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# SURVEY OF ESCAPE TRAINING IN THE AIR FORCE

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# FOREWORD

This study was performed at the request of the Escape Section, Biophysics Branch, Aerospace Medical Laboratory under Project 7222, "Biophysics of Flight," and Task 71748, "Escape." The request was made in recognition of the fact that psychological, as well as physiological factors, must be considered to provide successful escape from aircraft. The aim of this study was to identify deficiencies in the Air Force Ejection Training Program and to make recommendations for its improvement. The study began in October 1959 and was completed in December 1959.

The study was performed under the direction of Lt. Mchael Beer. Mr. Vernon Carter and Mr. Robert Jayson played an integral part in the collection of data, its analysis and the writing of the present report. Their efforts contributed heavily to the successful completion of this investigation.

Mr. Fred Kresse had overall cognizance of this project and was most helpful in formulating the plans for the study. He was intimately concerned with the interpretation of the results and in the organization and presentation of the materials in this report.

## ABSTRACT

The present state of the Air Force ejection training was studied and its contribution to the overall ejection problem was considered. Relevant information was obtained from the literature on ejection training, training films, aircrew personnel, aircrew personnel who have ejected, accident statistics, and escape training instructors. The results showed that ejection training is inadequate in content and frequency. There is a lack of standardized regular training programs. Furthermore, training media, such as ejection seat trainers and films, leave much to be desired in both quantity and quality. Even more important, training to reduce fear of and anxiety about ejection is needed. In general, aircrew personnel "know" when to eject; but hesitate to take action because of an inadequate knowledge of procedures and an anxiety produced by unfamiliarity with the ejection experience. Ejection training in the Air Force is inadequate and needs to be improved.

## PUBLICATION REVIEW

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# ESCAPE TRAINING IN THE AIR FORCE

## INTRODUCTION

In spite of a large increase in the percent of successful ejections from jet aircraft over the past 10 years, a significant proportion of ejections still result in fatalities or major injuries. To this must be added the unknown number of personnel who died because of a failure to eject when ejection would have been possible. There are many possible causes of unsuccessful ejection; some within and some beyond the control of the individual. Through proper system design and training the controllable causes of ejection accidents can be reduced to a minimum.

The purpose of the present study was to determine the strengths and weaknesses of Air Force escape training and make concrete recommendations to overcome any weaknesses. First it was necessary to determine what escape training was provided; then evaluate the results of that training, and finally isolate the specific causes of any deficiencies. Guiding the study were the following two questions:

1. Do aircrew personnel know how to eject?
2. Do aircrew personnel know when to eject?

To answer these questions it was necessary to determine the sort of escape training provided by the Air Force. Is this training adequate? If not, why is it deficient? In what ways can it be improved? In short, the purpose was to study Air Force escape training to the point at which concrete recommendations could be made for its improvement.

In approaching the problem the investigators probed a variety of information sources. This procedure not only tended to insure comprehensive coverage of the problem, but placed emphasis on certain critical areas as reference was made to them over and over again. It also served to fulfill a secondary purpose of the study: to evaluate the potential of the various information sources in order to make recommendations for future, more comprehensive investigations. The following sources were investigated:

1. A survey was made of all available literature dealing specifically with Air Force escape training. Such literature would indicate work which had already been done in this area, and might suggest possible methods and sources for future investigations.

2. A list was obtained from the Directorate of Flight Safety at Norton Air Force Base, California, of aircrew personnel who had ejected successfully during the first 6 months of 1959. A questionnaire (attached as Appendix A) was sent to each of these men.

3. Standardized direct interviews, based on the questionnaire, were prepared and administered to personnel of a Fighter Interceptor Squadron (F-104's), Air Defense Command and an Air Division (B-47's), Strategic Air Command.

4. Available Air Force Training Films having to do with training in ejection or ejection procedures were reviewed and analyzed in terms of their training value.

5. Escape training instructors at the Technical Training School and the Physiological Training Unit at Wright-Patterson AFB were interviewed. They were considered to be in an ideal position to describe current escape procedures and training practices.

6. A thorough study was made of Directorate of Flight Safety accident reports and statistics for the past 5 years. Attempts were made to isolate accident characteristics which might have training ramifications. The data were analyzed to uncover apparent trends and interrelationships meriting more intensive correlation.

When all of the data had been amassed extensive comparisons were made among sources and instances in which the same or related problems appeared again and again were carefully noted. In this way, the investigators were able to begin to formulate hypotheses concerning the training factors most influential in determining the quality of escape performance.

## SURVEY OF LITERATURE

### Method and Results

An initial phase of this program involved a survey of the literature on escape training in the Air Force. ASTIA catalogues were used in an attempt to locate studies which assess Air Force ejection training and discuss its contribution to successful ejections. Only two directly applicable studies were found. Two other reports, published by the Directorate of Flight Safety, Norton AFB, California, contain statistics which have implications for Air Force ejection training. These studies are reviewed below.

A study was conducted in 1957 by DeGaugh and Keller (ref. 1) for the purpose of determining the status of ejection seat training in the Strategic Air Command in order to make recommendations regarding future training programs and equipments. The study consisted of a survey of background information, a survey of four SAC bases to establish the level of proficiency in ejection procedures, and a survey of training in the ejection seat area.

In order to obtain a direct indication of proficiency, DeGaugh and Keller gave performance tests on ejection seat procedures to 164 randomly selected aircrew members at four Air Force bases. The tests covered preejection, ejection, and postejection procedures. Only 4 percent of these subjects were able to complete their ejection procedures without error and almost all were slow in responding to ejection

signals. Only about 55 percent performed a satisfactory preflight and demonstrated a satisfactory knowledge of the operation of the system. These same aircrew members expressed the feeling that their previous ejection seat training had been insufficient. First, they said that they were not sufficiently familiar with the over-all operation of the ejection system and its component parts; they had not received adequate individual instruction by qualified personnel using actual equipment. Second, they had not had the opportunity to practice ejection seat procedures.

DeGaugh and Keller administered a questionnaire to these personnel designed to obtain information about their previous experience in jet aircraft, the location, quantity, and quality of their ejection seat training; and their opinions about what should be included in an ejection seat training program. They found that there was no formal training on the ejection seat system at any of the bases they visited. The training that did exist was not extensive enough and did not devote sufficient time to the individual. Furthermore, they report that most students had had no actual practice in manipulating the controls on an ejection seat.

The investigators made the following recommendations for improving the ejection seat training program in SAC:

1. Each crew member should be required to perform a preflight check of actual equipment under the supervision of an ejection seat specialist.

2. He should "eject" repeatedly on a trainer until all procedures required for preparation, ejection, and postejection are performed satisfactorily.

3. Trainers should be provided with both downward and upward ejection seats. Such trainers were not available at the base mobile training units.

4. Individual crew members should be permitted to practice ejection on the trainer at least once every 90 days, and preferably once a month.

5. Examinations on preflight procedures and knowledge of the ejection system should be included in each standardization board check.

Although this study did not deal with maintenance problems or training of maintenance personnel, the Air Force Personnel and Training Research Center investigators discovered that, on one SAC base, an "inspection of ejection systems revealed that a majority of the systems would not have functioned even if they had been properly operated."

In 1956 Dr. Anchard Zeller of the Directorate of Flight Safety (ref. 7) analyzed the psychological factors in escape. Dr. Zeller's analysis was based on examination of reports submitted by successful ejectees or, in the case of death, on the accident reports submitted to the Directorate of Flight Safety Research by the accident investigation board.

The author approached the problem of ejection by analyzing the component behaviors associated with it. Each step in the ejection process, he says, "is a serial sequence; which, from the standpoint of the human, begins with perception of the situation, then involves a decision as to the action to be taken, and finally is followed by the initiation of the action." Using such a behavioral approach, Zeller was able to analyze the various steps in the ejection procedure in terms of the important psychological variables which affect the individuals behavior during the procedure. Such an approach yielded information that has direct implications for ejection training, as well as some specific recommendation for such training.

Dr. Zeller discusses the decision making process. With respect to speed of making decisions, he states that an unaccountably large difference has often been found between the altitude at which the emergency occurred and the altitude at which ejection finally took place. He concludes that the decision to eject is often a difficult one to make. There are, he says, varied reasons for a failure to make decisions in an emergency situation. Examples are:

1. Faulty interpretation of emergency.

2. Pilot over-confidence regarding the chances of a successful airstart and/or successful crash landing.

3. Over-concentration on details of the activity in progress at the time.

4. Confusion in suddenly changed situation.

5. Mistrust of equipment as a result of misinformation or knowledge of isolated cases of equipment failure.

6. Difficulties in communication among crew members in bomber aircraft.

A number of other general considerations are discussed, in the study. A lack of confidence in the particular aircraft being flown may result in premature ejection even before the nature or validity of the emergency has been explored. On the other hand, Zeller says, a lack of confidence in the ejection equipment may result in a weighing of possible injuries resulting from ejection, against those likely to be sustained in a crash landing. The effects of previous ejection training and experience are worthy of attention. Apparently a previous ejection experience, in Zeller's opinion, was extremely helpful in a number of cases. Furthermore, ejection towers were evidently considered of great value by pilots who had ejected successfully.

Zeller discusses the psychological effects of failing to initiate the ejection sequence successfully. Such a failure may produce increased anxiety and tension in the pilot, which in turn jeopardizes the chances for successful completion of the remaining steps of the total ejection procedure. One mistake can lead to a spiraling effect of panic which could result in the failure of ejection.

With regard to the design of equipment, three requirements are felt to be of prime importance.

1. Maximum reliability from the standpoint of mechanical efficiency.

2. Ease of positive operation.

   a. Reduce the number of required manipulations.

   b. Insure that the manipualtions are such as to be easily performed under adverse flying conditions.

   c. Standardize the sequence of operations from one system to another.

3. Ease of maintenance by currently available Air Force maintenance personnel. Provide, if possible, for some form of "packaging" or "module" design to facilitate replacement of components.

Zeller makes several training recommendations. Training should stress the ability to recognize emergencies and the necessity for positive decisions at sufficient altitude for successful escape. There should be precise indoctrination in the steps to be followed, once the decision to eject has been reached. Adequate dissemination of factual information regarding equipment to be used is needed as a weapon against rumor and unwarranted prejudice. Finally, until equipment design has been sufficiently standardized in various aircraft, there is an urgent need to provide formal ejection procedure training when a pilot transfers from one aircraft to another.

Two reports summarizing USAF ejection experience in the last 9 years have been published by the Directorate of Flight Safety, Norton AFB. The reports, (refs. 4, 5) cover the period from 1949-1954 and 1949-1958, respectively. Both reports are characterized by voluminous statistics describing USAF ejection experience.

During the period covered by both reports, 1,462 ejections have been made from USAF aircraft. Eighty percent of these were successful. They were accomplished at altitudes varying from less than 500 up to 40,000 feet and at indicated airspeeds up to 610 knots.

Altitude at the time of ejection is singled out, in both reports as the most crucial factor determining the outcome of an ejection. Approximately 70 percent of the ejections attempted below 1000 feet resulted in fatalities, while only 6 percent of those above 1000 feet were fatal. The earlier report concludes that some personnel particularly those in high speed dives and uncontrollable maneuvers, are delaying ejections until they reach too low an altitude.

Only one of the reports includes data which relates training variables to ejection outcome. These data are summarized and discussed in the section dealing with accident reports and statistics. These data were derived from only a small percentage of the total population due to incomplete training records for a large number of individuals. Both reports conclude that the current ejection escape systems, when properly maintained and operated, provide a means for successful escape from aircraft in a variety of situations, and at a variety of altitudes and airspeeds. Both reports recommend that aircrew personnel be provided with initial and refresher training on the procedures required to eject successfully from the specific aircraft being used.

## Discussion

The general lack of concern with Air Force escape training problems is reflected in the sparse literature available in this area. Only the DeGaugh and Keller study, and the Zeller study concern themselves directly with the status and problems of ejection training in the Air Force. The reports by the Directorate of Flight Safety concentrate on the more general problem of aircrew escape.

The DeGaugh and Keller study is particularly important because of its empirical approach to the question, "Do aircrew personnel know how to eject?" DeGaugh and Keller found the performance of SAC crew members to be inadequate, (only 4 percent complete the performance test correctly), and at the same time found their training inadequate (particularly practice of procedures). This finding emphasizes the significance of the relationship between ejection training and performance. This relationship will be discussed later in connection with the results of the present study.

In view of Zeller's contention about the spiraling effect of panic, one wonders how many of the 96 percent of SAC crew members who could not complete the ejection sequence correctly on the ground, would have completed it correctly under emergency conditions. Naturally, the criticality of the ejection step missed would determine the

effect of forgetting it. However, using Zeller's analysis, one would expect that even if a small step is missed, it could potentially disrupt the smooth flow of the ejection sequence. The ensuing anxiety and panic could result in an unsuccessful attempt to eject. Zeller's analysis seems reasonable and needs more scrutiny in view of the DeGaugh and Keller findings and the findings of the present study.

All the studies reviewed above are in agreement about the need for improved ejection training. More specifically, they point out the need for practice of procedures. DeGaugh and Keller found that in the opinion of the aircrew members they interviewed this was one of the greatest deficiencies in the training they had received. Zeller discusses the lack of standardization in ejection systems and stresses the necessity for formal ejection procedure transition training from one aircraft to another. We think this is probably the most critical ejection training problem, because pilots may fly more than one type of aircraft, each with a different ejection system. Also there is danger that previously learned ejection habits will interfere with the new one, particularly during an emergency when fear and anxiety tend to breakdown recent habits, and old training habits tend to recur.

The DeGaugh and Keller study has not had a discernible effect on SAC ejection training procedures. The present study reveals a picture almost identical to that presented 3 years ago. At this late date, the development of an ejection seat trainer has not yet been completed for the B-52 aircraft and an ejection seat trainer for the B-47 does not exist. Although the Zeller study, too, was written several years ago, it is striking in its continued relevance and applicability to present escape problems.

The reports of the Directorate of Flight Safety Research contain much data on the general ejection problem. Disappointingly little is to be found on training. Without such data, one of the possible causes of ejection accidents is being overlooked.

## TRAINING FILMS

### Method and Results

The Air Force Film Directory (AFM 95-2) dated 10 April 1959, was used to ascertain the kind and number of escape training films presently in the Air Force inventory. Only nine films were found, dealing specifically with escape training:

| | |
|---|---|
| 1. TF 1-5036a | Use of Automatic Personnel Parachute --Principles of Operation |
| 2. TF 1-5036b | Use of Automatic Personnel Parachute --Wearing and Use |
| 3. TF 1-5078 | Eject and Live |
| 4. Withdrawn from Directory | Pilot Ejection |
| 5. FTA 104 | The F-100A Ejection Procedures |
| 6. FTA 132 | The F-84T Canopy and Seat Ejection System |
| 7. FTA 15 | Ejection from the F-86F |

| | |
|---|---|
| 8. FTA 167 | F-86H Ejection Seat |
| 9. TF 1-5282 | Pilot Emergency Escape Survival System of the F/TF-102A. |

The only other films on ejection are in the nature of test data or engineering reports. These films show tests conducted on various ejection seat systems. Since they were not made specifically for training purposes, they have not been listed above.

Each of the films listed above was viewed in order to determine its training value. The films were evaluated in terms of general format, range of material covered, relevance to present-day operational aircraft and ejection systems, ability to evoke and maintain interest, clarity of presentation, accuracy of presentation, and use of review and summary.

Escape training films may serve a number of purposes. Rarely do they effectively serve more than one purpose at a time. They may take the form of pure instructional devices, carefully planned to impart knowledge of certain specific skills or procedures. They may be designed for purposes of indoctrination, to impress on the viewer the excellence or reliability of the device being discussed, to warn him of some potential danger inherent in its use, to inspire him to behave in a certain way with respect to the device, etc. They may merely summarize what has been taught in detail elsewhere. More specifically, they may deal with human operation of the equipment or they may be restricted to detailed analysis of mechanical and/or electronic functioning of that equipment. Again, rarely does one given film effectively serve more than one purpose at a time.

Many of the films reviewed attempt to cover too wide a range of material in too short a time. They are designed as training aids in ejection procedures, but go deeply into actual mechanisms and functioning of the ejection equipment. In one film, for example, the description of each behavioral step in the ejection sequence is followed by a detailed description of the mechanical operation accompanying that step.

The general format characterizing most of the films could be summarized as "describe, show, describe, show"; that is to say, a static verbal explanation is followed by an extended demonstration in dead silence. The pace in this type of film, as opposed to those which involve simultaneous description and presentation, tends to be oppressive.

Generally, the films lack interest. They do not show actual ejection sequences or even flying aircraft, which might hold the attention of the trainee. In one case, a deactivated seat is set out in the middle of an airstrip, where a dull lecture is given. In spite of the outdoor photography, the only sign of life throughout the film is an oil truck in the distance which, from time to time, drives distractingly in and out of the picture. The film, "Eject and Live," is exceptional. A variety of techniques are used to hold the attention of the viewer. There are actual aircraft flight and ejection sequences. Animation, and even comedy, is freely employed for explanatory purposes, and the film is in color. Further, the film takes many opportunities for reiteration, where emphasis or summation seems desirable.

With regard to this last point, the films, for the most part, lack cohesion. An old, but still valid, instructional cliche advises, "Tell them what you're going to tell them, then tell them, and then tell them what you've told them." This is particularly important in films designed to impart knowledge. Instead, the films appear to have neither a beginning nor an end. The viewer receives neither preparation nor closure.

On the whole, the films are accurate in the description of ejection procedures. However, certain discrepancies seem worthy of mention. In the film, "Eject and Live," among others, no mention is made of pulling the visor down and fastening the chin strap prior to ejection. In fact, a student is shown "ejecting" with his visor up. There is little or no mention of preejection positioning and postejection procedures, such as seat separation, chute control, landing techniques, etc. The films do not discriminate between the steps likely to be involved in a rapid, low-altitude ejection and those in a less critical, high altitude ejection.

There are many kinds of aircraft escape systems in use in the Air Force today. In some cases there may be two or three different systems in one aircraft, depending on the position of the aircrew member. The nine films listed here do not begin to cover this range of escape systems and, even of these films, only two deal with contemporary aircraft. There are no films at all which deal with bomber escape systems.

Discussions and Recommendations

The kind, number, and quality of training films in the Air Force inventory suggest that this type of training aid is not being used sufficiently in training aircrew personnel to eject. Nine films are hardly sufficient, considering the many kinds of aircraft escape systems in use. A greater number of up-dated escape training films, specific to a particular ejection system, are needed.

Escape training films should be designed to serve a particular purpose and to cover a carefully circumscribed area of training. Descriptions of the functioning of escape system mechanisms are an important part of ejection training to the extent that they facilitate accurate, thorough preflights and increase confidence in the ejection equipment. But it does not seem wise to take two segments of behavior which, in practice, are to be performed in rapid succession and intersperse a 5 or 10 minute explanation regarding the firing of initiators. If ejection procedures are to be learned properly, they should be presented one after another and in the order in which they are to be performed. They should be repeated over and over with particular emphasis on the most important procedures; e.g., those that are used in rapid low-altitude ejection. Material concerning actual functioning of the equipment should be reserved for another film. Emphasis should be principally on the behavior required to "blow" the seat and separate from it. However, no procedure should be omitted.

It was noted above that escape training films may serve purposes other than instruction in procedures. A great many responses to interviews and questionnaires indicate that aircrew personnel would welcome a greater familiarity with the subjective experiences which accompany ejection. What does the actual ejection feel like? How does tumbling feel, and how can it be controlled? Can a successful ejection be made under certain difficult conditions? Information such as this can be effectively transmitted through films, through clever photography of the ejection seat in action (ejected from the trainee's own type of aircraft and position), and through filmed interviews with people who have ejected safely. Such films can provide valuable adjuncts to those dealing strictly with ejection procedures and may serve to prevent a fatal hesitation.

Other types of valuable information could be presented in motion picture form. For a particular aircraft, the film could depict emergency conditions which do or do not justify ejection. In this way, certain generalizations could be given to aircrew personnel as "rules of thumb" to reduce or eliminate conflict in making a decision to eject. Filmed demonstrations, using dummies, could show the possible consequences of faulty positioning prior to ejection, of premature or delayed seat separation, of premature or delayed opening of the chute. A well-designed film can be expected to make a lasting impression on the trainee.

Good training films have many advantages. They are relatively inexpensive to prepare and can reach a wide audience. They carefully circumscribe a particular segment to be taught, presenting neither more nor less information than is wanted at that particular time. They can be shown many times, if necessary, to be sure that their content has been absorbed. They are excellent for the type of training which involves indoctrination, building of confidence, and intensive familiarization. However, because they provide no opportunity for practice, they are less appropriate than other training media for training a sequence of behaviors. It is difficult to incorporate any measures of proficiency in a film or to estimate the degree of attention paid by the trainee. In short, they cannot substitute for an effective training device where procedures are to be learned to a high degree of skill. But, increasing automation of equipment and consequent simplification of procedures is rapidly shifting training needs to the area of human evaluation and decision where films can play a powerful and effective role.

## QUESTIONNAIRE

### Method

A list of the 150 Air Force personnel who successfully ejected during the first 6 months of 1959 was obtained from the Directorate of Flight Safety at Norton AFB. The questionnaire shown in Appendix A was sent to all personnel on this list. Ninety-seven completed questionnaires were returned.

The questionnaire was specifically designed to take advantage of the first-hand experience of this highly select group. A variety of questions were included in an attempt to obtain as much information as possible which might have implications for escape training or future research in this area. All questions were of three general types; direct, indirect, and general information. Direct questions (1, 2, 4, 5, 6, 7, 8, 9, 18, 19) asked for opinions about training as well as for factual information about training received. Indirect questions (3, 10, 11) asked for information about the details of the experience which could be expected to have implications for training. General information questions (12, 13, 14, 15, 16, 17) asked for information about the ejectee or about circumstances surrounding his ejection such as the number of flying hours, speed at ejection, etc.

Because this was a preliminary study intended primarily to identify variables warranting further investigation, all questions except those requesting purely factual information were open ended. That is, they required the respondent to produce the answer rather than merely select one. Though this type of question produces an extreme variety of responses which makes categorization and summarization of results difficult and somewhat arbitrary, it produces information which might be lost by more specific questions designed according to preconceptions about the problem. The results may thus be interpreted as providing suggestions for further investigation or, with respect to those which are most clear-cut, as providing suggestions for certain limited training improvements. Without additional confirmation they should not be interpreted as forming the basis for extensive revisions in training practice.

In general, questions requiring purely numerical or categorical yes-no answers were simply averaged or tallied. Because of time restrictions, and the nature of the data, more elaborate statistical analyses were not done. Most of the time spent in analyzing data was devoted to an attempt to meaningfully categorize the responses to the open-ended questions 6, 7, 8, and 11. Questions 6, 7, and 8 were direct questions which attempted to exhaust any opinions the ejectee might have regarding improvements needed in training or the type of training found most valuable in bringing about his successful ejection. Question 11 was an indirect question which asked for a subjective description of the entire experience with emphasis upon how decisions were reached. (Many of the complete responses to question 11 are included in this report as Appendix C were they appear in their original form except for minor corrections in grammar and punctuation.)

## Results

Answers to the general information questions (12 through 17) have not been treated in the results since they did not provide information which was useful in interpreting the answers to other questions. The answers to question 1 (date of last formal training) are not included in the results since respondents varied markedly in their interpretation of what was meant by "formal training." It should be noted that in tabulating responses for the open-ended questions, an individual's response may have been placed in more than one category if he made several responses to that question. Therefore, some of the respondents included in the percent of total respondents for any given category may also be included in the percent of total respondents for another category in the same table.

Table 1 provides some basic information about the types of training and frequency of refresher training received by respondents. All respondents received at least one type of training. Lectures and the study of manuals and technical orders were the only types of training very widely received by this group (89 percent). While 67 percent of the respondents reported having seen at least one training film, it is not known whether these were actual training films or films of escape system tests. Slightly more than half of the respondents had received training in any one of the three types of procedural trainers shown in Table 1. It should be noted however that 92 percent of the respondents had received training in at least one of these procedural trainers—a fact not shown by Table 1. The tower ride—indicated by this and previous studies to be one of the most important types of escape training—was received by only 41 percent of all respondents.

The mean number of months since last training was computed for each of these types of training. (These figures do not appear in the table.) The mean time elapsed since last training was relatively small (2 mo) for the study of manuals and technical orders; it was 7 months for the aircraft simulator, nearly a year (11 months) for lectures, the deactivated seat, and training films, and nearly 2 years (23 months) for the ejection seat trainer. Considering the fact that only 41 percent of this group had received tower rides, it is especially disturbing to note that the mean time since the last ride was 41 months—nearly 3 1/2 years. These figures may be somewhat inflated due to the presence of some extreme cases who had not received training in a very long time. However, they would be even higher if it were not for the fact that many respondents received a flurry of training shortly after and probably because of their ejection.

TABLE I

TRAINING RECEIVED

| | Percent of 97 Respondents |
|---|---|
| Types of Training Received | |
| Tower Rides | 41 |
| Ejection Seat Trainer | 55 |
| Aircraft Simulator | 61 |
| Deactivated Seat | 51 |
| Training Films | 67 |
| Lectures | 89 |
| Study of Manuals and Technical Orders | 89 |

Table 2 shows the results for questions 2, 3, and the difficulties checklist from question 10. It can be seen that a substantially greater percentage of respondents reported having difficulty due to faulty or malfunctioning equipment than reported having difficulty due to insufficient or improper training. However, it should be noted that respondents who did not report difficulties due to training often revealed, through the subjective description of their ejection, that they did in fact have difficulties that could have been prevented by proper training.

Among the specific difficulties listed in Table II which might be directly attributed to improper training, failure to pull down the visor was reported by the greatest number of respondents (40 percent). Failure to lower the visor, especially when the chinstrap is not fastened, greatly increases the possibility of losing the helmet due to windblast upon ejection. It can be seen that 19 percent of the respondents did not fasten their chinstrap and that 24 percent did lose their helmets. Other difficulties reported by several respondents, which in many cases were probably due to improper training, were difficulties in the movement and operation of handgrips, in the operation of triggers, and in separating from the seat due to a prolonged grip on the handles. The fact that 18 percent of the respondents reported having insufficient time for proper positioning may also be significant since positioning should be trained until it is done rapidly and automatically, without thinking, and as an integral part of the ejection procedure.

TABLE II

DIFFICULTIES EXPERIENCED IN EJECTION

| | Percent of 97 Respondents |
|---|---|
| Difficulty Due to Training | 5 |
| Difficulty Due to Equipment | 24 |
| Specific Difficulties | |
| A. Smoke in Cockpit | 10 |
| B. Interphone or alarm system malfunction | 6 |
| C. Fastening chin strap on helmet | 19 |
| D. Pulling down visor | 40 |
| E. Disconnecting clamp on oxygen hose | 33 |
| F. Disconnecting oxygen hose | 37 |
| G. Actuation of oxygen bailout bottle | 29 |
| H. Canopy failed or was difficult to release | 5 |
| I. Insufficient time for proper positioning | 18 |
| J. Movement and operation of handgrips | 8 |
| K. Operation of triggers | 11 |
| L. Centrifugal force hindering movement to fire seat | 7 |
| M. Ejection through canopy | 2 |
| N. Premature ejection | 2 |
| O. Helmet lost during ejection | 24 |
| P. Hypoxia | 2 |
| Q. Windblast and air turbulence | 12 |
| R. Automatic lap belt failed | 5 |
| S. Severe tumbling, hindering seat release | 10 |
| T. Delayed seat separation due to prolonged grip on handles | 6 |
| U. Clothing or equipment interference | 2 |
| V. Seat entangled in shroud lines | 8 |

Table III shows the results for question 11, the open-ended question requesting a subjective description of the entire ejection experience. The answers to this question were carefully read and analyzed for details having implications for escape training. The results were broken down into difficulties encountered in executing the escape procedures and difficulties encountered in deciding to leave the aircraft. Since question 11 was highly open-ended (i.e., nonspecific), the percent of respondents shown for each category in Table III represents a smaller number of respondents than might have been expected if the information obtained in the categories had been specifically requested.

TABLE III

DIFFICULTIES MENTIONED IN THE DESCRIPTION OF THE EXPERIENCE

| | Percent of 97 Respondents |
|---|---|
| Execution of Procedures | |
| A. Failed to try to "beat" automatic equipment | 7 |
| B. Difficulty due to an unanticipated sensation or perception | 7 |
| C. Difficulty which required an alternate procedure | 7 |
| D. Difficulty apparently due to insufficient practice | 5 |
| E. Confused procedures with those of another aircraft | 4 |
| F. Difficulty due to a failure to observe a safety habit | 3 |
| Deciding to Eject | |
| A. Spent time avoiding or deciding to avoid populated areas | 7 |
| B. Called tower to report the intended ejection | 6 |
| C. Became detached from reality | 5 |
| D. Worried about saving the aircraft | 4 |
| E. Hesitated after there was no apparent hope of saving the aircraft | 4 |

Under difficulties due to "execution of procedures," category A, "failed to try to beat the automatic equipment," refers to the error of not attempting to activate the automatic system manually before it works automatically. Some respondents reported falling for a long time before realizing that the automatic equipment was not going to work and only then activating it manually. "Difficulty due to an unanticipated sensation or perception" refers to cases like the following:

> "In a stalled condition, with no control of the aircraft, and heading for the ground in an inverted position, I experienced no difficulty in making up my mind to bail out. ...in my hurry to get out I made one mad grab at the ejection handles. I only succeeded in pulling up the canopy handle, of course, but the canopy squibs made so much more noise than I had expected, I thought I had blown myself free of the aircraft. In looking down I reaffirmed that I hadn't and squeezed the trigger. This delayed my ejection about 2 sec..." (Respondent ejected at 3000 feet.)

Category B, "difficulty which required an alternate procedure," refers to those difficulties for which there exists a standard alternate (corrective) procedure. This category also subsumes difficulties for which there is no corrective procedure and for which the ejectee had to discover his own corrective procedure. An example of the latter is given by two respondents who discovered during their ejection that by bringing their arms directly into their body first, and then across to the D-ring, they could overcome flailing of the arms, caused by tumbling, and open their chutes.

An example of the type of response which was placed in the category, "confusing procedures with those of another aircraft," is given by the following responses:

> "...pulled the handles up. I squeezed the little rim inside the top of the handle but nothing happened. I suddenly thought I'd pulled up the triggers with the handles as in the old T-33, but immediately realized when I saw the canopy gone that the triggers were still untouched. I looked down and found the trigger on the right side and pulled."

Category F, "difficulty due to a failure to observe a safety habit," refers to cases like that of a respondent who reported having to stop to check his seat pins because he sometimes left them in.

The category, "deciding to eject," refers to difficulties which influenced the decision to eject rather than difficulties in recognizing and evaluating the physical indications of an emergency. Most of the specific difficulties, like some of those already discussed, were not necessarily due to faulty training. They are recorded because they are difficulties, inherent in ejection, which must be taken into account in training. Thus, the respondent who spent time avoiding or deciding to avoid populated areas probably should have done so, but the number of respondents who had to do this serves as a reminder that this is one of the problems which the pilot must be trained to face. Similarly, calling the tower to report an intended bailout may be as essential as ejection, itself, when survival after landing depends on being found. However, cases where the tower is called for no such good reason indicate that aircrew members may need to be trained to omit such formalities at low altitudes when time is critical. The category, "became detached from reality," includes responses such as the following:

"...The first reaction I had was just plain shocked disbelief—it wasn't happening to me. I actually think that at this point I could have just sat there and looked at myself crash, for it seemed to me that I had to make a definite effort to get myself to move and do something."

Some respondents reported a similar detachment from reality immediately following ejection. One respondent reported that it was like a "bad dream" and another that he knew he had to do something with his arms but could not think of anything in particular.

The following response is an example of the type which was placed in the category of "Worried about saving the aircraft."

"About this time I really began to feel a cold fear, especially as my mind conjured pictures of myself and the aircraft going in and exploding on impact. Up to this point I had been chiefly concerned about the fact that I might have to see the Wing Commander and Deputy Commander if the aircraft were damaged beyond minor category."

It should also be mentioned that several respondents reported that deciding to eject was by far the most difficult part of ejecting when the seriousness of the emergency was not clearcut. Note the following response:

"This was the greatest thing that could happen to me...the uncertainty was the worst...I definitely had a fire and definitely could not control the A/C. The decision had been made for me."

Some respondents mentioned specific methods by which they reached the decision to eject (not shown in Table III). Some of these involved attitude rules such as the following:

"Never once did I hesitate. I believe that if I had hesitated I would have gone down with the plane or else ejected too low and never made it. I have a rule of thumb that I will never ride an aircraft below 3000 ft. If I have an emergency and there is any doubt that I can make it, I will eject. Maybe this is wrong thinking but that is what I use."

One respondent made the decision to eject after he recalled that an ex-instructor, who had crash-landed a similarly damaged aircraft, had said he would not and could not do it again. This method of reaching the decision to eject is interesting in that it illustrates one of the advantages to be gained from exposing aircrew personnel to the experience of ejectees—a recommendation made by several individuals in response to the questions on how training could be improved (question 6 and 7).

Another interesting result of question 11, not shown in Table III, was that several respondents mentioned executing the ejection procedures reflexively—i.e., automatically and without thinking. Training in ejection procedures to such automaticity was recommended by several respondents in answer to questions 6, 7, and 8.

Tables IV and V present the results of questions 8 and 6, respectively. These were direct, open-ended questions which asked the respondent to make evaluations about his training or recommendations for improving it. All responses were broken down in terms of their relevance to training content or training media. Those responses

evaluating or recommending training content (questions 8 and 6) were placed in four categories: (1) training in ejection procedures; (2) training to build confidence or to preview the experience; (3) training in making the decision to eject; and (4) training in parachute manipulation and landing techniques. Those responses pertaining to training media or methods were placed in categories specific to a medium or a method of training (e.g., tower ride).

For the proper interpretation of Tables IV and V it should be remembered that respondents were free to make more than one response to the questions on which these tables are based. Therefore, some of the respondents included in the percent of total respondents for any one category may also be included in the percent of total respondents for other categories in the same table (i.e., two responses suggesting that training be improved through more procedures training and training in an ejection seat trainer were placed in the categories "training in ejection procedures," "practice in trainers"). This was not done very often since approximately 70 percent of the respondents made only one response. Twenty-two percent of the respondents made two responses and 8 percent made 3 responses. (These percentages are approximately the same for both questions 5 and 8.)

The category of "training for increased confidence" which appears in these tables was used for all responses having implications for training to build confidence or preview the ejection experience. These were primarily responses indicating the value of: (1) physical simulation of the ejection experience, such as tower rides, short-travel seats previous ejections or bailouts, and parachute tower jumps; (2) exposure to the details of the ejection experience through lectures or discussions by ejectees or films "showing exactly what happens"; and (3) explicit confidence building, such as lectures or films emphasizing the reliability of the equipment or the importance of the professional attitude ("keep calm, follow recommended procedures and all will be well"). The category of "practice in trainers" was used for all responses indicating the value of practice in the deactivated seat, ejection seat trainer, aircraft simulator, or procedures trainer. This was done since respondents did not always seem to be making accurate distinctions between these types of trainers. "Standardized regular training program" refers to responses which indicated the value of more frequent or more compulsory training. "Short-travel seats in trainers" was used for responses indicating the value of seats in trainers (usually found only in ejection seat trainers) which rapidly move the trainee a short distance upon the completion of the ejection sequence. "Tower jumps" refer to a type of parachute training which simulates the fall and landing shock.

Table IV shows the results for question 8 which asked respondents to name those aspects of training which were most valuable in enabling them to eject successfully. These results must be interpreted cautiously and with reservations, due to the fact that not all respondents received similar training. For example, the relatively large number of respondents who indicated that the study of technical orders was one of the most valuable types of training they had received, may only reflect the fact that this training is much more widely received than others. Likewise, to interpret the fact that 8 percent indicated tower rides as their most valuable training while 14 percent indicated technical orders, one must remember that the number of ejectees who had used technical orders for training was more than twice the number who had experienced tower rides. However, the data in Table IV can not be completely discounted since 76 percent of all respondents received at least four of the types of training shown in Table 1 and 92 percent received at least three types. This means that, in nearly all cases, respondents had a real choice among several types of training when asked to name the most valuable training they had. It is especially interesting to note that pre and inflight (personal) review of procedures and "exposure to the experience of ejectees" were among the training cited as most valuable (generally these are not even considered as escape training media).

TABLE IV

MOST VALUABLE TRAINING RECEIVED

| Most Valuable Training | Percent of 97 Respondents |
|---|---|
| Training Content | |
| A. Training in ejection procedures | 57 |
| B. Training in decision-making | 10 |
| C. Training for increased confidence | 19 |
| D. Training in parachute manipulation and landing | 2 |
| Training Methods or Media | |
| A. Practice in trainers | 28 |
| B. Technical Orders | 14 |
| C. Pre or inflight review | 8 |
| D. Deciding to eject in the aircraft simulator | 4 |
| E. Tower rides | 8 |
| F. Short-travel seats in trainers | 8 |
| G. Previous ejection or bailout | 5 |
| H. Exposure to the experiences of ejectees | 2 |
| I. Standardized regular training program | 9 |
| J. Lectures or briefings | 8 |
| K. Films | 2 |
| No most valuable training or no response | 3 |

Table V presents the results of question 6. This question asked the respondent for ways in which his own training could have been improved. The results of question 7, which asked the respondent for ways in which ejection training in general could be improved, are not presented because of their similarity to the results for question 6.

TABLE V

RECOMMENDATIONS FOR IMPROVING TRAINING—QUESTION 6

| Training Recommended | Percent of 97 Respondents |
|---|---|
| Training Content | |
| A. Training in ejection procedures | 28 |
| B. Training in decision making | 6 |
| C. Training for increased confidence | 14 |
| D. Training in parachute manipulation and landing | 7 |
| Training Methods or Media | |
| A. Practice in trainers | 13 |
| B. Technical Orders | 2 |
| C. Tower rides | 7 |
| D. Short-travel seats in trainers | 2 |
| E. Exposure to the experience of ejectees | 4 |
| F. Tower Jumps | 2 |
| G. Standardized regular training program | 6 |
| H. Lectures or briefing | 2 |
| No Improvement Necessary | 46 |
| No Response | 7 |

Table V shows that the majority of recommended improvements were in ejection procedures training and in training for increased confidence. Under training methods and media, the three most frequent improvements recommended were more practice in trainers, more tower rides, and a standardized regular training program. A greater use of short-travel seats in trainers was recommended in response to question 6, though the percent of such responses is small. Too, there was a recommendation for exposure to the experience of ejection.

Some responses did not specify training content or method and as such are not listed in Table IV or V. These were responses calling for more emphasis on making procedures reflexive and responses calling for training which is more specific to the aircraft flown.

Several responses to questions 6, 7, and 8 were given by only 2 or 3 respondents and therefore were not formed into separate categories. They are listed here only because they suggest additional problems in ejection training. For ejection procedures training, these were responses indicating the value of: (1) emphasizing the minimum ejection procedures to be used when there is no time for less important steps; (2) emphasizing alternate (corrective) procedures when equipment malfunctions or under unusual conditions; (3) more prompt transition training after changing aircraft or after procedural and equipment innovations; and (4) emphasis on positioning. (Some respondents mentioned the value of the tower ride and short-travel seat for realistically teaching the importance of positioning, since the possibility of being injured is actually present.)

For training to increase confidence, respondents indicated the value of (1) training in the "psychological aspects" of ejection (not clearly defined); and (2) more refresher training which specifically simulates ejection (tower rides). For training in decision-making, responses indicated the value of: (1) training or self-conditioning to be decisive; (2) a fuller realization of the possibility of emergencies necessitating ejection; (3) more emphasis on the "psychological aspects" of decision-making (not defined); (4) more emphasis on minimum ejection altitudes; and (5) less emphasis on saving the aircraft.

The results for questions 9, 18, and 19 have not been presented in the tables. In response to question 9, 92 percent of all respondents answered that they had received sufficient training to feel confident about their ejection procedures. In retrospect, a more informative question might have been "Do you feel that you could perform your ejection procedures rapidly and perfectly under conditions of extreme stress?"

Question 18 asked respondents how the pilot operating instructions covering escape procedures (in the dash-1 technical order) could be improved. Only 15 percent of all respondents indicated that improvement was needed. Twelve percent of the respondents called for improved coverage of various aspects of the ejection procedures, while the remaining 3 percent recommended a greater emphasis on making the decision to eject or on previewing the experience (i.e., telling what to expect).

Question 19 asked respondents if the pilot's dash-1 technical order adequately covered all of the conditions affecting escape from the aircraft. Only 8 percent of all respondents felt that it did not.

## Discussion

The population sampled by the questionnaire is unique in that it is composed of aircrew members who have ejected successfully. As such this population is the poorest source of information for determining deficiencies in Air Force ejection training. Because the population sampled was composed of successful ejectees, their responses

probably represent a minimum number of suggestions for improving training. Therefore, any indications from this population that training is deficient are particularly significant. Furthermore, it should be noted that the respondents are not training experts and that therefore it may have been particularly difficult for them to analyze their training and critique it accordingly.

The two questions which this study originally proposed to investigate were: (1) Do aircrew personnel know how to eject? (2) Do aircrew personnel know when to eject? One of the most significant findings of this questionnaire study is that these are not the only questions nor even necessarily the most important questions that should be asked in evaluating escape training. This result appeared most forcibly in attempting to set up two broad categories of response which would bear directly on the original two questions. Though a large proportion of responses could be placed in the category of responses pertaining to training in ejection procedures and some responses could be placed in the category of responses pertaining to training in decision-making, it became apparent that many responses did not fit into either of these categories. To achieve inclusive categorization, two additional broad categories of response had to be recognized. These were: (1) responses pertaining to training to increase confidence or to "preview" the experience; and (2) responses having implications for training in parachute manipulation and landing.

Responses pertaining to training to increase confidence or give the trainee an idea of what happens in an ejection were much more frequent than any others except those pertaining to ejection procedures training. The frequency of such responses clearly indicates that this type of training is a very important part of escape training.

These and other results in the study also strongly suggest that making the decision to eject interacts with and cannot be divorced from the willingness to eject. The ability to decide when the physical seriousness of the situation warrants ejection, taking into account such factors as the type of emergency, the altitude—a difficult task in itself—does not seem to guarantee the ability to eject on time.

The importance of confidence and other attitudinal factors in deciding to eject were often indicated by particular responses. Note the following response to question 6, "In what ways do you feel that your training could have been improved?":

> "Place more emphasis on the need to make a decision and implement it. More information on what to expect after the trigger is pulled could allay many fears. Every pilot of my acquaintance thoroughly agrees with the policy of ejection rather than attempting a "dead-stick" landing unless conditions are absolutely perfect. Yet records indicate that many pilots wait until the last minute to eject and are killed. Possibly the reason they delay until below a safe ejection altitude is: (1) a reluctance to leave the solid, tangible aircraft for the unknown dangers of ejection; or (2) a desire to save the aircraft and thus avoid the ordeal of an accident investigation board since the most popular result of these boards seems to be Pilot Error; or (3) a conscientious effort to save a valuable aircraft.
>
> "Whatever the reason behind a decision (to eject or stay with the aircraft), I certainly think that a more comprehensive knowledge of the subject will materially aid pilots in what is certainly a moment of great mental stress. I believe that pilots should be thoroughly educated in all aspects of the problem including the psychological ones."

Other responses of this type indicate that attitudinal factors are complexly interwoven with the decision-making process to the extent that they may subtly affect a man's estimation of the seriousness of a particular situation. Responses such as the following illustrate this point:

> "We spend hours on drilling pilots on A/C recovery techniques and too little time on techniques and procedures to save his life—why no sustained practice on getting out of untenable situations.
>
> "My thoughts were entirely on saving A/C until I blacked out and heard metal grinding. Only then because I though I was hitting the ground did I think of ejecting. Things happen so fast and most of our training is on saving the A/C, so that the pilot's mind is on saving A/C until too late."

Still other responses indicated that attitudinal factors (fear?) may destroy ones ability to estimate the seriousness of emergency situations:

> "NOTE: Main feature of experience to me was fact that I had what amounted to a suicidal tendency to give up when situation got hopeless. Had feeling that experience was unreal. Once faced with reality of situation, there was no problem. An article which made an impression on me was entitled The Decision to Live by Maj. Gen. J.V. Crabb. Implanted proper relation between aircraft and pilot. Feel that it influenced my decision to eject."

From the above it appears that the original question "Do aircrew personnel know when to eject?" cannot sensibly be asked without asking the question "Are aircrew personnel willing to eject?" It is apparent that any reservations an individual may have about the safety or practicality of ejection can be a hindrance to quick and decisive action in an emergency situation. The results of this questionnaire seem to indicate that the willingness to eject depends on several attitudinal factors and may be at least as important as the ability to decide whether or not the particular situation warrants ejection. The results also suggest that training in these attitudinal factors is often missing or inadequate. The extremely spotty use of the tower ride, in spite of the high opinion aircrew personnel seem to have of its training value, is a prime example.

The number of responses shown in Tables IV and V which pertain to training in parachute manipulation and landing, though small by comparison, indicate that the question "Do aircrew personnel know how to eject?" must be supplemented by the question, "Do aircrew personnel know how to get safely to earth after their chute has opened?." The training implication here is that ejection procedures training should be expanded to include all those procedures necessary to get out of the aircraft and land safely on earth.

The relatively large number of responses calling for improvements in ejection procedures training shown by Tables IV and V and the number of procedural difficulties shown in Tables II and III indicate that ejection procedures training could be greatly improved. Thus, the answer to the original question "Do aircrew personnel know how to eject?" seems to be that they often do not. Difficulties reported and responses such as those calling for "more practice in trainers" and "more emphasis on making procedures reflexive" further indicate that knowing how to eject is very much a matter of degree, and that it is imperative to be able to perform these procedures automatically

and perfectly under a wide range of unfavorable conditions. An abstract or quickly acquired knowledge of procedures does little to insure that they will be performed rapidly and properly in emergency situations. The fact that several respondents mentioned executing procedures automatically or without thinking in the description of the experience also suggests a correlation between the reflexive execution of procedures and successful ejection.

Responses calling for prompt transition training after aircraft change or equipment innovations, for training which is more specific to the aircraft, and for more refresher training in procedures, all point to specific problems in training to automaticity. New procedures cannot possibly be performed rapidly and perfectly unless they are almost identical to the procedures which have been trained. When they are even slightly different, the knowledge of the old procedures interferes seriously with the performance of the new. Examples of such negative transfer were given by respondents who reported a difficulty in executing ejection procedures because they confused the procedures with those for another aircraft they had flown. For the above reasons it may be undesirable to employ procedural training and trainers which are not sufficiently specific to any particular aircraft. This was pointed out by responses like the following to question 8:

> "The deactivated seat is best because it is the system you would use and not an ejection seat trainer that doesn't simulate any particular aircraft."

It is doubtful that even the simplest procedures will be automatically performed unless they are refreshed from time to time, regardless of the initial training received. In this context some respondents maintained that pre or inflight self-refreshing of procedures was the most valuable aspect of training. The following responses to question 8 convey this:

> "I feel that the personal review of procedures on the ground and in flight cannot be duplicated in formal training.

> "On almost every flight I assume the ejection position and mentally go through the ejection steps—even refresher training once a month would not obviate the need for this."

There were also indications that greater emphasis should be placed on procedures to overcome or prepare in advance for secondary emergencies; i.e., unexpected occurrences during the ejection experience such as equipment malfunction. Pulling the D-ring without waiting for the automatic equipment to work ("beating the equipment") or procedures to remove the canopy when it doesn't jettison are probably the most frequent examples of this. However, it seems that other difficulties are also encountered often enough in ejection to warrant an attempt to determine the best ways to overcome them. That the afore-mentioned training may not be emphasized enough in present training is reflected in the fact that several respondents reported failing to try to beat the automatic opener (see Table III), thereby losing precious time before realizing that the automatic equipment was not going to work.

Though training to recognize and evaluate the physical indications of an emergency, and to decide to eject on the basis of them is not sufficient training to gurantee timely ejection, it is an extremely important area of training. In view of the apparently limited amount of this type of training ordinarily received, it is surprising that ejectees did not often indicate the need for improvements in this area, per se, especially since several respondents strongly maintained that deciding to eject is the main problem area of escape training. This may stem in part from the opinion evinced by some respondents that the decision to eject cannot be trained because of the complexity of the situation: "The one aspect that enabled me to eject successfully was something that you cannot prepare for in advance—the feeling that says 'bail-out'." Certainly a more hopeful approach is suggested by the following response:

> "The biggest problem is when. Recommend that minimum bailout altitude be established by aircraft type and by major categories of emergencies. For example, in weather without instruments I feel a pilot should eject at 10,000 feet."

Such hard and fast rules for deciding to eject would require careful research and like all hard and fast rules, would not adequately cover all possible situations. Though aircraft might thus occasionally be lost "by the rules," a payoff in human lives could be expected.

It may be that other problems in deciding to eject, such as the problem of avoiding populated areas, are also amenable to the establishment of arbitrary, though carefully determined, rules.

At present the aircraft simulator seems to be the only training medium which affords realistic training in making the decision to eject. "Training in deciding to eject in the aircraft simulator" was the most frequent response pertaining to decision making. Though aircraft simulators seem to be used regularly where they are available, some respondents indicated that the trainee is not placed in situations requiring ejection often enough or that too much time is spent in training aircraft recovery techniques and too little on training in deciding to eject.

The three aspects of ejection training-procedural training, confidence training, and decision making training—seem to interact in producing a successful ejection. It is, therefore, important that each of the area of escape training be stressed with equal vigor. Escape training that embodies only one or two of these aspects of training is incomplete. However, these various aspects need not be trained at the same time or on the same device although this may sometimes be desirable.

## INTERVIEWS WITH AIRCREW PERSONNEL

### Method and Results

A standardized questionnaire was prepared and used to interview 28 flying personnel of a Strategic Air Command base (B-47's) and 15 members of a fighter squadron in the Air Defense Command (F-104's). A copy of the questionnaire is attached as Appendix B. The interview was intended to determine the nature and extent of training received by aircrew personnel in escape procedures, their reactions to that training, and the degree of confidence they had in their ability to eject and to judge when to eject. The questionnaire also elicited suggestions or recommendations concerning ways in which training could be improved.

The questions, in most cases, asked for specific information. Where questions elicited only pat phrases or simple yes or no answers, the investigators made an effort to obtain more complete responses. Those interviewed were quite cooperative and good rapport was established in all cases. They were told that their responses would be anonymous and that the results would be used only for the purposes of the study. The interviewers wrote down the essential points covered in the responses. Personnel interviewed came from a wide variety of bases to their present stations, although, in some cases, the latter represented their first operational assignments. The SAC personnel interviewed were on alert and, therefore, comprised crews from many different squadrons. Although the size of the total sample (43) is small and only one group was interviewed in each command, the variety of previous training and experience suggest that the groups are reasonably representative of operational units in SAC and ADC.

It may be noted in Table VI that the mean flying time for all personnel interviewed is 1019 hours. This includes a mean of 1306 hours for the ADC pilots and 865 for SAC crew members. In contrast, the mean hours spent in lectures on ejection is only 10.6 (ADC, 16.2; SAC, 7.3). In addition, approximately 44 percent of the personnel interviewed have had at least one tower ride, but with an average of only 1.3 tower rides per man. This includes 60 percent of the ADC people and 17 percent of the SAC crew members. Approximately 53 percent have had experience in an ejection seat trainer or flight simulator (ADC, 47 percent; SAC, 57 percent), but, again with an average of 1.3 practice sequences per man. All but one of those who received ejection training in a flight simulator were fighter pilots (ADC), inasmuch as the B-47 flight simulator contains ordinary seats, not ejection seats. There are no "emergencies" in the B-47 flight simulator training program which are "serious enough" to warrant "abandoning the aircraft."

None of the personnel interviewed had seen training films as part of their ejection training. In fact, there are no ejection training films specific to either the B-47 or the F-104. There are films of ejection tests which the majority had seen, but they do not contain specific information on ejection procedures. They are more in the nature of engineering reports in motion picture form.

Most individuals expressed confidence in their ability to eject successfully. This was also true of those individuals, fighter and bomber pilots, who had a responsibility for deciding when to eject. However, there was also a strongly expressed need for more frequent and comprehensive ejection training. Interestingly, as will be shown below, in spite of the statements of confidence in ability and judgment with respect to ejection, a large proportion of the requests for types of training concerned those sorts of training which would tend to indoctrinate, familiarize, or build confidence, rather than increase formal knowledge of procedures. It should also be remembered that these were individuals without previous ejection experience, sitting in a room well removed from their aircraft, answering a practical question in a relatively isolated situation. Under the circumstances, the average aircrew member would have no reason to believe that he could not eject easily and successfully.

TABLE VI

PREVIOUS TRAINING OF ADC AND SAC PERSONNEL

| | | Statistics | | | Sample Size | | |
|---|---|---|---|---|---|---|---|
| | | ADC | SAC | Total | ADC | SAC | Total |
| 1. | Mean of total jet flying hours | 1306 | 865 | 1019 | 15 | 28 | 43 |
| 2. | Mean of total lecture hours | 16.2 | 7.3 | 10.6 | 10 | 17 | 27** |
| 3. | Percent of individuals with one tower ride or more | 60% | 17% | 44% | 15 | 28 | 43 |
| 4. | Percent of individuals who had at least 1 practice sequence in an ejection seat trainer or a simulator | 47% | 57% | 53% | 15 | 28 | 43 |
| 5. | Percent of individuals having seen ejection training films | 0% | 0% | 0% | 15 | 28 | 43 |
| 6. | Percent of individuals having seen films of ejection tests | 90% | 88% | 89% | 10 | 18 | 28* |
| 7. | Mean number of test films seen | 5.1 | 3.3 | 4.0 | 10 | 18 | 28* |
| 8. | Recency of training (Mean number of months since last training) | 1.5 | 8.5 | 8.5 | 6 | 24 | 30** |
| 9. | Percent of personnel who reported knowing of or having had refresher training | 87% | 28% | 50% | 15 | 25 | 40** |
| 10. | Frequency of refresher training | 2.0 | 12.8 | 5.8 | 13 | 7 | 20*** |

* This data was obtained incidentally, by only a few of the interviewers and therefore the sample is smaller than the total number interviewed.

** Some of the individuals were unable to respond because they did not remember.

*** Only those that reported knowing of or having had ejection refresher training are included in this sample.

The responses to certain questions are of particular interest, from a training standpoint. Aircrew personnel were asked for example, for ways in which they felt training could be improved. The responses have been categorized in Table VII in terms of general content, and specific methods, media, or devices by means of which training is carried out. These data combine the responses to questions 3 and 7 of the questionnaire in Appendix B, since the two questions resulted in considerably more duplication of response than had been anticipated. Where types of training are classed with respect to content, 32 percent requested increased emphasis on training in ejection procedures. Even more striking were requests for training involving conferences with people who had ejected successfully, who could describe subjective feelings and experiences during ejection—what it feels like to eject; tower rides for increased confidence and familiarity with the ejection process; filmed or actual demonstrations of live ejections under doubtful or unusually hazardous conditions, proving that ejection could be successful under those conditions. In short, the type of training which would build confidence, familiarize, instill favorable attitudes toward ejection, and develop expectations of successful escape. This sort of need was implied in 53 percent of the responses.

With respect to training methods or media, 17 percent of the responses requested practice in an ejection seat trainer and another 17 percent requested tower rides. These requests nicely parallel the requests for practice in ejection procedures and for confidence-building activity, respectively. Sixteen percent of the responses indicated a need for standardization and scheduling of training activity. Those in this category felt that training differed greatly in nature and extent from one Air Force unit to another; that this training, even when available, was not mandatory and was given sporadically.

Discussion

Interviews with aircrew personnel suggested that overall escape training in the Air Force is not adequate in terms of methods, content, or regularity. There is an extremely small amount of lecture time per individual, a relatively small percent of personnel have had tower rides or practice in ejection seat trainers, and, of these, a man has had, on the average, one or two rides or opportunities to practice in his entire Air Force career to date. Ejection training films for almost all contemporary aircraft do not exist.

Much of the most valuable information, as might be expected, was obtained between specific questions or near the close of the interview after all planned questions had been asked. Many of the problems raised concerned a widespread lack of standardization of equipment. The problem of standardization is particularly critical in the Strategic Air Command, since SAC crews are not permanently assigned to one aircraft, but, on a given mission, may be assigned to any bomber that is available. Both Weber and Republic seats are used, often in the same aircraft, and the individual crew member can never predict which he will have next. One crew member was confronted with a totally unfamiliar seat before a standardization board. Both the MA-2 and MA-6 lap belts are in general use. One crew member, accustomed to an MA-2 belt, was given an MA-6 and had to call a maintenance technician to find out how to use it. Another man found himself with a belt that would not accommodate a zero second lanyard.

TABLE VII

RECOMMENDATIONS FOR IMPROVING TRAINING

| Training Recommended | Responses Number | Responses Percent |
|---|---|---|
| **Training Content** | | |
| A. Training in ejection procedures | 17 | 32 |
| B. Training in decision making | 1 | 2 |
| C. Training for increased confidence | 28 | 53 |
| D. Training in mechanics of seat operation | 7 | 13 |
| **Training Methods or Media** | | |
| A. Lectures and demonstrations | 7 | 10 |
| B. Standardized, regular training program | 11 | 16 |
| C. Films | 6 | 9 |
| D. Mockup and disassembled seat | 9 | 13 |
| E. Tower ride | 12 | 17 |
| F. Jump tower or actual jump | 7 | 10 |
| G. Briefing and recitation | 1 | 2 |
| H. Ejection seat trainer | 12 | 17 |
| I. Personal descriptions of the ejection experience | 4 | 6 |
| **No Improvement in Training Necessary** | 4 Individuals | |

There is considerable difficulty involved in actual operation of the seat. The navigator's seat in the B-47 can be rotated, but the navigator can eject safely only with the seat in a centered, forward position. However, there is no safety which would prevent the seat from firing in other than a forward position. Further, once the armrests have been pulled up with the seat not properly positioned, it cannot be repositioned. This is tantamount to saying that the navigator can no longer eject at all without serious injury. Body positioning can also be a problem. Personnel with short arms complain that they cannot reach the D-ring on the downward ejection seat and still keep the head back in the head rest.

Despite avowals to the contrary, personnel do not appear to be confident of ejection as a means of escape. This is evidenced, in many cases, by the hesitation reported prior to ejection, by the constant requests for more information regarding the feeling experienced in ejection, and by the expressed need for tower rides as an approximation of ejection experiences. One man said that the seat ride he received from a Mobile Training Detachment was particularly valuable, because he had not realized how hard the legs had to be kicked into the stirrups in order to actuate the leg guards. There was constant complaint by crew members regarding the lack of training films specific to their aircraft and to the various seats found in them. Many also evidenced a lack of confidence in the equipment itself. It may be recalled that DeGaugh and Keller (ref. 1) found upon inspection, that many seats would not have functioned even if properly operated.

Although there is some doubt about the representativeness of these small samples, it is of interest to note the consistent difference between ADC and SAC in Table VI. Wherever a sizeable difference occurs, it points to a more comprehensive training program in ADC. Such differences, if they are real, may result from any of a number of reasons. Further and more extensive comparisons could and should be made.

These interview data serve to corroborate the conclusions based on the other sources although they must be continously interpreted because of the small sample.

## ACCIDENT STATISTICS

### Method and Results

A study was made of accident reports and statistics prepared by the Directorate of Flight Safety at Norton AFB, California. The reports contain analyses of all major aircraft accidents from January 1957, through the first half of 1959. In connection with ejection accidents the following types of statistics are reported:

1. Seat ejections with injury to personnel by aircraft type and model.

2. Causative agents of injuries sustained during seat ejections by aircraft type and model.

3. Indicated airspeed and altitude relative to injury.

4. Ejection seat training received relative to degree of injury or fatality.

5. Difficulties reported during ejection from aircraft.

6. Difficulties in separating from seat by degree of injury or fatality.

7. Causes of emergencies in which ejection seats were used to abandon aircraft by aircraft model.

8. USAF seat ejections where zero second lanyards were available (altitude; connected/not connected; successful/unsuccessful).

The reports and statistics were studied primarily in order to isolate factors contributing to injury or fatality which might be attributable to inadequate training. Table VIII presents data on the number of ejections and type of injury as a function of aircraft type. Four-hundred sixty-seven ejections (65 percent) were made from jet fighters. Of these, 67 (14 percent) resulted in fatalities and 279 (60 percent) involved no injury of any kind. In contrast, although there were only 94 jet bomber ejections during

TABLE VIII

NUMBER OF EJECTIONS AND TYPE OF INJURY
BY AIRCRAFT TYPE

1 January 57 - 30 June 59

| Aircraft Type | Total Ejections | Fatal or Missing | Type of Injury | | Total Unsucessful Ejection | Without Injury |
|---|---|---|---|---|---|---|
| | | | Major | Minor | | |
| Jet Fighter | 467 | 67* (14%) | 65 (14%) | 56 (12%) | 188** (40%) | 279 (60%) |
| Jet Trainer | 155 | 26 (17%) | 30 (19%) | 18 (12%) | 74 (48%) | 81 (52%) |
| Jet Bomber | 94 | 30* (32%) | 28 (30%) | 15 (16%) | 73** (78%) | 21 (22%) |
| Total | 716 | 123 (17%) | 123 (17%) | 89 (13%) | 335 (47%) | 381 (53%) |

* A Chi Square test of the independence of aircraft type and number of fatalities turned out to be significant (16.89 for 1 df) beyond the .005 level.

** A Chi Square test of the independence of aircraft type and total injuries turned out to be significant (43.96 for 1 df) beyond the .005 level.

Thus the hypothesis of independence may be rejected in both cases.

this period, 30 of them, or 32 percent, resulted in fatalities, and only 21 (22 percent) were performed without injury. With almost five times as many jet fighter ejections as bomber ejections during this period, there were, numerically, only twice as many fatalities and 13 times as many jet fighter ejections with no injury of any kind. Although jet bombers were involved in only 13 percent of all ejections, they accounted for almost a quarter of ejection fatalities and only 5-1/2 percent of ejections without injury. A $X^2$ test to determine whether fatalities are independent of aircraft type (bombers and fighters) turned out to be highly significant. One can, therefore, conclude that there is a real difference in the fatality rates between fighter and bomber aircraft. A similar analysis of noninjuries also shows a real and significant difference between the two types of aircraft.

Interesting relationships were also found between types of ejection training and injuries or fatalities sustained in ejection. These data are indicated in Table IX. An analysis was made by the Directorate of Flight Safety of individual records for category of injury and for predominant type of ejection training. Each individual was classified according to what was considered to be the most effective element of his training. For example, if the individual had ejected previously, this experience was considered more vital than any other training he may have had. Successive priorities were given to tower rides, ejection seat trainers, lectures and demonstrations, and no training, in that order. This analysis also covers the period from 1 January 1957 to 30 June 1959.

Of the 716 ejections during this period, 123 resulted in fatalities. Of the 716 aircrew members who ejected, 295 (41 percent) had had at least one tower ride prior to ejection. In this group of 295, there were no fatalities, and 207, or 70 percent of the group escaped without injury of any kind. This 207 also constitutes 54 percent of all those who escaped without injury.

In contrast, of the 113 who had had practice in an ejection seat trainer, 37 (33 percent) became fatalities and only 52 (46 percent) escaped without injury. Although this 113 constitutes only 16 percent of all those who ejected, it accounts for 30 percent of the fatalities and only 14 percent of those who escaped without injury.

A similar situation may be seen with respect to those who had no training other than lectures and demonstrations. Of the 242 ejections in the group, 54 (22 percent) resulted in fatalities while 43 percent escaped without injury. However, while this group constituted 34 percent of the total ejections, it accounted for 44 percent of the fatalities and only 27 percent of all those who escaped without injury.

In summary, 54 percent of the ejected personnel, (those having had previous ejection experience, practice in an ejection seat trainer, or merely lectures and demonstrations) accounted for 77 percent of the fatalities, whereas 41 percent of the ejected personnel (those having had tower rides) had no fatalities at all. A $X^2$ test, relating fatalities and nonfatalities to tower rides or lack of tower rides, respectively, was found to be significant beyond the .005 level.

TABLE IX

NUMBER OF EJECTIONS AND TYPE OF INJURY
BY PREVIOUS TRAINING

1 January 57 - 30 June 59

| Type of Training | Total Ejections | Fatal or Missing | Type of Injury | | Total Accidents | Without Injury |
|---|---|---|---|---|---|---|
| | | | Major | Minor | | |
| Previous ejection/bailout | 35 | 4 (11%) | 8 (23%) | 5 (14%) | 17 (48%) | 18 (52%) |
| Tower Rides | 295 | 0* (0%) | 47 (16%) | 41 (14%) | 88** (30%) | 207 (70%) |
| Ejection Seat Trainers | 113 | 37* (33%) | 13 (12%) | 11 (9%) | 61** (54%) | 52 (46%) |
| Lectures | 242 | 54* (22%) | 54 (22%) | 32 (13%) | 140** (57%) | 102 (43%) |
| No Training | 3 | 0* | 1 | 0 | 1** | 2 |
| Unknown | 28 | 28 | 0 | 0 | 28 | 0 |
| TOTAL | 716 | 123 | 123 | 89 | 335 | 381 |

* A Chi Square test for the independence of number of fatalities and the presence or absence of a tower ride during training was significant (87.17 for 1 df) beyond the .005 level.

** A Chi Square test for the independence total injuries and the presence or absence of a tower ride during training was significant (46.34 for 1 df) beyond the .005 level.

Thus the hypothesis of independence can be rejected in both cases.

Table X combines some of the data in Table IX. (The "unknown" category has been dropped.) This table contrasts training in which some actual experience of ejection was or may have been gained (previous ejection, tower ride, and possible practice in ejection seat trainers) and training in which such experience would be

TABLE X

INJURIES AS A FUNCTION OF PRIOR EJECTION EXPERIENCE

1 January 57 - 30 June 59

| Prior Experience | Total Ejections | Fata or Missing | Type of Injury | | Total | Without Injury |
|---|---|---|---|---|---|---|
| | | | Major | Minor | | |
| Previous Ejection Tower Ride, or Ejection Seat Trainer | 443 | 41* (9%) | 68 (15%) | 57 (13%) | 166 (37%) | 277 (63%) |
| Lectures or no Training | 245 | 54* (22%) | 55 (22%) | 32 (13%) | 141 (57%) | 104 (43%) |
| TOTAL | 688 | 95 | 123 | 89 | 307 | 381 |

* A Chi Square test of the independence of number of fatalities and type of prior ejection experience was significant (20.6) beyond the .005 level.

Thus the hypothesis of independence may be rejected.

impossible (lectures and no training. Inspection of the table reveals a clear overall reduction of injuries of all types with training beyond the lecture level. A Chi Square test on the relationship of fatalities to the two types of training was highly significant. Apparently, type and extent of training has a profound effect on the number of fatalities and other injuries resulting from ejection. If the 245 people in the "Lecture" group had had a previous ejection, one or more tower rides, and/or ejection seat trainer experience, there would only have been 22 fatalities instead of 54 in this group. (This assumes a constant fatality rate of 9 percent).

The general overall lack of training is made quite apparent by the fact that 245 people (34 percent) had nothing more than lectures while only 408 (57 percent) had training up to and including a tower ride. An adequate training program should result in training beyond the lecture level (ejection seat trainer with seat travel and a tower ride) for at least 90 percent to 95 percent of all aircrew personnel.

In the period of time under discussion, force of ejection and or improper body position (see Table XI) accounted for 18-major injuries. Contact with cockpit structures during or prior to ejection resulted in 6-major injuries. Interestingly, parachute landing accidents were the cause of 49 major injuries. Two cases of frostbite were reported following descent from what was presumably an unusually high altitude (probably as a result of premature actuation of the D-ring). The major injuries described above total 75, or 10 percent, of all the ejections during this period.

TABLE XI

CAUSATIVE AGENTS OF MAJOR INJURIES SUSTAINED DURING SEAT EJECTIONS THOUGHT TO BE DUE TO DEFICIENCIES IN TRAINING

1 January 1957 - 30 June 1959

| | 1957 | 1958 | 1959 | Total |
|---|---|---|---|---|
| Force of ejection and/or improper body position | 8 | 6 | 4 | 18 |
| Contact with cockpit structures during or prior to ejection | 3 | 1 | 2 | 6 |
| Parachute landing accidents | 25 | 13 | 11 | 49 |
| Frostbite during descent | 1 | 1 | 0 | 2 |
| Total Major Injuries (thought to be due to training deficiencies) | | | | 75* |
| Total Ejections 1957 through 1959 | | | | 716 |

* These injuries constitute approximately 10 percent of all ejections.

Data regarding helmet and oxygen mask loss and retention are only available for a period of three months (1 January 1959 to 31 March 1959), but the sample of personnel is large enough to merit discussion (Table XII). A total of 55 aircrew personnel (74 percent) fastened their chin straps prior to ejection while 19 (26 percent) did not. Thirty-four (46 percent) of the aircrew members did lower visors prior to ejection. Fastened chin straps resulted in more frequent retention of helmets. This was also true when visors were lowered.

TABLE XII

HELMET AND OXYGEN MASK LOSS AND RETENTION DURING EJECTION

1 January 1959 - 31 March 1959

82 Successful Ejections Using Air Force Helmets

| | Total | Lost | | Retained | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| Chin Strap Fastened | 55 | 7 | 13 | 48 | 87 |
| Visor Down | 31 | 1 | 3 | 30 | 97 |
| Visor Up | 24 | 6 | 25 | 18 | 75 |
| Chin Strap Not Fastened | 19 | 14 | 74 | 5 | 26 |
| Visor Down | 8 | 5 | 63 | 3 | 37 |
| Visor Up | 11 | 9 | 82 | 2 | 18 |
| TOTAL | 74 | 21 | 28 | 53 | 72 |

NOTE: No significant injuries reported as result of having chin strap fastened; several cases of minor injuries reported due to helmet being forcibly torn off; several cases reported wherein retention of helmet prevented head injury or more serious head injury.

Discussion

In the analysis of accident statistics, it was noted that, although there were five times as many jet fighter ejections as jet bomber ejections during the period studied, jet fighters accounted for only twice as many fatalities and for thirteen times as many ejections with no injury of any kind. That a significant difference exists, at the probability level specified, is incontrovertible; however, the difference is subject to a number of interpretations. Undoubtedly, differences in actual ejection procedures account for some of the fighter/bomber discrepancies observed. In bomber aircraft, for example, there must be coordination among aircrew members before actual ejection can take place. The resultant delays may be the cause of some fatalities. However, where nonfatal injuries are concerned, the difference in frequency is not so easily explained in this way. It is felt that ejection training may be a contributing factor.

Interviews with SAC and ADC personnel have indicated that the quality and frequency of SAC ejection training suffers in comparison. This observation, in combination with those regarding injuries and fatalities, above, would appear to substantiate the theory that inadequate SAC ejection training at least partially accounts for the poor SAC ejection record. It should be noted, further, that no ejection training films exist for bomber aircraft and that B-47 flight simulators contain seats, rather than deactivated ejection seats. There are no ejection seat trainers specific to bomber aircraft, while such trainers for fighter aircraft like the F-101 are already in the active Air Force inventory.

Perhaps the most striking data derived from this portion of the study concerns the relation of number of fatalities to tower ride experience. As initiated above, all those aircrew personnel who had received tower ride prior to their ejection ejected safely (ejection did not result in fatality). On the other hand, all of those personnel who did not have tower rides prior to ejection, but who had some other form of training, (ejection seat trainer, lectures, etc.) accounted for 77 percent of the fatalities. One of the most interesting elements of this phenomenon is the fact that tower rides have less relation to the performed sequence of ejection procedures than almost any other form of training, including lectures and demonstrations. Ejection procedures are performed, but they are performed primarily for the purpose of initiating the tower ride experience. Practice of procedures, per se, is not emphasized in the ejection tower form of training. A man who becomes skilled in performance of ejection procedures acquires this skill through some other training medium.

It is hypothesized by the authors that tower rides are successful in averting fatalities because they help to build up the confidence of aircrew personnel in the ejection system. The tower ride provides the individual with information about the hitherto unknown ejection experience, thereby reducing fear and anxiety associated with the experience. As a result, there is likely to be less hesitation and more positive action in an emergency situation. The evidence gathered, thus far, strongly indicates that familiarity with the "feel" of the ejection experience is a much more critical factor than skill in performance of ejection procedures in averting injury or death. This, in a period when the ejection sequency for many types of seats is still fairly complex. As human factors inputs in ejection systems continue to simplify and optimize the required operations, the value of the ejection tower can be expected to become increasingly evident. Tower rides are also valuable in stressing the importance of body positioning. Several comments on questionnaires received from personnel who had ejected indicates that individuals who were hurt as a result of faulty positioning during the tower ride remembered to position themselves properly prior to ejection. However, it should be remembered that the above observations are only hypotheses. Further investigation will be required before they can be refuted or confirmed.

One curious fact is that experience in ejection seat trainers does not seem to have improved the overall injury picture beyond that found for lectures only. There are at least two possible reasons for this. The first is that very few trainers of this type exist. Therefore, few people get to use them. Evidence from other sources suggests that even when available the trainers are not used often enough to provide real practice in procedures. Typically people have had only a single "ride." From this they can't be expected to learn much beyond what they have already learned in lectures. Secondly, many of the trainers do not have seats that move upon "ejection." The trainers do not provide the experience of ejection. Thus, they probably do not contribute to reducing anxiety the way the tower ride does.

A significant number of major injuries were found to result from forces of ejection, improper body positioning, and contact with cockpit structures. Injuries such as these are the result of incorrect behavior during ejection. It seems probable that such incorrect behavior could have been minimized in both frequency and extent if personnel had practiced the procedures required for ejection until they became strong habits. Ejection seat trainers are probably the best devices for practice of ejection procedures. However, as noted above, a tower ride is far more effective in that it can forcibly emphasize the importance of correct ejection behavior.

As the results indicate, 49 major injuries resulted from parachute landing accidents. Relatively few aircrew personnel have had jump training. Even fewer have had previous ejection experience. For many of those who have ejected, the actual ejection represents their first experience in guiding or controlling a parachute. There is a small amount of parachute landing practice involved in the survival course given at Stead AFB, Reno, Nevada. This consists of practice jumps and rolls from a slightly elevated platform. Perhaps an expansion of such training is the answer to the problem of reducing landing accidents. As in the case of the tower rides, it is felt that, aside from the formal training value of such a course, confidence building would be an important by-product of parachute experience, perhaps its most critical output. Some thought should be given to the enormous waste in manpower and training expense involved when an otherwise successful ejection culminates in a broken back.

With regard to loss of helmets and oxygen masks during or following ejection, most of the personnel involved admitted that they had neglected to fasten helmet chinstraps and/or lower helmet visors prior to ejection. Relevant instructions are not to be found in appropriate T.O. checklists nor in ejection training films viewed by the investigators. Here, again, the difficulty would appear to stem from the nature of the training these men have received. Not only are these steps not included as an integral part of the ejection sequence, but, more important, no personal experience has been provided to drive home the unhappy consequences stemming from the loss of helmet and oxygen mask in the course of a high altitude, high speed ejection. Perhaps, we have not yet developed the training conditions necessary to teach these lessons so that they will be retained.

In spite of the overall caution that must be exercised in evaluating these results, it seems fair to say that there are gross inadequacies in the type and amount of ejection training being provided in the Air Force today. A well rounded program should include lectures and films (familiarization) ejection seat trainers (for extensive practice in procedures) and at least one tower ride (to reduce anxiety and build confidence).

Method and Results

There are instructors in Air Force physiological training units and in operational organizations throughout the country whose function it is to teach aircrew personnel proper ejection procedures. It was felt that these instructors would be in the best position to furnish information on current escape procedures and methods of training. Instructors at the Technical Training School and the Physiological Training Unit at Wright-Patterson AFB were interviewed in order to obtain such information.

An attempt was made to determine the methods used to train students, the specific content of training, the degree of proficiency attained by the students as a result of training, the measures of proficiency used, and the types of training devices used or needed for effective training.

At the Technical Training School, the investigators spoke with the instructor presently training personnel in the maintenance of ejection systems. It was learned that no training in ejection procedures was being provided at that time. The instructor who previously performed this function is no longer with the Air Force and has not been replaced. An ejection seat trainer, built locally at the request of the school, is available for use by students. However, no class plans or course outlines were immediately available. It was learned that there is no Air Force requirement for mandatory ejection training and no standardized Air Force equipment or program for training ejection skills and procedures. Where courses exist, they apparently do not include any form of student proficiency test at the conclusion of the program.

Instructors at the Physiological Training Unit confirmed the fact that no standardized ejection training exists in the Air Force. It was also reiterated that there is, at present, no specific Air Force requirement for ejection training. Training programs in physiological training units throughout the country vary in their organization and nature. Each trainee is usually given one ride in the MH-15 ejection seat catapult, commonly used as a training device in these units. The MH-15 is built with a T-33 ejection seat, and there is no provision for substituting other seats. The course itself is not adapted so as to be specific to the ejection system of a particular aircraft.

Discussion

This source of data yielded little information of value. Time did not permit extensive interviews of training personnel. In spite of their limitations these interviews point up the lack of any standardization or explicit Air Force requirement for ejection training. The acquisition and organization of training personnel and equipment for escape training programs appears to be the responsibility, for the most part, of individual units, and the assumption of this responsibility is by no means mandatory. This is substantiated

by responses to questionnaires and by data gathered from interviews with aircrew personnel. In the authors' experience, many ejection training programs owe a fortuitous existence to one or two individuals who are sufficiently concerned about the ejection problem to gather or construct their own training materials and, lacking any guidance from professional Air Force training personnel, to develop their own ejection training curricula. Such programs are both ingenious and effective. However, they generally lack official backing in terms of explicit scheduling or financial support and, at best, reach only a small percentage of Air Force flying personnel. This is a situation which calls for large-scale rectification.

This source of information has hardly been tapped. The information gained has been included more for completeness than for its intrinsic value. In order to get a clear picture of the training programs actually in use in the Air Force, a far more extensive survey of training personnel would be required.

## CONCLUSIONS AND RECOMMENDATIONS

### General

Before proceeding to specific conclusions and recommendations concerning ejection training, it seems in order to mention a few general considerations.

It has been said that in order to be a difference, a difference must make a difference. To assert that ejection training is inadequate is one thing; to assert that training "makes a difference" is another. To be completely convincing, one must be able to make both assertions. Normally, this is not possible. Normally, we are faced with the fact of inadequate performance and we have to infer that insufficient or inadequate training is one of the causal factors.

DeGaugh and Keller (ref. 1) have demonstrated better than anyone else (including the present authors) that ejection procedure performance was not what it should be. They had to infer, however, that this would be rectified by improved training. One of the major purposes served by the present study is the demonstration that training makes a difference. For ejection performance, it establishes as a fact what previous writers were only able to infer. The evidence is found in the accident statistics where the relationship of amount or level of training and percentage of injuries and fatalities is clearly shown.

In this respect, the present study adds to the work of DeGaugh and Keller. In demonstrating inadequacies in ejection training it serves primarily to substantiate and reemphasize the significance of their work. As far as can be told from this investigation, things haven't changed much.

What types of behavior does ejection involve? Recall that Zeller referred to perception, decision, and action. This study began with a similar approach by asking whether people know how to eject (can they perform the action?) and when to eject (can they perceive and recognize a situation which requires ejection?). To this a third question must now be added. Will the individuals eject?

Ejection is a multidimensional task. In an analysis similar to Zeller's, it appears to have three major components which the authors have chosen to call procedural, decisional, and attitudinal. It appears, furthermore, that these components are relatively independent and training must be provided for each one.

The procedural component involves motor or manipulation skills. These include preflight inspection, positioning, canopy or hatch release, actions to eject, separation from the seat, and parachute and landing techniques.

The decisional component involves intellectual and judgmental skills. These include detection of an emergency, accurate assessment of possible alternative actions and their consequences, and selection of the appropriate alternative. Dr. Zeller has listed a number of factors which may delay or even inhibit this process.

The attitudinal component (for lack of a better term) involves the individual's willingness to eject. This component appears to be a function of such things as confidence in the equipment (both aircraft and ejection), familiarity with the physical and psychological experience of ejection, and confidence in ejection as a means of escape and survival.

This study reveals an urgent need for training in the procedural and attitudinal aspects of ejection. There is virtually no information available about the decisional aspects of the task. All the interviewees indicated confidence in their ability to judge when to eject. It must be remembered, however, that they had never actually done it.

Further work needs to be done to more firmly establish the usefulness of this division into components. Performance tests of the decisional aspect of ejection would reveal whether the reported confidence is justified.

In the following sections the deficiencies of present-day ejection training will be summarized, some recommendations will be made for their improvement, and finally some suggestions will be made for future investigations.

## Summary of Ejection Training Deficiencies

The following paragraphs deal with training deficiencies in terms of content, administration, and facilities.

With respect to training content, data from interviews with aircrew personnel and ejection training instructors, results of questionnaires, and accident statistics indicate that many aircrew personnel have had no training whatsoever in actual ejection procedures, a relatively small number have had tower rides, and some have never even had so much as a lecture or training film on the subject. The needs for training, expressed by interviewees, emphasize procedures and attitudinal components. There is virtually no information on the adequacy of training in decision making. The large percentage of injuries due to parachute landing accidents further bespeaks the need for improved procedures training.

There does not seem to be any standardization in the administration of ejection training. There appear to be very few formalized training "programs." Methods of administering training vary between commands and probably within commands. Scheduling of courses is haphazard. Attendance appears often to be optional with no allowance for unavoidable conflicts with missions, alerts, etc. There seems to be a widespread lack of transition training from one type of seat to another. There is no overall policy on ejection training. Good programs are apparently the product of a few interested individuals.

Training facilities include equipment and instructors. In general, there does not appear to be enough of either. There is a gross lack of up-to-date ejection procedures trainers. There are no training films specific to the F-104, B-52, B-47, and other commonly flown aircraft. The films that are available are outdated, not wholly suitable for training, and they have not received wide distribution. The training equipment available is not always maintained or used to capacity. There appears to be a lack of instructional personnel. A few representative remarks from interviews give a clear picture:

"We have a trainer here, but there usually aren't any shells to fire it."

"The Moble Training Detachment (MTD) operates a trainer, but most of time it doesn't work."

"A captain used to give a course here with slides he'd made up from the T.O., but he's no longer in the Air Force."

"We have a trainer for B-47 crews, but it uses a T-33 seat and can't be changed."

"There was a (MTD) until about 6 months ago, but they've moved out."

## Recommendations for Currently Feasible Improvements

Although many improvements require the development of new training equipment and aids, many can also be made immediately.

As regards content, training should be directed at all three of the aspects of ejection discussed above. Many accounts of ejection experiences refer to an almost reflex performance of ejection procedures. These procedures should be practiced to the point of virtual automaticity in an ejection seat trainer. This is absolutely essential for proper action under the stress produced in an emergency situation. Training in making decisions can be provided. Each aircrew member and especially pilots should be made fully aware of the factors in an emergency which require ejection. At present this could be done with lectures in which various emergencies are discussed in terms of available actions and their consequences. Although it is not known exactly what factors determine man's willingness to eject, the evidence of greater success in ejections following at least one tower ride leads to the strong recommendation that every aircrew member be subjected, under close supervision, to this experience. The reports of those who have ejected successfully should be more widely distributed. This could be done at almost any level of command. It would be well if Flying Safety publicized the details of successful ejections as assiduously as they do the accounts of emergency landings of damaged aircraft. The decision to eject can be as worthy of recommendation as the decision to "bring her in." In connection with all of these areas steps should be taken to evaluate proficiency. Even crude tests of performance developed at the base level would be valuable in determining local training needs. More refined tests could be developed by ARDC.

The administration of ejection training programs can be improved. The following methods are recommended: Training should be offered on a regular scheduled basis. It should be mandatory for all those on flying status. It might even be made a requirement as is the periodic flight physical. An officer at each base should be designated to set up and administer the program. An initial run of 10 to 20 trials in an ejection seat trainer should be required for flight status and should be followed in 90 days by refresher ejection training. Additional refresher training in the form of lectures and proficiency tests should be given at 6 months intervals. Again, at least one tower ride should be required every 6 months. Equally important is a requirement for transition training whenever a change of aircraft or ejection seat is involved.

Schedules such as this should be determined and established on an Air Force-wide basis. This becomes particularly critical for the thousands of Air Force pilots who are no longer in active flying roles, but who maintain monthly flying time. Solutions must be found for the constant disintegration of training programs as a result of turnover in training personnel.

With respect to training media, an inventory should be completed of available training devices and aids, by type and location. For the time being, much more extensive use should be made of existing equipment, flying aircrew personnel to this equipment if necessary. Where training devices are not available, it might be noted that the ejection seat trainer mentioned in the DeGaugh and Keller study was built at Wright-Patterson AFB for $2000 and could be built inexpensively at other bases where training equipment is unavailable. The DeGaugh and Keller study supplies fairly complete plans and design specifications for such a trainer.

All available equipment should be maintained and made available for use. Salvaged ejection seats may be used as instructional aids or, with some slight modification and repair, be made suitable for basic procedural training in preflight checks, positioning, etc. Even the films that are presently available could be shown more widely.

## Recommendations for Future Improvements

Most of the future improvements involve the development of additional training equipment and aids. Although much can now be done to improve training content and administration, the extent of such improvement depends very much upon the availability of training equipment. Survival through ejection cannot be achieved by lectures alone. Aircrews need practice, and lots of it, in the sequential, motor aspects of the task. The device most suited to this purpose (and smallest in supply) is the ejection seat trainer. With seat travel, such a device can be used as a demonstrator, as a procedures trainer (with the exception of parachute and landing techniques), as a means of approximating the ejection "experience," and even as a maintenance trainer. Through careful design such a trainer can act as a self-tutoring device. That is, it can be operated by the student without instructor assistance. It can also record and report, through a system of tell-tale lights, what procedures were omitted during a given trial.

A prototype of such a trainer, for upward and downward ejection, has just been developed for SAC by Burton-Rodgers, Inc., of Cincinnati, Ohio. Development was monitored by the Training Equipment Branch, of Wright Air Development Division. This trainer will accommodate all seats in the B-52. Follow-on quantities have not been contracted. More trainers of this type should be built. Trainers which will be specific to particular aircraft and which will be capable of keeping pace with operational developments and changes. An aircrew member should never have to fly an unfamiliar aircraft or operate an unfamiliar seat. If he does, adequate transition training is not being furnished.

Improved training films should be developed; films that are specific to a given ejection configuration. Films may serve a number of valuable training purposes. They could be used especially well in refresher training or as a means of building confidence in escape systems. Large-scale use of films might make training programs less dependent on the interest and ingenuity of the instructor who happens to have the job at the moment.

Finally, some thought should be given the use of self-instructional devices. Such devices could easily be developed for use in ready rooms or other places where crew members congregate. They could serve as vehicles for a mental review of procedures or for practice and evaluation of decision making skills.

These recommendations are, it must be remembered, based on limited information. Much more must be known about the relationship between type and amount of training and success in ejection before a completely efficient training program can be formulated. More complete information about the character (content), recency, and frequency of training is required. This could be obtained through more detailed accident statistics. The statistics reported here are indicative of an extremely marked relationship between training and success in ejection. Yet they leave much unanswered. They are too gross. For example, we do not know what was covered in lectures, we do not know how much training was received in ejection trainers, we do not know what characteristics these trainers had, or how often a man has had refresher training, etc. In short, it is one thing to report training in terms of the type of medium used and another thing to describe the training actually received. Within a year or two some deep insights into such questions could be gained simply by keeping more analytical records of the training of future ejectees. The authors welcome any opportunity to assist in establishing such indices.

## Suggestions for Future Studies and Research

Some of the sources investigated in this study have been exhausted, others have been barely tapped. We believe that the literature on ejection training per se has been covered. There is, of course, a much larger general literature which may be of some value. Little more can be said about training films. Accident statistics may yield more information through further analysis. This information will be limited, however, until more comprehensive records of individual training are maintained. The least thoroughly investigated sources are successful ejectees, aircrew personnel, and training personnel. Data on larger samples could be amassed through the use of improved questionnaires and interviews. Such investigations would yield a more accurate and representative picture of the status of Air Force ejection training. The conclusions reached here should be confirmed or modified by this means.

An experimental approach in the laboratory is probably even more desirable. We need to know more about the nature of the task. We need to know more about the influence of stress and whether this influence can be compensated for thorough training. We need to know what other variables influence performance and how they operate. Only through careful research can such questions be answered. Until then we must be satisfied with good guesses.

## BIBLIOGRAPHY


1. DeGaugh, R.A., and J.R. Keller, Ejection Seat Training in the Strategic Air Command, Technical Memorandum OL-TM-57-16, Air Force Personnel and Training Research Center, Randolph Air Force Base, Texas, October 1957.

2. General Data on Seat Ejection, Quarterly Report, Office of Inspector General, USAF, Directorate of Flight Safety Research, Norton Air Force Base, California, 1 January 1957 - 31 December 1957.

3. General Data on Seat Ejection, Quarterly Report, Office of Inspector General, USAF, Directorate of Flight Safety Research, Norton Air Force Base, California, 1 January 1958 - 31 December 1958.

4. Moseley, H.G., USAF Operational Experience With Escape from High Performance Aircraft (Period: 29 August 1949 through 31 May 1956), Publication No. M-24-56, Office of Inspector General, USAF, Directorate of Flight Safety Research, Norton Air Force Base, California, September 1956.

5. Operational Experience with Ejection Escape Systems from 1 January 1949 through 31 December 1954, Publication No. 23-55, Office of Inspector General, USAF, Directorate of Flight Safety Research, Norton Air Force Base, California, August 1955.

6. USAF Seat Ejection, 1 January 1959 through 30 June 1959, Quarterly Report, Office of Inspector General, USAF, Directorate of Flight Safety Research, Norton Air Force Base, California.

7. Zeller, A.F., Psychological Factors in Escape, Publication No. M-12-56, Office of Inspector General, USAF, Directorate of Flight Safety Research, Norton Air Force Base, California, April 1956.

APPENDIX A

EJECTION STUDY QUESTIONNAIRE

Name _____

Rank _____ Age _____ Primary AFSC _____

Organization _____

_____

1. Have you had ejection training? Yes _____ No _____

   When? (Last date of formal training) _____ _____
   (Month) (Year)

2. Do you attribute any of the difficulties you had in ejection, if any, to inadequate training? Please explain.

3. Do you attribute any of the difficulties you had in ejecting, if any, to malfunctioning equipment? Please explain.

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4. What types of ejection seat training have you had? Indicate (X) (1) the approximate numbers or hours of each type, (2) the date of last training (month, year), (3) the major command under which the training was conducted and (4) the type of training unit which conducted the training.

| Types of Training | Numbers of Hours | Date of Last Training | Major Command | Type of Training Unit: Mobile (MTD) | Physio-logical | Base | Wind | Other |
|---|---|---|---|---|---|---|---|---|
| Tower Rides | | | | | | | | |
| Lectures | | | | | | | | |
| Deactivated Seat | | | | | | | | |
| Ejection Seat Trainer | | | | | | | | |
| Aircraft Simulator | | | | | | | | |
| Live Demonstrations | | | | | | | | |
| Training Films | | | | | | | | |
| Study of Manuals and TO's | | | | | | | | |

5. Please indicate how often you have received refresher training in ejection procedures prior to this ejection.

_____ Every 3 months

_____ Every 6 months

_____ Every 9 months

_____ Every 12 months

_____ Every 18 months

_____ Longer

6. In what ways do you feel that your own training could have been improved?

7. In what ways do you feel that ejection training in general could be improved?

8. Which aspects of your previous training do you consider to have been most valuable in enabling you to eject successfully? Why?

9. Have you had sufficient training to feel confident about your ejection procedures?
Yes_____ No_____

10. What difficulties, if any, did you have in ejecting? (If you did not perform a task listed below and, according to proper procedures, you should have, consider this a "difficulty.")

a. _____ Smoke in cockpit.

b. _____ Interphone or alarm system malfunction (not applicable to to single seat aircraft).

c. _____ Fastening chin strap on helmet.

d. _____ Pulling down visor.

e. _____ Disconnecting clamp on oxygen hose.

f. _____ Disconnecting oxygen hose.

g. _____ Actuation of oxygen bailout bottle.

h. _____ Canopy failed or was difficult to release.

i. _____ Insufficient time for proper positioning.

j. _____ Movement and operation of handgrips.

k. _____ Operation of triggers (Did you have difficulty in finding them or in operating them.)

l. _____ Centrifugal force hindering movement to fire seat.

m. _____ Ejection through canopy.

n. _____ Premature ejection (not properly positioned).

o. _____ Helmet lost during ejection.

p. _____ Hypoxia.

q. _____ Windblast and air turbulence.

r. _____ Automatic lap belt failed.

s. _____ Serve tumbling, hindering seat release.

t. _____ Delayed seat separation due to prolonged grip on handles.

u. _____ Clothing or equipment interference.

v. _____ Seat entangled in shroud lines.

w. _____ Others.

If you wish to do so, please use the remarks space below to elaborate on the difficulties you had.

Remarks:

11. As best you can, please describe what went through your mind from the time you first experienced the emergency to the time you hit the ground. (Emphasize the decisions you had to make and how you reached them.)

12. At approximately what altitude did you eject? _____ ft.

13. Approximately what was your airspeed at the time of ejection?

_____

14. What factors caused the emergency?

_____ Fuel starvation

_____ Loss of control

_____ Engine failure

_____ Fire or explosion

_____ Structural failure

_____ Canopy lost in flight

_____ Mid-air collision

Others

15. Please indicate the total numbers of hours of flying time you have had in:

    a. _____ All jet aircraft.

    b. _____ Jet fighters.

    c. _____ Jet bombers.

    d. _____ Jet trainer aircraft.

    e. _____ The type of jet aircraft from which you ejected.

16. At approximately what altitude did you detect the emergency which led to your ejection? _____ft.

17. Approximately what was your airspeed at the time you first detected the emergency? _____

18. How could the pilot operating instructions covering escape procedures be improved?

19. Do you feel that the pilot's --1 T.O. adequately covers all of the conditions covering or affecting escape from the aircraft?

# APPENDIX B

## INTERVIEW

Identify Yourself

I am here to obtain some information on the type and quality of ejection training that you have had. This information will help us in completing a study on ejection training in the Air Force. Please answer the questions as accurately as possible.

1. What type of ejection training have you had? (How much, and when did you have it last?)

   a. Tower Rides

   b. Lectures

   c. Ejection Seat Trainer or Simulator

   d. Training Films

2. In what way do you feel that your own training could have been improved?

3. How confident do you feel about your ability to eject?

4. How confident do you feel about your ability to judge when to eject?

5. Please indicate how often you have received refresher ejection training.

6. In what ways do you feel that ejection training in general could be improved?

7. Which aspects of your previous training do you consider to have been most valuable? Why?

8. Please indicate the total number of hours of flying time you have had in:

   a. _____All Jet Aircraft

   b. _____Jet Fighters

   c. _____Jet Bombers

   d. _____Jet Trainer Aircraft

# APPENDIX C

## REPRESENTATIVE DESCRIPTIONS OF EJECTION EXPERIENCES BY AIRCREW PERSONNEL

(This section contains personal accounts of ejection obtained by questionnaire from aircrew personnel who ejected.)

QUESTION: As best you can, please describe what went through your mind from the time you first experienced the emergency to the time you hit the ground. (Emphasize the decisions you had to make and how you reached them.)

1. "The flight was composed of the following crew: IP, a student A/C, student C/P, navigator—instructor, and a jet engine mechanic. It was the first ride for the jet mechanic, and the student C/P had approximately 10 hours flying time since graduation and this was his third ride in a B-47. The student A/C was a qualified C/P and was being upgraded. The navigator and myself were both instructors.

"C/P was in the rear seat for instrument practice—I was in the front seat, giving detailed instructions for a range orientation—student A/C in the fourth man position—jet mechanic in the fifth man position—and the navigator in his seat. A turn was started to the left upon intercept of the S/W course of the Little Rock Range—and half way through the turn a violent explosion occurred. The number 6 engine had exploded and damaged the control systems. I alerted the crew for bailout and took control of the aircraft, pulled the number 6 Fire Button, turned off the Right Aileron Control Unit, had the C/P put the number 6 throttle to cutoff and check the C/B's in, to insure fire shutdown. Depressurized, the fire went out and by putting number 1 and number 2 throttle to idle and with full left rudder and full left aileron, control was marginal. I directed the student A/C into the rear seat to assist me since he was an experienced C/P. A rapid change was effected. —up to that point not more than three minutes had elapsed—with the student in the rear seat and strapped in. Now the right wing began to drop and was again on fire. Also, the wing started buckling up between number 5 and number 6. The aircraft was shivering as if in a stall and our UHF was not operating. The left turn took us away from the Little Rock area and I ordered the crew out. The fourth man did not hear the order over interphone. His plug to the helmet must have become disengaged during the seat change, so both the A/C and myself directed him with hand signals to bail out. I watched him pull the pressure door handle—the door (inner door) came down and I saw him pull the T handle to jettison the outer door and extend the Spoiler Door. At this time I directed my attention to flying the aircraft which was in a 10-20 right bank. The C/P states after pulling the T handle, the inner door slammed shut and he did see daylight. The navigator, seeing the difficulty the C/P was having, ejected, the jet mechanic, in the fifth man seat, followed him out. The C/P went forward.

I had the A/C hold the aircraft, I bent forward and observed the C/P bail out. Assured that all crew members were gone, I ordered the A/C to raise his right hand grip and eject the canopy and go. The canopy lifted off nicely—I heard a whoosh and knew the A/C had gone. The aircraft was on a 45°-90° bank—I raised my right hand grip, squeezed the trigger and everything worked perfectly. I came to, face down, spread-eagled, with no helmet or oxygen mask. I had the feeling I had no chute—saw the D ring and pulled it, not waiting for the automatic opening. I did this because I had a strange feeling I was losing everything and I was overwhelmed at seeing I still had a chute on. Nothing felt so good as that soft sweet pop of the opening chute. The crash was directly beneath me and I could see the A/C in his chute down to my right.

"This crew had no 'togetherness,' but the discipline was outstanding. Five members survived with minor bruises except myself—a fractured T-12 vertebra when hitting the ground. The equipment worked perfectly and the crew followed every order and considering a total elapse of 3-4 minutes from emergency to first man out—the training and professional attitude paid off."

2. "My actions followed a logical pattern which would indicate the absence of panic. Moments of anxiety occurred after realizing I was still in the seat. A subconscious reaction of security undoubtedly made me clutch the seat handles. After the tumbling stopped, I returned to a fully conscious state of mind in that I attempted to kick free of the seat.

"At one point in the descent, chute oscillation worried me. At the apex of one oscillation, the shroud lines actually became slack. Pulling on the lines soon stopped the oscillation. The last few feet of fall went by much faster than I had anticipated. I was both mentally and physically unprepared to land. However, I was lucky."

3. "Just after becoming airborne, I knew something was wrong with the aileron system. The aircraft started rolling to the right. Up until the time I ejected, I was thinking about what could be wrong and what I could do to correct it. (Time was scarce as no more than one minute elapsed from the moment I started to roll until I was on the ground.) When the aircraft was in a near 90° bank, I realized that I had to get out—this decision came instantaneously—I had not dwelled on the possibility of ejecting prior to this. At the same time, I had a low feeling as if the end had come. The ejection was noisy and confusing to the mind and, after hitting the airstream, I began tumbling rapidly. All I thought of during this period was I wonder if the chute will open and what the impact will feel like if it doesn't. I did not remember to kick the seat away from me. After the chute opened, I was calm and had to unfasten my mask to facilitate breathing. (I did not have time to actuate the bail-out bottle.) I was in the air approximately 4 seconds after the chute opened."

4. "My decision to eject was made at the last possible moment and only when I felt that a safe dead stick landing was very doubtful. From then on, I followed training procedures and everything worked fine."

5. "My emergency was a flameout at 1500 ft. above the ground at 300 kts. I was too far from the runway to land dead stick—consequently I had no decision to make, or at least to ponder. I was conditioned to the fact that should I have a flameout at low altitude, I would eject (altitude permitting, of course,) since I know of no successful belly-in landings in the F-100. My wing commander at that time urged no attempted flameout landings and no attempts below 10,000 ft. My main decision was to steer it to the unpopulated area. The entire ordeal amounted to the fact that I observed my flameout condition, steered the plane toward a wooded area and ejected. I was in the chute a very short while, hit the ground extremely easy, and had no difficulty in spilling the chute."

6. "I was just taking off and at reaching 1000 ft. and at 300 knots I came out of afterburner. The engine came out of afterburner, went into a compressor stall, overtempted, and flamed out. The first reaction I had was just plain shocked disbelief—it wasn't happening to me. I actually think that at this point I could have just sat there and looked at myself crash, for it seemed to me that I really had to make an effort to get myself to move and do something. The first thing I did was to tell my wingman I had a flameout, then immediately tried an airstart. It was right here that I realized my altitude and had to do something in a hurry. As soon as the engine quit, I started climbing and turning toward a swamp area, and as soon as the airstart did not take, my decision was made to get out. As soon as that decision was made, it seems as though I calmed down and started to prepare myself. I relaxed and started checking—seat pin out—zero lanyard attached—pulled my visor down. Chin strap is always locked with me. As soon as the ship peaked out at maximum altitude 2400 ft. and 185 knots, I sat well back in the seat and pulled both armrests, then immediately squeezed the right trigger. It appeared to me that I tumbled forward, but was next aware that I was hanging in the harness with the seat falling away from me. The ejection system with zero second lanyard worked like a charm. I experienced a little difficulty in breathing and realized that my oxygen mask disconnect valve was the cause of it, but in seeing that I was going to land in a very heavily wooded area and would need the face protection the mask afforded, I kept the mask on. There was also a lot of water in this area so I inflated my one man dinghy which hung below me so that it would be handy if I needed it. I went into the trees and came to a very gently stop as the canopy covered a tree top. I was still about 15 feet up, but I gently swung over to the tree and while holding on with both legs and one arm I realeased one canopy release which let me slide down the tree gently to the ground.

"I would like to say now that I am the squadron flying safety officer and just three hours before ejecting I had given a lecture to all squadron pilots on the use of the ejection system, especially the zero second lanyard. I do not doubt that this helped a great deal."

7. "The Fire Warning Light triggered my first thought; My, this can't really be happening to me. I had just raised my gear and in AB the power was okay. Nothing, I can do but pull her up and eject. I was afraid that the airplane would explode before I could get out. I called tower to let them know about the emergency. At about 75 to 100 feet, I came out of AB. TPT was impossible to read due to the position of the sun. At 200 feet I breathed a sigh of relief, believing that I was high enough to eject successfully. Automatically I was slowly retarding the throttle, hoping the light would go out. I consciously thought about keeping the airplane away from inhabited areas and steered the airplane accordingly. With the throttle all the way back, I coasted up to 1400 over field elevation at 220 knots. By this time the stark terror was over and I felt quite calm and confident. Maybe almost secure. My mind was working much faster than usual, and though I was wanting very badly to eject, I wanted to be more certain that I had a real fire and not just crossed wires. As I started to roll in a little more bank to see if I had smoke, Tower called to tell the flight that something had fallen off one of the airplanes. In quick order, I got smoke in the cockpit and the controls froze. This was the greatest thing that could happen, I thought. The uncertainty was the worst part of the situation. I definitely had a fire and I definitely could not control the airplane. In effect, the decision had been made for me. I pulled the right hand guard and the canopy went with a bang. As I started to squeeze where I thought the trigger should be, I was startled as my fingers closed on empty air. I stuck my head down in the cockpit to see what the trouble was and could see that the trigger had not been positioned. It seemed like a long time, but must have actually been a very short time until I got the trigger positioned. Much as I hated to, I stop cocked the throttle and called Tower to let them know I was abandoning the aircraft. This is rough, I thought as I catapulted out of the plane. A feeling of now it's up to the parachute rigger prevailed for several seconds during which I tumbled three complete turns. My arms were flailing in the air and several attempts to bring my arms into my body failed. I finally got to the D ring by bringing my arms directly into my body and then bringing my hand across to the ring. The chute opened abruptly and I hit the ground. When I was somersaulting, it seemed to be sideways and I never saw the ground after the chute opened until I was lying on it."

8. "I struck approach lights during a night GCA. Windscreen was obscured by ice or snow and a missed approach was executed to late, i.e., after striking approach lights.

"Climb was made at 130 knots to safe altitude with gear down (My impression was that I had merely touched down short of runway on the gear. Considering the rather hard jolts I received, I elected to leave the gear down in case of damage which might have enhanced the situation by retracting the gear.) Aircraft felt on the verge, of a stall, thoughout climb and I leveled at about 1000 ft. terrain clearance to get some air speed. As air speed built up to 145-150 knots, the aircraft began to roll to the left in spite of the large amount of right aileron control being applied. (Rolling, I found next day, was due to the entire damage being done to the left wing causing lots of drag and no lift.)

"I retracted the gear with the hope that the rolling would subside. I had no logical reason for this except that I couldn't or hadn't found any other possible source of my left roll. About this time I really began to feel a cold fear, especially as my mind conjured pictures of myself and the aircraft going in and exploding on impact.

"Up to this point, I had been deeply concerned about the fact that I might have to see the Wg Commander and Deputy Commander (USAFB ADON) if the aircraft were damaged beyond minor category; however, as the aircraft reached a 45° left bank, I dropped all thought of everything except survival (ejection).

"I clearly heard a 'pop' sound as the canopy jettisoned. I don't believe I delayed more than two seconds before I armed the seat. My right arm fitted the armrest ok, but I couldn't find the left one (I had flown the F-100 about 200 hours, prior. Its ejection seat arm rests are physically connected and both move together.) I kept trying to find it with my left elbow and forearm without taking my eyes off the aircraft altitude indicator. Not wanting to spend too much time at that task, I put my left hand in my lap and squeezed the right trigger.

"I kept my eyes opened and as I tumbled forward I saw the aircraft pass under me. Also, the engine noise faded very rapidly and left me very alone. Before I could really feel lonely, I thought about the D ring, but by that time I felt a jolt. Although I was in a cloud at night, the whole world took on a brighter look in my mind's eye. This elation lasted only a few seconds for although I had no reference points, I know that I was going up instead of down. Another shot of adrenaline was shot into my system, but I quickly rationalized that even if this were so it would be temporary and Newton is still right.

"Next I realized that we (the parachute and I) were spinning quite fast and I couldn't make myself dispute this spining, as one does with vertigo, so I continued spinning.

"I looked up and saw a dark spot in my canopy and really got a good jolt, as I decided that my seat was tangled in the canopy (as was another pilot's two weeks before who received back injuries on touchdown.)

"Of course, all this was happening very fast and after I assured myself that I'd made a good ejection, I started thinking about the Colonel and the General again. I broke out of the clouds at about 400 ft. and realized that I was not spinning nor falling up so to speak.

"The sight of the ground brought back many phases heard in every jump lecture. Feet together, knees slightly bent, look straight ahead, pull on both risers as you are about to T.D., fall with T.D., allow your thighs, hip, and shoulder to absorb some of the shock.

"It was an extremely soft landing and I walked about 1 1/2 miles to the aircraft wreckage. When I first alighted, I said a little prayer that the A/C had landed in open country. It had missed a group of houses as had the canopy and seat."

9. "It was a dark night. I was on the base leg of the GCA pattern at 2000 ft. Gear down, flaps up, and speed brakes in. My airspeed was 175 knots IAS stabilized. Suddenly, the RPM started to decrease rapidly and TPT dropped to approximately 200-250°C. My first impulse was to immediately eject, but this was a fleeting desire and my first action was to attempt to restore power. My hand was resting on the throttle at the time of the power failure. I flipped the gear handle up and retarded the throttle to idle and selected the emergency fuel system. Readvancing the throttle did not alter the TPT or fuel flow which was Ø. The throttle was placed in the stopcocked position, airstart switch was activated, and the throttle was readvanced, Regardless of the position of the throttle, the fuel flow and TPT did not change. The aircraft was on the verge of stalling. I pulled my visor down, my feet back in the footrests and raised the armrests and pulled the triggers. The raising of the armrests and pulling of the triggers was one continuous motion. I did not feel any windblast or notice any shock on ejection. I had a sensation of rolling foreward, but only slightly, not more than one eighth of a turn.

"My first thought was that I had to do something with my arms. I didn't think of anything in particular to do like opening the lap belt or pulling the D ring. I don't remember releasing my grip on the armrests, either. Within a second or two, I was hanging beneath my open chute. There wasn't any noticeable opening shock or oscillation. Zero second lanyard was connected. I raised my visor to orient myself and saw the explosion of my aircraft as it struck the ground. I looked down and saw that I would be landing in trees, so I placed my visor down again, held my feet together, slightly bent at the knees, crossed my arms in front of my face with hands on risers above my head. I remember hearing branches breaking when I passed through the trees; however, I did not feet anything, probably because of the heavy flying clothes I was wearing. The impact with the ground was light. All of my personal equipment was intact. I don't believe I made any conscious decisions. Almost everything I did was instinctive due to past training. I had read the ejection procedures in the Dash-1 on that same day, so they were fresh in my mind. The time from engine failure to impact with the ground was extremely short, somewhere from 1-1 1/2 minutes."

10. "First indication was compressor stall on top of undercase—this presented no problem—having experienced this before. Followed normal procedures, descending and reducing power. Entered clouds and continued experiencing stalls. Still not particularly worried—had plenty of altitude and self-confidence. As descent continued, I realized I was entering a severe thunderstorm. Started to pay more attention to problem at hand. Severe turbulence placed my A/C in

inverted position and flamed me out. Now began to get really concerned. Switched to emergency AC power and recovered from altitude. Momentary elation at success followed by dismay when emergency AC failed. Confused period during which I unsuccessfully attempted to maintain control W/O instruments in turbulence. Had quality of bad dream rather than reality. Tendency was to give up and wait for tumbling to end. Finally realized watching altimeter unwind that if I was to get out it had better be soon. Decided to go and then all motions were automatic. Felt no force of ejection other than cold air. Parachute was open before had chance to think about it. Tremendous feeling of elation as had always been convinced that chute would never open for me. This again followed by dispair as chute collapsed several times from oscillations in high winds. Very cold and uncomfortable. Attempted to control chute with no success. Kept looking for sight of ground. Finally broke out of clouds and tried to get layout of area for after-landing purposes. Found it impossible to judge where I would hit in high wind. Struck ground before expecting contact and was picked up immediately.

"NOTE: Main feature of experience to me was fact that I had what amounted to a suicidal tendency to give up when situation got hopeless. Had feeling that experience was unreal. Once faced with reality of situation, there was no problem. An article which made an impression on me was entitled "The Decision to Live" by Maj. Gen. J.V. Crabb. Implanted proper relation between aircraft and pilot. Feel that it influenced my decision to eject."

11. "I was riding as navigator in the rear seat of a B-57. We were on the initial approach in a two A/C formation. Altitude approximately 1200 ft. We heard or felt a noise and our aircraft immediately began buffeting and vibrating. After approximately 2-3 seconds, the pilot indicated ejection was necessary. The elevator control was knocked out.

"During the 2-3 seconds interval from the first difficulty until the pilot said bail out, I had decided that ejection was highly probable. I had glanced quickly around the cockpit and checked the safety pins. When I received word to bail out, I was ready and found the decision to eject surprisingly easy under the circumstances.

"As indicated above, I don't remember details until the chute opened. At that time I glanced up to see if the chute was fully open and seeing that it was, I looked down to see where I was going to land. A barbed wire fence was of some concern to me, but I missed it, and landed in very short time. Observers at the Air Base estimated my chute opened at about 200 ft. In my case, there was no time to ponder alternatives, therefore, the decisions were easy."

12. "As soon as the engine failure occurred and the engine had been stopcocked, the IP informed me that we would have to leave the aircraft. I was a bit apprehensive at this point, but the IP calling off the bailout

procedure helped a lot. The IP was in the back seat so he left first. After raising the left arm rest, I found that my arm was between the arm rest and the canopy rail. I placed my arm in the proper position and after raising the right arm rest, ejected. I felt very little force from the ejection and very little wind blast. I held on to the seat longer than necessary. There was very little opening shock. After the chute opened, I began to worry about where the plane would hit. After seeing it hit in a pasture, I began trying to turn myself in the harness as I was drifting backward. I misjudged my distance above the ground badly and was still trying to turn myself when I contacted the ground."

13. "Emergency occurred at 40,000 ft. and I went through normal emergency procedures. I was 60 miles out to sea at that time. I set up glide for land at best glide speed for windmilling engine. I knew I could never make it back to the base, but might make land before I had to bail out. As it was, I had to bail out over water because at 3000 ft. I was 15 miles from land. I blew canopy at 4000 ft., positioned myself, and squeezed the trigger. I had zero second lanyard connected. From the time I ejected until my chute opened, it happened so fast that I could only recall sensations of going up, starting to tumble forward, the seat leaving me and then the chute opening. As I floated down I activated LPU life preserver and inflated life raft.

"The decisions I had to make were cut and dried. I had the choice of staying with the aircraft and hitting the water or bailing out and living. When I passed through 5000 ft. I was ready. I had checked seat pins out and cockpit cleaned up, with all connections connected. As I passed through 4000 ft., I blew canopy and, at 3000 ft., squeezed the trigger. Never once did I hesitate. I believe that if I had hesitated I would have gone down with the plane or else ejected too low, and never made it. I have a rule of thumb that I will never ride on aircraft below 3000 ft. if I have an emergency and there is any doubt that I can make it I will eject. Maybe this is wrong thinking, but that is what I use."

14. "I experienced what I thought was a stick lock and no real emergency existed until the aircraft pitched up violently and stalled through the top of a loop. In a stalled condition, with no control of the aircraft, and heading for the ground in an inverted position, I experienced no difficulty in making up my mind to bail out. My only concern was that in my hurry to get out I made one mad grab at the ejection handles. I only succeeded in pulling up the canopy handle, of course, but the canopy squibs made so much more noise than I had expected, I thought that I had blown myself free of the aircraft. In looking down, I reaffirmed that I hadn't and squeezed the seat trigger. This delayed my ejection about 2 seconds. The rest of the ride was very enjoyable."

15. "I always had complete confidence in the ejection system. After leaving the seat, I was worried about my legs becoming entangled in the shroud lines while tumbling. I tried twice to turn around to see where I was going, but finally gave up and let well enough alone."

16. "Naturally when our emergency (pitchup) first occurred, I assumed that the aircraft would recover (Previous briefings had indicated this) and it occurred so rapidly that there was no time for

fear—rather—merely an interest in what was happening. When the decision was made to eject, I acted reflexively. In the F-101B, either armrest will blow the canopy and eject the occupant. I cannot overemphasize the importance of this because, being left-handed, I actuated the canopy and seat from the left armrest. I should think this ease of operation would warrant retrofits into other aircraft."

17. "I had just taken off six minutes prior and was at low altitude in hilly country. After experiencing engine trouble, I was certain I would have to bail out. I tried to get thrust and stayed with the aircraft as long as possible. When everything failed, I advised the other pilot we would have to bail out and he acknowledged. After that, I advised him I was jettisoning the canopy and once again he acknowledged. We both then ejected. Within a second or two, I decided to look for and pull the D ring, but, much to my surprise, the chute already was streamed out and opened. (I had the zero altitude lanyard attached to the D ring.) My next thought was This is one ... of a place to be stuck without money so I checked my flight suit pocket and found wallet intact. My next thought (while in weather) was where am I going to land? So I disconnected my helmet and threw it away, thinking that I might land in water. Fortunately I landed in the side of a hill, but the wind drove me along the field (hilly) for a considerable distance. I tried to release the riser, but could not do so until I got to my feet and ran into the open country."

18. "T-33 internal engine failure. This was time to prepare for ejection. No suitable landing area was available. After trying to get to the field and failing, we selected a spot near a highway to eject. It was difficult to decide to actually leave since the aircraft was under perfect control. We delayed ejection a little too long—partly due to forgetting momentarily that ground elevation was about 8000 ft. with higher peaks. Preparation was leisurely, but actual ejection was hurried due to belated realization that it was time to go. Upon raising the arm rest, I am certain that my arms were in proper position. When the canopy did not fire, I pulled the T-handle and the canopy left. Then, I apparently hurriedly replaced my arm and squeezed the trigger. My arm was apparently not tucked into my side and was struck during ejection which severely lacerated and broke it. After the ejection injury, I worried about inability to pull the rip cord with my right arm. But automatic features worked okay. Worried about ground impact, but due to injury, I couldn't do much and impact was not very bad. Main feelings were shock upon injury—great relief when chute opened and more relief when ground contact was made okay."

19. "I first had an indication of trouble at lift-off and began to climb. I decided to eject and let go of the stick and pulled the seat handle up, blowing the canopy. I attempted to squeeze the right trigger, but, with my hand over the handle, my fingers didn't get the trigger. I moved my hand down beside the seat and raked upwards. I had looked down, also, I believe; this, my head was not against the rest but was straight up, and my right arm was not in the rest. I also remember seeing the ground over the nose, indicating that the aircraft had already stalled and fallen forward before I left it.

"Although it did not hinder my separation from the seat, the survival kit release cord hung in the seat and the kit was torn open, inflating the dinghy and losing both it and the kit of gear. As for not being properly positioned, this was due to simply lack of time, as I ejected something like 30 seconds after lift-off. I was violently tumbled around for a short while, and then the chute opened and it was quiet. I was in a face-up position and my feet 30 degrees down from horizontal. I swung backward into some brush and small trees. Contact with the ground was very gentle. The only decision I had to make was to eject, and I reached it very simply because of explosion in the aft section. The only problem was that I had never pulled the handles in an F-100, so I was unprepared for the distance between the handle and the trigger."

20. "At the time of the emergency, I was a student pilot on a dual ride with my instructor. After the mid-air, he controlled the aircraft and made all the decisions. Plenty of time was available between the actual mid-air and the escape from the aircraft. My first reaction was to insure the tightness of my parachute and then cleaning the cockpit up and getting set for the ejection. At no time did I consider staying with the aircraft, instead of ejection. The idea of an unsuccessful ejection did not enter my mind. A successful ejection, followed by a pleasant ride down ends the story. If ever I need to use the ejection system again, it will be done with confidence."

21. "The engine blew up with a loud noise, accompanied by thumps and vibrations. My first thought was that I would have to bail out, but that I was too high. Both fire warning lights came on and, when they didn't go out, within 10 seconds after retarding the throttle, I attempted one radio call—placed my IFF to Emergency and made one quick stab for my bail out bottle green apple. I couldn't find it and decided to go, and pull it later. I didn't think of my visor. I positioned myself in the seat, feet in the stirrups. Just as I raised both armrests and squeezed the right trigger, I wondered if I had disconnected my lanyard and remembered that GCI had reminded me to disconnect it on the way up. From the explosion until ejection was approximately 15-20 seconds. The jolt of the seat wasn't very bad, but the airblast, tumbling and flailing about after leaving the aircraft were severe. I remember thinking, this is a helluva way to die.

"Because I didn't lower my visor or pull the bailout bottle until after ejecting, my mask was twisted and pulled high and to the side of my face. As a result, I didn't get the full effect of the bailout bottle until I realized that my mask was twisted. It was probably 7-8 seconds before I got to the bailout bottle and pulled the apple. It didn't move very far and I thought it hadn't actuated. I reached over with both hands and pulled as hard as I could. The seat was gone while this was going on—I don't remember leaving it. At this point I realized that my mask and helmet were twisted, and repositioned them. I believe that I was becoming hypoxic by the time I did this. If I had taken the time to lower the visor, I don't think I would have felt the windblast as much or had trouble with my mask. I knew then

that I was getting oxygen, as I could feel it on my face. After several deep breaths (I was practically gasping), I heard the pilot chute pop and was given a hard, but not severe, jolt as the main chute opened. About halfway between the time my chute opened and the ground, my bailout bottle gave out and I had a very hard time unfastening my mask. My fingers were very stiff. My thoughts after the chute opened until I hit the ground were about where the airplane had hit, what to do as I landed and whether or not I did the right thing in leaving the airplane. I couldn't tell how high I was until about 50 feet from the ground. I landed in a soft plowed field and sat down hard with no injuries."

22. "Flameout occurred for unknown reasons at cruising altitude of 33,000 feet. I felt there was no particular problem at this time, that the A/C would respond to an airstart and we would continue with no particular difficulty. This was not the case, however, and, after several airstart attempts, the possibility that we would have to bailout became apparent. I turned the plane slightly inland to be sure we wouldn't have to go out over water. It was certain we couldn't glide to any known airfield. A town was sighted at about 15000 feet and a row of lights resembling an airfield was sighted, however, it was not. Bailout became the only course of action and I was concerned about the possibility of my knees hitting the windscreen, as I was wearing a back pack and had not been measured. Altitude was slipping away, so the decision was mutually made to get out. I heard a "click" from the rear cockpit and assumed the other pilot had attempted to blow the canopy. By checking the jettison handles, I found it was still up, so I jettisoned the canopy. After I heard the other pilot go, I made a turn away from all lights on the ground and bailed out with the ejection seat. The next thing I recall is a feeling I was tumbling and wondered why I couldn't get rid of the seat. I came to the conclusion that the lap belt was still attached and attempted to unhook it, with difficulty as my arms seemed to be outstretched and I couldn't get them into the armrests of the seat. This was finally done and I pulled the D-ring and was attempting to pull the arming lanyard when the chute opened."

23. F-100F on takeoff—wingman advised we were on fire, altitude 50 feet. We kept on full power to approximately 1000 feet and ejected. One decision only—get altitude for ejection. Zero lanyard hooked up."

24. I was at 9000 feet in penetration turn inbound at flameout. I pulled aircraft up to 11,000 feet immediately while attempting airstart and headed toward March Field—in sight (clear) but 38 miles away. I thought of these three things first, in this order:

1. Airstart—I've flamed out—it was very quiet all pressure and temperature down.

2. Gain all possible altitude and set up 160K glide.

3. Keep headed toward March—try to make it—heading 314 degrees.

"After about ten airstarts (none of which worked—both normal emergency and normal procedures.) I kept having to tell the passenger not to blow the canopy and bail out—he wanted to at 9M, at 7M and again at 5. Finally I concluded that (1) we couldn't start it, (2) we couldn't reach March, and (3) we'd have to bail out.

"I told him to duck his head and I would blow the canopy. The right armrest is supposed to remain in the horizontal position once it is pulled up from the down position. When horizontal, the trigger comes up off the lower side of the handle and then can be squeezed after the fingers are put around it. My handle did not stop at the horizontal, I pulled it up so that it hit the canopy—about 45 degrees above horizontal. The canopy did not fire. The slide tube, which prevents the handle from returning down to its original position, broke, and the handle snapped down to its original position when I let go momentarily to put my fingers around the trigger. I finally used the T-handle to blow the canopy and held the right handle with my left hand so that I could pull the trigger with my right hand—wasn't easy!

"When the canopy went, I told the passenger to put his feet in the stirrups, his buttocks to the rear, head against head rest, elbows in, left armrest up, right up, squeeze trigger. He did. Good ejection! He went out at 4300 feet indicated, about 2500 feet above ground. I then attempted to eject. By the time I got out, I was about 1000 feet above ground. When I came to, I was headed straight down and there was a tree coming at me fast. I reached for the rip cord and as I did, the chute opened automatically. I never felt the seat separate. I swung once and hit the ground. Opening shock and landing shock were negligible."

25. "When I realized that I would not be able to get full power from the engine, (failure of throttle linkage) I immediately started looking for a place to land the aircraft. I was about 1 mile from a good runway and on a downwind for the runway at 700 feet M.S.D. (Field elevation is 30 feet). My first thought was to glide to this runway. As I started the turn to base and was already unconsciously stretching the glide, I decided to bail out. After raising the armrest, I had to hunt for the triggers. I felt little or no shock from the ejection or chute opening. I felt as if I was tumbling forward when the seat left. I tried to determine if the zero lanyard was connected and found that it wasn't. I then thought to reach back to pull the D ring, however, the chute had already opened automatically. I then looked down to see what I was to land on. I correctly estimated an asphalt road. My immediate thought was that the road would be extremely hard and that the soft-looking fields on either side would make a better landing spot. I tried to relax as much as possible for the touchdown. I think that I closed my eyes so as not to be alerted to the time of touchdown. I highly recommend this procedure as I was very relaxed on the touchdown and didn't receive a landing jolt or injuries."

26. "The aircraft flamed out at 34,000 feet due to icing in the normal fuel filter. As soon as I realized that the aircraft had flamed out, I naturally was thinking of the procedures for an airstart. I was in the back seat and was assisting in aircraft control while the IP attempted airstarts. At first I was not alarmed because I had previously experienced flameouts, and airstarts were successful. However, after several airstarts were unsuccessful and it became apparent that we had also experienced complete electrical failure, it became evident that an ejection would probably be necessary. We were over an undercast and were not certain of our position; however, I kept hoping that we would be able to see the field in order to make a flameout landing. We saw a hole in the clouds and dove through it in an attempt to get our bearings. When it was evident that airstarts were not possible, and that the field was not in sight, we agreed to bail out. I bailed out first and as soon as I was drifting down and saw that the other pilot was out and his chute had opened, I really felt good. In fact, I tried to wave to the other pilot to get his attention. I didn't at any time feel that my equipment would not be safe."

27. "When the emergency (fuel starvation) first came, I was not really worried, I have been flying with my pilot for a year and a half and have complete confidence in him. So at first I was not worried at all. But when the engines did not start when he tried the airstart, I got a little worried. That's when I tightened my leg straps. When I really got scared is when he said he was going to try to ditch it. But the Squadron Commander told us to get out. I was relieved then. I had no fear of ejecting; we were low and slow and it didn't bother me at all. It seems to me it would have been a lot worse at altitude in the cold air, free falling about 10,000 feet. I knew I had enough time, but my mind was going too fast. And I completely forgot my chin strap and my visor was too tight on my oxygen mask and therefore did not lock down. If I had a helmet that fit and a mask to go with it, it might have helped. But the Air Force does not make a medium-sized mask. So, therefore, I believe I will always have a little trouble.

"In any case, when the pilot said Go!, I ejected immediately. Did not even think about it. I just automatically pulled the handle and squeezed the trigger. The seat really gave me a jolt. It knocked the wind right out of me. I didn't know which end was up and I had the sensation of tumbling, but do not think I was. Everything was blurred. I believe I was right on the edge of graying out, and, with the wind rushing past, I felt I was tumbling through the air. I do not remember feeling the chute opening. There seemed to be no shock at all. In a matter of seconds I was hitting the ground. It was not what I was expecting. I did not sting my feet or get bruised at all in the fall. I was really amazed at how easy I hit. I think the shock of the seat on ejection made everything else seem so mild. I was thankful for the D ring lanyard because, thinking back, I don't see how I could have managed to pull the rip cord. It was fast and everything worked perfect. I will not hesitate to eject again. I have every faith in the ejection seat and will be more prepared if it should happen again. The only thing I would do differently is hook my chin strap and put the visor down.

28. "At first a panic and then a thought of the things I must do in proper sequence, including inflating my Mae West, releasing dinghy, and dumping parachute canopy upon contact with water—all this besides normal ejection procedures. For unknown reasons, I did not an automatic chute opening, though my lap belt opened. Possibly I did not have belt fully locked or accidently opened it in preparation for ejection."

29. "I was on final approach for a LABS bombing run when the accident occurred. This involves flight very close to the ground at high airspeed. At the time of the accident I was flying about 50-100 feet above the ground at 500 knots indicated airspeed. The first thing I noticed was slight engine vibrations, but before I had time to evaluate these vibrations, they rapidly became severe and were climaxed by a hard explosion and partial loss of control.

"At this time, I noticed that my eyes were smarting, as if from fumes, and the aft fire warning light was illuminated. The engine was decelerating very rapidly, although I had reduced power only to one-half power. I knew immediately that I was on fire and in serious trouble. My foremost thought was to get out of the aircraft before it exploded again or I lost complete control and crashed without time to eject. From this point on, everything I did was almost an automatic reaction. I simply pulled up slightly and ejected. I do not remember anything going through my mind. I did not consciously go through an ejection procedure or checklist, but I had no trouble ejecting. The push of the ejection seat was mild, but the shock of the slipstream at the high airspeed at which I was moving (approximately 480 KTS) was enough to stun me almost to unconsciousness. I do not remember separating from the seat, but do remember the hard opening shock of the chute.

"I remember seeing the ground coming up at me. I reached up and caught the chute risers and tried to position myself to land. However, muscular coordination had not returned to my legs and I hit the ground in an uncoordinated leap, striking my head on the ground, breaking my helmet and visor, and knocking me out for a second. My chute pulled me slowly along the ground for a few yards until I released the quick release on the left shoulder. If my automatic equipment had not functioned perfectly after ejection, I doubt if I could have done it manually before reaching too low an altitude."

30. "When the engine malfunction occurred, I thought that we had fuel control problems. I was sitting in the back seat (T-33A), so I suggested use of emergency fuel system, which was activated. The vibration did not stop, so the pilot in front stopcocked the throttle. We decided to turn back home (Oaher) but Kauai looked closer, so we headed for it. While the other pilot flew the aircraft, I called the GCI station to let them know of our possible fuel control malfunctioning. After he stopcocked, we turned off unnecessary electrical equipment and turned on our emergency IFF. We both took out our emergency checklist to determine if we overlooked anything. When we saw we would not be able to glide to Kauai, we decided to start the engine and lengthen our glide.

"We decided to eject at 5000 feet, but this altitude is too low if there are any malfunctions such as the canopy failing to jettison and being trapped in the ejection seat. In any case, we wanted to get as close to land as possible. At 6000 feet, I prepared to eject, lowering my visor, disconnecting my oxygen and radio plug and activating my bailout bottle. The canopy would not jettison, so I had to connect my radio plug again to find out why. The pilot told me to pull my right arm rest, which I did, but the canopy did not go.

"He finally got rid of the canopy by unlocking and using the electrical switch. I immediately squeezed my trigger without hesitation. The next thing I knew was that I was tumbling at a rapid rate. I moved unfasten my belt, but the automatic feature operated right away. I pushed the chair without thinking, and noticed I was gyrating wildly. Without attempting to stop the gyrations, I pulled my D ring. The next thing I remembered was that it was very quiet except for the rushing of the air. I looked around for the a/c and the other pilot and saw the explosion and the deployed chute.

"The D ring was still in my hand, so I put it in my pocket as a souvenir. I then released my clipboard and helmet because I thought they would hinder me in the water. Then, to see how high I was, I dropped both shoes and saw them drop out of sight. I then looked out at the horizon and saw I was descending at a rapid rate, so I inflated half of my Mae West, but decided not to ready my quick release of the parachute, fearing it would fall and I would drop from the chute."

31. "When smoke first filled the pit, we tried to find out where it was coming from and/or get rid of it. After going to 100 percent $O_2$, we dumped cabin pressure (of which there was very little), turned off all electrical power after making an emergency transmission, and finally stopcocked the throttle. We then lost interphone control and the IP turned around and motioned upward with his thumb. I wasn't sure whether he meant he was going to blow the canopy or get out, but, assuming the latter, I went about preparing for ejection, stowing equipment, checking that my D lanyard was unhooked, and pulling down my helmet visor. The canopy left, and about 3-5 seconds later, I saw the IP's seat go out so I pulled the H-2 bottle release, raised both armrests, assured ejection position and squeezed the trigger.

"The next thing I knew, after feeling the initial jolt, was that I was still in the seat, tumbling head over heels. I reached down to hit the lap belt release and thought I had unfastened it, but apparently only knocked it out of my lap. I then kicked free of the seat and reached for the D ring. Just then, I looked up at my feet and saw the chute opening, so I left the D ring alone and waited for the opening shock. It was impressive, but not overly severe. The next thing I knew I was hanging in the chute and I looked it over. It appeared to be all right so I settled down as best I could for the ride down, which seemed interminable. I had no idea of my altitude which must have been from 12-15,000 feet, judging from descent time and the functioning of the automatic chute.

"On the way down, I was a little cold and very uncomfortable, especially in the bruised crotch region. I had a few anxious moments when I drifted across some high line wires, maybe 20 feet below me, but decided to take the chance of hitting them rather than risk collapsing the chute by trying to steer it. In addition, I had tried slipping the chute at higher altitude and it seemed to produce very little effect compared to the effect involved. I landed in a plowed field at the intersection of two paved roads, the landing was hard, but I sustained no injuries as I was fairly relaxed and fell in the direction of chute drift. I did worry a little about hypoxia after the chute first opened when I discovered that the hose on the bailout bottle had failed, but decided there was nothing I could do about it and assumed that I must be below (4,000 anyway since the chute had opened automatically). The only difficulty I had had was in reaching for the bailout bottle as if I were wearing a back pack chute. The release position could easily be standardized for both types."

32. "Made decision to eject while IFR from T-33A when low visibility in snow precluded successful GCA and fuel became critical. Pulled up and briefed pilot in rear seat on procedure to be used. We disconnected all leads, except radio cords, and ejected at 5000 feet terrain clearance. Rear seat occupant went first, immediately after canopy. When I ejected, seemed to tumble rapidly for a few seconds (no ground or horizon reference). As tumbling slowed, I realized I was still strapped in seat. Automatic lap belt failed, released manually and immediately separated from seat.

"I remember looking at the D ring as I pulled it. Chute deployed, but seat caught in canopy. Canopy only approximately half open, the rest was tangled, shroud lines slack. Could not see the seat and only knew that canopy was fouled and not fully deployed. My first thought was that I'd had it, but I did not attempt to free the canopy with the risers.

"Did not see ground until just before impact, then realized I'd probably make it okay. But rate of descent was hard to judge, due to poor visibility. Impact was severe. Fell on hip and back in plowed field, suffering severe back strain and compression fracture of Lumbar vertebra. Was not dragged. After impact, noted the seat lying on ground, wrapped in canopy of chute."

33. "Right after the collision, I raised the seat handles and waited for seat to fire. Then I remembered that I would have to regrasp the handles in order to squeeze the exposed trigger. When the chute opened, I didn't know if I was still on earth until I looked up and saw the chute canopy above me. Parachute opened at 30,000 feet or above. Apparently the low altitude D ring lanyard was still connected. Got frostbite as a result (-65 degrees).

"My life raft broke loose and drifted away while descending. First thought was to dive after it. Decided I must be rather high when it drifted out of sight. Half of the water wings inflated by $CO_2$ and the other half had to be inflated by mouth. Released the parachute after I was in the water. Waving my white scarf resulted in being spotted by the Coast Guard cutter.

"The actual ejection was less severe than my formal ejection training. However, my helmet was lost because it was not retained by the Hardman Retention Kit."

34. "I was debating in my mind the decision to go or not to go as the aircraft (T-33) became more difficult to fly on instruments. When I decided to go, I reached down and disconnected my oxygen hose, placed my feet in the stirrups and pulled the left armrest and then the right armrest. When the canopy blew, the cockpit filled with smoke (altitude 27, 500). When I pulled the ejection trigger, my body seemed to compress to about 15 inches in height and I seemed to leap about three feet over the fuselage. I would recommend that aircrew personnel be indoctrinated to expect a severe shock in ejecting. The seat trainers do not push as fast and they create an attitude of complacency.

"The real thing is much more impressive.

"I started a slow forward rotation which gradually accelerated until I was spinning fast. I tried to unfasten the safety belt but couldn't seem to locate it. Then I was free falling or floating quietly, with the wind blowing down my body. I appeared to be spinning head down from left to right in relationship to my body. In an effort to stop the head down position, I thrust out my arms and proceeded to spin head down with my chest to the outside. Because the air was cold down my chest, I manipulated my arms until I tumbled end over end and eventually resumed the original position.

"After falling an undertermined amount of time, I believe that the automatic feature was not working and pulled the ripcord. The chute opening was not so severe as the ejection. It was snowing during my descent and snow kept blowing up my nose. The chute seemed to be oscillating wildly for some time. My feet became cold, but the snow stopped. I could not actuate the back dinghy and, after numerous trys, decided to wait until I was in the water.

"I broke out of an overcast at about 700 feet and could see some lights which were quickly obscured by an intervening ridge. I knew I was near the ground; however, I wasn't braced when I hit and I really hit hard. I was slightly breathless, but managed to take off the helmet and gather up the parachute. My injuries were both knees having cuts and later determined to be loose cartilage torn from knee cap. I am not sure but that the injuries could have occurred during ejection as I am 6'2" tall and was wearing a back chute with dinghy and survival kit."

35. "Just prior to turning the base leg on the landing pattern, I extended the gear and flaps at 185 knots and called "Purple One, base, gear down and checked." Tower acknowledged and cleared me to land. At this point I had approximately 1400 feet altitude. The next incident occurred as I was turning from downwind through base to 45 degrees to the final approach. Airspeed was dropping slowly through 165 knots and I realized that I'd need power to make the runway. When I advanced the throttle, I noticed that the RPM began to drop off slowly. I quickly retarded the

throttle to idle and switched the emergency fuel system. The emergency fuel amber light did not illuminate, but I again advanced the throttle and the RPM continued to drop off. During this lapse of time, the airspeed had dropped to 150 knots and I realize that I could not make the runway. Over the radio I transmitted, "Purple One has flamed out."

"Upon electing to eject from the aircraft, I raised both armrests and the canopy jettisoned. I then apparently assumed a reasonable ejection position and squeezed the trigger in both armrests. The ejection shock seemed light, but I was not fully conscious of its effects. Then complete—or at least partial—confusion was experienced over a period of a few seconds until I began thinking that I must pull the D ring in the event the automatic opener did not function. At this time, I must have been in a horizontal position, facing up, and as I reached for the D ring (which seemed to take a great deal of effort), I glanced over my shoulder and saw the parachute risers trailing behind me. In another second, the chute opened and the shock seemed light. The automatic lap belt had functioned properly, actuating the automatic parachute and the seat had fallen away from me without being kicked away.

"As I swung in the harness, I began thinking again and realized that things had to be done. I knew that I was going to land in water, so I inflated the life raft and it fell away below me, remaining attached to the seat survival kit by a length of rope. I then inflated my life vest. I could look down and see that the water was shallow and that I should attempt to land feet first, but before I could position myself, I hit the water flat on my back. The water was a foot and a half deep and I didn't hit bottom. I stood up in the water and removed parachute harness, survival kit, and life preserver. I piled everything into the raft and began walking toward shore. At this time, I noticed two SA-16's circling overhead and I waved my arms to show them I was all right. I had walked perhaps fifty yards when a helicopter picked me up by lowering a sling from its open side door. For the next week, I experienced sore muscles in every part of my body, particularly in my back. There would have been an easier descent if I had not neglected to fasten my zero second lanyard prior to entering the traffic pattern."

36. "The decision was made for me with no airport in sight, night, weather, low on fuel and no navigational aids. When the aircraft flamed out, I bailed out.

"Storing loose gear before flaming out, I zoomed the aircraft, and, as the plane stalled at about 8500 feet. I raised the handles, blowing the canopy, squeezed the trigger, and ejected. I pulled the ripcord and the chute opened. The only difficulty encountered was terrific oscillation, caused by winds. After hitting the ground, a fence caught the chute and I unbuckled from it and walked to a farmhouse."

## APPENDIX D

The following is a list of Air Force Bases at which MH-15 Ejection Tower Trainers are located. The list was obtained from the Flight Surgeon's Office, Hq. USAF.

Brooks AFB, Texas

Lackland AFB, Texas

Eglin AFB, Florida

Tyndall AFB, Florida

Langley AFB, Virginia

Mitchel AFB, New York

Harlingen AFB, Texas

Webb AFB, Texas

Williams AFB, Arizona

Wiesbaden AFB, Germany

Kadena AFB, Okinawa

Laredo AFB, Texas