takeoff before becoming airborne.

21 Alternator failure - subsequent fire in engine accessory section resulting in loss of all 4 turbo super chargers and all AC instrumentation at 23000 feet - resulting in loss of cabin pressure - loss of power on all four engines - feathering of No. 1 _____Emergency descent.

22 3 Engine instrument approach with Boost off in L-49.

23 Low, L.F. Range approach in snow squall -- approach made on E. Leg or range with a north landing planned because of wind. Capt. missed runway on line up and started to attempt landing on taxi strip due to mistaken identity. Emergency pull up and go around required and executed with no further incident.

Other 20 man life raft inflated (by 2-20 pound CO^2 bottles) in forward bin (flight compartment) of pressurized DC-6. This was before smoke masks installed. The terrific strain on Bin structure and gate led me to believe raft would explode. Position was over _____halfway between _____ and _____.
Depressurized aircraft - descending to 7500 feet and proceeded to _____. After some delay we succeeded in deflating raft (on ground) and released pressure on bin gate.