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SEP 76 G WITTLIN, M A GAMON
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A METHOD OF ANALYSIS FOR GENERAL AVIATION AIRPLANE STRUCTURAL CRASHWORTHINESS

LOCKHEED-CALIFORNIA COMPANY, BURBANK

SEPTEMBER 1976

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A METHOD OF ANALYSIS FOR GENERAL AVIATION AIRPLANE STRUCTURAL CRASHWORTHINESS

Gil Wittlin

Max A. Gamon

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16. Abstract

The results of the Task I effort to develop a method of analysis of the structural response of general aviation airplane subjected to a crash environment are presented.

A review and evaluation of 8491 accidents obtained from National Transportation Safety Board (NTSB) tapes are presented. Eighteen (18) accident cases from the FAA Civil Aeromedical Institute (CAMI) files are discussed. The performance parameters and structural design characteristics associated with 61 general aviation airplane models are used to establish several airplane categories for light fixed-wing aircraft. An accident data computer program, developed by the Cessna Aircraft Company, is presented.

The requirements for performing computerized crash analysis of general aviation airplanes during probable accident conditions are described. Program KRASH, as modified to meet the requirements of the general aviation industry, is described and assessed with the use of two sets of crash test (stall-spin and overturn) data for a single-engine high-wing and a single-engine low-wing airplane. The mathematical models and the comparison of analysis and test results for both airplanes and accidents are presented. Program KRASH is shown to have the potential to be used as an analytical tool which can facilitate the development of improved crashworthiness in general aviation airplanes.

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METRIC CONVERSION FACTORS

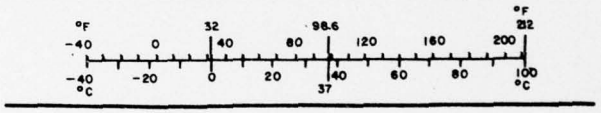
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



FOREWORD

This report was prepared by the Lockheed-California Company under Contract DOT-FA75-WA-3707. The report contains a partial description of the effort performed as part of Task I and covers the period from July 1975 to July 1976. The work was administered under the direction of the Federal Aviation Administration Development Section C, with H. Spicer acting as Technical monitor.

The program leader was Gil Wittlin of the Lockheed-California Company. Important contributions were made to the program by the Cessna Aircraft Company, which participated as a subcontractor. Under the direction of D. J. Ahrens and W. B. Bloedel, the Cessna Aircraft Company provided valuable data with regard to general aviation structure, designs, and procedures and developed a computer program for selecting accident data from NTSB tapes. M. A. Gamon of the Lockheed-California modified program KRASH, which he originally developed. R. Ortiz of the Lockheed-California Company provided valuable computer programming support. P. C. Durup of the Lockheed-California Company assisted in the preparation of reports. The Lockheed effort was performed under the supervision of J. E. Wignot.

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SUMMARY

The results of the Task I effort to develop a method of analysis of the structural dynamic response of general aviation airplanes subjected to a crash environment are presented.

Included in this report is the review and evaluation of 8491 accidents obtained from the National Transportation Safety Board (NTSB) tapes for the period 1971 through 1973, the detail evaluation of 18 accident cases from the FAA Civil Aeromedical Institute (CAMI) accident files, and the performance parameters and structural design characteristics associated with 61 general aviation airplane models produced by the major domestic manufacturers. Several categories are established and presented which relate airplane configuration (low-wing, high-wing, single-engine, twin-engine), performance (speed, weight), usage, and occupant capacity. The accident data is related to the airplane categories with the use of a computer program designed to select and process NTSB accident data. This computer program was developed by the Cessna Aircraft Company during this task and is described, in detail, in Appendix A. The accident data is presented with regard to the potential of incurring fatalities during probable accident conditions.

The current and near future computer capability available to the general aviation industry was investigated and found to be compatible with the reasonably large computer programs needed to perform crash analysis. Requirements for performing computerized crash analysis of general aviation airplanes during probable accident conditions are presented. These requirements are compatible with the need to analyze reasonably complex crash conditions, yet, not impose unrealistic and costly investments in specialized manpower and/or equipment to facilitate improved future crashworthy designs.

Program KRASH is briefly described. The modifications to meet the requirements of the general aviation industry, as well as expand KRASH's versatility, flexibility and economy of operation are described. The capability

of program KRASH, modified during Task I, is assessed with the use of two sets of crash test data (stall-spin and overturn) for a single-engine high-wing airplane and a single-engine low-wing airplane. The tests and their results are described in detail. The math models for both airplanes and crash conditions are presented.

Program KRASH is shown to have the potential to be used as an analytical tool which can facilitate the development of improved crashworthiness in general aviation airplanes. The program requires verification with fully instrumented full scale crash tests to ascertain its maximum capability, as well as define its limitations.

The results of the Task I effort are summarized prior to stating the Task I conclusions. Appendices B and C are included and contain film analysis data, airplane model data and typical structural data and configurations for the two airplanes which are analyzed in Task I.

The development of a KRASH User's Manual and structural crashworthiness design guidelines during the Task I effort is described in a separate document.

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SECTION 1

INTRODUCTION

1.1 BACKGROUND

The general aviation industry has grown to the point where their airplanes now carry 90 million people annually and operate out of all the nation's 12,700 airports (Reference 1). Since general aviation airplanes have been proven to be competitive with other forms of transportation, it can be anticipated that the industry's growth rate will continue to accelerate rather than abate. With the increase in air traffic there has been an increase in the number of injuries and fatalities as a result of aircraft accidents. Correspondingly, an increasing effort is being expended to reduce the number of persons injured and the number of deaths resulting from vehicular accidents. The aircraft industry has been mindful of their obligations in this area over a number of years. Through the guidance of the FAA (CAA in the past) great strides have been made in the prevention of accidents by including improved air safety and airworthiness characteristics in the design of aircraft. FAA requirements have been developed and proven by study, tests and operations, that have led to significant improvements to survivability in controlled crashes. These requirements have primarily pertained to seat, harness and seat attachment strength capabilities. General airframe capability requirements for controlled crashes have been in the form of showing that the ditching characteristics and structural strength, under certain impact conditions, will not inhibit egress from the airframe.

The controlled crash requirements have undoubtedly provided some measure of protection for the more severe uncontrolled crash. Efforts such as the joint program sponsored by the FAA (CAA) and the Department of Agriculture in 1950 at Texas A and M have resulted in the development of an agricultural airplane with significant crashworthy features. The designers recognized

that to survive a crash that may be encountered by this airplane, the occupant chances of survival could be increased by placing the hopper, a large mass item, ahead of the pilot which then acted also as crushable material on impact. In addition, the cockpit was designed to provide a protective cage for the pilot during uncontrolled crash conditions and was equipped with a seat and harness of commensurate capabilities. This effort illustrated what could be accomplished with an airplane of a specific configuration having a definable mission and that normally flies at low airspeeds. This agricultural airplane program undoubtedly has resulted in the saving of a number of lives because it formed the basis for later agricultural airplane designs.

FAA sponsored research in the areas of seat harness designs, seat attachment strengths, and fire hazards has improved the occupant's chances to survive under crash conditions. With the progress in technologies and the ability to reduce them to practice, further advancements in crashworthiness can be expected. However, the methods that are to provide the advancements must be adaptable to a number of practical considerations in order to be successful. Some of these considerations are:

- o ease of airframe producibility,
- o operational use of the airplane,
- o adaptability to various preliminary design iterative procedures,
- o effect on airframe weight and cost, and
- o adaptability to various airframe configurations and airplane crash conditions.

In addition to these practical considerations, the methods that produce the advancements in crashworthiness must reliably predict for occupant safety whether or not

- o the structure containing the habitable space will collapse sufficiently to impinge upon the occupant,
- o the structure will crush and deform in a controlled predictable manner such that the forces imposed upon the occupant are minimized, and

- the occupant is protected from lethal blows as a result of contact with hardware.

Through efforts sponsored by the FAA, NASA/LRC (Reference 2), and the U.S. Army, Fort Eustis Directorate, methods have been and are being developed which predict the response of airframes and the occupants to impacts encountered in crash conditions. The methods vary in concept, detail, and philosophy; but all approaches have as an end objective the provision of a tool by which the crashworthiness of aircraft can be improved. Since the airframe must properly dissipate the energy imposed by a crash impact, the ability to describe the energy absorption characteristics of the various parts comprising the airframe as well as their interaction is of prime importance. There are a number of programs for predicting the airframe response accurately in the elastic range backed by a great amount of test data. However, the energy in the elastic range of an airframe is minor when compared to the total energy to be absorbed in a crash. Consequently, the success of any methods that are intended to predict airframe response to a crash impact depends primarily on the ability to define the airframe response in the nonlinear range.

Ideally the nonlinear response could be analytically obtained by using a micro-finite element representation of the structure. However, several difficulties have to be overcome before such a representation can become practical such as: definition of the exact characteristics of the element (linear and nonlinear) and how they interface, management of the large amount of data that would be required, and proper handling of the expected large deflections (in the order of 10 times the dimensions of the elements). In addition, as a practical matter, experience with crushing of sheet/stringer types of built-up structures indicates that, although the total performance is repeatable, the detail response of the various parts of the structure will vary as a result of differences, within tolerance, encountered in manufacture. These difficulties with the micro-finite element representation which may be overcome in the future) and the need to provide guidance in selection of adequate crashworthy structural concepts early in the preliminary design stages of an airframe to minimize penalties, suggest that a simpler representation be employed.

Recent efforts, References 3 and 4, have shown that complete vehicle analysis for multidirectional crash conditions can be performed in a practical and cost-effective manner. The programs described in References 3 and 4 involved verification of analytical techniques with full-scale vehicle and substructure testing. The results of these programs and that of the FAA sponsored three-dimensional mathematical model of an aircraft seat, occupant, and restraint system (Reference 5) form the basis for the formulation of analytical methods for evaluating and upgrading the crashworthiness of general aviation airplanes.

The development of analytical methods to assess the crashworthiness capability of airplanes, while important, is not sufficient in itself to assure that general aviation airplanes will be crashworthy in the future. In addition, supporting procedures and rational crash design criteria are required. The development of methods for showing compliance with crashworthiness design criteria requires that particular consideration be given to the crash condition as it applies to different types of airplanes and to different operational requirements which affect the probable crash conditions. In Reference 1 it is stated that 72 percent of all general aviation operations are for commercial purposes (business, air taxi, commuter airlines), 23 percent involves personal transportation and proficiency flying, and 5 percent involves sport flying. Thus, using accident data in conjunction with usage data can provide some indication of the accident conditions that are most likely to produce the greatest amount of fatalities and injuries.

In general, the basic ingredients for a further step forward in improving the crashworthiness of future general aviation airplanes are available; however, refinements and verification of the analytical methods are needed along with formulation of the procedures needed to incorporate the techniques in the iterative design process.

1.2 PROGRAM OBJECTIVES

The objectives of the program are:

- to develop a computerized mathematical simulation which can predict the dynamic response of general aviation airplanes when exposed to a crash environment,

- o to develop proposed design crash environment criteria for general aviation airplanes,

- o to identify and analyze preliminary design concepts to be used in formulating a potentially optimum crashworthy airframe design configuration for future consideration, and

- o to develop a user's manual for the mathematical simulation including supporting structural crashworthiness design guidelines.

To facilitate the achievement of the stated objectives, the study is performed in the following three technical tasks.

Task I - Development of a mathematical simulation

Task II - Verification of mathematical simulation with full-scale controlled crash test data

Task III - Development of proposed design crash environment criteria and the formulation of an optimum conceptual crashworthiness configuration

The goals for each of the major tasks are delineated as follows.

TASK I GOALS

- o Evaluate and summarize accident data to assist in developing computer modeling requirements, selection of test conditions for verification of a computer simulation and developing crash environment design criteria.

- o Identify general aviation airplane structural design features and the characteristics and crash conditions that the mathematical models must be capable of treating.

- o Evaluate current and future computer capability within the general aviation industry.

- o Modify, as needed, the capability of existing computer program KRASH to meet the requirements for modeling light fixed-wing propeller driven general aviation airplanes under crash conditions.

- o Develop a user's manual and supporting structural crashworthiness design guidelines to facilitate the application of program KRASH by industry members.

TASK II GOALS

- o Provide compatibility between the output of the computerized mathematical model developed in Task I and the input requirements of the mathematical model of an aircraft seat, occupant and restraint system (Reference 5).

- Perform three full-scale controlled crash tests using fully instrumented single-engine high-wing airplanes representing both probable accident conditions and a potentially catastrophic impact condition.

- Verify the crash analysis capability using controlled crash test data for single-engine high-wing airplanes (to be performed during the program) and available crash test data for a twin-engine low-wing airplane and a partial airframe structure.

- Perform correlation studies using test and analytically derived data and refine the mathematical simulation, as required.

TASK III GOALS

- Perform parametric variation studies to demonstrate the capability of the mathematical simulation to model a wide range of airplane configurations and crash conditions.

- Develop proposed design crash environment criteria based on the results of Tasks I and II.

- Formulate an optimum conceptual crashworthiness configuration taking into consideration the crash environment, current and future crashworthy features, and the cost, weight, and performance trade-off penalties.

In this report only Task I related items are presented. Task II and Task III will be reported on at a later date.

SECTION 2

REVIEW AND EVALUATION OF GENERAL AVIATION AIRPLANE DESIGN CHARACTERISTICS

2.1 AIRPLANE CONFIGURATIONS

The development of a mathematical model which is capable of predicting the dynamic response of the structure and occupants for light fixed-wing airplanes during severe, yet survivable, accidents requires that consideration be given to those conditions that influence the manner in which the structure containing habitable space deforms and the forces that are imposed on the occupant from the response of the airplane structure and/or the occupant's motion relative to hardware that he may impact. Examples of airplane configuration design characteristics that potentially influence the load pulse imparted to the seat during a crash are:

- o location of the wing relative to the cabin and occupant position
- o location of engine, or engines, with respect to the cabin; wing mounted (high or low), forward or aft
- o type of landing gear; fixed or retractable

The loads imposed on the airframe and the occupants are a function of airplane usage, structural design, and location of major masses and attachments. Consequently, it is desireable to identify the various airplane configurations and associated characteristics in a manner which will lead to the development of mathematical modeling requirements and rational crash environment design criteria. The following types of airplane configurations represent a majority of the various configurations of airplane designs presently operating:

a. single-engine, low-wing

b. single-engine, high-wing

c. twin-engine, low-wing

d. twin-engine, high-wing

There are a few variations within these categories, such as a tandem push/pull propellor driven airplane.

2.2 OPERATIONAL USAGE AND GENERAL STRUCTURAL DESIGN CHARACTERISTICS

A total of 61 general aviation basic airplane models, produced by the seven leading domestic manufacturers in the industry, were reviewed with regard to their operational usage and structural design characteristics. While not all inclusive, the data is representative of more than 95 percent of the general aviation airplanes currently in operation. Pertinent information such as: probable usage, approximate maximum cruise (75 percent power) and stall speed (flaps down), number of engines, wing position, type of structure and passenger accommodations is noted. The data is compiled from Reference 6 and discussions with industry airplane design personnel. The following airplane manufacturers and their respective models* are represented:

Piper:	PA-18, PA-23, PA-24, PA-25, PA-28, PA-31, PA-32, PA-34, PA-36, PA-39
Beech:	A24R, B24R, B19, C23, V35B, F33, G33, A36, E55, B55, Baron 58, A60, B60, B80, A50, C90, E90, B99
Cessna:	150, 172, 177, 180, 182, 185, 188, 206, 207, 210, 310, 337, 340, 401, 402, 414, 421
Bellanca:	Viking 300A, Champion 7ECA/7GCAA/7KCAB Citabria, 8GCBC, 8KCAB
Grumman-American:	AA-1B, AA-5, AA-5B, AgCat
Mooney:	Ranger (Mark 21), Chapparral (Super 21), Executive
Rockwell International:	112A, 500S, 685, 690, S2R

* Some models are no longer manufactured.

The categories of usage associated with general aviation airplanes are listed below along with the category general description.

a. Agriculture: Application of chemicals or seeding crops involving low altitude maneuvering flight.

b. Sport, aerobatic: Performance of sporting and aerobatic functions usually involving high maneuvering load factors.

c. Training: Used for instructional purposes usually involving initial flight training. Some of the larger airplanes may be classified as trainers for instrument rating purposes which is not the usage that would lead to the accidents encountered in initial flight training operation.

d. Business, executive: This category may overlap into several areas, such as transport, cargo, and in a few cases testing and developing equipment. These airplanes in some cases may operate out of uncontrolled airfields.

e. Commuter, transport, air taxi: Used to carry people for commercial purposes in very short-range flights and may include operations from uncontrolled airfields.

f. Cargo, freight: Hauling of freight or cargo which can include operations from uncontrolled airfields.

g. Utility: This is a multipurpose usage. Generally, an airplane in this category is used in activities such as ranching, photographing, power and pipeline inspection, ambulance work, and support transportation which requires operating from unprepared airfields.

h. Pleasure: Generally applicable to smaller economical airplanes used mainly for the purposes of flight proficiency and personal transportation.

Most of the airplanes, with the exception of agricultural airplanes, have multiple uses. Some airplane models have as many as three different usages. Of the 61 airplane models included in this evaluation, twenty (20) are twin-engine low-wing airplanes, twenty-four (24) are single-engine low-wing airplanes, including five* agricultural types, thirteen (13) are single-engine high-wing airplanes, and four** (4) are twin-engine high-wing airplanes. The usage of the airplanes, considering the number of engines, can

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* One biplane is included.

** One has the engines mounted in tandem on the fuselage.

be seen by the following distribution. (Because some models are used for multiple purposes, the total number of usages exceeds the number of models included in the evaluation.)

Usage	Number of Airplanes Twin-Engine	Single-Engine
Executive/Business	18	20
Training	3	11
Commuter	10	10
Aerobatics/Sport	-	11
Cargo/Freight	5	4
Utility	2	7
Agriculture	-	5

Table 1 presents a matrix of airplane configurations as a function of maximum takeoff weight and usage.

Table 2 identifies the general structural design characteristics of the major airframe regions such as the wing, fuselage, engine attachments, landing gear, and empennage associated with different categories of airplanes. (The categories shown in Table 2 are defined in Section 2.3.)

Engine mounts are generally either of a steel tube arrangement type or of a keel type. Figure 1 illustrates an arrangement for each of these two types. The structural characteristics for the two arrangements will differ; and, consequently, the modeling requirements will have to satisfactorily represent their behavior if a reasonably accurate assessment of the entire airframe response is to be performed. The failure of the tubular structure (Figure 1(a)) may likely be through dynamic instability which will occur at a load which is substantially below the yield stress. Wherein failure through elastic instability occurs, the load carrying capability of the structural element tends to decrease rapidly as deflection increases once the failure

TABLE 1. MATRIX OF AIRPLANE CONFIGURATIONS AND MAXIMUM TAKEOFF WEIGHT AND USAGE

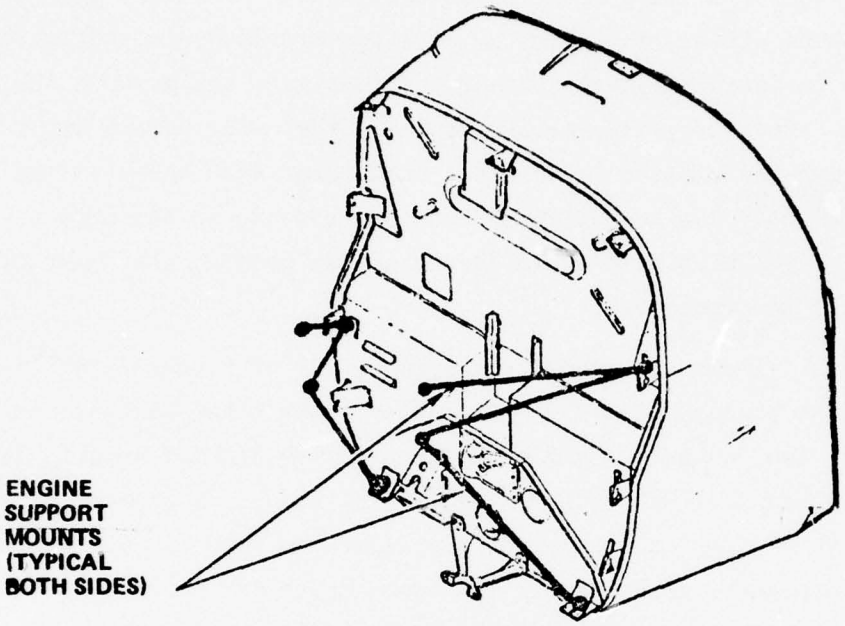
Maximum Takeoff Weight (lb)	Single-Engine Low-Wing	Single-Engine High-Wing	Twin-Engine Low-Wing	Twin-Engine High-Wing
≤ 2000	Trainer Utility	Aerobatic Pleasure Trainer		
2000-2499	Trainer Sport Utility Pleasure	Trainer Business Aerobatic Utility Pleasure		
2500-3999	Business Agriculture Commuter Trainer Utility Pleasure	Business Utility Cargo/Freight Commuter Pleasure		
4000-5999	Agricultural (a)		Business Commuter Cargo	Business Commuter
6000-7999			Business Commuter Cargo/Freight	Business Commuter Cargo/Freight
8000-12500				Business Commuter

(a) Consits of one low wing and one biplane

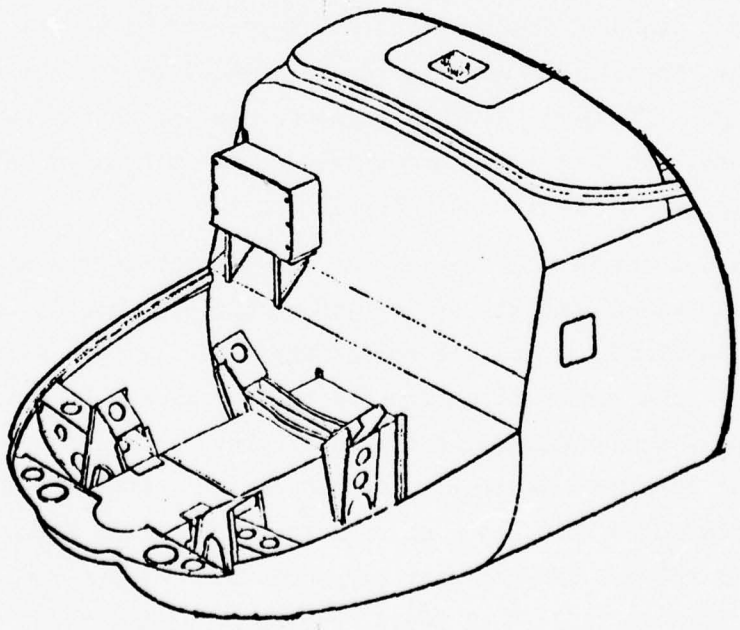
TABLE 2. STRUCTURAL DESIGN CHARACTERISTICS OF CURRENT GENERAL AVIATION AIRPLANES

Structure	Category 1 Single-Engine, Low or High-Wing, Weight < 2500 lb.	Category 2 Single-Engine, Low or High-Wing, Weight 2500-4000 lb.	Category 3, Single-Engine, Low-Wing, (a) Agricultural Use Only, Weight 2500-4000 lb.	Category 4 Twin-Engine, Low or High-Wing, Weight 4000-10900 lb.
Wing	o Braced Wing 1,2 or 3 spar, mostly metal, some wood spars o Cantilever 1,2 or 3 spar, mostly metal, some wood spars	o Cantilever 1,2 or 3 spar mostly metal, some wood spars	o Braced 1 or 2 spar metal construction	o Cantilever 1,2 or 3 spar, mostly metal, some wood spars o One braced, all metal
Fuselage	o All-metal semi-monocoque o Rectangular section welded steel tube o Keel formed by floor and lower skin (cabin), semi-monocoque (rear)	o All-metal semi-monocoque o Weld steel tube o Welded steel tube (cabin), semi-monocoque (rear)	o Rectangular section welded steel tube o Welded steel tube (cabin), semi-monocoque (rear) o Long nose section o Isolated occupant region o Strong turnover structure	o All-metal semi-monocoque
Engine Attachment	o Tubular	o Tubular o Keel	o Tubular	o Tubular o Keel
Landing Gear	o Tail wheel o Tricycle o Cantilever spring main gears o Nonretractable	o Tail wheel retractable o Tricycle retractable and nonretractable o Cantilever spring main gears o Hydraulically activated system	o Tail wheel type o Nonretractable o Cantilever spring main gears	o Mostly tricycle retractable o Some nonretractable with cantilever spring main gears o Hydraulic or electromechanical actuated system
Tail Unit	o Cantilever all-metal o Welded steel tube and channel with fabric covering	o Cantilever all-metal	o Welded steel tube o Cantilever all-metal	o Cantilever all metal

(a) With the exception of one biplane



(a) Tubular



(b) Keel

Figure 1. Two Typical Engine Mount Arrangements

load has been reached. The keel mount arrangement shown in Figure 1(b) can be expected to behave differently. The mount structure for this configuration can be considered to be an integral part of the fuselage, and as such the deformation of the structure will involve crushing that will absorb considerable energy during the plastic deformation associated with the post-failure region. The location of the two different mounts relative to the impact region and terrain will also have an influence on the loading that each of the structures will be exposed to.

The wings in all airplane categories are generally of a cantilever (with the exception of one biplane with flying wires and interplane struts) design with either a one, two, or three spar arrangement. The lighter weight airplanes usually have supporting brace struts for the wing. While most wings are all metal, some of the lighter weight airplanes use wood spars. The wings for the heavier airplanes, particularly the twin-engine airplanes (4,000 pounds and up) generally are unbraced and are of an all metal construction. The empennage for most airplanes is usually an all metal cantilever structure. The landing gear arrangement tends to be a function of weight, the light weight (<2500 pounds) airplane uses a tricycle or tailwheel nonretractable landing gear, wherein the main gears are usually of a cantilevered metal spring design. The agricultural airplanes use tailwheel type nonretractable landing gears, while the heavier single-engine airplanes (2500-4000 pounds) predominantly employ retractable tricycle gears.

Fuselage construction for most of the airplanes (the agricultural airplanes are an exception) are of semi-monocoque construction. A few of the single-engine airplanes and all of the agricultural type airplanes use a welded steel tube construction for the cabin region. In some instances a combination of semi-monocoque and welded tube construction is employed. The agricultural airplanes generally contain design features that are unique such as isolated cockpit, long nose section and strong turnover structure. In all the airplanes the occupant accommodation designs and arrangements vary widely and include individual seats, reclining seats, front and rear facing seats, bench seats, side facing seating, tandem seating, articulated seats, progressively collapsible seats, and a variety of lap belt and shoulder

harness arrangements. Details concerning material characteristics, typical structural components and examples of fastening methods used in the design and construction of general aviation airplanes are presented in Appendix B.

Table 3 presents a grouping of the general aviation airplanes as a function of configuration, maximum takeoff weight, stall speed, operating speed, usage and occupant capacity. Combining the data presented in Tables 1 through 3 provides the following general information on the three major airplane configurations.

a. Twin-engine low and high-wing airplanes

- o Maximum takeoff weight range is 3700 pounds to 10,900 pounds, with the majority of twin-engine low and high-wing airplanes weighing between 5300 and 8700 pounds and between 5700 and 9600 pounds, respectively..
- o Stall speed (landing configuration) range is 59 to 82 knots.
- o Cruise speed range (75 percent of max. power) is 162 to 280 knots.
- o Retractable tricycle gears are used.
- o Both tubular and keel type engine mounts are used.
- o A predominantly semi-monocoque fuselage structure is used.
- o Shoulder harnesses and design features which would reduce the potential for occupant injury from impact with structure (padding, no protrusions) are not incorporated as standard features.
- o Occupant capacity ranges from 4 to 11 (except B99 airliner).

b. Single-engine low and high-wing airplanes, except agricultural airplanes

- o Maximum takeoff weight range is 1560 to 3900 pounds.
- o Stall speed (landing configuration) range is 38 to 61 knots.
- o Maximum cruise speed (75 percent max. power) range is 100 to 176 knots.
- o Occupant capacity ranges from 2 to 6.
- o Both retractable and non-retractable type landing gears are used.
- o Wing construction is usually unbraced cantilever with two or three spars.

TABLE 3. RELATIONSHIP OF GENERAL AVIATION AIRPLANE CONFIGURATIONS TO PERFORMANCE PARAMETERS, USAGE AND OCCUPANT CAPACITY

Airplane Configuration	Maximum Takeoff Weight (Pounds)	Stall Speed Range, Flap Down (Knots)	Cruise Speed Range, 75 Percent Max. Power (Knots)	Primary Usage	Occupant Capacity
Single-Engine Low-Wing	< 2500	49-54	108-128	Training Pleasure	1-4
Single-Engine High-Wing	< 2500	38-45	100-114	Training Pleasure Aerobatics	2-4
Single-Engine Low-Wing	2500-4000	49-61	132-176	Business Commuting Training Utility	4-7
Single-Engine High-Wing	2500-4000	45-59	124-163	Business Utility Cargo	4-7
Single-Engine (a) Low-Wing	2900-6000	47-59	101-138	Agriculture	1
Twin-Engine Low-Wing	3700-10900	59-82	162-247	Commuting Business Cargo Commuting	4-17 (b)
Twin-Engine High-Wing	4600-10250	61-77	170-280	Business Cargo Commuting	4-11

(a) Includes one biplane

(b) 17 occupants for 1 airplane only, otherwise maximum is 11

- o Fuselage structure is semi-monocoque design.
- o Shoulder harnesses and design features which would reduce the potential for occupant injury from impact with structure (padding, no protrusions) are not generally incorporated as standard features.

c. Single-engine agricultural airplanes

- o The maximum takeoff weight range is 2900 to 6000 pounds.
- o The stall speed (landing configuration) range is 47 to 59 knots.
- o The maximum cruise speed (75 percent max. power) range is 101 to 138 knots.
- o Crashworthy design features such as overturn structure, shoulder harness, padded instrument panel, isolated cockpit and long nose structure are incorporated.
- o The fuselage consists of a welded steel tube truss type of structure.
- o Wing construction is generally braced cantilever design with the exception of one biplane.
- o Landing gears are non-retractable tailwheel with cantilevered spring steel main gears.
- o Single place cockpit.
- o Payload carried forward of the pilot.
- o A tubular engine mount support structure is used.

The design characteristics of the various categories of general aviation airplanes described herein indicate that there is a tendency for a particular manufacturer to generally use the same type of design features, including structure, because of past success, engineering cost considerations and ease of manufacture.

2.3 AIRPLANE CATEGORIES

The review and evaluation of the various airplane configurations discussed in Sections 2.1 and 2.2 indicate that there are several categories that can be established to facilitate the accident data evaluation, the development of mathematical modeling requirements and the development of crash environment design criteria. The crash environment depends primarily

on airplane usage and operating speeds while the modeling requirements, to ascertain the survivability of occupants during a crash, include consideration of not only the crash environment but also the airplane structural configuration. From Table 3 it can be seen that light single-engine airplanes (< 2500 pounds) have similar usage and operational requirements, irrespective of the wing and engine configuration. This situation implies that they may be exposed to the same crash environment. How the airplanes respond to the crash environment can be influenced by the location and method of attachment of the major mass items (i.e. wing, engine). Similarly it can be expected that the heavier weight (2500-4000 pound) single-engine airplanes (except agricultural configurations) and the twin-engine airplanes, because of their differences in weight, operating speeds and usage, can each be exposed to their own particular crash environment, which is not a function of the wing and engine locations. (Agricultural airplanes, because of their unique mission, can be exposed to an entirely different crash environment than that of the other airplanes.) Consequently, the definition of the crash environment for general aviation airplanes can be obtained from as little as four categories, as shown in Table 4. On the other hand, the requirements for modeling the different airplanes and assessing current capability to protect occupants during a severe crash may indicate the need for additional categories. Thus subcategories (i.e. 1A, 1B, 2A, 2B, and 4A, 4B), shown in Table 4, are also established and used as noted in the following sections of this report.

TABLE 4. CATEGORIES FOR GENERAL AVIATION AIRPLANES

Category	Airplane Configuration	Maximum Takeoff Weight (Pounds)	Stall Speed Range Flap Down (Knots)	Cruise Speed Range 75 Percent Max. Power (Knots)	Primary Usage	Occupant Capacity
1	Single-Engine A. Low-Wing B. High-Wing	<2500	38-54	100-128	Training Sport Aerobatic Pleasure	1-4
2	Single-Engine A. Low-Wing B. High-Wing	2500-4000	45-61	124-176	Business Utility Commuting Training	4-7
3	(a) Single-Engine Low-Wing	2900-6000	50-53	101-122	Agriculture	1
4	Twin-Engine A. Low-Wing B. High-Wing	>4000-10900	59-82	162-280	Business Cargo Commuting	4-11 (b)

(a) Includes one biplane

(b) Except for 1 airplane accommodates 17

SECTION 3

REVIEW AND EVALUATION OF ACCIDENT DATA

3.1 SOURCES OF DATA

The primary sources for the accident data used in the study are:

- o FAA Civil Aeromedical Institute (CAMI), Oklahoma City, Oklahoma
- o The National Transportation Safety Board (NTSB), Washington, D.C.
- o General aviation accident investigation summaries and reports

The FAA Civil Aeromedical Institute is situated in Oklahoma City. Crash investigators from CAMI cover only a selected number of accidents that mostly occur in the states of Oklahoma, Texas and Arkansas. The records for each accident contain, when available, the airplane make and model identification, the flight condition under which the accident occurred (i.e. crop spraying maneuvers, loss of power, stall on turn, obstacle impact), impact angle, post crash behavior, stopping distance, structural damage, use and condition of seat belts and harness, number of occupants involved, occupant injuries/fatalities, and cause of injuries/fatalities. Some of the accident reports contain photographs of the airplanes in the post crash condition. Copies of 18 accident reports, obtained from CAMI, were reviewed and evaluated. The results of this effort are contained in Section 3.2 of this report.

The National Transportation Safety Board compiles records of accidents that have occurred throughout the nation. The data from these accidents are stored on tape by calendar year. While the tapes may be accessed such that a requester may solicit several sheets of data concerning each accident, much of the information needed to support this program does not appear as a regular part of the format. The Cessna Aircraft Company,

prior to developing the program described herein, developed a computer software program which utilizes portions of the accident data from the NTSB tapes. While the format of the Cessna accident software program provides useful information it was decided that in order to meet the objectives of this project the software program should be refined. The changes to the software program and the results of the NTSB data evaluation are presented in Section 3.3. Details of the software program (a copy of which has been submitted to the FAA) including a User's Manual and listing are presented in Appendix A.

In addition to the NTSB and CAMI data, several reports which provide summaries of accident data and/or descriptions of selected accidents were reviewed. The information obtained from these reports was included as part of the accident review and evaluation. In particular, the information contained in References 7, 8, 9, 10 and 11 was reviewed and the applicable data is integrated into the discussions contained in Sections 3.2 and 3.3.

3.2 CAMI DATA

At the initiation of this program, CAMI investigation reports (References 7 and 8) were reviewed. The latter reference contains a summary of 110 accident investigations and presents data describing the accident, identifying the airplane, on the location of the accident, on the accident type, concerning airplane damage, and data on occupant injury. The summary data provided in Reference 8 was used as a guide in the selection of the detailed accident cases that were obtained from CAMI. Photographs and case histories came from an on-site search of CAMI records. The criteria for selecting a CAMI recorded accident for detail review required that the particular accident report contain information regarding one or more of the following: flight path angle at impact; impact velocity; stopping distance; airplane pitch, roll or yaw angle at impact; and availability of photographs.

Data for the 18 accident cases selected from CAMI files for detail review, are presented in Table 5. Table 6 is a summary of the results

TABLE 5. Description of Detailed Accident Cases Obtained From CAMI(f)

Accident Case	Airplane Designation	Airplane Configuration	Maximum Takeoff Weight(lb) (g)	Accident Type	Kinematics: Impact Angle (degrees)	Kinematics: Deceleration Distance (feet)	Structural Damage: Fuselage	Structural Damage: Wings	Structural Damage: Terrain Composition	Seat Failures: Used	Cabin Accommodations: Lap Belt: Failed	Cabin Accommodations: Lap Belt: Install	Cabin Accommodations: Shoulder Harness: Used	Cabin Accommodations: Shoulder Harness: Failed	Occupant Injury Data (h): Fatal (e)	Occupant Injury Data (h): Critical (b)	Occupant Injury Data (h): Serious (c)	Occupant Injury Data (h): Moderate (d)	Occupant Injury Data (h): Minor/None (e)	Occupant Injury Data (h): Probable Area of Fatal Injury	Occupant Injury Data (h): Probable Area of Occupant Impact	Occupant Injury Data (h): Post Crash Fire	Remarks
1	Piper PA-25 N6128Z	Single-Engine, Low-Wing		Stalled (Aerial Application	45	NA	1. Fwd nose strut crumpled. 2. Cockpit bent.	1. Destroyed by tree	Hard Ground	Yes	Yes	Yes	Yes	Yes	Yes			1C			1.Inst. Panel at windshield 2. Hopper 3. Rudder Pedal	No		
2	Cessna C-140 N90045	Single-Engine, High-Wing		Contacted Power Line (Enroute)	30	64	Fwd Nose Section		Hard Ground	NA	NA	NA	NA	NA	NA	1C					1.Control wheel 2. Rudder Pedal 3. Lower Fuselage Structure	No		
3	Cessna C-182B	Single-Engine, High-Wing		Enroute: Fin sheared by telephone wire over lake, dived into water from 18'	NA	NA	Fin torn off by wire		Water	NA	NA	NA	NA	NA	NA	1P 1C					1. Instr. Panel		Asphyxiation

TABLE 5. Description of Detailed Accident Cases Obtained From CAMI(f) (Cont'd)

Accident Case	Airplane Designation	Airplane Configuration	Maximum Takeoff Weight(lb) (g)	Accident Type	Kinematics: Impact Angle (degrees)	Kinematics: Deceleration Distance (feet)	Structural Damage: Fuselage	Structural Damage: Wings	Structural Damage: Terrain Composition	Seat Failures	Cabin Accommodations: Lap Belt Used	Lap Belt Failed	Lap Belt Install	Shoulder Harness Used	Shoulder Harness Failed	Fatal (a)	Critical (b)	Serious (c)	Moderate (d)	Minor/None (e)	Occupant Injury Data (h): Probable Area of Fatal Injury	Probable Area of Occupant Impact	Post Crash Fire	Remarks
4	Piper PA-24-250	Single-Engine, Low-Wing	2900	Struck Ground (Enroute)	0	305	Fuselage Broke Aft of Cabin		Mud	2*	Yes	No	NA	NA	NA		1P	1C 2P			1.Inst. Panel 2.Control Wheel 3.Seat Back	No		*Two Passenger Seat Back
5	Mooney M-20 N2570W	Single-Engine, Low-Wing		Hit Trees & Impact Ground (Forced Landing)	9	NA		Damaged by Trees	Grassy pasture	NA	NA	NA	NA	NA	NA	1P	1C 1P			*	1.Inst. Panel 2.Control Wheel	Yes (Engine Comp)		*Fatality was involved in auto accident. Victim dead before crash.
6	Piper PA-28 N0730J	Single-Engine, Low-Wing		Impact Ground (Enroute)	45	NA	Destroyed	Destroyed	Swamp Like	2	Yes	No	No	-	-	1C 1P				Extensive Lacerations & Internal injuries	1.Inst. Panel 2.Fwd Cockpit Structure	No		

TABLE 5. Description of Detailed Accident Cases Obtained From CAMI(f) (Cont'd)

Accident Case	Airplane Designation	Airplane Configuration	Maximum Takeoff Weight(lb) (g)	Accident Type	Kinematics: Impact Angle (degrees)	Kinematics: Deceleration Distance (feet)	Structural Damage: Fuselage	Structural Damage: Wings	Terrain Composition	Seat Failures: Used	Seat Failures: Failed	Cabin Accommodations: Lap Belt: Install	Cabin Accommodations: Lap Belt: Used	Cabin Accommodations: Lap Belt: Failed	Cabin Accommodations: Shoulder Harness: Used	Cabin Accommodations: Shoulder Harness: Failed	Occupant Injury Data (h): Fatal (a)	Critical (b)	Serious (c)	Moderate (d)	Minor/None (e)	Probable Area of Fatal Injury	Probable Area of Occupant Impact	Post Crash Fire	Remarks
7	Piper PA-22 N2642A	Single-Engine, High-Wing		Stalled (Takeoff)	< 10	159	Crumpled	Crumpled	Black Top Road	No	Yes	1*	NA	NA	NA	1C		3P			1.Severe Lacerations & Bruises (Upper Head & Torso) 2. Severe Internal Injuries	1.Inst. Panel & Control Wheel	No	*Pilot Seat Belt Fitting Failed
8	Luscombe 8A N71153 1946	Single-Engine, High-Wing		Unstable Air Down Draft (Enroute)	20	NA	Windshield Broken		River Bed	NA	Yes	No	NA	NA	NA					1C		1.Inst. Panel 2. Rudder Pedal	No	
9	Cessna C-150 N23177 68	Single-Engine, High-Wing	1600	Hit Tree (Enroute)	15	75	Tail Section Broke Off		Pasture	No	Yes	No	NA	NA	NA			1C 1P				Suspect Upper Cabin Structure	No	

TABLE 5. Description of Detailed Accident Cases Obtained From CAMI(g) (Cont'd)

Accident Case	Airplane Designation	Airplane Configuration	Maximum Takeoff Weight(lb) (a)	Accident Type	Kinematics: Impact Angle (degrees)	Kinematics: Deceleration Distance (feet)	Structural Damage: Fuselage	Structural Damage: Wings	Structural Damage: Terrain Composition	Seat Failures	Cabin Accommodations: Lap Belt: Used	Lap Belt: Failed	Lap Belt: Install.	Shoulder Harness: Used	Shoulder Harness: Failed	Fatal (a)	Occupant Injury Data (h): Critical (b)	Serious (c)	Moderate (d)	Minor/None (e)	Probable Area of Fatal Injury	Probable Area of Occupant Impact	Post Crash Fire	Remarks
10	Piper PA-22 N2955P	Single-Engine, High-Wing		Hit Turbulence from a Commercial jet taking off. Diving into ground (landing).	50	NA		L. Wing Torn Crumpled	Hard Soil	1*	Yes	No	NA	NA	NA		1C 1P				1.Inst. Panel 2.Control Wheel 3. Rudder Bars	No	*Front Seat Pulled loose from track
11	Beech C55 N4807J	Twin-Engine, Low-Wing		Impacted Ground in R.H. Turn (Enroute) ⚠	50	38	Destroyed	Destroyed	Grassy Field	2*	Yes	1**	NA	NA	NA	1C 1P				High G Impact Occupants thrown from A/C		No	*One seat thrown 190', one seat thrown 267' **Belt buckle failed
12	Piper PA-22 N8723C	Single-Engine, High-Wing		Hit Fence (attempted landing after engine failure in takeoff)	12	48	Fuselage broken fwd of tail assy.	L. Wing Crumpled	Hard Ground	NA	No	No	NA	NA	NA		1C	1P	3P		1.Inst. Panel 2.Control 3.Post	No	

⚠ Considered Non-survivable

TABLE 5. Description of Detailed Accident Cases Obtained From CAMI(f)(Cont'd)

Accident Case	Airplane Designation	Airplane Configuration	Maximum Takeoff Weight(lb) (g)	Accident Type	Kinematics: Impact Angle (degrees)	Kinematics: Deceleration Distance (feet)	Structural Damage: Fuselage	Structural Damage: Wings	Structural Damage: Terrain Composition	Seat Failures	Cabin Accommodations: Lap Belt: Used	Lap Belt: Failed	Shoulder Harness: Install	Shoulder Harness: Used	Shoulder Harness: Failed	Fatal (a)	Occupant Injury Data (h): Critical (b)	Serious (c)	Moderate (d)	Minor/None (e)	Probable Area of Fatal Injury	Probable Area of Occupant Impact	Post Crash Fire	Remarks
13	Ercoupe N2208H	Single-Engine, Low-Wing		Landed short in thick growth of trees (landing)	20	NA	1.Nose Gear 2.Lwr Fuselage 3.Windshield	Wing L.E. Damaged Substantially	Woods	NA	NA	No	NA	NA	NA			1C				1.Inst. Panel 2.Windshield	No	
14	Piper J-3 N3507K	Single-Engine, High-Wing		Hit side of hill (coyote hunting 50' altitude flying)	45 ≤ 80	NA	Fwd side structure buckled	NA	Hilly	2*	Yes	1	NA	NA	NA	1C 1P				1. Upper Head & Torso & Extremities. 2.L. foot dislocated	1.Inst. Panel 2.Fwd tubular cockpit structure 3.Rudder Bar	No	*1.Fwd Seat legs bent & broken. 2.Wooden seat bottom splintered.
15	Beech J-35 N7209B	Single-Engine, Low-Wing		Hit trees on mountain (landing thru overcast)	5	NA	1.Fuselage broken. 2. Engine broke off.	NA	Mountains	No	Yes	1*	2	1	No			1C	1P			1. Thrown thru windshield. 2.Fwd aft load against restraint system.	No	*Pilot seat belt buckle inadverently released.

TABLE 5. Description of Detailed Accident Cases Obtained From CAMI(f) (Cont'd)

Accident Case	Airplane Designation	Airplane Configuration	Maximum Takeoff Weight(lb) (g)	Accident Type	Kinematics: Impact Angle (degrees)	Kinematics: Deceleration Distance (feet)	Structural Damage: Fuselage	Structural Damage: Wings	Structural Damage: Terrain Composition	Seat Failures	Cabin Accommodations: Lap Belt: Used	Lap Belt: Failed	Shoulder Harness: Install	Shoulder Harness: Used	Shoulder Harness: Failed	Occupant Injury Data (h): Fatal (e)	Critical (b)	Serious (c)	Moderate (d)	Minor/None (e)	Probable Area of Fatal Injury	Probable Area of Occupant Impact	Post Crash Fire	Remarks
16	Piper PA-24 N6028P	Single-Engine, Low-Wing		Struck fence & dam, landed in farm pond. (power failure in takeoff)	45	NA	1.Main Gear & Nose Gear Separated. 2.Windshield broken.	NA	Earth-Dam	1*	2**	No	NA	NA	NA	1C 2P				1.Head lacerations & bruises. Drowned. 2. Massive Head Injuries (No seat belts).	1.Inst. Panel.	No		*L. aft leg of R. front seat broken. **Rear passengers did not use lap belt.
17	Mooney 20	Single-Engine, Low-Wing		Hit Tree during cruise	15	NA	Extensive		Farm Land	Yes	Yes	No	No	NA	NA	1C					Impact with Inst. Panel.			

TABLE 5. Description of Detailed Accident Cases Obtained From CAMI(f) (Cont'd)

	Accident Case	Airplane Designation	Airplane Configuration	Maximum Takeoff Weight(lb) (g)	Accident Type	Kinematics: Impact Angle (degrees)	Kinematics: Deceleration Distance (feet)	Structural Damage: Fuselage	Structural Damage: Wings	Structural Damage: Terrain Composition	Seat Failures		Cabin Accommodations: Lap Belt: Used	Lap Belt: Failed	Shoulder Harness: Installed	Shoulder Harness: Used	Shoulder Harness: Failed	Fatal (a)	Occupant Injury Data (h): Critical (b)	Serious (c)	Moderate (d)	Minor/None (e)	Probable Area of Fatal Injury	Probable Area of Occupant Impact	Post Crash Fire	Remarks
											Yes	Used															
18	Mono-coupe 110 N12350	Single-Engine, High-Wing			Stalled, Impacted ground (engine failure in take-off. Attempted LH turn back to field. Stalled at 200' altitude)	60	NA	Crumpled	Crumpled	NA	Yes	Yes	1*	NA	NA	NA	1C**	1P				Skull & Extremity Fractures	1.Inst. Panel 2. Cabin Structure	No	*RH seat belt stitching failed. **Death within 24 Hours

(a) Fatal. Death within 24 hours.
(b) Critical. Lacerations, fractures and bruises with dangerous bleeding, concussion with unconsciousness longer than 30 minutes, depressed fractures of skull, dangerous intracranial damage, dangerous internal injuries, etc.
(c) Serious. Concussion with unconsciousness 5 to 30 minutes, comminuted fractures of nose, arms, legs, and back, loss of eye, internal injuries, etc.
(d) Moderate. Mild bone fractures, mild concussion with unconsciousness less than 5 minutes, "disfiguring" lacerations and bruises without severe hemorrage, etc.
(e) Minor or None. Minor cuts, bruises, sprains, broken or loosened teeth, dislocated nose, etc.
(f) Data obtained from FAA AERONAUTICAL CENTER, CAMI, Oklahoma, Project No. 74-779-120A (01545) May 1975
(g) Data is entered in this column only when such information was supplied in the CAMI Report.
(h) C denotes crew and P denotes passengers.

TABLE 6. RESULTS OF SELECTED CAMI ACCIDENT DATA

Frequency of Occurrence		Damage, Failures, Injuries	
Phase of Operation		**Cabin Damage**	
Takeoff	4	Intact, None	4
(a) Landing	4	Minor, Moderate	8
Cruise	8	Substantial, Destroyed	6
Aerial Application	2		
Type of Accident		**Structure Damage**	
Stall	3	Intact, None	0
Ground/Water Impact	5	Minor, Moderate	7
Contact w/tree/object	5	Substantial, Destroyed	11
Landing Short	1		
Side of Hill	2	**Impact with Control Panel/Knobs**	
Miscellaneous	2	Yes	15
		No	1
Angle of Impact (degrees)		Unknown	2
0-10	4	**Seat Failures**	
11-20	5	Yes	9
21-30	1	No	3
31-45	3	Unknown	6
46-90	4		
Unknown	1	**Injuries** (Total)	
		Fatalities	15
Roll/Yaw Attitude		Serious and/or Critical	15
Significant Roll/Yaw	3	Moderate	6
Slight or No Roll/Yaw	9	Minor, None	4
Overturn	2		
Unknown	4	**Lap Belt Failures** (TOTAL)	
		Yes	6
Terrain		No	27
Hard Soil	7	Unknown	7
Grassy Land	4		
Water	1		
Mud/Swamp	2		
Trees	1		
Mountainous/hilly	2		
Unknown	1		

(a) Generally impact occurs with tree, object, or ground, due to bad weather or stall.

of the review of the 18 accident cases. Included in the summary are 9 single-engine high-wing airplanes, 8 single-engine low-wing airplanes and one twin-engine low-wing airplane.

An examination of Table 6 shows that for the 18 CAMI accident cases, 38 percent of the occupants died and another 38 percent of the occupants received serious or critical injuries. Seat failures occurred in 50 percent of the 18 accidents. In those accidents in which lap belts were used, lap belt failures occurred 15 percent of the time. A very significant statistic is that in 15 of 16 reported cases, impact of occupants with the instrument panel and/or control knobs occurred. In only two of the 18 accidents that were reviewed were the airplanes equipped with shoulder harnesses and only one person involved in these accidents used the harness. The occupant that used his harness suffered a minor injury while, in the same accident, the other occupant, who did not use his harness, was thrown through the windshield and received a severe injury. This distribution of accidents for the 18 selected cases by phase of operation and accident type is similar to the distribution noted in the NTSB data evaluation. The angle of impact is ≤ 45 degrees in 13 of 17 (77 percent) cases in which this information was reported. This impact angle data is consistent with the overall data presented in References 7 and 8, which show the impact angle to be ≤ 45 degrees in 20 of 28 accidents (71.4 percent) and 22 of 28 accidents (78.6 percent), respectively. The cabin damage assessment of the 18 cases shows moderate, minor or no cabin damage in 67.5 percent of the accidents where this information is reported. Reference 9 states that the cabin remains intact in 67.3 percent of the accidents. Substantial structural damage occurs in approximately 60 to 65 percent of the accidents.

The following discussion of the 18 accidents describes and illustrates typical crashes and the resultant damage to the structure and injury to the occupants. One of the prime concerns in reviewing accident data is to relate the critical structural regions for typical crashes to general aviation airplane mathematical modeling requirements.

Figure 2 shows the post crash condition of a single-engine low-wing agricultural airplane (case 1, Table 5). This particular airplane was reported to have stalled, while engaged in aerial application of insecticide, nosed over, and impacted hard soil at an approximate angle of 45 degrees. The pilot was wearing a helmet, shoulder harness and a 3-inch seat belt. The helmet penetrated the windshield and was torn off. The seat belt and shoulder harness broke in the webbing. The pilot was thrown straight forward and suffered moderate head and extremity injuries. In Figure 2 it can be seen that the tubular framework of the cockpit maintained its integrity, with regard to cabin volume. The impact energy was absorbed by the forward section of the fuselage as can be seen by the substantial damage forward of the cockpit.

Figure 3 shows the results of a single engine low wing airplane (case 4, Table 5) used primarily as a commuter. The accident report states that the airplane encountered bad weather and contacted the ground in a flat attitude and skidded 305 feet up and over a small hill. All the occupants were wearing seat belts and none of the belts failed. No shoulder harnesses were in the aircraft. One serious and three moderate injuries were sustained. The two front occupants impacted the upper and lower section of the instrument panel with their heads and extremities, respectively. All the seats stayed intact. In Figure 3 it can be seen that the forward fuselage, the cabin region and the rear fuselage did not undergo large deformations which is consistant with the kinetic energy absorbed in the post-impact slideout of 305 feet.

Figures 4 and 5 illustrate the post-crash condition of the instrument panel and airplane, respectively, of a single engine high wing airplane (case 10, Table 5). The airplane, with the pilot and one passenger on board, while landing at an airport, was caught in the turbulent wake of a commercial jet and crashed on the runway. No shoulder harnesses were in the aircraft. Both occupants, who were wearing seat belts, sustained severe injuries. The seats tore loose during the crash and the occupants impacted the instrument panel. The airplane which impacted the ground initially with its left wing sustained a crushed forward

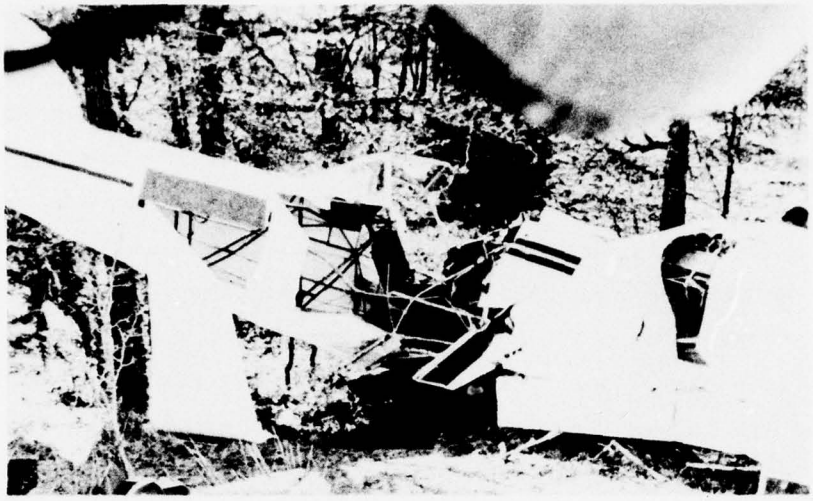


Figure 2. Side View of the Post Crash Condition of a Single-Engine Low-Wing Agricultural Airplane (Accident Case 1)

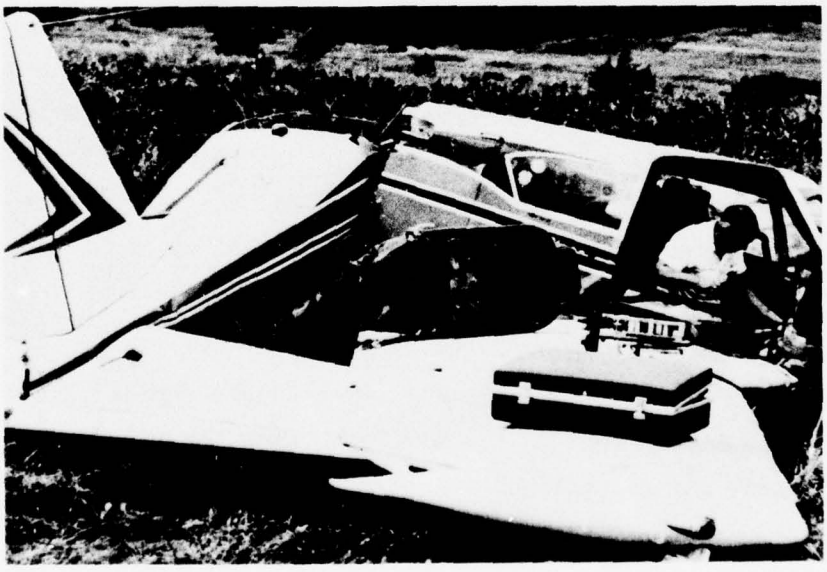


Figure 3. Side View of the Post Crash Condition of a Single-Engine Low-Wing Commuter Type Airplane (Accident Case 4)

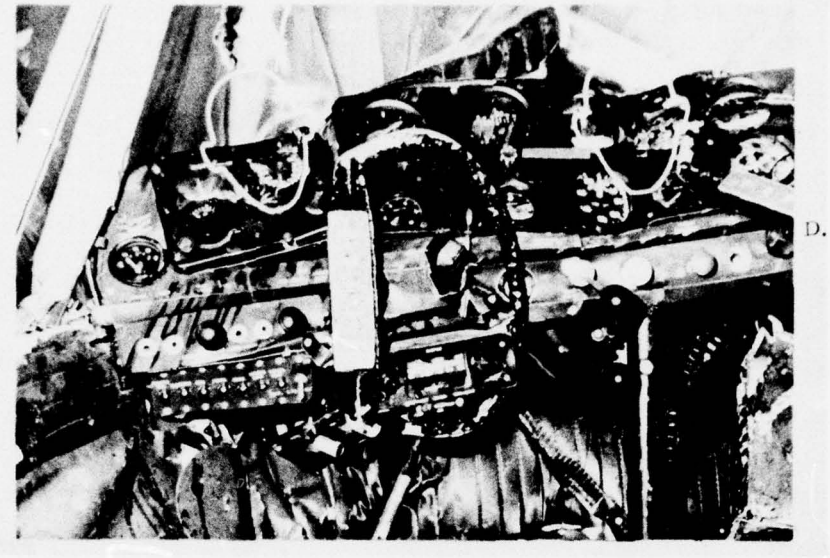


Figure 4. View Looking Forward of the Post Crash Condition of Instrument Panel (Accident Case 10)

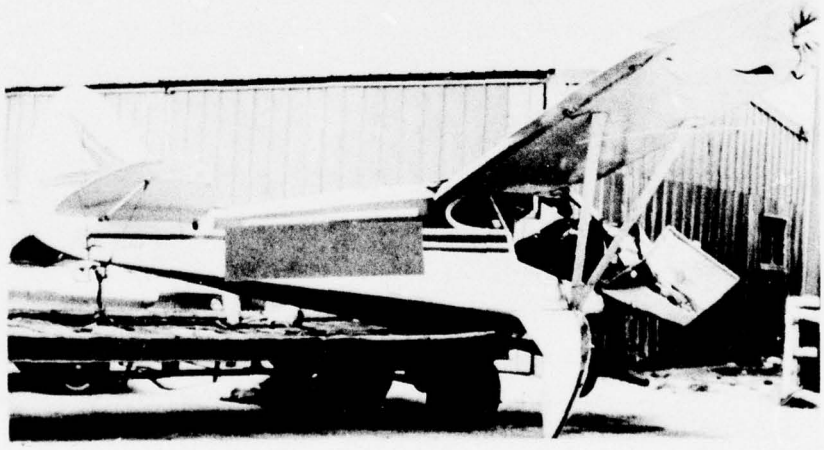


Figure 5. Side View of the Post Crash Condition of a Single-Engine High-Wing Airplane (Accident Case 10)

fuselage and crumpled left wing (not shown). However, as can be seen in Figure 5, the aircraft structure from approximately the location of wing brace attachments at the fuselage to the tail shows no significant external damage. The white head outlines in Figure 4 show where the heads of the occupants impacted the instrument panel.

Figures 6 and 7 depict the post crash condition of the structure and the cockpit, respectively, for a single-engine high-wing airplane (case 12, Table 5). The accident report states that the airplane, containing a pilot and four passengers, had just taken off and was approximately two miles from the airport when the engine started to miss. As the pilot returned to land, the engine stopped and the pilot made an emergency landing in a field. The left wing tip and landing gear struck the top strand of a four foot high fence. The airplane experienced two impacts. Seat belts were in use and they did not fail. No shoulder harnesses were installed. The occupants were thrown to the left and forward. The pilot suffered a severe injury, the co-pilot a moderate injury and the three passengers in the rear received minor or no injuries. Figure 7 shows the dent at the top of the instrument panel caused by the co-pilot's head on impact. The crushing sustained by the left wing and lower forward fuselage and the failure of the left main and nose gears can be seen in Figure 6. Most of the impact energy was absorbed by the lower forward fuselage.

Figures 8, 9, 10 and 11 show the post crash damage for several different accidents. Figure 8 shows the post crash damage to a single-engine low-wing airplane (case 5, Table 5) when the right wing first contacted muddy ground after the airplane hit the tops of small trees. Figure 8 shows that the damage to the airplane is primarily confined to the wing tips, engine and forward fuselage. For the most part, the cabin appears in good condition although the forward lower fuselage absorbed most of the impact energy. The airplane shown in Figure 8 does not look as if it sustained damage as a result of inverting, which the accident report indicates took place. The three occupants in the airplane experienced critical and fatal injuries. Figure 9 shows the post crash

Figure 6. Side View of the Post Crash Condition of a Single-Engine High-Wing Airplane (Accident Case 12)

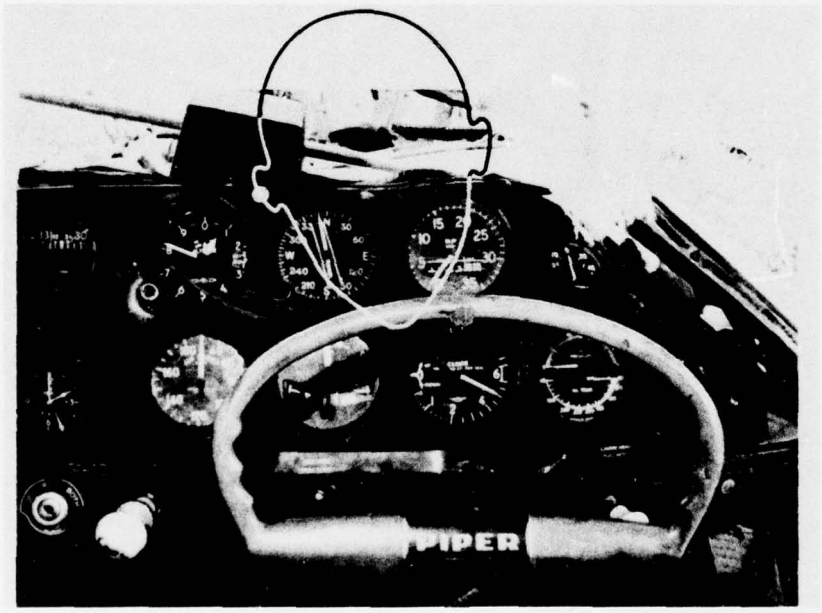


Figure 7. View Looking Forward of the Instrument Panel Impact Region (Accident Case 12)

Figure 8. Overall View of the Post Crash Condition of a Single-Engine Low-Wing Airplane (Accident Case 5)

Figure 9. Side View of the Post Crash Condition of a Single-Engine Low-Wing Airplane (Accident Case 11)

condition of a low-wing single engine airplane (case 11, Table 5) which landed short in a thick growth of trees. The airplane sustained forward fuselage and wing leading edge damage. All other visible structure appears to have escaped damage. The pilot, who was flying alone, experienced a severe injury as a result of impacting the instrument panel. Figure 10 shows the post crash condition of a single-engine high-wing airplane (case 14, Table 5). The airplane, containing a pilot (rear) and one passenger (front), crashed into the side of a hill while flying low on a hunting mission. Both occupants were fatalities. Although they were wearing seat belts, the pilot's seat belt failed at its attachment allowing the pilot to be thrown on top of and over the front seat passenger. Both occupants impacted the instrument panel. Structural damage to the forward fuselage, wing, landing gear and forward cabin region appears severe. Figure 11 shows the post crash condition of a single-engine low-wing airplane (case 16, Table 5). While on takeoff, the airplane with a pilot and two passengers failed to clear a fence. The nose gear and nose section struck an earthen dam, bounced over it and sank in the pond. (The photograph was taken after the airplane was removed from the pond). Occupants were thrown forward and to the left. All three occupants drowned. However, both front seat occupants received massive head injuries caused by impact with the instrument panel. The cabin remained intact. The interior and instrument panel (not shown) appeared in good condition after the crash.

The results of the evaluation of the selected CAMI accident cases are in general agreement with the overall conclusions in Reference 8 and 10. The CAMI data indicates that, while the cabin remains intact, occupants are still exposed to a high injury or fatality potential and it appears that improved crashworthiness can be obtained by providing restraint systems and airframe structural deformation characteristics that are consistent with the physiological capabilities of the occupants.

Figure 10. Side View of the Post Crash Condition of a Single-Engine High-Wing Airplane (Accident Case 14)

Figure 11. Side View of the Post Crash Condition of a Single-Engine Low-Wing Airplane (Accident Case 16)

3.3 NTSB DATA

A current Cessna software program, used to survey accident reports produced by the NTSB, is modified in accordance with the requirements of the program described in this report. The details of the software program including a User's Manual and listing are provided in Appendix A.

The program searches the NTSB accident tapes and summarizes all case histories which contain data concerning any of the following items.

- Impact Angle
- Impact Velocity
- Stopping Distance
- Seat Failure
- Seat Belt Failure
- Attitude at Impact

A summary of the NTSB accident tape data files is assembled by individual airplane models by manufacturer and a grand summary of all airplanes, irrespective of manufacturer or model, is also compiled. The individual accident cases and aircraft model summaries are screened to insure that no irrelevant accident data is retrieved from the NTSB tapes. The screening criteria is identical for the individual accident cases and the model summaries with departure from this norm occurring only in the summary printout under the "Major Phases of Operation".

Initial screening is accomplished by selecting those accidents which involve airplanes produced by the following seven manufacturers:

Beech Aircraft Corporation
Bellanca Aircraft Corporation
Cessna Aircraft Company
Gruman American Aviation Corporation
Mooney Aircraft Company

Piper Aircraft Corporation
Rockwell International Corporation

The models chosen from those of the above manufacturers are limited to a gross weight of less than 12,500 pounds (FAR 23) and are propeller driven. A secondary screening of the NTSB tapes is accomplished by selecting accidents of certain types which are identified in the NTSB accident data files. The following list identifies the types of accidents used in the search.

Ground Water Loop-Swerve
Stall
Wheels Up
Hard Landing
Nose Over/Down
Roll Over
Overshoot
Undershoot
Collision with Ground/Water
Collided with Obstacles
Dragged Wingtip, Float, or Pod*
Airframe Failure*
Engine Tearaway*
Engine Failure or Malfunction*
Propeller Failure*
Turbulence*

The above grouping of accidents is selected to delineate occurrences which would cover a majority of the hazards that might be encountered in general aviation operations. Also, the above list should include those accidents in which major airframe failure, loss of cabin crashworthiness capability or occupant injury may occur. Some of the types of accidents which are not included because they are not relevant to the study are; collision between aircraft, lightning strike, hail damage, bird strike, ditching and missing aircraft. The accident types listed above that are noted by an asterik are considered secondary data and are not necessarily related to impact conditions.

Tertiary screening of the NTSB tapes is accomplished by selecting "Phases of Operation" which are identified in five (5) major categories in the NTSB code classification manual. Three major phases of operation (takeoff, in-flight and landing) are used to screen the accident tapes for the summary and also the individual accident case print out. This technique is employed throughout the individual accident case retrieval. However, in the summaries under "Major Phases of Operation" two additional phases of operation (static and taxi) were selected for data retrieval and are printed out under the heading of "other".

The modifications to the Cessna program for handling accident data provide the following three types of printout.

- Concerning a Particular Airplane - The following data, if available from the accident reports, is provided: airplane identification number; accident date; airplane manufacturer; structural damage; nature of the flight; terrain; type of accident; phase of operation; cause/factor injury index; qualitative assessment of impact severity; estimated acceleration levels; severity of the damage; and data regarding stopping distance, direction of principal deceleration, seat belt failures, seat failures, use of shoulder harnesses and death due to fires, if information is available. A sample printout of a modified accident report, obtained from NTSB tapes, is shown in Figure 12.

- Concerning an Airplane Model by the Year - Derivatives of a model are combined (i.e. Cessna Model 150 includes 150, A150, A150K, etc.). Included in the summary are airplane manufacturer and model designation, date; (number of accidents and occupants involved, and number of accidents with fatalities and injuries), total number of injuries; flight conditions, accident types, impact conditions, airplane cabin occupant capacity and impact area (terrain).

- Concerning Accident Data for All Airplanes for a Given Period of Time - The format of the data is the same as that for the individual airplane summary. A sample of this output is shown in Figure 13.

The NTSB accident summary for 1971 through 1973 includes a survey of accidents. A total of 8,491 accidents are surveyed. Of this total 8,030 (95%) involved airplane models that are used to establish the different airplane categories presented in Table 3 (Section 2.2). Foreign manufactured airplanes that are final assembled or marketed by the major domestic

DATE	04/22/72
AIRCRAFT MAKE	AERO COMDR
AIRCRAFT MODEL	500-B
AIRCRAFT DAMAGE	DESTROYED
FIRE AFTER IMPACT	YES
KIND OF FLYING (GENERAL AVIATION)	PLEASURE/PERSONAL TRANSP
TYPE OF ACCIDENT, FIRST	COLLIDED WITH
TYPE OF ACCIDENT, FIRST	TREES
PHASE OF OPERATION, FIRST	LANDING
PHASE OF OPERATION, FIRST	FINAL APPROACH
AIRPORT PROXIMITY	WITHIN 5 MILES
RUNWAY COMPOSITION	CONCRETE
RUNWAY LENGTH	10000
TERRAIN (TYPE) OF AIRPORT	HILLY

CAUSE / FACTOR

CAUSE / FACTOR	IMPROPER IFR OPERATION
CAUSE / FACTOR	ATTEMPTED OPERATION W/KNOWN DEFICIENCIES IN EQUIPMENT
CAUSE / FACTOR	LACK OF FAMILIARITY WITH AIRCRAFT
CAUSE / FACTOR	LOW CEILING
CAUSE / FACTOR	RAIN
CAUSE / FACTOR	FOG

INJURY - INDEX

	F	S	M	N	Z	T
PILOT	1					1
PASSENGERS	4					4
TOTAL ABOARD	5					5

REMARKS	ACFT RADIOS OPERATED INTERMITTENTLY WHILE ENROUT E. DESCENDED BLO MDA ON ILS APCH.1 HR DUAL IN TYPE
AIRCRAFT SERIAL NUMBER	00001384-138
RATE OF DECELERATION	EXCESSIVE
DIRECTION OF PRINCIPAL DECELERATION	FORWARD
STOPPING DISTANCE	85
DAMAGE SEVERITY - IMPACT (NON-TRANS. AIRCRAFT)	EXTREME

Figure 12. Individual Airplane Output Format, NTSB Data

AIRCRAFT MANUFACTURER / MODEL - ALL / ALL

MAXIMUM TO WEIGHT - POUNDS

WING CONFIGURATION

NUMBER OF ENGINES / LOCATION -

GENERAL INFORMATION

TOTAL NUMBER OF ACCIDENTS SURVEYED - - - - - - - - - - - - - - 8491

TOTAL APPLICABLE ACCIDENTS SURVEYED - - - - - - - - - - - - - - 7471

TOTAL NUMBER OF OCCUPANTS - 15609

AVERAGE NUMBER OF OCCUPANTS PER ACCIDENT - - - - - - - - - - 2

NUMBER OF ACCIDENTS WITH AT LEAST ONE (1) FATAL INJURY - - 1217

NUMBER OF ACCIDENTS WITH AT LEAST ONE (1) SERIOUS INJURY - 638
AND NONE MORE SERIOUS

NUMBER OF ACCIDENTS WITH AT LEAST ONE (1) MINOR INJURY - - 1032
AND NONE MORE SERIOUS

NUMBER OF ACCIDENTS WITH NO INJURY - - - - - - - - - - - - - - 4589
AND NONE MORE SERIOUS

***** TOTALS OF SERIOUSNESS OF INJURIES *****

	FATAL	SERIOUS	MINOR	NONE
PILOT	1134	584	956	4795
COPILOT	81	21	15	91
PASSENGERS	1257	544	997	4767
* OTHER	48	40	47	310

* OTHER INCLUDES DUAL STUDENT & CHECK PILOT

FLIGHT CONDITIONS -

Figure 13. Grand Total Summary For 1971 through 1973

FLIGHT CONDITIONS -

TOTAL NUMBER OF ACCIDENTS WHICH OCCURRED DURING THE FOLLOWING FIVE MAJOR PHASES OF OPERATION / NUMBER OF ACCIDENTS WITH AT LEAST ONE FATALITY WHICH OCCURRED DURING THE MAJOR PHASE

TAKEOFF - - 1355 / 113

IN FLIGHT - 2450 / 888

LANDING - - 3666 / 216

OTHER - - - 375 / 16

NOT REPORTED 11 / 6

NINE (9) MOST FREQUENT MINOR PHASES OF OPERATION WITHIN THE FIRST THREE MAJOR PHASES ABOVE LISTED IN DESCENDING ORDER OF FREQUENCY

MINOR PHASE OF OPERATION	TOTAL NO. OF ACCIDENTS	********** INJURIES ********** FATAL	SERIOUS	MINOR	NONE
1. NORMAL CRUISE	477	411	200	366	186
2. INITIAL CLIMB	383	231	193	354	152
3. FINAL APPROACH	252	125	148	221	62
4. UNCONTROLLED DESCENT	249	511	25	14	1
5. LEVEL OFF/TOUCHDOWN	201	27	69	237	143
6. ROLL	106	3	16	120	45
7. TRAFFIC PATTERN-CIRCLING	101	67	59	71	30
8. GO-AROUND	98	46	52	84	24
9. OTHERS	590	503	269	309	115

EIGHT (8) MOST FREQUENT TYPES OF ACCIDENTS WITHIN THE FIRST THREE MAJOR PHASES ABOVE LISTED IN DESCENDING ORDER OF FREQUENCY

TYPE OF ACCIDENT	TOTAL NO. OF ACCIDENTS	********** INJURIES ********** FATAL	SERIOUS	MINOR	NONE
1. ENGINE FAILURE OR MALFUNCTION	719	289	318	743	300
2. COLLISION WITH GROUND/WATER	569	961	180	129	44
3. COLLIDED WITH	549	480	255	309	118
4. STALL	540	550	271	256	94
5. GROUND-WATER LOOP-SWERVE	119	1	23	141	43
6. OVERSHOOT	99	19	40	114	76
7. OTHERS	285	228	104	224	115
8. NOT REPORTED					

NOTE -- OTHER IS SUM OF ALL ACCEPTABLE PHASES AND TYPES EXCEPT THOSE LISTED

Figure 13. Grand Total Summary For 1971 through 1973 (Continued)

IMPACT CONDITIONS

TOTAL NUMBER OF ACCIDENTS WHICH RECORD IMPACT ANGLES - 27

IMPACT ANGLE NUMERICAL SUMMARY -

AVERAGE ANGLE DEGREES	IMPACT ANGLE CATEGORIES - DEGREES						
	0 -15	16-30	31-45	46-60	61-75	76-90	90+
62	4	2	5	1	2	13	

TOTAL NUMBER OF ACCIDENTS WHICH RECORD IMPACT VELOCITY - 2

IMPACT VELOCITY NUMERICAL SUMMARY -

AVERAGE VELOCITY KNOTS	IMPACT VELOCITY CATEGORIES - KNOTS				
	1-30	31-60	61-90	91-120	120+
148			1		1

TOTAL NUMBER OF ACCIDENTS WHICH RECORD STOPPING DISTANCES - 499

STOPPING DISTANCE NUMERICAL SUMMARY -

AVERAGE STOPPING DISTANCE - FEET	STOPPING DISTANCE CATEGORIES - FEET						
	1 -60	61-120	121-180	181-240	241-300	301-360	360+
194	174	87	73	48	38	17	62

OCCUPANT INJURY NUMERICAL SUMMARY AT RESPECTIVE AIRCRAFT DAMAGE SEVERITY INDICES -

DAMAGE SEVERITY	* * * * OCCUPANT INJURY * * * *			
	FATAL	SERIOUS	MINOR	NONE
EXTREME	1701	152	18	1
SEVERE	96	59	14	4
MODERATE	21	6	3	2
MINOR	17	1	4	
NONE				5

Figure 13. Grand Total Summary For 1971 through 1973 (Continued)

AIRCRAFT CABIN ACCOMMODATIONS -

NUMBER OF ACCIDENTS IN WHICH SEAT FAILURE OCCURRED - - -	149
TOTAL NUMBER OF SEAT FAILURES - - - - - - - - - - - - - - -	328
NUMBER OF ACCIDENTS IN WHICH SEAT BELT FAILURE OCCURRED -	204
TOTAL NUMBER OF SEAT BELT FAILURES - - - - - - - - - - - -	344
* NUMBER OF SHOULDER HARNESS USED - - - - - - - - - - - - -	237
* NUMBER OF SHOULDER HARNESS FAILURES - - - - - - - - - - -	21
* NUMBER OF CRASH HELMETS USED / NOT USED - - - - - - - - -	442 / 68

* APPLICABLE TO AGRICULTURAL AIRCRAFT ONLY

IMPACT AREA

PERCENT OF ACCIDENTS WHICH OCCURRED IN PARTICULAR TERRAIN TYPE

TERRAIN TYPE	PERCENT ACCIDENT OCCURRENCE (1)
UNKNOWN/NOT REPORTED	52
LEVEL,FLAT	19
ROLLING	8
MOUNTAINOUS	6
DENSE WITH TREES	4
HILLY	4
WATER-LAKES,RIVERS,ETC.	3
PLOWED	2
OTHER	1
CITY AREA	1

(1) PERCENT IS RATIO OF PARTICULAR TERRAIN TO NUMBER OF ACCIDENTS SCREENED

Figure 13. Grand Total Summary For 1971 through 1973 (Continued)

CAUSE / FACTOR GRAND SUMMARY

CAUSE / FACTOR SUMMARY

CAUSE	FATAL ACCIDENTS	NONFATAL ACCIDENTS
* * PILOT * *		
1. INADEQUATE PREFLIGHT PREPARATION AND/OR PLANNING	200	829
2. FAILED TO OBTAIN/MAINTAIN FLYING SPEED	304	630
3. FAILED TO MAINTAIN DIRECTIONAL CONTROL	3	740
4. IMPROPER LEVEL OFF	4	687
* * COPILOT * *		
1. IMPROPER LEVEL OFF		5
2. IMPROPER LEVEL OFF		4
* * DUAL STUDENT * *		
1. IMPROPER LEVEL OFF	8	25
2. IMPROPER LEVEL OFF		32
* * CHECK PILOT * *		
1. IMPROPER LEVEL OFF		7
2. IMPROPER LEVEL OFF		1
* * AIRFRAME * *		
1. BRAKING SYSTEM (NORMAL SYSTEM)		65
2. NORMAL RETRACTION/EXTENSION ASSEMBLY		59
* * MISCELLANEOUS ACTS, CONDITIONS * *		
1. OVERLOAD FAILURE	52	1067
2. FUEL EXHAUSTION	27	370
3. FUEL STARVATION	24	264
4. MATERIAL FAILURE	13	262

Figure 13. Grand Total Summary For 1971 through 1973 (Continued)

manufacturers are included in the final summary but not in the development of airplane categories. This accounts for the difference between 8491 accidents and 8030 accidents. The data is reviewed with regard to the potential for an occupant fatality to occur (for accidents in which at least one injury is reported), the distribution of accidents by terrain conditions, the total number of occupants involved, the total number of fatalities, and the total number of accidents. To facilitate the evaluation, two ratios are established. The first ratio (Ratio No. 1) is for all accident types and relates the total number of fatalities to total number of occupants involved in all accidents. This ratio is defined below as:

$$\text{Ratio No. 1} = \frac{\text{total number of fatalities}}{\text{total number of occupants}} \text{ (all accidents)}$$

The second ratio (Ratio No. 2) defines the number of fatalities relative to the number of occupants involved for a particular accident type. This ratio is established for accident types such as the stall, collision with ground/water and collision with obstacle.

$$\text{Ratio No. 2} = \frac{\text{number of fatalities}}{\text{number of occupants}} \left(\begin{array}{l} \text{for a particular accident type} \\ \text{involving an injury} \end{array} \right)$$

Obviously, larger airplanes. which carry more passengers, will have a higher ratio of fatalities to accidents than the smaller airplanes. In dividing by the number of occupants involved for each particular accident type a more rational manner of comparing different size and weight airplanes on an equal basis can be utilized.

Both ratios are intended to give an indication of the occupant's chance for a fatal injury potential in each category of airplane as well as in all the airplanes combined.

Table 7 presents a summary of the accident distribution for general aviation airplanes in accordance with the terrain configuration. The summary is based on a sampling of airplanes for the three airplane categories (categories 1, 2 and 4 of Table 4) for which the majority of accident data

TABLE 7. SUMMARY OF TERRAIN CONFIGURATIONS FOR ACCIDENTS (NTSB DATA 1971 THROUGH 1973)

	All Airplanes		Single-Engine, High-Wing (a)		Single-Engine Low-Wing (b)		Twin-Engine Low-Wing (c)	
Type Terrain	Number of Accidents	Percent	Number of Accidents	Percent	Number of Accidents	Percent	Number of Accidents	Percent
Level, Flat	1,444	46.0	339	40.9	175	37.0	43	36.1
Rolling	676	21.6	186	22.5	193	26.0	22	18.5
Mountainous	422	13.5	146	17.6	92	19.4	19	16.0
Hilly	253	8.1	91	11.0	53	11.2	13	10.9
Dense with Trees	253	8.1	67	8.0	30	6.4	15	12.6
City	84	2.7	--	--	--	--	7	5.9
	3,132	100	829	100	473	100	119	100

(a) Based on Category 1B Type Airplanes, 2-4 Occupants, Sport, Trainer, Pleasure, and Business Usage.

(b) Based on Category 2A Type Airplanes, 2-6 Occupants, Sport, Trainer, and Business Usage.

(c) Based on Category 4 Type Airplanes, 4-10 Occupants, Executive, Commuter, and Cargo Usage.

is available. Although the number of accidents per terrain configuration varies somewhat for the different airplane categories, each category of airplanes has about the same percent of accidents per terrain configuration. Single-engine airplanes have accidents in rolling, mountainous and hilly terrains, somewhat more often, percentage-wise, than do the twin-engine airplanes. The reason may be associated with the fact that engine failure in a twin-engine airplane does not mean that a landing needs to be made immediately.

Table 8 provides a summary of the accident data using the different categories of accidents, the accident data pertinent to the models within each of the categories and the two ratios described earlier. Ratio No. 1 will identify the more crashworthy categories of airplanes, whether it be due to the structural design or the crash environment, to be those with lower ratios than that of the composite of all airplanes. On this basis the smaller lighter weight airplanes and the agricultural airplanes appear to be more crashworthy than the other airplanes.

The data presented in Table 8 indicates that the most probable accident for the lighter weight airplanes (<2500 pounds) is a stall condition. The most fatal accidents for heavier weight airplanes (>2500 pounds) are associated with collisions with ground or water. This particular type of accident can be either controlled or uncontrolled in nature. The NTSB information does not provide sufficient data with which to delineate between the two situations. Miscellaneous accident types, such as a hard landing, undershoot, overshoot, ground swerve, generally do not result in fatalities. The 1971 through 1973 NTSB data indicates that less than 5 percent of the occupants involved in these types of accidents received fatal injuries. This value is extremely low by comparison to the overall average of 45.5, 70.7, and 39 percent, respectively, for all categories of airplanes involved in the three major accident types shown in Table 8.

From the data shown in Table 8, of the three major accident types, the most survivable appears to be an accident which is initiated by contact with some obstacle. One possible reason for this is that this type of

TABLE 8. SUMMARY OF ACCIDENT DATA EVALUATION (NTSB DATA 1971 THROUGH 1973)

Category (a)	Number of Accidents Surveyed	Ratio No. 1 (b)	Ratio No. 2 (c)			Order of Occurrence of Accident Type (Percent Distribution (d))		
			Stall	Collision with Ground	Collision with Obstacle	Stall	Collision with Ground	Collision with Obstacle
1 (<2500)	4502	.122	.439	.652	.326	1(37.5)	3(29.2)	2(33.3)
2 (>2500)	2245	.149	.408	.625	.346	3(22.3)	1(49.1)	2(28.6)
3 (Agriculture)	601	.081	.300	.222	.273	2(39.0)	3(6.5)	1(54.5)
4 (2 Engines)	682	.283	.728	.788	.695	3(21.3)	1(44.3)	2(34.4)
All Categories	8030	.147	.455	.707	.390	3(32.5)	2(33.6)	1(33.9)

(a) See Table 4 for Complete Definition of Categories.

(b) Ratio No. 1 = (Total Number of Fatalities/Total Number of Occupants) All Accidents

(c) Ratio No. 2 =(Number of Fatalities/Number of Occupants) For a Particular Accident Type Involving an Injury and/or Fatality

(d) Accident Types Involving an Injury. Percentage distribution is for the three types shown. Applicable to the Ratio No. 2.

accident occurs close to the ground at reduced airplane operating speeds (i.e. landing, approaches and takeoffs) and the impact angle usually is flat. The least chance of occupant survival occurs in collisions with the ground. With the exception of agricultural airplanes, at least 62 percent of the occupants that are involved in this type of accident sustain a fatal injury. While collisions with the ground represent a wide range of accidents (e.g. forced landings, bad weather, misjudged altitude and/or clearance), most of the accidents generally occur at speeds approaching that of cruise.

The agriculture airplanes (Category 3) which have a takeoff weight comparable to that of the single-engine airplanes used primarily for business, utility, commuter and cargo purposes (Category 2), demonstrate considerably more crashworthiness capability for all the three major accident types. Factors that most likely account for this difference are:

- Agricultural airplanes are designed with specific crashworthy features (overturn pylon, long fuselage, harness, isolated cockpit) that are compatible with their mission.
- Agriculture airplanes may crash under more controlled conditions, usually after hitting some obstacle.
- The pilots of agricultural airplanes generally are more experienced in emergency conditions than the average general aviation pilot.

While the agricultural airplanes provide a greater chance of occupant survivability during a crash, the pilot will sustain a fatal injury in about 30 percent of the accidents in which injuries occur.

The data presented in Table 8 indicates that benefits due to improvements in crashworthiness design for the twin-engine airplanes may provide the biggest payoff in reducing the degree of severe or fatal injuries that are sustained relative to the number of people involved. However, on an absolute basis there have been substantially more fatalities in single-engine airplane accidents than in twin-engine airplanes because there are substantially more single-engine airplanes in operation. Therefore, from a life saving point of view, if a priority is to be assigned, emphasis should be placed on upgrading the crashworthiness characteristics of

single engine airplanes.

Table 9 sets forth the accident data for the categories wherein a distinction is made between a low-wing configuration and a high-wing configuration and indicates that:

- With the exception of the comparisons between high-wing and low-wing configurations for both light airplanes (< 2500 pounds) and two-engine airplanes in accidents involving collision with obstacles, the deviation from the mean value does not exceed $\pm$ 8.5 percent for all accident types and airplane categories noted in Table 9. This trend indicates that for the airplane and accidents considered and the period of time covered (1971-73) the location of the wing, for a particular category of airplane, is not very significant with regard to fatality potential in injury incurred accidents.

- The low-wing, single-engine airplane experiences approximately the same rate of fatalities in accidents involving stall as do the high-wing, single-engine configurations. The data for the lower weight (< 2500 pounds) airplane indicate a slightly higher fatality rate for the high wing airplane (45.7 versus 38.6 percent). This trend is reversed for the higher weight (2500-4000 pound) category (38.5 percent versus 43 percent).

- The lower weight (< 2500 pounds) low-wing, single-engine airplanes experience approximately the same rate of fatalities in accidents involving collision with ground/water as do the high-wing, single engine airplanes (66.3 versus 64.5 percent). For the heavier weight (2500 to 4000 pounds) single-engine airplanes, the fatality rate for the ground/water type of accident is slightly in favor of high-wing configurations (67.4 versus 56.8 percent).

- The heavier weight (2500 to 4000 pounds) low-wing, single-engine airplanes experience approximately the same rate of fatalities in collision with obstacle type accidents as compared to the high-wing configuration (35.3 versus 34.2 percent). The lower weight (< 2500 pounds) low-wing, single-engine airplanes exhibit higher rates of fatalities for this type of accident when compared to the high-wing configuration (38.3 versus 28.3 percent). However, a closer examination of the lower weight category shows that for airplanes weighing between 2000 and 2500 pounds the rate of fatality for this type of accident is relatively close (38.9 for the low-wing configuration and 32.5 percent for the high-wing configuration). The rate of fatalities for the extremely light-weight airplanes (< 2000 pounds) for this type of accident is 27 percent for the low-wing configuration and 24.4 percent for the high-wing configuration. The low fatality rate for these light-weight airplanes may

TABLE 9. SUMMARY OF ACCIDENT DATA FATALITIES TO OCCUPANTS INVOLVED BY SUBCATEGORIES AND ACCIDENT TYPES (NTSB DATA 1971 THROUGH 1973)

Subcategory (a)	Number of Accidents Surveyed	Ratio No. 2 (b), Percent			Deviation from Mean Average Value of Ratio No. 2 (c) for Category (Percent)		
		Stall	Collision with Ground	Collision with Obstacle	Stall	Collision with Ground	Collision with Obstacle
1A Low-Wing	1595	38.6	66.3	38.3	±8.5	±1.1	±15
1B High-Wing	2907	45.7	64.5	28.3			
2A Low-Wing	933	43.	56.8	35.3	±5.4	±8.5	± 1.4
2B High-Wing	1312	38.5	67.4	34.2			
4A Low-Wing	583	74.3	78.3	66.1	±2.6	±1.5	±11.5
4B High-Wing	99	70.4	80.8	83.3			

(a) See Table 4 for definition of subcategories

(b) Ratio No. 2 = (Number of fatalities/number of occupants) (for a particular accident type involving an injury and/or a fatality)

(c) Based on average of low and high-wing ratio values for each type of accident

be attributed to the lower impact speeds of these airplanes as a result of their lower flight speeds. The fatality rate associated with the agricultural airplane for this type of accident is 27.3 percent (Table 8). Since there are very few low-wing airplanes weighing less than 2000 pounds in the accident data as compared to 2000 to 2500 pound low-wing airplanes, the 38.9 percent shown in Table 9 is due to the fact that the weighted value is based on relative number of accident cases included.

- The comparison of the number of fatalities by accident types for twin-engine high-wing and low-wing airplanes is generally within $\pm$ 3 percent of their mean average except for the case of impact with an obstacle. However, the sample of this type accident in the data bank for the twin-engine high-wing airplane is inadequate for a true comparison.

Ratio No. 2 (Table 8) is used in an effort to provide a level of severity of an accident by only including accidents in which injuries occur. (Accordingly, the data does not indicate the chances of survival in accidents which do not involve injuries). This ratio indicates that "collision with the ground" consistently results, except for the agricultural airplanes, in a high fatality rate. The impact velocities associated with this type of accident are higher and will require the absorption of a greater amount of energy than that of the stall and the obstacle collision types of accidents. Although it may not be practical from weight and cost effectiveness considerations to provide crashworthiness capabilities to fully cover this type of accident, the use of a consistent crashworthy design philosophy in the design of a new airplane should provide a reduction in potential fatalities.

The results of the CAMI and NTSB data review and evaluation indicates that work should be performed to evaluate the effectiveness of incorporating shoulder harnesses along with seat and safety belt installations that are consistent with the present structural crashworthiness capabilities of each of the general aviation airplane models now in operation.

SECTION 4.

MATHEMATICAL MODEL REQUIREMENTS

4.1 GENERAL AVIATION INDUSTRY COMPUTER CAPABILITIES

Seven members of the General Aviation Manufacturers Association (GAMA) were sent an inquiry regarding their current and anticipated computer capabilities. Included in the inquiry was a data sheet soliciting information regarding:

- o computer manufacturer and model number
- o core storage
- o peripherals (tapes, discs, drums)
- o systems (operating, plotting, interactive, Fortran levels)

The information was solicited from the manufacturers for the purpose of evaluating the capability of the general aviation industry to use program KRASH, modified as noted in Section 4.4, identify the types of changes that may be required in the program before it is distributed to the industry, and identify the equipment (or arrangements) required of the industry members in order to utilize KRASH to its fullest capability.

Based on the responses received from the manufacturers, the results of the survey indicate the following:

- o Access to a computer with 500,000 bytes or more is, or will shortly be available for six of the companies.
- o Four of the companies noted that they have 7 or 9 track tapes available for physical storage of data. However, KRASH, as presently coded, uses tapes only for plotting.

- Four of the companies stated that they have discs comparable to the TELEX 6330 model used by KRASH. The discs are an internal means of managing data.

- None of the companies have drums as part of their peripheral equipment. However, since the use of drums only increases the rate at which data is transferred, the only effect on the program will be in the area of computer run time.

- The companies have different operating systems (mostly disc operating virtual systems) than the type of system that KRASH operates on (IBM 360 Multiprogramming with a Variable number of Tasks, MVT). The operating system is internal and only reflects the manner in which the computer jobs are managed, based on peripheral usage, allocation of core, and priorities.

- Only one company has plotting capability.

- Only one company has interactive capability.

- All the companies use basic Fortran IV (F,G,H, levels)

Program KRASH currently requires 490,000 bytes of core. The program is written in basic Fortran IV, level H. It is compatible with the larger computers (CDC, IBM 360, 370), taking into consideration the normal adjustments in adapting to different operating systems. The general aviation industry is equipped to use program KRASH, as is, with the exception of the plot routine. The plot routine is most valuable in the presentation of data. Generally, unless operating in the interactive mode, the plots may not be available to the designer until a couple of days after the computer printout is received, reviewed and input data changed. Currently, the plotting routine used in KRASH is stored in core and requires approximately 20 percent of the 490,000 bytes. Deletion of the current plot routine for the general aviation industry will allow for the following two alternatives.

- Reduction in core size and, therefore, a higher run priority leading to faster turn-around time.

- Maintain the same core size and enlarge the capability to treat larger math models (masses, members), or provide additional features at a future date.

Even if the current in-core plotting routine is replaced with an out-of-core plotting routine, the problem still remains that the industry does not currently, nor plans in the near future, to have plotting capability.

The major considerations for the industry with regard to using KRASH are: (1) whether to perform analysis using in-house computer facilities or to utilize a time sharing computer, (2) to use KRASH with its maximum capability (core size, plotting), which could involve additional capital investment, or to use a limited version of the program (smaller, no plotting)

4.2 GENERAL AVIATION AIRPLANE CRASH ANALYSIS REQUIREMENTS

The review and evaluation of general aviation airplane configurations, usages, operational and structural design characteristics, accidents, industry design practices and industry computer capabilities, indicates that the use of a computerized analytical technique for performing crash analysis would be an asset to the industry if it contained certain features. The development of a general aviation airplane industry crash analysis computer program must take into consideration the need to analyze reasonably complex crash conditions, yet not impose unrealistic and costly investments in specialized manpower and/or equipment to facilitate improved future crashworthy designs.

Ideally, the computer program should have the capability to:

- Provide sufficient information which can be used to assess an occupant's chances for survival. As a minimum this information should consist of defining floor acceleration pulses and evaluating cabin damage and cabin geometry change.
- Define forces, accelerations, velocities and displacements in three directions.
- Treat multidirectional impact forces, angles and angular rates representative of the probable crash conditions associated with the different airplane usages and operational characteristics.
- Represent various types of structural behavior for a wide range of structural element types, particularly wherein post-failure large deflections occur.

- o Treat structural failures and the consequences of the failures on surrounding structure.

- o Represent different airplane configurations such as high-wing, low-wing, single-engine, twin-engine, tandem engines, individual and multiple seating accommodations, weights up to at least 12500 pounds, and retracted or extended landing gear.

- o Provide the means to treat differences in terrain (level, hilly, water, dirt, concrete) using available data for describing the properties of the terrain.

- o Treat the significant phases of multiple impact crashes wherein the effect of an initial impact is accounted for in subsequent impacts during the same crash.

- o Utilize crash input acceleration magnitude, shape, duration and direction information as an input to the airplane, if available.

- o Provide data as part of the analysis which can be used to assess energy flow, member stresses, and structure rupture.

- o Facilitate usage and understanding of standard values, English symbols and simplified input requirements.

Furthermore, the program should be written in Fortran IV and be applicable for use on the larger size computers (i.e. IBM 360, IBM 370, CDC 6600) having at least 375,000 bytes of core storage. Plotting capability, while a potentially useful tool, can be dispensed with for the present. A plot routine should be compatible with the particular user's system, otherwise, unless all user's have "like" systems the plot routine will be superfluous.

While the description of the computer program's requirements is comprehensive, its usefulness will be inhibited unless the program is accompanied by appropriate documentation. As a minimum the documentation should consist of a User's Manual describing the theory, input-output requirements, a sample illustrative problem, techniques for representing structure, instructions on how to utilize specialized features, program limitations, and structural design guidelines.

4.3 PROGRAM KRASH

Program KRASH was developed for the purpose of providing a practical engineering analytical approach to determine the crashworthiness capabilities

of vehicles.

The digital computer program KRASH predicts the response of vehicles to multidirectional crash environments. The program computes the time histories of N interconnected masses. Each mass is allowed six degrees of freedom defined by inertial coordinates x_i, y_i, z_i, and Eulerian angles ϕ_i, θ_i, Ψ_i, where i = 1, 2...N. Euler's equations of motion are written for each mass. The equations of motion are integrated numerically to obtain velocities, displacements and rotations. Gravity forces, internal forces and moments, and external forces are computed. For small deflections a linear analysis is followed, and for large deflections general plastic deformation is allowed. The program provides for unloading and subsequent reloading along a linear elastic line.

A succinct description of program KRASH and the techniques it applies are presented in Reference 14, along with the experimental data obtained during a fully instrumented, full scale vehicle drop test with which the capability of the program was successfully verified. The essential features of program KRASH are:

(a) The program is designed to provide sufficiently accurate data from which an assessment can be made of the occupant's chances of survival in a crash environment.

(b) The formulation takes into consideration that the load-deflection behavior of a structure can be approximated using good engineering judgement so as to provide sufficiently accurate responses for the intended use.

(c) The analysis is premised on the fact that only a portion of the major structural elements (and these can be readily identified) need be modeled in the post-failure region.

(d) The program employs stiffness reduction factors (KR's) which are a method by which the linear stiffness of each structural element can be modified to treat nonlinear behavior.

Program KRASH's formulation is consistent with the amount and quality of detailed data that is available during a preliminary design study. Furthermore, analyses during preliminary design studies can serve to:

- ascertain critical design regions wherein alterations to the structural response will be most beneficial,

- determine the extent to which additional energy absorption is needed, and

- determine the structural element load-deflection characteristics and, consequently, structural design and size requirements that are needed to meet a specified or desired crashworthiness capability.

Prior to the initiation of the study, program KRASH had the capability to:

- Define a six-degree-of-freedom (DOF) response at each representative location, including three translations and three rotations (accelerations, velocities, and displacements are computed).

- Determine mass accelerations, velocities and displacements, and internal member loads and deformations at each time interval.

- Provide for general nonlinear stiffness properties in the plastic regime, including different types of load-limiting devices, and determine the amount of permanent deformation.

- Determine how and when rupture of an element takes place and redistribute its load-carrying capability over the other structural elements involved.

- Define mass penetration into an occupiable volume.

- Provide for ground contact by external structure including sliding friction.

- Include viscous damped internal elements.

- Include a measure of injury potential to the occupants; for instance, the probability of spinal injury indicated by the Dynamic Response Index (DRI).

- Determine the distribution of kinetic and potential energy by mass item, the distribution of strain and damping energy by element, and the crushing energy associated with each external spring.

- Determine the vehicle response to an initial condition that includes linear and angular velocity about three axes and any arbitrary vehicle attitude.

- Treat up to 80 masses (480 DOF), 100 internal (6 x 6) beam elements and provide plots of the responses.

A comprehensive description of KRASH prior to this program is presented in References 3 and 4. Changes to KRASH related to this program are described in Section 4.4. A complete description of KRASH updated for the general aviation airplane industry is presented in the User's Manual and Structural Design Guide (Reference 13).

4.4 MODIFICATIONS TO KRASH

The requirements of a computer program to meet the needs of the general aviation industry were evaluated both with regard to KRASH's capability, as developed previously, as well as to the modifications that could be incorporated to extend the program's capability and yet be consistent with the philosophy under which KRASH was developed, which is to be a practical preliminary design tool. Program KRASH, as originally developed, meets many of the requirements necessary to perform crash analysis of general aviation airplanes. To comply with the overall requirements and to facilitate KRASH's usage by the industry, several modifications are incorporated. Since a comprehensive discussion of each modification is contained in Section 1 of the User's Manual (Reference 13) a brief description of each is presented in the following paragraphs.

4.4.1 Generalized Impact Surface Capability

This modification allows the user to specify a surface which makes an angle with the horizontal of up to 90 degrees. The airplane represented by the math model can be positioned relative to the surface with the proper input data selection, or, if the user chooses, the program will automatically position the vehicle in the proper attitude relative to the surface using the existing external spring input data. This is a practical feature and requires only one additional input term, the angle of the slope. The generalized impact surface is applied in the analysis of a stall-spin crash test that impacts into a 45 degree slope which is described in Section 5. The generalized surface capability is useful for analyzing crash conditions involving hillsides, mounds and possibly trees.

4.4.2 Cabin Volume Change

The prime concern in a crash is the protection of the occupant. As is noted earlier, one of the design goals is to have the structure crush and deform in such a manner that a liveable cabin volume will be maintained for the occupant and that the occupant is kept from impacting structure or hardware in such a manner as to receive serious or fatal injuries. Consequently, coding is added to KRASH wherein any eight masses are specified for a particular volume. The original coordinate positions of the masses are used to compute an initial volume. The new coordinates of the specified masses are computed at each integration. The ratio of the new volume to the original volume is calculated and printed out along with the regular output print. Although usually only one volume (occupiable region) is of concern, the program allows the user to specify up to eight distinct volumes. This modification in no way alters the program's basic computations. Since there will be an occupant-seat-restraint system model available later in the program, a refinement for future consideration would involve combining the volume history from KRASH and the occupant model history to ascertain relative positions and velocities of the structure and occupant extremities.

4.4.3 Acceleration Pulse Input

KRASH is modified to include provisions for specifying an acceleration pulse magnitude, shape, duration and direction for as many as 50 mass-directions* The program requires that the following information be defined:

- o location of pulse (which masses)
- o direction of pulse (one or more of six directions)
- o history of the acceleration at the specified mass and its direction

Once specified, the accelerations of the designated masses are prescribed in the subroutine where accelerations are normally computed so that system velocities, displacements and subsequent forces are computed thereafter. Generally, a crash analysis is initiated with a known set of impact velocities. The velocity at each mass point is integrated to obtain a

* Each mass can have accelerations acting in six directions.

displacement. The displacement is used to develop forces via external force-deflection curves and internal member stiffnesses. However, this routine makes it possible to excite the system with an acceleration. It may be most useful in modeling substructure (seat system) or where an impact can be idealized with an acceleration pulse, (i.e. water impact).

4.4.4 Internal Computation of Element Linear Stiffnesses

The internal computation of element linear stiffnesses involves providing the following input data for each member:

E = modulus of elasticity

G = shear modulus

J = polar moment of inertia

A = cross sectional area

L = member length

I_y, I_z = area moment of inertia about the y and z axis

The data is used in the program to formulate a 6 x 6 linear stiffness matrix for each element. One line (card) of input data per internal element member is required instead of six cards of stiffness terms as was formerly required. Since stiffnesses are often obtained from the member properties prior to input to the program, this change can result in a substantial saving in effort. Wherein stiffnesses are known from available data, material properties representative of the section can still be readily obtained since the beam stiffness terms are related to the member properties in a relatively straightforward manner. The formulation of linear stiffness within the program does not alter any of the basic computations. Direct input of the stiffness matrices is still available as an option.

4.4.5 Member Directional Stresses

The determination of member directional stresses is obtained using the material property data used by the program to computer linear stiffnesses. The computation of stresses is an option which can be used even for

members wherein direct input of the stiffness matrix is employed.

When stresses are desired, the program requires that the members be identified and that, in addition to the member properties used to formulate element stiffnesses, the respective distances to the neutral axis of the element and appropriate yield stress be provided. The procedure the program follows to compute stresses with the required input data is as follows.

- Using member forces computed in the program and the member properties, the element stresses acting at the top, bottom, right and left side on each of the selected members is determined. The method of calculating the member forces is unchanged; stresses are calculated only for output information and are not used internally in the force calculations.

- Combined stresses due to bending, axial, shear and torsional forces are computed.

- The principal and maximum shear stresses are computed.

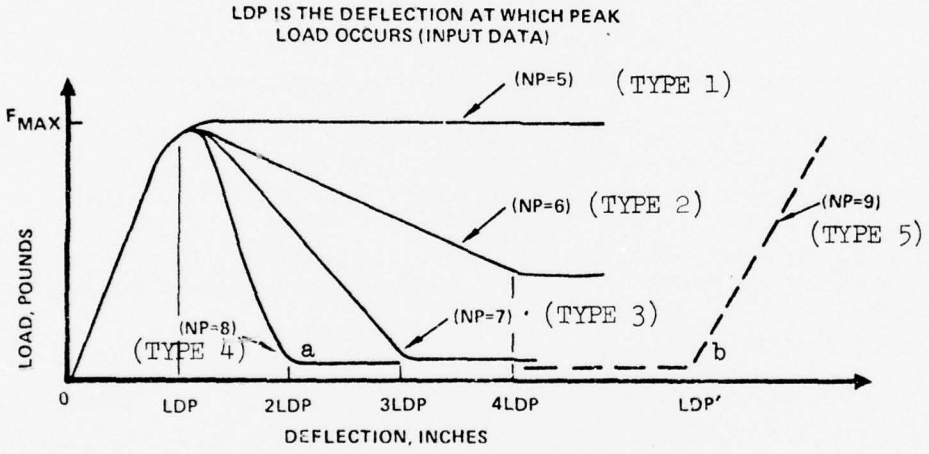
- The maximum shear failure theory and the theory of constant energy of distortion for a combined axial and shear stress condition are applied.

- Ratios of element stress to yield stress are computed during the entire analysis (A ratio of >1.0 indicates yield has been exceeded)

The above approach is simple and consistent with the techniques utilized in KRASH and, as such, has limitations. The incorporation of the stress check offers the advantage of being able to monitor selected elements to determine if they have reached a yield condition. Once the element has yielded the failure theories are invalid and, consequently, the most meaningful use of the stress data is to identify which elements yield and at what time during the crash analysis. The stress data can help assess the validity of results with regard to the data used in modeling some of the structure. However, the computed stresses should not be used to verify structural designs because they do not provide sufficiently accurate data with which to make critical design decisions. For example, the effect of stress concentrations, unique geometry shapes and detail attachment practices at joints, are not included. Furthermore, care should be exercized in using this option since many times a complex structure is idealized with beam properties.

4.4.6 Internal Computation of Nonlinear Curves

The determination of the exact nonlinear behavior of structural elements is very difficult, particularly when interaction of loads is involved. By the use of linear stiffness reduction curves, KR, different types of nonlinear behavior can be represented. It is shown in Reference 4 that by approximating the nonlinear behavior in this manner, while representing the proper failure load, responses which are sufficiently accurate for crash analysis purposes are obtained. Thus, carrying this approach one step further by preprogramming the typical nonlinear curve shapes, as shown in the following sketch, the need to input all KR tables is obviated.



A type 1 curve uses five data points (NP=5)*

A type 2 curve uses six data points (NP=6)*

A type 3 curve uses seven data points (NP=7)*

A type 4 curve uses eight data points (NP=8)*

A type 5 curve uses nine data points (NP=9)*

The input requirements to use the nonlinear curves consist of the identification of the member for which nonlinear behavior is desired, the deflection (LDP) at which inelastic behavior occurs, the direction of interest (3 translation and 3 rotations are possible), and the number of points (NP)

* Coding is self contained in KRASH

defining the curve. When NP = 5, 6, 7 or 8 or 9, the program computes the nonlinear curve. When a 9 point curve is used the user also specifies the deflection corresponding to point b in the above sketch. When NP ≥ 10 a series of KR versus deflection data points is required. This allows the user to retain the capability to define an arbitrary load-deflection curve. The relationship between KR versus deflection and load versus deflection is defined in the User's Manual (Reference 13, Section 3).

4.4.7 Provisions for Modeling Earth Scooping and Plowing

This modification is applied only to the masses which are identified as having an external spring. Following the principles outlined in Reference 12, the average scoop force acting on the airplane can be determined and approximated using a trapezoidal force-time history. Plow forces are computed in the same routine wherein crash forces and energies are obtained. Usage of this routine requires an input of average force at the appropriate mass location where scooping takes place.

4.4.8 Standardization of Terms

The purpose of using standardized terms is to simplify the input requirements for the user. Several areas where standardization is incorporated into program KRASH are described in Reference 4. The use of internally coded KR curves in this program is another example of standardization. The manner in which member damping is input into the program is altered to give the user more flexibility. The original version of KRASH requires one card of input data for each member. Thus, representing percent of critical damping for the particular member could require a maximum of 120 cards. KRASH is now coded that all members have a standard one (1) percent of critical damping. The user can use this standard value, give all members a different value, or give the members any combination of damping values. It is possible to run a 120 member analysis with as little as 1 damping card, instead of 120 damping cards.

4.4.9 Refinement of Damping Force Formulation

This change recodes the manner in which rotational velocities are

calculated which lead to the damping forces. Previously, negative damping terms could be developed which could hinder the analysis. Now, with judicious selection of damping coefficients and integration interval, this should no longer be a problem.

4.4.10 Addition of 'Model Parameter Data' Printout

This change provides a printout of vehicle c.g. coordinates, mass and inertia properties, member frequencies, and damping terms. This printout is valuable in the initial checkout of the math model to ascertain that the math model properly represents the vehicle properties. It also allows the user to detect any potential instability problem which could be associated with high frequencies or large damping terms.

4.4.11 Treatment of Beam Longitudinal Elongation

The manner in which the program treats beam longitudinal elongation due to large lateral translations and rotations is improved. The program previously utilized a method which led to inaccurate axial deflections under conditions of large lateral deflections or beam rotations. Now the current overall beam length is calculated, and incremental axial deflections are based on differences in beam lengths from one integration interval to the next.

4.4.12 Addition of External Spring Force and Compression Data

The program now prints out the external spring forces along with the spring compression in both ground and mass axis coordinates. The directions in which the forces act are identified. The added external spring force data is conveniently located with the external spring deflection data and provides useful information to help the user assess the results. The data allows the user to distinguish between crushing and friction forces.

4.4.13 Separation of Crushing and Friction Energy

The program now separates the crushing and friction energy terms. Previously both were included under the heading "crushing energy". The user can now assess the relative effect of the structure crushing and ground

friction employed in the analysis.

4.14.14 Revision to the KR Function Usage

The manner in which the KR function is used in the program has been revised. This change does not effect the input of data. The linear forces are multiplied by KR's to obtain reduced forces. Previously, the KR's reduced the linear deflections which, in turn, were multiplied by a linear stiffness matrix to obtain the reduced forces. The program is now coded such that, for the normally coupled beam motions (z, θ and y, ψ), the proportions of the total force and the moment due to deflection and rotation inherent in the linear system are preserved, while still accounting for the nonlinear load-deflection characteristics. It is desirable to retain this relationship in order to minimize the possibility of developing negative strain energy with large nonlinear responses.

4.14.15 Revisions to the Input Format

This change simplifies the data input requirements and organizes the print of data in a more orderly fashion. The data that is normally required (basic data) is now input initially in the following sequence:

- control cards
- mass coordinates and associated data
- external member data
- internal member data
- options (volume, stress, DRI)
- seldom used data (Euler angles, inertia cross products)

Section 2 of the KRASH User's Manual (Reference 13) describes and illustrates the revised impact format.

4.4.16 Revisions to the Output Format

This change organizes the output data in a more orderly manner and provides additional information to facilitate the user's understanding and

evaluation of the results. Included in this change are the following:

- The print-out of the input data is presented in a more organized manner such that standard mass and member data is easily delineated.
- The unnecessary presentation of large zero matrices of data is eliminated.
- The output data provides a print of member strain force and total forces. Previously only the member strain force was available. The difference between member total force and member strain force is the damping force contribution. Consequently, the user can assess the relative effect of the stiffness and damping data that contributes to these forces.
- The output format contains expanded print for external spring forces and deflections which now includes ground contact point loads in ground (or slope) and mass axes.
- Vehicle c.g. translational velocities in ground axes, based on system linear momentum considerations are presented at each print interval.

4.4.17 Miscellaneous Coding Changes

The program has been recoded to allow the use of large initial pitch angles (> 90 degrees), and to properly calculate forces resulting from negative external spring lengths (required for the inverted crash condition). This change eliminates the possibility of computing negative crushing energy.

The program has also been recoded to allow external springs to deflect beyond the maximum free length value that may be used as an input. This change eliminates one of the conditions which could result in negative external spring energy being developed in a math model.

4.4.18 Addition of Subroutine ECHO

This subroutine was added to the program to facilitate the user's task of evaluating the validity of the input data format. ECHO prints out the input in card image format which allows for a rapid assessment of any potential errors in data, input format, out of order cards and/or improper control cards.

4.4.19 Use of English Words

English words have been added in such a manner that they precede the printed symbols, which are retained. The English words clarify the meaning of the output while the symbols in many instances relate to the coding contained in the program.

SECTION 5

ASSESSMENT OF PROGRAM KRASH

5.1 PURPOSE AND METHOD

Program KRASH was verified using experimental data obtained from a full scale helicopter crash test involving a combined vertical and lateral impact velocity(Reference 3). There are many similarities in the requirements for the crash analysis of helicopters and general aviation airplanes, including:

- o exposure to multidirectional forces during a crash
- o comparable takeoff weights for certain classes of each
- o similar structure in many areas
- o multiple impacts for certain crash conditions
- o comparable crash durations

However, airplanes and helicopters have significant differences which affect the requirements for performing crash analysis. These differences involve:

- o design configurations
- o mass locations
- o seat systems
- o operational modes which will affect probable impact conditions

Furthermore, the results of the evaluation of airplane design characteristics, as well as the accident review and evaluation, led to the inclusion of additional capability for KRASH (discussed in previous section). Consequently, the development of KRASH, modified for general aviation airplane application, requires that some reasonable assessment of its capability be made prior to initiating fully instrumented full scale airplane crash tests in support of

the verification program of Task II.

Ideally, it is desirable to compare analytical results with controlled crash test data from test articles of comparable size, configuration, complexity and weight as the intended structural system. The availability of such test data for two different general aviation airplanes of current design and representing two probable accident conditions, provides a practical means of assessing program KRASH. The crash tests, while limited in the amount of measured quantitative structural response data, provided a significant quantity of high speed film and photographic coverage with which to assess KRASH's capability to predict structural deformation, multiple impacts and rigid-body large motion post-impact behavior. The tests also provide data with which to assess the validity of program modifications and to obtain information which can be utilized in the development of a KRASH User's Manual and Structural Design Guide (Reference 13). The crash tests represent impact conditions for typical general aviation airplane crashes in which multidirectional forces are involved. The mathematical models, crash test data, comparison of analysis and test results, and the assessment of KRASH are described in the following subsections.

5.2 GENERAL DESCRIPTION OF AIRPLANES

To demonstrate that program KRASH is potentially an acceptable analytical method with which to perform crash analysis for general aviation airplanes, two representative airplanes are selected to be modeled and the results of the analyses compared to the available test data. The airplanes designated Airplane A and Airplane B are shown in Figures 14 and 15 and are described below:

Airplane A

- Category 1 (See Table 4)
- single-engine, high-wing configuration
- side by side seats (2 occupants)

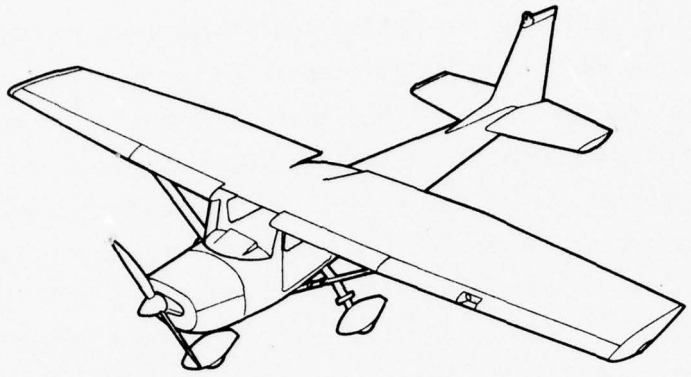


Figure 14. Airplane A, High-Wing Single-Engine Type

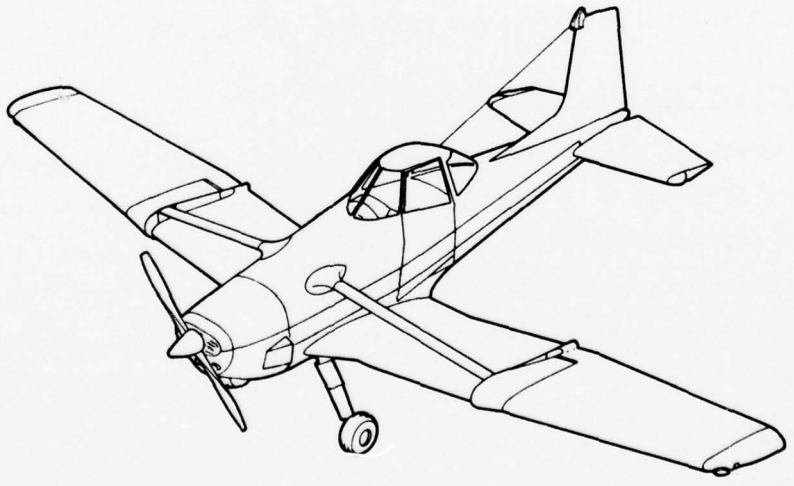


Figure 15. Airplane B, Low-Wing Single-Engine Type

Airplane A (Cont.)

- o used for training, sport and aerobatic (acrobatic) purposes
- o stall speed ≤ 42 knots
- o cruise speed (75 percent power) ≤ 102 knots
- o maximum takeoff weight, 1600 pounds
- o fuselage is of all semi-monocoque construction. The wing is a cantilever structure designed with two main spars and with a midspan braced strut. The landing gear is a non-retractable tricycle type. The tail is of cantilever design.
- o flight design load factors of: +4.4 g's and -1.76 g's (utility)
  +6.0 g's and -3.00 g's (aerobatic)
- o overall dimensions are: wing span = 384 inches, length = 280 inches
- o the weight - c.g. envelope is shown in Figure 16

Airplane B

- o Category 3 (see Table 4)
- o single-engine, low-wing configuration
- o single seat
- o used for application of chemicals to or seeding crops
- o stall speed ≤ 50 knots
- o cruise speed (75 percent power) ≤ 122 knots
- o maximum takeoff weight = 3300 pounds (4000 pounds in restricted category)
- o Fuselage structure is a rectangular section, welded steel tube construction in the forward and cabin area and semi-monocoque construction in the rear. The wing is a cantilever structure designed with two main spars with a midspan braced strut. The landing gear is a non-retractable tail-wheel type. The tail is of cantilever design.
- o flight design load factors of: +3.8 g's and -1.52 g's
- o overall dimensions are: wing span = 474 inches, length = 273 inches
- o the weight-c.g. envelope is shown in Figure 17

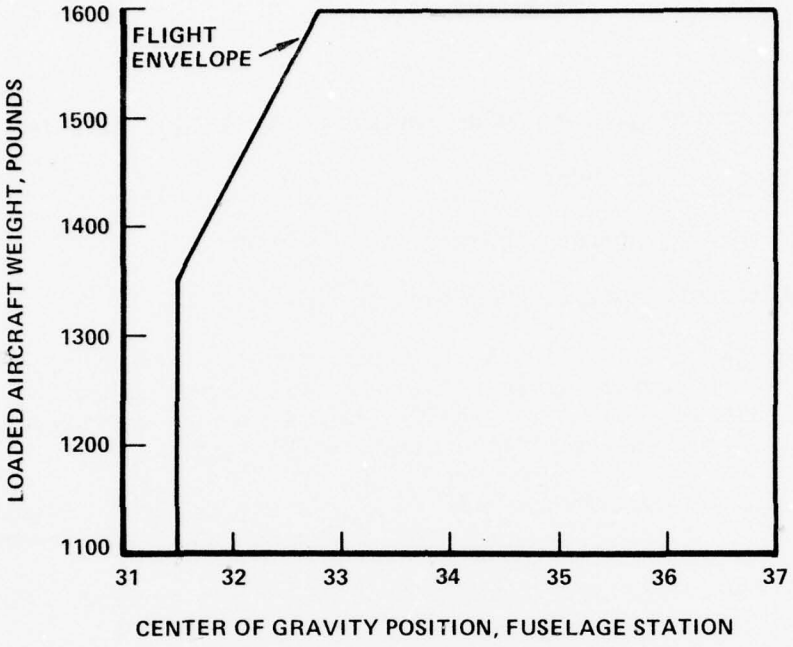


Figure 16. Weight - CG Flight Envelope for Airplane A

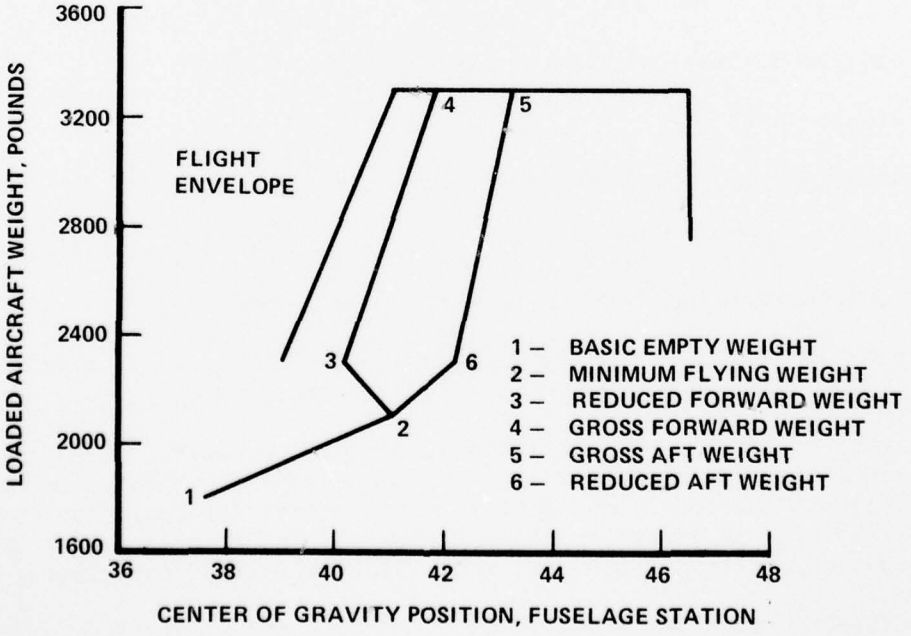


Figure 17. Weight - CG Flight Envelope for Airplane B

5.3 CRASH TEST DATA

5.3.1 Airplane A Stall-Spin Crash Test

5.3.1.1 Test Objectives

The test objectives were to:

- o check out the crash test facility and determine potential improvements for further tests
- o determine crash characteristics of the Category 1 airplane during a stall-spin crash
- o determine the chances of survival for the occupants during a stall-spin crash

This was the first full scale airplane crash test performed at a test site which consists of an asphalt track 20 feet wide and 600 feet long terminating in a dirt barrier that is readily shaped to simulate selected crash impact angles. A steel rail in the center of the track is used for control of the tow dolly during acceleration of the specimen. Propulsion is provided by an engine and winch applying direct power to the specimen tow dolly through a steel cable.

5.3.1.2 Test Setup and Procedure

The test specimen contained two instrumented dummies as occupants (95th percentile (pilot) and 50th percentile (co-pilot)). The accelerometers in the dummies were located at F.S. 44.0, W.L. -16.0, B.L. ±9.0 in the pelvises. and F.S. 48.0, W.L. +19.0, B.L. 9.0 for the pilot head and F.S. 47.0, W.L. +17.0, B.L. -9.0 for the co-pilot head. Accelerometers were located on the centerline of the floorboard (F.S. 56.7, W.L.-11.0, B.L. 0.0) and oriented in the vertical and longitudinal directions. One wing had lead secured in the fuel tank bay and the other fuel tank was filled with colored water representative of the fuel weight. Angular spoilers were attached to the leading edge upper surface of each wing to prevent lift off. The instrument panel was representative of the panel normally used in this particular airplane. The seats were standard 1969 versions. The left seat had the regular seat belt but the right seat restraint system included a seat belt, shoulder harness and attachments. The nose wheel was replaced with a wheel and dolly.

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A METHOD OF ANALYSIS FOR GENERAL AVIATION AIRPLANE STRUCTURAL C--ETC(U)
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UNCLASSIFIED LR-27698 FAA-RD-76-123 NL

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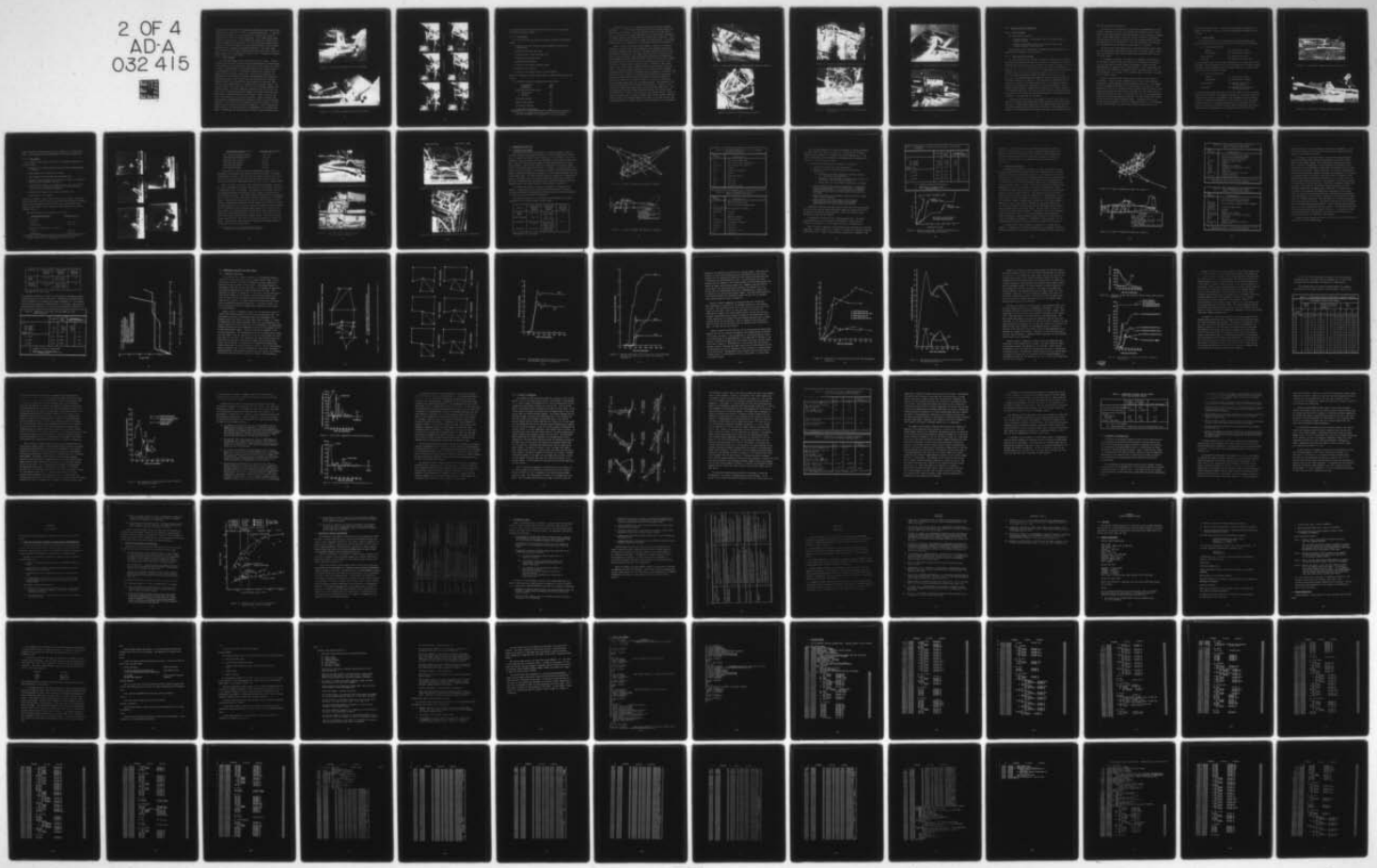


The dolly and tow attachment incorporated a mechanical release system which caused both the dolly and tow cable to release simultaneously. A 'dead man' brake system consisting of an accumulator and solenoid valve connected directly to the ship's battery was installed. One 47 frame/second camera filmed the overall crash. One 64 frame/second camera with telephoto lens filmed the impact with the barrier. One 1000 frame/second camera filmed a close-up of the barrier impact (the poor lighting provided for this camera made the results unusable for engineering analysis). Two normal speed (18 frames/second) documentary cameras filmed the overall crash. Figure 18 shows a side view of the airplane in position prior to impacting the barrier with a velocity of 45 feet/second.

5.3.1.3 Crash Sequence

The nose wheel makes initial contact with the dirt barrier. Failure of the nose wheel strut aft does not significantly impede the forward motion of the airplane and the spinner and lower portion of the engine cowl contact the barrier approximately 30 milliseconds later, with a forward velocity of approximately 45 ft/sec. The forward fuselage, after impacting the barrier, rides up as high as three feet. The tail cone buckles at its attachment to the fuselage aft bulkhead at approximately 100 milliseconds after spinner impact. The co-pilot, who was restrained with a shoulder harness, appears to move forward and nearly impacts the instrument panel with his head at approximately 140 milliseconds after spinner impact. The co-pilot impacted the control wheel and his lower extremities impacted the instrument panel. The pilot apparently submarined under his lap belt (he did not have a shoulder harness) and impacted the control wheel with sufficient force to break the left grip of the wheel. Figure 19 shows a side view of the airplane in its post crash condition. Figure 20 depicts the crash sequence from approximately nose (spinner) impact to 180 milliseconds thereafter. The film analysis was performed during this program. The film analysis data and results are provided in Appendix C. The 47 frame/second film was used for the analysis, which is approximately 20 milliseconds per frame. Consequently, the sequence shown in Figure 20 may be delayed by up

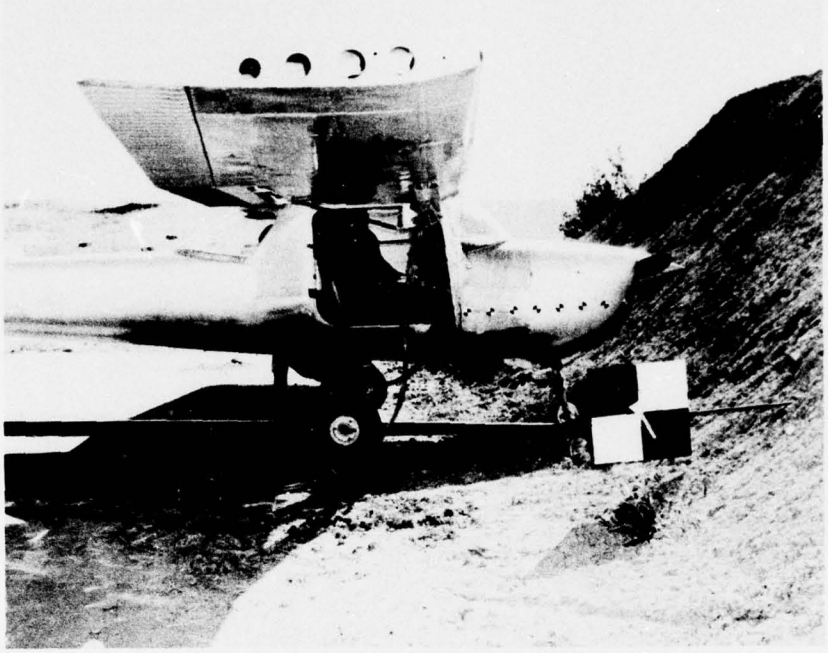


Figure 18. Side View of Airplane A Prior to Crash Test

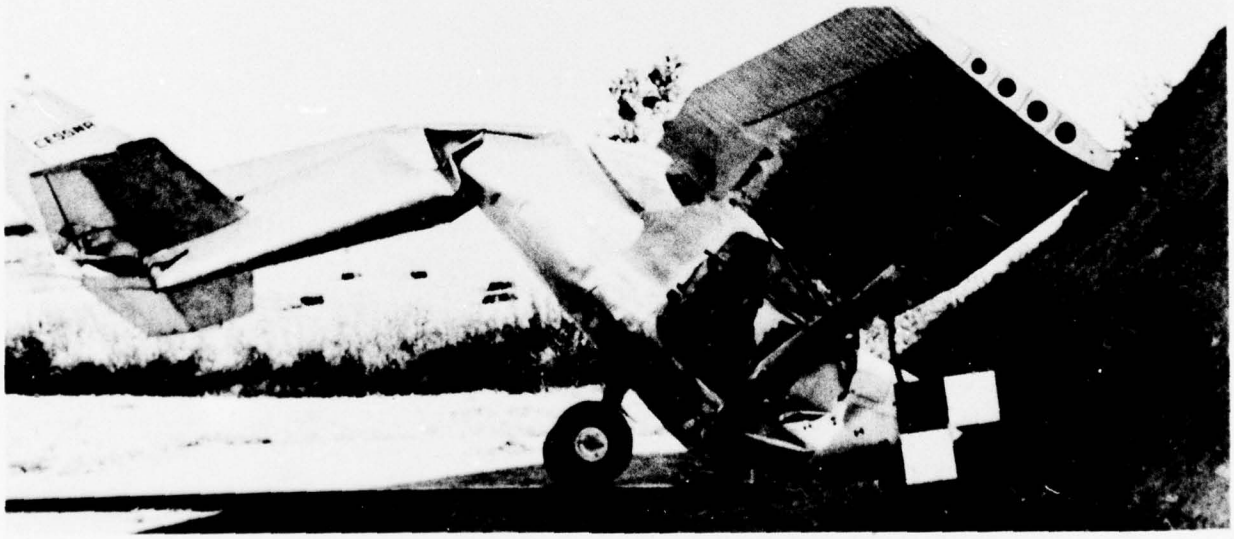


Figure 19. Side View of Airplane A After the Crash Test

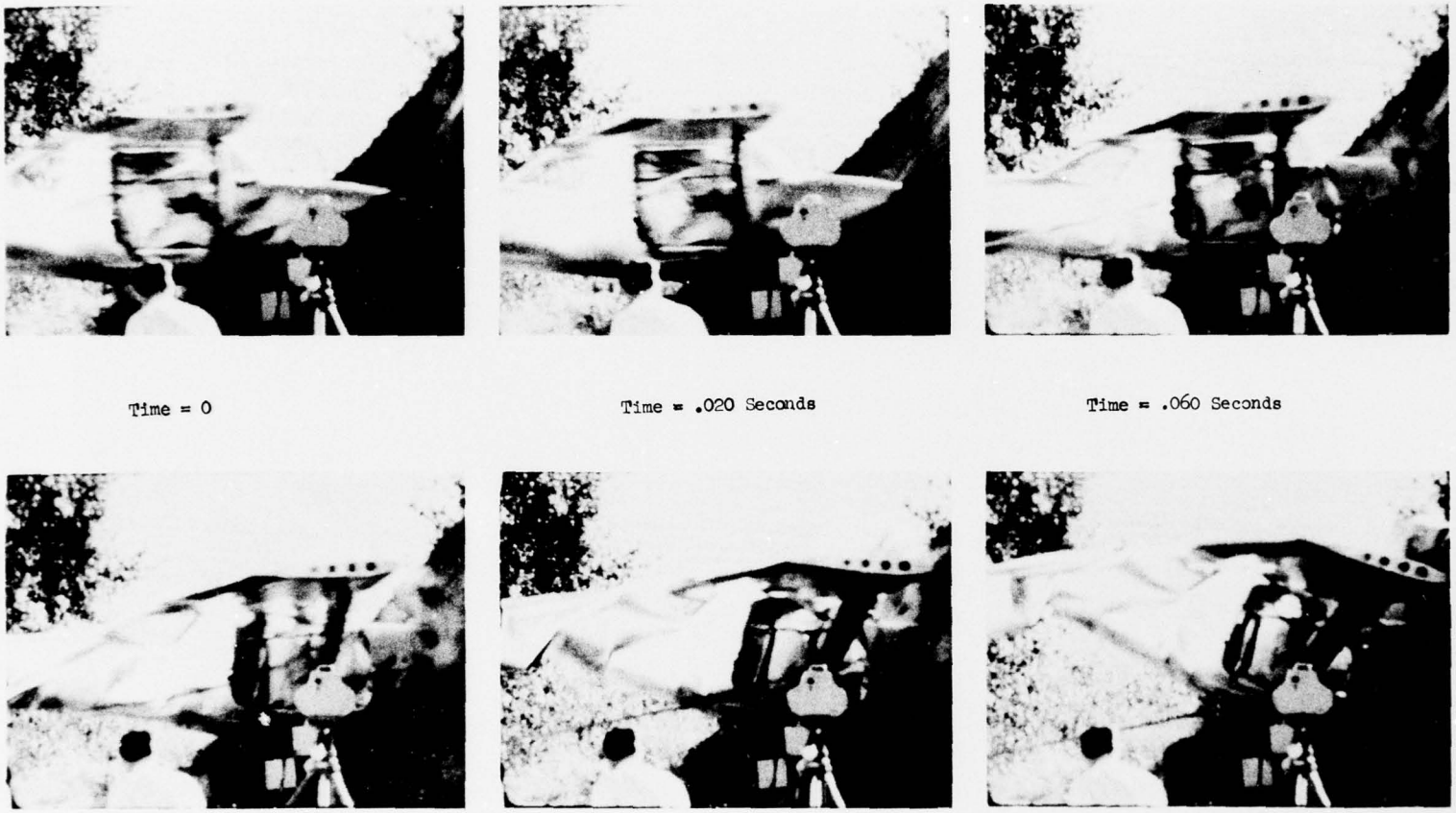


Figure 20. Crash Test Sequence for Airplane A

to 20 milliseconds if the event noted at time zero is due to nose gear failure and not spinner impact.

5.3.1.4 Test Results

As a result of the test crash, the airplane sustained the following damage:

- Failure of the left wing rear spar attachment (this was not a standard part)
- Failure of the right door post
- Buckling (aft) of the nose wheel strut
- Buckling of the engine mounts
- Buckling of the firewall
- Bending of the control column and wheel
- Denting of the nose cap
- Wedging of the rudder to the full right position

There was no damage to the main gears, seats, occupant restraints and fuel system.

The summary of recorded accelerations is given below:

Accelerometer * Location	Peak g's
Floorboard over the main gear	
o longitudinal	121
o vertical	106
Pilot head vertical	100
Co-pilot head vertical	104
Pilot pelvis vertical	94
Co-pilot head longitudinal	113

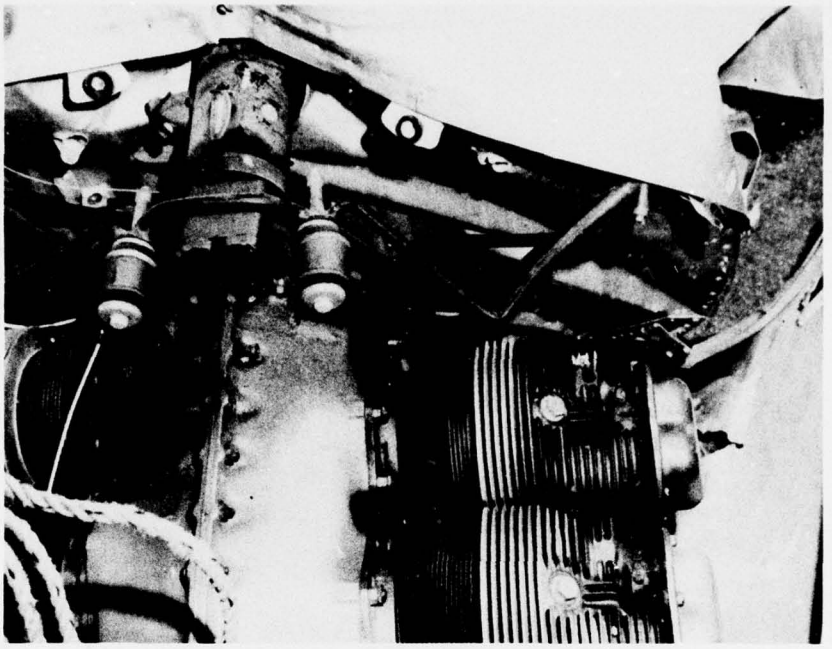
* Presented in airplane coordinate system for the structure and body axis (see Figure 1-4, Reference 12) for the occupants

A composite of all the accelerometer traces indicated that the peak amplitudes all occurred simultaneously and they have approximately the same levels and waveforms. From past experience, there is a time lag between the fuselage and occupant responses as well as significant differences in response frequency which indicates that the data may be deficient. Only the floor response data was used to compare with KRASH results. The occupant response data is more applicable to occupant-seat-restraint system models.

Figure 21 shows the forward fuselage damage, consisting of extensive crushing of the lower cowl, some deformation of the propeller spinner and very little damage to the upper cowl. The upper structure aft of the firewall failed in compression. The lower structure moved aft relative to the wing and upper structure. The lower fuselage structure has substantially less deformation than the upper structure. Figure 22 shows the cabin damage. The occupant (right side) with the seat belt and shoulder harness is restrained. Unlike the other occupant, he did not submarine. The volume change shown is less than the maximum distortion that occurred during the crash. The structure sprang back from 25 to 50 percent from its maximum deflected position, which is consistent with data reported in Reference 4 and findings by NASA. Analysis of the high speed camera data was performed during this program and the cabin volume behavior which was obtained is described in Section 5.5. Figure 23, which is a top view of the engine, shows the upper engine mounts in a buckled condition. The generator at the top aft portion impacted the severely buckled firewall. Figure 24 illustrates the buckled lower engine mounts and aft bent nose wheel strut. The top engine and nose strut support structure has been cut to allow access to the structure. Figure 25 shows the tail cone bending failure. Figure 26 shows the non-standard wing spar attachment shear failure described earlier. Unlike the cabin and fuselage damage, the failure of the tail cone and wing spar attachment did not pose a threat to the survivability of the occupants.

Figure 21. Three-quarter View of Forward Section Damage (Airplane A)

Figure 22. Side View of Cabin Damage (Airplane A)



AFT

Figure 23. Top View of Engine Mount Damage (Airplane A)

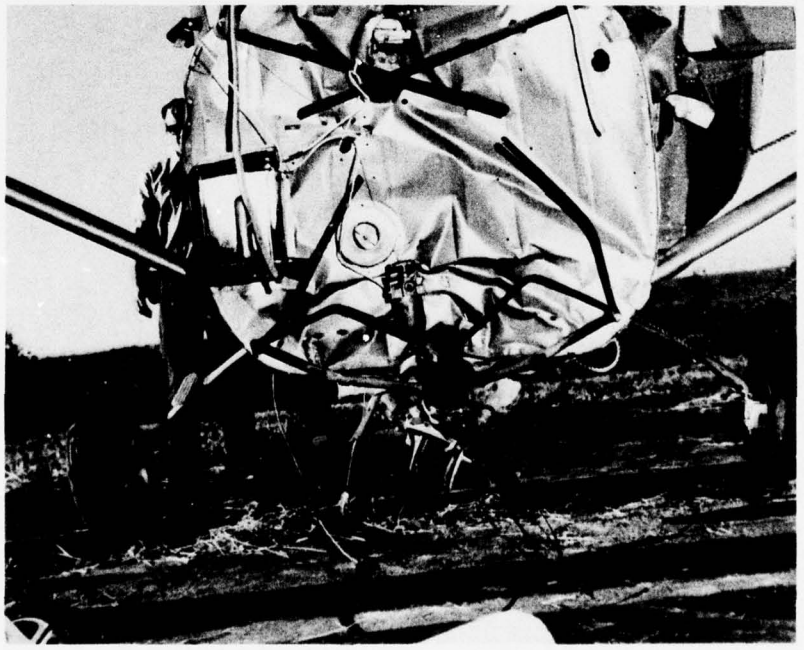


Figure 24. Front View of Engine Mount and Firewall Damage (Airplane A)

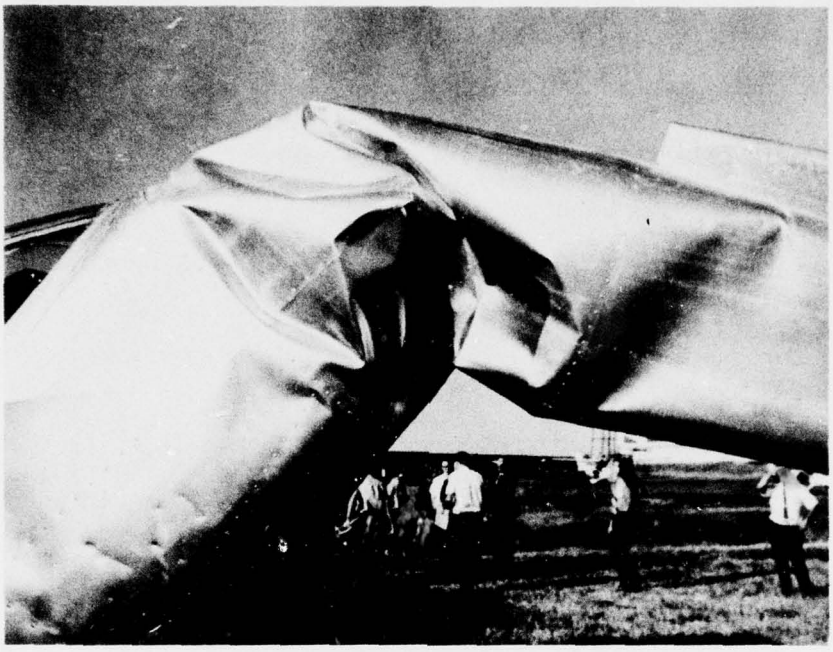


Figure 25. Side View of Tail Cone Damage (Airplane A)

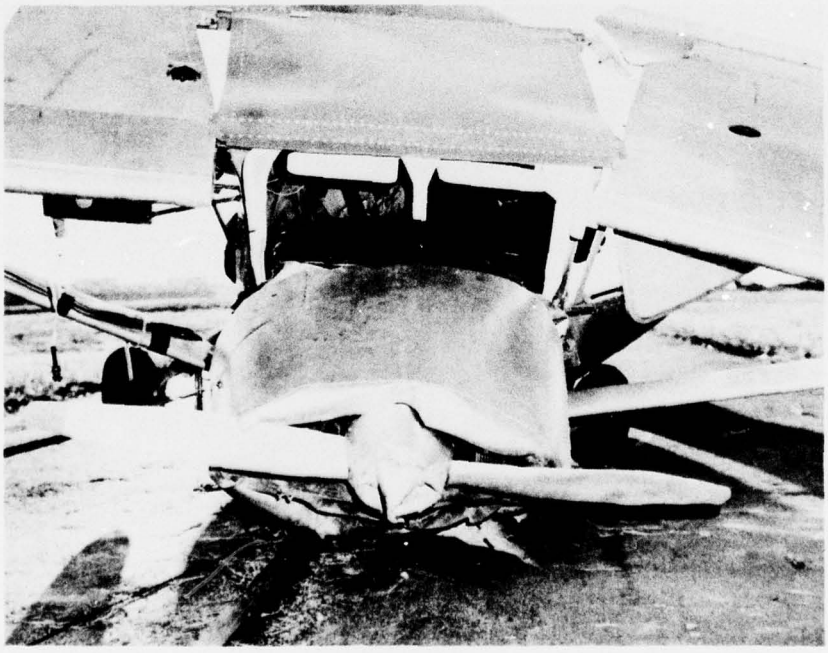


Figure 26. Front View of Wing Damage (Airplane A)

5.3.2 Airplane B Turnover Crash Test

5.3.2.1 Test Objectives

The test objectives were to:

- o determine chances of survivability for the occupant during a turnover accident
- o determine acceleration levels on the structure and on the occupant during a turnover accident

The turnover test was performed at the same test facility that the stall-spin test (Airplane A) was conducted.

5.3.2.2 Test Setup and Procedure

The test specimen was an original engineering prototype and contained one 95th percentile instrumented dummy as an occupant. Accelerometers, oriented longitudinally and vertically, were located in the head of the dummy (F.S. 103, W.L. +50, B.L. 0.0) and on the structure near the airplane intermediate c.g. position (F.S. 41, W.L. +2.0, B.L. 19.0). Accelerometers were also located in a vertical position on the aft turnover structure (F.S. 110, W.L. 45.8, B.L. 0.0) and on the forward turnover structure (F.S. 84.6, W.L. 47.3, B.L. 0.0). The aircraft hopper was empty and the fuel tank was filled with 40 gallons of water (8.34 lbs/gal). The water added an additional load of 99 pounds in excess of the normal weight of fuel. The seat and restraint system for the airplane were standard for this type of airplane. The restraint system included a standard shoulder harness with a rolled lap belt to accommodate load cells. The load cells were located on the left and right hand sides of both the lap belt and shoulder harness. The instrument panel contained a full complement of instruments.

Batteries were installed in the airplane to power a wing (left side) mounted 1000 frame/second camera which filmed the occupant and cabin during the crash. Another camera operating at 1000 frames/second filmed the test run from a stationary position outside the airplane. Cameras operating at speeds of 24 frames/second and 64 frames/second were used to record the total

test run and monitor the turnover.

The airplane was accelerated by a tow engine to approximately 30.5 mph through a distance of 75 feet. The airplane was attached to the tow dolly system at the front wheels to enable the airplane to be towed along a straight line. A rear support dolly was provided to keep the tail of the airplane from descending during the tow phase of the test, thereby simulating a wheel landing condition. At a distance of 1 foot from the barrier, the airplane was disengaged from the tow dollies and proceeded as a free body.

The wheel brake system employed was the standard airplane brakes except for the replacement of the master cylinder with a 'dead man' system, consisting of an accumulator and a solenoid valve which was plumbed directly into the wheel brakes.

To accomplish a turnover, the brakes on the airplane were locked and the tow engine stopped for the final 28 feet to the barrier; the resulting drag load acting at the wheels caused the airplane to rotate nose down approximately 32.5 degrees from its towed position. After nose contact with the ground, the airplane did a complete turnover and came to rest in an inverted position. To simulate a field condition impact, the track was covered with 12 inches of dirt.

Prior to the actual test, several runs were made for the purpose of calibration. During the first calibration run, the tail of the airplane inadvertently rotated upwards caused by excessive cable slack. This mishap resulted in damage to the skin of the lower center of the tailcone. Calibration runs were used to determine starting distance from the barrier, brake application distance from the barrier, dead time and skid distance during braking, and linear velocities. During the first test run, the brake system failed and the airplane impacted the barrier. The main landing gear sheared off but there was no other structural damage. On another test run, the velocity was insufficient to result in a complete turnover. As a consequence of this aborted attempt, the engine mount assembly failed and had to be

welded before testing resumed. The test was accomplished finally with no further difficulties. Figure 27 shows the airplane test setup prior to the turnover.

5.3.2.3 Crash Sequence

Film analysis of the test indicates that the airplane forward cowl section initially contacts the ground with the following impact conditions:

c.g. velocity (ground axis)	
vertical	19.5 inches/second (down)
longitudinal	259 inches/second (forward)
pitch attitude	38.5 degrees (nose down)
pitch rate	106 degrees/second (nose down)

The film analysis shows that it takes approximately 1.5 seconds after initial nose impact for the airplane to pitch over and impact on the forward turnover structure. When the airplane is in its inverted position, it contacts the ground under the following conditions:

c.g. velocity (ground axis)	
vertical	102 inches/second (down)
longitudinal	45.5 inches/second (forward)
pitch attitude	19.6 degrees (nose down in inverted position)
Pitch rate	89.4 degrees/second (nose down in inverted position)

After the initial impact and prior to the second impact, the left wing made contact with the ground. The damage to the wing tip due to this contact is slight and the effect on the response of the fuselage, cabin structure and occupant is considered insignificant. After turning over onto the forward turnover structure, the airplane continues its nose-over motion and the vertical tail section contacts the ground before the airplane comes to rest. Figure 28 shows the airplane in its inverted position after the crash.

Figure 27. Side View of Airplane B Prior to the Crash Test

Figure 28. Side View of Airplane B After the Crash Test

Figure 29 shows the crash sequence from nose impact to 1.5 seconds thereafter. Data obtained from the film analysis is presented in Appendix C.

5.3.2.4 Test Results

As a result of the turnover crash test, the airplane sustained the following damage:

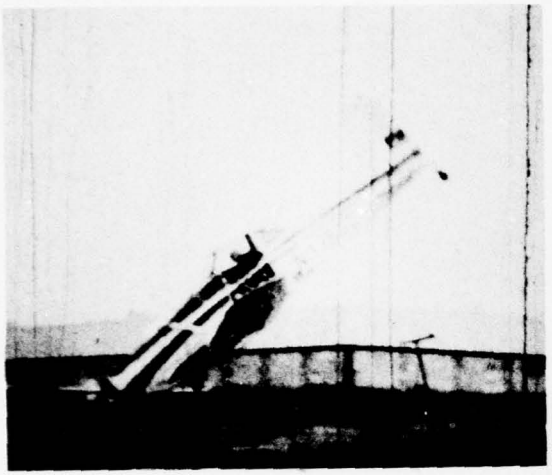
- Failure of the forward turnover structure (downward approximately 2.5 inches)
- Minor damage to the vertical tail section
- Minor damage to the left wing tip and leading edge
- Failure of the left engine mount in shear or tension at a position between the mount assembly and engine
- Failure of the tubular mount assembly on the left side (location of failure is at the position where failure occurred during a test run and the structure was welded)
- Extensive skin damage to the cowling and hopper area
- Minor damage to the firewall

There was no damage to the main gears, tailcone, aft turnover structure, seat and restraint system, right wing, and right engine mounts and assembly. Based on the acceleration levels, tolerance curves and severity index analysis, the occupant was not expected to have experienced any brain or vertabrae injury.

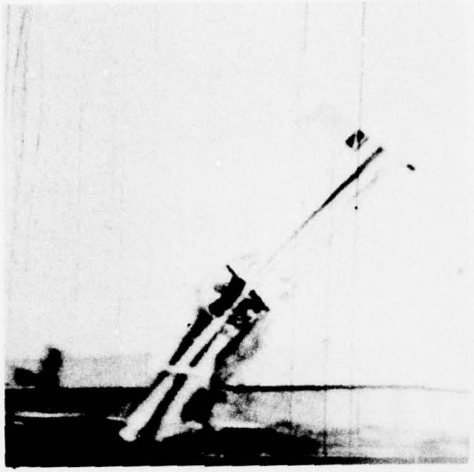
The peak response data is summarized as follows:

Accelerometer Location*	Peak Load or g's
Pilot's Head	
vertical	32.9 g's
longitudinal	20.1 g's
Proximity of Longitudinal C.G. Position	
vertical	21.24 g's
longitudinal	11.81 g's

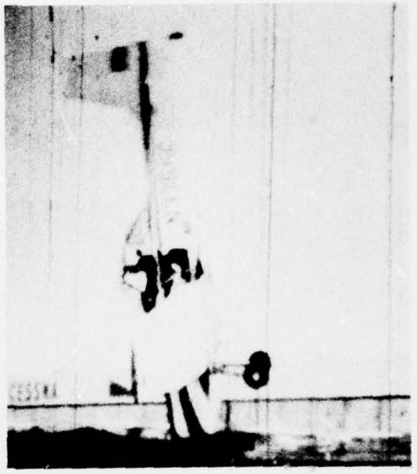
* Presented in the airplane coordinate system for the structure and body axis (see Figure 1-4, Reference 12) for the occupant



TIME = 0.0 SECONDS



TIME = .083 SECONDS



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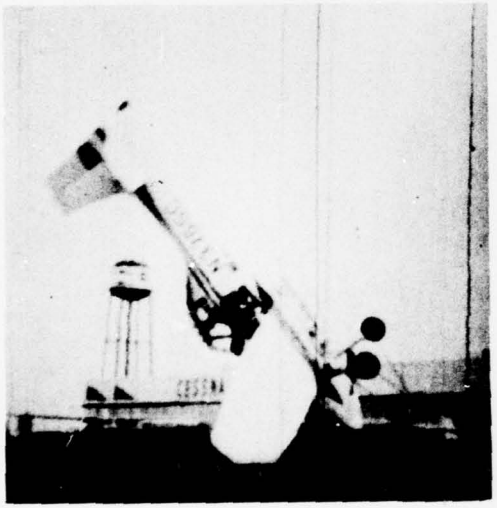
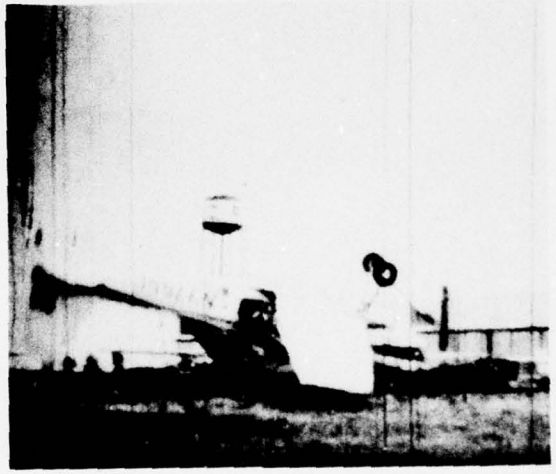


TIME = 1.25 SECONDS



TIME = 1.50 SECONDS

Figure 29. Crash Test Sequence for Airplane B

Accelerometer Location* (Cont.)	Peak Load or g's (Cont.)
Fwd. Turnover Structure Vertical	97.2 g's
Aft Turnover Structure Vertical	72.2 g's
Right Seat Belt (rolled)	399 lbs.
Left Seat Belt (rolled)	699 lbs.
Right Shoulder Harness	792 lbs.
Left Shoulder Harness	521 lbs.

During the test, the tape recorder malfunctioned causing a loss of definition of the response wave forms and times of occurrence of the peak accelerations and loads. While seat belt and harness load cell data may be useful in future evaluation of occupant-seat-restraint system models, the structural acceleration measurements were of little value in assessing KRASH.

Figure 30 shows a side view of the forward fuselage damage. Although the cowl is substantially deformed, the structure at the firewall and aft of it experienced little or no damage. The damage to the underside of the cowl was experienced during the preliminary tests. Figure 31 shows the pilot position after the crash. The forward turnover structure has been compressed and is buried in the dirt while the aft turnover structure had no noticeable damage. The structure surrounding the cabin and below it appears to have remained unchanged which indicates that the energy associated with the impact had been absorbed by the dirt and in crushing the forward turnover structure. While no quantitative data regarding volume change could be obtained from film analysis, the photographs during and after the crash indicate that no significant volume change occurred. Figures 32 and 33 show front and side views of the engine mount and mount assembly damage. The left side mounts failed during the test. The right side mounts were damaged in removing the engine. The left side mount assembly was damaged during pretest checkout and was welded for the turnover test.

*Presented in the airplane coordinate system

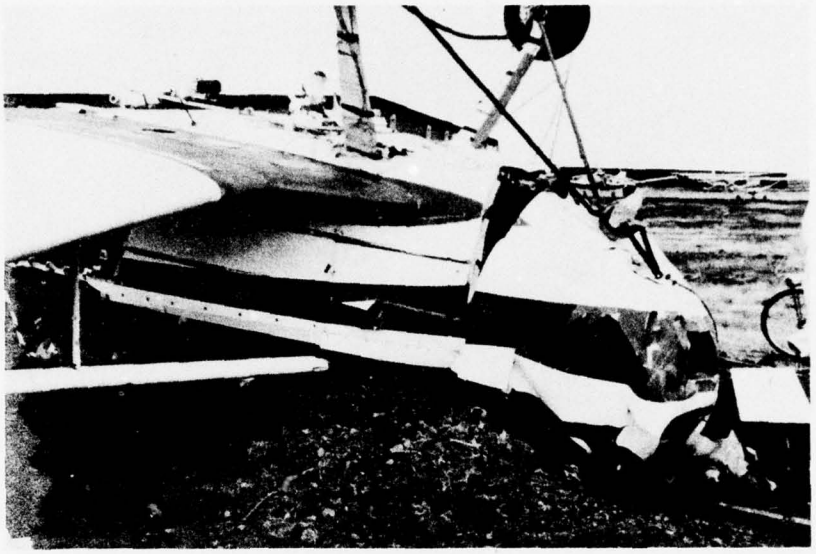


Figure 30. Side View of Forward Fuselage Damage (Airplane B)

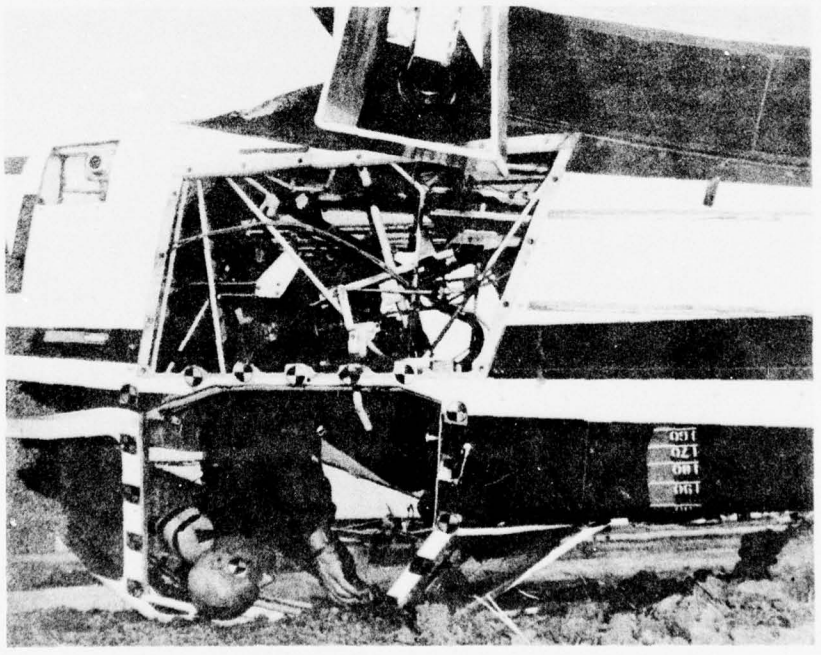


Figure 31. Side View of Cabin Area and Turnover Structural Damage (Airplane B)

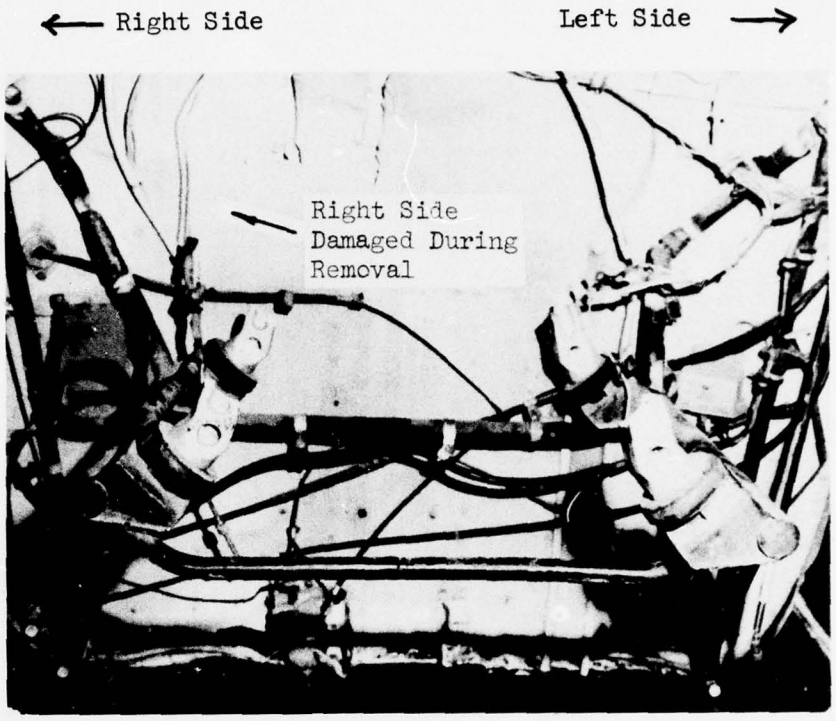


Figure 32. Front View of Engine Mount Failure, Left Side (Airplane B)

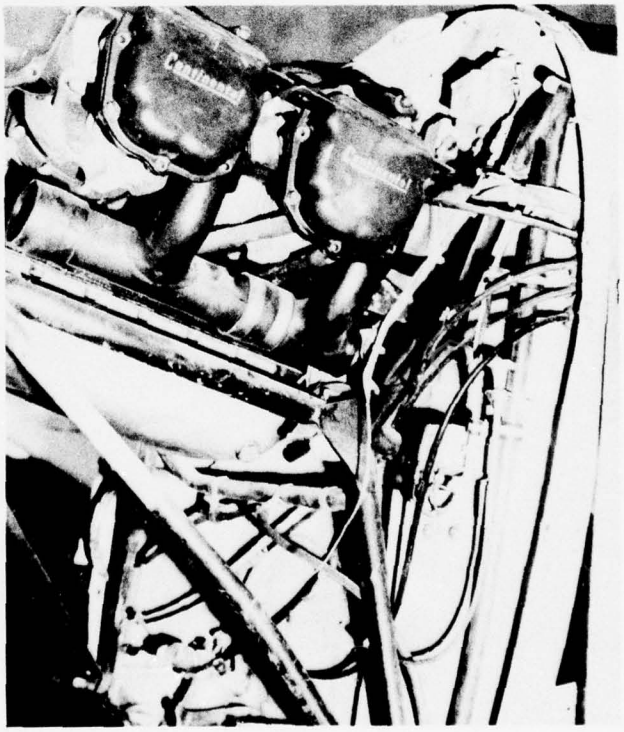


Figure 33. Side View of Engine Mount Failure, Left Side (Airplane B)

5.4 MATHEMATICAL MODEL DATA

5.4.1 Airplane A Math Model

The mathematical models for Airplane A are shown in Figures 34 and 35. The crash condition being analyzed involves a forward fuselage (nose) impact into a 45-degree dirt barrier with no initial yaw or roll angles. Due to the symmetry of the crash impact, and the availability of only side-view film coverage, a math model with a reduced number of masses and members can be used to good advantage. The model size reduction is obtained by utilizing a planar model of the fuselage (all masses in the Y = 0 plane). The smaller model size permits an initial checkout, to determine the portions of the model wherein more rigorous modeling requirements are needed, in a more economical manner than that of the larger model. The model shown in Figure 35 consists of 21 masses and 32 members. A description of the mass representations is provided in Table 10. The model coordinates, mass properties, inertia properties, member properties, damping factors, and initial conditions are presented in Appendix C.

The larger model, shown in Figure 34, consists of 35 masses and 69 members. A description of the mass representations is given in Table 11. The model coordinates, mass properties, inertia properties, member properties and damping values are presented in Appendix C.

The internal elements in the math models are represented with linear properties at all locations except as noted below:

Location	21 Mass Model Nonlinear Members	35 Mass Model Nonlinear Members	Type of* Nonlinear Curve(s)
Engine Mount	9-13, 10-13	9-13, 10-13, 11-13, 12-13	5
Fwd. Fuselage	7-10, 6-9	7-10, 6-9, 12-17, 11-16	5
Mid Cabin	4-5, 4-6, 6-7, 7-8, 5-8.	4-5, 4-6, 5-20, 18-20, 19-20, 16-18, 16-19, 6-15, 15-16.	3, 4, 5
Tail Cone	11-17, 12-17	30-32, 31-32, 21-32, 22-32	3

*See page 66 for curve types

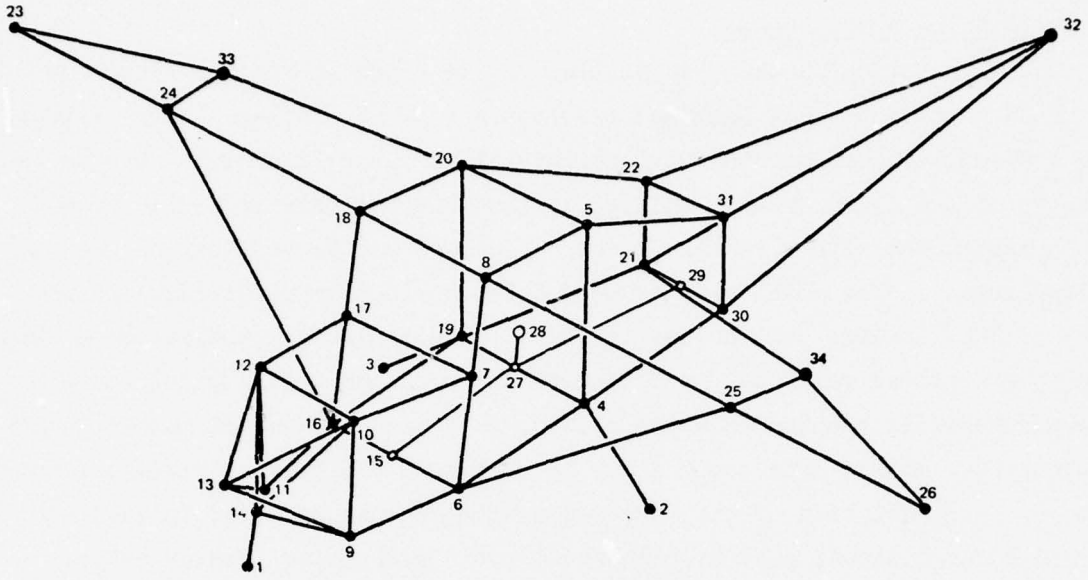
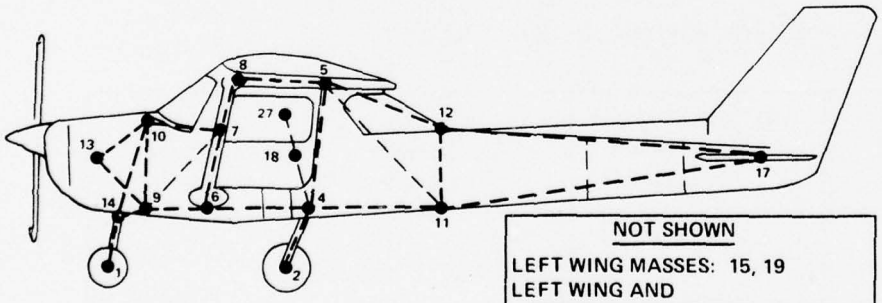


Figure 34. 35 Mass, 69 Member Math Model for Airplane A



NOT SHOWN

LEFT WING MASSES: 15, 19
LEFT WING AND
STRUT MEMBERS: 8-15, 15-19, 6-19
RIGHT WING MASSES: 16, 20
RIGHT WING AND
STRUT MEMBERS: 8-16, 6-20, 6-16

Figure 35. 21 Mass, 32 Member Math Model for Airplane A

TABLE 10. MASS IDENTIFICATION FOR 21 MASS, 32 MEMBER AIRPLANE A MATH MODEL

Mass Point(s)	Representation
1	Nose Gear Unsprung Mass
2,3	Main Landing Gear Unsprung Mass
4,5,6,7,8	Mid Fuselage Cabin Region
9,10	Firewall
11,12	Fuselage Aft Bulkhead
13	Engine
14	Nose Gear Trunnion
15,19	Left Wing
16,20	Right Wing
17	Tail Unit
18,21	Occupant and Seat

TABLE 11. MASS IDENTIFICATION FOR 35 MASS, 69 MEMBER AIRPLANE A MATH MODEL

Mass Point(s)	Representation
1	Nose Gear Unsprung Mass
2,3	Main Landing Gear Unsprung Mass
4,5,6,7,8,16 17,18,19,20	Mid Fuselage Cabin Region
9,10,11,12	Firewall
13	Engine
14	Nose Gear Trunnion
15,27,29	Floor Structure
21,22,30,31	Fuselage Aft Bulkhead
25,26,33	Left Wing
23,24,34	Right Wing
28,35	Occupant and Seat
32	Tail Unit

The nonlinear properties are based on estimates of buckling strengths, available design load data and/or test data. Procedures for obtaining input data are described in the KRASH User's Manual (Reference 13). The standard nonlinear curves incorporated in program KRASH, and described in Section 4.4 of this report, are used.

The procedure for performing the analysis is as follows:

1. Establish both small and large linear models
2. Using the 'model parameter' printout data described in Section 4.4:
   a) determine if the model accurately reproduces airplane C.G. and vehicle mass properties,
   b) determine if the stiffness and damping factor values will potentially cause instability problems, and
   c) refine model mass and stiffness properties, if required.
3. Using the smaller model, initiate analysis for a limited time duration (approximately 20 to 40 milliseconds) and determine energy flow distribution. Use initial estimate of external force-deflection curve with initial impact velocities, rates and angles.
4. Refine the smaller model nonlinear representations and perform longer duration checkouts.
5. Perform checkout with larger model, using nonlinear representations based on the results of the smaller model analysis, for a short duration time period.

Preliminary analytical runs were made to verify that the nose gear fails and in so doing does not absorb significant energy nor change the attitude at impact of the spinner with the barrier. The initial spinner impact velocity was based on film analysis.

A description of the use of the 'model parameter data', the energy distribution printout, the external force-deflection curves, and how failure loads are estimated is presented in Section 3 of Reference 13.

Table 12 shows a comparison of the Airplane A and math model C.G. and mass properties. The math model C.G. is within 0.6 inches of the estimated fuselage station and within 2 inches of the waterline, respectively, compared to the

TABLE 12. COMPARISON OF AIRPLANE A AND MATH MODEL C.G. AND MASS PROPERTIES

	Airplane A	Math[a] Model	Difference	
			Inches	Percent[b]
C.G.				
FS, inches	36.9	36.32	.58	
BL, inches	.28	0.0	.28	
WL, inches	1.85	3.77	1.92	
Weight, lb.	1600	1600		0
Moment of inertia, lb.-in.-sec.^{2}				
I_x (roll)	9000	9243		2.7
I_y (pitch)	9657	10186		5.5
I_z (yaw)	16192	16366		1.1

(a) average of small and large model

(b) $\frac{\text{model value - airplane value}}{\text{airplane value}} \times 100$

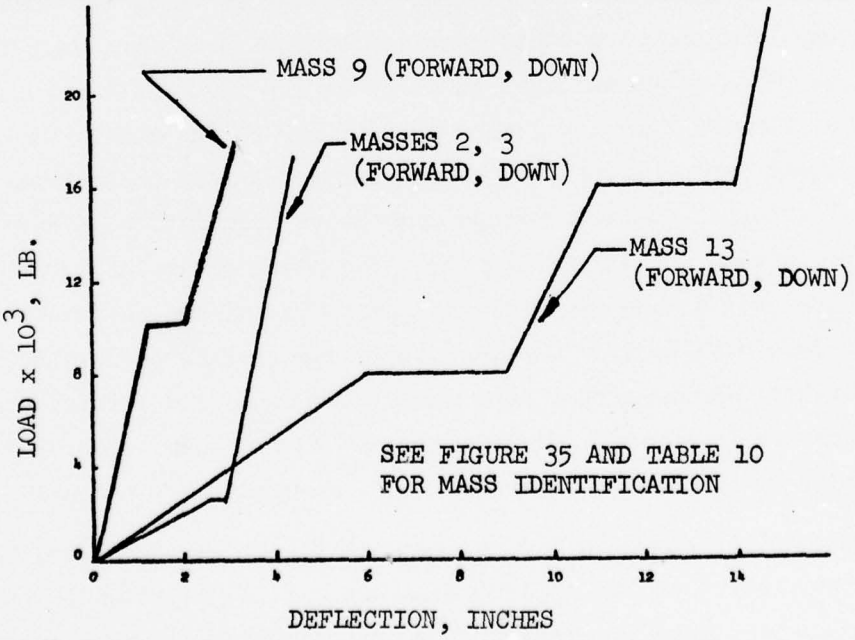


Figure 36. External Spring Load - Deflection Characteristics Used in the Math Model For Airplane A

airplane C.G. The math model inertia properties are within at least 5.5 percent of the estimated airplane values. Actual airplane inertia properties for the test configuration are not available. The external load-deflection characteristics used for Airplane A are shown in Figure 36. The results of the analysis and comparison with test data are given in Section 5.5.1.

5.4.2 Airplane B Math Model

The mathematical models for Airplane B are shown in Figures 37 and 38. The crash condition being analyzed involves an airplane moving at a forward velocity while pitching and rotating nose down. The forward section of the airplane digs into the dirt and the airplane rotates tail over onto its turnover structure. The time duration of the complete crash is approximately 1.7 seconds which is an order of magnitude longer than the significant portion of a typical crash. For most of that time no significant damage occurs. Consequently, this type of accident is idealized as two separate impacts. The damage sustained during the initial impact is included in the model when treating the second impact condition. The technique of using two models (small and large) for each impact is adopted for this crash analysis for the same reasons as that of the analysis of Airplane A. The models developed for the initial forward fuselage impact are similar to the models needed to analyze the second impact (overturn) except for some minor changes such as location of external contact springs and the representation of structure that is damaged during the initial impact. The model shown in Figure 38 consists of 25 masses and 38 members. A description of the mass representations is provided in Table 13. The mass coordinates, mass properties, inertia properties, member properties, damping factors, and initial conditions are presented in Appendix C. Differences in the modeling of the two separate impacts during the turnover are noted in Figure 38 and Table 13.

The larger model, shown in Figure 37, consists of 44 masses and 81 members. A description of the mass representations is presented in Table 14. The mass coordinates, mass properties, inertia properties, member properties,

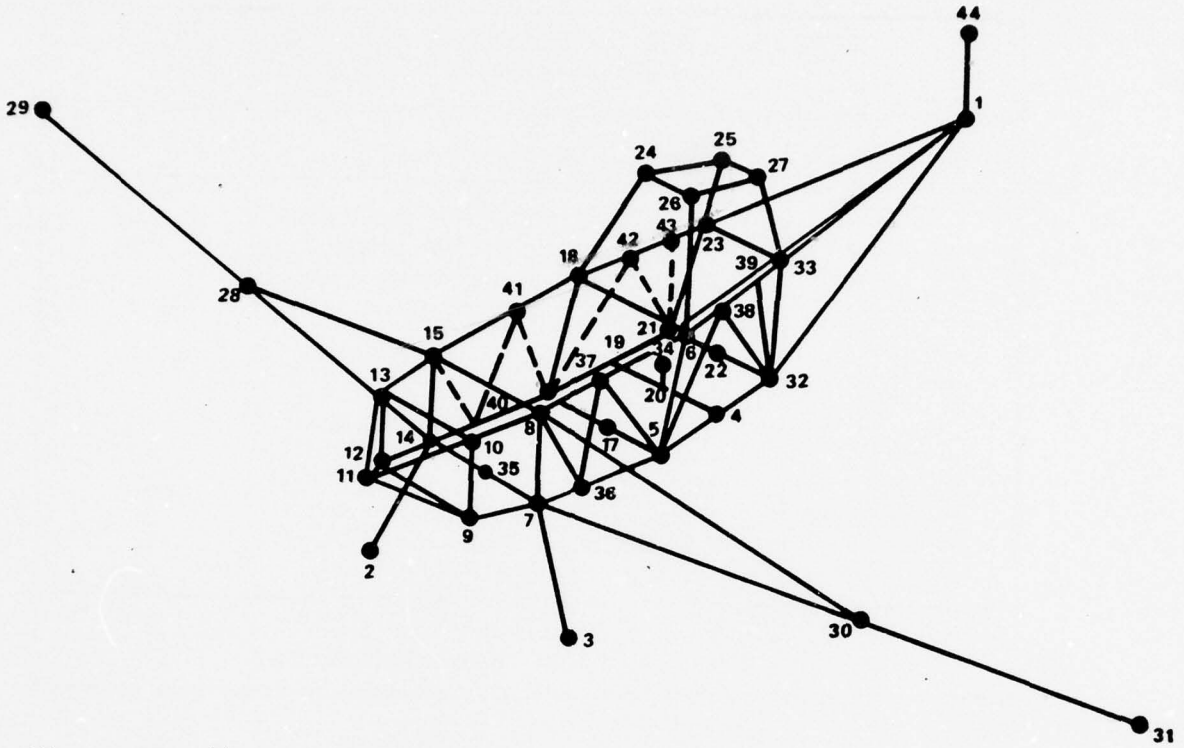
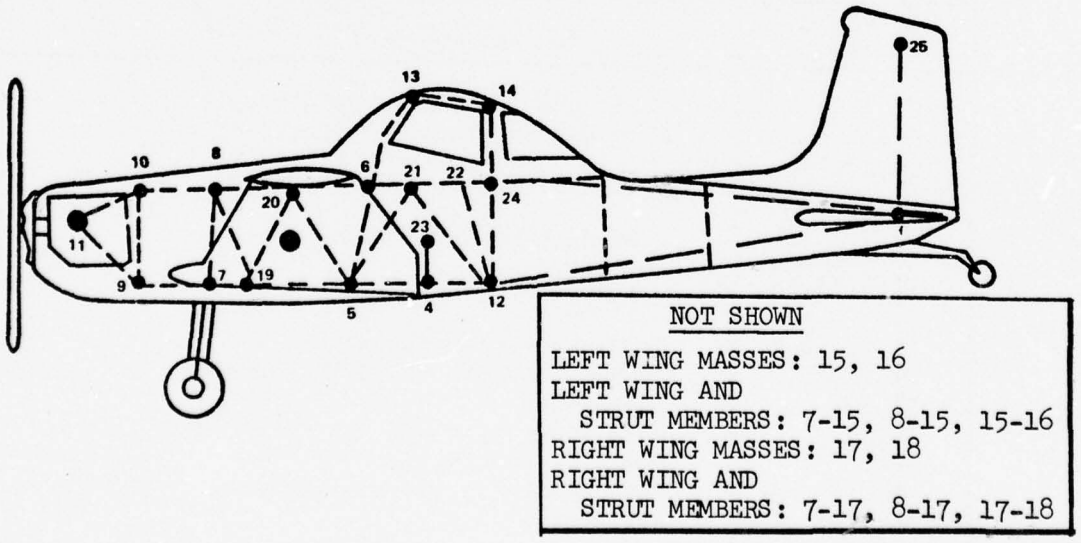


Figure 37. 44 Mass, 81 Member Math Model for Airplane B



NOT SHOWN

LEFT WING MASSES: 15, 16
LEFT WING AND
STRUT MEMBERS: 7-15, 8-15, 15-16
RIGHT WING MASSES: 17, 18
RIGHT WING AND
STRUT MEMBERS: 7-17, 8-17, 17-18

Figure 38. 25 Mass, 38 Member Math Model for Airplane B

TABLE 13. MASS IDENTIFICATION FOR 25 MASS, 38 MEMBER AIRPLANE B MATH MODEL

Mass Point(s)	Representation
1	Tail Unit (including tail wheel)
2,3	Main Landing Gear Unsprung Mass
4	Floor Structure Mid Fuselage
5,6,7,8	Fuselage, Hopper Region
9,10	Firewall
11	Engine
12,24	Fuselage Aft Bulkhead
13,14	Forward and Aft Turnover Structure
15,16	Left Wing
17,18	Right Wing
19,20,21,22	Fuselage Welded Tube Structure
23	Occupant and Seat
25 (a)	Vertical Tail Unit

(a) This mass is used for the turnover impact only. It is included with mass 1 for the initial impact.

TABLE 14. MASS IDENTIFICATION FOR 44 MASS, 81 MEMBER AIRPLANE B MATH MODEL

Mass Point(s)	Representation
1	Tail Unit (including tail wheel)
2,3	Main Landing Gear Unsprung Mass
14,17,19, 20,22,35	Floor Structure, Forward and Mid Fuselage
5,6,7,8,14 15,16,18	Fuselage, Hopper Region
9,10,12,13	Firewall
11	Engine
21,23,32,33	Fuselage Aft Bulkhead
24,26,25,27	Forward and Aft Turnover Structure
28,29	Right Wing
30,31	Left Wing
34	Occupant and Seat
36 thru 43	Fuselage Welded Tube Structure
44 (a)	Vertical Tail

(a) This mass is used for the turnover impact only. It is included with mass 1 for the initial impact.

damping factors, and initial conditions are presented in Appendix C. The data shown in Figure 37 and Table 14 are used for both impacts during the turnover crash, except where noted.

As discussed in the presentation of the test data (Section 5.3.2.4), there is relatively little structural deformation in the initial impact except for the engine cowling, and the applicable acceleration response data is limited. Consequently, of prime concern in the modeling of the turnover test is the requirement to reproduce the airplane large rigid body motions and the multiple impacts that occur. The forward fuselage impact is modeled using external springs. The ground is represented, in the locality of the impact point, as a mound of dirt with a face at 90 degrees to the ground plane having a coefficient of friction of 1.0, so that the line of action of the resultant forces acts on the airplane to slow down its motion as it approaches a vertical position. Other than the external springs that represent the crushing of the structure and ground plowing, the only nonlinear elements are the engine mounts (Figure 39). The wing tips and tail impacts and subsequent deformations are considered to have a minor effect on the resultant airplane motions and, accordingly, are represented as linear elements. Table 15 shows a comparison of the Airplane B and math model C.G. and mass properties. The math model C.G. is within 0.33 inches of the estimated airplane value. The inertia properties are within 12.8 percent of the estimated airplane properties. Actual airplane inertia properties for the test configuration are not available. The nonlinear curves used for the turnover crash test are shown in Figure 39. The procedure for performing the turnover crash analysis is the same as that described in the previous section for the stall-spin crash analysis.

Linear internal elements are used in the math models at all locations except as noted on the following page.

Location	25 Mass Model Nonlinear Members	44 Mass Model Nonlinear Members	Type of* Nonlinear Curve(s)
Engine Mount	9-11,10-11	9-11, 10-11, 11-12, 11-13	3,4
Turnover Structure	6-13, 14-22 13-14	18-24, 6-26, 23-25, 27-33, 24-25, 26-27	3

*See page 66 for curve types

The nonlinear properties are based on the estimates of buckling strengths, available design load data and test data. Procedures for obtaining input data are described in the KRASH User's Manual (Reference 3). The standard nonlinear curves contained in KRASH (Section 4.3) are used. The results of the analysis and comparisons with test data are presented in Section 5.5.2.

TABLE 15. COMPARISON OF AIRPLANE B AND MATH MODEL C.G. AND MASS PROPERTIES

	Airplane B	Math[(a)] Model	Difference Inches	Difference Percent[(b)]
C.G.				
FS, inches	41.	41.33	0.33	-
BL, inches	.12	-.122	.142	-
WL, inches	2.0	2.248	.248	-
Weight, lb.	2475	2475	-	0
Moment of inertia, lb.-in.-sec.^{2}				
I_x (roll)	19700	17185	-	-12.8
I_y (pitch)	23250	25804	-	11.0
I_z (yaw)	38450	38680	-	0.6

(a) average of small and large model

(b) $\frac{\text{model value - airplane value}}{\text{airplane value}} \times 100$

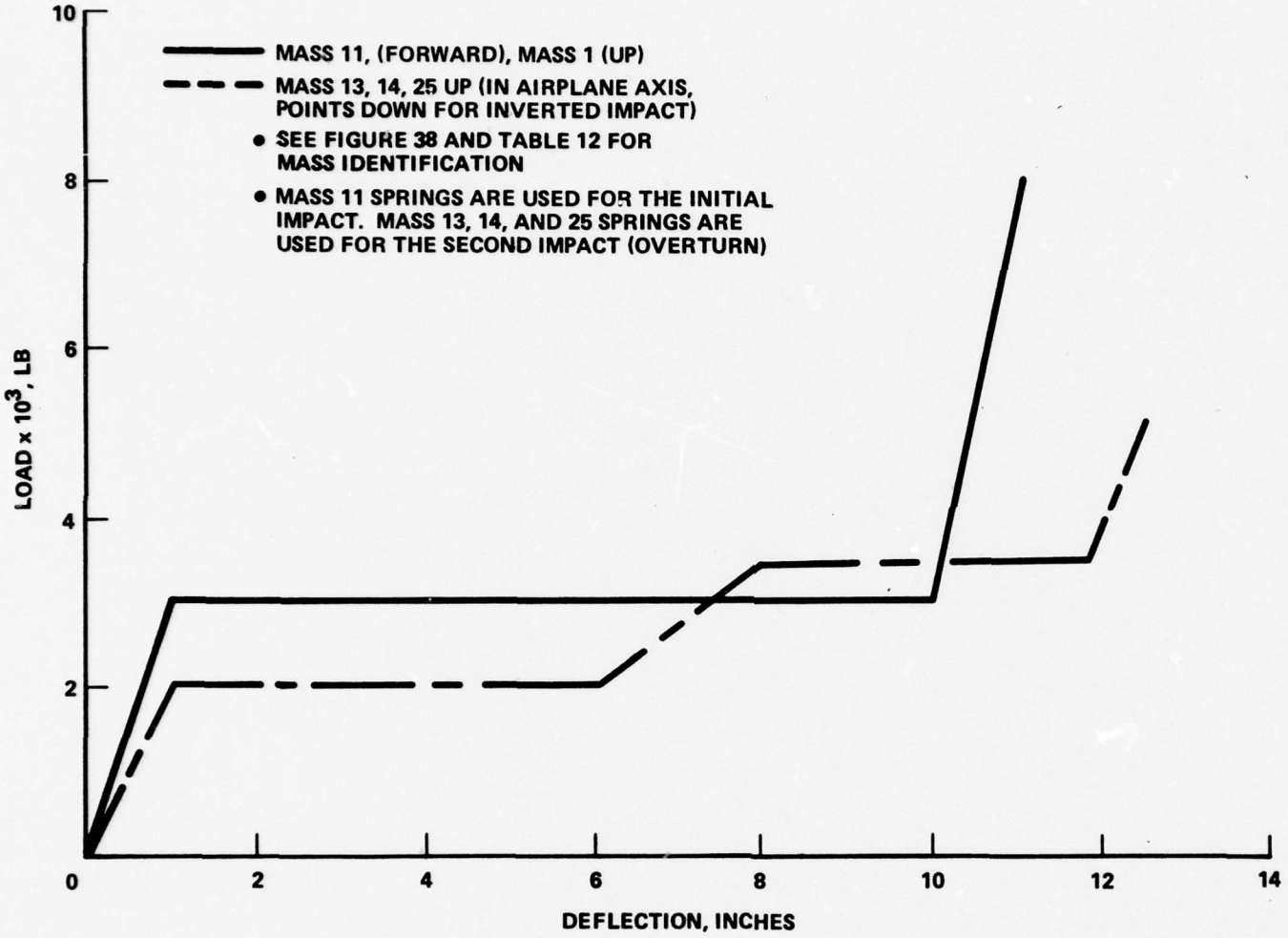


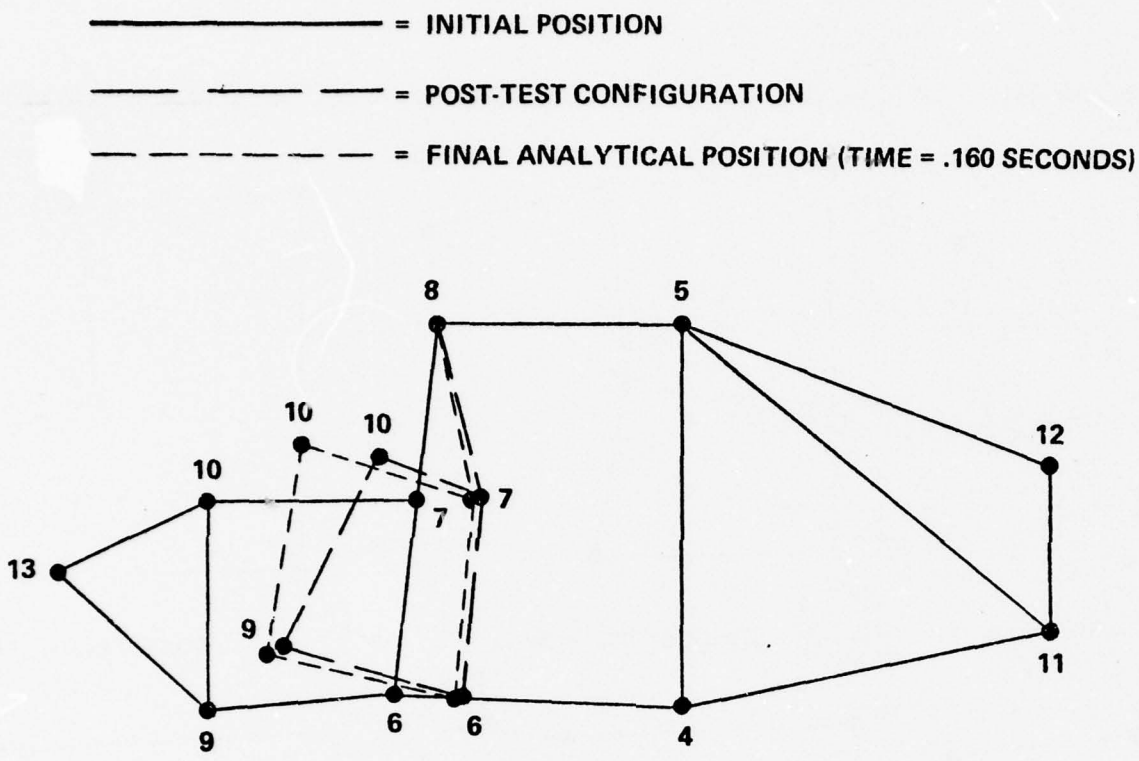
Figure 39. External Spring Load - Deflection Characteristics Used in the Math Model for Airplane B

5.5 COMPARISON OF ANALYSIS AND TEST RESULTS

5.5.1 Airplane A Comparison

The crash condition analyzed consists of a longitudinal approach velocity of 45 feet per second into a 45 degree earthen slope. In the actual test, the nose gear fails aft immediately without appreciably altering the kinetic energy of the airplane. Preliminary analysis is performed to show that the nose gear fails in this manner and thereafter the analysis commences with the spinner impacting the slope. From inspection of Figures 21 through 26, it can be seen that the most significant vehicle damage is the crushing of the structure forward of and below the engine, and the subsequent rearward deflection and upward rotation of the engine. The upper engine mounts buckle and the forward cabin area deflects rearward substantially. Also highly visible, but not too significant from the occupant safety viewpoint, is the failure of the aft fuselage.

Figure 40 shows a comparison between test and analytical results of the post test deflected position of the engine and cabin structure. The test results are based on measurements made from photographs. The analyses results are based on the math model shown in Figure 35. Figure 40 demonstrates good overall agreement between test and analysis for the engine deflection and rotation and the cabin deformation. The analytically obtained deflected position corresponds to the end of the analysis at 0.16 seconds after spinner impact. Figure 41 presents the sequence of the vehicle deformations. The rearward deflection of the center of the forward door post (mass 7) and the shortening of the cabin floor (beam 4-6) occur quite early in the crash. The buckling of the engine mounts and the full deflection and rotation of the engine and upper cowl structure take a longer time to develop. The phasing of the significant internal beam element deflections is given in Figures 42 and 43. All the beam elements shown in Figures 42 and 43 utilize nonlinear KR curves that incorporate restiffening after the structural elements have been exposed to substanial deflection in the post failure region at low loads. The restiffening



NOTE: (1) DIAGONAL ELEMENT 7-9 OMITTED FOR CLARITY
(2) MASS 13 NOT SHOWN IN DEFLECTED POSITIONS FOR CLARITY

Figure 40. Comparison of Test and Analytical Airplane Deformations (Airplane A).

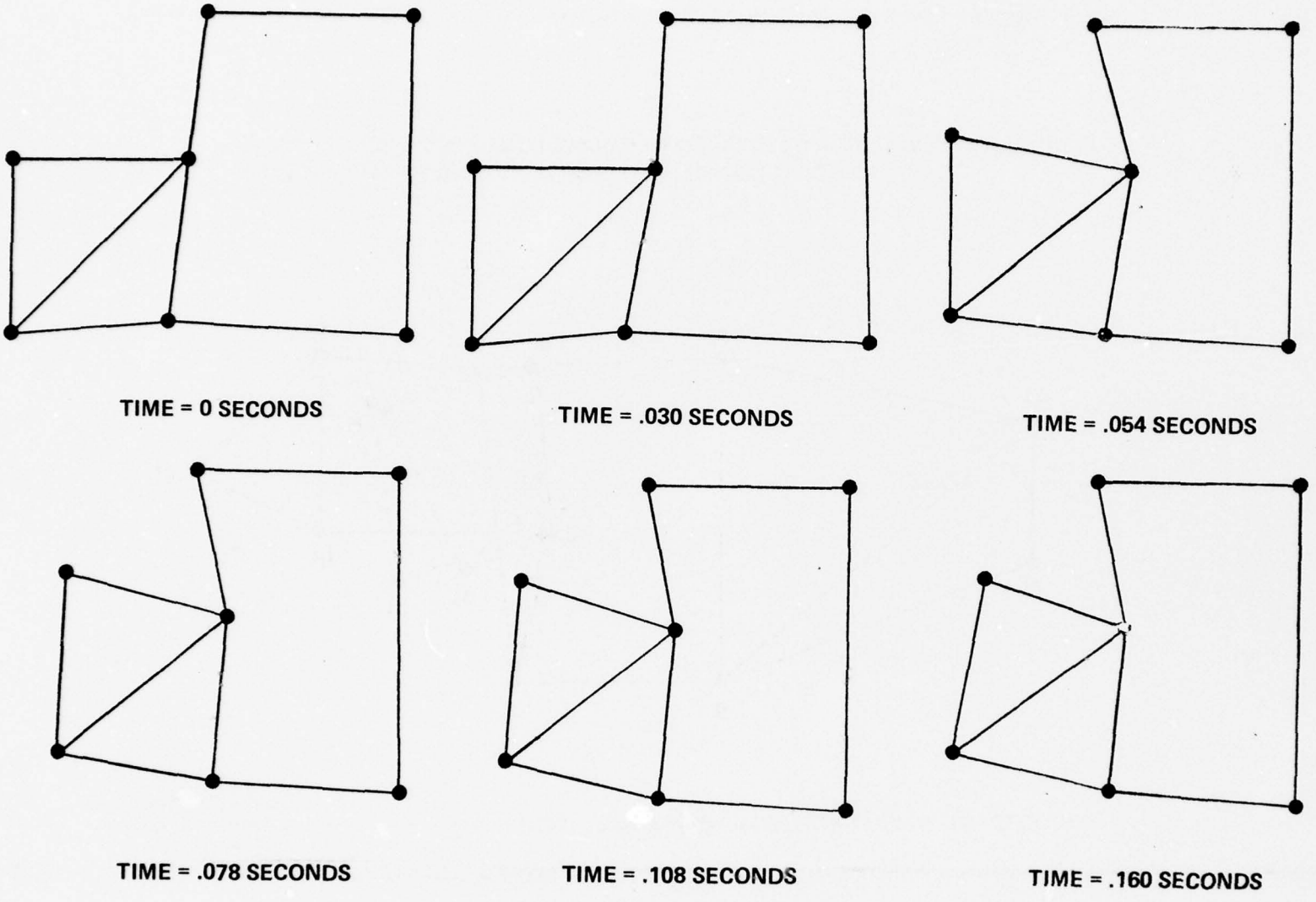


Figure 41. Sequence of Cabin Deformation Obtained from Analysis (Airplane A).

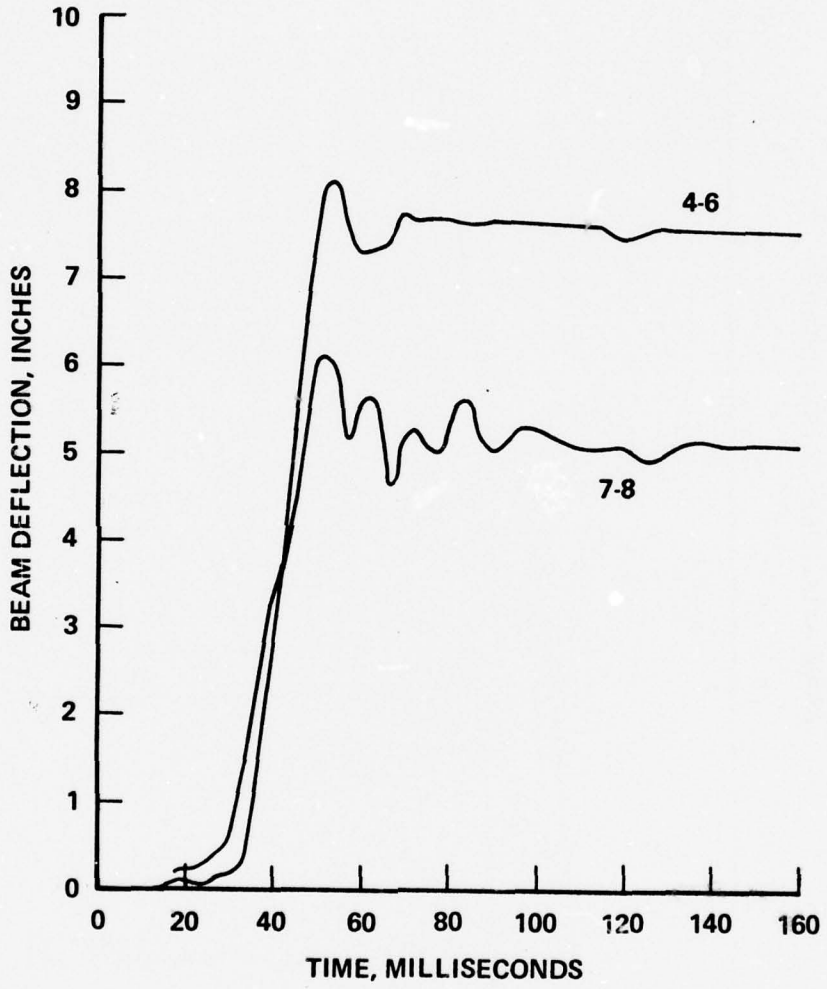


Figure 42. Internal Beam Deflection Time Histories Obtained from Analysis, Cabin Area (Airplane A)

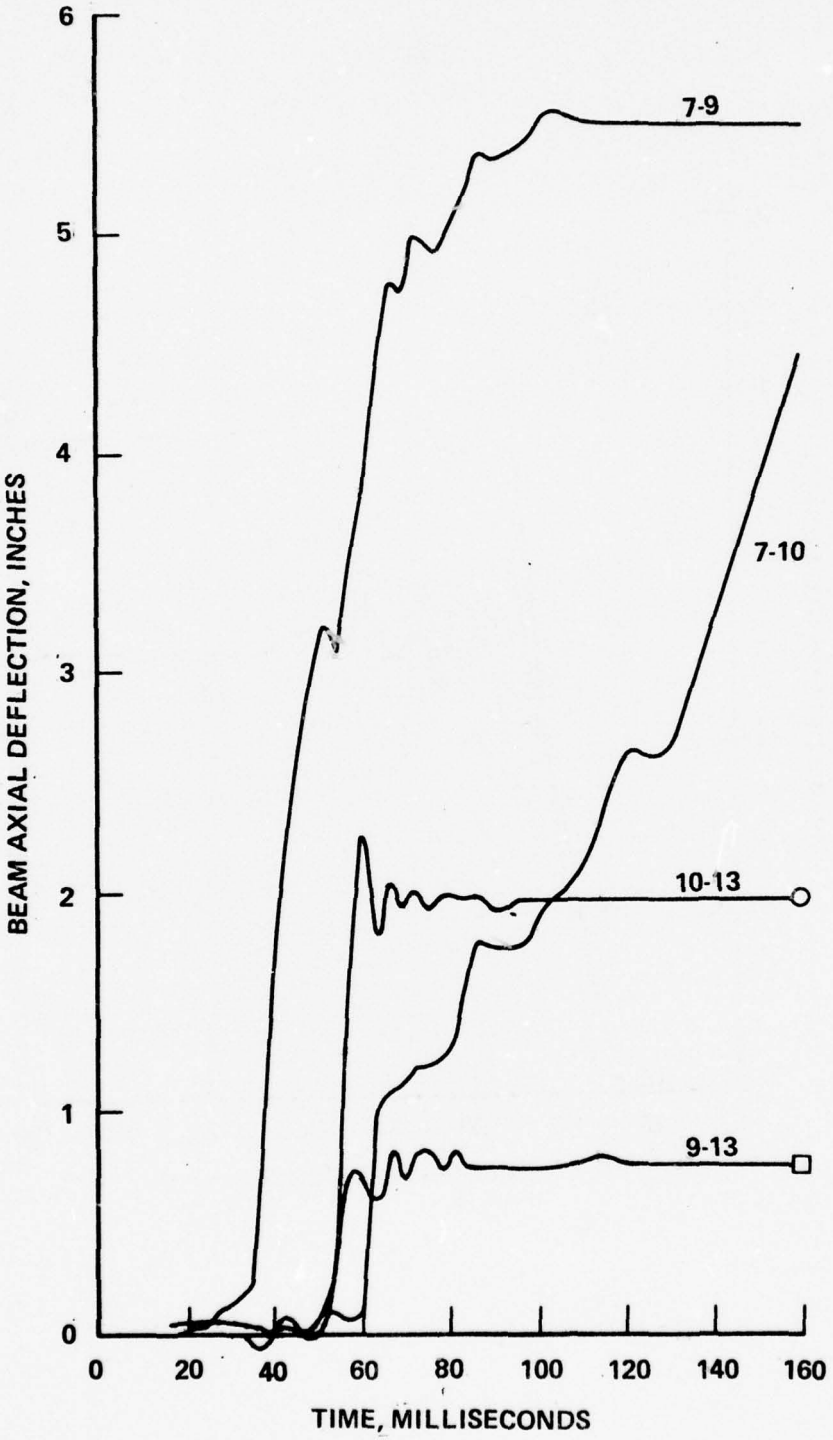


Figure 43. Internal Beam Deflection Time Histories, Forward Fuselage Structure and Engine Mounts Obtained from Analysis (Airplane A)

represents the crushing of structure in a confined region. Test data from Reference 4 shows this phenomenon and the observations from those tests combined with the geometry associated with the airplane structure are used to determine when restiffening can occur. All the internal structural elements shown in Figures 42 and 43 have reached the restiffening deflections except the upper cowl structure (beam 7-10). However, from the trend of the history of the axial deflection of element 7-10 (Figure 43), it is evident that its restiffening deflection of approximately 9 inches would be reached by 0.25 second after spinner impact. This additional deflection would further improve the correlation between the test and the analysis final deflected position shown in Figure 40.

Figure 44 shows a comparison of analytical and test results for cabin deformation, consisting of the rearward deflection of the forward door post. The correlation at WL 19.1, which is near the top of the door frame, is quite good. At WL 2.4, near the center of the door, the correlation is good in the initial loading region, but the test results indicate a peak deflection of around 10 inches at 140 milliseconds, with a final deflection of 9 inches, while the analysis predicts about 7 inches constant beyond 100 milliseconds. This is consistent with the results shown in Figure 40, which indicate that the analytical aft deflection of mass 7 is less than the test results.

Figure 45 shows the time histories of the external spring deflections. Springs 13-1 and 13-3 (Figure 36) represent the airplane structure forward of and below the engine. Also incorporated in the load-deflection curves for these springs is an approximation of the compliance or softness of the ground. The springs at mass 9 are much shorter and absorb far less energy than those at mass 13. From Figure 45 it can be seen that the external springs at mass 13 develop their peak loads within 35 milliseconds and then unload gradually during the remainder of the run having a secondary peak at 90 milliseconds. The springs at mass 9 contact later but also reach an initial peak at 35 milliseconds, and then reload later to a second peak at 90 milliseconds.

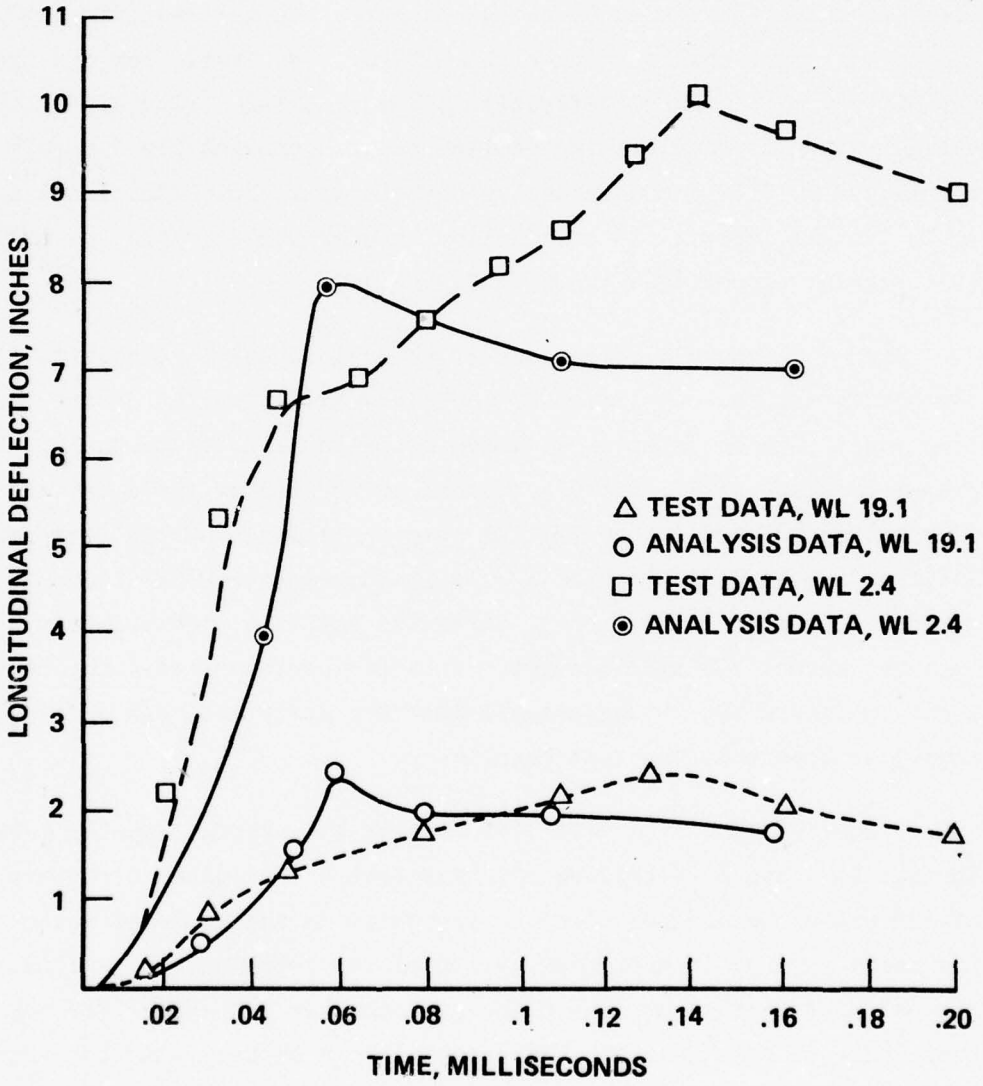


Figure 44. Comparison of Analysis and Test Data for Cabin Deformation (Airplane A)

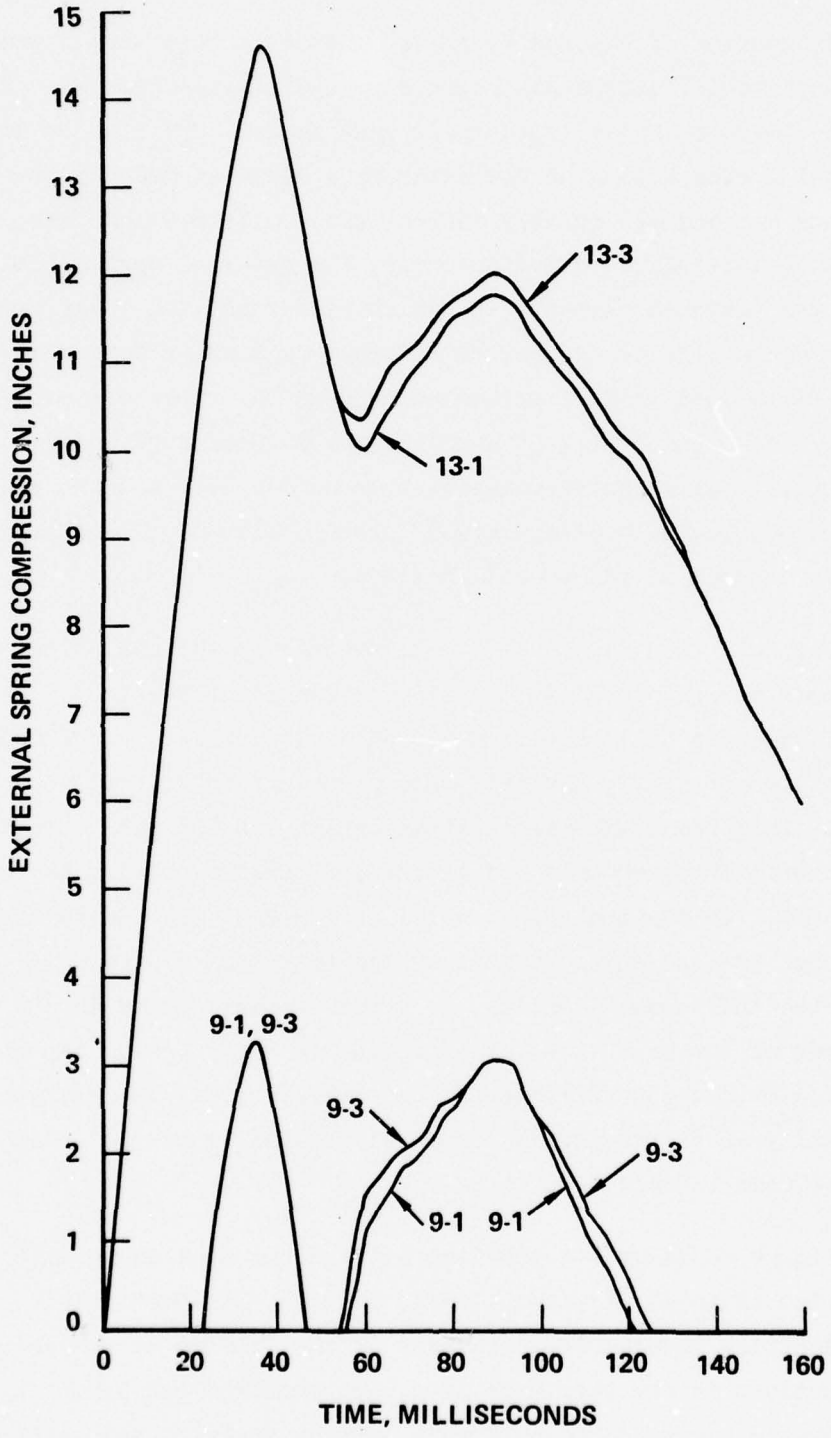


Figure 45. External Spring Deflection Time Histories Obtained from Analysis (Airplane A)

Inspection of Figures 42 and 43 indicates that the internal element structural deformations all begin after 30 milliseconds when the external springs have nearly developed their peak loads. The line of action of the external forces acting on the external springs at mass 13 is such that elements 4-6 and 7-8 quickly deflect aft, while 6-9 and 7-10 retain their integrity initially. Simultaneously, the external spring loads at mass 9 cause the diagonal element 7-9, which represents the shear capability of the fuselage side structure, to deform. Only after this element has deflected almost to its maximum value does the upper element 7-10 begin to shorten. Once 7-9, 7-8, and 4-6 have all deformed sufficiently to reach their restiffening regions, both member 7-10 and the upper engine mount 10-13 begin to deform significantly, with 10-13 buckling rather quickly between 50 and 60 milliseconds.

The tail cone fails at 75 milliseconds in the analytical model, with the lower element 11-17 failing in compression (buckling). At the time of failure, the tail section has bent downward just over 2 inches. After the failure of 11-17, the tail cone structure is reduced to only element 12-17. This beam fails in vertical bending at 108 milliseconds. The tail cone failure sequence and timing are consistent with the crash test film data. In the analytical model, no attempt is made to simulate the very large deflections and rotations of the tail cone observed in the crash test. While the tail cone "flapping" is a predominant motion in the motion pictures of the crash test, this motion is not of great importance to the question of occupant survivability. Therefore, in the analytical model, the tail cone is treated as completely failed (ruptured) once the buckling failure mode is well established.

Figure 46 shows a comparison between the test and analytical time histories of total airplane kinetic energy. The test results are based on velocities deduced from analysis of the film data. Minor velocity fluctuations in the test data have been smoothed out prior to calculating the kinetic energy. The agreement between analysis and test results shown in Figure 46 is quite good, and indicates that the energy absorption in the analytical model is very reasonable. Two percent structural damping was used for all the members.

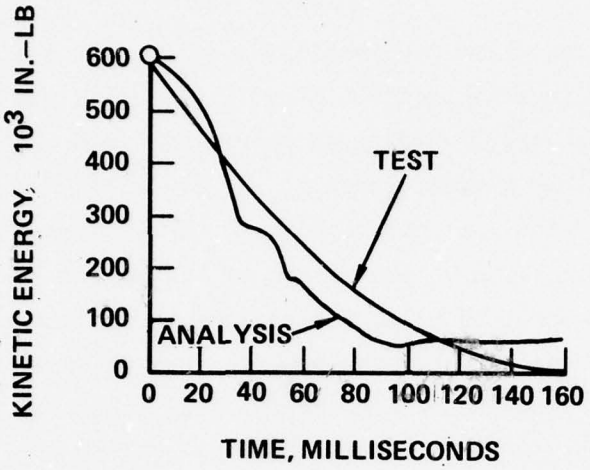


Figure 46. Comparison of Test and Analytical Kinetic Energy Time Histories (Airplane A)

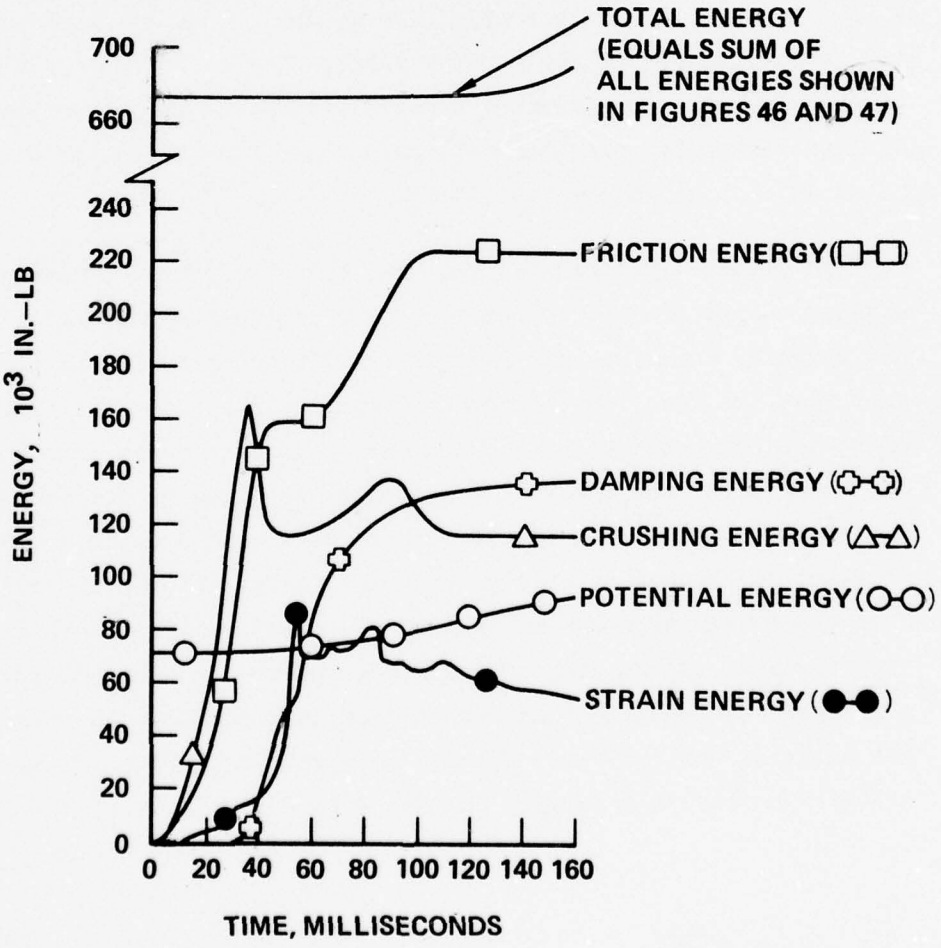


Figure 47. Time Variation of Analytical Energy Components (Airplane A)

Figure 47 illustrates the time variation of the various energy terms which account for the reduction of the kinetic energy in the analytical model. The terms shown are the friction energy (FE) and crushing energy (CE) associated with the external springs, the strain energy (SE) and damping energy (DE) of the internal beams, and the potential energy (PE) of the vehicle. Figure 47 shows the nature of the energy absorption in the system. Prior to about 40 milliseconds, the entire energy absorption is due to the friction and crushing energies of the external springs. From 40 to 60 milliseconds the strain energy of the internal beams increases from virtually zero to its peak value. The damping energy also increases rapidly during this time span, but continues to increase significantly during the remainder of the analysis. There is a slight increase in the potential energy during the run that results from the vehicle riding up the earthen slope. The energy absorption results of Figure 47 are consistent with the deflection time histories observed earlier; initially the external springs are compressed, driving the internal beams which respond somewhat later.

In Figure 47 it can be seen that both the friction energy and the damping energy are monotonically increasing quantities, while the strain and crushing energies peak and fall. This behavior is attributed to the fact that the friction and damping energies are both dissipative; the energy is converted to heat and cannot be reintroduced into the system. The behavior of the strain and crushing energies, on the other hand, results from energy storage in structural elements which are partially elastic, and therefore part of the peak energy absorbed is reintroduced into the system when the members unload elastically. The flat portion of the friction and crushing energy curves between 45 and 60 milliseconds and beyond 115 milliseconds result from the fact that in these regions all external springs have unloaded to a zero load level; between 60 and 115 milliseconds the springs on mass 9 have reloaded.

At the end of 160 milliseconds of analysis the total energy has increased by only 2.5 percent from its original time = 0 value which indicates that the math model is behaving in a stable manner.

Also available from the output of program KRASH is the spatial distribution of the strain energy at each time print. Table 16 is a

TABLE 16. STRAIN ENERGY SPATIAL DISTRIBUTION, AIRPLANE A ANALYSIS

	Percentages of Total Strain Energy								
	Engine Mounts		Firewall & Fuselage Structure Aft of the Firewall				Mid Cabin		
Time \ Beam	9-13	10-13	6-9	7-9	7-10	9-10	4-6	6-7	7-8
.012	22.8	16.5	6.3	0	4.5	2.28	19.3	13.4	11.3
.018	7.6	9.6	1.8	0.2	6.2	1.66	16.1	28.0	20.1
.024	2.3	12.0	0.4	0.8	8.7	1.11	6.3	37.1	24.2
.030	0.2	2.8	3.8	6.4	2.5	0.24	19.6	31.4	25.7
.036	9.0	5.2	5.3	8.2	0.9	1.32	25.6	3.2	30.3
.042	4.0	1.6	23.1	6.1	7.6	1.86	17.6	1.9	16.0
.048	2.1	2.0	20.3	3.7	9.5	0.78	9.4	3.0	23.7
.054	3.2	2.6	12.0	2.5	6.8	0.52	20.0	14.1	19.8
.060	8.6	19.8	11.2	1.6	10.5	4.72	7.4	1.6	9.7
.066	4.0	14.9	15.2	1.5	16.3	3.20	6.3	1.6	9.6
.072	11.7	7.6	18.3	1.7	16.7	1.99	6.9	4.4	8.2
.078	8.7	6.2	13.2	2.0	16.3	4.14	7.2	4.9	14.1
.084	7.4	8.1	15.8	1.5	15.1	2.23	4.2	6.5	11.1
.090	6.8	11.0	18.5	1.9	18.6	3.30	5.2	4.1	10.1

summary of the time variation of the percentages of the total strain energy accounted for by the internal beams that absorb most of the energy. Figure 48 is a plot of the data from Table 16, where the percentages from the individual beam elements in each airplane region have been added. While the oscillations in Figure 48 are complex, the essential trends are that the strain energy is initially concentrated primarily in the cabin region, and during the crash the strain energy concentration shifts to the fuselage structure aft of the firewall (members 6-9, 7-9, 7-10). The percentage of the total strain energy in the cabin region reduces from a peak of 75 percent at 30 milliseconds to 20 percent at 90 milliseconds. During the same time span the strain energy associated with the fuselage aft of the firewall has risen from approximately 12 percent to 40 percent of the total strain energy. During this time period the strain energy associated with the engine mounts has oscillated about a fairly constant value of 25 percent of the total strain energy. The energy attributed to cabin deformation is greater than the contribution from the fuselage or engine structure deformation up until 60 milliseconds after impact. This result is consistent with the analytical results shown in Figures 41 through 44.

While it might be expected that the strain energy concentration will start near the impact region and flow rearward during the crash, the actual concentration pattern depends on the relative stiffnesses of the various regions of the airplane. For this particular airplane the film analysis indicates that structural buckling occurs in several regions at or shortly after impact. For example, from Figure 20, which provides a partial sequence of the crash event, at approximately 20 to 60 milliseconds after impact there is noticeable damage in the cabin and the structure forward and aft of the cabin. At 100 milliseconds after impact the deformation has progressed significantly. Thereafter, the damage to the fuselage structure aft of the firewall and forward of the cabin continues to develop to a much greater extent than in the cabin area itself. The film analysis shows the maximum cabin deformation has been passed while the fuselage structure aft of the firewall continues to deform. While the computer analysis shows that the maximum cabin deformation transpires earlier than

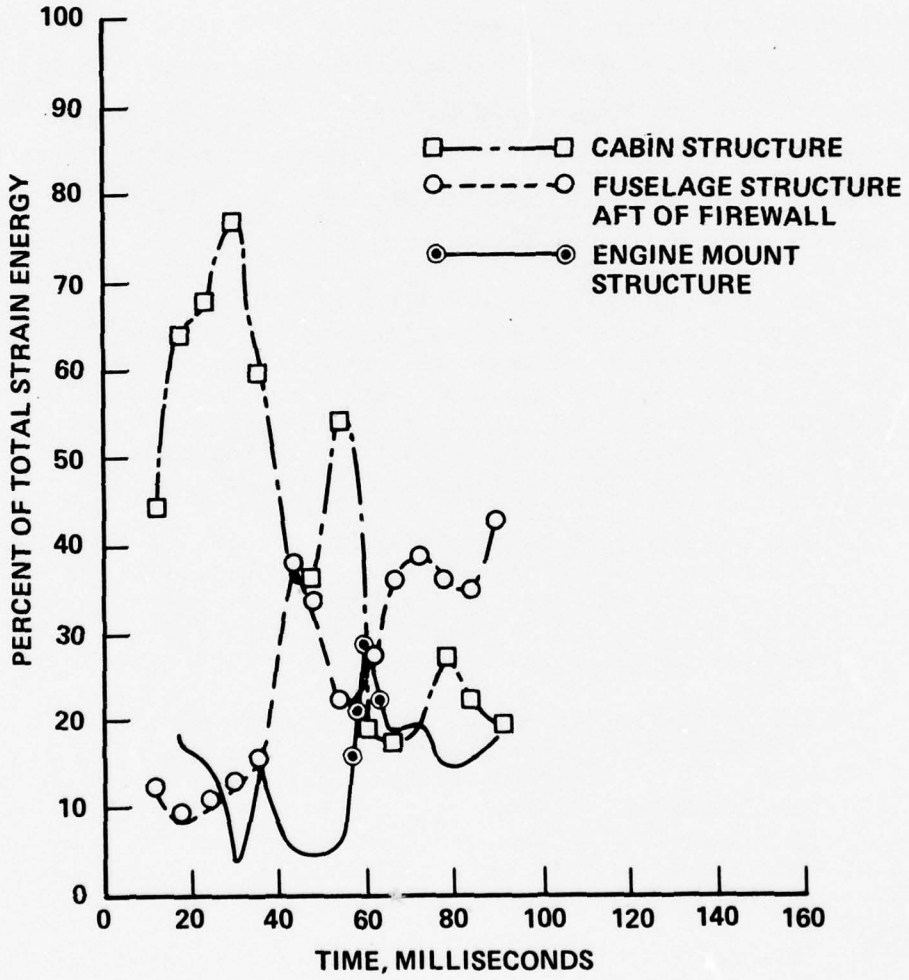


Figure 48. Time Variation of Strain Energy by Region Obtained from Analysis (Airplane A)

the film analysis indicates, it appears that the math model shows a reasonably good relationship between the sequence of events as depicted by the concentration of energies.

Figures 49 and 50 show the cabin floor longitudinal and vertical acceleration histories, both analytical and test results. The analytical results are for mass 4. In both cases, the test results reach their peak in 12 milliseconds, whereas the analytical peaks occur from 50 to 75 milliseconds. Figures 49 and 50 indicate a large discrepancy between test and analytical accelerations. However, examination of the test sequence and related data indicates that the measured test results are most likely not valid for the following reasons.

1. As discussed in Section 5.3.1.4 all the accelerometer signals appear to be activated simultaneously. Considering that the accelerometers measured vertical and longitudinal responses for the structure and occupant (pelvis and head) at different locations and directions and with different individual frequency responses, it is highly improbable that the peak responses for all would occur at the same time and with the same pulse shape.

2. The measured test peak acceleration occurs at approximately 12 milliseconds after impact while the sequence of the crash test (Figure 20) indicates that a maximum response might occur at or after 40 to 60 milliseconds. The analysis shows peak responses between 50 and 75 milliseconds.

3. If, in fact, the measured test responses are valid, it would represent a very localized response appropriate to a very small mass. If the test acceleration pulse acted on the entire vehicle, the initial forward velocity of 45 ft/sec would be stopped in 20 milliseconds. From the film data it appears that the forward velocity is stopped in approximately 160 milliseconds, at an overall average rate of deceleration of about 8.7 g's.

4. Data presented in Reference (12), showing the magnitude of impact velocities and acceleration pulses for a 95th percentile accident condition for light fixed-wing aircraft, supports the analytical results. The 95th percentile longitudinal velocity is given as 50 ft/sec and the associated peak acceleration pulse is 30 g's and 24 g's in the cockpit and passenger compartment, respectively. Furthermore, the duration of the pulse is given as over 100 milliseconds. While the results obtained in this analysis consist of five or six individual separate cycles, the envelope of these cycles has a duration of about 100 milliseconds.

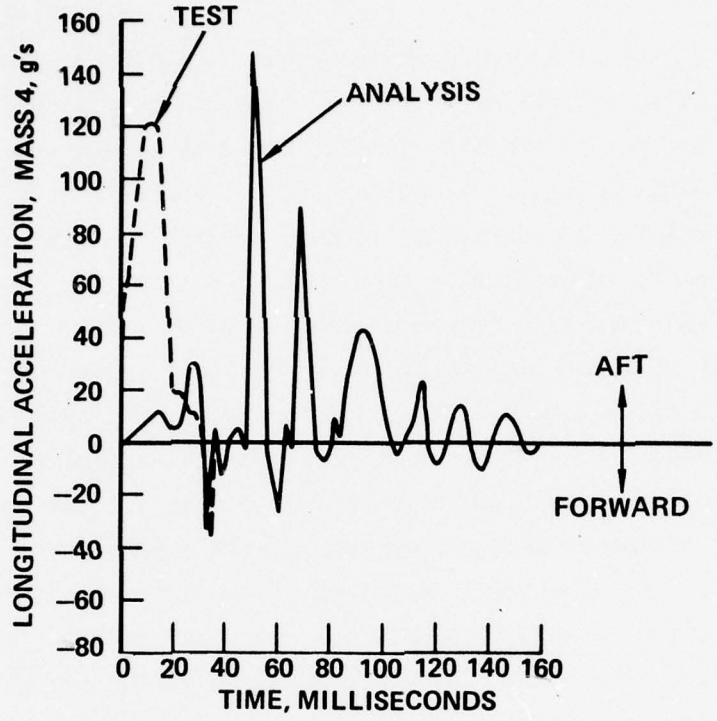


Figure 49. Cabin Floor Longitudinal Acceleration (Airplane A)

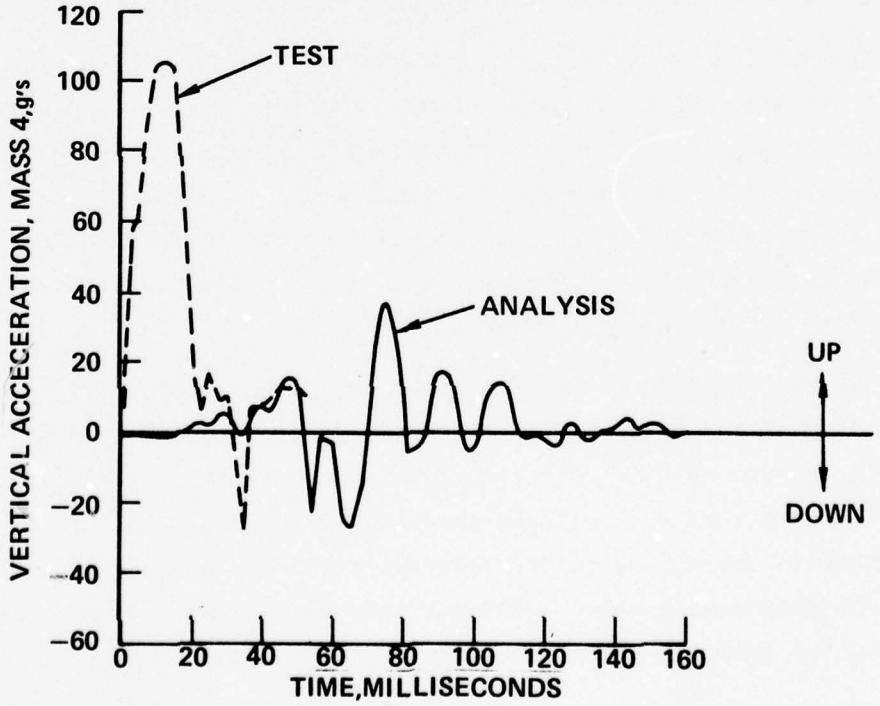


Figure 50. Cabin Floor Vertical Acceleration (Airplane A)

In Figure 49, the first two sharp peaks at 51 and 69 milliseconds result from the bottoming of internal beam 4-6. If the peak acceleration values at these two points are disregarded, the peak acceleration then becomes 43 g's longitudinally. It appears that the restiffening process for beam 4-6 is modeled too abruptly; a more gradual restiffening would lower these peaks to substantually less than 20-30 g's. If this were done, the envelope of the resulting responses would be about 30-40 g's peak with a duration of 100 milliseconds, which is in reasonable agreement with the data contained in Reference 12. The restiffening element type used for beam 4-6 is a standard NP = 9 curve (see section 4.4.6), and at present is internally coded such that the bottoming stiffness is equal to the linear stiffness of the element. Furthermore, the element behavior is similiar to an NP = 8 curve until bottoming occurs. The results of the airplane A comparison between test and analysis indicate that these limitations are too inhibiting. Consequently, the coding for this type of curve will be changed for the Task II effort to allow the user more flexibility in modeling this type of behavior. In particular the user will be able to define as input data the post-failure load-deflection behavior and the stiffening after structural confinement occurs.

The vertical acceleration at mass 4 (Figure 50) indicates a peak acceleration of approximately 38 g's with a long term response of approximately 70 milliseconds (40 to 110). The vertical acceleration pulse is in response to a longitudinal impact, thus it is difficult to relate this data to that given in Reference 12 which describes a vertical response to vertical impact. In that situation the Reference 12 data indicates a peak acceleration of 48 g's for 54 milliseconds duration.

The responses noted in Figures 49 and 50 are indicative of structure responding with a frequency in the 50-60 Hz range. The type of structure used in general aviation aircraft fuselage design is relatively light and stiff and may very well respond as shown by the analysis. It is also important in the evaluation of occupant survival to recognize that the occupant responds in a low frequency mode (6-12 Hz.). Thus pulses with frequencies above 25 Hz. have little effect on the occupant.

5.5.2 Airplane B Comparison

The Airplane B crash sequence is depicted in Figure 51 from initial impact (time = 0) to final position (time = 1.66 seconds). The modeling of the initial impact is performed for the first 80 milliseconds for the airplane positions shown in Figure 51 (a) and 51 (b). For the second impact, the sequences shown in Figure 51 (e) and 51 (f) are used. In the initial impact the ground is modeled with a 90 degree slope in the local region where the forward fuselage impacts. The forward fuselage has two external springs, one along the longitudinal axis of the airplane, and the other normal to the airplane longitudinal axis. Both external springs emanate from the engine mass (mass 11, Figures 37, 38) and represent the characteristics of the confined terrain deformation and spinner and cowl structure crushing. While the external spring is symbolized by a point contact it in fact represents a much broader area of contact. In this particular case, both the contact area and the region making ground contact change as the airplane rotates about the nose. The analytical model reproduces the initial crushing of the forward section of the fuselage with the longitudinal spring and also the subsequent contact of the upper cowl with the top of the slope as the airplane rotates over onto its top side. The analytical results show that the upper engine mount buckled. As stated in Section 5.3.2.4, the upper left engine mount failed during the test. However, since this mount had been previously repaired, the actual strength of the mount is not known. Outside of extensive damage to the upper cowl and hopper skins during the test, no other damage or failure was noted that could be attributed to the initial impact. In this respect the analytical model results agree with the test results.

Table 17 presents a comparison of analytical and test results for the initial impact of the forward fuselage section with the terrain. The test results are based on analysis of the motion pictures taken during the test. The film analysis is based on a 24 frame/second film speed. This film speed provides only one frame of data for every 40

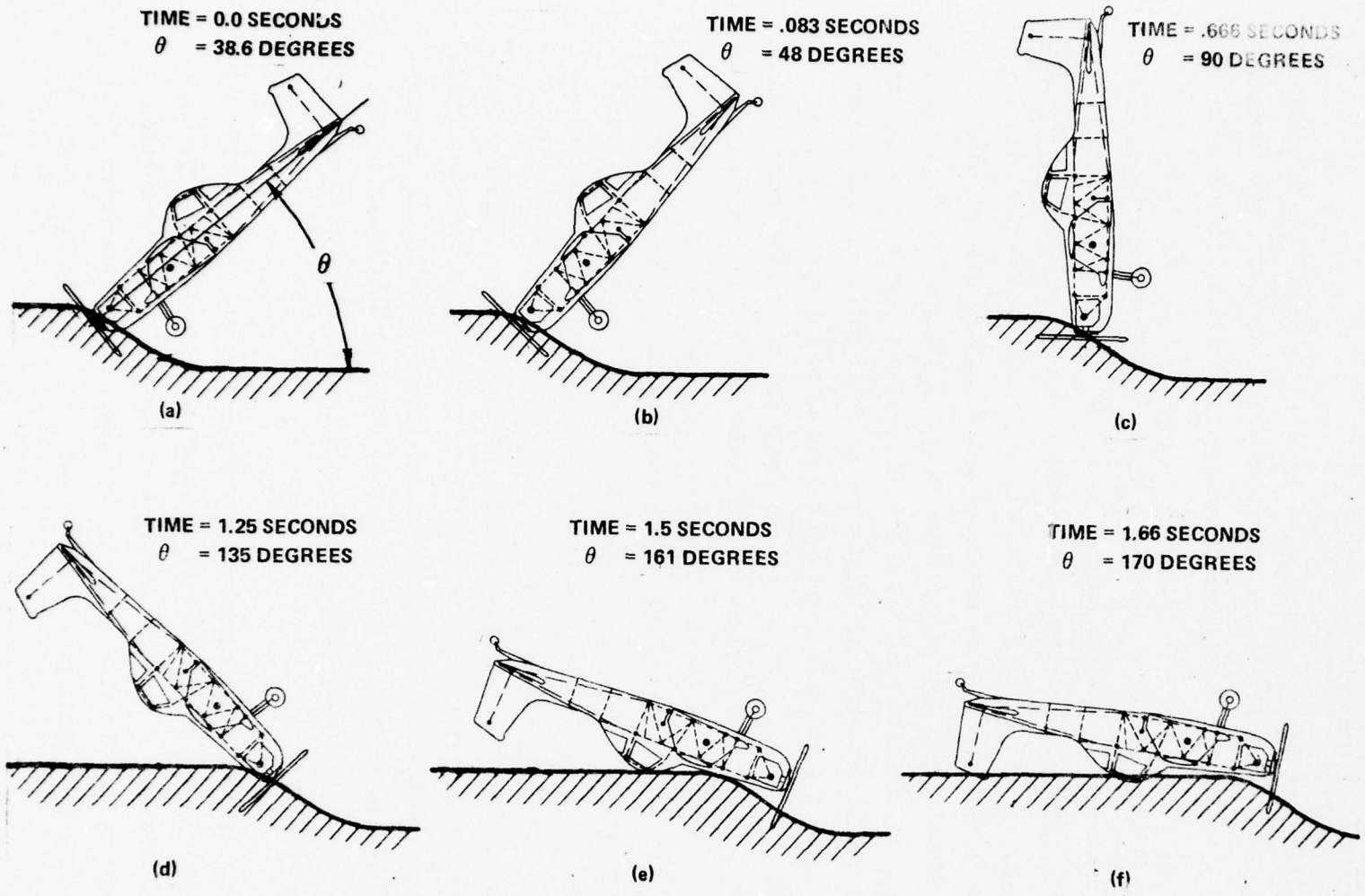


Figure 51. Crash Test Sequence of Airplane B as Determined from Photographs

milliseconds of motion, which is an order of magnitude slower than normally used in crash analysis. Normally, if available, 200 to 500 frame/second film speed is used to determine the details of a crash test. The results of the film analysis for the test sequence is presented and described in Appendix C. From Table 17 it can be seen that the rigid body rotational motion of the airplane is depicted with good accuracy (less than 1.5 percent) when compared to the results of the test film analysis for the 40 milliseconds involved in the initial impact. The energy that is absorbed, is mostly in crushing and friction. The kinetic energy obtained from the analysis is within 8 percent of the estimated kinetic energy at 40 milliseconds. At approximately 70 milliseconds after the impact the analysis indicates a buckle failure of the upper engine mount. At this time the c.g. longitudinal acceleration (average of masses 5, 6, 7 and 8, Figure 38) is computed to be 18.4 g's which is higher than the test peak value of 11.8 g's. Higher c.g. airplane axis vertical accelerations (20 g's) noted in the test results are not obtained by the analysis. The analysis shows vertical acceleration values less than the longitudinal results. This situation seems appropriate considering the orientation of the airplane for the first 80 milliseconds. As the airplane rotates onto the overturn structure (Figure 51 (c) and 51 (d)) higher c.g. airplane axis vertical acceleration may occur. At this point the energy absorbed by the airplane structure and ground obtained from the analysis is substantially higher than indicated by the data from the film analysis, although overall rotation of the airplane is within 1.5 percent of the estimated test value. It would appear that the test results, if adequate accuracy is assumed, would indicate closer agreement in energy and less agreement in motion than shown. The lack of definition of acceleration pulses (shape, duration and phasing) from the test results makes it difficult to quantify the comparison between analysis and test beyond the type and extent of structural damage and airplane motion.

The analytical results are influenced by the manner in which the deformation of the terrain is modeled using external springs. If the ground contact surface were concrete instead of soft dirt, there would be no

TABLE 17. COMPARISON OF AIRPLANE B ANALYTICAL AND TEST RESULTS FOR THE INITIAL IMPACT CONDITION

	Test	Analysis	Percent Difference (a)
Initial Rotation, θ (Degrees)	38.6	38.6	-
Initial Rotational Velocity, $\dot{\theta}$ (Degrees/Sec.)	106.	106.	-
Rotation, θ, at Time = .040 Sec. (Degrees)	42.8	42.7	.23
Kinetic Energy prior to Impact, Time = 0 (in-lbs)	2.611×10^5	2.607×10^5	.15
Kinetic Energy at Time = .040 Sec. (in-lb)	2.42×10^5	2.234×10^5	7.7

(a) (Test Value - Analytical Value) X 100/Test Value

TABLE 18. COMPARISON OF AIRPLANE B ANALYTICAL AND TEST RESULTS FOR THE TURNOVER INVERTED IMPACT

	Test	Analysis	Percent Difference (a)
Initial Rotation, θ (Degrees)	162.	162.	-
Initial Rotational Velocity, $\dot{\theta}$ (Degrees/Sec.)	89.	89.	-
Rotation, θ, at Time = .040 Sec. (Degrees)	165.7	165.6	0.06
Change in Rotation, $\Delta\theta$, at Time = .040 Sec. (Degrees)	3.7	3.6	2.7
Kinetic Energy Prior to Impact, Time = 0 (in.-lbs.)	7.19×10^4	7.106×10^4	1.17
Kinetic Energy at Time = .040 Sec. (in.-lbs.)	5.18×10^4	5.901×10^4	-13.9

(a) (Test Value - Analytical Value) X 100/Test Value

appreciable interaction between the ground and the structure. The analysis provides for the structure to penetrate the earth as much as 10 inches, wherein the earth is modeled softer than the structure. Thereafter the spinner and cowl structure influence the stiffness of the external spring that is used. The interaction between the terrain and the structure is difficult to define, which is further complicated by the fact that the area of contact is changing as the airplane penetrates and rotates. Analytical studies described in Reference 4 in which program KRASH was used to assess the effect of load-deflection variations on the response indicate that the results are most sensitive to the modeling of structure wherein confined crushing takes place. Generally, when crushing occurs the stiffness of the structure (or terrain) increases rapidly as it is compressed.

The impact of the turnover structure with the ground is modeled as depicted in the sequences shown in Figure 51 (e) and 51 (f). For the second impact, Figure 51 (e) represents the airplane position at time zero. In this condition, external springs are applied at masses 13, 14 and 25 as shown in Figure 38 (masses 24, 25, 26, 27, and 44, Figure 37). From Table 18 it can be seen that the analytical results compare favorably with test results for the period of time over which the high speed film could be analyzed. The rotation and the kinetic energy obtained by analysis are shown to be within 2.7 percent and 13.9 percent, respectively, of the test results obtained from film analysis. The analysis further shows that at 80 milliseconds after time zero, for the inverted impact, the kinetic energy has been reduced to approximately 23 percent of the kinetic energy available in this impact. The analysis further indicates that failure of the forward turnover structure, member 6-13, Figure 38 occurs. The test results indicate that a failure of the forward structure occurred during the test. While test data is not available for making a quantitative evaluation of cabin volume change, the films of the test and the photographs of the post test airplane condition (see Figure 31), indicate that little or no cabin volume change occurred which is consistent with the results of the analysis.

In addition to providing data for assessing the capabilities of the analysis to predict the behavior of an airplane during a multiple impact with large rigid body rotations, the tests also provide data concerning airplane/soil interaction. The test and analytical results agree in that the major energy absorption occurs in the action of the ground and the structure in contact with the ground. The lack of distortion of structure and minimal structural failure indicate very little (almost negligible) dissipation of energy as a result of permanent strain.

The analysis of this crash test, as well as the airplane A crash test, indicates that estimating the proper terrain representation, other than hard surfaces such as concrete and asphalt, is difficult because of the lack of terrain and airframe interaction data. While KRASH has provisions (external linear and nonlinear springs, generalized impact surface and ground friction) to utilize available terrain data, it should be recognized that terrain and airplane interaction is a complex phenomenon, which at best can only be approximated in KRASH at this time.

Of interest is the economics of running small models, if appropriate. Table 19 shows a comparison of results for the 43 mass and 24 mass models used for the initial impact. Since the crash in this particular case is symmetrical,the smaller model can be used to an economic advantage, if the accuracy of results is acceptable. As can be observed in Table 19 the results agree within 6 percent while the larger model requires more than twice the time (and cost) to perform the same analysis.

TABLE 19. COMPARISON OF RESULTS FOR THE 43 MASS AND 24 MASS AIRPLANE B MODELS

	24 Mass 37 Member Model (a)	43 Mass 80 Member Model (a)	Percent Difference (b)
Incremental Rotation (Degrees)	4.12	3.90	-5.6
Kinetic Energy (in.-lbs.)	2.23×10^5	2.187×10^5	-2.0
External Spring Deflection (inches)			
Longitudinal	8.93	9.07	1.5
Vertical	7.00	7.42	5.7
Computer Time (hrs)	.0455	.097	53.1

(a) Time = .040 seconds

(b) (Large Model Value - Small Model Value)X 100/Large Model Value

5.6 ASSESSMENT OF PROGRAM KRASH

In addition to performing comparison studies between analytical and test data using two general aviation airplanes, other portions of the Task I effort directly and indirectly provide information for assessing the capabilities of program KRASH to assist in establishing the crashworthiness of general aviation airplanes. These related efforts include the determination of the general aviation industry's computer capability, improvements in the ease and cost of operating the program, as well as the availability of structural data and the methods to be used for obtaining data.

The comparisons of two different general aviation airplane configurations subjected to two probable accident conditions along with a previous correlation using full scale crash test data (Reference 3) and accident results (Reference 15)have shown that program KRASH can provide satisfactory data to:

- Facilitate an evaluation of occupant injury assessment by providing the floor pulse to the occupant seat, describe structural deformation in and around the occupiable region, and provide a Dynamic Response Index (DRI) reading,

- Meet the general aviation airplane design requirements by providing multidirectional force, acceleration, velocity and deflection data,

- Account for large nonlinear behavior of different types of structure including failure modes, loss of structure, and an evaluation of member directional stresses,

- Treat probable crash conditions taking into account impact velocities, attitude, angular rates, terrain and position of the aircraft relative to the terrain,

- Describe different general aviation airplane configurations including low-wing, high-wing, single-engine and twin-engine types,

- Simulate significant portions of a crash wherein multiple impacts are involved, and

- Describe the temporal and spatial distribution of energy throughout the crash including mass kinetic and potential energy, member strain and damping energy and structural crushing and the ground friction associated energy.

In addition KRASH has been modified to standardize many parameters, simplify imput data requirements and clarify output data with the use of English symbols where appropriate. All modifications are briefly described in Section 4 of this report and comprehensively detailed in Section 1 of Reference 13.

The program has demonstrated its capability to treat a wide variety of vehicles and crash situations. However, as is the situation with any analytical approach, the accuracy that can be achieved depends to a large extent on the understanding of the program limitations and the manner in which the program is utilized. Fundamental to using KRASH effectively is to recognize that the program is best at describing vehicle general structural behavior and may employ simplified representation of large structural sections in some areas. While the program allows for a definition of a wide range of nonlinear behavior, it only approximates

post-failure behavior. However, the results of sensitiveity studies using KRASH are described in Reference 4, and they show that acceptable accuracy commensurate with the requirements for this type of analysis can be obtained with this approach as long as the peak failure load and deflection are satisfactorily represented.

Although program KRASH provides inputs to help assess occupant's chances of survival it does not, by itself, provide a measure of more than one injury type (DRI) which is limited to describing vertebrae compression. The program does supply a multidirectional pulse at the seat attach point along with an overall description of the behavior of the occupiable space for use in a detailed occupant, seat and restraint system model that would provide potential injury information.

As described in the modeling of the overturn accident, this type of crash would normally require an order of magnitude more computer time than a normal crash sequence. Considering that very little structural damage occurs and that no significant loads act on the occupants during most of the sequence, the use of a numerical integration scheme with a fine integration interval is a very inefficient approach. Consequently, KRASH, complemented with rigid body analysis, should be used to model only significant portions of a crash.

In some respects the program is limited by the availability of data. This limitation applies to all current analytical techniques. In particular, it is difficult to substantiate combined loading and/or unloading and ground-structure interaction, because of the lack of measured data in these areas, for many types of situations that apply to airplane structure and crash conditions. If measured data and/or proven analytical techniques become available, they can be readily used with program KRASH. As noted in Reference 4 the use of simplified techniques to obtain data as input to KRASH are practical.

SECTION 6

TASK I RESULTS

The following discussion presents a summary of the results of the Task I effort.

6.1 REVIEW AND EVALUATION OF GENERAL AVIATION AIRPLANE CHARACTERISTICS

A review and evaluation of 61 light fixed-wing airplane models, produced by the major domestic general aviation airplane manufacturers was performed. The evaluation takes into consideration airplane configuration, usage, operational characteristics, and structural characteristics.

Included in the review and evaluation of general aviation airplane characteristics are:

- a matrix of airplane configuration, maximum takeoff weight and usage,
- a description of structural design characteristics of current general aviation airplanes,
- a description of the various general aviation airplane types, and
- a categorization of airplanes as a function of configuration, maximum takeoff weight, stall speed, cruise speed, usage and accommodations.

The results of the study show that:

(a) There are four basic airplane configurations; single-engine low-wing, single-engine high-wing, twin-engine low-wing and twin-engine high-wing.

(b) With the exception of the agricultural airplane most airplanes have multiple uses.

(c) There is a trend, insofar as usage, accommodations, weight and speed characteristics are involved which leads to a logical grouping of the airplanes by categories.

(d) While there are many manufacturers and airplane models and the design details of the structure may vary, there are only two basic structural designs: monocoque and tubular.

A plot of airplane maximum cruise and flaps down stall speeds as a function of maximum takeoff weight for the different airplane models reviewed during this effort, is presented in Figure 52. The envelope reflects a practical range of velocities that would encompass most crash conditions which will aid in establishing the crash environment.

6.2 REVIEW AND EVALUATION OF ACCIDENT DATA

Accident data from CAMI, NTSB and referenced reports were obtained, reviewed and evaluated. Included in the accident evaluation are:

- results of 18 CAMI accident records showing (a) the frequency of occurrence by phase of operation, type of accident, angle of impact roll/yaw attitude, and terrain, (b) the distribution by degree of cabin damage, structural damage, and injury types and (c) the occurrence of seat and seat belt failures and occupant impact with controls and instrument panels;

- the description of a computer program, developed during this task, to sort and process selected pertinent crashworthiness accident data from NTSB data tapes; and

- results of 1971 through 1973 NTSB accident records, encompassing 8491 accidents, obtained from the accident computer program employing the airplane categories established during this task.

The results of the NTSB accident data evaluation indicate that:

(a) The impact angle in a crash is predominantly ≤ 45 degrees.

(b) Stall, collisions with ground/water and collisions with obstacles are the prevalent types of accidents which result in serious or fatal injuries.

(c) In accidents wherein injuries are involved, light weight single-engine airplanes have a greater number of stall accidents than accidents involving collision with ground/water or obstacles. Conversely, heavier weight single-engine and twin-engine airplanes experience more accidents involving collision with the ground.

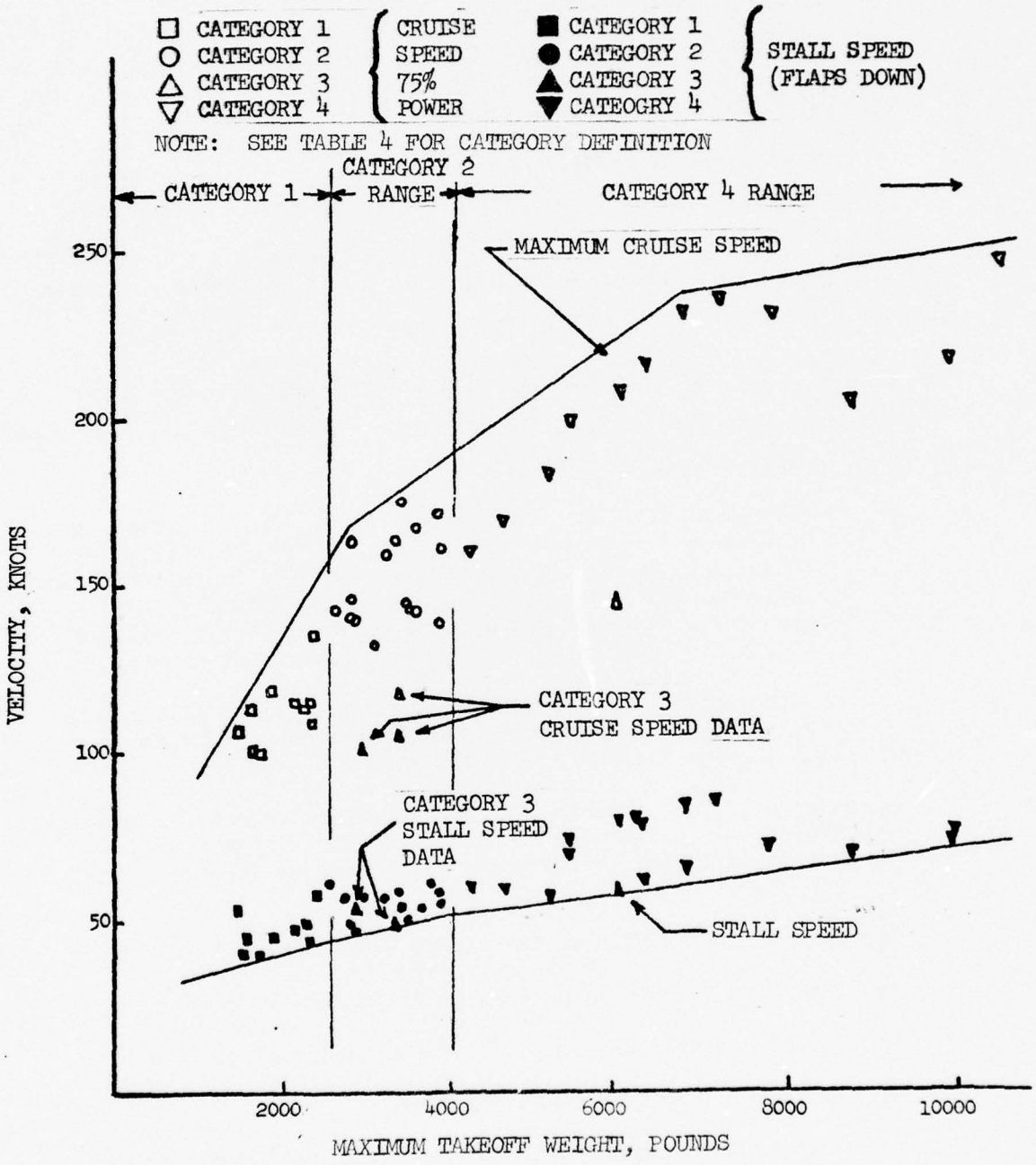


Figure 52. Operational Velocity/Weight Envelope for Current General Aviation Airplanes

(d) The personnel involved in agricultural type airplane accidents, wherein injuries occur, experience less fatalities per occupant in all types of accidents.

(e) The ratio of fatalities to number of occupants, for accidents involving injuries, is generally lower for the single-engine airplane than the corresponding ratio for twin-engine airplanes for the same type of accident.

6.3 MATHEMATICAL MODELING REQUIREMENTS

Seven members of the General Aviation Manufacturer's Association (GAMA) were sent an inquiry regarding their current and anticipated computer capability. Their responses indicate that the industry computer capability as a whole will, by 1977, be sufficient to utilize reasonably large ($\approx$500,000 bytes) computer programs. However, based on the lack of current standard plotting capability within the industry, no attempt should be made to have a plot package compatible with any particular routine.

Based on the results of the review of industry computer capability and evaluation of general aviation airplane designs and accident statistics, a mathematical model, to be of benefit to the industry, should have the capability described in Section 4.2.

A brief description of program KRASH, which is the basis of the analytical method for the development of a general aviation airplane mathematical computer program is presented. The modifications to program KRASH to improve its modeling capability, add flexibility and versatility, and to facilitate its usage by the industry are described. Program KRASH, as modified for this program, contains many features not available in other current analytical techniques. A summary of program KRASH modifications, briefly stating their advantages and noting associated current restraints is presented in Table 20. The restraints do not inhibit the program's use, but serve to indicate to a potential user that program KRASH, like any analytical procedure, has certain limitations in its application. An understanding of the program's capabilities will enhance its usage and, consequently, the benefits that can be obtained therefrom.

TABLE 20. MODIFICATIONS TO KRASH

Modification	Advantage(s)	Current Restraints
Generalized Surface	• Adds modeling flexibility and versatility and requires only one additional input term • Treats slope angle $\geq 0^\circ$ and $< 90^\circ$	• Surface can only slope upward • Surface is rigid
Standard Non-Linear Curves	• Five (5) standard load-deflection shapes • Ease of input • Representative of structural behavior • Facilitates parametric studies	• Approximate technique • Requires user selection based on available guidelines
Member Directional Stress	• Detects potential failure for selected members • Tests against two (2) yield criteria	• Primarily of use in linear range • Excludes effects of stress concentrations and detail design practices
Cabin Volume Change	• Detects potential danger to occupants in occupiable region	• Describes motion of mass points only
Linear Stiffness Matrix	• Input E, A, G, I_y, I_z member properties and program computes member stiffness matrix • Doesn't alter basic response computations • User still has option to input member stiffness, if available • User can identify joint attachment • Reduces input to one card per member instead of 6 cards per member	• Each internal member is represented by only a 6 x 6 stiffness matrix which is related to a set of properties (E, A, G, I_y, I_z, length)
Model Parameter Data	• Program Computes from the input data; (a) vehicle mass and inertia properties, C.G. location and position relative to the ground contact point and (b) element stiffness, frequency and damping values	• Element frequency and damping values are based on KRASH formulation and are "relative" terms. Guidelines for interpreting this data are available
Plow Effects	• Represents drag force as a constant average force acting over a time span • Can use ground friction with external springs to model plowing effects	• Depends on the availability of applicable data • Detailed interaction with soft earth not modeled
Acceleration Pulse	• Includes provisions for specifying an acceleration pulse (location, direction, time history) acting on a mass or masses	• Restricted in number of masses to which the pulse can be applied
Damping Terms	• Standard member damping internally coded can reduce input card to 1 for whole model instead of 1 for each member • Revised damping force computation reduces the chance for instability	• Damping is only related to percent critical structural values. Incompatible damping value and/or integration interval can cause numerical instability. (User's Manual provides guidelines for proper selection of values)
Miscellaneous Coding Change	• Treatment of beam longitudinal elongation is improved • Computation of external spring forces and energies is improved • Relationship between coupled force moment terms is preserved	• Nonlinear relationship for coupled forces and moments depends on nonlinear characteristics which is input data
Input and Output Format	• New format is more consistent and uniform • Expanded print of input and output terms to facilitate understanding and usage • Substantially less input data cards required (>2/3 reduction can be achieved)	

6.4 ASSESSMENT OF KRASH

KRASH, as modified during this effort, is used to model two different general aviation airplane models for which controlled crash test data is available. The data was obtained from controlled crash tests which represented a stall spin and an overturn accident. The assessment of KRASH encompasses the following.

- Descriptions of the two crash tests including purpose, sequence, instrumentation, photographic coverage, failures and photographs of the airplanes in the pretest and post test conditions.
- Descriptions of the mathematical models that are developed to represent each of the airplanes for the particular crash conditions.
- Comparisons of test and analysis results were performed for the following three impact conditions.
  - (a) 45 ft/sec longitudinal velocity impact into a 45 degree dirt barrier
  - (b) c.g. velocity of 19.5 inches/second (down), 259 inches/second (forward)pitch attitude of 38.5 degrees (nose down)
  - (c) c.g. velocity of 102 inches/second (down), 45.5 inches/second (forward)
    pitch attitude of 19.6 degrees (nose down in inverted position)
    pitch rate of 89.4 degrees/second (nose down in inverted position)

The results of the assessment indicate that Program KRASH meets the general aviation airplane crash analysis requirements as noted in Section 4.2. In particular, program KRASH has been shown to be capable of defining:

- spatial and temporal energy distribution including mass kinetic and potential, member strain and damping, structural crushing, and ground friction;
- large nonlinear behavior into the post-failure region including occupiable cabin deformations;

- acceleration pulses at the floor in regions where occupants are located for the purpose of determining occupant response using an available occupant-seat-restraint system math model;
- forces, accelerations, velocities and deflections resulting from multidirectional impacts;
- structural behavior for a wide range of structural element types associated with general aviation airplane design;
- large motion rigid-body behavior wherein ground contact forces can be defined; and
- mathematical model requirements for two different airplane configurations (high-wing, low-wing).

Program KRASH has also been shown to have some limitations with regard to modeling certain impact conditions such as terrain-structure interaction and coupling of nonlinear loading and unloading behavior. The limitations associated with KRASH are at present applicable to all other analytical techniques. In some instances the development of additional analytical techniques or the acquisition of additional experimental data may alleviate these limitations.

Table 21 summarizes program KRASH's capability with regard to meeting the mathematical model requirements. Included are pertinent comments that indicate areas wherein the user should have a good understanding of KRASH's limitations with regard to input data as well as the output that is obtained.

TABLE 21. ASSESSMENT OF KRASH'S CAPABILITY

Requirement	KRASH Capability	Comments
Assessment of Occupant Survival	o Provides acceleration pulses (magnitude, shape, and duration), DRI, volume change and penetration data o Describes structural behavior which can influence occupant survival	o Present occupant, seat and restraint systems are not modeled rigorously o Detail volume change is dependent on the number of masses representing a region o DRI is a measurement of only one type of injury
Multidirectional Forces	o Provides accelerations, forces, velocities and displacements for translations (3) and rotations (3)	o Difficult to obtain test data to substantiate combined loading interaction
Structural Behavior, Deformation and Failure	o Represents linear and nonlinear load-deflection characteristics o Provides member directional stresses o Provides forces, velocities, and deflections o Represents crushing of structure and friction due to ground forces o Provides temporal and spatial energy distribution	o Approximate representations of post-yield load-deflection behavior o May require simplified representation of large section structural characteristics o Stresses alone are inadequate measures of structural behavior and/or failure
Airplane Configurations	o Treats all configurations including single-engine, twin-engine, low-wing, high-wing, and light and heavy-weight airplanes o Treats welded tube and semi-monocoque fuselages, tubular and keel engine mount designs, and cantilever wing and tail units	o Obtains vehicle gross behavior, thus number and location of nodes are to be selected and represented based on suggested guidelines
Multiple Impacts	o Determines significant portions of a crash utilizing the generalized surface routine to represent contact surface	o Not economical for performing entire crash sequence (supporting rigid body analysis can define subsequent impact conditions)
Crash Environment	o Can treat probable crash conditions (velocity, impact angle, attitude, initial rates) and terrain with the use of external springs, plow term, generalized surface and specification of initial conditions	o Depends on available data regarding terrain characteristics and effects of interaction with structure o Capabilities would be improved with addition of a flexible ground surface
Practical and Economical	o Utilizes available data and approximates structural behavior o Emphasizes peak force transmittal and energy absorption o Performs crash analysis using numerical integration o Uses English symbols to define input and output o Contains standardized data o Particularly effective in preliminary design	o Potential refinements include a) variable time step integration scheme b) symmetrical model coding c) restart capability d) additional standardization of data e) increase modeling flexibility

SECTION 7.0

CONCLUSIONS

1. Based on the results of the correlation studies made, program KRASH, modified as described in this report, is a satisfactory method of performing structural crashworthiness analysis of general aviation airplanes during probable accident conditions.

2. Program KRASH is most appropriate for use during preliminary design, wherein it is desired to determine approximate airframe response to crash conditions to aid in incorporating crashworthy features in an economical manner.

3. The crash environment is influenced by airplane operating characteristics such as usage, stall and cruise speed, and mode of operation; and, by airplane configuration such as weight, and number of engines.

4. Typical crashes involving light fixed-wing aircraft indicate that the behavior of structure in some regions of the aircraft, during a crash, can have a significantly greater influence on occupant survivability than other regions. Consequently, simplified representations of structure in noncritical regions can be used in crash analysis.

5. A computer program developed by Cessna provides the basis by which NTSB accident data can be compiled and evaluated with regard to airplane configuration and/or usage as a function of accident types, terrain, injuries and/or fatalities to aid in determining crash environment design criteria.

SECTION 8
REFERENCES

1. Green, S.J., THE CURRENT STATUS OF GENERAL AVIATION TECHNOLOGY, AIAA Paper 75-289, presented at the AIAA 11th Annual Meeting, Wash., D.C. Feb. 24-26, 1975.

2. Dr. Hayduk, R.S. and Dr. Thomson, R.G., SIMULATION OF AIRCRAFT CRASH AND ITS VALIDATION, AIAA Paper 72-271, presented at the AIAA 11th Annual Meeting, Wash., D.C., Feb. 24-26, 1975.

3. Wittlin, G., Gamon, M.A., EXPERIMENTAL PROGRAM FOR THE DEVELOPMENT OF IMPROVED HELICOPTER STRUCTURAL CRASHWORTHINESS ANALYTICAL AND DESIGN TECHNIQUES, Lockheed-California Company; USAAMRDL TR 72-72A,72B, U.S. Army Air Mobility Research and Development Laboratory, Ft. Eustis, Va., May 1973.

4. Wittlin, G., Park, K.C., DEVELOPMENT AND EXPERIMENTAL VERIFICATION OF PROCEDURES TO DETERMINE NONLINEAR LOAD-DEFLECTION CHARACTERISTICS OF HELICOPTER SUBSTRUCTURES SUBJECTED TO CRASH FORCES, USAAMRDL TR 74-12A, 12B, U.S. Army Air Mobility Research and Development Laboratory, Ft. Eustis, Va., May 1974.

5. Dr. Laananen, D.H., DEVELOPMENT OF A SCIENTIFIC BASIS FOR ANALYSIS OF AIRCRAFT SEATING SYSTEMS, FAA-RD-74-130, U.S. Dept. of Transportation, Federal Aviation Administration, Systems Research and Development Service, Wash., D.C., January 1975.

6. JANE'S ALL THE WORLDS AIRCRAFT 1975-75, Jane's Yearbooks, London, England, 1975.

7. Wullenwaber, G.E., A SUMMARY OF CRASHWORTHINESS INFORMATION FOR SMALL AIRPLANES, FAA-FS-70-592-120A, FAA Aeronautical Center, Oklahoma City, Oklahoma, Feb. 1973.

8. Wilson, G.L., SELECTED CRASHWORTHINESS DATA FROM CAMI INVESTIGATIONS OF GENERAL AVIATION ACCIDENTS, FAA Project Number 74-779-120A, FAA Aeronautical Center, Oklahoma City, Oklahoma, May 1975.

9. ANNUAL REVIEW OF AIRCRAFT ACCIDENT DATA, NTSB-ARG-74-1 (1970) and NTSB-ARG-74-2 (1971), National Transportation Safety Board, Wash., D.C.

10. Dr. Snyder, R.G., CRASHWORTHINESS INVESTIGATION OF GENERAL AVIATION ACCIDENTS, Presented at the Society of Air Safety Investigators, Fall Issue, 1975.

11. Bergey, K., THE DESIGN OF CRASHWORTHY GENERAL AVIATION AIRCRAFT, Univ. of Oklahoma, SAE Paper 740376, April 1974.

12. Turnbow, J.W., et al, CRASH SURVIVAL DESIGN GUIDE, USAAMRDL-TR-71-22, Eustis Directorate, U.S. Army Air Mobility and Research Laboratory, Ft. Eustis, Va., Oct. 1971.

13. Gamon, M.A., Wittlin, G., KRASH USER'S MANUAL AND STRUCTURAL CRASHWORTHINESS DESIGN GUIDELINES, Volume I, FAA Contract DOT-FA75-WA-3707, to be completed July 1976.

14. Gamon, M.A., Wittlin, G., EXPERIMENTALLY VERIFIED ANALYTICAL TECHNIQUES FOR PREDICTING VEHICLE CRASH RESPONSE, presented at the Aircraft Crashworthiness Symposium, Cincinatti, Ohio, October 1975.

15. Widmayer, E., APPLICATION OF KRASH TO SOAC ACCIDENT, Presented at the Aircraft Crashworthiness Symposium, Cincinatti, Ohio, October 1975.

APPENDIX A
ACCIDENT COMPUTER PROGRAM

A.1 OBJECTIVE

The purpose of this program is to summarize and to provide individual record print-outs of selected fields of selected makes and models of aircraft contained on the National Transportation and Safety Board (NTSB) data files for the years 1971, 1972, and 1973.

A.2 GENERAL INFORMATION

Minimum System Requirements

Core - 92K
Disk Space - 3800 tracks of IBM 3330
Tape Drives - 3
Printer - 1 IBM 1403
Card Reader - 1
Paper - 14" x 11"
Carriage Tape - 88 lines/page
Language - Cobol level G
Operating System - DOS/VS
Machine - IBM 370/158
Code - EDCDIC

Typical Run Time

MTSB0002 - 3 Minutes/Tape
SMTSB02 - 2 Minutes
1325020D - 12 Minutes
MTSB0001 - 2 Minutes
Print Time - 15 Minutes/Tape (Approximately 15000 lines/tape)

Manuals and Input Files

Before this program is exercised the user must acquire the manuals listed below:

Manuals

For a complete description of the input record, refer to the NTSB documents numbered 1, 2 and 3 below. Item number 4 refers to a manual associated with an NTSB program and data tape.

1. Tape Positions and Subject Matter, Aircraft Accident Files, U.S. Civil Aviation.

2. Manual of Aircraft and Engine Code Classifications.

3. Manual of Code Classifications, Aircraft Accidents & Incidents.

4. User Instructions ADP Programs - Automated Aircraft Accident and Incident Information System.

The NTSB files and manuals may be obtained by writing:

National Transportation Safety Board
Department of Transportation
Washington, D.C. 20591

You must ask specifically for each of the items listed above. If you have a problem interpreting the manuals, call:

Dave Kelly
1-202-426-3976

in Washington, D.C. He and his office have been very helpful in Cessna's work with the files.

Input Files

Full Print Header Files

A tape file which contains the Full Print Headers to be used by MTSB0001.

Record Layout for the Accident Record

This file resides on our source statement library and is copied into MTSB0002 and MTSB0001.

Accident Data Files

These files contain the actual accident record. The years 1963 thru 1974 are currently available.

In summary, the input which must be available to these programs as they exist now is as follows:

1. Accident Data Files - input to MTSB0002.

2. English Meaning Header File - input to 1-325-020-D.

3. Data Record Book on a Source Statement Library - Input to MTSB0001 and MTSB0002.

How to Execute the System

Step 1 - Obtain a copy of the program, Job Control and Data Tape from Lockheed Aircraft.

This tape will contain the programs necessary to process all the input data, the job control required to execute the programs and the Full Print Header File in that order. See Section A.8 for a discussion of this tape.

Step 2 - Compile and catalog all the programs on the tape and put the Accident Data File input record description on your source statement library.

Step 3 - Make a magnetic tape labeled "NTSB Headers" as noted in the JCL listing which contains the Full Print Headers.

Step 4 - Execute the system. Mount the input tapes as called for in the machine room setup sheets. You may mount the Accident Data Files in any order. It is suggested that the user write a small program to read each accident data file before processing the entire job because the tapes have been known to produce data checks.

If a user should find it necessary to change the screening in the programs to meet objectives different than those of the existing system, certain program changes will be necessary. See the individual program description in this report for information on how to carry out changes.

A.3 PROGRAM DESCRIPTION

Program MTSB0002 - Record selector by make and model code and model number.

This program selects accidents from as many NTSB accident data files as desired and writes them to a separate tape file. A tape file is selected to eliminate the necessity for rerunning this program each time a run on MTSB0001 is made.

It should be noted that the table for selection of airplanes is built directly into the program. Any user would need to change the table if years other than 1971, 1972, 1973 or 1974 are to be used to satisfy different requirements. The table, named MK-MOD-01, must be in ascending order Col 46 thru 56. The table content is:

Card Col	Content
46-48	Make Code
49-50	Model Code
51-56	Model Name

See a current manual of Aircraft and Engine Code Classifications for a complete description of the content.

It is suggested that a user write a program, to search the accident data tapes on the make and model codes and model numbers which are needed and let the program punch the table. This will prevent the lengthy research necessary to determine exactly how the model name was entered in the accident records. The selected records should be listed, sorted, duplicates eliminated, then punched. The list can be edited and selected models may be removed from the table of punched cards. This, then, will be the final table used in MTSB0002. All the accident data files to be processed by MTSB0002 should be used in the creation of the make and model table. It should also be noted that the model names contain some error. For example, Cessna has Model 150 names entered as 15Ø and 150. Also, the names may not always be left justified in the field. By writing a program to pre-edit and punch the three fields, all the fielding and punching errors can be easily found and used.

Input

Selected NTSB accident data tapes. As of this writing 1963-1974 are available with 1975 soon to be released. See Appendix A for sample input record.

Output

A tape file which contains NTSB accident records is selected by make and model codes and model name.

Console Messages	Operator Response
IF THIS IS THE LAST FILE ENTER LAST IF NOT THEN MOUNT NEXT TAPE AND ENTER NEXT	Enter NEXT or Last
YOU GOOFED REENTER YOUR RESPONSE	Enter Correctly spelled response

Program SMTSB002

This is a sort which sorts the selected records on make and model code. See the SORT FIELDS record in the sort for exact fielding and sort hierarchy.

Input

Tape created by MTSB0002 which contains selected accidents.

Output

Tape file which contains sorted accident records.

Program 1-325-020-D

This program creates a direct access Full Print Header file to be used by MTSB0001.

Input

Tape file which contains the English meaning Full Print Headers. These headers are on the program and data tape.

Output

A direct access file of Full Print Headers.

Program MTSB0001

This program further selects accidents based upon the following criteria:

a. Certain Aircraft Types.

b. Certain Major Operational Phases.

c. Certain Minor Operational Phases within Major Phases C, D, or E.

d. Terrain Types

e. Cause - Factors

If the aircraft accident is of type D, E, F, L, P, R, 0, 1, 2, 4, 5 and 7, the accident is not processed further. These types are in the variable named TYPES - 77 and moved to TYPES - 01.

The major operational phase summary at top of Page 2 summarizes all major phases. However, thereafter, if the major phase is not Code C, D or E, i.e., takeoff, inflight or landing respectively, the information is not tallied and the accident is rejected entirely except for its tally in total accidents surveyed and the grand total accidents surveyed.

All minor operational phases are surveyed except the 'Øther' categories under major phases C, D and E.

If the terrain type, cause-factors or certain minor phases were not acceptable, processing continues to obtain tallies in other applicable areas.

Input

A file which contains the NTSB records is selected and sorted by MTSB0002 and SMTSB002 respectively.

Output

Printed output which consists of:

1. Individual record print-outs if the accident reported

   a) impact angle
   b) impact velocity
   c) stopping distance
   d) seat failure
   e) seat belt failure
   f) attitude at impact

   This does not constitute a complete record print-out, only selected portions.

   There are no codes printed. The information is either taken directly from the record or the code is used to retrieve a header from the header file created by program 1-325-020-D.

2. Five pages of summary data which summarizes a make and model for all years are entered into MTSB0002.

   The discussion of each page that follows deals only with those outputs which are not self-explanatory.

   First Page Summary - General Information

   The aircraft model is an aircraft model code because the summary is for all selected specific models in all the years processed.

   The total number of accidents surveyed is a count of all those accidents, in a make and model code, on the input file.

   The total applicable accidents surveyed is a count of those accidents of an acceptable type.

   The total number of occupants is a summation of all the aircraft occupants in the applicable accidents.

   The average number of occupants is the rounded quotient of the division of number of occupants by number of applicable accidents.

   The sum of all entries in the Totals of Seriousness of Injuries table should equal the total number of occupants.

Second Page Summary - Flight Conditions

The major phase summary at top of the page summarizes all accidents on the input file of acceptable type.

The second summary on minor phase of operation summarizes only upon meeting type, major phase and minor phase requirement. No 'Other' category minor phases were summarized here. Which means that the total number of accidents will always be equal to or less than the total applicable accidents.

The third summary on types summarizes only upon meeting type and major phase requirements. The total number of accidents here should equal the total applicable accidents.

Third Page Summary - Impact Conditions

The 90+, 120+ and 360+ include 90, 120 and 360 respectively in their tallies.

The occupant injury table cannot be depended upon to record all injuries because not all the accident records contain an entry in the damage severity field. Summation was done only if a damage severity was recorded.

Fourth Page Summary - Aircraft Cabin Accommodations

The Impact Area summary percentages should total to nearly 100%. If they do not, then it can be attributed to round-off error. The list is sorted in descending order by percent.

Program Areas Which a User May Wish to Change

All the major operational phases are built into the procedure division. The program areas which must be changed are:

1. The page layout for Page 2 which begins at Statement Number 055400. This will probably change the number of array elements in Statement Number 065300.

2. The screen is at Statement Number 105200.

3. If the number of array elements for Page 2 has changed then the PERFORM at Statement Number 213700 must be changed to equal the number of array elements used in No. 1 above.

he minor phases used for screening are contained in an array named OP-PH-01. The codes contained in this array must be in ascending order. A change in the number of codes means that this OCCURS clause at Statement Number 088600 must change and also the number in the MOVE in Statement Number 168900.

The terrain types are in a 77 level data named TERRAIN - 77. The items in this array must be in ascending order. A change in the number of items means the picture size must change in Statement Number 019700 and the values in Statement Number 024000, 040900, 041000, 186300, and 186400 must change to equal the picture size in 019700.

The cause-factors are contained in an array named CAUSE-FACTOR-01. No change need be made in the occurs clause until more than 500 cause-factor codes are used. Currently 494 are used. It should be noted that due to a few errors in the original key punching of the table, certain duplication of codes were introduced in order to avoid repunching the entire table. This will cause no problem in the searching of the table. If the number of array elements is changed then MOVE in Statement Number 191600 must change to correspond.

A.4 LIST OF JOB CONTROL

```
* $$ JOB MTSB001                              SUMNER
* $$ PRT 0,*814,1,,1000000000000000000000C0076
// JOB MTSB0001              SUMMARIZE AND LIST SELECTED AIRCRAFT
// OPTION CATAL,SYM
   PHASE TMTSB001,*
// EXEC FCOBOL
/*
// LBLTYP NSD(04)
// EXEC LNKEDT
/*
// EXEC FGPPAGE
SUMNER
/*
/&
* $$ EOJ
// JOB MTSB0002          SELECT AIRCRAFT FROM NTSB FILES
// OPTION CATAL
   PHASE TMTSB002,*
// EXEC FCOBOL
/*
// LBLTYP NSD(04)
// EXEC LNKEDT
/*
// EXEC FGPPAGE
SUMNER
/*
/&
// JOB R3250200D          FULL PRINT HEADERS TO DIRECT ACCESS DISK
// OPTION CATAL
   PHASE R3250200D,*
// EXEC FCOBOL
/*
// LBLTYP NSD(04)
// EXEC LNKEDT
/*
// EXEC FGPPAGE
SUMNER
/*
/&
* $$ JOB MTSB0002          SELECT AIRCRAFT FROM NTSB FILES
// JOB MTSB0002
// ASSGN SYS018,X'T01'
// ASSGN SYS019,X'T02'
// LBLTYP NSD(04)
// EXEC TMTSB002
/*
// EXEC FGPPAGE
SUMNER
/*
/&
* $$ EOJ
// JOB SORT          SELECTED AIRCRAFT
// ASSGN SYS001,X'T03'
// ASSGN SYS002,X'T02'
// ASSGN SYS003,X'WK1'
// DLBL SORTWK1,'MTSB0001',72/001,SD
// EXTENT SYS003,,1,0,0019,1850
// ASSGN SYS004,X'WK2'
// DLBL SORTWK2,'MTSB0001',72/001,SD
// EXTENT SYS004,,1,0,0019,1850
// EXEC SORT
   SORT FIELDS=(82,5,BI,A),WORK=2
   RECORD TYPE=F,LENGTH=1800
   OPTION LABEL=(U,U,S)
   END
/*
// MTC RUN,SYS002
/&
* $$ JOB 1325020D          FULL PRINT HEADERS TO DIRECT ACCESS DISK
* $$ PRT 0,14P1,1,,10000000000000000000000056
```

```
// JOB 1325020D
// LBLTYP NSD(04)
// ASSGN SYSLST,IGN
// ASSGN SYS010,X'T01'
// TLBL SYS010,'NTSB HEADERS',,325020
// ASSGN SYS012,X'WK2'
// DLBL SYS012,'NTSB',69/200,DA
// EXTENT SYS012,,1,0,0019,1900
// EXEC R325020D
/*
// EXEC FGPPAGE
SUMNER
/*
// MTC RUN,SYS010
/&
* $$ EOJ
* $$ JOB MTSB0001       SUMMARIZE AND LIST SELECTED AIRCRAFT
* $$ PRT D,14P4,1,,1000000000000000000000056
// JOB MTSB0001
// ASSGN SYS018,X'T03'
// ASSGN SYS019,X'WK2'
// DLBL SYS019,'NTSB',69/200,DA
// EXTENT SYS019,,1,0,0019,1900
// ASSGN SYSLST,IGN
// LBLTYP NSD(04)
// EXEC TMTSB001
/*
// EXEC FGPPAGE
SUMNER
/*
/&
* $$ EOJ
// JOB CATALOG NTSBMSTR TO SOURCE LIBRARY
// EXEC MAINT
 CATALS C.NTSBMSTR
 BKEND C.NTSBMSTR
 BKEND C.NTSBMSTR
/*
// EXEC SSERV
 DSPLY C.NTSBMSTR
/*
// EXEC FGPPAGE
RENNEKE
/*
/&
```

A.5 PROGRAM LISTING

```
1  IBM DOS AMERICAN NATIONAL STANDARD COBOL   VERSION 3 REL3.2  PP NO. 5736-CB2

 CBL CLIST,LIBR=YES,SXREF
00001    000100 ID DIVISION.
00002    000200 PROGRAM-ID. MTS80002.
00003    000300 AUTHOR.  J. A. SUMNER.
00004    000400 INSTALLATION.   THE CESSNA AIRCRAFT COMPANY.
00005    000500 DATE-WRITTEN.   9-20-75.
00006    000600 DATE-COMPILED. 04/09/76.
00007    000700 SECURITY.   NOT CLASSIFIED.
00008    000800 REMARKS.
00009    000900     THIS PROGRAM SELECTS CERTAIN AIRCRAFT FROM THE NTSB MASTER
00010    001000     FILES TO BE SUMMARIZED BY MTS80001.
00011    001100 ENVIRONMENT DIVISION.
00012    001200 CONFIGURATION SECTION.
00013    001300 SOURCE-COMPUTER.     IBM-370.
00014    001400 OBJECT-COMPUTER.     IBM-370.
00015    001500 INPUT-OUTPUT SECTION.
00016    001600 FILE-CONTROL.
00017    001700     SELECT NTSB ASSIGN SYS018-UT-2400-S.
00018    001800     SELECT NTSB-TAPE ASSIGN SYS019-UT-2400-S.
00019    001900 DATA DIVISION.
00020    002000 FILE SECTION.
00021    002100 FD  NTSB
00022    002200     LABEL RECORDS ARE OMITTED
00023    002300     RECORDING MODE IS F
00024    002400     DATA RECORD IS NTSB-REC.
00025    002500 01  NTSB-REC COPY NTSBMSTR REPLACING REC BY NTSB-REC.
00026 C  002670 01  NTSB-REC.                                                RON
00027 C  002680     02  F001.                                               RON
00028 C  002690         03  F00101       PICTURE 99.                        RON
00029 C  002700         03  F00102       PICTURE XX.                        RON
00030 C  002710         03  F00103       PICTURE XX.                        RON
00031 C  002720     02  F002             PICTURE X(6).                      RON
00032 C  002730     02  F003             PICTURE X(10).                     RON
00033 C  002740     02  F004.                                               RON
00034 C  002750         03  FILLER       PICTURE X(5).                      RON
00035 C  002760         03  F00401       PICTURE X.                         RON
00036 C  002770     02  AF004   REDEFINES F004.                             RON
00037 C  002780         03  AF00401      PICTURE 99.                        RON
00038 C  002790         03  AF00402      PICTURE XX.                        RON
00039 C  002800         03  AF00403      PICTURE XX.                        RON
00040 C  002810     02  F005.                                               RON
00041 C  002820         03  F00501       PICTURE X.                         RON
00042 C  002830         03  F00502.                                         RON
00043 C  002840             04  FILLER       PICTURE X(16).                  RON
00044 C  002850             04  FC050201     PICTURE X.                      RON
00045 C  002860     02  F006             PICTURE X(11).                     RON
00046 C  002870     02  F007             PICTURE X(6).                      RON
00047 C  002880     02  F008.                                               RON
00048 C  002890         03  FILLER       PICTURE X(9).                      RON
00049 C  002900         03  F00801       PICTURE X.                         RON
00050 C  002910     02  F009.                                               RON
00051 C  002920         03  FILLER       PICTURE XXX.                       RON
00052 C  002930         03  F00901       PICTURE X.                         RON
00053 C  002940     02  FILLER           PICTURE X.                         RON
00054 C  002950                                                            RON
00055 C  002960                                                            RON
00056 C  002970     02  GEN-INFO.                                           RON
00057 C  002980                                                            RON
00058 C  002990       03 F010             PICTURE X.                       RON
00059 C  003000       03 F011             PICTURE XX.                      RON
00060 C  003010       03 F012             PICTURE XXX.                     RON
00061 C  003020       03 F013             PICTURE XX.                      RON
00062 C  003030       03 F014             PICTURE XX.                      RON
00063 C  003040       03 F015             PICTURE XX.                      RON
00064 C  003050       03 F016             PICTURE X.                       RON
00065 C  003060       03 F017             PICTURE X.                       RON
00066 C  003070       03 F018             PICTURE X.                       RON
00067 C  003080       03 F019             PICTURE X.                       RON
00068 C  003090       03 F020             PICTURE X.                       RON
00069 C  003100       03 F021             PICTURE X.                       RON
00070 C  003110       03 F022             PICTURE X.                       RON
00071 C  003120       03 F023.                                             RON
00072 C  003130          04  F02301       PICTURE X.                       RON
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00073 C 000740          04  F02302      PICTURE X.                    RON
00074 C 000750       03 F024            PICTURE X.                    RON
00075 C 000760       03 F025.                                         RON
00076 C 000770          04  F02501      PICTURE X.                    RON
00077 C 000780          04  F02502      PICTURE X.                    RON
00078 C 000790       03 F026            PICTURE XX.                   RON
00079 C 000800       03 F027            PICTURE X.                    RON
00080 C 000810       03 F028.                                         RON
00081 C 000820          04  F02801      PICTURE X.                    RON
00082 C 000830          04  F02802      PICTURE X.                    RON
00083 C 000840       03 F029.                                         RON
00084 C 000850          04  F02901      PICTURE X.                    RON
00085 C 000860          04  F02902      PICTURE X.                    RON
00086 C 000870       03 F030.                                         RON
00087 C 000880          04  F03001      PICTURE X.                    RON
00088 C 000890          04  F03002      PICTURE X.                    RON
00089 C 000900       03 F031.                                         RON
00090 C 000910          04  F03101      PICTURE X.                    RON
00091 C 000920          04  F03102      PICTURE X.                    RON
00092 C 000930       03 F032.                                         RON
00093 C 000940          04  FILLER      PICTURE X(4).                 RON
00094 C 000950          04  F03201      PICTURE X.                    RON
00095 C 000960       03 F033.                                         RON
00096 C 000970          04  FILLER      PICTURE X(4).                 RON
00097 C 000980          04  F03301      PICTURE X.                    RON
00098 C 000990       03 F034.                                         RON
00099 C 001000          04  FILLER      PICTURE XX.                   RON
00100 C 001010          04  F03401      PICTURE X.                    RON
00101 C 001020       03 F035.                                         RON
00102 C 001030          04  FILLER      PICTURE X(13).                RON
00103 C 001040          04  F03501      PICTURE X.                    RON
00104 C 001050                                                        RON
00105 C 001060                                                        RON
00106 C 001070    02  EMGCY-COND.                                     RON
00107 C 001080                                                        RON
00108 C 001090       03 F036            PICTURE X.                    RON
00109 C 001100       03 F037.                                         RON
00110 C 001110          04  F03701      PICTURE X.                    RON
00111 C 001120          04  F03702      PICTURE X.                    RON
00112 C 001130       03 F038            PICTURE X.                    RON
00113 C 001140       03 F039            PICTURE X.                    RON
00114 C 001150       03 F040.                                         RON
00115 C 001160          04  F04001      PICTURE X.                    RON
00116 C 001170          04  F04002      PICTURE X.                    RON
00117 C 001180                                                        RON
00118 C 001190                                                        RON
00119 C 001200    02  WEATHER.                                       RON
00120 C 001210                                                        RON
00121 C 001220       03 F041            PICTURE X.                    RON
00122 C 001230       03 F042            PICTURE X.                    RON
00123 C 001240       03 F043            PICTURE X.                    RON
00124 C 001250       03 F044            PICTURE X.                    RON
00125 C 001260       03 F045            PICTURE X.                    RON
00126 C 001270       03 F046            PICTURE X.                    RON
00127 C 001280       03 F047            PICTURE X.                    RON
00128 C 001290                                                        RON
00129 C 001300                                                        RON
00130 C 001310    02  AIRPORT.                                       RON
00131 C 001320                                                        RON
00132 C 001330       03 F048            PICTURE X.                    RON
00133 C 001340       03 F049            PICTURE X.                    RON
00134 C 001350       03 F050            PICTURE X(5).                 RON
00135 C 001360       03 F051            PICTURE X.                    RON
00136 C 001370       03 F052            PICTURE X(17).                RON
00137 C 001380       03 F053            PICTURE X(5).                 RON
00138 C 001390       03 F054            PICTURE X.                    RON
00139 C 001400       03 F055            PICTURE X.                    RON
00140 C 001410       03 F056.                                         RON
00141 C 001420          04  F05601      PICTURE X.                    RON
00142 C 001430          04  F05602      PICTURE X.                    RON
00143 C 001440       03 F057            PICTURE X.                    RON
00144 C 001450       03 F058            PICTURE X.                    RON
00145 C 001460       03 F059            PICTURE X.                    RON
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00146 C 001470      03 F060              PICTURE X(5).                    RON
00147 C 001480                                                            RON
00148 C 001490                                                            RON
00149 C 001500      02  ITINERARY.                                         RON
00150 C 001510                                                            RON
00151 C 001520       03 F061.                                             RON
00152 C 001530          04  F06101       PICTURE X.                       RON
00153 C 001540          04  FILLER       PICTURE X(20).                   RON
00154 C 001550       03 F062.                                             RON
00155 C 001560          04  F06201       PICTURE X.                       RON
00156 C 001570          04  FILLER       PICTURE X(20).                   RON
00157 C 001580       03 F063.                                             RON
00158 C 001590          04  F06301       PICTURE X.                       RON
00159 C 001600          04  FILLER       PICTURE X(20).                   RON
00160 C 001610                                                            RON
00161 C 001620                                                            RON
00162 C 001630      02  ACC-SITE.                                          RON
00163 C 001640                                                            RON
00164 C 001650       03 F064.                                             RON
00165 C 001660          04  FILLER       PICTURE X(4).                    RON
00166 C 001670          04  F06401       PICTURE X.                       RON
00167 C 001680       03 F065              PICTURE X.                       RON
00168 C 001690                                                            RON
00169 C 001700                                                            RON
00170 C 001710      02  MISC.                                              RON
00171 C 001720                                                            RON
00172 C 001730       03 F066              PICTURE X.                       RON
00173 C 001740       03 F067              PICTURE X.                       RON
00174 C 001750       03 FILLER            PICTURE X.                       RON
00175 C 001760                                                            RON
00176 C 001770                                                            RON
00177 C 001780      02  PILOT-DATA.                                        RON
00178 C 001790                                                            RON
00179 C 001800       03 F068.                                             RON
00180 C 001810          04  F06801       PICTURE X.                       RON
00181 C 001820          04  F06802       PICTURE X.                       RON
00182 C 001830       03 F069.                                             RON
00183 C 001840          04  F06901.                                        RON
00184 C 001850              05  F0690101.                                  RON
00185 C 001860                  06  FILLER       PICTURE X(4).            RON
00186 C 001870                  06  F069010101   PICTURE X.               RON
00187 C 001880              05  FILLER           PICTURE X.               RON
00188 C 001890          04  F06902.                                        RON
00189 C 001900              05  F0690201.                                  RON
00190 C 001910                  06  FILLER       PICTURE X(4).            RON
00191 C 001920                  06  F069020101   PICTURE X.               RON
00192 C 001930              05  FILLER           PICTURE X.               RON
00193 C 001940       03 F070.                                             RON
00194 C 001950          04  F07001.                                        RON
00195 C 001960              05  F0700101.                                  RON
00196 C 001970                  06  FILLER       PICTURE X(4).            RON
00197 C 001980                  06  F070010101   PICTURE X.               RON
00198 C 001990              05  FILLER           PICTURE X.               RON
00199 C 002000          04  F07002.                                        RON
00200 C 002010              05  F0700201.                                  RON
00201 C 002020                  06  FILLER       PICTURE X(4).            RON
00202 C 002030                  06  F070020101   PICTURE X.               RON
00203 C 002040              05  FILLER           PICTURE X.               RON
00204 C 002050       03 F071.                                             RON
00205 C 002060          04  F07101.                                        RON
00206 C 002070              05  F0710101.                                  RON
00207 C 002080                  06  FILLER       PICTURE X.               RON
00208 C 002090                  06  F071010101   PICTURE X.               RON
00209 C 002100              05  FILLER           PICTURE X.               RON
00210 C 002110          04  F07102.                                        RON
00211 C 002120              05  F0710201.                                  RON
00212 C 002130                  06  FILLER       PICTURE X.               RON
00213 C 002140                  06  F071020101   PICTURE X.               RON
00214 C 002150              05  FILLER           PICTURE X.               RON
00215 C 002160       03 F072.                                             RON
00216 C 002170          04  F07201.                                        RON
00217 C 002180              05  F0720101    PICTURE X.                     RON
00218 C 002190              05  FILLER      PICTURE X.                     RON
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00219 C 002200           04  F07202.                                                    RON
00220 C 002210               05  F0720201     PICTURE X.                               RON
00221 C 002220               05  FILLER       PICTURE X.                               RON
00222 C 002230       03 F073.                                                            RON
00223 C 002240           04  F07301.                                                    RON
00224 C 002250               05  F0730101     PICTURE X.                               RON
00225 C 002260               05  FILLER       PICTURE X.                               RON
00226 C 002270           04  F07302.                                                    RON
00227 C 002280               05  F0730201     PICTURE X.                               RON
00228 C 002290               05  FILLER       PICTURE X.                               RON
00229 C 002300       03 F074.                                                            RON
00230 C 002310           04  F07401.                                                    RON
00231 C 002320               05  F0740101     PICTURE X.                               RON
00232 C 002330               05  FILLER       PICTURE X.                               RON
00233 C 002340           04  F07402.                                                    RON
00234 C 002350               05  F0740201     PICTURE X.                               RON
00235 C 002360               05  FILLER       PICTURE X.                               RON
00236 C 002370       03 F075.                                                            RON
00237 C 002380           04  F07501.                                                    RON
00238 C 002390               05  F0750101     PICTURE X.                               RON
00239 C 002400               05  FILLER       PICTURE X.                               RON
00240 C 002410           04  F07502.                                                    RON
00241 C 002420               05  F0750201     PICTURE X.                               RON
00242 C 002430               05  FILLER       PICTURE X.                               RON
00243 C 002440       03 F076.                                                            RON
00244 C 002450           04  F07601.                                                    RON
00245 C 002460               05  F0760101     PICTURE X.                               RON
00246 C 002470               05  FILLER       PICTURE X.                               RON
00247 C 002480           04  F07602.                                                    RON
00248 C 002490               05  F0760201     PICTURE X.                               RON
00249 C 002500               05  FILLER       PICTURE X.                               RON
00250 C 002510       03 F077                  PICTURE X.                               RON
00251 C 002520                                                                         RON
00252 C 002530                                                                         RON
00253 C 002540   02  DUM1.                                                             RON
00254 C 002550                                                                         RON
00255 C 002560    03 FILLER          PICTURE X(20).                                    RON
00256 C 002570                                                                         RON
00257 C 002580                                                                         RON
00258 C 002590   02  CAUSE-FACTOR.                                                     RON
00259 C 002600                                                                         RON
00260 C 002610    03 F078    OCCURS 17 TIMES.                                          RON
00261 C 002620        04  F07801       PICTURE XX.                                     RON
00262 C 002630        04  F07802       PICTURE X.                                      RON
00263 C 002640        04  F07803.                                                      RON
00264 C 002650            05  F0780301    PICTURE X.                                  RON
00265 C 002660            05  F0780302    PICTURE X.                                  RON
00266 C 002670                                                                         RON
00267 C 002680                                                                         RON
00268 C 002690   02  INJRY.                                                           RON
00269 C 002700                                                                         RON
00270 C 002710    03 F079            PICTURE X.                                        RON
00271 C 002720    03 F080A.                                                           RON
00272 C 002730        04  F08001A OCCURS 3 TIMES.                                     RON
00273 C 002740            05  F08001O1A   OCCURS 6 TIMES  PICTURE XXX.               RON
00274 C 002750        04  FILLER          PICTURE X(7).                              RON
00275 C 002760    03 F080B   OCCURS 4 TIMES.                                          RON
00276 C 002770        04  F08001B      OCCURS 3 TIMES.                               RON
00277 C 002780            05  F08001O1B   OCCURS 6 TIMES  PICTURE XXX.               RON
00278 C 002790        04  FILLER       PICTURE X(8).                                 RON
00279 C 002800    03 F081.                                                            RON
00280 C 002810        04  F08101  OCCURS 6 TIMES  PICTURE XXX.                       RON
00281 C 002820        04  FILLER       PICTURE X(8).                                 RON
00282 C 002830                                                                         RON
00283 C 002840                                                                         RON
00284 C 002850   02  RMRKS.                                                           RON
00285 C 002860                                                                         RON
00286 C 002870    03 F082.                                                            RON
00287 C 002880        04  F08201       PICTURE X.                                    RON
00288 C 002890        04  F08202       PICTURE X(49).                                RON
00289 C 002900    03 FILLER            PICTURE X(11).                                RON
00290 C 002910                                                                         RON
00291 C 002920                                                                         RON
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00292 C 002930      02  CAUSE.                                                  RON
00293 C 002940                                                                   RON
00294 C 002950       03 F083.                                                    RON
00295 C 002960          04  F08301  OCCURS 50 TIMES PICTURE X.                  RON
00296 C 002970       03 FILLER              PICTURE X(11).                       RON
00297 C 002980                                                                   RON
00298 C 002990                                                                   RON
00299 C 003000      02  DUM2.                                                   RON
00300 C 003010                                                                   RON
00301 C 003020       03 FILLER              PICTURE X(20).                       RON
00302 C 003030                                                                   RON
00303 C 003040                                                                   RON
00304 C 003050      02  E-P-DATA.                                               RON
00305 C 003060                                                                   RON
00306 C 003070       03 F084                PICTURE X.                           RON
00307 C 003080       03 F085                PICTURE X.                           RON
00308 C 003090       03 F086                PICTURE X.                           RON
00309 C 003100       03 F087                PICTURE X.                           RON
00310 C 003110       03 F088                PICTURE X.                           RON
00311 C 003120       03 F089                PICTURE X.                           RON
00312 C 003130                                                                   RON
00313 C 003140                                                                   RON
00314 C 003150      02  OVERHAUL.                                               RON
00315 C 003160                                                                   RON
00316 C 003170       03 F090.                                                    RON
00317 C 003180          04  FILLER          PICTURE X(4).                        RON
00318 C 003190          04  F09001          PICTURE X.                           RON
00319 C 003200       03 F091.                                                    RON
00320 C 003210          04  F09101  OCCURS 4 TIMES.                             RON
00321 C 003220              05  FILLER      PICTURE XXX.                         RON
00322 C 003230              05  F0910101    PICTURE X.                           RON
00323 C 003240       03 F092.                                                    RON
00324 C 003250          04  F09201  OCCURS 4 TIMES.                             RON
00325 C 003260              05  FILLER      PICTURE XXX.                         RON
00326 C 003270              05  F0920101    PICTURE X.                           RON
00327 C 003280       03 F093.                                                    RON
00328 C 003290          04  FILLER          PICTURE X(5).                        RON
00329 C 003300          04  F09301          PICTURE X.                           RON
00330 C 003310       03 F094.                                                    RON
00331 C 003320          04  F09401          PICTURE X.                           RON
00332 C 003330          04  FILLER          PICTURE X(11).                       RON
00333 C 003340       03 FILLER              PICTURE X.                           RON
00334 C 003350                                                                   RON
00335 C 003360                                                                   RON
00336 C 003370      02  WEATHER-SITE.                                           RON
00337 C 003380                                                                   RON
00338 C 003390       03 F095                PICTURE X.                           RON
00339 C 003400       03 F096.                                                    RON
00340 C 003410          04  FILLER          PICTURE X(4).                        RON
00341 C 003420          04  F09601          PICTURE X.                           RON
00342 C 003430       03 F097                PICTURE X.                           RON
00343 C 003440       03 F098.                                                    RON
00344 C 003450          04  F09801          PICTURE X.                           RON
00345 C 003460          04  F09802          PICTURE X.                           RON
00346 C 003470       03 F099                PICTURE X.                           RON
00347 C 003480       03 F100                PICTURE X.                           RON
00348 C 003490       03 F101                PICTURE XX.                          RON
00349 C 003500       03 F102                PICTURE X(4).                        RON
00350 C 003510       03 F103.                                                    RON
00351 C 003520          04  F10301          PICTURE X.                           RON
00352 C 003530          04  F10302          PICTURE X.                           RON
00353 C 003540          04  F10303          PICTURE X.                           RON
00354 C 003550       03 F104                PICTURE XXX.                         RON
00355 C 003560       03 F105                PICTURE XXX.                         RON
00356 C 003570       03 F106.                                                    RON
00357 C 003580          04  FILLER          PICTURE XX.                          RON
00358 C 003590          04  F10601          PICTURE X.                           RON
00359 C 003600                                                                   RON
00360 C 003610                                                                   RON
00361 C 003620      02  AAA.                                                    RON
00362 C 003630                                                                   RON
00363 C 003640       03 F107                PICTURE X.                           RON
00364 C 003650       03 F108                PICTURE X.                           RON
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00365 C 003660       03 F109                PICTURE X.                    RON
00366 C 003670       03 F110                PICTURE X.                    RON
00367 C 003680       03 F111                PICTURE X.                    RON
00368 C 003690       03 F112                PICTURE X.                    RON
00369 C 003700       03 F113                PICTURE X.                    RON
00370 C 003710       03 F114                PICTURE X.                    RON
00371 C 003720       03 F115                PICTURE X.                    RON
00372 C 003730       03 F116                PICTURE X.                    RON
00373 C 003740       03 F117                PICTURE X.                    RON
00374 C 003750       03 F118                PICTURE X.                    RON
00375 C 003760       03 F119                PICTURE X.                    RON
00376 C 003770                                                            RON
00377 C 003780                                                            RON
00378 C 003790     02  DUM3.                                              RON
00379 C 003800                                                            RON
00380 C 003810      03 FILLER               PICTURE X(20).                RON
00381 C 003820                                                            RON
00382 C 003830                                                            RON
00383 C 003840     02  FLIGHT-DATA.                                       RON
00384 C 003850                                                            RON
00385 C 003860      03 F120.                                              RON
00386 C 003870          04  FILLER         PICTURE XXX.                  RON
00387 C 003880          04  F12001         PICTURE X.                    RON
00388 C 003890      03 F121.                                              RON
00389 C 003900          04  FILLER         PICTURE XXX.                  RON
00390 C 003910          04  F12101         PICTURE X.                    RON
00391 C 003920      03 F122                PICTURE XXX.                  RON
00392 C 003930      03 F123                PICTURE XX.                   RON
00393 C 003940      03 F124.                                              RON
00394 C 003950          04  FILLER         PICTURE XXX.                  RON
00395 C 003960          04  F12401         PICTURE X.                    RON
00396 C 003970      03 F125.                                              RON
00397 C 003980          04  F12501.                                      RON
00398 C 003990              05  FILLER         PICTURE X.                RON
00399 C 004000              05  F1250101       PICTURE X.                RON
00400 C 004010          04  F12502.                                      RON
00401 C 004020              05  FILLER         PICTURE XX.               RON
00402 C 004030              05  F1250201       PICTURE X.                RON
00403 C 004040          04  F12503.                                      RON
00404 C 004050              05  FILLER         PICTURE XX.               RON
00405 C 004060              05  F1250301       PICTURE X.                RON
00406 C 004070      03 F126.                                              RON
00407 C 004080          04  FILLER         PICTURE X.                    RON
00408 C 004090          04  F12601         PICTURE X.                    RON
00409 C 004100      03 F127.                                              RON
00410 C 004110          04  FILLER         PICTURE X.                    RON
00411 C 004120          04  F12701         PICTURE X.                    RON
00412 C 004130      03 F128                PICTURE XX.                   RON
00413 C 004140      03 F129.                                              RON
00414 C 004150          04  FILLER         PICTURE X(16).                RON
00415 C 004160          04  F12901         PICTURE X.                    RON
00416 C 004170      03 F130.                                              RON
00417 C 004180          04  FILLER         PICTURE X(9).                 RON
00418 C 004190          04  F13001         PICTURE X.                    RON
00419 C 004200      03 FILLER              PICTURE X(4).                 RON
00420 C 004210                                                            RON
00421 C 004220                                                            RON
00422 C 004230     02  HUMAN-FACTORS.                                     RON
00423 C 004240                                                            RON
00424 C 004250      03 F131.                                              RON
00425 C 004260          04  F13101         PICTURE X.                    RON
00426 C 004270          04  F13102         PICTURE X.                    RON
00427 C 004280          04  F13103         PICTURE X.                    RON
00428 C 004290          04  F13104         PICTURE X.                    RON
00429 C 004300      03 F132                PICTURE XX.                   RON
00430 C 004310      03 F133.                                              RON
00431 C 004320          04  F13301         PICTURE X.                    RON
00432 C 004330          04  F13302.                                      RON
00433 C 004340              05  FILLER         PICTURE X.                RON
00434 C 004350              05  F1330201       PICTURE X.                RON
00435 C 004360      03 F134                PICTURE X.                    RON
00436 C 004370      03 F135                PICTURE X.                    RON
00437 C 004380      03 F136.                                              RON
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00438 C 004390          04  FILLER          PICTURE XXX.          RON
00439 C 004400          04  F13601          PICTURE X.            RON
00440 C 004410       03 F137.                                     RON
00441 C 004420          04  F13701          PICTURE X.            RON
00442 C 004430          04  F13702          PICTURE X.            RON
00443 C 004440          04  F13703          PICTURE X.            RON
00444 C 004450          04  F13704          PICTURE X.            RON
00445 C 004460          04  F13705          PICTURE X.            RON
00446 C 004470       03 F138                 PICTURE X.            RON
00447 C 004480       03 F139.                                     RON
00448 C 004490          04  FILLER          PICTURE XX.           RON
00449 C 004500          04  F13901          PICTURE X.            RON
00450 C 004510       03 F140.                                     RON
00451 C 004520          04  FILLER          PICTURE XX.           RON
00452 C 004530          04  F14001          PICTURE X.            RON
00453 C 004540       03 F141.                                     RON
00454 C 004550          04  FILLER          PICTURE XX.           RON
00455 C 004560          04  F14101          PICTURE X.            RON
00456 C 004570       03 F142                 PICTURE X.            RON
00457 C 004580       03 F143                 PICTURE X.            RON
00458 C 004590       03 F144                 PICTURE X.            RON
00459 C 004600       03 F145                 PICTURE X.            RON
00460 C 004610       03 F146                 PICTURE X.            RON
00461 C 004620       03 F147                 PICTURE X.            RON
00462 C 004630       03 F148.                                     RON
00463 C 004640          04  F14801          PICTURE X.            RON
00464 C 004650          04  F14802          PICTURE X.            RON
00465 C 004660          04  F14803          PICTURE X.            RON
00466 C 004670          04  F14804          PICTURE X.            RON
00467 C 004680       03 F149.                                     RON
00468 C 004690          04  F14901.                              RON
00469 C 004700              05  FILLER      PICTURE XX.           RON
00470 C 004710              05  F1490101    PICTURE X.            RON
00471 C 004720          04  F14902.                              RON
00472 C 004730              05  FILLER      PICTURE XX.           RON
00473 C 004740              05  F1490201    PICTURE X.            RON
00474 C 004750       03 F150                 PICTURE X.            RON
00475 C 004760       03 F151.                                     RON
00476 C 004770          04  F15101          PICTURE X.            RON
00477 C 004780          04  F15102          PICTURE X.            RON
00478 C 004790          04  F15103          PICTURE X.            RON
00479 C 004800       03 F152.                                     RON
00480 C 004810          04  FILLER          PICTURE XX.           RON
00481 C 004820          04  F15201          PICTURE X.            RON
00482 C 004830       03 F153                 PICTURE X.            RON
00483 C 004840       03 FILLER               PICTURE X(7).         RON
00484 C 004850                                                    RON
00485 C 004860                                                    RON
00486 C 004870    02 FIRE-INFO.                                   RON
00487 C 004880                                                    RON
00488 C 004890       03 F154                 PICTURE X.            RON
00489 C 004900       03 F155                 PICTURE X.            RON
00490 C 004910       03 F156                 PICTURE X.            RON
00491 C 004920       03 F157                 PICTURE X.            RON
00492 C 004930       03 F158.                                     RON
00493 C 004940          04  F15801          PICTURE X.            RON
00494 C 004950          04  F15802.                              RON
00495 C 004960              05  F1580201    PICTURE X.            RON
00496 C 004970              05  F1580202    PICTURE X.            RON
00497 C 004980          04  F15803.                              RON
00498 C 004990              05  F1580301    PICTURE X.            RON
00499 C 005000              05  F1580302    PICTURE X.            RON
00500 C 005010       03 F159                 PICTURE X.            RON
00501 C 005020       03 F160                 PICTURE X.            RON
00502 C 005030       03 F161.                                     RON
00503 C 005040          04  F16101          PICTURE X.            RON
00504 C 005050          04  F16102          PICTURE X.            RON
00505 C 005060                                                    RON
00506 C 005070                                                    RON
00507 C 005080    02 EQUIP.                                       RON
00508 C 005090                                                    RON
00509 C 005100       03 F162                 PICTURE X.            RON
00510 C 005110       03 F163                 PICTURE X.            RON
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00511 C 005120      03 F164.                                                    RON
00512 C 005130          04  F16401          PICTURE X.                         RON
00513 C 005140          04  F16402          PICTURE X.                         RON
00514 C 005150      03 F165                  PICTURE X.                         RON
00515 C 005160      03 F166                  PICTURE X.                         RON
00516 C 005170                                                                  RON
00517 C 005180                                                                  RON
00518 C 005190      02 W-B-DAMAGE.                                              RON
00519 C 005200                                                                  RON
00520 C 005210      03 F167                  PICTURE X.                         RON
00521 C 005220      03 F168                  PICTURE X.                         RON
00522 C 005230      03 F169                  PICTURE X.                         RON
00523 C 005240      03 F170                  PICTURE X.                         RON
00524 C 005250      03 F171                  PICTURE X.                         RON
00525 C 005260      03 F172                  PICTURE X.                         RON
00526 C 005270      03 F173                  PICTURE X.                         RON
00527 C 005280      03 F174.                                                    RON
00528 C 005290          04  F17401          PICTURE X.                         RON
00529 C 005300          04  F17402          PICTURE X.                         RON
00530 C 005310      03 F175                  PICTURE X.                         RON
00531 C 005320      03 F176                  PICTURE X.                         RON
00532 C 005330      03 F177.                                                    RON
00533 C 005340          04  F17701          PICTURE X.                         RON
00534 C 005350          04  F17702          PICTURE X.                         RON
00535 C 005360      03 F178                  PICTURE X.                         RON
00536 C 005370      03 F179                  PICTURE X.                         RON
00537 C 005380      03 F180                  PICTURE X.                         RON
00538 C 005390      03 F181                  PICTURE X.                         RON
00539 C 005400      03 F182                  PICTURE X.                         RON
00540 C 005410      03 F183                  PICTURE X.                         RON
00541 C 005420                                                                  RON
00542 C 005430                                                                  RON
00543 C 005440      02  DUM4.                                                   RON
00544 C 005450                                                                  RON
00545 C 005460      03 FILLER                PICTURE X(23).                     RON
00546 C 005470      03 FILLER                PICTURE X(20).                     RON
00547 C 005480                                                                  RON
00548 C 005490                                                                  RON
00549 C 005500      02  ADMIN-DATA.                                            RON
00550 C 005510                                                                  RON
00551 C 005520      03 FILLER                PICTURE XXX.                       RON
00552 C 005530      03 F184                  PICTURE X(12).                     RON
00553 C 005540      03 F185                  PICTURE X(6).                      RON
00554 C 005550      03 F186     OCCURS 3 TIMES.                                 RON
00555 C 005560          04  F18601          PICTURE 99.                        RON
00556 C 005570          04  F18602          PICTURE XX.                        RON
00557 C 005580          04  F18603          PICTURE XX.                        RON
00558 C 005590      03 F187                  PICTURE 99.                        RON
00559 C 005600      03 F188                  PICTURE XXX.                       RON
00560 C 005610      03 F189                  PICTURE X(13).                     RON
00561 C 005620                                                                  RON
00562 C 005630                                                                  RON
00563 C 005640      02  IDN.                                                   RON
00564 C 005650                                                                  RON
00565 C 005660      03 F190                  PICTURE X(4).                      RON
00566 C 005670                                                                  RON
00567 C 005680                                                                  RON
00568 C 005690      02  DUM5.                                                  RON
00569 C 005700                                                                  RON
00570 C 005710      03 FILLER                PICTURE X(20).                     RON
00571 C 005720                                                                  RON
00572 C 005730                                                                  RON
00573 C 005740      02  AERIAL-APP.                                            RON
00574 C 005750                                                                  RON
00575 C 005760      03 F191.                                                    RON
00576 C 005770          04  FILLER          PICTURE XXX.                       RON
00577 C 005780          04  F19101          PICTURE X.                         RON
00578 C 005790      03 F192                  PICTURE X.                         RON
00579 C 005800      03 F193                  PICTURE X.                         RON
00580 C 005810      03 F194                  PICTURE X.                         RON
00581 C 005820      03 F195                  PICTURE X.                         RON
00582 C 005830      03 F196                  PICTURE X.                         RON
00583 C 005840      03 F197                  PICTURE X.                         RON
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00584 C 005850      03 F198                    PICTURE X.                    RON
00585 C 005860      03 F199                    PICTURE X.                    RON
00586 C 005870      03 F200                    PICTURE X.                    RON
00587 C 005880      03 F201                    PICTURE X.                    RON
00588 C 005890      03 F202                    PICTURE X.                    RON
00589 C 005900      03 F203                    PICTURE X.                    RON
00590 C 005910      03 F204                    PICTURE X.                    RON
00591 C 005920      03 F205                    PICTURE X.                    RON
00592 C 005930      03 F206                    PICTURE X.                    RON
00593 C 005940      03 F207                    PICTURE X.                    RON
00594 C 005950      03 F208                    PICTURE X(5).                 RON
00595 C 005960      03 F209.                                                 RON
00596 C 005970          04  F20901             PICTURE X.                    RON
00597 C 005980          04  F20902             PICTURE X.                    RON
00598 C 005990          04  F20903             PICTURE X.                    RON
00599 C 006000      03 F210.                                                 RON
00600 C 006010          04  F21001             PICTURE X.                    RON
00601 C 006020          04  F21002             PICTURE X.                    RON
00602 C 006030          04  F21003             PICTURE X.                    RON
00603 C 006040      03 F211                    PICTURE X.                    RON
00604 C 006050      03 F212                    PICTURE X.                    RON
00605 C 006060                                                               RON
00606 C 006070                                                               RON
00607 C 006080      02  DUM6.                                               RON
00608 C 006090                                                               RON
00609 C 006100       03 FILLER                 PICTURE X(28).                RON
00610 C 006110       03 FILLER                 PICTURE X(20).                RON
00611 C 006120                                                               RON
00612 C 006130                                                               RON
00613 C 006140      02  COL.                                                RON
00614 C 006150                                                               RON
00615 C 006160       03 F213                   PICTURE X.                    RON
00616 C 006170       03 F214                   PICTURE X.                    RON
00617 C 006180       03 F215                   PICTURE X.                    RON
00618 C 006190       03 F216                   PICTURE X.                    RON
00619 C 006200       03 F217                   PICTURE X.                    RON
00620 C 006210       03 F218                   PICTURE X.                    RON
00621 C 006220       03 F219                   PICTURE X.                    RON
00622 C 006230       03 F220                   PICTURE XXX.                  RON
00623 C 006240       03 F221                   PICTURE XXX.                  RON
00624 C 006250       03 F222.                                                RON
00625 C 006260           04  F22201            PICTURE XXX.                  RON
00626 C 006270           04  F22202            PICTURE XXX.                  RON
00627 C 006280       03 F223                   PICTURE X.                    RON
00628 C 006290       03 F224                   PICTURE X.                    RON
00629 C 006300       03 F225                   PICTURE X.                    RON
00630 C 006310       03 F226                   PICTURE X.                    RON
00631 C 006320       03 F227                   PICTURE X.                    RON
00632 C 006330                                                               RON
00633 C 006340                                                               RON
00634 C 006350      02  DUM7.                                               RON
00635 C 006360                                                               RON
00636 C 006370       03 FILLER                 PICTURE X(37).                RON
00637 C 006380                                                               RON
00638 C 006390                                                               RON
00639 C 006400      02  DITCH-SURVIVAL.                                     RON
00640 C 006410                                                               RON
00641 C 006420       03 F228                   PICTURE X.                    RON
00642 C 006430       03 F229                   PICTURE XX.                   RON
00643 C 006440       03 F230.                                                RON
00644 C 006450           04  F23001            PICTURE XX.                   RON
00645 C 006460           04  F23002            PICTURE XXX.                  RON
00646 C 006470       03 F231                   PICTURE X.                    RON
00647 C 006480       03 F232                   PICTURE X.                    RON
00648 C 006490       03 FILLER                 PICTURE X.                    RON
00649 C 006500       03 F233                   PICTURE X.                    RON
00650 C 006510       03 F234                   PICTURE X.                    RON
00651 C 006520       03 F235                   PICTURE X.                    RON
00652 C 006530       03 F236                   PICTURE X.                    RON
00653 C 006540       03 F237                   PICTURE X.                    RON
00654 C 006550       03 F238                   PICTURE X.                    RON
00655 C 006560       03 F239                   PICTURE X.                    RON
00656 C 006570      02  DUM8.                                               RON
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00657 C 006580          03 FILLER                    PICTURE X(127).                  RON
00658   006600 FD  NTSB-TAPE
00659   006700     RECORDING MODE IS F
00660   006800     LABEL RECORDS ARE OMITTED
00661   006900     DATA RECORD IS NTSB-OUT.
00662   007000 01  NTSB-OUT          PIC X(1600).
00663   007100 WORKING-STORAGE SECTION.
00664   007200 77  HISAVE      PIC 9(3) VALUE 455.
00665   007300 77  HI       PIC 9(3).
00666   007400 77  LO           PIC 9(3) VALUE ZERO.
00667   007500 77  I            PIC 9(3).
00668   007600 77  SEARCH-WORD PIC X(11).
00669   007700 77  FOUND-WORD  PIC X VALUE ZERO.
00670   007800 77  REPLY-77     PIC X(4).
00671   007900 01  NTSB-WORK-01.
00672   008000     02  NTSB-WORK    PIC X(1600).
00673   008100 01  FIELD-01.
00674   008200     02  FIELD-1 PIC X(3).
00675   008300     02  FIELD-3      PIC XX.
00676   008400     02  FIELD-2 PIC X(6).
00677   008500 01  MK-MOD-01.
00678   008600     02  MK-MOD-02.
00679   008700         03  FILLER   PIC X(11) VALUE   '00201100    '.
00680   008800         03  FILLER   PIC X(11) VALUE   '00201500    '.
00681   008900         03  FILLER   PIC X(11) VALUE   '00201500-A  '.
00682   009000         03  FILLER   PIC X(11) VALUE   '00201500-B  '.
00683   009100         03  FILLER   PIC X(11) VALUE   '00201500-S  '.
00684   009200         03  FILLER   PIC X(11) VALUE   '00201500B   '.
00685   009300         03  FILLER   PIC X(11) VALUE   '00201500S   '.
00686   009400         03  FILLER   PIC X(11) VALUE   '00201560    '.
00687   009500         03  FILLER   PIC X(11) VALUE   '00201560-A  '.
00688   009600         03  FILLER   PIC X(11) VALUE   '00201560-E  '.
00689   009700         03  FILLER   PIC X(11) VALUE   '00201560A   '.
00690   009800         03  FILLER   PIC X(11) VALUE   '00201560E   '.
00691   009900         03  FILLER   PIC X(11) VALUE   '00202560-F  '.
00692   010000         03  FILLER   PIC X(11) VALUE   '00202560F   '.
00693   010100         03  FILLER   PIC X(11) VALUE   '00202680    '.
00694   010200         03  FILLER   PIC X(11) VALUE   '00202680-E  '.
00695   010300         03  FILLER   PIC X(11) VALUE   '00202680-F  '.
00696   010400         03  FILLER   PIC X(11) VALUE   '00202680-FL '.
00697   010500         03  FILLER   PIC X(11) VALUE   '00202680-V  '.
00698   010600         03  FILLER   PIC X(11) VALUE   '00202680E   '.
00699   010700         03  FILLER   PIC X(11) VALUE   '00202680F   '.
00700   010800         03  FILLER   PIC X(11) VALUE   '00202680FL  '.
00701   010900         03  FILLER   PIC X(11) VALUE   '00202680FLP '.
00702   011000         03  FILLER   PIC X(11) VALUE   '00202680FP  '.
00703   011100         03  FILLER   PIC X(11) VALUE   '00202680S   '.
00704   011200         03  FILLER   PIC X(11) VALUE   '00202680T   '.
00705   011300         03  FILLER   PIC X(11) VALUE   '00202680V   '.
00706   011400         03  FILLER   PIC X(11) VALUE   '00202680W   '.
00707   011500         03  FILLER   PIC X(11) VALUE   '00202681    '.
00708   011600         03  FILLER   PIC X(11) VALUE   '00202690    '.
00709   011700         03  FILLER   PIC X(11) VALUE   '00202690A   '.
00710   011800         03  FILLER   PIC X(11) VALUE   '00205112    '.
00711   011900         03  FILLER   PIC X(11) VALUE   '00312 7ECA  '.
00712   012000         03  FILLER   PIC X(11) VALUE   '00312S-7CCM '.
00713   012100         03  FILLER   PIC X(11) VALUE   '00312S7BCM  '.
00714   012200         03  FILLER   PIC X(11) VALUE   '00312S7EC   '.
00715   012300         03  FILLER   PIC X(11) VALUE   '00312?AC    '.
00716   012400         03  FILLER   PIC X(11) VALUE   '00312?ACA   '.
00717   012500         03  FILLER   PIC X(11) VALUE   '00312?ACM   '.
00718   012600         03  FILLER   PIC X(11) VALUE   '00312?BC    '.
00719   012700         03  FILLER   PIC X(11) VALUE   '00312?BCM   '.
00720   012800         03  FILLER   PIC X(11) VALUE   '00312?CCM   '.
00721   012900         03  FILLER   PIC X(11) VALUE   '00312?CGAA  '.
00722   013000         03  FILLER   PIC X(11) VALUE   '00312?DC    '.
00723   013100         03  FILLER   PIC X(11) VALUE   '00312?EAC   '.
00724   013200         03  FILLER   PIC X(11) VALUE   '00312?EC    '.
00725   013300         03  FILLER   PIC X(11) VALUE   '00312?ECA   '.
00726   013400         03  FILLER   PIC X(11) VALUE   '00312?FC    '.
00727   013500         03  FILLER   PIC X(11) VALUE   '00312?GC    '.
00728   013600         03  FILLER   PIC X(11) VALUE   '00312?GC-AA '.
00729   013700         03  FILLER   PIC X(11) VALUE   '00312?GCA   '.
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00730  009800  03  FILLER  PIC X(11)  VALUE  '003127GCAA  '.
00731  009900  03  FILLER  PIC X(11)  VALUE  '003127GCB   '.
00732  010000  03  FILLER  PIC X(11)  VALUE  '003127GCBA  '.
00733  010100  03  FILLER  PIC X(11)  VALUE  '003127GCBC  '.
00734  010200  03  FILLER  PIC X(11)  VALUE  '003127HC    '.
00735  010300  03  FILLER  PIC X(11)  VALUE  '003127KC-AB '.
00736  010400  03  FILLER  PIC X(11)  VALUE  '003127KCAB  '.
00737  010500  03  FILLER  PIC X(11)  VALUE  '003198KCAB  '.
00738  010600  03  FILLER  PIC X(11)  VALUE  '02217C-18S  '.
00739  010700  03  FILLER  PIC X(11)  VALUE  '02217C18S   '.
00740  010800  03  FILLER  PIC X(11)  VALUE  '02217D-18-S '.
00741  010900  03  FILLER  PIC X(11)  VALUE  '02217D-18S  '.
00742  011000  03  FILLER  PIC X(11)  VALUE  '02217D18    '.
00743  011100  03  FILLER  PIC X(11)  VALUE  '02217D18C   '.
00744  011200  03  FILLER  PIC X(11)  VALUE  '02217D18S   '.
00745  011300  03  FILLER  PIC X(11)  VALUE  '02217D185   '.
00746  011400  03  FILLER  PIC X(11)  VALUE  '02217E18    '.
00747  011500  03  FILLER  PIC X(11)  VALUE  '02217E18E   '.
00748  011600  03  FILLER  PIC X(11)  VALUE  '02217E18S   '.
00749  011700  03  FILLER  PIC X(11)  VALUE  '02217G-18-S '.
00750  011800  03  FILLER  PIC X(11)  VALUE  '02217G18S   '.
00751  011900  03  FILLER  PIC X(11)  VALUE  '02217H18    '.
00752  012000  03  FILLER  PIC X(11)  VALUE  '02217H18S   '.
00753  012100  03  FILLER  PIC X(11)  VALUE  '0221718     '.
00754  012200  03  FILLER  PIC X(11)  VALUE  '02220A-36   '.
00755  012300  03  FILLER  PIC X(11)  VALUE  '02220A33    '.
00756  012400  03  FILLER  PIC X(11)  VALUE  '02220A36    '.
00757  012500  03  FILLER  PIC X(11)  VALUE  '02220BE33   '.
00758  012600  03  FILLER  PIC X(11)  VALUE  '02220B35    '.
00759  012700  03  FILLER  PIC X(11)  VALUE  '02220C35    '.
00760  012800  03  FILLER  PIC X(11)  VALUE  '02220D35    '.
00761  012900  03  FILLER  PIC X(11)  VALUE  '02220E33    '.
00762  013000  03  FILLER  PIC X(11)  VALUE  '02220E33A   '.
00763  013100  03  FILLER  PIC X(11)  VALUE  '02220F33    '.
00764  013200  03  FILLER  PIC X(11)  VALUE  '02220F33A   '.
00765  013300  03  FILLER  PIC X(11)  VALUE  '02220G33    '.
00766  013400  03  FILLER  PIC X(11)  VALUE  '02220H-35   '.
00767  013500  03  FILLER  PIC X(11)  VALUE  '02220H35    '.
00768  013600  03  FILLER  PIC X(11)  VALUE  '02220J35    '.
00769  013700  03  FILLER  PIC X(11)  VALUE  '02220K35    '.
00770  013800  03  FILLER  PIC X(11)  VALUE  '02220M-35   '.
00771  013900  03  FILLER  PIC X(11)  VALUE  '02220M35    '.
00772  014000  03  FILLER  PIC X(11)  VALUE  '02220M35B   '.
00773  014100  03  FILLER  PIC X(11)  VALUE  '02220N35    '.
00774  014200  03  FILLER  PIC X(11)  VALUE  '02220P-35   '.
00775  014300  03  FILLER  PIC X(11)  VALUE  '02220P35    '.
00776  014400  03  FILLER  PIC X(11)  VALUE  '02220S-35   '.
00777  014500  03  FILLER  PIC X(11)  VALUE  '02220S35    '.
00778  014600  03  FILLER  PIC X(11)  VALUE  '02220V35    '.
00779  014700  03  FILLER  PIC X(11)  VALUE  '02220V35-TC '.
00780  014800  03  FILLER  PIC X(11)  VALUE  '02220V35A   '.
00781  014900  03  FILLER  PIC X(11)  VALUE  '02220V35ATC '.
00782  015000  03  FILLER  PIC X(11)  VALUE  '02220V35B   '.
00783  015100  03  FILLER  PIC X(11)  VALUE  '02220V35TC  '.
00784  015200  03  FILLER  PIC X(11)  VALUE  '0222033     '.
00785  015300  03  FILLER  PIC X(11)  VALUE  '0222035     '.
00786  015400  03  FILLER  PIC X(11)  VALUE  '0222035-A33 '.
00787  015500  03  FILLER  PIC X(11)  VALUE  '0222035-B33 '.
00788  015600  03  FILLER  PIC X(11)  VALUE  '0222035-C33 '.
00789  015700  03  FILLER  PIC X(11)  VALUE  '0222035-E33 '.
00790  015800  03  FILLER  PIC X(11)  VALUE  '0222035-G33 '.
00791  015900  03  FILLER  PIC X(11)  VALUE  '0222035-33  '.
00792  016000  03  FILLER  PIC X(11)  VALUE  '0222035B33  '.
00793  016100  03  FILLER  PIC X(11)  VALUE  '0222035C33A '.
00794  016200  03  FILLER  PIC X(11)  VALUE  '0222035S    '.
00795  016300  03  FILLER  PIC X(11)  VALUE  '0222036     '.
00796  016400  03  FILLER  PIC X(11)  VALUE  '02222A55    '.
00797  016500  03  FILLER  PIC X(11)  VALUE  '02223A65    '.
00798  016600  03  FILLER  PIC X(11)  VALUE  '02223A65-88 '.
00799  016700  03  FILLER  PIC X(11)  VALUE  '02223A90    '.
00800  016800  03  FILLER  PIC X(11)  VALUE  '02223BE65   '.
00801  016900  03  FILLER  PIC X(11)  VALUE  '02223B80    '.
00802  017000  03  FILLER  PIC X(11)  VALUE  '02223B90    '.
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00803  017100      03  FILLER  PIC X(11)  VALUE  '02223C90   '.
00804  017200      03  FILLER  PIC X(11)  VALUE  '02223E90   '.
00805  017300      03  FILLER  PIC X(11)  VALUE  '0222365    '.
00806  017400      03  FILLER  PIC X(11)  VALUE  '0222365-A80'.
00807  017500      03  FILLER  PIC X(11)  VALUE  '0222365-A90'.
00808  017600      03  FILLER  PIC X(11)  VALUE  '0222365-B80'.
00809  017700      03  FILLER  PIC X(11)  VALUE  '0222365-80 '.
00810  017800      03  FILLER  PIC X(11)  VALUE  '0222365-88 '.
00811  017900      03  FILLER  PIC X(11)  VALUE  '0222365A90 '.
00812  018000      03  FILLER  PIC X(11)  VALUE  '0222365S   '.
00813  018100      03  FILLER  PIC X(11)  VALUE  '0222370    '.
00814  018200      03  FILLER  PIC X(11)  VALUE  '0222390    '.
00815  018300      03  FILLER  PIC X(11)  VALUE  '02224B55   '.
00816  018400      03  FILLER  PIC X(11)  VALUE  '02224B55-95'.
00817  018500      03  FILLER  PIC X(11)  VALUE  '02224C55   '.
00818  018600      03  FILLER  PIC X(11)  VALUE  '02224D55   '.
00819  018700      03  FILLER  PIC X(11)  VALUE  '02224E55   '.
00820  018800      03  FILLER  PIC X(11)  VALUE  '02224E58   '.
00821  018900      03  FILLER  PIC X(11)  VALUE  '0222455    '.
00822  019000      03  FILLER  PIC X(11)  VALUE  '0222456T   '.
00823  019100      03  FILLER  PIC X(11)  VALUE  '0222456TC  '.
00824  019200      03  FILLER  PIC X(11)  VALUE  '022245B    '.
00825  019300      03  FILLER  PIC X(11)  VALUE  '02225A-23  '.
00826  019400      03  FILLER  PIC X(11)  VALUE  '02225A-23A '.
00827  019500      03  FILLER  PIC X(11)  VALUE  '02225A19   '.
00828  019600      03  FILLER  PIC X(11)  VALUE  '02225A23   '.
00829  019700      03  FILLER  PIC X(11)  VALUE  '02225A23-19'.
00830  019800      03  FILLER  PIC X(11)  VALUE  '02225A23-24'.
00831  019900      03  FILLER  PIC X(11)  VALUE  '02225A23A  '.
00832  020000      03  FILLER  PIC X(11)  VALUE  '02225A24R  '.
00833  020100      03  FILLER  PIC X(11)  VALUE  '02225B-23  '.
00834  020200      03  FILLER  PIC X(11)  VALUE  '02225BE-23 '.
00835  020300      03  FILLER  PIC X(11)  VALUE  '02225BE23  '.
00836  020400      03  FILLER  PIC X(11)  VALUE  '02225B19   '.
00837  020500      03  FILLER  PIC X(11)  VALUE  '02225B23   '.
00838  020600      03  FILLER  PIC X(11)  VALUE  '02225B23-19'.
00839  020700      03  FILLER  PIC X(11)  VALUE  '02225C-23  '.
00840  020800      03  FILLER  PIC X(11)  VALUE  '02225C23   '.
00841  020900      03  FILLER  PIC X(11)  VALUE  '02225M-23  '.
00842  021000      03  FILLER  PIC X(11)  VALUE  '0222519    '.
00843  021100      03  FILLER  PIC X(11)  VALUE  '02225194   '.
00844  021200      03  FILLER  PIC X(11)  VALUE  '0222523    '.
00845  021300      03  FILLER  PIC X(11)  VALUE  '0222523-19 '.
00846  021400      03  FILLER  PIC X(11)  VALUE  '0222523-19A'.
00847  021500      03  FILLER  PIC X(11)  VALUE  '02226A60   '.
00848  021600      03  FILLER  PIC X(11)  VALUE  '0222660    '.
00849  021700      03  FILLER  PIC X(11)  VALUE  '02227A99A  '.
00850  021800      03  FILLER  PIC X(11)  VALUE  '02227B99   '.
00851  021900      03  FILLER  PIC X(11)  VALUE  '02227100   '.
00852  022000      03  FILLER  PIC X(11)  VALUE  '0222799    '.
00853  022100      03  FILLER  PIC X(11)  VALUE  '0222799A   '.
00854  022200      03  FILLER  PIC X(11)  VALUE  '03405B-1   '.
00855  022300      03  FILLER  PIC X(11)  VALUE  '03405B-1A  '.
00856  022400      03  FILLER  PIC X(11)  VALUE  '03912  150 '.
00857  022500      03  FILLER  PIC X(11)  VALUE  '03912A150  '.
00858  022600      03  FILLER  PIC X(11)  VALUE  '03912A150-K'.
00859  022700      03  FILLER  PIC X(11)  VALUE  '03912A150K '.
00860  022800      03  FILLER  PIC X(11)  VALUE  '03912A150K '.
00861  022900      03  FILLER  PIC X(11)  VALUE  '03912A150L '.
00862  023000      03  FILLER  PIC X(11)  VALUE  '03912150F  '.
00863  023100      03  FILLER  PIC X(11)  VALUE  '03912150K  '.
00864  023200      03  FILLER  PIC X(11)  VALUE  '03912150   '.
00865  023300      03  FILLER  PIC X(11)  VALUE  '03912150A  '.
00866  023400      03  FILLER  PIC X(11)  VALUE  '03912150B  '.
00867  023500      03  FILLER  PIC X(11)  VALUE  '03912150C  '.
00868  023600      03  FILLER  PIC X(11)  VALUE  '03912150C  '.
00869  023700      03  FILLER  PIC X(11)  VALUE  '03912150E  '.
00870  023800      03  FILLER  PIC X(11)  VALUE  '03912150F  '.
00871  023900      03  FILLER  PIC X(11)  VALUE  '03912150G  '.
00872  024000      03  FILLER  PIC X(11)  VALUE  '03912150H  '.
00873  024100      03  FILLER  PIC X(11)  VALUE  '03912150J  '.
00874  024200      03  FILLER  PIC X(11)  VALUE  '03912150K  '.
00875  024300      03  FILLER  PIC X(11)  VALUE  '03912150L  '.
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00876  024400      03  FILLER  PIC X(11)  VALUE  '03914172   '.
00877  024500      03  FILLER  PIC X(11)  VALUE  '03914172A  '.
00878  024600      03  FILLER  PIC X(11)  VALUE  '03914172B  '.
00879  024700      03  FILLER  PIC X(11)  VALUE  '03914172C  '.
00880  024800      03  FILLER  PIC X(11)  VALUE  '03914172D  '.
00881  024900      03  FILLER  PIC X(11)  VALUE  '03914172E  '.
00882  025000      03  FILLER  PIC X(11)  VALUE  '03914172F  '.
00883  025100      03  FILLER  PIC X(11)  VALUE  '03914172G  '.
00884  025200      03  FILLER  PIC X(11)  VALUE  '03914172H  '.
00885  025300      03  FILLER  PIC X(11)  VALUE  '039141721  '.
00886  025400      03  FILLER  PIC X(11)  VALUE  '03914172K  '.
00887  025500      03  FILLER  PIC X(11)  VALUE  '03914172L  '.
00888  025600      03  FILLER  PIC X(11)  VALUE  '03914172M  '.
00889  025700      03  FILLER  PIC X(11)  VALUE  '03914172S  '.
00890  025800      03  FILLER  PIC X(11)  VALUE  '03914177   '.
00891  025900      03  FILLER  PIC X(11)  VALUE  '03916150   '.
00892  026000      03  FILLER  PIC X(11)  VALUE  '03916180   '.
00893  026100      03  FILLER  PIC X(11)  VALUE  '03916180A  '.
00894  026200      03  FILLER  PIC X(11)  VALUE  '03916180B  '.
00895  026300      03  FILLER  PIC X(11)  VALUE  '03916180C  '.
00896  026400      03  FILLER  PIC X(11)  VALUE  '03916180D  '.
00897  026500      03  FILLER  PIC X(11)  VALUE  '03916180E  '.
00898  026600      03  FILLER  PIC X(11)  VALUE  '03916180F  '.
00899  026700      03  FILLER  PIC X(11)  VALUE  '03916180G  '.
00900  026800      03  FILLER  PIC X(11)  VALUE  '03916180H  '.
00901  026900      03  FILLER  PIC X(11)  VALUE  '03916180J  '.
00902  027000      03  FILLER  PIC X(11)  VALUE  '039161821  '.
00903  027100      03  FILLER  PIC X(11)  VALUE  '03916182L  '.
00904  027200      03  FILLER  PIC X(11)  VALUE  '03917180   '.
00905  027300      03  FILLER  PIC X(11)  VALUE  '03917182   '.
00906  027400      03  FILLER  PIC X(11)  VALUE  '03917182-E '.
00907  027500      03  FILLER  PIC X(11)  VALUE  '03917182A  '.
00908  027600      03  FILLER  PIC X(11)  VALUE  '03917182B  '.
00909  027700      03  FILLER  PIC X(11)  VALUE  '03917182C  '.
00910  027800      03  FILLER  PIC X(11)  VALUE  '03917182D  '.
00911  027900      03  FILLER  PIC X(11)  VALUE  '03917182E  '.
00912  029000      03  FILLER  PIC X(11)  VALUE  '03917182F  '.
00913  028100      03  FILLER  PIC X(11)  VALUE  '03917182G  '.
00914  028200      03  FILLER  PIC X(11)  VALUE  '03917182H  '.
00915  028300      03  FILLER  PIC X(11)  VALUE  '03917182J  '.
00916  028400      03  FILLER  PIC X(11)  VALUE  '03917182K  '.
00917  028500      03  FILLER  PIC X(11)  VALUE  '03917182L  '.
00918  028600      03  FILLER  PIC X(11)  VALUE  '03917182M  '.
00919  028700      03  FILLER  PIC X(11)  VALUE  '03917182N  '.
00920  028800      03  FILLER  PIC X(11)  VALUE  '03917182P  '.
00921  028900      03  FILLER  PIC X(11)  VALUE  '03917182R  '.
00922  029000      03  FILLER  PIC X(11)  VALUE  '03917182S  '.
00923  029100      03  FILLER  PIC X(11)  VALUE  '03917185   '.
00924  029200      03  FILLER  PIC X(11)  VALUE  '03919T-210  '.
00925  029300      03  FILLER  PIC X(11)  VALUE  '03919T210   '.
00926  029400      03  FILLER  PIC X(11)  VALUE  '03919T210-H '.
00927  029500      03  FILLER  PIC X(11)  VALUE  '03919T210F  '.
00928  029600      03  FILLER  PIC X(11)  VALUE  '03919T210G  '.
00929  029700      03  FILLER  PIC X(11)  VALUE  '03919T210H  '.
00930  029800      03  FILLER  PIC X(11)  VALUE  '03919T210J  '.
00931  029900      03  FILLER  PIC X(11)  VALUE  '03919T210K  '.
00932  030000      03  FILLER  PIC X(11)  VALUE  '03919T210L  '.
00933  030100      03  FILLER  PIC X(11)  VALUE  '03919210    '.
00934  030200      03  FILLER  PIC X(11)  VALUE  '03919210-5  '.
00935  030300      03  FILLER  PIC X(11)  VALUE  '03919210A   '.
00936  030400      03  FILLER  PIC X(11)  VALUE  '03919210B   '.
00937  030500      03  FILLER  PIC X(11)  VALUE  '03919210C   '.
00938  030600      03  FILLER  PIC X(11)  VALUE  '03919210D   '.
00939  030700      03  FILLER  PIC X(11)  VALUE  '03919210E   '.
00940  030800      03  FILLER  PIC X(11)  VALUE  '03919210F   '.
00941  030900      03  FILLER  PIC X(11)  VALUE  '03919210G   '.
00942  031000      03  FILLER  PIC X(11)  VALUE  '03919210H   '.
00943  031100      03  FILLER  PIC X(11)  VALUE  '03919210J   '.
00944  031200      03  FILLER  PIC X(11)  VALUE  '03919210K   '.
00945  031300      03  FILLER  PIC X(11)  VALUE  '03919210L   '.
00946  031400      03  FILLER  PIC X(11)  VALUE  '03919210T   '.
00947  031500      03  FILLER  PIC X(11)  VALUE  '03922T310P  '.
00948  031600      03  FILLER  PIC X(11)  VALUE  '03922T310Q  '.
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00949  031700          03  FILLER  PIC X(11) VALUE  '039223100'.
00950  031800          03  FILLER  PIC X(11) VALUE  '03922310 '.
00951  031900          03  FILLER  PIC X(11) VALUE  '039223109'.
00952  032000          03  FILLER  PIC X(11) VALUE  '03922310B'.
00953  032100          03  FILLER  PIC X(11) VALUE  '03922310C'.
00954  032200          03  FILLER  PIC X(11) VALUE  '03922310D'.
00955  032300          03  FILLER  PIC X(11) VALUE  '03922310E'.
00956  032400          03  FILLER  PIC X(11) VALUE  '03922310G'.
00957  032500          03  FILLER  PIC X(11) VALUE  '03922310H'.
00958  032600          03  FILLER  PIC X(11) VALUE  '039223101'.
00959  032700          03  FILLER  PIC X(11) VALUE  '03922310J'.
00960  032800          03  FILLER  PIC X(11) VALUE  '03922310K'.
00961  032900          03  FILLER  PIC X(11) VALUE  '03922310L'.
00962  033000          03  FILLER  PIC X(11) VALUE  '03922310N'.
00963  033100          03  FILLER  PIC X(11) VALUE  '03922310P'.
00964  033200          03  FILLER  PIC X(11) VALUE  '039223100'.
00965  033300          03  FILLER  PIC X(11) VALUE  '03926A185E'.
00966  033400          03  FILLER  PIC X(11) VALUE  '03926A185F'.
00967  033500          03  FILLER  PIC X(11) VALUE  '039261850'.
00968  033600          03  FILLER  PIC X(11) VALUE  '03926185A'.
00969  033700          03  FILLER  PIC X(11) VALUE  '03926185B'.
00970  033800          03  FILLER  PIC X(11) VALUE  '03926185C'.
00971  033900          03  FILLER  PIC X(11) VALUE  '03926185D'.
00972  034000          03  FILLER  PIC X(11) VALUE  '03926185E'.
00973  034100          03  FILLER  PIC X(11) VALUE  '03926185F'.
00974  034200          03  FILLER  PIC X(11) VALUE  '03927340 '.
00975  034300          03  FILLER  PIC X(11) VALUE  '03929P206 '.
00976  034400          03  FILLER  PIC X(11) VALUE  '03929P206A'.
00977  034500          03  FILLER  PIC X(11) VALUE  '03929P206B'.
00978  034600          03  FILLER  PIC X(11) VALUE  '03929P206C'.
00979  034700          03  FILLER  PIC X(11) VALUE  '03929IP206 '.
00980  034800          03  FILLER  PIC X(11) VALUE  '03929IP206B'.
00981  034900          03  FILLER  PIC X(11) VALUE  '03929IP206C'.
00982  035000          03  FILLER  PIC X(11) VALUE  '03929IP206D'.
00983  035100          03  FILLER  PIC X(11) VALUE  '03929IU206 '.
00984  035200          03  FILLER  PIC X(11) VALUE  '03929IU206A'.
00985  035300          03  FILLER  PIC X(11) VALUE  '03929IU206B'.
00986  035400          03  FILLER  PIC X(11) VALUE  '03929IU206C'.
00987  035500          03  FILLER  PIC X(11) VALUE  '03929IU206D'.
00988  035600          03  FILLER  PIC X(11) VALUE  '03929IU206E'.
00989  035700          03  FILLER  PIC X(11) VALUE  '03929IU206F'.
00990  035800          03  FILLER  PIC X(11) VALUE  '03929IU206U'.
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00992  036000          03  FILLER  PIC X(11) VALUE  '03929U206A'.
00993  036100          03  FILLER  PIC X(11) VALUE  '03929U206B'.
00994  036200          03  FILLER  PIC X(11) VALUE  '03929U206C'.
00995  036300          03  FILLER  PIC X(11) VALUE  '03929U206D'.
00996  036400          03  FILLER  PIC X(11) VALUE  '03929U206E'.
00997  036500          03  FILLER  PIC X(11) VALUE  '03929U206F'.
00998  036600          03  FILLER  PIC X(11) VALUE  '039292060'.
00999  036700          03  FILLER  PIC X(11) VALUE  '03929206A'.
01000  036800          03  FILLER  PIC X(11) VALUE  '03929206B'.
01001  036900          03  FILLER  PIC X(11) VALUE  '03929206D'.
01002  037000          03  FILLER  PIC X(11) VALUE  '03929206P'.
01003  037100          03  FILLER  PIC X(11) VALUE  '03930I-337'.
01004  037200          03  FILLER  PIC X(11) VALUE  '03930I-337C'.
01005  037300          03  FILLER  PIC X(11) VALUE  '03930I337 '.
01006  037400          03  FILLER  PIC X(11) VALUE  '03930I337C'.
01007  037500          03  FILLER  PIC X(11) VALUE  '03930I337D'.
01008  037600          03  FILLER  PIC X(11) VALUE  '03930I337E'.
01009  037700          03  FILLER  PIC X(11) VALUE  '03930I337F'.
01010  037800          03  FILLER  PIC X(11) VALUE  '039303370'.
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01012  038000          03  FILLER  PIC X(11) VALUE  '03930337B'.
01013  038100          03  FILLER  PIC X(11) VALUE  '03930337C'.
01014  038200          03  FILLER  PIC X(11) VALUE  '03930337D'.
01015  038300          03  FILLER  PIC X(11) VALUE  '03930337E'.
01016  038400          03  FILLER  PIC X(11) VALUE  '03930337F'.
01017  038500          03  FILLER  PIC X(11) VALUE  '03930337G'.
01018  038600          03  FILLER  PIC X(11) VALUE  '03931401 '.
01019  038700          03  FILLER  PIC X(11) VALUE  '03931401A'.
01020  038800          03  FILLER  PIC X(11) VALUE  '03931401B'.
01021  038900          03  FILLER  PIC X(11) VALUE  '03931402 '.
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01022  039000      03  FILLER  PIC X(11) VALUE  '039314028  '.
01023  039100      03  FILLER  PIC X(11) VALUE  '03931411   '.
01024  039200      03  FILLER  PIC X(11) VALUE  '039314114  '.
01025  039300      03  FILLER  PIC X(11) VALUE  '03931414   '.
01026  039400      03  FILLER  PIC X(11) VALUE  '03932A-188 '.
01027  039500      03  FILLER  PIC X(11) VALUE  '03932AG188 '.
01028  039600      03  FILLER  PIC X(11) VALUE  '03932A188  '.
01029  039700      03  FILLER  PIC X(11) VALUE  '03932A188A '.
01030  039800      03  FILLER  PIC X(11) VALUE  '03932A188B '.
01031  039900      03  FILLER  PIC X(11) VALUE  '03932188   '.
01032  040000      03  FILLER  PIC X(11) VALUE  '03932188A  '.
01033  040100      03  FILLER  PIC X(11) VALUE  '03932188B  '.
01034  040200      03  FILLER  PIC X(11) VALUE  '03932188C  '.
01035  040300      03  FILLER  PIC X(11) VALUE  '03933C177  '.
01036  040400      03  FILLER  PIC X(11) VALUE  '03933177   '.
01037  040500      03  FILLER  PIC X(11) VALUE  '03933177A  '.
01038  040600      03  FILLER  PIC X(11) VALUE  '03933177B  '.
01039  040700      03  FILLER  PIC X(11) VALUE  '03934421   '.
01040  040800      03  FILLER  PIC X(11) VALUE  '03934421A  '.
01041  040900      03  FILLER  PIC X(11) VALUE  '03934421B  '.
01042  041000      03  FILLER  PIC X(11) VALUE  '03935T207  '.
01043  041100      03  FILLER  PIC X(11) VALUE  '03935207   '.
01044  041200      03  FILLER  PIC X(11) VALUE  '03936177 RG'.
01045  041300      03  FILLER  PIC X(11) VALUE  '03936177RG '.
01046  041400      03  FILLER  PIC X(11) VALUE  '0560114-19 '.
01047  041500      03  FILLER  PIC X(11) VALUE  '0560114-192'.
01048  041600      03  FILLER  PIC X(11) VALUE  '0560114-193'.
01049  041700      03  FILLER  PIC X(11) VALUE  '056011419-2'.
01050  041800      03  FILLER  PIC X(11) VALUE  '0560114193A'.
01051  041900      03  FILLER  PIC X(11) VALUE  '05603A-1   '.
01052  042000      03  FILLER  PIC X(11) VALUE  '05603AA-1  '.
01053  042100      03  FILLER  PIC X(11) VALUE  '05603AA-1A '.
01054  042200      03  FILLER  PIC X(11) VALUE  '05603AA-1B '.
01055  042300      03  FILLER  PIC X(11) VALUE  '05603AA1   '.
01056  042400      03  FILLER  PIC X(11) VALUE  '05603AA1-A '.
01057  042500      03  FILLER  PIC X(11) VALUE  '05603AA1-B '.
01058  042600      03  FILLER  PIC X(11) VALUE  '05603AA1-1A'.
01059  042700      03  FILLER  PIC X(11) VALUE  '05603AA1A  '.
01060  042800      03  FILLER  PIC X(11) VALUE  '05603AA1B  '.
01061  042900      03  FILLER  PIC X(11) VALUE  '05605AA-5  '.
01062  043000      03  FILLER  PIC X(11) VALUE  '05605AA5   '.
01063  043100      03  FILLER  PIC X(11) VALUE  '07113G-164 '.
01064  043200      03  FILLER  PIC X(11) VALUE  '07113G-164A'.
01065  043300      03  FILLER  PIC X(11) VALUE  '07113G164  '.
01066  043400      03  FILLER  PIC X(11) VALUE  '07113G164A '.
01067  043500      03  FILLER  PIC X(11) VALUE  '07113G64A  '.
01068  043600      03  FILLER  PIC X(11) VALUE  '07113164   '.
01069  043700      03  FILLER  PIC X(11) VALUE  '07113164A  '.
01070  043800      03  FILLER  PIC X(11) VALUE  '10103M-20  '.
01071  043900      03  FILLER  PIC X(11) VALUE  '10103M-20C '.
01072  044000      03  FILLER  PIC X(11) VALUE  '10103M-20C '.
01073  044100      03  FILLER  PIC X(11) VALUE  '10103M-20F '.
01074  044200      03  FILLER  PIC X(11) VALUE  '10103M-20G '.
01075  044300      03  FILLER  PIC X(11) VALUE  '10103MK-20E'.
01076  044400      03  FILLER  PIC X(11) VALUE  '10103M20-C '.
01077  044500      03  FILLER  PIC X(11) VALUE  '10103M20-F '.
01078  044600      03  FILLER  PIC X(11) VALUE  '10103M20B  '.
01079  044700      03  FILLER  PIC X(11) VALUE  '10103M20C  '.
01080  044800      03  FILLER  PIC X(11) VALUE  '10103M20D  '.
01081  044900      03  FILLER  PIC X(11) VALUE  '10103M20E  '.
01082  045000      03  FILLER  PIC X(11) VALUE  '10103M20F  '.
01083  045100      03  FILLER  PIC X(11) VALUE  '10103M20G  '.
01084  045200      03  FILLER  PIC X(11) VALUE  '10103M20H  '.
01085  045300      03  FILLER  PIC X(11) VALUE  '10103M21   '.
01086  045400      03  FILLER  PIC X(11) VALUE  '10103M21F  '.
01087  045500      03  FILLER  PIC X(11) VALUE  '10103201F  '.
01088  045600      03  FILLER  PIC X(11) VALUE  '10103201   '.
01089  045700      03  FILLER  PIC X(11) VALUE  '10104M-22  '.
01090  045800      03  FILLER  PIC X(11) VALUE  '10104M20F  '.
01091  045900      03  FILLER  PIC X(11) VALUE  '10104M22   '.
01092  046000      03  FILLER  PIC X(11) VALUE  '12420PA-18 '.
01093  046100      03  FILLER  PIC X(11) VALUE  '12420PA-18A'.
01094  046200      03  FILLER  PIC X(11) VALUE  '12420PA-18C'.
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01095    046300          03  FILLER  PIC X(11) VALUE  '12420PA-18S'.
01096    046400          03  FILLER  PIC X(11) VALUE  '12420PA18  '.
01097    046500          03  FILLER  PIC X(11) VALUE  '12424PA-23  '.
01098    046600          03  FILLER  PIC X(11) VALUE  '12424PA23   '.
01099    046700          03  FILLER  PIC X(11) VALUE  '12425PA-23  '.
01100    046800          03  FILLER  PIC X(11) VALUE  '12425PA-24  '.
01101    046900          03  FILLER  PIC X(11) VALUE  '12425PA24   '.
01102    047000          03  FILLER  PIC X(11) VALUE  '12426PA-25  '.
01103    047100          03  FILLER  PIC X(11) VALUE  '12426PA25   '.
01104    047200          03  FILLER  PIC X(11) VALUE  '12428PA-24  '.
01105    047300          03  FILLER  PIC X(11) VALUE  '12428PA-28  '.
01106    047400          03  FILLER  PIC X(11) VALUE  '12428PA-28R '.
01107    047500          03  FILLER  PIC X(11) VALUE  '12428PA-28S '.
01108    047600          03  FILLER  PIC X(11) VALUE  '12428PA28   '.
01109    047700          03  FILLER  PIC X(11) VALUE  '12428PA28-R '.
01110    047800          03  FILLER  PIC X(11) VALUE  '12429PA-30  '.
01111    047900          03  FILLER  PIC X(11) VALUE  '12429PA-30B '.
01112    048000          03  FILLER  PIC X(11) VALUE  '12429PA-32  '.
01113    048100          03  FILLER  PIC X(11) VALUE  '12429PA-39  '.
01114    048200          03  FILLER  PIC X(11) VALUE  '12429PA30   '.
01115    048300          03  FILLER  PIC X(11) VALUE  '12430PA-32  '.
01116    048400          03  FILLER  PIC X(11) VALUE  '12430PA32   '.
01117    048500          03  FILLER  PIC X(11) VALUE  '12431PA-31  '.
01118    048600          03  FILLER  PIC X(11) VALUE  '12431PA-31A '.
01119    048700          03  FILLER  PIC X(11) VALUE  '12431PA-31P '.
01120    048800          03  FILLER  PIC X(11) VALUE  '12432PA-34  '.
01121    048900          03  FILLER  PIC X(11) VALUE  '14803S-2D   '.
01122    049000          03  FILLER  PIC X(11) VALUE  '14803S-2R   '.
01123    049100          03  FILLER  PIC X(11) VALUE  '14803S2R    '.
01124    049200          03  FILLER  PIC X(11) VALUE  '14803THRUSH '.
01125    049300          03  FILLER  PIC X(11) VALUE  '1480360052D '.
01126    049400          03  FILLER  PIC X(11) VALUE  '1480360052R '.
01127    049500          03  FILLER  PIC X(11) VALUE  '1480360052A '.
01128    049600          03  FILLER  PIC X(11) VALUE  '1480360052R '.
01129    049700          03  FILLER  PIC X(11) VALUE  '21601MU-2   '.
01130    049800          03  FILLER  PIC X(11) VALUE  '21601MU-2B  '.
01131    049900          03  FILLER  PIC X(11) VALUE  '21601MU-2F  '.
01132    050000          03  FILLER  PIC X(11) VALUE  '21601MU-2G  '.
01133    050100          03  FILLER  PIC X(11) VALUE  '21601MU2B20 '.
01134    050200      02  MK-MOD REDEFINES MK-MOD-02 OCCURS 550 TIMES PIC X(11).
01135    050300 PROCEDURE DIVISION.
01136    050400     OPEN INPUT NTSB  OUTPUT NTSB-TAPE.
01137    050500 READ-NTSB.
01138    050600     READ NTSB INTO NTSB-WORK-01 AT END GO TO END-OF-TAPE.
01139    050700     MOVE F012 TO FIELD-1.
01140    050800     MOVE F007 TO FIELD-2.
01141    050900     MOVE F013 TO FIELD-3.
01142    051000     MOVE FIELD-01 TO SEARCH-WORD.
01143    051100     MOVE ZERO TO FOUND-WORD.
01144    051200     PERFORM MAKE-MODEL THRU END-BI.
01145    051300     IF FOUND-WORD = ZERO GO TO READ-NTSB.
01146    051400     WRITE NTSB-OUT  FROM NTSB-REC.
01147    051500     GO TO READ-NTSB.
01148    051600 END-OF-TAPE.
01149    051700     CLOSE NTSB.
01150    051800         DISPLAY 'IF THIS IS THE LAST FILE ENTER LAST'
01151    051900             UPON CONSOLE
01152    052000         DISPLAY 'IF NOT THEN MOUNT NEXT TAPE AND ENTER NEXT'
01153    052100             UPON CONSOLE
01154    052200         ACCEPT REPLY-77 FROM CONSOLE.
01155    052300 REPLY-TEST.
01156    052400     IF REPLY-77 = SPACES OR 'NEXT' OR 'LAST' NEXT SENTENCE ELSE
01157    052500         DISPLAY 'YOU GOOFED' UPON CONSOLE
01158    052600         DISPLAY 'REENTER YOUR RESPONSE' UPON CONSOLE
01159    052700         ACCEPT REPLY-77 FROM  CONSOLE
01160    052800         GO TO REPLY-TEST.
01161    052900     IF REPLY-77 = 'NEXT'
01162    053000     OPEN INPUT NTSB
01163    053100     GO TO READ-NTSB.
01164    053200     IF REPLY-77 = 'LAST'
01165    053300     CLOSE NTSB-TAPE WITH LOCK.
01166    053400     STOP RUN.
01167    053500 MAKE-MODEL.
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01168  053600      MOVE ZERO TO LO.
01169  053700      MOVE HISAVE TO HI.
01170  053800 AA.   COMPUTE I = (HI + LO) / 2.
01171  053900      IF SEARCH-WORD LESS THAN MK-MOD (I)
01172  054000          MOVE I TO HI
01173  054100          GO TO BB.
01174  054200      IF SEARCH-WORD GREATER THAN MK-MOD (I)
01175  054300          MOVE I TO LO
01176  054400          GO TO BB.
01177  054500      MOVE '1' TO FOUND-WORD.
01178  054600      GO TO END-BI.
01179  054700 BB.   IF I LESS THAN (HI - LO) GO TO AA.
01180  054800 END-BI.
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*CBL LIST,NUM,NOR=YES,SXREF
00001    000100 ID DIVISION.
00002    000200 PROGRAM-ID. MTSB0001.
00003    000300 AUTHOR. J. A. SUMNER.
00004    000400 INSTALLATION. THE CESSNA AIRCRAFT COMPANY.
00005    000500 DATE-WRITTEN. 9-20-75.
00006    000600 DATE-COMPILED. 04/09/76.
00007    000700 SECURITY. NOT CLASSIFIED.
00008    000800 REMARKS.
00009    000900     THIS PROGRAM SURVEYS CERTAIN NTSB (NATIONAL TRANSPORTATION &
00010    001000     SAFETY BOARD) FILES, 1971 - 1973, TO SATISFY THE REQUIREMENTS
00011    001100     OF A SUB-CONTRACT WITH LOCKHEED AIRCRAFT CO. IN THEIR EFFORT
00012    001200     TO PRODUCE A MATHEMATICAL MODEL OF AN AIRCRAFT CRASH.
00013    001300 ENVIRONMENT DIVISION.
00014    001400 CONFIGURATION SECTION.
00015    001500 SOURCE-COMPUTER.  IBM-370.
00016    001600 OBJECT-COMPUTER.  IBM-370.
00017    001700 INPUT-OUTPUT SECTION.
00018    001800 FILE-CONTROL.
00019    001900     SELECT NTSB ASSIGN SYS018-UT-2400-S.
00020    002000     SELECT HEAD ASSIGN SYS019-DA-3330-D
00021    002100         ACCESS IS RANDOM
00022    002200         ACTUAL KEY IS ACT-KEY.
00023    002300     SELECT PRT ASSIGN SYS016-UR-1403-S
00024    002400         RESERVE NO ALTERNATE AREA.
00025    002500 DATA DIVISION.
00026    002600 FILE SECTION.
00027    002700 FD  HEAD
00028    002800     LABEL RECORDS ARE STANDARD
00029    002900     DATA RECORD IS HEADERR.
00030    003000 01  HEADERR.
00031    003100     02  HDER                PIC X(68).
00032    003200 FD  PRT
00033    003300     LABEL RECORDS ARE OMITTED
00034    003400     DATA RECORD IS P-REC.
00035    003500 01  P-REC                   PIC X(133).
00036    003600 FD  NTSB
00037    003700     LABEL RECORDS ARE OMITTED
00038    003800     RECORDING MODE IS F
00039    003900     DATA RECORD IS NTSB-REC.
00040    004000 01  NTSB-REC COPY NTSBMSTR REPLACING REC BY NTSB-REC.
00041 C  000270 01  NTSB-REC.                                                RON
00042 C  000280     02  F001.                                               RON
00043 C  000290         03  F00101          PICTURE 99.                     RON
00044 C  000300         03  F00102          PICTURE XX.                     RON
00045 C  000310         03  F00103          PICTURE XX.                     RON
00046 C  000320     02  F002                PICTURE X(6).                   RON
00047 C  000330     02  F003                PICTURE X(10).                  RON
00048 C  000340     02  F004.                                               RON
00049 C  000350         03  FILLER          PICTURE X(5).                   RON
00050 C  000360         03  F00401          PICTURE X.                      RON
00051 C  000370     02  AF004   REDEFINES F004.                             RON
00052 C  000380         03  AF00401         PICTURE 99.                     RON
00053 C  000390         03  AF00402         PICTURE XX.                     RON
00054 C  000400         03  AF00403         PICTURE XX.                     RON
00055 C  000410     02  F005.                                               RON
00056 C  000420         03  F00501          PICTURE X.                      RON
00057 C  000430         03  F00502.                                         RON
00058 C  000440             04  FILLER          PICTURE X(16).              RON
00059 C  000450             04  F00502O1        PICTURE X.                  RON
00060 C  000460     02  F006                PICTURE X(11).                  RON
00061 C  000470     02  F007                PICTURE X(6).                   RON
00062 C  000480     02  F008.                                               RON
00063 C  000490         03  FILLER          PICTURE X(9).                   RON
00064 C  000500         03  F00801          PICTURE X.                      RON
00065 C  000510     02  F009.                                               RON
00066 C  000520         03  FILLER          PICTURE XXX.                    RON
00067 C  000530         03  F00901          PICTURE X.                      RON
00068 C  000540     02  FILLER              PICTURE X.                      RON
00069 C  000550                                                             RON
00070 C  000560                                                             RON
00071 C  000570     02  GEN-INFO.                                           RON
00072 C  000580                                                             RON
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00073 C 000590      03 F010              PICTURE X.                    RON
00074 C 000600      03 F011              PICTURE XX.                   RON
00075 C 000610      03 F012              PICTURE XXX.                  RON
00076 C 000620      03 F013              PICTURE XX.                   RON
00077 C 000630      03 F014              PICTURE XX.                   RON
00078 C 000640      03 F015              PICTURE XX.                   RON
00079 C 000650      03 F016              PICTURE X.                    RON
00080 C 000660      03 F017              PICTURE X.                    RON
00081 C 000670      03 F018              PICTURE X.                    RON
00082 C 000680      03 F019              PICTURE X.                    RON
00083 C 000690      03 F020              PICTURE X.                    RON
00084 C 000700      03 F021              PICTURE X.                    RON
00085 C 000710      03 F022              PICTURE X.                    RON
00086 C 000720      03 F023.                                           RON
00087 C 000730          04  F02301        PICTURE X.                    RON
00088 C 000740          04  F02302        PICTURE X.                    RON
00089 C 000750      03 F024              PICTURE X.                    RON
00090 C 000760      03 F025.                                           RON
00091 C 000770          04  F02501        PICTURE X.                    RON
00092 C 000780          04  F02502        PICTURE X.                    RON
00093 C 000790      03 F026              PICTURE XX.                   RON
00094 C 000800      03 F027              PICTURE X.                    RON
00095 C 000810      03 F028.                                           RON
00096 C 000820          04  F02801        PICTURE X.                    RON
00097 C 000830          04  F02802        PICTURE X.                    RON
00098 C 000840      03 F029.                                           RON
00099 C 000850          04  F02901        PICTURE X.                    RON
00100 C 000860          04  F02902        PICTURE X.                    RON
00101 C 000870      03 F030.                                           RON
00102 C 000880          04  F03001        PICTURE X.                    RON
00103 C 000890          04  F03002        PICTURE X.                    RON
00104 C 000900      03 F031.                                           RON
00105 C 000910          04  F03101        PICTURE X.                    RON
00106 C 000920          04  F03102        PICTURE X.                    RON
00107 C 000930      03 F032.                                           RON
00108 C 000940          04  FILLER        PICTURE X(4).                 RON
00109 C 000950          04  F03201        PICTURE X.                    RON
00110 C 000960      03 F033.                                           RON
00111 C 000970          04  FILLER        PICTURE X(4).                 RON
00112 C 000980          04  F03301        PICTURE X.                    RON
00113 C 000990      03 F034.                                           RON
00114 C 001000          04  FILLER        PICTURE XX.                   RON
00115 C 001010          04  F03401        PICTURE X.                    RON
00116 C 001020      03 F035.                                           RON
00117 C 001030          04  FILLER        PICTURE X(13).                RON
00118 C 001040          04  F03501        PICTURE X.                    RON
00119 C 001050                                                         RON
00120 C 001060                                                         RON
00121 C 001070      02  EMGCY-COND.                                     RON
00122 C 001080                                                         RON
00123 C 001090       03 F036              PICTURE X.                    RON
00124 C 001100       03 F037.                                          RON
00125 C 001110          04  F03701        PICTURE X.                    RON
00126 C 001120          04  F03702        PICTURE X.                    RON
00127 C 001130       03 F038              PICTURE X.                    RON
00128 C 001140       03 F039              PICTURE X.                    RON
00129 C 001150       03 F040.                                          RON
00130 C 001160          04  F04001        PICTURE X.                    RON
00131 C 001170          04  F04002        PICTURE X.                    RON
00132 C 001180                                                         RON
00133 C 001190                                                         RON
00134 C 001200      02  WEATHER.                                       RON
00135 C 001210                                                         RON
00136 C 001220       03 F041              PICTURE X.                    RON
00137 C 001230       03 F042              PICTURE X.                    RON
00138 C 001240       03 F043              PICTURE X.                    RON
00139 C 001250       03 F044              PICTURE X.                    RON
00140 C 001260       03 F045              PICTURE X.                    RON
00141 C 001270       03 F046              PICTURE X.                    RON
00142 C 001280       03 F047              PICTURE X.                    RON
00143 C 001290                                                         RON
00144 C 001300                                                         RON
00145 C 001310      02  AIRPORT.                                       RON
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                C 001320                                                        RON
                C 001330        03 F048             PICTURE X.                  RON
                C 001340        03 F049             PICTURE X.                  RON
                C 001350        03 F050             PICTURE X(5).               RON
                C 001360        03 F051             PICTURE X.                  RON
                C 001370        03 F052             PICTURE X(17).              RON
                C 001380        03 F053             PICTURE X(5).               RON
                C 001390        03 F054             PICTURE X.                  RON
                C 001400        03 F055             PICTURE X.                  RON
                C 001410        03 F056.                                        RON
                C 001420            04  F05601      PICTURE X.                  RON
                C 001430            04  F05602      PICTURE X.                  RON
                C 001440        03 F057             PICTURE X.                  RON
                C 001450        03 F058             PICTURE X.                  RON
                C 001460        03 F059             PICTURE X.                  RON
                C 001470        03 F060             PICTURE X(5).               RON
                C 001480                                                        RON
                C 001490                                                        RON
                C 001500    02  ITINERARY.                                      RON
                C 001510                                                        RON
                C 001520        03 F061.                                        RON
                C 001530            04  F06101      PICTURE X.                  RON
                C 001540            04  FILLER      PICTURE X(20).              RON
                C 001550        03 F062.                                        RON
                C 001560            04  F06201      PICTURE X.                  RON
                C 001570            04  FILLER      PICTURE X(20).              RON
                C 001580        03 F063.                                        RON
                C 001590            04  F06301      PICTURE X.                  RON
                C 001600            04  FILLER      PICTURE X(20).              RON
                C 001610                                                        RON
                C 001620                                                        RON
                C 001630    02  ACC-SITE.                                      RON
                C 001640                                                        RON
                C 001650        03 F064.                                        RON
                C 001660            04  FILLER      PICTURE X(4).               RON
                C 001670            04  F06401      PICTURE X.                  RON
                C 001680        03 F065             PICTURE X.                  RON
                C 001690                                                        RON
                C 001700                                                        RON
                C 001710    02  MISC.                                          RON
                C 001720                                                        RON
                C 001730        03 F066             PICTURE X.                  RON
                C 001740        03 F067             PICTURE X.                  RON
                C 001750        03 FILLER           PICTURE X.                  RON
                C 001760                                                        RON
                C 001770                                                        RON
                C 001780    02  PILOT-DATA.                                    RON
                C 001790                                                        RON
                C 001800        03 F068.                                        RON
                C 001810            04  F06801      PICTURE X.                  RON
                C 001820            04  F06802      PICTURE X.                  RON
                C 001830        03 F069.                                        RON
                C 001840            04  F06901.                                RON
                C 001850                05  F0690101.                          RON
                C 001860                    06  FILLER          PICTURE X(4).   RON
                C 001870                    06  F069010101      PICTURE X.      RON
                C 001880                05  FILLER              PICTURE X.      RON
                C 001890            04  F06902.                                RON
                C 001900                05  F0690201.                          RON
                C 001910                    06  FILLER          PICTURE X(4).   RON
                C 001920                    06  F069020101      PICTURE X.      RON
                C 001930                05  FILLER              PICTURE X.      RON
                C 001940        03 F070.                                        RON
                C 001950            04  F07001.                                RON
                C 001960                05  F0700101.                          RON
                C 001970                    06  FILLER          PICTURE X(4).   RON
                C 001980                    06  F070010101      PICTURE X.      RON
                C 001990                05  FILLER              PICTURE X.      RON
                C 002000            04  F07002.                                RON
                C 002010                05  F0700201.                          RON
                C 002020                    06  FILLER          PICTURE X(4).   RON
                C 002030                    06  F070020101      PICTURE X.      RON
                C 002040                05  FILLER              PICTURE X.      RON
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AD-A032 415 LOCKHEED-CALIFORNIA CO BURBANK F/G 1/2
A METHOD OF ANALYSIS FOR GENERAL AVIATION AIRPLANE STRUCTURAL C--ETC(U)
SEP 76 G WITTLIN, M A GAMON DOT-FA75WA-3707
UNCLASSIFIED LR-27698 FAA-RD-76-123 NL

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AD-A
032 415

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00219 C 002050       03 F071.                                                    RON
00220 C 002060          04  F07101.                                              RON
00221 C 002070              05  F0710101.                                        RON
00222 C 002080                  06  FILLER          PICTURE X.                   RON
00223 C 002090                  06  F071010101      PICTURE X.                   RON
00224 C 002100              05  FILLER              PICTURE X.                   RON
00225 C 002110          04  F07102.                                              RON
00226 C 002120              05  F0710201.                                        RON
00227 C 002130                  06  FILLER          PICTURE X.                   RON
00228 C 002140                  06  F071020101      PICTURE X.                   RON
00229 C 002150              05  FILLER              PICTURE X.                   RON
00230 C 002160       03 F072.                                                    RON
00231 C 002170          04  F07201.                                              RON
00232 C 002180              05  F0720101       PICTURE X.                       RON
00233 C 002190              05  FILLER         PICTURE X.                       RON
00234 C 002200          04  F07202.                                              RON
00235 C 002210              05  F0720201       PICTURE X.                       RON
00236 C 002220              05  FILLER         PICTURE X.                       RON
00237 C 002230       03 F073.                                                    RON
00238 C 002240          04  F07301.                                              RON
00239 C 002250              05  F0730101       PICTURE X.                       RON
00240 C 002260              05  FILLER         PICTURE X.                       RON
00241 C 002270          04  F07302.                                              RON
00242 C 002280              05  F0730201       PICTURE X.                       RON
00243 C 002290              05  FILLER         PICTURE X.                       RON
00244 C 002300       03 F074.                                                    RON
00245 C 002310          04  F07401.                                              RON
00246 C 002320              05  F0740101       PICTURE X.                       RON
00247 C 002330              05  FILLER         PICTURE X.                       RON
00248 C 002340          04  F07402.                                              RON
00249 C 002350              05  F0740201       PICTURE X.                       RON
00250 C 002360              05  FILLER         PICTURE X.                       RON
00251 C 002370       03 F075.                                                    RON
00252 C 002380          04  F07501.                                              RON
00253 C 002390              05  F0750101       PICTURE X.                       RON
00254 C 002400              05  FILLER         PICTURE X.                       RON
00255 C 002410          04  F07502.                                              RON
00256 C 002420              05  F0750201       PICTURE X.                       RON
00257 C 002430              05  FILLER         PICTURE X.                       RON
00258 C 002440       03 F076.                                                    RON
00259 C 002450          04  F07601.                                              RON
00260 C 002460              05  F0760101       PICTURE X.                       RON
00261 C 002470              05  FILLER         PICTURE X.                       RON
00262 C 002480          04  F07602.                                              RON
00263 C 002490              05  F0760201       PICTURE X.                       RON
00264 C 002500              05  FILLER         PICTURE X.                       RON
00265 C 002510       03 F077                   PICTURE X.                       RON
00266 C 002520                                                                   RON
00267 C 002530                                                                   RON
00268 C 002540    02  DUM1.                                                     RON
00269 C 002550                                                                   RON
00270 C 002560     03 FILLER              PICTURE X(20).                         RON
00271 C 002570                                                                   RON
00272 C 002580                                                                   RON
00273 C 002590    02  CAUSE-FACTOR.                                             RON
00274 C 002600                                                                   RON
00275 C 002610     03 F078     OCCURS 17 TIMES.                                  RON
00276 C 002620         04  F07801       PICTURE XX.                            RON
00277 C 002630         04  F07802       PICTURE X.                             RON
00278 C 002640         04  F07803.                                             RON
00279 C 002650             05  F0780301     PICTURE X.                         RON
00280 C 002660             05  F0780302     PICTURE X.                         RON
00281 C 002670                                                                   RON
00282 C 002680                                                                   RON
00283 C 002690    02  INJRY.                                                    RON
00284 C 002700                                                                   RON
00285 C 002710     03 F079                 PICTURE X.                            RON
00286 C 002720     03 F080A.                                                     RON
00287 C 002730         04  F08001A OCCURS 3 TIMES.                              RON
00288 C 002740             05  F0800101A   OCCURS 6 TIMES  PICTURE XXX.         RON
00289 C 002750         04  FILLER          PICTURE X(7).                        RON
00290 C 002760     03 F080B    OCCURS 4 TIMES.                                   RON
00291 C 002770         04  F080B1B      OCCURS 3 TIMES.                         RON
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                    05  F0800101B   OCCURS 6 TIMES  PICTURE XXX.
                04  FILLER          PICTURE X(8).
             03 F081.
                04  F08101  OCCURS 6 TIMES  PICTURE XXX.
                04  FILLER          PICTURE X(8).

          02  RMRKS.

             03 F082.
                04  F08201          PICTURE X.
                04  F08202          PICTURE X(49).
             03 FILLER               PICTURE X(11).

          02  CAUSE.

             03 F083.
                04  F08301  OCCURS 50 TIMES PICTURE X.
             03 FILLER               PICTURE X(11).

          02  DUM2.

             03 FILLER               PICTURE X(20).

          02  E-P-DATA.

             03 F084                 PICTURE X.
             03 F085                 PICTURE X.
             03 F086                 PICTURE X.
             03 F087                 PICTURE X.
             03 F088                 PICTURE X.
             03 F089                 PICTURE X.

          02  OVERHAUL.

             03 F090.
                04  FILLER          PICTURE X(4).
                04  F09001          PICTURE X.
             03 F091.
                04  F09101  OCCURS 4 TIMES.
                    05  FILLER      PICTURE XXX.
                    05  F0910101    PICTURE X.
             03 F092.
                04  F09201  OCCURS 4 TIMES.
                    05  FILLER      PICTURE XXX.
                    05  F0920101    PICTURE X.
             03 F093.
                04  FILLER          PICTURE X(5).
                04  F09301          PICTURE X.
             03 F094.
                04  F09401          PICTURE X.
                04  FILLER          PICTURE X(11).
             03 FILLER               PICTURE X.

          02  WEATHER-SITE.

             03 F095                 PICTURE X.
             03 F096.
                04  FILLER          PICTURE X(4).
                04  F09601          PICTURE X.
             03 F097                 PICTURE X.
             03 F098.
                04  F09801          PICTURE X.
                04  F09802          PICTURE X.
             03 F099                 PICTURE X.
             03 F100                 PICTURE X.
             03 F101                 PICTURE XX.
             03 F102                 PICTURE X(4).
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00365 C 003510       03 F103.                                                  RON
00366 C 003520          04  F10301        PICTURE X.                         RON
00367 C 003530          04  F10302        PICTURE X.                         RON
00368 C 003540          04  F10303        PICTURE X.                         RON
00369 C 003550       03 F104               PICTURE XXX.                       RON
00370 C 003560       03 F105               PICTURE XXX.                       RON
00371 C 003570       03 F106.                                                  RON
00372 C 003580          04  FILLER         PICTURE XX.                        RON
00373 C 003590          04  F10601         PICTURE X.                         RON
00374 C 003600                                                                RON
00375 C 003610                                                                RON
00376 C 003620    02  AAA.                                                     RON
00377 C 003630                                                                RON
00378 C 003640       03 F107               PICTURE X.                         RON
00379 C 003650       03 F108               PICTURE X.                         RON
00380 C 003660       03 F109               PICTURE X.                         RON
00381 C 003670       03 F110               PICTURE X.                         RON
00382 C 003680       03 F111               PICTURE X.                         RON
00383 C 003690       03 F112               PICTURE X.                         RON
00384 C 003700       03 F113               PICTURE X.                         RON
00385 C 003710       03 F114               PICTURE X.                         RON
00386 C 003720       03 F115               PICTURE X.                         RON
00387 C 003730       03 F116               PICTURE X.                         RON
00388 C 003740       03 F117               PICTURE X.                         RON
00389 C 003750       03 F118               PICTURE X.                         RON
00390 C 003760       03 F119               PICTURE X.                         RON
00391 C 003770                                                                RON
00392 C 003780                                                                RON
00393 C 003790    02  DUM3.                                                   RON
00394 C 003800                                                                RON
00395 C 003810       03 FILLER             PICTURE X(20).                     RON
00396 C 003820                                                                RON
00397 C 003830                                                                RON
00398 C 003840    02  FLIGHT-DATA.                                            RON
00399 C 003850                                                                RON
00400 C 003860       03 F120.                                                  RON
00401 C 003870          04  FILLER         PICTURE XXX.                       RON
00402 C 003880          04  F12001         PICTURE X.                         RON
00403 C 003890       03 F121.                                                  RON
00404 C 003900          04  FILLER         PICTURE XXX.                       RON
00405 C 003910          04  F12101         PICTURE X.                         RON
00406 C 003920       03 F122               PICTURE XXX.                       RON
00407 C 003930       03 F123               PICTURE XX.                        RON
00408 C 003940       03 F124.                                                  RON
00409 C 003950          04  FILLER         PICTURE XXX.                       RON
00410 C 003960          04  F12401         PICTURE X.                         RON
00411 C 003970       03 F125.                                                  RON
00412 C 003980          04  F12501.                                           RON
00413 C 003990              05  FILLER         PICTURE X.                     RON
00414 C 004000              05  F1250101       PICTURE X.                     RON
00415 C 004010          04  F12502.                                           RON
00416 C 004020              05  FILLER         PICTURE XX.                    RON
00417 C 004030              05  F1250201       PICTURE X.                     RON
00418 C 004040          04  F12503.                                           RON
00419 C 004050              05  FILLER         PICTURE XX.                    RON
00420 C 004060              05  F1250301       PICTURE X.                     RON
00421 C 004070       03 F126.                                                  RON
00422 C 004080          04  FILLER         PICTURE X.                         RON
00423 C 004090          04  F12601         PICTURE X.                         RON
00424 C 004100       03 F127.                                                  RON
00425 C 004110          04  FILLER         PICTURE X.                         RON
00426 C 004120          04  F12701         PICTURE X.                         RON
00427 C 004130       03 F128               PICTURE XX.                        RON
00428 C 004140       03 F129.                                                  RON
00429 C 004150          04  FILLER         PICTURE X(16).                     RON
00430 C 004160          04  F12901         PICTURE X.                         RON
00431 C 004170       03 F130.                                                  RON
00432 C 004180          04  FILLER         PICTURE X(9).                      RON
00433 C 004190          04  F13001         PICTURE X.                         RON
00434 C 004200       03 FILLER             PICTURE X(4).                      RON
00435 C 004210                                                                RON
00436 C 004220                                                                RON
00437 C 004230    02  HUMAN-FACTORS.                                          RON
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00438 C 004240                                                          RON
00439 C 004250       03 F131.                                           RON
00440 C 004260          04  F13101          PICTURE X.                 RON
00441 C 004270          04  F13102          PICTURE X.                 RON
00442 C 004280          04  F13103          PICTURE X.                 RON
00443 C 004290          04  F13104          PICTURE X.                 RON
00444 C 004300       03 F132                PICTURE XX.                RON
00445 C 004310       03 F133.                                           RON
00446 C 004320          04  F13301          PICTURE X.                 RON
00447 C 004330          04  F13302.                                    RON
00448 C 004340              05  FILLER      PICTURE X.                 RON
00449 C 004350              05  F1330201    PICTURE X.                 RON
00450 C 004360       03 F134                PICTURE X.                 RON
00451 C 004370       03 F135                PICTURE X.                 RON
00452 C 004380       03 F136.                                           RON
00453 C 004390          04  FILLER          PICTURE XXX.               RON
00454 C 004400          04  F13601          PICTURE X.                 RON
00455 C 004410       03 F137.                                           RON
00456 C 004420          04  F13701          PICTURE X.                 RON
00457 C 004430          04  F13702          PICTURE X.                 RON
00458 C 004440          04  F13703          PICTURE X.                 RON
00459 C 004450          04  F13704          PICTURE X.                 RON
00460 C 004460          04  F13705          PICTURE X.                 RON
00461 C 004470       03 F138                PICTURE X.                 RON
00462 C 004480       03 F139.                                           RON
00463 C 004490          04  FILLER          PICTURE XX.                RON
00464 C 004500          04  F13901          PICTURE X.                 RON
00465 C 004510       03 F140.                                           RON
00466 C 004520          04  FILLER          PICTURE XX.                RON
00467 C 004530          04  F14001          PICTURE X.                 RON
00468 C 004540       03 F141.                                           RON
00469 C 004550          04  FILLER          PICTURE XX.                RON
00470 C 004560          04  F14101          PICTURE X.                 RON
00471 C 004570       03 F142                PICTURE X.                 RON
00472 C 004580       03 F143                PICTURE X.                 RON
00473 C 004590       03 F144                PICTURE X.                 RON
00474 C 004600       03 F145                PICTURE X.                 RON
00475 C 004610       03 F146                PICTURE X.                 RON
00476 C 004620       03 F147                PICTURE X.                 RON
00477 C 004630       03 F148.                                           RON
00478 C 004640          04  F14801          PICTURE X.                 RON
00479 C 004650          04  F14802          PICTURE X.                 RON
00480 C 004660          04  F14803          PICTURE X.                 RON
00481 C 004670          04  F14804          PICTURE X.                 RON
00482 C 004680       03 F149.                                           RON
00483 C 004690          04  F14901.                                    RON
00484 C 004700              05  FILLER      PICTURE XX.                RON
00485 C 004710              05  F1490101    PICTURE X.                 RON
00486 C 004720          04  F14902.                                    RON
00487 C 004730              05  FILLER      PICTURE XX.                RON
00488 C 004740              05  F1490201    PICTURE X.                 RON
00489 C 004750       03 F150                PICTURE X.                 RON
00490 C 004760       03 F151.                                           RON
00491 C 004770          04  F15101          PICTURE X.                 RON
00492 C 004780          04  F15102          PICTURE X.                 RON
00493 C 004790          04  F15103          PICTURE X.                 RON
00494 C 004800       03 F152.                                           RON
00495 C 004810          04  FILLER          PICTURE XX.                RON
00496 C 004820          04  F15201          PICTURE X.                 RON
00497 C 004830       03 F153                PICTURE X.                 RON
00498 C 004840       03 FILLER              PICTURE X(7).              RON
00499 C 004850                                                          RON
00500 C 004860                                                          RON
00501 C 004870    02 FIRE-INFO.                                         RON
00502 C 004880                                                          RON
00503 C 004890       03 F154                PICTURE X.                 RON
00504 C 004900       03 F155                PICTURE X.                 RON
00505 C 004910       03 F156                PICTURE X.                 RON
00506 C 004920       03 F157                PICTURE X.                 RON
00507 C 004930       03 F158.                                           RON
00508 C 004940          04  F15801          PICTURE X.                 RON
00509 C 004950          04  F15802.                                    RON
00510 C 004960              05  F1580201    PICTURE X.                 RON
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00511 C 004970                05  F1580202     PICTURE X.                    RON
00512 C 004980             04  F15803.                                       RON
00513 C 004990                05  F1580301     PICTURE X.                    RON
00514 C 005000                05  F1580302     PICTURE X.                    RON
00515 C 005010          03 F159                 PICTURE X.                    RON
00516 C 005020          03 F160                 PICTURE X.                    RON
00517 C 005030          03 F161.                                              RON
00518 C 005040             04  F16101          PICTURE X.                    RON
00519 C 005050             04  F16102          PICTURE X.                    RON
00520 C 005060                                                               RON
00521 C 005070                                                               RON
00522 C 005080       02  EQUIP.                                              RON
00523 C 005090                                                               RON
00524 C 005100          03 F162                 PICTURE X.                    RON
00525 C 005110          03 F163                 PICTURE X.                    RON
00526 C 005120          03 F164.                                              RON
00527 C 005130             04  F16401          PICTURE X.                    RON
00528 C 005140             04  F16402          PICTURE X.                    RON
00529 C 005150          03 F165                 PICTURE X.                    RON
00530 C 005160          03 F166                 PICTURE X.                    RON
00531 C 005170                                                               RON
00532 C 005180                                                               RON
00533 C 005190       02 W-B-DAMAGE.                                          RON
00534 C 005200                                                               RON
00535 C 005210          03 F167                 PICTURE X.                    RON
00536 C 005220          03 F168                 PICTURE X.                    RON
00537 C 005230          03 F169                 PICTURE X.                    RON
00538 C 005240          03 F170                 PICTURE X.                    RON
00539 C 005250          03 F171                 PICTURE X.                    RON
00540 C 005260          03 F172                 PICTURE X.                    RON
00541 C 005270          03 F173                 PICTURE X.                    RON
00542 C 005280          03 F174.                                              RON
00543 C 005290             04  F17401          PICTURE X.                    RON
00544 C 005300             04  F17402          PICTURE X.                    RON
00545 C 005310          03 F175                 PICTURE X.                    RON
00546 C 005320          03 F176                 PICTURE X.                    RON
00547 C 005330          03 F177.                                              RON
00548 C 005340             04  F17701          PICTURE X.                    RON
00549 C 005350             04  F17702          PICTURE X.                    RON
00550 C 005360          03 F178                 PICTURE X.                    RON
00551 C 005370          03 F179                 PICTURE X.                    RON
00552 C 005380          03 F180                 PICTURE X.                    RON
00553 C 005390          03 F181                 PICTURE X.                    RON
00554 C 005400          03 F182                 PICTURE X.                    RON
00555 C 005410          03 F183                 PICTURE X.                    RON
00556 C 005420                                                               RON
00557 C 005430                                                               RON
00558 C 005440       02  DUM4.                                               RON
00559 C 005450                                                               RON
00560 C 005460          03 FILLER               PICTURE X(23).                RON
00561 C 005470          03 FILLER               PICTURE X(20).                RON
00562 C 005480                                                               RON
00563 C 005490                                                               RON
00564 C 005500       02  ADMIN-DATA.                                         RON
00565 C 005510                                                               RON
00566 C 005520          03 FILLER               PICTURE XXX.                  RON
00567 C 005530          03 F184                 PICTURE X(12).                RON
00568 C 005540          03 F185                 PICTURE X(6).                 RON
00569 C 005550          03 F186     OCCURS 3 TIMES.                          RON
00570 C 005560             04  F18601          PICTURE 99.                   RON
00571 C 005570             04  F18602          PICTURE XX.                   RON
00572 C 005580             04  F18603          PICTURE XX.                   RON
00573 C 005590          03 F187                 PICTURE 99.                   RON
00574 C 005600          03 F188                 PICTURE XXX.                  RON
00575 C 005610          03 F189                 PICTURE X(13).                RON
00576 C 005620                                                               RON
00577 C 005630                                                               RON
00578 C 005640       02  IDN.                                                RON
00579 C 005650                                                               RON
00580 C 005660          03 F190                 PICTURE X(4).                 RON
00581 C 005670                                                               RON
00582 C 005680                                                               RON
00583 C 005690       02  DUM5.                                               RON
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00584 C 005700
00585 C 005710      03 FILLER                  PICTURE X(20).                  RON
00586 C 005720                                                                 RON
00587 C 005730                                                                 RON
00588 C 005740      02  AERIAL-APP.                                            RON
00589 C 005750                                                                 RON
00590 C 005760      03 F191.                                                   RON
00591 C 005770          04  FILLER            PICTURE XXX.                    RON
00592 C 005780          04  F19101            PICTURE X.                      RON
00593 C 005790      03 F192                    PICTURE X.                      RON
00594 C 005800      03 F193                    PICTURE X.                      RON
00595 C 005810      03 F194                    PICTURE X.                      RON
00596 C 005820      03 F195                    PICTURE X.                      RON
00597 C 005830      03 F196                    PICTURE X.                      RON
00598 C 005840      03 F197                    PICTURE X.                      RON
00599 C 005850      03 F198                    PICTURE X.                      RON
00600 C 005860      03 F199                    PICTURE X.                      RON
00601 C 005870      03 F200                    PICTURE X.                      RON
00602 C 005880      03 F201                    PICTURE X.                      RON
00603 C 005890      03 F202                    PICTURE X.                      RON
00604 C 005900      03 F203                    PICTURE X.                      RON
00605 C 005910      03 F204                    PICTURE X.                      RON
00606 C 005920      03 F205                    PICTURE X.                      RON
00607 C 005930      03 F206                    PICTURE X.                      RON
00608 C 005940      03 F207                    PICTURE X.                      RON
00609 C 005950      03 F208                    PICTURE X(5).                   RON
00610 C 005960      03 F209.                                                   RON
00611 C 005970          04  F20901              PICTURE X.                      RON
00612 C 005980          04  F20902              PICTURE X.                      RON
00613 C 005990          04  F20903              PICTURE X.                      RON
00614 C 006000      03 F210.                                                   RON
00615 C 006010          04  F21001              PICTURE X.                      RON
00616 C 006020          04  F21002              PICTURE X.                      RON
00617 C 006030          04  F21003              PICTURE X.                      RON
00618 C 006040      03 F211                    PICTURE X.                      RON
00619 C 006050      03 F212                    PICTURE X.                      RON
00620 C 006060                                                                 RON
00621 C 006070                                                                 RON
00622 C 006080      02  DUM6.                                                  RON
00623 C 006090                                                                 RON
00624 C 006100      03 FILLER                  PICTURE X(28).                  RON
00625 C 006110      03 FILLER                  PICTURE X(20).                  RON
00626 C 006120                                                                 RON
00627 C 006130                                                                 RON
00628 C 006140      02  COL.                                                   RON
00629 C 006150                                                                 RON
00630 C 006160      03 F213                    PICTURE X.                      RON
00631 C 006170      03 F214                    PICTURE X.                      RON
00632 C 006180      03 F215                    PICTURE X.                      RON
00633 C 006190      03 F216                    PICTURE X.                      RON
00634 C 006200      03 F217                    PICTURE X.                      RON
00635 C 006210      03 F218                    PICTURE X.                      RON
00636 C 006220      03 F219                    PICTURE X.                      RON
00637 C 006230      03 F220                    PICTURE XXX.                    RON
00638 C 006240      03 F221                    PICTURE XXX.                    RON
00639 C 006250      03 F222.                                                   RON
00640 C 006260          04  F22201              PICTURE XXX.                    RON
00641 C 006270          04  F22202              PICTURE XXX.                    RON
00642 C 006280      03 F223                    PICTURE X.                      RON
00643 C 006290      03 F224                    PICTURE X.                      RON
00644 C 006300      03 F225                    PICTURE X.                      RON
00645 C 006310      03 F226                    PICTURE X.                      RON
00646 C 006320      03 F227                    PICTURE X.                      RON
00647 C 006330                                                                 RON
00648 C 006340                                                                 RON
00649 C 006350      02  DUM7.                                                  RON
00650 C 006360                                                                 RON
00651 C 006370      03 FILLER                  PICTURE X(37).                  RON
00652 C 006380                                                                 RON
00653 C 006390                                                                 RON
00654 C 006400      02  DITCH-SURVIVAL.                                        RON
00655 C 006410                                                                 RON
00656 C 006420      03 F228                    PICTURE X.                      RON
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00657 C 006430       03 F229                    PICTURE XX.                          RON
00658 C 006440       03 F230.                                                        RON
00659 C 006450          04  F23001               PICTURE XX.                          RON
00660 C 006460          04  F23002               PICTURE XXX.                         RON
00661 C 006470       03 F231                    PICTURE X.                           RON
00662 C 006480       03 F232                    PICTURE X.                           RON
00663 C 006490       03 FILLER                  PICTURE X.                           RON
00664 C 006500       03 F233                    PICTURE X.                           RON
00665 C 006510       03 F234                    PICTURE X.                           RON
00666 C 006520       03 F235                    PICTURE X.                           RON
00667 C 006530       03 F236                    PICTURE X.                           RON
00668 C 006540       03 F237                    PICTURE X.                           RON
00669 C 006550       03 F238                    PICTURE X.                           RON
00670 C 006560       03 F239                    PICTURE X.                           RON
00671 C 006570    02  DUMB.                                                         RON
00672 C 006580       03 FILLER                  PICTURE X(127).                      RON
00673    004100 WORKING-STORAGE SECTION.
00674    004200 77  ADD-TOT-AC                  PIC X.
00675    004300 77  ANGLE-SUM                       PIC 9(7) VALUE ZERO.
00676    004400 77  ANGLE-15                        PIC 9(5) VALUE ZERO.
00677    004500 77  ANGLE-30                        PIC 9(5) VALUE ZERO.
00678    004600 77  ANGLE-45                        PIC 9(5) VALUE ZERO.
00679    004700 77  ANGLE-60                        PIC 9(5) VALUE ZERO.
00680    004800 77  ANGLE-75                        PIC 9(5) VALUE ZERO.
00681    004900 77  ANGLE-90                        PIC 9(5) VALUE ZERO.
00682    005000 77  ANGLE-90-PLUS                   PIC 9(5) VALUE ZERO.
00683    005100 77  AV-OCC                  PIC 9(5) VALUE ZERO.
00684    005200 77  AVG-ANGLE                       PIC 9999 VALUE ZERO.
00685    005300 77  AVG-DIST                        PIC 9999 VALUE ZERO.
00686    005400 77  AVG-VEL                         PIC 9999   VALUE ZERO.
00687    005500 77  BEEN-THERE              PIC X.
00688    005600 77  C-HI       PIC 9(3).
00689    005700 77  C-INITIAL        PIC 9(3).
00690    005800 77  C-SAVE                  PIC 9(3) VALUE ZERO.
00691    005900 77  C-SV                    PIC 9 VALUE 1.
00692    006000 77  C-SV-LIMIT              PIC 9.
00693    006100 77  C-TEST          PIC 9 VALUE 1.
00694    006200 77  CAUSE-FACTOR-77                 PIC 9(4).
00695    006300 77  CAUSE-77                PIC 9(5) VALUE ZERO.
00696    006400 77  CFF                         PIC 99.
00697    006500 77  D                           PIC 99 VALUE 01.
00698    006600 77  DIST-SUM                        PIC 9(6)  VALUE ZERO.
00699    006700 77  DIST-10                         PIC 9(5)  VALUE ZERO.
00700    006800 77  DIST-20                         PIC 9(5)  VALUE ZERO.
00701    006900 77  DIST-30                         PIC 9(5)  VALUE ZERO.
00702    007000 77  DIST-40                         PIC 9(5)  VALUE ZERO.
00703    007100 77  DIST-50                         PIC 9(5)  VALUE ZERO.
00704    007200 77  DIST-60                         PIC 9(5)  VALUE ZERO.
00705    007300 77  DIST-60-PLUS                    PIC 9(5)  VALUE ZERO.
00706    007400 77  DIVIDE-HOLD       PIC 9(4) USAGE COMP SYNC VALUE 0.
00707    007500 77  DIVIDEND-HOLD     PIC 9(5) USAGE COMP SYNC VALUE 0.
00708    007600 77  DUMBO                       PIC X.
00709    007700 77  ERR      PIC X(20).
00710    007800 77  ERR-RT PIC X(20).
00711    007900 77  F                        PIC 9(3) VALUE ZERO.
00712    008000 77  FACTOR-SAVE             PIC XX.
00713    008100 77  FACTOR-77               PIC XX.
00714    008200 77  FAT-INFLT     PIC 9(5) VALUE ZERO.
00715    008300 77  FAT-LDG       PIC 9(5) VALUE ZERO.
00716    008400 77  FAT-NR                          PIC 9(5) VALUE ZERO.
00717    008500 77  FAT-TO        PIC 9(5) VALUE ZERO.
00718    008600 77  FAT-TS                          PIC 9(5) VALUE ZERO.
00719    008700 77  FDATA                       PIC X(68).
00720    008800 77  FOUND-WORD              PIC X VALUE '0'.
00721    008900 77  G-ANG-SUM               PIC 9(6) VALUE ZERO.
00722    009000 77  G-ANG-15                PIC 9(5) VALUE ZERO.
00723    009100 77  G-ANG-30                PIC 9(5) VALUE ZERO.
00724    009200 77  G-ANG-45                PIC 9(5) VALUE ZERO.
00725    009300 77  G-ANG-60                PIC 9(5) VALUE ZERO.
00726    009400 77  G-ANG-75                PIC 9(5) VALUE ZERO.
00727    009500 77  G-ANG-90                PIC 9(5) VALUE ZERO.
00728    009600 77  G-ANG-90-PLUS           PIC 9(5) VALUE ZERO.
00729    009700 77  G-AVG-ANGLE      PIC 9999 VALUE ZERO.
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00730    009800 77  G-AVG-DIST      PIC 9999 VALUE ZERO.
00731    009900 77  G-AVG-VEL     PIC 9999 VALUE ZERO.
00732    010000 77  G-DIST-SUM              PIC 9(6) VALUE ZERO.
00733    010100 77  G-DIST-10               PIC 9(5) VALUE ZERO.
00734    010200 77  G-DIST-20               PIC 9(5) VALUE ZERO.
00735    010300 77  G-DIST-30               PIC 9(5) VALUE ZERO.
00736    010400 77  G-DIST-40               PIC 9(5) VALUE ZERO.
00737    010500 77  G-DIST-50               PIC 9(5) VALUE ZERO.
00738    010600 77  G-DIST-60               PIC 9(5) VALUE ZERO.
00739    010700 77  G-DIST-60-PLUS          PIC 9(5) VALUE ZERO.
00740    010800 77  G-VEL-SUM               PIC 9(6) VALUE ZERO.
00741    010900 77  G-VEL-120               PIC 9(5) VALUE ZERO.
00742    011000 77  G-VEL-120-PLUS          PIC 9(5) VALUE ZERO.
00743    011100 77  G-VEL-30                PIC 9(5) VALUE ZERO.
00744    011200 77  G-VEL-60                PIC 9(5) VALUE ZERO.
00745    011300 77  G-VEL-90                PIC 9(5) VALUE ZERO.
00746    011400 77  GAVG-OCC                PIC 9(5) VALUE ZERO.
00747    011500 77  GFAT-INFLT                   PIC 9(5) VALUE ZERO.
00748    011600 77  GFAT-LDG                     PIC 9(5) VALUE ZERO.
00749    011700 77  GFAT-NR                           PIC 9(5) VALUE ZERO.
00750    011800 77  GFAT-TO                      PIC 9(5) VALUE ZERO.
00751    011900 77  GFAT-TS                           PIC 9(5) VALUE ZERO.
00752    012000 77  GHEL-UNUSED             PIC 9(5) VALUE ZERO.
00753    012100 77  GHEL-USED               PIC 9(5) VALUE ZERO.
00754    012200 77  GS-H-FAILED             PIC 9(5) VALUE ZERO.
00755    012300 77  GS-H-INST               PIC 9(5) VALUE ZERO.
00756    012400 77  GS-H-USED               PIC 9(5) VALUE ZERO.
00757    012500 77  GTOT-AC                 PIC 9(5) VALUE ZERO.
00758    012600 77  GTOT-AC-TYPE                 PIC 9(5) VALUE ZERO.
00759    012700 77  GTOT-ACC-ANG            PIC 9(5) VALUE ZERO.
00760    012800 77  GTOT-ACC-DIST           PIC 9(5) VALUE ZERO.
00761    012900 77  GTOT-ACC-VEL            PIC 9(5) VALUE ZERO.
00762    013000 77  GTOT-FAT                PIC 9(5) VALUE ZERO.
00763    013100 77  GTOT-FLY                     PIC 9(5) VALUE ZERO.
00764    013200 77  GTOT-LDG                     PIC 9(5) VALUE ZERO.
00765    013300 77  GTOT-MNR                PIC 9(5) VALUE ZERO.
00766    013400 77  GTOT-NON                PIC 9(5) VALUE ZERO.
00767    013500 77  GTOT-NR                           PIC 9(5) VALUE ZERO.
00768    013600 77  GTOT-OCC                PIC 9(5) VALUE ZERO.
00769    013700 77  GTOT-SER                PIC 9(5) VALUE ZERO.
00770    013800 77  GTOT-ST-ACC             PIC 9(5) VALUE ZERO.
00771    013900 77  GTOT-ST-FAIL            PIC 9(5) VALUE ZERO.
00772    014000 77  GTOT-STBLT-ACC          PIC 9(5) VALUE ZERO.
00773    014100 77  GTOT-STBLT-FAIL         PIC 9(5) VALUE ZERO.
00774    014200 77  GTOT-T-O                     PIC 9(5) VALUE ZERO.
00775    014300 77  GTOT-TS                           PIC 9(5) VALUE ZERO.
00776    014400 77  HD      PIC X(20).
00777    014500 77  HEAD-COUNT      PIC 9(5) VALUE 0.
00778    014600 77  HELMET-UNUSED                     PIC 9(5) VALUE ZERO.
00779    014700 77  HELMET-USED                       PIC 9(5) VALUE ZERO.
00780    014800 77  HI                       PIC 999 VALUE ZERO.
00781    014900 77  HISAVE                  PIC 999.
00782    015000 77  HOLD-MAKE               PIC X(3) VALUE LOW-VALUE.
00783    015100 77  HOLD-MAKE-NAME               PIC X(11).
00784    015200 77  HOLD-MODEL              PIC XX   VALUE LOW-VALUE.
00785    015300 77  HOLD-YEAR               PIC XX VALUE LOW-VALUE.
00786    015400 77  I                        PIC 999 VALUE ZERO.
00787    015500 77  INDEX-HOLD      PIC 9(5) VALUE ZERO.
00788    015600 77  INJ1                         PIC 99 VALUE 1.
00789    015700 77  INJ2                         PIC 99.
00790    015800 77  ITER-4      PIC 9(5) VALUE ZERO.
00791    015900 77  J                        PIC 99    VALUE ZERO.
00792    016000 77  LO                       PIC 999 VALUE ZERO.
00793    016100 77  NTSBXY1                 PIC 9(3).
00794    016200 77  NTSBXY2                 PIC 9(3).
00795    016300 77  NTSBXY3                 PIC 9(3).
00796    016400 77  NTSBXY4                 PIC 9(3).
00797    016500 77  NTSB9                   PIC 9.
00798    016600 77  OP                             PIC 99 VALUE ZERO.
00799    016700 77  OP-PH-HOLD              PIC 9(5).
00800    016800 77  PCNTT                PIC 99999.
00801    016900 77  PCT-HOLD          PIC X(5).
00802    017000 77  PERCNT      PIC X(8) VALUE ' %      '.
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00803   017100 77  PRINT-ID                    PIC X.
00804   017200 77  READER-SWITCH               PIC X.
00805   017300 77  REC-TOT-OCC                     PIC 9(3) VALUE ZERO.
00806   017400 77  REPLY-77                            PIC X(4) VALUE SPACES.
00807   017500 77  S-H-FAILED                          PIC 9(5) VALUE ZERO.
00808   017600 77  S-H-INSTALLED                       PIC 9(5) VALUE ZERO.
00809   017700 77  S-H-USED                            PIC 9(5) VALUE ZERO.
00810   017800 77  S-SUB                       PIC 9 VALUE ZERO.
00811   017900 77  SAV-CARD                        PIC X(9) VALUE SPACES.
00812   018000 77  SEARCH-CODE                         PIC XX.
00813   018100 77  SEARCH-TYPE                         PIC X.
00814   018200 77  SEARCH-WORD                 PIC X(5).
00815   018300 77  SER-IND      PIC 99.
00816   018400 77  SER-SUB                     PIC 9 VALUE 1.
00817   018500 77  SEV-IND              PIC 99.
00818   018600 77  SEVERITY-77                     PIC X(5) VALUE 'ABCDE'.
00819   018700 77  SPACE-LINE                          PIC X(132) VALUE SPACES.
00820   018800 77  SS                           PIC 99.
00821   018900 77  SSS                          PIC 99.
00822   019000 77  SUM-A      PIC 9(18) USAGE COMP SYNC VALUE 0.
00823   019100 77  SUMMARY-COUNTER               PIC 9(6) VALUE ZERO.
00824   019200 77  SUMMARY-HEAD-1 PIC X(89) VALUE '
00825   019300-    '                                * * * * *  ACCIDENT SUMMARY  * * * * *'.
00826   019400 77  SUMMARY-HEAD-2 PIC X(69) VALUE '
00827   019500-    '                                        FOR'.
00828   019600 77  TER-IND                     PIC 99.
00829   019700 77  TERRAIN-77                      PIC X(13) VALUE 'ABCDEFGHIJKYZ'.
00830   019800 77  TOT-AC                      PIC 9(5) VALUE ZERO.
00831   019900 77  TOT-AC-TYPE                     PIC 9(5) VALUE ZERO.
00832   020000 77  TOT-ACC-ANG                         PIC 9(5) VALUE ZERO.
00833   020100 77  TOT-ACC-VEL                         PIC 9(5) VALUE ZERO.
00834   020200 77  TOT-ACC-DIST                        PIC 9(5)  VALUE ZERO.
00835   020300 77  TOT-FAT                     PIC 9(5) VALUE ZERO.
00836   020400 77  TOT-FLY                             PIC 9(5) VALUE ZERO.
00837   020500 77  TOT-LDG                             PIC 9(5) VALUE ZERO.
00838   020600 77  TOT-MNR                     PIC 9(5) VALUE ZERO.
00839   020700 77  TOT-NON                     PIC 9(5) VALUE ZERO.
00840   020800 77  TOT-NR                          PIC 9(5) VALUE ZERO.
00841   020900 77  TOT-OCC                     PIC 9(5) VALUE ZERO.
00842   021000 77  TOT-SER                     PIC 9(5) VALUE ZERO.
00843   021100 77  TOT-ST-ACC                          PIC 9(5) VALUE ZERO.
00844   021200 77  TOT-ST-FAIL                         PIC 9(5) VALUE ZERO.
00845   021300 77  TOT-STBLT-ACC                       PIC 9(5) VALUE ZERO.
00846   021400 77  TOT-STBLT-FAIL                      PIC 9(5) VALUE ZERO.
00847   021500 77  TOT-T-O                             PIC 9(5) VALUE ZERO.
00848   021600 77  TOT-TS                              PIC 9(5) VALUE ZERO.
00849   021700 77  TYP-HOLD                    PIC 9(5).
00850   021800 77  TYPES-77                        PIC X(12) VALUE 'DEFLPRO12457'.
00851   021900 77  VEL-SUM                             PIC 9(6) VALUE ZERO.
00852   022000 77  VEL-120                             PIC 9(5) VALUE ZERO.
00853   022100 77  VEL-120-PLUS                        PIC 9(5) VALUE ZERO.
00854   022200 77  VEL-30                              PIC 9(5) VALUE ZERO.
00855   022300 77  VEL-60                              PIC 9(5) VALUE ZERO.
00856   022400 77  VEL-90                              PIC 9(5) VALUE ZERO.
00857   022500 77  PCNT-OCC          PIC 999V99.
00858   022600 01  HOLD-KEY.
00859   022700       02  HOLD-KEY-1                 PIC XX.
00860   022800       02  HOLD-KEY-2                 PIC XX.
00861   022900 01  P-WORK.
00862   023000       02  P-WORK-02A.
00863   023100       03  FILLER                     PIC X(10) VALUE SPACES.
00864   023200       03  DESCRIPTION                PIC X(48).
00865   023300       03  FILLER                     PIC X(3) VALUE SPACES.
00866   023400       03  DATAA                      PIC X(68).
00867   023500       03  FILLER                     PIC X(6) VALUE SPACES.
00868   023600       02  P-WORK-02C REDEFINES P-WORK-02A.
00869   023700           03  FILL-ER       PIC X.
00870   023800           03  P-WORK-028       PIC X(131).
00871   023900 01  TERRAIN-001.
00872   024000       02  TERRAIN-COUNT OCCURS 13 TIMES   PIC 9(4).
00873   024100
00874   024200 01  HD-KEY-ACT.
00875   024300       02  HD-KEY.
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00876  024400          03  CCC.
00877  024500              04  CC   PIC X(4).
00878  024600              04  C    PIC XX.
00879  024700          03  FILL    PIC XX.
00880  024800          03  CODE4.
00881  024900              04  CHAR4   PIC X.
00882  025000              04  CODE3.
00883  025100                  05  CHAR3   PIC X.
00884  025200                  05  CODE2.
00885  025300                      06  CHAR2   PIC X.
00886  025400                      06  CHAR1   PIC X.
00887  025500      02  HD-KEY-TWO REDEFINES HD-KEY.
00888  025600          10  KYA             PIC 9(10) USAGE COMP.
00889  025700          10  KYB             PIC 9(6)  USAGE COMP.
00890  025800  01  DATE-HOLD-01A.
00891  025900      02  MO                  PIC XX.
00892  026000      02  DA                  PIC XX.
00893  026100      02  YR                  PIC XX.
00894  026200  01  DATE-HOLD-01B.
00895  026300      02  MO-B                PIC XX.
00896  026400      02  FILLER              PIC X VALUE '/'.
00897  026500      02  DA-B                PIC XX.
00898  026600      02  FILLER              PIC X VALUE '/'.
00899  026700      02  YR-B                PIC XX.
00900  026800  01  TYPES-01.
00901  026900      02  TYPES-02                PIC X(12).
00902  027000      02  TYYP REDEFINES TYPES-02 OCCURS 12 TIMES PIC X.
00903  027100  01  SERIOUSNESS.
00904  027200      02  SER OCCURS 5 TIMES INDEXED BY S-INDEX.
00905  027300          03  S OCCURS 4 TIMES INDEXED BY SERIOUS-INDEX PIC 9(5).
00906  027400  01  ATT-WORK.
00907  027500      02  ATT-02              PIC X(20).
00908  027600      02  FILLER              PIC X(48).
00909  027700  01  ATTITUDE.
00910  027800      02  ATTITUDE-1              PIC X(20).
00911  027900      02  FILLER                  PIC XX VALUE ', '.
00912  028000      02  ATTITUDE-2              PIC X(20).
00913  028100      02  FILLER                  PIC XX VALUE ', '.
00914  028200      02  ATTITUDE-3              PIC X(20).
00915  028300  01  DESCRIPTION-01.
00916  028400      02  DESCRIPTION-02.
00917  028500          03  FILLER PIC X(48) VALUE
00918  028600              'DATE . . . . . '.
00919  028700          03  FILLER PIC X(48) VALUE
00920  028800              'AIRCRAFT MAKE . . . . . '.
00921  028900          03  FILLER PIC X(48) VALUE
00922  029000              'AIRCRAFT MODEL . . . . . '.
00923  029100          03  FILLER PIC X(48) VALUE
00924  029200              'AIRCRAFT DAMAGE . . . . . '.
00925  029300          03  FILLER PIC X(48)  VALUE
00926  029400              'FIRE AFTER IMPACT . . . . . '.
00927  029500          03  FILLER PIC X(48)  VALUE
00928  029600              'KIND OF FLYING (GENERAL AVIATION) . . . . . '.
00929  029700          03  FILLER PIC X(48)  VALUE
00930  029800              'TYPE OF ACCIDENT, FIRST . . . . . '.
00931  029900          03  FILLER PIC X(48)  VALUE
00932  030000              'PHASE OF OPERATION, FIRST . . . . . '.
00933  030100          03  FILLER PIC X(48)  VALUE
00934  030200              'TYPE OF ACCIDENT, SECOND . . . . . '.
00935  030300          03  FILLER PIC X(48)  VALUE
00936  030400              'PHASE OF OPERATION, SECOND . . . . . '.
00937  030500          03  FILLER PIC X(48)  VALUE
00938  030600              'AIRCRAFT SPEED . . . . . '.
00939  030700          03  FILLER PIC X(48)  VALUE
00940  030800              'AIRPORT PROXIMITY . . . . . '.
00941  030900          03  FILLER PIC X(48)  VALUE
00942  031000              'RUNWAY COMPOSITION . . . . . '.
00943  031100          03  FILLER PIC X(48)  VALUE
00944  031200              'RUNWAY SURFACE . . . . . '.
00945  031300          03  FILLER PIC X(48)  VALUE
00946  031400              'RUNWAY HAZARDS . . . . . '.
00947  031500          03  FILLER PIC X(48)  VALUE
00948  031600              'RUNWAY LENGTH . . . . . '.
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00949  031700          03  FILLER PIC X(48)  VALUE
00950  031800              'TERRAIN (TYPE) OF AIRPORT . . . . . '.
0095'  031900          03  FILLER PIC X(48)  VALUE
0095.  032000              'CAUSE / FACTOR . . . . . '.
00953  032100          03  FILLER PIC X(48)  VALUE
00954  032200              'CAUSE / FACTOR . . . . . '.
00955  032300          03  FILLER PIC X(48)  VALUE
00956  032400              'CAUSE / FACTOR . . . . . '.
00957  032500          03  FILLER PIC X(48)  VALUE
00958  032600              'CAUSE / FACTOR . . . . . '.
00959  032700          03  FILLER PIC X(48)  VALUE
00960  032800              'CAUSE / FACTOR . . . . . '.
00961  032900          03  FILLER PIC X(48)  VALUE
00962  033000              'CAUSE / FACTOR . . . . . '.
00963  033100          03  FILLER PIC X(48)  VALUE
00964  033200              'CAUSE / FACTOR . . . . . '.
00965  033300          03  FILLER PIC X(48)  VALUE
00966  033400              'CAUSE / FACTOR . . . . . '.
00967  033500          03  FILLER PIC X(48)  VALUE
00968  033600              'CAUSE / FACTOR . . . . . '.
00969  033700          03  FILLER PIC X(48)  VALUE
00970  033800              'CAUSE / FACTOR . . . . . '.
00971  033900          03  FILLER PIC X(48)  VALUE
00972  034000              'PILOT . . . . . '.
00973  034100          03  FILLER PIC X(48)  VALUE
00974  034200              'COPILOT . . . . . '.
00975  034300          03  FILLER PIC X(48)  VALUE
00976  034400              'DUAL PILOT . . . . . '.
00977  034500          03  FILLER PIC X(48)  VALUE
0097   034600              'CHECK PILOT . . . . . '.
00979  034700          03  FILLER PIC X(48)  VALUE
00980  034800              'PASSENGERS . . . . . '.
00981  034900          03  FILLER PIC X(48)  VALUE
00982  035000              'TOTAL ABOARD . . . . . '.
00983  035100          03  FILLER PIC X(48)  VALUE
00984  035200              'REMARKS . . . . . '.
00985  035300          03  FILLER PIC X(48)  VALUE
00986  035400              '                                                '.
00987  035500          03  FILLER PIC X(48)  VALUE
00988  035600              'AIRCRAFT SERIAL NUMBER . . . . . '.
00989  035700          03  FILLER PIC X(48)  VALUE
00990  035800              'IMPACT SEVERITY . . . . . '.
00991  035900          03  FILLER PIC X(48)  VALUE
00992  036000              'IMPACT ANGLE . . . . . '.
00993  036100          03  FILLER PIC X(48)  VALUE
00994  036200              'RATE OF DECELERATION . . . . . '.
00995  036300          03  FILLER PIC X(48)  VALUE
00996  036400              'DIRECTION OF PRINCIPLE DECELERATION . . . . . '.
00997  036500          03  FILLER PIC X(48)  VALUE
00998  036600              'STOPPING DISTANCE . . . . . '.
00999  036700          03  FILLER PIC X(48)  VALUE
01000  036800              'DAMAGE SEVERITY - IMPACT (NON-TRANS. AIRCRAFT)  '.
01001  036900          03  FILLER PIC X(48)  VALUE
01002  037000              'SEATING CONFIGURATION . . . . . '.
01003  037100          03  FILLER PIC X(48)  VALUE
01004  037200              'SEAT FAILURES - NUMERICAL SUMMARY . . . . . '.
01005  037300          03  FILLER PIC X(48)  VALUE
01006  037400              'SEAT BELT FAILURES - NUMERICAL SUMMARY . . . . '.
01007  037500          03  FILLER PIC X(48)  VALUE
01008  037600              'DEATH RESULTING FROM FIRE  AFTER IMPACT . . . . '.
01009  037700          03  FILLER PIC X(48)  VALUE
01010  037800              'ATTITUDE AT IMPACT - ROLL . . . . . '.
01011  037900          03  FILLER PIC X(48)  VALUE
01012  038000              'ATTITUDE AT IMPACT - PITCH . . . . . '.
01013  038100          03  FILLER PIC X(48)  VALUE
01014  038200              'ATTITUDE AT IMPACT - YAW . . . . . '.
01015  038300          03  FILLER PIC X(48)  VALUE
01016  038400              'SPEED AT IMPACT - KNOTS . . . . . '.
01017  038500          03  FILLER PIC X(48)  VALUE
01018  038600              'KIND OF OPERATION . . . . . '.
01019  038700          03  FILLER PIC X(48)  VALUE
01020  038800              'SHOULDER HARNESS . . . . . '.
01021  038900          03  FILLER PIC X(48)  VALUE
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01022  039000                'SEAT BELT . . . . . '.
01023  039100           03   FILLER PIC X(48)  VALUE
01024  039200                'CRASH HELMET . . . . . '.
01025  039300           03   FILLER PIC X(48)  VALUE
01026  039400                'COCKPIT CRASH PAD . . . . . '.
01027  039500           03   FILLER PIC X(48)  VALUE
01028  039600                'CRASH BAR . . . . . '.
01029  039700           03   FILLER PIC X(48)  VALUE
01030  039800                'OBSTRUCTIONS . . . . . '.
01031  039900           03   FILLER PIC X(48)  VALUE
01032  040000                'TERRAIN TYPE . . . . . '.
01033  040100      02  DESC REDEFINES DESCRIPTION-02 OCCURS 70 TIMES PIC X(48).
01034  040200 01   ACT-KEY.
01035  040300      05  TRACK-ID    PIC S9(8) USAGE COMP SYNC VALUE 0.
01036  040400      05  SYMBOLIC-KEY.
01037  040500          10  KYF    PIC X(6).
01038  040600          10  FILLER    PIC XX VALUE SPACES.
01039  040700          10  KYG     PIC X(4).
01040  040800 01   TERRAIN-01.
01041  040900      02  TERRAIN-02     PIC X(13).
01042  041000      02  TERRAIN REDEFINES TERRAIN-02 OCCURS 13 TIMES
01043  041100          INDEXED BY TERRAIN-INDEX PIC X.
01044  041200 01   SEVERITY.
01045  041300      02  SEVERITY-02     PIC X(5).
01046  041400      02  SEV REDEFINES SEVERITY-02 OCCURS 5 TIMES
01047  041500          INDEXED BY SEVERITY-INDEX PIC X.
01048  041600 01   NTSB-WORK.
01049  041700      02  FILLER    PIC X(1600).
01050  041800 01   INJ-01.
01051  041900      02  INJ-02    PIC X(3).
01052  042000      02  INJURY REDEFINES INJ-02 PIC 9(3).
01053  042100 01   DIST-01.
01054  042200      02  DIST-02                    PIC 9(4).
01055  042300 01   S-01.
01056  042400      02  SEAT                       PIC 9(3).
01057  042500 01   MK-MOD.
01058  042600      02 MK                          PIC XXX.
01059  042700      02 MOD                         PIC XX.
01060  042800 01   S-B-01.
01061  042900      02  SEAT-BELT                  PIC 9(3).
01062  043000 01   ANGLE-01.
01063  043100      02  ANGLE-02                   PIC 99.
01064  043200 01   VEL-01.
01065  043300      02  VEL-02                     PIC 9(3).
01066  043400 01   TYP-OP-01.
01067  043500      02  TYP-OP-02                  PIC X(22)  VALUE 'ABCGHIJKMNQSTUV
01068  043600-                                   'WXYZ367'.
01069  043700      02  TYP-OP REDEFINES           TYP-OP-02 OCCURS 22 TIMES PIC X.
01070  043800 01   TYP-TOT-01.
01071  043900          03  TYP-TOT-03            OCCURS 23 TIMES.
01072  044000              04  TYP-TOT           OCCURS 5 TIMES PIC 9(5).
01073  044100 01   OP-PH-TOT.
01074  044200          03  OP-PH-03              OCCURS 43 TIMES.
01075  044300              04  OP-PH-04          OCCURS 5 TIMES PIC 9(5).
01076  044400 01   CAUSE-01.
01077  044500          02 CAUSE-492 OCCURS 487 TIMES PIC 9(5).
01078  044600 01   CAUSE-FATAL-01.
01079  044700          02 CAUSE-FATAL OCCURS 487 TIMES PIC 9(5).
01080  044800 01   CAUSE-NONFAT-01.
01081  044900          02 CAUSE-NON-FAT OCCURS 487 TIMES PIC 9(5).
01082  045000 01   PAGE-1-01.
01083  045100      02  PAGE-1-02.
01084  045200          03  PAGE-1-03A.
01085  045300              04 FILLER PIC X(32) VALUE
01086  045400                 'AIRCRAFT MANUFACTURER / MODEL - '.
01087  045500              04  PAGE-1-MAKE       PIC X(11).
01088  045600              04  FILLER            PIC X(3) VALUE ' / '.
01089  045700              04  PAGE-1-MOD        PIC X(6).
01090  045800              04  FILLER            PIC X(16) VALUE SPACES.
01091  045900          03  PAGE-1-03C.
01092  046000              04  FILLER  PIC X(34) VALUE 'MAXIMUM TO WEIGHT -
01093  046100-                 '  POUNDS'
01094  046200              04  FILLER  PIC X(34) VALUE SPACES
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01095  046300          03  FILLER PIC X(68) VALUE 'WING CONFIGURATION
01096  046400-             '.
01097  046500          03  FILLER PIC X(68) VALUE 'NUMBER OF ENGINES / LOCATION
01098  046600-             '.
01099  046700          03  FILLER PIC X(68) VALUE 'GENERAL INFORMATION
01100  046800-             '.
01101  046900          03  PAGE-1-03D.
01102  047000              04 FILLER PIC X(63) VALUE    '   TOTAL NUMBER OF ACCID
01103  047100-                'ENTS SURVEYED  - - - - - - - - - - - - - '.
01104  047200              04  PG-1-TOTA        PIC Z(5).
01105  047300          03  PAGE-1-03DB.
01106  047400              04  FILLER PIC X(63) VALUE    '   TOTAL APPLICABLE ACCI
01107  047500-                'DENTS SURVEYED - - - - - - - - - - - - - '.
01108  047600              04  PG-1-TOTAB       PIC Z(5).
01109  047700          03  PAGE-1-03E.
01110  047800              04  FILLER PIC X(63) VALUE '   TOTAL NUMBER OF OCCUPA
01111  047900-                'NTS - - - - - - - - - - - - - - - - - - '.
01112  048000              04  PG-1-TOTB        PIC Z(5).
01113  048100          03  PAGE-1-03F.
01114  048200              04  FILLER PIC X(63) VALUE '   AVERAGE NUMBER OF OCCU
01115  048300-                'PANTS PER ACCIDENT  - - - - - - - - - - - '.
01116  048400              04  PG-1-TOTC        PIC Z(5).
01117  048500          03  PAGE-1-03G.
01118  048600              04  FILLER PIC X(63) VALUE '   NUMBER OF ACCIDENTS WI
01119  048700-                'TH AT LEAST ONE (1) FATAL INJURY  - - - '.
01120  048800              04  PG-1-TOTD        PIC Z(5).
01121  048900          03  PAGE-1-03H.
01122  049000              04  FILLER PIC X(63) VALUE '   NUMBER OF ACCIDENTS WI
01123  049100-                'TH AT LEAST ONE (1) SERIOUS INJURY  - - '.
01124  049200              04  PG-1-TOTE        PIC Z(5).
01125  049300          03  FILLER PIC X(68) VALUE '       AND NONE MORE SERIOUS
01126  049400-             '.
01127  049500          03  PAGE-1-03J.
01128  049600              04  FILLER PIC X(63) VALUE '   NUMBER OF ACCIDENTS WI
01129  049700-                'TH AT LEAST ONE (1) MINOR INJURY  - - - '.
01130  049800              04  PG-1-TOTF        PIC Z(5).
01131  049900          03  FILLER PIC X(68) VALUE '       AND NONE MORE SERIOUS
01132  050000-             '.
01133  050100          03  PAGE-1-03L.
01134  050200              04  FILLER PIC X(63) VALUE '   NUMBER OF ACCIDENTS WI
01135  050300-                'TH NO INJURY  - - - - - - - - - - - - - - '.
01136  050400              04  PG-1-TOTH        PIC Z(5).
01137  050500          03  FILLER PIC X(68) VALUE '       AND NONE MORE SERIOUS
01138  050600-             '.
01139  050700          03  FILLER PIC X(68) VALUE '          *****  TOTALS OF SER
01140  050800-                'IOUSNESS OF INJURIES  *****              '.
01141  050900          03  FILLER PIC X(68) VALUE '                      FATAL   SE
01142  051000-                'RIOUS   MINOR    NONE                    '.
01143  051100          03  PAGE-1-03M.
01144  051200              04  FILLER PIC X(19) VALUE '       PILOT       '.
01145  051300              04  PG-1-TOTI        PIC Z(5).
01146  051400              04  FILLER           PIC X(4) VALUE SPACES.
01147  051500              04  PG-1-TOTJ        PIC Z(5).
01148  051600              04  FILLER           PIC X(4) VALUE SPACES.
01149  051700              04  PG-1-TOTK        PIC Z(5).
01150  051800              04  FILLER           PIC X(4) VALUE SPACES.
01151  051900              04  PG-1-TOTL        PIC Z(5).
01152  052000              04  FILLER           PIC X(17) VALUE SPACES.
01153  052100          03  PAGE-1-03N.
01154  052200              04  FILLER PIC X(19) VALUE '       COPILOT     '.
01155  052300              04  PG-1-TOTM        PIC Z(5).
01156  052400              04  FILLER           PIC X(4) VALUE SPACES.
01157  052500              04  PG-1-TOTN        PIC Z(5).
01158  052600              04  FILLER           PIC X(4) VALUE SPACES.
01159  052700              04  PG-1-TOTP        PIC Z(5).
01160  052800              04  FILLER           PIC X(4) VALUE SPACES.
01161  052900              04  PG-1-TOTQ        PIC Z(5).
01162  053000              04  FILLER           PIC X(17) VALUE SPACES.
01163  053100          03  PAGE-1-03P.
01164  053200              04  FILLER PIC X(19) VALUE '       PASSENGERS  '.
01165  053300              04  PG-1-TOTR        PIC Z(5).
01166  053400              04  FILLER           PIC X(4) VALUE SPACES.
01167  053500              04  PG-1-TOTS        PIC Z(5).
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01168    053600                 04  FILLER              PIC X(4) VALUE SPACES.
01169    053700                 04  PG-1-TOTT           PIC Z(5).
01170    053800                 04  FILLER              PIC X(4) VALUE SPACES.
01171    053900                 04  PG-1-TOTU           PIC Z(5).
01172    054000                 04  FILLER              PIC X(17) VALUE SPACES.
01173    054100             03  PAGE-1-03Q.
01174    054200                 04  FILLER PIC X(19) VALUE '     * OTHER       '.
01175    054300                 04  PG-1-TOTV           PIC Z(5).
01176    054400                 04  FILLER              PIC X(4) VALUE SPACES.
01177    054500                 04  PG-1-TOTW           PIC Z(5).
01178    054600                 04  FILLER              PIC X(4) VALUE SPACES.
01179    054700                 04  PG-1-TOTX           PIC Z(5).
01180    054800                 04  FILLER              PIC X(4) VALUE SPACES.
01181    054900                 04  PG-1-TOTY           PIC Z(5).
01182    055000                 04  FILLER              PIC X(17) VALUE SPACES.
01183    055100             03  FILLER PIC X(68) VALUE '          *  OTHER INCLUDES D
01184    055200-                'UAL STUDENT & CHECK PILOT                '.
01185    055300         02  PAGE-1 REDEFINES PAGE-1-02 OCCURS 23 TIMES PIC X(68).
01186    055400 01  PAGE-2-01.
01187    055500         02  PAGE-2-02.
01188    055600             03  FILLER PIC X(120) VALUE 'FLIGHT CONDITIONS -
01189    055700-                '
01190    055800-                '                                          '.
01191    055900             03  FILLER PIC X(120) VALUE '     TOTAL NUMBER OF ACCIDEN
01192    056000-                'TS WHICH OCCURRED DURING THE FOLLOWING FIVE  MAJOR P
01193    056100-                'HASES OF OPERATION /                      '.
01194    056200             03  FILLER PIC X(120) VALUE '          NUMBER OF ACCIDENT
01195    056300-                'S WITH AT LEAST ONE FATALITY WHICH OCCURRED DURING T
01196    056400-                'HE MAJOR PHASE                            '.
01197    056500             03  PAGE-2-03A.
01198    056600                 04  FILLER              PIC X(28) VALUE '
01199    056700-                    'TAKEOFF - - - '.
01200    056800                 04  PG-2-TO             PIC Z(5).
01201    056900                 04  FILLER              PIC X(3) VALUE ' / '.
01202    057000                 04  PG-2-TOFAT          PIC Z(5).
01203    057100                 04  FILLER              PIC X(79) VALUE SPACES.
01204    057200             03  PAGE-2-03B.
01205    057300                 04  FILLER              PIC X(28) VALUE '
01206    057400-                    'IN FLIGHT - - '.
01207    057500                 04  PG-2-IF             PIC Z(5).
01208    057600                 04  FILLER              PIC X(3) VALUE ' / '.
01209    057700                 04  PG-2-IFFAT          PIC Z(5).
01210    057800                 04  FILLER              PIC X(79) VALUE SPACES.
01211    057900             03  PAGE-2-03C.
01212    058000                 04  FILLER              PIC X(28) VALUE '
01213    058100-                    'LANDING - - - '.
01214    058200                 04  PG-2-LDG            PIC Z(5).
01215    058300                 04  FILLER              PIC X(3) VALUE ' / '.
01216    058400                 04  PG-2-LDGFAT         PIC Z(5).
01217    058500                 04  FILLER              PIC X(79) VALUE SPACES.
01218    058600             03  PAGE-2-03CB.
01219    058700                 04  FILLER              PIC X(28) VALUE '
01220    058800-                    'OTHER - - - - '.
01221    058900                 04  PG-2-OTHER          PIC Z(5).
01222    059000                 04  FILLER              PIC X(3) VALUE ' / '.
01223    059100                 04  PG-2-OTHERFAT       PIC Z(5).
01224    059200                 04  FILLER              PIC X(79) VALUE SPACES.
01225    059300             03  PAGE-2-03CC.
01226    059400                 04  FILLER              PIC X(28) VALUE '
01227    059500-                    'NOT REPORTED'.
01228    059600                 04  PG-2-NR             PIC Z(5).
01229    059700                 04  FILLER              PIC X(3) VALUE ' / '.
01230    059800                 04  PG-2-NRFAT          PIC Z(5).
01231    059900                 04  FILLER              PIC X(79) VALUE SPACES.
01232    060000             03  FILLER PIC X(120) VALUE '     NINE (9) MOST FREQUENT
01233    060100-                'MINOR PHASES OF OPERATION WITHIN THE FIRST THREE MAJ
01234    060200-                'OR PHASES ABOVE                           '.
01235    060300             03  FILLER PIC X(120) VALUE '          LISTED IN DESCENDI
01236    060400-                'NG ORDER OF FREQUENCY                     '.
01237    060500             03  FILLER PIC X(120) VALUE '
01238    060600-                '     MINOR PHASE OF OPERATION                    TO
01239    060700-                'TAL NO.   ********* INJURIES ********** '.
01240    060800             03  FILLER PIC X(120) VALUE '
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18        MTS80001        11.47.53        04/09/76

01241  060900-                '                                                    OF
01242  061000-              'ACCIDENTS  FATAL  SERIOUS  MINOR   NONE '.
01243  061100         03  PAGE-2-03D OCCURS 9  TIMES.
01244  061200             04  FILLER              PIC X(7).
01245  061300             04  MP-NO               PIC Z9.
01246  061400             04  PERIOD-04           PIC XX.
01247  061500             04  MINOR P1            PIC X(68).
01248  061600             04  FILLER              PIC XX.
01249  061700             04  TOT-ACC-MP          PIC Z(5).
01250  061800             04  FILLER              PIC X(5).
01251  061900             04  FAT-INJ-MP          PIC Z(5).
01252  062000             04  FILLER              PIC X(3).
01253  062100             04  SER-INJ-MP          PIC Z(5).
01254  062200             04  FILLER              PIC X(3).
01255  062300             04  MIN-INJ-MP          PIC Z(5).
01256  062400             04  FILLER              PIC X(3).
01257  062500             04  NON-INJ-MP          PIC Z(5).
01258  062600         03  FILLER PIC X(120) VALUE '     EIGHT (8) MOST FREQUENT
01259  062700-              ' TYPES OF ACCIDENTS WITHIN THE FIRST THREE MAJOR PHA
01260  062800-            'SES ABOVE                                          '.
01261  062810         03  FILLER PIC X(120) VALUE '           LISTED IN DESCEND
01262  062820-              'ING ORDER OF FREQUENCY
01263  062830-            '                                                    '.
01264  062900         03  FILLER PIC X(120) VALUE '
01265  063000-              '     TYPE OF ACCIDENT                                TO
01266  063100-            'TAL NO.    ********* INJURIES ********** '.
01267  063200         03  FILLER PIC X(120) VALUE '
01268  063300-            '                                                      OF
01269  063400-            'ACCIDENTS  FATAL  SERIOUS  MINOR   NONE '.
01270  063500         03  PAGE-2-03DA OCCURS  8 TIMES.
01271  063600             04  FILLER                  PIC X(7).
01272  063700             04  TYP-NO                  PIC Z9.
01273  063800             04  PERIODT-04              PIC XX.
01274  063900             04  TYP-DESC                PIC X(68).
01275  064000             04  FILLER                  PIC XX.
01276  064100             04  TOT-ACC-TYP             PIC Z(5).
01277  064200             04  FILLER                  PIC X(5).
01278  064300             04  FAT-INJ-TYP             PIC Z(5).
01279  064400             04  FILLER                  PIC XXX.
01280  064500             04  SER-INJ-TYP             PIC Z(5).
01281  064600             04  FILLER                  PIC XXX.
01282  064700             04  MIN-INJ-TYP             PIC Z(5).
01283  064800             04  FILLER                  PIC XXX.
01284  064900             04  NON-INJ-TYP             PIC Z(5).
01285  065000         03  FILLER PIC X(120) VALUE ' NOTE -- OTHER IS SUM OF ALL
01286  065100-              ' ACCEPTABLE PHASES AND TYPES EXCEPT THOSE LISTED
01287  065200-            '                                                    '.
01288  065300     02  PAGE-2 REDEFINES PAGE-2-02 OCCURS 34 TIMES PIC X(120).
01289  065400 01  PAGE-3-01.
01290  065500     02  PAGE-3-02.
01291  065600         03  FILLER PIC X(120) VALUE 'IMPACT CONDITIONS
01292  065700-            '                                                    '.
01293  065800-
01294  065900         03  PAGE-3-03E.
01295  066000             04  FILLER PIC X(60) VALUE '     TOTAL NUMBER OF ACCI
01296  066100-                  'DENTS WHICH RECORD IMPACT ANGLES - '.
01297  066200             04  TOT-IMPACT          PIC Z(5).
01298  066300             04  FILLER              PIC X(55) VALUE SPACES.
01299  066400         03  FILLER PIC X(120) VALUE '     IMPACT ANGLE NUMERICAL
01300  066500-              'SUMMARY -
01301  066600-            '                                                    '.
01302  066700         03  FILLER PIC X(120) VALUE '          AVERAGE ANGLE
01303  066800-                                 'IMPACT ANGLE CATEGORIES - DEGREES
01304  066900-            '                                                    '.
01305  067000         03  FILLER PIC X(120) VALUE '              DEGREES
01306  067100-            '                                                    '.
01307  067200-
01308  067300         03  FILLER PIC X(120) VALUE '
01309  067400-              ' 0 -15      16-30      31-45      46-60      61-75      7
01310  067500-            '6-90        90+                                     '.
01311  067600         03  PAGE-3-03F.
01312  067700             04  FILLER              PIC X(13) VALUE SPACES.
01313  067800             04  AVG-ANGLE-3         PIC Z(5).
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                    04  FILLER              PIC X(11) VALUE SPACES.
                    04  F0-15               PIC Z(5).
                    04  FILLER              PIC X(5) VALUE SPACES.
                    04  F16-30              PIC Z(5).
                    04  FILLER              PIC X(5) VALUE SPACES.
                    04  F31-45              PIC Z(5).
                    04  FILLER              PIC X(5) VALUE SPACES.
                    04  F46-60              PIC Z(5).
                    04  FILLER              PIC X(5) VALUE SPACES.
                    04  F61-75              PIC Z(5).
                    04  FILLER              PIC X(5) VALUE SPACES.
                    04  F76-90              PIC Z(5).
                    04  FILLER              PIC X(5)  VALUE SPACES.
                    04  F90        PIC Z(5).
                    04  FILLER      PIC X(26) VALUE SPACES.
             03  PAGE-3-03G.
                    04  FILLER PIC X(73) VALUE '     TOTAL NUMBER OF ACCI
                'DENTS WHICH RECORD IMPACT VELOCITY -  '.
                    04  VEL-IMP             PIC Z(5).
                    04  FILLER              PIC X(42) VALUE SPACES.
             03  FILLER PIC X(120) VALUE '      IMPACT VELOCITY NUMERIC
                'AL SUMMARY -
                '                                                       '.
             03  FILLER PIC X(120) VALUE '           AVERAGE VELOCITY
                '       IMPACT VELOCITY CATEGORIES - KNOTS
                '                                                       '.
             03  FILLER PIC X(120) VALUE '                KNOTS
                '                                                       '.
             03  FILLER PIC X(120) VALUE '
                ' 1-30       31-60      61-90      91-120       120+
                '                                                       '.
             03  PAGE-3-03H.
                    04  FILLER PIC X(65) VALUE '     TOTAL NUMBER OF ACCI
                'DENTS WHICH RECORD STOPPING DISTANCES - '.
                    04  STOP-DIST           PIC Z(5).
                    04  FILLER              PIC X(50) VALUE SPACES.
             03  FILLER PIC X(120) VALUE '      STOPPING DISTANCE NUMER
                'ICAL SUMMARY -
                '                                                       '.
             03  FILLER PIC X(120) VALUE '           AVERAGE STOPPING
                '       STOPPING DISTANCE CATEGORIES - FEET
                '                                                       '.
             03  FILLER PIC X(120) VALUE '             DISTANCE - FEET
                '                                                       '.
             03  FILLER PIC X(120) VALUE '
                ' 1 -59    60-119   120-179   180-239   240-299   300
                '-359      360+
                '                                                       '.
             03  FILLER PIC X(120) VALUE '      OCCUPANT INJURY NUMERIC
                'AL SUMMARY AT RESPECTIVE AIRCRAFT DAMAGE SEVERITY IN
                'DICES -                                                '.
             03  FILLER PIC X(120) VALUE '                DAMAGE SEVERITY
                '          * * * *   OCCUPANT  INJURY    * * * *
                '                                                       '.
             03  FILLER PIC X(120) VALUE '
                '           FATAL     SERIOUS     MINOR       NONE
                '                                                       '.
             03  PAGE-3-03I OCCURS 5 TIMES.
                    04  FILLER              PIC X(12).
                    04  SEV-NAME            PIC X(8).
                    04  FILLER              PIC X(16).
                    04  SEV-FAT             PIC Z(5).
                    04  FILLER              PIC X(5).
                    04  SEV-SER             PIC Z(5).
                    04  FILLER              PIC X(5).
                    04  SEV-MIN             PIC Z(5).
                    04  FILLER              PIC X(5).
                    04  SEV-NON             PIC Z(5).
                    04  FILLER              PIC X(49).
      02  PAGE-3 REDEFINES PAGE-3-02 OCCURS 25 TIMES PIC X(120).
      02  PAGE-4-02.
             03  FILLER PIC X(91)  VALUE 'AIRCRAFT CABIN ACCOMMODATION
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01387  075200-            'S -
01388  075300-            '                '.
01389  075400         03  PAGE-4-03A.
01390  075500             04  FILLER PIC X(63) VALUE '     NUMBER OF ACCIDENTS
01391  075600-                'IN WHICH SEAT FAILURE OCCURRED  - - - '.
01392  075700             04  SEAT-FAIL-ACC   PIC Z(5).
01393  075800             04  FILLER          PIC X(23) VALUE SPACES.
01394  075900         03  PAGE-4-03B.
01395  076000             04  FILLER PIC X(63) VALUE '     TOTAL NUMBER OF SEAT
01396  076100-                ' FAILURES - - - - - - - - - - - - - - - '.
01397  076200             04  SEAT-FAIL       PIC Z(5).
01398  076300             04  FILLER          PIC X(23) VALUE SPACES.
01399  076400         03  PAGE-4-03C.
01400  076500             04  FILLER PIC X(63) VALUE '     NUMBER OF ACCIDENTS
01401  076600-                'IN WHICH SEAT BELT FAILURE OCCURRED - '.
01402  076700             04  SEAT-BELT-ACC   PIC Z(5).
01403  076800             04  FILLER          PIC X(23) VALUE SPACES.
01404  076900         03  PAGE-4-03D.
01405  077000             04  FILLER PIC X(63) VALUE '     TOTAL NUMBER OF SEAT
01406  077100-                ' BELT FAILURES - - - - - - - - - - - - - '.
01407  077200             04  SEAT-BELT-FAIL  PIC Z(5).
01408  077300             04  FILLER          PIC X(23) VALUE SPACES.
01409  077400         03  PAGE-4-03E.
01410  077500             04  FILLER PIC X(63) VALUE '   * NUMBER OF SHOULDER H
01411  077600-                'ARNESS USED - - - - - - - - - - - - - - '.
01412  077700             04  SH-HARN-USED    PIC Z(5).
01413  077800             04  FILLER          PIC X(23) VALUE SPACES.
01414  077900         03  PAGE-4-03F.
01415  078000             04  FILLER PIC X(63) VALUE '   * NUMBER OF SHOULDER H
01416  078100-                'ARNESS FAILURES - - - - - - - - - - - - '.
01417  078200             04  SH-HARN-FAIL    PIC Z(5).
01418  078300             04  FILLER          PIC X(23) VALUE SPACES.
01419  078400         03  PAGE-4-03G.
01420  078500             04  FILLER PIC X(63) VALUE '   * NUMBER OF CRASH HELM
01421  078600-                'ETS USED / NOT USED - - - - - - - - - - '.
01422  078700             04  CRASH-HEL-USED  PIC Z(5).
01423  078800             04  FILLER     PIC X(3) VALUE ' / '.
01424  078900             04  CRASH-HEL-UNUSED    PIC Z(5).
01425  079000             04  FILLER          PIC X(15) VALUE SPACES.
01426  079100         03  FILLER PIC X(91) VALUE '          *  APPLICABLE TO AGRIC
01427  079200-                'ULTURAL AIRCRAFT ONLY
01428  079300-                '                '.
01429  079400         03  FILLER PIC X(91) VALUE 'IMPACT AREA
01430  079500-                '                '.
01431  079600-                '                '.
01432  079700         03  FILLER PIC X(91) VALUE '     PERCENT OF ACCIDENTS WHI
01433  079800-                'CH OCCURRED IN PARTICULAR TERRAIN TYPE
01434  079900-                '                '.
01435  080000         03  FILLER PIC X(91) VALUE '
01436  080100-                'TERRAIN TYPE
01437  080200-                '                '.
01438  080300         03  FILLER PIC X(91) VALUE '
01439  080400-                '                                                PER
01440  080500-                'CENT      '.
01441  080600         03  FILLER PIC X(91) VALUE '
01442  080700-                '                                                ACC
01443  080800-                'IDENT     '.
01444  080900         03  FILLER PIC X(91) VALUE '
01445  081000-                '                                                OCCU
01446  081100-                'RRENCE (1)'.
01447  081200         03  PAGE-4-03GROUP.
01448  081300             04  PAGE-4-03H OCCURS 13 TIMES.
01449  081400                 05  TERR-TYP        PIC X(68).
01450  081500                 05  FILLER          PIC X(10).
01451  081600                 05  PCT-TER         PIC Z(5).
01452  081700                 05  FILLER-4-03H    PIC X(8).
01453  081800             03  FILLER PIC X(91) VALUE '          (1)  PERCENT IS RATI
01454  081900-                'O OF PARTICULAR TERRAIN TO NUMBER OF ACCIDENTS SCREE
01455  082000-                'NED       '.
01456  082100     02  PAGE-4 REDEFINES PAGE-4-02 OCCURS 29 TIMES PIC X(91).
01457  082200     02  PAGE-5-02.
01458  082300         03  FILLER PIC X(110) VALUE 'CAUSE / FACTOR SUMMARY
01459  082400-                '
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                 082600          03  FILLER PIC X(110) VALUE '
                 082700-                  '                CAUSE
                 082800-                  '     FATAL       NONFATAL    '.
                 082900          03  FILLER PIC X(110) VALUE '
                 083000-                  '
                 083100-                  '   ACCIDENTS     ACCIDENTS   '.
01467            083200          03  PAGE-5-02A.
01468            083300              04  FILLER PIC X(5) VALUE SPACES.
01469            083400              04  CF-NO  PIC X.
01470            083500              04  FILLER PIC XX VALUE '. '.
01471            083600              04  CAUSE-FACTOR-5    PIC X(68).
01472            083700              04  FILLER            PIC X(7)  VALUE SPACES.
01473            083800              04  FILLER            PIC X(3) VALUE SPACES.
01474            083900              04  CF-FATALS         PIC Z(5).
01475            084000              04  FILLER            PIC X(10) VALUE SPACES.
01476            084100              04  CF-NONFAT         PIC Z(5).
01477            084200              04  FILLER            PIC X(12) VALUE SPACES.
01478            084300          03  FILLER PIC X(110) VALUE '* * PILOT * *
01479            084400-                  '                                '.
01480            084500-                  '                                '.
01481            084600          03  FILLER PIC X(110) VALUE '* * COPILOT * *
01482            084700-                  '                                '.
01483            084800-                  '                                '.
01484            084900          03  FILLER PIC X(110) VALUE '* * DUAL STUDENT * *
01485            085000-                  '                                '.
01486            085100-                  '                                '.
01487            085200          03  FILLER PIC X(110) VALUE '* * CHECK PILOT * *
01488            085300-                  '                                '.
01489            085400-                  '                                '.
01490            085500          03  FILLER PIC X(110) VALUE '* * AIRFRAME * *
01491            085600-                  '                                '.
01492            085700-                  '                                '.
01493            085800          03  FILLER PIC X(110) VALUE '* * MISCELLANEOUS ACTS, COND
01494            085900-                  'ITIONS * *
01495            086000-                  '                                '.
01496            086100      02  PAGE-5 REDEFINES PAGE-5-02 OCCURS 10 TIMES PIC X(110).
01497            086200  01  P-IND-REC-01.
01498            086300      02  P-IND-02.
01499            086400          03  P-IND-DESC  PIC X(48).
01500            086500          03  P-IND-ENG   PIC X(68).
01501            086600  01  GTOT-OP-01.
01502            086700      02  GTOT-OP-02.
01503            086800          03  GTOT-OP-03 OCCURS 43 TIMES.
01504            086900              04  GTOT-OP OCCURS 5 TIMES PIC 9(5).
01505            087000  01  GTOT-TYP-01.
01506            087100      02  GTOT-TYP-02.
01507            087200          03  GTOT-TYP-03 OCCURS 23 TIMES.
01508            087300              04  GTOT-TYP OCCURS 5 TIMES PIC 9(5).
01509            087400  01  G-CAUSE-01.
01510            087500      02  G-CAUSE OCCURS 487 TIMES PIC 9(5).
01511            087600  01  G-CAUSE-FAT-01.
01512            087700      02  G-CAUSE-FAT OCCURS 487 TIMES PIC 9(5).
01513            087800  01  G-CAUSE-NONFAT-01.
01514            087900      02  G-CAUSE-NONFAT OCCURS 487 TIMES PIC 9(5).
01515            088000  01  OP-PH-01.
01516            088100      02  OP-PH-CODE.
01517            088200          03  FILLER PIC X(22) VALUE 'C0C1C2C3C4C5C6DADBDCDE'.
01518            088300          03  FILLER PIC X(22) VALUE 'DFDGDHDIDJDKDLDMDNDOD1'.
01519            088400          03  FILLER PIC X(22) VALUE 'D2D3D4D5D6D7D8D9EAEBEC'.
01520            088500          03  FILLER PIC X(22) VALUE 'EDEEEFEGEHEIEJEKZ     '.
01521            088600      02  OP-PH REDEFINES OP-PH-CODE OCCURS 42 TIMES PIC XX.
01522            088700  01  CAUSE-FACTOR-01.
01523            088800      02  CAUSE-FACTOR-02.
01524            088900          03 FILLER PIC X(28) VALUE '6401640264036404640564066407'.
01525            089000          03 FILLER PIC X(28) VALUE '6408640964106411641264136414'.
01526            089100          03 FILLER PIC X(28) VALUE '6415641664176418641964206421'.
01527            089200          03 FILLER PIC X(28) VALUE '6422642364246425642664276428'.
01528            089300          03 FILLER PIC X(28) VALUE '6429643064316432643364346435'.
01529            089400          03 FILLER PIC X(28) VALUE '6436643764386439644064426443'.
01530            089500          03 FILLER PIC X(28) VALUE '6444644564466447644864496450'.
01531            089600          03 FILLER PIC X(28) VALUE '6451645264536454645564566462'.
01532            089700          03 FILLER PIC X(28) VALUE '6464646564666467647164746479'.
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01533   089800          03 FILLER PIC X(28) VALUE '648064816482650165026503650 4'.
01534   089900          03 FILLER PIC X(28) VALUE '650565066507650865096510651 1'.
01535   090000          03 FILLER PIC X(28) VALUE '651265136514651565166517651 8'.
01536   090100          03 FILLER PIC X(28) VALUE '651965206521652265236524652 5'.
01537   090200          03 FILLER PIC X(28) VALUE '652665276528652965306531653 2'.
01538   090300          03 FILLER PIC X(28) VALUE '653365346535653665376538653 9'.
01539   090400          03 FILLER PIC X(28) VALUE '654065426543654465456546654 7'.
01540   090500          03 FILLER PIC X(28) VALUE '654865496550655165526553655 4'.
01541   090600          03 FILLER PIC X(28) VALUE '655565566562656465656566656 7'.
01542   090700          03 FILLER PIC X(28) VALUE '657165746579658065816582660 1'.
01543   090800          03 FILLER PIC X(28) VALUE '660266036604660566066076608 '.
01544   090900          03 FILLER PIC X(28) VALUE '660966106611661266136614661 5'.
01545   091000          03 FILLER PIC X(28) VALUE '661666176618661966206621662 2'.
01546   091100          03 FILLER PIC X(28) VALUE '662366246625662666276628662 9'.
01547   091200          03 FILLER PIC X(28) VALUE '663066316632663366346635663 6'.
01548   091300          03 FILLER PIC X(28) VALUE '663766386639664066426643664 4'.
01549   091400          03 FILLER PIC X(28) VALUE '664566466647664866496650665 1'.
01550   091500          03 FILLER PIC X(28) VALUE '665266536654665566566626664 '.
01551   091600          03 FILLER PIC X(28) VALUE '665966666667667166746679668 0'.
01552   091700          03 FILLER PIC X(28) VALUE '668166326701670267036704670 5'.
01553   091800          03 FILLER PIC X(28) VALUE '670667076708670967106711671 2'.
01554   091900          03 FILLER PIC X(28) VALUE '671367146715671667176718671 9'.
01555   092000          03 FILLER PIC X(28) VALUE '672067216722672367246725672 6'.
01556   092100          03 FILLER PIC X(28) VALUE '672767286729673067316732673 3'.
01557   092200          03 FILLER PIC X(28) VALUE '673467356736673767386739674 0'.
01558   092300          03 FILLER PIC X(28) VALUE '674267436744674567466747674 8'.
01559   092400          03 FILLER PIC X(28) VALUE '674967506751675267536754675 5'.
01560   092500          03 FILLER PIC X(28) VALUE '675667626764676567666767677 1'.
01561   092600          03 FILLER PIC X(28) VALUE '677467796780678167826 0AA0AB '.
01562   092700          03 FILLER PIC X(28) VALUE '0AC0AD0AE0AF0AG0AH0AJ0AK0AL0A'.
01563   092800          03 FILLER PIC X(28) VALUE '0AY0BA0BB0BC0BD0BE0BF0BG0BH0B'.
01564   092900          03 FILLER PIC X(28) VALUE '0BG0BH0BJ0BK0BL0BM0BN0BP0CA0CB'.
01565   093000          03 FILLER PIC X(28) VALUE '0CC0CD0CE0CF0CG0CH0CJ0CK0CL0C'.
01566   093100          03 FILLER PIC X(28) VALUE '0CJ0CK0CL0CM0CN0CP0CY0D0D1 0D'.
01567   093200          03 FILLER PIC X(28) VALUE '0D0D1 0D2 0D3 0D4 0D5 0D6 0D7'.
01568   093300          03 FILLER PIC X(28) VALUE '0D9 8BA8BB8BC8BD8BE8BF8BG8BH8B'.
01569   093400          03 FILLER PIC X(28) VALUE '8BA8BB8BC8BD8BE8BF8BG8BH8BJ8BK'.
01570   093500          03 FILLER PIC X(28) VALUE '8BM8BN8BP8BQ8BR8BS8BT8BU8BV8BW'.
01571   093600          03 FILLER PIC X(28) VALUE '8BX8BY8BZ8CA8CB8CC8CD8CE8CF8CG'.
01572   093700          03 FILLER PIC X(28) VALUE '8CH8CJ8CK8CL8CM8CN8CP8CQ8CR8CS'.
01573   093800          03 FILLER PIC X(28) VALUE '8CT8CU8CV8CW8CX8CY8CZ8DA8DB8DC'.
01574   093900          03 FILLER PIC X(28) VALUE '8DD8DE8DF8DG8DH8DJ8DK8DL8DM8DN'.
01575   094000          03 FILLER PIC X(28) VALUE '8DP8DQ8DR8DS8DT8DU8DV8DW8DX8DY'.
01576   094100          03 FILLER PIC X(28) VALUE '8DZ8EA8EB8EC8ED8EE8EF8EG8EH8EJ'.
01577   094200          03 FILLER PIC X(28) VALUE '8EK8EL8EM8EN8EP8EQ8ER8ES8ET8EU'.
01578   094300          03 FILLER PIC X(28) VALUE '8EV8EW8EX8EY8EZ8FA8FB8FC8FD8FE'.
01579   094400          03 FILLER PIC X(28) VALUE '8FF8FG8FH8FJ8FK8FL8FM8FN8FP8FQ'.
01580   094500          03 FILLER PIC X(28) VALUE '8FR8FS8FT8FU8FV8FW8FX8FY8FZ8GA'.
01581   094600          03 FILLER PIC X(28) VALUE '8GB8GC8GD8GE8GF8GG8GH8GJ8GK8GL'.
01582   094700          03 FILLER PIC X(28) VALUE '8GM8GN8GP8GQ8GR8GS8GT8GU8GV8GW'.
01583   094800          03 FILLER PIC X(28) VALUE '8GX8GY8GZ8HA8HB8HC8HD8HE8HF8HG'.
01584   094900          03 FILLER PIC X(28) VALUE '8HH8HJ8HK8HL8HM8HN8HP8HQ8HR8HS'.
01585   095000          03 FILLER PIC X(28) VALUE '8HT8HU8HV8HW8HX8HY8HZ8JA8JB8JC'.
01586   095100          03 FILLER PIC X(28) VALUE '8JD8JE8JF8JG8JH8JJ8JK8JL8JM8JN'.
01587   095200          03 FILLER PIC X(28) VALUE '8JP8JQ8JR8JS8JT8JU8JV8JW8JX8JY'.
01588   095300          03 FILLER PIC X(28) VALUE '8JZ8KA8KB8KC8KD8KE8KF8KG8KH8KJ'.
01589   095400          03 FILLER PIC X(28) VALUE '8KK8KL8KM8KN8KP8KQ8KR8KS8KT8KU'.
01590   095500          03 FILLER PIC X(28) VALUE '8KV8KW8KX8KY8KZ8LA8LB8LC8LD8LE'.
01591   095600          03 FILLER PIC X(28) VALUE '8LF8LG8LH8LJ8LK8LL8LM8LN8LP8LQ'.
01592   095700          03 FILLER PIC X(28) VALUE '8LR8LS8LT8LU8LV8LW8LX8LY8LZ8MA'.
01593   095800          03 FILLER PIC X(28) VALUE '8MB8MC8MD8ME8MF8MG8MH8MJ8MK8ML'.
01594   095900      02  CAUSE-FACTOR-02R REDEFINES CAUSE-FACTOR-02
01595   096000          OCCURS 500 TIMES PIC X(4).
01596   096100  01  SAVE-SUB-01.
01597   096200      02  SAVE-SUB OCCURS 16 TIMES PIC 99.
01598   096300  01  G-PG-1-01.
01599   096400      02  G-PG-1-02 OCCURS 4 TIMES.
01600   096500          03  G-PG-1 OCCURS 4 TIMES PIC 9(5).
01601   096600  01  PG-1-SERIOUS-01.
01602   096700      02  PG-1-SER-02 OCCURS 4 TIMES.
01603   096800          03  PG-1-SER OCCURS 4 TIMES PIC 9(5).
01604   096900  01  HOLD-ARRAY-01.
01605   097000      02  HOLD-ARRAY OCCURS 6 TIMES PIC X(3).
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 23        MTSB0001        11.47.53        04/09/76

01606   097100 01  C-SAVE-01.
01607   097200     02  C-SAVE-02 OCCURS 4 TIMES PIC 9(3).
01608   097300 01  CAUSE-FACTOR-HOLD.
01609   097400     02  FACTOR-02          PIC XX.
01610   097500     02  CAUSE-02           PIC XX.
01611   097600 01  GTERRAIN-01.
01612   097700     02  GTERRAIN-COUNT OCCURS 13 TIMES PIC 9(4).
01613   097800 01  G-SERIOUS.
01614   097900     02  GSER    OCCURS 5 TIMES INDEXED BY GS-INDEX.
01615   098000         03  GS   OCCURS 4 TIMES INDEXED BY  GSERIOUS-INDEX
01616   098100                                                    PIC 9(5).
01617   098200 01  F080B-01.
01618   098300     02  F080B-A                    PIC X(12).
01619   098400     02  FILLER          PIC X(6).
01620   098500 01  PAGE-4-WORK.
01621   098600     02  PAGE-4-W02  OCCURS 13 TIMES PIC X(91).
01622   098700 PROCEDURE DIVISION.
01623   098800     OPEN INPUT NTSB, HEAD
01624   098900          OUTPUT PRT.
01625   099000     MOVE SPACES TO FILL-ER.
01626   099100     MOVE SEVERITY-77 TO SEVERITY.
01627   099200     MOVE TERRAIN-77 TO TERRAIN-01.
01628   099300     MOVE TYPES-77 TO TYPES-01.
01629   099400     MOVE ZERO TO G-PG-1-01.
01630   099500     MOVE ZERO TO GTERRAIN-01.
01631   099600     MOVE ZERO TO GTOT-OP-01 G-SERIOUS G-CAUSE-FAT-01.
01632   099700     MOVE ZERO TO G-CAUSE-01 GTOT-TYP-01 G-SERIOUS G-PG-1-01.
01633   099800     MOVE ZERO TO G-CAUSE-NONFAT-01.
01634   099900     MOVE SPACES TO P-WORK.
01635   099910*
01636   099920******** PLACE PERCENT SYMBOL IN ITS FIELD
01637   099930*
01638   100000 MOVE-PCT.
01639   100100     ADD 1 TO I.
01640   100200     IF I GREATER THAN 13 MOVE ZERO TO I
01641   100300         GO TO READ-NTSB ELSE
01642   100400         MOVE PERCNT TO FILLER-4-03H (I)
01643   100500         GO TO MOVE-PCT.
01644   100600 READ-NTSB.
01645   100700     READ NTSB INTO NTSB-WORK AT END
01646   100800         CLOSE NTSB WITH LOCK
01647   100900         PERFORM PRINT-SUMMARY THRU END-PAGE-5
01648   101000         PERFORM INITIALIZE-COUNTERS THRU END-INITIALIZE
01649   101100         GO TO EOJ.
01650   101200*
01651   101300******** INITIALIZE COUNTERS AND FLAGS
01652   101400*
01653   101500 CHECK-HOLD.
01654   101600     IF NOT (F012 = HOLD-MAKE AND F013 = HOLD-MODEL)
01655   101700         ADD 1 TO SUMMARY-COUNTER
01656   101800         IF SUMMARY-COUNTER GREATER THAN 1
01657   101900             PERFORM PRINT-SUMMARY THRU END-PAGE-5.
01658   102000     IF NOT(F012 = HOLD-MAKE AND F013 = HOLD-MODEL)
01659   102100         PERFORM INITIALIZE-COUNTERS THRU END-INITIALIZE
01660   102200         MOVE F006 TO HOLD-MAKE-NAME
01661   102300         MOVE F012 TO HOLD-MAKE
01662   102400         MOVE F013 TO HOLD-MODEL.
01663   102500     MOVE 1 TO D.
01664   102600     ADD 1 TO GTOT-AC.
01665   102700     ADD 1 TO TOT-AC.
01666   102800*
01667   102900******** SEARCH TYPE OF ACCIDENT IN MAJOR FIELD BUT REJECT THOSE
01668   103000******** FOR WHICH A MATCH IS FOUND.
01669   103100*
01670   103200 SEARCH-TYPES.
01671   103300     ADD 1 TO J.
01672   103400     IF J GREATER THAN 12
01673   103500         MOVE ZERO TO J
01674   103600         MOVE '0' TO ADD-TOT-AC
01675   103700         GO TO TOTAL-AC.
01676   103800     IF TYYP  (J) = F02801
01677   103900         MOVE ZERO TO J
01678   104000         MOVE '1' TO ADD-TOT-AC
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01679  104400          GO TO READ-NTSB.
01680  104500      GO TO SEARCH-TYPES.
01681  104600 TOTAL-AC.
01682  104700*
01683  104800******* ACCUMULATE TOTAL FATALITIES, SERIOUS, MINOR & NONE
01684  104900*
01685  105000*         SKIP ALL Z CODES IN TOTAL ON BOARD AREA
01686  105100*
01687  105200      IF F02901 = 'C'
01688  105300          ADD 1 TO GTOT-T-O
01689  105400          ADD 1 TO TOT-T-O
01690  105500          IF F079 = 'F' ADD 1 TO FAT-TO
01691  105600              ADD 1 TO GFAT-TO.
01692  105700      IF F02901 = 'D'
01693  105800          ADD 1 TO GTOT-FLY
01694  105900          ADD 1 TO TOT-FLY
01695  106000          IF F079 = 'F' ADD 1 TO FAT-INFLT
01696  106100              ADD 1 TO GFAT-INFLT.
01697  106200      IF F02901 = 'E'
01698  106300          ADD 1 TO GTOT-LDG
01699  106400          ADD 1 TO TOT-LDG
01700  106500          IF F079 = 'F' ADD 1 TO FAT-LDG
01701  106600              ADD 1 TO GFAT-LDG.
01702  106700      IF F02901 = 'A' OR 'B'
01703  106800          ADD 1 TO GTOT-TS
01704  106900          ADD 1 TO TOT-TS
01705  107000          IF F079 = 'F' ADD 1 TO FAT-TS
01706  107100                        ADD 1 TO GFAT-TS.
01707  107200      IF F02901 = 'Z' OR ' '
01708  107300          ADD 1 TO GTOT-NR
01709  107400          ADD 1 TO TOT-NR
01710  107500          IF F079 = 'F' ADD 1 TO FAT-NR
01711  107600                        ADD 1 TO GFAT-NR.
01712  107610*
01713  107620******** CHECK OPERATIONAL PHASES - TAKE-OFF, IN FLIGHT & LANDING
01714  107630*
01715  107700      IF NOT (F02901 = 'C' OR 'D' OR 'E')
01716  107800          GO TO READ-NTSB.
01717  107900      ADD 1 TO TOT-AC-TYPE.
01718  108000      ADD 1 TO GTOT-AC-TYPE.
01719  108100      TRANSFORM F0808 (3) FROM SPACES TO ZEROS.
01720  108200      MOVE F08001018 (3,1,6) TO REC-TOT-OCC.
01721  108300      ADD REC-TOT-OCC TO TOT-OCC.
01722  108400      ADD REC-TOT-OCC TO GTOT-OCC.
01723  108500      IF TOT-AC-TYPE  NOT = ZERO
01724  108600      DIVIDE TOT-OCC BY TOT-AC-TYPE GIVING  AV-OCC ROUNDED.
01725  108700      IF GTOT-AC-TYPE NOT = ZERO
01726  108800      DIVIDE GTOT-OCC BY GTOT-AC-TYPE GIVING GAVG-OCC ROUNDED.
01727  108900*
01728  109000**** TALLY THE HIGHEST SEVERITY LEVEL RECORDED FOR THE ACCIDENT.
01729  109100**** FOR PAGE 1 SUMMARY USING TOTAL ON BOARD FIELD
01730  109200*
01731  109300      MOVE F08001018 (3,1,1) TO NTSBXY1.
01732  109400      MOVE F08001018 (3,1,2) TO NTSBXY2.
01733  109500      MOVE F08001018 (3,1,3) TO NTSBXY3.
01734  109600      MOVE F08001018 (3,1,4) TO NTSBXY4.
01735  109700      IF  F079 = 'F'
01736  109800          ADD 1 TO GTOT-FAT
01737  109900          ADD 1 TO TOT-FAT.
01738  110000      IF NTSBXY1              IS = ZEROS AND
01739  110100         NTSBXY2              IS NOT = ZEROS
01740  110200          ADD 1 TO GTOT-SER
01741  110300            ADD 1 TO TOT-SER.
01742  110400      IF NTSBXY1              IS = ZEROS AND
01743  110500         NTSBXY2              IS = ZEROS AND
01744  110600         NTSBXY3              IS NOT = ZEROS
01745  110700          ADD 1 TO GTOT-MNR
01746  110800            ADD 1 TO TOT-MNR.
01747  110900      IF NTSBXY1              IS = ZEROS AND
01748  111000         NTSBXY2              = ZERO AND
01749  111100         NTSBXY3              = ZERO AND
01750  111200         NTSBXY4              IS NOT = ZEROS
01751  111300          ADD 1 TO GTOT-NON
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01752   111400           ADD 1 TO TOT-NON.
01753   111500*
01754   111600******** ACCUMULATE INJURIES INTO PILOT, COPILOT, PASSENGERS AND
01755   111700******** OTHERS.  OTHERS TO INCLUDE DUAL STUDENT AND CHECK PILOT.
01756   111800*
01757   111900      MOVE 1 TO SER-SUB.
01758   112000 ACCUMULATE-PG-1.
01759   112100      IF SER-SUB = 5 MOVE 4 TO S-SUB
01760   112200          ELSE MOVE SER-SUB TO S-SUB.
01761   112300      IF SER-SUB = 1 MOVE F08001A (1)      TO HOLD-ARRAY-01.
01762   112400      IF SER-SUB = 2 MOVE F08001A (2)      TO HOLD-ARRAY-01.
01763   112500      IF SER-SUB = 3 MOVE F08001B (2,3)    TO HOLD-ARRAY-01.
01764   112600      IF SER-SUB = 4 MOVE F08001A (3)      TO HOLD-ARRAY-01.
01765   112700      IF SER-SUB = 5 MOVE F08001B (1,1)    TO HOLD-ARRAY-01.
01766   112800      MOVE HOLD-ARRAY (1) TO NTSBXY1.
01767   112900      MOVE HOLD-ARRAY (2) TO NTSBXY2.
01768   113000      MOVE HOLD-ARRAY (3) TO NTSBXY3.
01769   113100      MOVE HOLD-ARRAY (4) TO NTSBXY4.
01770   113200      ADD NTSBXY1 TO PG-1-SER (S-SUB, 1).
01771   113300      ADD NTSBXY2 TO PG-1-SER (S-SUB, 2).
01772   113400      ADD NTSBXY3 TO PG-1-SER (S-SUB, 3).
01773   113500      ADD NTSBXY4 TO PG-1-SER (S-SUB, 4).
01774   113600      ADD NTSBXY1 TO G-PG-1   (S-SUB, 1).
01775   113700      ADD NTSBXY2 TO G-PG-1   (S-SUB, 2).
01776   113800      ADD NTSBXY3 TO G-PG-1   (S-SUB, 3).
01777   113900      ADD NTSBXY4 TO G-PG-1   (S-SUB, 4).
01778   114000      ADD 1 TO SER-SUB.
01779   114100      IF SER-SUB GREATER THAN 5 NEXT SENTENCE
01780   114200          ELSE GO TO ACCUMULATE-PG-1.
01781   114300*
01782   114400******** CHECK FOR PRESENCE OF IMPACT ANGLE, IMPACT VELOCITY,
01783   114500******** STOPPING DISTANCE, SEAT FAILURE, SEAT BELT FAILURE OR ATT
01784   114600******** AT IMPACT.
01785   114700*
01786   114800 PRINT-CRITERIA.
01787   114900      IF F13302 = SPACES NEXT SENTENCE ELSE
01788   115000          EXAMINE F13302 TALLYING ALL 'Z'
01789   115100          IF TALLY = ZERO GO TO FORM-RECORD.
01790   115200      MOVE ZERO TO TALLY.
01791   115300      IF F136 = SPACES NEXT SENTENCE ELSE
01792   115400          EXAMINE F136 TALLYING ALL 'Z'
01793   115500          IF TALLY = ZERO GO TO FORM-RECORD.
01794   115600      MOVE ZERO TO TALLY.
01795   115700      IF F152 = SPACES NEXT SENTENCE ELSE
01796   115800          EXAMINE F152 TALLYING ALL 'Z'
01797   115900          IF TALLY = ZERO GO TO FORM-RECORD.
01798   116000      MOVE ZERO TO TALLY.
01799   116100      IF F139 = SPACES NEXT SENTENCE ELSE
01800   116200          EXAMINE F139 TALLYING ALL 'Z'
01801   116300          IF TALLY = ZERO GO TO FORM-RECORD.
01802   116400      MOVE ZERO TO TALLY.
01803   116500      IF F140 = SPACES NEXT SENTENCE ELSE
01804   116600          EXAMINE F140 TALLYING ALL 'Z'
01805   116700          IF TALLY = ZERO GO TO FORM-RECORD.
01806   116800      MOVE ZERO TO TALLY.
01807   116900      IF F151  = SPACES NEXT SENTENCE ELSE
01808   117000          EXAMINE F151 TALLYING ALL 'Z'
01809   117100          IF TALLY NOT = 3 MOVE ZERO TO TALLY
01810   117200          GO TO FORM-RECORD.
01811   117300      MOVE ZERO TO TALLY.
01812   117400      GO TO CABIN-INJURY.
01813   117500 FORM-RECORD.
01814   117600      MOVE '0' TO READER-SWITCH.
01815   117700      IF ADD-TOT-AC = '1'
01816   117800          MOVE '0' TO ADD-TOT-AC
01817   117900          ADD 1 TO GTOT-AC
01818   118000          ADD 1 TO TOT-AC.
01819   118100      WRITE P-REC FROM SPACE-LINE AFTER POSITIONING 0.
01820   118200      WRITE P-REC FROM SPACE-LINE AFTER POSITIONING 3.
01821   118300*
01822   118400******** CHECK DATE OF ACCIDENT
01823   118500      MOVE SPACES TO P-WORK.
01824   118600*
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01825   118700      IF F004 = SPACES OR F00401 = 'Z' NEXT SENTENCE ELSE
01826   118800          MOVE F004 TO DATE-HOLD-01A
01827   118900          MOVE DA TO DA-B
01828   119000      MOVE MO TO MO-B
01829   119100          MOVE YR TO YR-B
01830   119200          MOVE DATE-HOLD-01B TO FDATA
01831   119300          PERFORM MOVE-DIRECT.
01832   119400      ADD 1 TO D.
01833   119500*
01834   119600******** CHECK AIRCRAFT MAKE
01835   119700*
01836   119800      IF F006 = SPACES NEXT SENTENCE ELSE
01837   119900          MOVE F006 TO FDATA
01838   120000          PERFORM MOVE-DIRECT.
01839   120100      ADD 1 TO D.
01840   120200*
01841   120300******** CHECK AIRCRAFT MODEL
01842   120400*
01843   120500      IF F007 = SPACES NEXT SENTENCE ELSE
01844   120600          MOVE F007 TO FDATA
01845   120700      PERFORM MOVE-DIRECT.
01846   120800      ADD 1 TO D.
01847   120900      WRITE P-REC FROM SPACE-LINE AFTER POSITIONING 1.
01848   121000*
01849   121100******** CHECK AIRCRAFT DAMAGE
01850   121200*
01851   121300      IF F021 = SPACES OR 'Z' NEXT SENTENCE ELSE
01852   121400          MOVE SPACES TO HD-KEY
01853   121500          MOVE 013434 TO CCC
01854   121600          MOVE F021 TO CHAR1
01855   121700          PERFORM READER THRU REXIT.
01856   121800      ADD 1 TO D.
01857   121900*
01858   122000******** FIRE AFTER IMPACT
01859   122100*
01860   122200      IF F022 = SPACES OR 'Z' NEXT SENTENCE ELSE
01861   122300          MOVE SPACES TO HD-KEY
01862   122400          MOVE 013535 TO CCC
01863   122500          MOVE F022 TO CHAR1
01864   122600          PERFORM READER THRU REXIT.
01865   122700      ADD 1 TO D.
01866   122800*
01867   122900******** KIND OF FLYING
01868   123000*
01869   123100      IF F025 = SPACES OR 'CZ' OR 'DZ' NEXT SENTENCE ELSE
01870   123200          MOVE SPACES TO HD-KEY
01871   123300          MOVE 013940 TO CCC
01872   123400          MOVE F025 TO CODE2
01873   123500          PERFORM READER THRU REXIT.
01874   123600      ADD 1 TO D.
01875   123700      WRITE P-REC FROM SPACE-LINE AFTER POSITIONING 1.
01876   123800*
01877   123900******** FIRST TYPE OF ACCIDENT
01878   124000*
01879   124100      IF F028 = SPACES OR '7 ' NEXT SENTENCE ELSE
01880   124200          ADD 1 TO HEAD-COUNT
01881   124300          MOVE SPACES TO HD-KEY
01882   124400          MOVE 014447 TO CCC
01883   124500          MOVE F02801 TO CHAR2
01884   124600          PERFORM READER THRU REXIT.
01885   124700      IF F02802 NOT = SPACES
01886   124800          ADD 1 TO HEAD-COUNT
01887   124900          MOVE F02802 TO CHAR1
01888   125000          PERFORM READER THRU REXIT.
01889   125100      ADD 1 TO D.
01890   125200      MOVE ZERO TO HEAD-COUNT.
01891   125300      WRITE P-REC FROM SPACE-LINE AFTER POSITIONING 1.
01892   125400*
01893   125500******** FIRST PHASE OF OPERATION
01894   125600*
01895   125700      IF F029 = SPACES OR '7 ' NEXT SENTENCE ELSE
01896   125800          ADD 1 TO HEAD-COUNT
01897   125900          MOVE SPACES TO HD-KEY
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01898   126000           MOVE 014851 TO CCC
01899   126100           MOVE F02901 TO CHAR2
01900   126200           PERFORM READER THRU REXIT.
01901   126300       IF F02902 NOT = SPACES
01902   126400           ADD 1 TO HEAD-COUNT
01903   126500           MOVE F02902 TO CHAR1
01904   126600           PERFORM READER THRU REXIT.
01905   126700       ADD 1 TO D.
01906   126800       MOVE ZERO TO HEAD-COUNT.
01907   126900*
01908   127000******** SECONDARY TYPE OF ACCIDENT
01909   127100*
01910   127200       IF F030 = SPACES OR '7 ' NEXT SENTENCE ELSE
01911   127300           ADD 1 TO HEAD-COUNT
01912   127400           MOVE SPACES TO HD-KEY
01913   127500           MOVE 014447 TO CCC
01914   127600           MOVE F03001 TO CHAR2
01915   127700           PERFORM READER THRU REXIT.
01916   127800       IF F03002 NOT = SPACES
01917   127900           ADD 1 TO HEAD-COUNT
01918   128000           MOVE F03002 TO CHAR1
01919   128100           PERFORM READER THRU REXIT.
01920   128200       ADD 1 TO D.
01921   128300       MOVE ZERO TO HEAD-COUNT.
01922   128400*
01923   128500******** SECONDARY PHASE OF OPERATION
01924   128600*
01925   128700       IF F031 = SPACES OR 'Z ' NEXT SENTENCE ELSE
01926   128800           ADD 1 TO HEAD-COUNT
01927   128900           MOVE SPACES TO HD-KEY
01928   129000           MOVE 014851 TO CCC
01929   129100           MOVE F03101 TO CHAR2
01930   129200           PERFORM READER THRU REXIT.
01931   129300       IF F03102 NOT = SPACES
01932   129400           ADD 1 TO HEAD-COUNT
01933   129500           MOVE F03102 TO CHAR1
01934   129600           PERFORM READER THRU REXIT.
01935   129700       ADD 1 TO D.
01936   129800       MOVE ZERO TO HEAD-COUNT.
01937   129900*
01938   130000******** AIRCRAFT SPEED
01939   130100*
01940   130200       EXAMINE F034 TALLYING ALL 'Z'.
01941   130300       IF F034 = SPACES OR TALLY GREATER THAN ZERO NEXT SENTENCE
01942   130400           ELSE
01943   130500           EXAMINE F034 REPLACING LEADING ZERO BY SPACES
01944   130600           MOVE F034 TO FDATA
01945   130700           PERFORM MOVE-DIRECT.
01946   130800       ADD 1 TO D.
01947   130900       MOVE ZERO TO TALLY.
01948   131000*
01949   131100******** AIRPORT PROXIMITY
01950   131200*
01951   131300       IF F048 = SPACES OR 'Z' NEXT SENTENCE ELSE
01952   131400           MOVE SPACES TO HD-KEY
01953   131500           MOVE 023131 TO CCC
01954   131600           MOVE F048 TO CHAR1
01955   131700           PERFORM READER THRU REXIT.
01956   131800       ADD 1 TO D.
01957   131900*
01958   132000******** RUNWAY COMPOSITION
01959   132100*
01960   132200       IF F054 = SPACES OR 'Z' NEXT SENTENCE ELSE
01961   132300           MOVE SPACES TO HD-KEY
01962   132400           MOVE 026161 TO CCC
01963   132500           MOVE F054 TO CHAR1
01964   132600           PERFORM READER THRU REXIT.
01965   132700       ADD 1 TO D.
01966   132800*
01967   132900******** RUNWAY SURFACE
01968   133000*
01969   133100       IF F055 = SPACES OR 'Z' NEXT SENTENCE ELSE
01970   133200           MOVE SPACES TO HD-KEY
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01971   133300           MOVE 026262 TO CCC
01972   133400           MOVE F055 TO CHAR1
01973   133500           PERFORM READER THRU REXIT.
01974   133600       ADD 1 TO D.
01975   133700*
01976   133800******** RUNWAY HAZARDS
01977   133900*
01978   134000       IF F057 = SPACES OR 'Z' NEXT SENTENCE ELSE
01979   134100           MOVE SPACES TO HD-KEY
01980   134200           MOVE 026565 TO CCC
01981   134300           MOVE F057 TO CHAR1
01982   134400           PERFORM READER THRU REXIT.
01983   134500       ADD 1 TO D.
01984   134600*
01985   134700******** RUNWAY LENGTH
01986   134800*
01987   134900       EXAMINE F060 TALLYING ALL 'Z'.
01988   135000       IF F060 = SPACES OR TALLY GREATER THAN ZERO NEXT SENTENCE
01989   135100           ELSE
01990   135200           EXAMINE F060 REPLACING LEADING ZERO BY SPACES
01991   135300           MOVE F060 TO FDATA
01992   135400           PERFORM MOVE-DIRECT.
01993   135500       ADD 1 TO D.
01994   135600       MOVE ZERO TO TALLY.
01995   135700*
01996   135800******** TERRAIN TYPE
01997   135900*
01998   136000       IF F065 = SPACES OR 'Z' NEXT SENTENCE ELSE
01999   136100           MOVE SPACES TO HD-KEY
02000   136200           MOVE 042222 TO CCC
02001   136300           MOVE F065 TO CHAR1
02002   136400           PERFORM READER THRU REXIT.
02003   136500       ADD 1 TO D.
02004   136600*
02005   136700******** CAUSE / FACTOR
02006   136800*
02007   136900       MOVE 1 TO CFF.
02008   137000       MOVE SPACES TO P-WORK
02009   137100       WRITE P-REC FROM SPACE-LINE AFTER POSITIONING 1.
02010   137200       MOVE '                                    CAUSE / FACTOR' TO
02011   137300           DESCRIPTION.
02012   137400       WRITE P-REC FROM P-WORK AFTER POSITIONING 1.
02013   137500       PERFORM C-F-PRINT THRU C-F-EXIT UNTIL CFF GREATER THAN 10.
02014   137600       MOVE ZERO TO HEAD-COUNT.
02015   137700*
02016   137800******** INJURY INDEX
02017   137900*
02018   138000       MOVE SPACES TO P-WORK.
02019   138100       WRITE P-REC FROM SPACE-LINE AFTER POSITIONING 1.
02020   138200       MOVE '                                    INJURY - INDEX' TO
02021   138300           DESCRIPTION.
02022   138400       WRITE P-REC FROM P-WORK AFTER POSITIONING 1.
02023   138500       MOVE SPACES TO P-WORK.
02024   138600       MOVE ' F   S   M   N   Z   T   ' TO DATAA.
02025   138700       WRITE P-REC FROM P-WORK AFTER POSITIONING 1.
02026   138800       MOVE SPACES TO P-WORK.
02027   138900  INJ-PRINT.
02028   139000       IF F080A = SPACES GO TO CHECK-PILOT.
02029   139100       PERFORM UNIQUE THRU END-UNIQUE 3 TIMES.
02030   139200       MOVE 1 TO INJ1.
02031   139300*
02032   139400******** CHECK PILOT INJURIES
02033   139500*
02034   139600  CHECK-PILOT.
02035   139700       IF F08001B (1, 1) = ZERO   NEXT SENTENCE ELSE
02036   139800           MOVE F08001B (1, 1) TO F08001A (1)
02037   139900           PERFORM UNIQUE THRU END-UNIQUE.
02038   140000       MOVE 1 TO INJ1.
02039   140100       IF F08001B (1, 1) = ZERO   ADD 1 TO D.
02040   140200*
02041   140300******** PASSENGER INJURIES
02042   140400*
02043   140500       IF F08001B (2, 3) = ZERO   NEXT SENTENCE ELSE
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02044  140600          MOVE F080018 (2, 3) TO F08001A (1)
02045  140700          PERFORM UNIQUE THRU END-UNIQUE.
02046  140800      MOVE 1 TO INJ1.
02047  140900      IF F080018 (2, 3) = ZERO    ADD 1 TO D.
02048  141000*
02049  141100******** TOTAL ABOARD INJURIES
02050  141200*
02051  141300      IF F080018 (3, 1) = ZERO    NEXT SENTENCE ELSE
02052  141400          MOVE F080018 (3, 1) TO F08001A (1)
02053  141500          PERFORM UNIQUE THRU END-UNIQUE.
02054  141600      MOVE 1 TO INJ1.
02055  141700 AFTER-INJURY.
02056  141800      IF F080018 (3, 1) = ZERO    ADD 1 TO D.
02057  141900      WRITE P-REC FROM SPACE-LINE AFTER POSITIONING 1.
02058  142000*
02059  142100******** REMARKS
02060  142200*
02061  142300      IF F08202 = SPACES NEXT SENTENCE ELSE
02062  142400          MOVE F08202 TO FDATA
02063  142500          PERFORM MOVE-DIRECT.
02064  142600      ADD 1 TO D.
02065  142700*
02066  142800******** SECOND REMARK
02067  142900*
02068  143000      IF F07801 (1) = '84' OR F083 = SPACES NEXT SENTENCE ELSE
02069  143100          MOVE F083 TO FDATA
02070  143200          PERFORM MOVE-DIRECT.
02071  143300      ADD 1 TO D.
02072  143400*
02073  143500******** AIRCRAFT SERIAL NUMBER
02074  143600*
02075  143700      IF F094 = SPACES OR F09401 = 'Z' NEXT SENTENCE ELSE
02076  143800          MOVE F094 TO FDATA
02077  143900          PERFORM MOVE-DIRECT.
02078  144000      ADD 1 TO D.
02079  144100*
02080  144200******** IMPACT SEVERITY
02081  144300*
02082  144400      IF F13101 = SPACES OR 'Z' OR ZERO NEXT SENTENCE ELSE
02083  144500          MOVE SPACES TO HD-KEY
02084  144600          MOVE 202323 TO CCC
02085  144700          MOVE F13301 TO CHAR1
02086  144800          PERFORM READER THRU REXIT.
02087  144900      ADD 1 TO D.
02088  145000*
02089  145100******** ANGLE OF IMPACT
02090  145200*
02091  145300      IF F13302 = SPACES OR ' Z' NEXT SENTENCE ELSE
02092  145400          MOVE F13302 TO FDATA
02093  145500          PERFORM MOVE-DIRECT.
02094  145600      ADD 1 TO D.
02095  145700*
02096  145800******** RATE OF DECELERATION
02097  145900*
02098  146000      IF F134 = SPACES OR 'Z' NEXT SENTENCE ELSE
02099  146100          MOVE SPACES TO HD-KEY
02100  146200          MOVE 202626 TO CCC
02101  146300          MOVE F134 TO CHAR1
02102  146400          PERFORM READER THRU REXIT.
02103  146500      ADD 1 TO D.
02104  146600*
02105  146700******** DIRECTION OF PRINCIPLE DECELERATION
02106  146800*
02107  146900      IF F135 = SPACES OR 'Z' NEXT SENTENCE ELSE
02108  147000          MOVE SPACES TO HD-KEY
02109  147100          MOVE 202727 TO CCC
02110  147200          MOVE F135 TO CHAR1
02111  147300          PERFORM READER THRU REXIT.
02112  147400      ADD 1 TO D.
02113  147500*
02114  147600******** STOPPING DISTANCE
02115  147700*
02116  147800      IF F136 = SPACES OR '   Z' OR ZERO NEXT SENTENCE ELSE
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02117   147900          EXAMINE F136 REPLACING LEADING ZERO BY SPACES
02118   148000          MOVE F136 TO FDATA
02119   148100          PERFORM MOVE-DIRECT.
02120   148200      ADD 1 TO D.
02121   148300*
02122   148400******** DAMAGE SEVERITY - IMPACT
02123   148500*
02124   148600      IF F13705 = SPACES OR 'Z' NEXT SENTENCE ELSE
02125   148700          MOVE SPACES TO HD-KEY
02126   148800          MOVE 203636 TO CCC
02127   148900          MOVE F13705 TO CHAR1
02128   149000          PERFORM READER THRU REXIT.
02129   149100      ADD 1 TO D.
02130   149200*
02131   149300******** SEATING CONFIGURATION
02132   149400*
02133   149500      IF F138 = SPACES OR 'Z' NEXT SENTENCE ELSE
02134   149600          MOVE SPACES TO HD-KEY
02135   149700          MOVE 203737 TO CCC
02136   149800          MOVE F138 TO CHAR1
02137   149900          PERFORM READER THRU REXIT.
02138   150000      ADD 1 TO D.
02139   150100*
02140   150200******** SEAT FAILURES
02141   150300*
02142   150400      IF F139 = SPACES OR '  Z' OR ZERO NEXT SENTENCE ELSE
02143   150500          EXAMINE F139 REPLACING LEADING ZERO BY SPACES
02144   150600          MOVE F139 TO FDATA
02145   150700          PERFORM MOVE-DIRECT.
02146   150800      ADD 1 TO D.
02147   150900*
02148   151000******** SEAT BELT FAILURES
02149   151100*
02150   151200
02151   151300      IF F140 = SPACES OR '  Z' OR ZERO NEXT SENTENCE ELSE
02152   151400          EXAMINE F140 REPLACING LEADING ZERO BY SPACES
02153   151500          MOVE F140 TO FDATA
02154   151600          PERFORM MOVE-DIRECT.
02155   151700      ADD 1 TO D.
02156   151800*
02157   151900******** DEATHS FROM FIRE AFTER IMPACT
02158   152000*
02159   152100      IF F141 = SPACES OR '  Z' OR ZERO NEXT SENTENCE ELSE
02160   152200          EXAMINE F141 REPLACING LEADING ZERO BY SPACES
02161   152300          MOVE F141 TO FDATA
02162   152400          PERFORM MOVE-DIRECT.
02163   152500      ADD 1 TO D.
02164   152600      MOVE '1' TO READER-SWITCH.
02165   152700*
02166   152800******** ATTITUDE AT IMPACT
02167   152900*
02168   153000      IF F151 = 'ZZZ'
02169   153100          ADD 3 TO D
02170   153200          GO TO AFTER-ATTITUDE.
02171   153300      IF F15101 = 'Z' NEXT SENTENCE ELSE
02172   153400          IF F15101 = SPACES MOVE SPACES TO ATTITUDE-1 ELSE
02173   153500              MOVE SPACES TO HD-KEY
02174   153600              MOVE 206464 TO CCC
02175   153700              MOVE F15101 TO CHAR1
02176   153800              PERFORM READER THRU REXIT
02177   153900              MOVE FDATA TO ATT-WORK
02178   154000              MOVE ATT-02 TO ATTITUDE-1.
02179   154100      ADD 1 TO D.
02180   154200      IF F15102 = 'Z' NEXT SENTENCE ELSE
02181   154300          IF F15102 = SPACES MOVE SPACES TO ATTITUDE-2 ELSE
02182   154400              MOVE SPACE TO HD-KEY
02183   154500              MOVE 206565 TO CCC
02184   154600              MOVE F15102 TO CHAR1
02185   154700              PERFORM READER THRU REXIT
02186   154800              MOVE FDATA TO ATT-WORK
02187   154900              MOVE ATT-02 TO ATTITUDE-2.
02188   155000      ADD 1 TO D.
02189   155100      IF F15103 = 'Z' NEXT SENTENCE ELSE
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02190   155200           IF F15103 = SPACES MOVE SPACES TO ATTITUDE-3 ELSE
02191   155300               MOVE SPACES TO HD-KEY
02192   155400               MOVE 206666 TO CCC
02193   155500               MOVE F15103 TO CHAR1
02194   155600               PERFORM READER THRU REXIT
02195   155700               MOVE FDATA TO ATT-WORK
02196   155800               MOVE ATT-02 TO ATTITUDE-3.
02197   155900       ADD 1 TO D.
02198   156000 AFTER-ATTITUDE.
02199   156100       MOVE '0' TO READER-SWITCH.
02200   156200*
02201   156300******** SPEED AT IMPACT
02202   156400*
02203   156500       IF F152 = SPACES OR '  Z' NEXT SENTENCE ELSE
02204   156600           MOVE F152 TO FDATA
02205   156700           PERFORM MOVE-DIRECT.
02206   156800       ADD 1 TO D.
02207   156900*
02208   157000******** TEST FOR AGRICULTURAL AIRCRAFT
02209   157100*
02210   157200       IF F02501 = 'C' AND (F02502 = 'A' OR 'B' OR 'C' OR 'D')
02211   157300           NEXT SENTENCE ELSE ADD 10 TO D GO TO CABIN-INJURY.
02212   157400*
02213   157500******** KIND OF OPERATION
02214   157600M
02215   157700       IF F192 = SPACES OR 'Z' NEXT SENTENCE ELSE
02216   157800           MOVE SPACES TO HD-KEY
02217   157900           MOVE 252121 TO CCC
02218   158000           MOVE F192 TO CHAR1
02219   158100           PERFORM READER THRU REXIT.
02220   158200       ADD 1 TO D.
02221   158300*
02222   158400******** SHOULDER HARNESS USED
02223   158500*
02224   158600       IF F198 = SPACES OR 'Z' NEXT SENTENCE ELSE
02225   158700           MOVE SPACES TO HD-KEY
02226   158800           MOVE 252727 TO CCC
02227   158900           MOVE F198 TO CHAR1
02228   159000           PERFORM READER THRU REXIT.
02229   159100       ADD 1 TO D.
02230   159200*
02231   159300******** SEAT BELT STATUS
02232   159400*
02233   159500       IF F199 = SPACES OR 'Z' NEXT SENTENCE ELSE
02234   159600           MOVE SPACES TO HD-KEY
02235   159700           MOVE 252828 TO CCC
02236   159800           MOVE F199 TO CHAR1
02237   159900           PERFORM READER THRU REXIT.
02238   160000       ADD 1 TO D.
02239   160100*
02240   160200******** CRASH HELMET STATUS
02241   160300*
02242   160400       IF F204 = SPACES OR 'Z' NEXT SENTENCE ELSE
02243   160500           MOVE SPACES TO HD-KEY
02244   160600           MOVE 253333 TO CCC
02245   160700           MOVE F204 TO CHAR1
02246   160800           PERFORM READER THRU REXIT.
02247   160900       ADD 1 TO D.
02248   161000*
02249   161100******** COCKPIT CRASH PAD STATUS
02250   161200*
02251   161300       IF F205 = SPACES OR 'Z' NEXT SENTENCE ELSE
02252   161400           MOVE SPACES TO HD-KEY
02253   161500           MOVE 253434 TO CCC
02254   161600           MOVE F205 TO CHAR1
02255   161700           PERFORM READER THRU REXIT.
02256   161800       ADD 1 TO D.
02257   161900*
02258   162000******** CRASH BAR STATUS
02259   162100*
02260   162200       IF F206 = SPACES OR 'Z' NEXT SENTENCE ELSE
02261   162300           MOVE SPACES TO HD-KEY
02262   162400           MOVE 253535 TO CCC
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02263   162500          MOVE F206 TO CHAR1
02264   162600          PERFORM READER THRU REXIT.
02265   162700      ADD 1 TO D.
02266   162800*
02267   162900******** OBSTRUCTION STATUS
02268   163000*
02269   163100      IF F20901 = SPACES OR 'Z' NEXT SENTENCE ELSE
02270   163200          MOVE SPACES TO HD-KEY
02271   163300          MOVE 255153 TO CCC
02272   163400          MOVE F20901 TO CHAR1
02273   163500          PERFORM READER THRU REXIT.
02274   163600      ADD 1 TO D.
02275   163700      IF F20902 = SPACES OR 'Z' NEXT SENTENCE ELSE
02276   163800          MOVE SPACES TO HD-KEY
02277   163900          MOVE 255153 TO CCC
02278   164000          MOVE F20902 TO CHAR1
02279   164100          PERFORM READER THRU REXIT.
02280   164200      ADD 1 TO D.
02281   164300      IF F20903 = SPACES OR 'Z' NEXT SENTENCE ELSE
02282   164400          MOVE SPACES TO HD-KEY
02283   164500          MOVE 255153 TO CCC
02284   164600          MOVE F20903 TO CHAR1
02285   164700          PERFORM READER THRU REXIT.
02286   164800      ADD 1 TO D.
02287   164900*
02288   165000******** TERRAIN TYPE
02289   165100*
02290   165200      IF F21001 = SPACES NEXT SENTENCE ELSE
02291   165300          MOVE SPACES TO HD-KEY
02292   165400          MOVE 255456 TO CCC
02293   165500          MOVE F21001 TO CHAR1
02294   165600          PERFORM READER THRU REXIT.
02295   165700      ADD 1 TO D.
02296   165800      IF F21002 = SPACES NEXT SENTENCE ELSE
02297   165900          MOVE SPACES TO HD-KEY
02298   166000          MOVE 255456 TO CCC
02299   166100          MOVE F21003 TO CHAR1
02300   166200          PERFORM READER THRU REXIT.
02301   166300*
02302   166400*                        INJURY SUMMARIES
02303   166500*
02304   166600*         DID INJURY OCCUR IN CABIN
02305   166700*
02306   166800 CABIN-INJURY.
02307   166900*
02308   167000******** COLLECT PAGE 2 INFORMATION **********************************
02309   167100*
02310   167200      IF ADD-TOT-AC = '1'
02311   167300          ADD 1 TO TOT-AC
02312   167400          ADD 1 TO GTOT-AC.
02313   167500      MOVE F080018 (3, 1) TO F0808-01.
02314   167505      DISPLAY 'STATEMENT 168100, F3808-01 = ' F0808-01.
02315   167600      IF F0808-A  = ZERO    GO TO IMPACT-ANGLE.
02316   167700*
02317   167800******** CHECK AND TALLY MINOR OPERATIONAL PHASES
02318   167900*
02319   168000      MOVE 42 TO HISAVE.
02320   168100      MOVE F029 TO SEARCH-CODE.
02321   168200      PERFORM OP-SEARCH THRU END-OP.
02322   168300      IF FOUND-WORD = '1' MOVE ZERO TO FOUND-WORD
02323   168400          GO TO LOAD-ARRAY.
02324   168500      GO TO CHECK-TYPES.
02325   168600*
02326   168700******** CHECK TOTAL ON BOARD AREA FOR VALUES IN INJURY CATEGORIES
02327   168800*
02328   168900 LOAD-ARRAY.
02329   169000      MOVE '0' TO BEEN-THERE.
02330   169100      IF F08001018 (3,1,1) NOT = ZERO
02331   169200          MOVE 1 TO OP
02332   169300          PERFORM SERIOUS-B THRU END-SERIOUS-B.
02333   169400      IF F08001018 (3,1,2) NOT = ZERO
02334   169500          MOVE 2 TO OP
02335   169600          PERFORM SERIOUS-B THRU END-SERIOUS-B.
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02336   170600      IF F08001018 (3,1,3) NOT = ZERO
02337   170700          MOVE 3 TO OP
02338   170800          PERFORM SERIOUS-B THRU END-SERIOUS-B.
02339   170900      IF F08001018 (3,1,4) NOT = ZERO
02340   171000          MOVE 4 TO OP
02341   171100          PERFORM SERIOUS-B THRU END-SERIOUS-B.
02342   171200
02343   171300*
02344   171400******** CHECK AND TALLY TYPES OF ACCIDENTS
02345   171500*
02346   171600 CHECK-TYPES.
02347   171700      MOVE 22 TO HISAVE.
02348   171800      MOVE F02801 TO SEARCH-TYPE.
02349   171900      PERFORM TYPE-SEARCH THRU END-TYPE.
02350   172000      IF FOUND-WORD = '1' MOVE ZERO TO FOUND-WORD
02351   172100          GO TO COLLECT-TYPES.
02352   172200      GO TO IMPACT-ANGLE.
02353   172300
02354   172400 COLLECT-TYPES.
02355   172500      MOVE '0' TO BEEN-THERE.
02356   172600      IF F08001018 (3,1,1) NOT = ZERO
02357   172700          MOVE 1 TO OP
02358   172800          PERFORM TYPE-COLLECT THRU END-COLLECT.
02359   172900      IF F08001018 (3,1,2) NOT = ZERO
02360   173000          MOVE 2 TO OP
02361   173100          PERFORM TYPE-COLLECT THRU END-COLLECT.
02362   173200      IF F08001018 (3,1,3) NOT = ZERO
02363   173300          MOVE 3 TO OP
02364   173400          PERFORM TYPE-COLLECT THRU END-COLLECT.
02365   173500
02366   173600      IF F08001018 (3,1,4) NOT = ZERO
02367   173700          MOVE 4 TO OP
02368   173800          PERFORM TYPE-COLLECT THRU END-COLLECT.
02369   173900
02370   174000 IMPACT-ANGLE.
02371   174200      IF F13302 = SPACES GO TO IMPACT-VELOCITY.
02372   174300      MOVE ZERO TO TALLY.
02373   174400      EXAMINE F13302 TALLYING ALL 'Z'.
02374   174500      IF TALLY NOT = ZERO GO TO IMPACT-VELOCITY.
02375   174600      IF F13302 IS GREATER THAN  ' ' AND LESS THAN  '16'
02376   174700          ADD 1 TO G-ANG-15
02377   174800          ADD 1 TO ANGLE-15.
02378   174900      IF F13302 IS GREATER THAN  '15' AND LESS THAN  '31'
02379   175000          ADD 1 TO G-ANG-30
02380   175100          ADD 1 TO ANGLE-30.
02381   175200      IF F13302 IS GREATER THAN  '30' AND LESS THAN  '46'
02382   175300          ADD 1 TO G-ANG-45
02383   175400          ADD 1 TO ANGLE-45.
02384   175500      IF F13302 IS GREATER THAN  '45' AND LESS THAN  '61'
02385   175600          ADD 1 TO G-ANG-60
02386   175700          ADD 1 TO ANGLE-60.
02387   175800      IF F13302 IS GREATER THAN  '60' AND LESS THAN  '76'
02388   175900          ADD 1 TO G-ANG-75
02389   176000          ADD 1 TO ANGLE-75.
02390   176100      IF F13302 IS GREATER THAN  '75' AND LESS THAN  '90'
02391   176200          ADD 1 TO G-ANG-90
02392   176300          ADD 1 TO ANGLE-90.
02393   176400      IF F13302 IS GREATER THAN  '89'
02394   176500          ADD 1 TO G-ANG-90-PLUS
02395   176600          ADD 1 TO ANGLE-90-PLUS.
02396   176700      ADD 1 TO GTOT-ACC-ANG.
02397   176800      ADD 1 TO TOT-ACC-ANG.
02398   176900      TRANSFORM F13302 FROM SPACES TO ZERO.
02399   177000      MOVE F13302 TO ANGLE-01.
02400   177100      ADD ANGLE-02 TO ANGLE-SUM.
02401   177200      ADD ANGLE-02 TO G-ANG-SUM.
02402   177300      DIVIDE ANGLE-SUM BY TOT-ACC-ANG GIVING AVG-ANGLE  ROUNDED.
02403   177400      DIVIDE G-ANG-SUM BY GTOT-ACC-ANG GIVING G-AVG-ANGLE ROUNDED.
02404   177500
02405   177600 IMPACT-VELOCITY.
02406   177700      EXAMINE F152   REPLACING LEADING ZERO BY SPACES.
02407   177800      IF F152 = SPACES GO TO STOPPING-DISTANCE.
02408   177900      MOVE ZERO TO TALLY.
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02409   178000      EXAMINE F152 TALLYING ALL 'Z'.
02410   178100      IF TALLY NOT = ZERO GO TO STOPPING-DISTANCE.
02411   178200      IF F152 GREATER THAN '   ' AND LESS THAN ' 31'
02412   178300          ADD 1 TO G-VEL-30
02413   178400          ADD 1 TO VEL-30.
02414   178500      IF F152 GREATER THAN ' 30' AND LESS THAN ' 61'
02415   178600          ADD 1 TO G-VEL-60
02416   178700          ADD 1 TO VEL-60.
02417   178800      IF F152 GREATER THAN ' 60' AND LESS THAN ' 91'
02418   178900          ADD 1 TO G-VEL-90
02419   179000          ADD 1 TO VEL-90.
02420   179100      IF F152 GREATER THAN ' 90' AND LESS THAN '120'
02421   179200          ADD 1 TO G-VEL-120
02422   179300          ADD 1 TO VEL-120.
02423   179400      IF F152 GREATER THAN '119'
02424   179500          ADD 1 TO G-VEL-120-PLUS
02425   179600          ADD 1 TO VEL-120-PLUS.
02426   179700      ADD 1 TO TOT-ACC-VEL.
02427   179800      ADD 1 TO GTOT-ACC-VEL.
02428   179900      TRANSFORM F152 FROM SPACES TO ZERO.
02429   180000      MOVE F152 TO VEL-01.
02430   180100      ADD VEL-02 TO VEL-SUM.
02431   180200      ADD VEL-02 TO G-VEL-SUM.
02432   180300      DIVIDE VEL-SUM BY TOT-ACC-VEL GIVING AVG-VEL ROUNDED.
02433   180400      DIVIDE G-VEL-SUM BY GTOT-ACC-VEL GIVING G-AVG-VEL ROUNDED.
02434   180500
02435   180600  STOPPING-DISTANCE.
02436   180700      EXAMINE F136   REPLACING LEADING ZERO BY SPACES.
02437   180800      IF F136 = SPACES GO TO OCCUPANT-INJURY.
02438   180900      MOVE ZERO TO TALLY.
02439   181000      EXAMINE F136 TALLYING ALL 'Z'.
02440   181100      IF TALLY NOT = ZERO GO TO SEAT-BELT-FAILURE.
02441   181200      IF F136 IS GREATER THAN '    ' AND LESS THAN '  59'
02442   181300          ADD 1 TO G-DIST-10
02443   181400          ADD 1 TO DIST-10.
02444   181500      IF F136 IS GREATER THAN '  59' AND LESS THAN ' 120'
02445   181600          ADD 1 TO G-DIST-20
02446   181700          ADD 1 TO DIST-20.
02447   181800      IF F136 IS GREATER THAN ' 119' AND LESS THAN ' 180'
02448   181900          ADD 1 TO G-DIST-30
02449   182000          ADD 1 TO DIST-30.
02450   182100      IF F136 IS GREATER THAN ' 179' AND LESS THAN ' 240'
02451   182200          ADD 1 TO G-DIST-40
02452   182300          ADD 1 TO DIST-40.
02453   182400      IF F136 IS GREATER THAN ' 239' AND LESS THAN ' 300'
02454   182500          ADD 1 TO G-DIST-50
02455   182600          ADD 1 TO DIST-50.
02456   182700      IF F136 IS GREATER THAN ' 299' AND LESS THAN ' 360'
02457   182800          ADD 1 TO G-DIST-60
02458   182900          ADD 1 TO DIST-60.
02459   183000      IF F136 IS GREATER THAN ' 359'
02460   183100      ADD 1 TO G-DIST-60-PLUS
02461   183200          ADD 1 TO DIST-60-PLUS.
02462   183300      ADD 1 TO TOT-ACC-DIST.
02463   183400      ADD 1 TO  GTOT-ACC-DIST.
02464   183500      TRANSFORM F136 FROM SPACES TO ZEROS.
02465   183600      MOVE F136 TO DIST-01.
02466   183700      ADD DIST-02 TO DIST-SUM.
02467   183800      ADD DIST-02 TO G-DIST-SUM.
02468   183900      DIVIDE DIST-SUM BY TOT-ACC-DIST GIVING AVG-DIST ROUNDED.
02469   184000      DIVIDE G-DIST-SUM BY GTOT-ACC-DIST GIVING G-AVG-DIST ROUNDED.
02470   184100  OCCUPANT-INJURY.
02471   184200*
02472   184300*******  NUMERICAL OCCUPANT INJURY SUMMARY
02473   184400*
02474   184500      IF F13705 IS = SPACES OR 'Z' GO TO TERRAIN-CHECK.
02475   184600      PERFORM SEVERITY-TEST THRU END-SEVERITY VARYING
02476   184700          SEVERITY-INDEX FROM 1 BY 1
02477   184800          UNTIL SEVERITY-INDEX GREATER THAN 5.
02478   184900      IF SEVERITY-INDEX IS GREATER THAN 5
02479   185000          GO TO TERRAIN-CHECK.
02480   185100  PERFORM-SERIOUS.
02481   185200      PERFORM SERIOUS-TEST THRU END-SERIOUS VARYING
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02482  185300           SERIOUS-INDEX FROM 1 BY 1
02483  185400           UNTIL SERIOUS-INDEX GREATER THAN 4.
02484  185500*
02485  185600******** SEARCH FOR ACCEPTABLE TERRAIN TYPE.  IF FOUND INCREMENT
02486  185700******** THAT TERRAIN COUNT BY 1.
02487  185800*
02488  185900 TERRAIN-CHECK.
02489  186000      IF F065 = SPACES MOVE 'Z' TO F065.
02490  186100      PERFORM TERRAIN-A THRU END-TERRAIN VARYING TERRAIN-INDEX
02491  186200          FROM 1 BY 1 UNTIL F065 = TERRAIN (TERRAIN-INDEX) OR
02492  186300          TERRAIN-INDEX GREATER THAN 13.
02493  186400      IF TERRAIN-INDEX GREATER THAN 13 GO TO SEAT-BELT-FAILURE.
02494  186500      SET TER-IND TO TERRAIN-INDEX.
02495  186600      ADD 1 TO GTERRAIN-COUNT (TER-IND).
02496  186700      ADD 1 TO TERRAIN-COUNT (TER-IND).
02497  186800 SEAT-BELT-FAILURE.
02498  186900      IF F140 = SPACES OR ZERO  GO TO SEAT-FAILURE.
02499  187000      MOVE ZERO TO TALLY.
02500  187100      EXAMINE F140 TALLYING ALL 'Z'.
02501  187200      IF TALLY NOT = ZERO GO TO SEAT-FAILURE.
02502  187300      ADD 1 TO GTOT-STBLT-ACC.
02503  187400      ADD 1 TO TOT-STBLT-ACC.
02504  187500      TRANSFORM F140 FROM SPACES TO ZERO.
02505  187600      MOVE F140 TO S-B-01.
02506  187700      ADD SEAT-BELT TO TOT-STBLT-FAIL.
02507  187800      ADD SEAT-BELT TO GTOT-STBLT-FAIL.
02508  187900 SEAT-FAILURE.
02509  188000      IF F139 = SPACES OR ZERO GO TO AG-PLANE.
02510  188100      MOVE ZERO TO TALLY.
02511  188200      EXAMINE F139 TALLYING ALL 'Z'.
02512  188300      IF TALLY NOT = ZERO GO TO AG-PLANE.
02513  188400      ADD 1 TO GTOT-ST-ACC.
02514  188500      ADD 1 TO TOT-ST-ACC.
02515  188600      TRANSFORM F139 FROM SPACES TO ZERO.
02516  188700      MOVE F139 TO S-01.
02517  188800      ADD SEAT TO TOT-ST-FAIL.
02518  188900      ADD SEAT TO GTOT-ST-FAIL.
02519  189000
02520  189100 AG-PLANE.
02521  189200      MOVE F012 TO MK.
02522  189300      MOVE F013 TO MOD.
02523  189400      IF MK-MOD = '03932' OR '07113' OR
02524  189500          '03405' OR '12426' OR '14803'
02525  189600          NEXT SENTENCE ELSE GO TO CAUSE-FACTOR-P.
02526  189700      IF F198 = 'A' OR 'B' OR 'C' OR 'E'
02527  189800          ADD 1 TO GS-H-INST
02528  189900          ADD 1 TO S-H-INSTALLED.
02529  190000      IF F198 = 'A' OR 'C' OR 'E'
02530  190100          ADD 1 TO GS-H-USED
02531  190200          ADD 1 TO S-H-USED.
02532  190300      IF F198 = 'B'
02533  190400          ADD 1 TO GS-H-FAILED
02534  190500          ADD 1 TO S-H-FAILED.
02535  190600      IF F204 = 'A'
02536  190700          ADD 1 TO GHEL-USED
02537  190800          ADD 1 TO HELMET-USED.
02538  190900      IF F204 = 'B'
02539  191000          ADD 1 TO GHEL-UNUSED
02540  191100          ADD 1 TO HELMET-UNUSED.
02541  191200*
02542  191300******** CAUSE-FACTOR SUMMARY
02543  191400*
02544  191500 CAUSE-FACTOR-P.
02545  191600      MOVE 487 TO HISAVE.
02546  191700      MOVE 1 TO CFF.
02547  191710*
02548  191720******** THIS PERFORM IS DONE 10 TIMES BECAUSE THERE ARE A POSSIBLE
02549  191730******** 10 CAUSE/FACTORS IN THE CAUSE-FACTOR FIELD
02550  191740*
02551  191800      PERFORM C-F-SEARCH THRU END-CF-SEARCH UNTIL CFF IS
02552  191900          GREATER THAN 10.
02553  192000      GO TO READ-NTSB.
02554  192100*
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02555  192200******** PRINT SUMMARIES
02556  192300*
02557  192400 PRINT-SUMMARY.
02558  192500      WRITE P-REC FROM SPACE-LINE      AFTER POSITIONING 0.
02559  192600      WRITE P-REC FROM SUMMARY-HEAD-1 AFTER POSITIONING 3.
02560  192700      WRITE P-REC FROM SUMMARY-HEAD-2 AFTER POSITIONING 1.
02561  192800      WRITE P-REC FROM SPACE-LINE      AFTER POSITIONING 2.
02562  192900      MOVE ZERO TO D.
02563  193000 STOP-SUMMARY.
02564  193100*
02565  193200******** FILL PAGE 1 FIELDS
02566  193300*
02567  193400      MOVE HOLD-MAKE-NAME TO PAGE-1-MAKE.
02568  193500      MOVE HOLD-MODEL TO PAGE-1-MOD.
02569  193600      MOVE TOT-AC                 TO PG-1-TOTA.
02570  193700      MOVE TOT-AC-TYPE TO PG-1-TOTAB.
02571  193800      MOVE TOT-OCC                TO PG-1-TOTB.
02572  193900      MOVE AV-OCC                 TO PG-1-TOTC.
02573  194000      MOVE TOT-FAT                TO PG-1-TOTD.
02574  194100      MOVE TOT-SER                TO PG-1-TOTE.
02575  194200      MOVE TOT-MNR                TO PG-1-TOTF.
02576  194300      MOVE TOT-NON                TO PG-1-TOTH.
02577  194400      MOVE PG-1-SER (1, 1)        TO PG-1-TOTI.
02578  194500      MOVE PG-1-SER (1, 2)        TO PG-1-TOTJ.
02579  194600      MOVE PG-1-SER (1, 3)        TO PG-1-TOTK.
02580  194700      MOVE PG-1-SER (1, 4)        TO PG-1-TOTL.
02581  194800      MOVE PG-1-SER (2, 1)        TO PG-1-TOTM.
02582  194900      MOVE PG-1-SER (2, 2)        TO PG-1-TOTN.
02583  195000      MOVE PG-1-SER (2, 3)        TO PG-1-TOTP.
02584  195100      MOVE PG-1-SER (2, 4)        TO PG-1-TOTQ.
02585  195200      MOVE PG-1-SER (3, 1)        TO PG-1-TOTR.
02586  195300      MOVE PG-1-SER (3, 2)        TO PG-1-TOTS.
02587  195400      MOVE PG-1-SER (3, 3)        TO PG-1-TOTT.
02588  195500      MOVE PG-1-SER (3, 4)        TO PG-1-TOTU.
02589  195600      MOVE PG-1-SER (4, 1)        TO PG-1-TOTV.
02590  195700      MOVE PG-1-SER (4, 2)        TO PG-1-TOTW.
02591  195800      MOVE PG-1-SER (4, 3)        TO PG-1-TOTX.
02592  195900      MOVE PG-1-SER (4, 4)        TO PG-1-TOTY.
02593  196000      PERFORM PAGE-1-P THRU END-PG-1 UNTIL D = 23.
02594  196100      PERFORM SKIP-TO-HEAD.
02595  196200*
02596  196300******** FILL PAGE 2 FIELDS
02597  196400*
02598  196500      MOVE TOT-T-O TO PG-2-TO.
02599  196600      MOVE TOT-FLY TO PG-2-IF.
02600  196700      MOVE TOT-LDG TO PG-2-LDG.
02601  196800      MOVE FAT-TS TO PG-2-OTHERFAT.
02602  196900      MOVE TOT-TS TO PG-2-OTHER.
02603  197000      MOVE FAT-TO  TO PG-2-TOFAT.
02604  197100      MOVE FAT-INFLT TO PG-2-IFFAT.
02605  197200      MOVE TOT-NR TO PG-2-NR.
02606  197300      MOVE FAT-NR TO PG-2-NRFAT.
02607  197400      MOVE FAT-LDG   TO PG-2-LDGFAT.
02608  197500      MOVE ZERO TO SAVE-SUB-01.
02609  197600      MOVE 1 TO SS.
02610  197700      MOVE 1 TO OP.
02611  197800      MOVE ZERO TO SSS.
02612  197900*
02613  198000******** SEARCH OPERATIONAL PHASES TOTAL FIELD FOR  8 HIGHEST
02614  198100******** TOTAL NO. OF ACCIDENTS.
02615  198200*
02616  198300 SEARCH-OP-A.
02617  198400      MOVE OP-PH-04 (1, 5) TO OP-PH-HOLD.
02618  198500      IF SS GREATER THAN 8
02619  198600      DISPLAY 'SAVE-SUB-01 = ' SAVE-SUB-01
02620  198700          MOVE 1 TO SS
02621  198800          GO TO OP-HEADERS.
02622  198900 SEARCH-OP-B.
02623  199000      IF OP GREATER THAN 42
02624  199100          MOVE 1 TO OP
02625  199200          ADD 1 TO SS
02626  199300          GO TO SEARCH-OP-A.
02627  199400*
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02628  199500******** SEE IF SUBSCRIPT HAS ALREADY BEEN USED
02629  199600*
02630  199700      PERFORM BEGIN-SUB-SEARCH THRU END-SUB-SEARCH.
02631  199800      IF FOUND-WORD = '1'
02632  199900          ADD 1 TO OP
02633  200000          GO TO SEARCH-OP-B.
02634  200100      IF OP-PH-04 (OP, 5) IS GREATER THAN OP-PH-HOLD
02635  200200          OR EQUAL TO OP-PH-HOLD
02636  200300          MOVE OP-PH-04 (OP, 5) TO OP-PH-HOLD
02637  200400          IF OP-PH-HOLD = ZERO
02638  200500              MOVE 99 TO SAVE-SUB (SS) ELSE
02639  200600              MOVE OP TO SAVE-SUB (SS).
02640  200700      ADD 1 TO OP.
02641  200800      GO TO SEARCH-OP-B.
02642  200900 OP-HEADERS.
02643  201000      MOVE SPACES TO MINOR-P1 (SS).
02644  201100      MOVE '1' TO READER-SWITCH.
02645  201200      MOVE SPACES TO PAGE-2-03D (SS).
02646  201300      MOVE SAVE-SUB (SS) TO SSS.
02647  201400      IF NOT (SSS = 99 OR ZERO)
02648  201500      MOVE SPACES TO HD-KEY
02649  201600      MOVE 014851 TO CCC
02650  201700      MOVE OP-PH (SSS) TO CODE2
02651  201800      PERFORM READER THRU REXIT
02652  201900      MOVE HDER TO MINOR-P1 (SS).
02653  202000      MOVE SS TO MP-NO (SS).
02654  202100      MOVE '. ' TO PERIOD-04 (SS).
02655  202200      IF SSS = 99 OR ZERO NEXT SENTENCE ELSE
02656  202300      SUBTRACT OP-PH-04 (SSS, 5) FROM OP-PH-04 (43, 5)
02657  202400      SUBTRACT OP-PH-04 (SSS, 1) FROM OP-PH-04 (43, 1)
02658  202500      SUBTRACT OP-PH-04 (SSS, 2) FROM OP-PH-04 (43, 2)
02659  202600      SUBTRACT OP-PH-04 (SSS, 3) FROM OP-PH-04 (43, 3)
02660  202700      SUBTRACT OP-PH-04 (SSS, 4) FROM OP-PH-04 (43, 4)
02661  202800      MOVE OP-PH-04 (SSS, 5) TO TOT-ACC-MP (SS)
02662  202900      MOVE OP-PH-04 (SSS, 1) TO FAT-INJ-MP (SS)
02663  203000      MOVE OP-PH-04 (SSS, 2) TO SER-INJ-MP (SS)
02664  203100      MOVE OP-PH-04 (SSS, 3) TO MIN-INJ-MP (SS)
02665  203200      MOVE OP-PH-04 (SSS, 4) TO NON-INJ-MP (SS).
02666  203300      ADD 1 TO SS.
02667  203400      IF SS GREATER THAN 8  NEXT SENTENCE ELSE
02668  203500          GO TO OP-HEADERS.
02669  203600      MOVE SPACES TO PAGE-2-03D (9).
02670  203700      MOVE 09 TO MP-NO (9).
02671  203800      MOVE '. ' TO PERIOD-04 (9).
02672  203900      MOVE 'OTHERS' TO MINOR-P1 (9).
02673  204000      MOVE OP-PH-04 (43, 5) TO TOT-ACC-MP (9).
02674  204100      MOVE OP-PH-04 (43, 1) TO FAT-INJ-MP (9).
02675  204200      MOVE OP-PH-04 (43, 2) TO SER-INJ-MP (9).
02676  204300      MOVE OP-PH-04 (43, 3) TO MIN-INJ-MP (9).
02677  204400      MOVE OP-PH-04 (43, 4) TO NON-INJ-MP (9).
02678  204500*
02679  204600******** SEARCH TYPE HEADERS FOR  6 HIGHEST
02680  204700*
02681  204800      MOVE ZERO TO SAVE-SUB-01.
02682  204900      MOVE 1 TO SS.
02683  205000      MOVE 1 TO OP.
02684  205100      MOVE ZERO TO SSS.
02685  205200 SEARCH-TYP-A.
02686  205300      MOVE TYP-TOT (1, 5) TO TYP-HOLD.
02687  205400      IF SS GREATER THAN 6
02688  205500          MOVE 1 TO SS
02689  205600      DISPLAY 'SAVE-SUB-01-TYPS ' SAVE-SUB-01
02690  205700          GO TO TYP-HEADERS.
02691  205800 SEARCH-TYP-B.
02692  205900      IF OP GREATER THAN 22
02693  206000          MOVE 1 TO OP
02694  206100          ADD 1 TO SS
02695  206200          GO TO SEARCH-TYP-A.
02696  206300      PERFORM BEGIN-SUB-SEARCH THRU END-SUB-SEARCH.
02697  206400      IF FOUND-WORD = '1'
02698  206500          ADD 1 TO OP
02699  206600          GO TO SEARCH-TYP-B.
02700  206700      IF TYP-TOT (OP, 5) IS GREATER THAN TYP-HOLD OR = TYP-HOLD
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02701    208200          MOVE TYP-TOT (OP, 5) TO TYP-HOLD
02702    208300          IF TYP-HOLD = ZERO
02703    208400              MOVE 99 TO SAVE-SUB (SS) ELSE
02704    208500              MOVE OP TO SAVE-SUB (SS).
02705    208600      ADD 1 TO OP.
02706    208700      GO TO SEARCH-TYP-8.
02707    208800  TYP-HEADERS.
02708    208900      MOVE SPACES TO TYP-DESC (SS).
02709    209000      MOVE SPACES TO PAGE-2-03DA (SS).
02710    209100      MOVE SAVE-SUB (SS) TO SSS.
02711    209200      IF NOT (SSS = 99 OR ZERO)
02712    209300      MOVE SPACES TO RD-KEY
02713    209400      MOVE 014447 TO CCC
02714    209500      MOVE TYP-OP (SSS) TO CHAR2
02715    209600      PERFORM READER THRU REXIT
02716    209700      MOVE HDER TO TYP-DESC (SS).
02717    209800      MOVE SS TO TYP-NO (SS).
02718    209900      MOVE '. ' TO PERIODT-04 (SS).
02719    210000      IF SSS = 99 OR ZERO NEXT SENTENCE ELSE
02720    210100      SUBTRACT TYP-TOT (SSS, 5) FROM TYP-TOT (23, 5)
02721    210200      SUBTRACT TYP-TOT (SSS, 1) FROM TYP-TOT (23, 1)
02722    210300      SUBTRACT TYP-TOT (SSS, 2) FROM TYP-TOT (23, 2)
02723    210400      SUBTRACT TYP-TOT (SSS, 3) FROM TYP-TOT (23, 3)
02724    210500      SUBTRACT TYP-TOT (SSS, 4) FROM TYP-TOT (23, 4)
02725    210600      MOVE TYP-TOT (SSS, 5) TO TOT-ACC-TYP (SS)
02726    210700      MOVE TYP-TOT (SSS, 1) TO FAT-INJ-TYP (SS)
02727    210800      MOVE TYP-TOT (SSS, 2)  TO SER-INJ-TYP (SS)
02728    210900      MOVE TYP-TOT (SSS, 3) TO MIN-INJ-TYP (SS)
02729    211000      MOVE TYP-TOT (SSS, 4) TO NON-INJ-TYP (SS).
02730    211100      ADD 1 TO SS.
02731    211200      IF SS GREATER THAN  6 NEXT SENTENCE ELSE
02732    211300          GO TO TYP-HEADERS.
02733    211400      MOVE SPACES TO PAGE-2-03DA (7).
02734    211500      MOVE SPACES TO PAGE-2-03DA (8).
02735    211600      SUBTRACT TYP-TOT (22, 5) FROM TYP-TOT (23, 5).
02736    211700      SUBTRACT TYP-TOT (22, 1) FROM TYP-TOT (23, 1).
02737    211800      SUBTRACT TYP-TOT (22, 2) FROM TYP-TOT (23, 2).
02738    211900      SUBTRACT TYP-TOT (22, 3) FROM TYP-TOT (23, 3).
02739    212000      SUBTRACT TYP-TOT (22, 4) FROM TYP-TOT (23, 4).
02740    212100      MOVE 07 TO TYP-NO (7).
02741    212200      MOVE '. ' TO PERIODT-04 (7).
02742    212300      MOVE 'OTHERS' TO TYP-DESC (7).
02743    212400      MOVE TYP-TOT (23, 5) TO TOT-ACC-TYP (7).
02744    212500      MOVE TYP-TOT (23, 1) TO FAT-INJ-TYP (7).
02745    212600      MOVE TYP-TOT (23, 2) TO SER-INJ-TYP (7).
02746    212700      MOVE TYP-TOT (23, 3) TO MIN-INJ-TYP (7).
02747    212800      MOVE TYP-TOT (23, 4) TO NON-INJ-TYP (7).
02748    212900      MOVE 8 TO TYP-NO (8).
02749    213000      MOVE '. ' TO PERIODT-04 (8).
02750    213100      MOVE 'NOT REPORTED' TO TYP-DESC (8).
02751    213200      MOVE TYP-TOT (22, 5) TO TOT-ACC-TYP (8).
02752    213300      MOVE TYP-TOT (22, 1) TO FAT-INJ-TYP (8).
02753    213400      MOVE TYP-TOT (22, 2) TO SER-INJ-TYP (8).
02754    213500      MOVE TYP-TOT (22, 3) TO MIN-INJ-TYP (8).
02755    213600      MOVE TYP-TOT (22, 4) TO NON-INJ-TYP (8).
02756    213700      PERFORM PAGE-2-P THRU END-PG-2 UNTIL D = 34.
02757    213800  END-PAGE-2.
02758    213900      PERFORM SKIP-TO-HEAD.
02759    214000*
02760    214100******** LOAD PAGE 3 OCCUPANT INJURY TABLE.
02761    214200*
02762    214300      PERFORM LOAD-PG-3 THRU END-LOAD-3
02763    214400          VARYING S-INDEX FROM 1 BY 1
02764    214500          UNTIL S-INDEX GREATER THAN 5
02765    214600          AFTER SERIOUS-INDEX FROM 1 BY 1
02766    214700          UNTIL SERIOUS-INDEX GREATER THAN 1.
02767    214800      MOVE 'EXTREME ' TO SEV-NAME (1).
02768    214900      MOVE 'SEVERE  ' TO SEV-NAME (2).
02769    215000      MOVE 'MODERATE' TO SEV-NAME (3).
02770    215100      MOVE 'MINOR   ' TO SEV-NAME (4).
02771    215200      MOVE 'NONE    ' TO SEV-NAME (5).
02772    215300      MOVE TOT-ACC-ANG TO TOT-IMPACT.
02773    215400      MOVE TOT-ACC-VEL TO VEL-IMP.
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02774    215500      MOVE TOT-ACC-DIST TO STOP-DIST.
02775    215600      PERFORM PAGE-3-P THRU END-PG-3 UNTIL D = 25.
02776    215700      PERFORM SKIP-TO-HEAD.
02777    215800  END-PAGE-3.
02778    215900*
02779    216000******** LOAD PAGE 4
02780    216100*
02781    216200      MOVE TOT-ST-ACC TO SEAT-FAIL-ACC.
02782    216300      MOVE TOT-ST-FAIL TO SEAT-FAIL.
02783    216400      MOVE TOT-STBLT-ACC TO SEAT-BELT-ACC.
02784    216500      MOVE TOT-STBLT-FAIL TO SEAT-BELT-FAIL.
02785    216600      MOVE S-H-USED TO SH-HARN-USED.
02786    216700      MOVE S-H-FAILED TO SH-HARN-FAIL.
02787    216800      MOVE HELMET-USED TO CRASH-HEL-USED.
02788    216900      MOVE HELMET-UNUSED TO CRASH-HEL-UNUSED.
02789    217000*
02790    217100******** LOAD PAGE 4 TERRAIN TYPE TABLE
02791    217200*
02792    217300  LOAD-4.
02793    217400      PERFORM LOAD-PG-4 THRU END-LOAD-4 VARYING TERRAIN-INDEX
02794    217500          FROM 1 BY 1 UNTIL TERRAIN-INDEX GREATER THAN 13.
02795    217600      MOVE SPACES TO PAGE-4-WORK.
02796    217700      MOVE 1 TO TER-4.
02797    217800      MOVE PCT-TER (1) TO PCT-HOLD.
02798    217900      MOVE ZERO TO TER-IND.
02799    218000      PERFORM SORT-PG-4 THRU END-SORT.
02800    218100  LOAD-4-A.
02801    218200      PERFORM PAGE-4-P THRU END-PG-4 UNTIL D = 29.
02802    218300      PERFORM SKIP-TO-HEAD.
02803    218400  END-PAGE-4.       EXIT.
02804    218500*
02805    218600*
02806    218700********                    PRINT PAGE 5
02807    218800********           PRINT CAUSE/FACTOR SUMMARIES.
02808    218900*
02809    219000  LOAD-5.
02810    219100      MOVE 1 TO C-INITIAL.
02811    219200      MOVE ZERO TO C-SAVE-01.
02812    219300      MOVE PAGE-5 (1) TO P-WORK-028.
02813    219400      WRITE P-REC FROM P-WORK      AFTER POSITIONING 3.
02814    219500      MOVE PAGE-5 (2) TO P-WORK-028.
02815    219600      WRITE P-REC FROM P-WORK      AFTER POSITIONING 2.
02816    219700      MOVE PAGE-5 (3) TO P-WORK-028.
02817    219800      WRITE P-REC FROM P-WORK      AFTER POSITIONING 1.
02818    219900      MOVE PAGE-5 (5) TO P-WORK-028.
02819    220000      WRITE P-REC FROM P-WORK      AFTER POSITIONING 2.
02820    220100      WRITE P-REC FROM SPACE-LINE AFTER POSITIONING 1.
02821    220200      MOVE 4 TO C-SV-LIMIT.
02822    220300*
02823    220400******** PRINT PILOT SUMMARY
02824    220500*
02825    220600      MOVE ZERO TO C-SAVE.
02826    220700      PERFORM SEARCH-FACTOR THRU END-FACTOR.
02827    220800*
02828    220900******** PRINT COPILOT SUMMARY
02829    221000*
02830    221100      DISPLAY 'C-HI ' C-HI 'C-INITIAL ' C-INITIAL.
02831    221200      MOVE C-HI TO C-INITIAL.
02832    221300      MOVE PAGE-5 (6) TO P-WORK-028.
02833    221400      WRITE P-REC FROM P-WORK      AFTER POSITIONING 2.
02834    221500      MOVE ZERO TO C-SAVE-01.
02835    221600      MOVE 2 TO C-SV-LIMIT.
02836    221700      MOVE ZERO TO C-SAVE.
02837    221800      PERFORM SEARCH-FACTOR THRU END-FACTOR.
02838    221900*
02839    222000******** PRINT DUAL STUDENT SUMMARY
02840    222100*
02841    222200      DISPLAY 'C-HI ' C-HI 'C-INITIAL ' C-INITIAL.
02842    222300      MOVE C-HI TO C-INITIAL.
02843    222400      MOVE PAGE-5 (7) TO P-WORK-028.
02844    222500      WRITE P-REC FROM P-WORK      AFTER POSITIONING 2.
02845    222600      MOVE ZERO TO C-SAVE-01.
02846    222700      MOVE C-HI TO C-INITIAL.
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02847   222800      MOVE ZERO TO C-SAVE.
02848   222900      PERFORM SEARCH-FACTOR THRU END-FACTOR.
02849   223000*
02850   223100******** PRINT CHECK PILOT SUMMARY
02851   223200*
02852   223300      DISPLAY 'C-HI ' C-HI 'C-INITIAL ' C-INITIAL.
02853   223400      MOVE C-HI TO C-INITIAL.
02854   223500      MOVE PAGE-5 (8) TO P-WORK-028.
02855   223600      WRITE P-REC FROM P-WORK      AFTER POSITIONING 2.
02856   223700      MOVE C-HI TO C-INITIAL.
02857   223800      MOVE ZERO TO C-SAVE-01.
02858   223900      MOVE ZERO TO C-SAVE.
02859   224000      PERFORM SEARCH-FACTOR THRU END-FACTOR.
02860   224100*
02861   224200******** PRINT AIRFRAME SUMMARY
02862   224300*
02863   224400      DISPLAY 'C-HI ' C-HI 'C-INITIAL ' C-INITIAL.
02864   224500      MOVE C-HI TO C-INITIAL.
02865   224600      MOVE PAGE-5 (9) TO P-WORK-028.
02866   224700      WRITE P-REC FROM P-WORK      AFTER POSITIONING 2.
02867   224800      MOVE C-HI TO C-INITIAL.
02868   224900      MOVE ZERO TO C-SAVE-01.
02869   225000      MOVE ZERO TO C-SAVE.
02870   225100      PERFORM SEARCH-FACTOR THRU END-FACTOR.
02871   225200*
02872   225300******** PRINT MISC ACTS & CONDITIONS SUMMARY
02873   225400*
02874   225500      DISPLAY 'C-HI ' C-HI 'C-INITIAL ' C-INITIAL.
02875   225600      MOVE C-HI TO C-INITIAL.
02876   225700          MOVE 4 TO C-SV-LIMIT.
02877   225800      MOVE PAGE-5 (10) TO P-WORK-028.
02878   225900          WRITE P-REC FROM P-WORK      AFTER POSITIONING 2.
02879   226000      MOVE C-HI TO C-INITIAL.
02880   226100          MOVE ZERO TO C-SAVE-01.
02881   226200      MOVE ZERO TO C-SAVE.
02882   226300          PERFORM SEARCH-FACTOR THRU END-FACTOR.
02883   226400 END-PAGE-5.    EXIT.
02884   226500 EOJ.
02885   226600*
02886   226700******** PRINT GRAND TOTAL SUMMARIES
02887   226800*
02888   226900********              FILL PAGE 1
02889   227000*
02890   227100*
02891   227200      MOVE '                                                  * * * * *  GRAN
02892   227300-     'D TOTAL ACCIDENT SUMMARY  * * * * *' TO SUMMARY-HEAD-1.
02893   227400      PERFORM PRINT-SUMMARY.
02894   227500      MOVE 'ALL' TO PAGE-1-MAKE.
02895   227600      MOVE 'ALL' TO PAGE-1-MOD.
02896   227700      MOVE GTOT-AC                TO PG-1-TOTA.
02897   227710      MOVE GTOT-AC-TYPE TO PG-1-TOTAB.
02898   227800      MOVE GTOT-OCC               TO PG-1-TOTB.
02899   227900      MOVE GAVG-OCC               TO PG-1-TOTC.
02900   228000      MOVE GTOT-FAT               TO PG-1-TOTD.
02901   228100      MOVE GTOT-SER               TO PG-1-TOTE.
02902   228200      MOVE GTOT-MNR               TO PG-1-TOTF.
02903   228300      MOVE GTOT-NON               TO PG-1-TOTH.
02904   228400      MOVE G-PG-1 (1, 1)          TO PG-1-TOTI.
02905   228500      MOVE G-PG-1 (1, 2)          TO PG-1-TOTJ.
02906   228600      MOVE G-PG-1 (1, 3)          TO PG-1-TOTK.
02907   228700      MOVE G-PG-1 (1, 4)          TO PG-1-TOTL.
02908   228800      MOVE G-PG-1 (2, 1)          TO PG-1-TOTM.
02909   228900      MOVE G-PG-1 (2, 2)          TO PG-1-TOTN.
02910   229000      MOVE G-PG-1 (2, 3)          TO PG-1-TOTP.
02911   229100      MOVE G-PG-1 (2, 4)          TO PG-1-TOTQ.
02912   229200      MOVE G-PG-1 (3, 1)          TO PG-1-TOTR.
02913   229300      MOVE G-PG-1 (3, 2)          TO PG-1-TOTS.
02914   229400      MOVE G-PG-1 (3, 3)          TO PG-1-TOTT.
02915   229500      MOVE G-PG-1 (3, 4)          TO PG-1-TOTU.
02916   229600      MOVE G-PG-1 (4, 1)          TO PG-1-TOTV.
02917   229700      MOVE G-PG-1 (4, 2)          TO PG-1-TOTW.
02918   229800      MOVE G-PG-1 (4, 3)          TO PG-1-TOTX.
02919   229900      MOVE G-PG-1 (4, 4)          TO PG-1-TOTY.
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02920   230000      PERFORM PAGE-1-P THRU END-PG-1 UNTIL D = 24.
02921   230100*
02922   230200********              FILL AND PRINT PG 2 GRAND TOTAL
02923   230300*
02924   230400      MOVE GTOT-T-O TO     PG-2-TO.
02925   230500      MOVE GTOT-FLY TO     PG-2-IF.
02926   230600      MOVE GTOT-LDG TO     PG-2-LDG.
02927   230700      MOVE GFAT-TO  TO     PG-2-TOFAT.
02928   230800      MOVE GFAT-INFLT TO   PG-2-IFFAT.
02929   230900      MOVE GFAT-LDG TO     PG-2-LDGFAT.
02930   231000      MOVE GTOT-TS TO PG-2-OTHER.
02931   231100      MOVE GFAT-TS TO PG-2-OTHERFAT.
02932   231200      MOVE GTOT-NR TO PG-2-NR.
02933   231300      MOVE GFAT-NR TO PG-2-NRFAT.
02934   231400      MOVE ZERO TO SAVE-SUB-01.
02935   231500      MOVE 1 TO SS.
02936   231600      MOVE ZERO TO SSS.
02937   231700      MOVE 1 TO OP.
02938   231800      MOVE GTOT-TYP-01 TO TYP-TOT-01.
02939   231900      MOVE GTOT-OP-01 TO OP-PH-TOT.
02940   232000      PERFORM SKIP-TO-HEAD.
02941   232100      PERFORM SEARCH-OP-A THRU TYP-HEADERS.
02942   232200*
02943   232300********      FILL AND PRINT PG 3 GRAND TOTALS
02944   232400*
02945   232500      MOVE G-ANG-15 TO ANGLE-15.
02946   232600      MOVE G-ANG-30 TO ANGLE-30.
02947   232700      MOVE G-ANG-45 TO ANGLE-45.
02948   232800      MOVE G-ANG-60 TO ANGLE-60.
02949   232900      MOVE G-ANG-75 TO ANGLE-75.
02950   233000      MOVE G-ANG-90 TO ANGLE-90
02951   233100      MOVE G-ANG-90-PLUS TO ANGLE-90-PLUS
02952   233200      MOVE G-VEL-30    TO VEL-30.
02953   233300      MOVE G-VEL-60    TO VEL-60.
02954   233400      MOVE G-VEL-90    TO VEL-90.
02955   233500      MOVE G-VEL-120   TO VEL-120.
02956   233600      MOVE G-VEL-120-PLUS TO VEL-120-PLUS.
02957   233700      MOVE G-DIST-10   TO  DIST-10.
02958   233800      MOVE G-DIST-20   TO  DIST-20.
02959   233900      MOVE G-DIST-30   TO  DIST-30.
02960   234000      MOVE G-DIST-40   TO  DIST-40.
02961   234100      MOVE G-DIST-50   TO  DIST-50.
02962   234200      MOVE G-DIST-60   TO  DIST-60
02963   234300      MOVE G-DIST-60-PLUS TO DIST-60-PLUS.
02964   234400      MOVE  G-SERIOUS TO SERIOUSNESS.
02965   234500      MOVE GTOT-ACC-ANG TO TOT-ACC-ANG.
02966   234600      MOVE GTOT-ACC-VEL TO TOT-ACC-VEL.
02967   234700      MOVE GTOT-ACC-DIST TO TOT-ACC-DIST.
02968   234800      MOVE G-AVG-ANGLE TO AVG-ANGLE.
02969   234900      MOVE G-AVG-VEL TO AVG-VEL.
02970   235000      MOVE G-AVG-DIST TO AVG-DIST.
02971   235100      PERFORM END-PAGE-2.
02972   235200*
02973   235300********      FILL AND PRINT PG 4 GRAND TOTALS
02974   235400*
02975   235500      MOVE GTOT-ST-ACC          TO SEAT-FAIL-ACC.
02976   235600      MOVE GTOT-ST-FAIL         TO  SEAT-FAIL.
02977   235700      MOVE GTOT-STBLT-ACC       TO  SEAT-BELT-ACC.
02978   235800      MOVE GTOT-STBLT-FAIL      TO  SEAT-BELT-FAIL.
02979   235900      MOVE GS-H-USED            TO  SH-HARN-USED.
02980   236000      MOVE GS-H-FAILED          TO  SH-HARN-FAIL.
02981   236100      MOVE GHEL-USED         TO  CRASH-HEL-USED.
02982   236200      MOVE GHEL-UNUSED       TO  CRASH-HEL-UNUSED.
02983   236300      MOVE GTOT-AC-TYPE TO TOT-AC-TYPE.
02984   236400      MOVE GTERRAIN-01     TO TERRAIN-001.
02985   236500      PERFORM LOAD-4 THRU END-PAGE-4.
02986   236600*
02987   236700*********      LOAD AND PRINT PAGE 5 GRAND TOTALS
02988   236800*
02989   236900      MOVE '                                    CAUSE / FACTOR GRAND SUMM
02990   237000-          'ARY' TO P-REC.
02991   237100      WRITE P-REC AFTER POSITIONING 2.
02992   237200      MOVE G-CAUSE-01 TO CAUSE-01.
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02993    237300          MOVE G-CAUSE-FAT-01 TO CAUSE-FATAL-01.
02994    237400          MOVE G-CAUSE-NONFAT-01 TO CAUSE-NONFAT-01.
02995    237500          MOVE ZERO TO C-SAVE-01.
02996    237600          MOVE ZERO      TO CAUSE-77.
02997    237700          PERFORM LOAD-5 THRU END-PAGE-5.
02998    237800          CLOSE       HEAD PRT.
02999    237900          STOP RUN.
03000    238000 UNIQUE.
03001    238100          MOVE ZERO TO INJ2.
03002    238200          IF F08001A (INJ1) = SPACES
03003    238300              ADD 1 TO D, INJ1
03004    238400              GO TO END-UNIQUE.
03005    238500 TRANS-INJURY.
03006    238600          ADD 1 TO INJ2.
03007    238700          IF INJ2 GREATER THAN 6 GO TO AFTER-TRANS.
03008    238800          EXAMINE F08001O1A (INJ1, INJ2) REPLACING LEADING ZEROS
03009    238900                  BY SPACES.
03010    239000          GO TO TRANS-INJURY.
03011    239100 AFTER-TRANS.
03012    239200          MOVE F08001A (INJ1) TO FDATA.
03013    239300          PERFORM MOVE-DIRECT.
03014    239400          ADD 1 TO D, INJ1.
03015    239500 END-UNIQUE.      EXIT.
03016    239600 READER.
03017    239700          MULTIPLY KYB BY KYB GIVING SUM-A.
03018    239800          ADD KYA TO SUM-A.
03019    239900          DIVIDE SUM-A BY 2999 GIVING DIVIDEND-HOLD
03020    240000              REMAINDER DIVIDE-HOLD.
03021    240100          DIVIDE DIVIDE-HOLD BY 32 GIVING TRACK-ID.
03022    240200          MOVE CCC TO KYF.
03023    240300          MOVE CODE4 TO KYG.
03024    240400 READER-X.
03025    240500          READ HEAD INVALID KEY MOVE HD-KEY TO ERR
03026    240600              DISPLAY 'HD-KEY ERROR = ',  ERR
03027    240700              MOVE ERR-RT TO HD    GO TO REXIT.
03028    240800          MOVE HDER TO FDATA.
03029    240900          IF READER-SWITCH = '1' GO TO REXIT.
03030    241000 BUILD-LINE.
03031    241100          PERFORM MOVE-DIRECT.
03032    241200*
03033    241300******** HEAD-COUNT UNEQUAL TO 1 OR 0 SUPPRESSES TH DESCRIPTION
03034    241400******** PREVIOUSLY TAKEN FROM TABLE.  MAKE SURE IT IS SET TO PROP
03035    241500******** VALUE BEFORE PERFORMING THIS ROUTINE.
03036    241600*
03037    241700          IF NOT (HEAD-COUNT = 1 OR 0)
03038    241800          MOVE SPACES TO DESCRIPTION.
03039    241900 REXIT.       EXIT.
03040    242000 SEVERITY-TEST.
03041    242100          IF SEV (SEVERITY-INDEX) IS = F13705
03042    242200              GO TO PERFORM-SERIOUS.
03043    242300 END-SEVERITY.      EXIT.
03044    242400 SERIOUS-TEST.
03045    242500          SET S-INDEX TO SEVERITY-INDEX.
03046    242600          SET GS-INDEX TO S-INDEX.
03047    242700          SET GSERIOUS-INDEX TO SERIOUS-INDEX.
03048    242800          SET SER-IND TO SERIOUS-INDEX.
03049    242900          MOVE F08001018 (3, 1, SER-IND)        TO INJURY.
03050    243000          IF INJURY NOT = ZEROS AND INJURY IS NUMERIC
03051    243100              ADD INJURY TO GS (GS-INDEX, GSERIOUS-INDEX)
03052    243200              ADD INJURY TO S (S-INDEX, SERIOUS-INDEX).
03053    243300 END-SERIOUS.       EXIT.
03054    243400 TERRAIN-A.
03055    243500          MOVE SPACES TO DUMBO.
03056    243600 END-TERRAIN.       EXIT.
03057    243700 C-F-PRINT.
03058    243800          IF F078 (CFF) = SPACES OR (F07801 (CFF) = '84' AND
03059    243900              F0780302 (CFF)  = 'J') NEXT SENTENCE ELSE
03060    244000              ADD 1 TO HEAD-COUNT
03061    244100              MOVE SPACES TO HD-KEY
03062    244200              MOVE 061766 TO CCC
03063    244300              MOVE F07801 (CFF) TO HOLD-KEY-1
03064    244400              MOVE F07802 (CFF) TO HOLD-KEY-2
03065    244500              MOVE HOLD-KEY TO CODE4
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03066    244600           MOVE '0' TO READER-SWITCH
03067    244700           PERFORM READER THRU REXIT.
03068    244800       ADD 1 TO D.
03069    244900       ADD 1 TO CFF.
03070    245000 C-F-EXIT.      EXIT.
03071    245100 MOVE-DIRECT.
03072    245200       MOVE DESC (D) TO DESCRIPTION.
03073    245300       MOVE FDATA TO DATAA.
03074    245400       WRITE P-REC FROM P-WORK AFTER POSITIONING 1 EOP
03075    245500           MOVE SPACES TO P-REC
03076    245600           WRITE P-REC AFTER POSITIONING 0
03077    245700           WRITE P-REC AFTER POSITIONING 3.
03078    245800 END-DIRECT.        EXIT.
03079    245900 OP-SEARCH.
03080    246000       MOVE ZERO TO LO.
03081    246100       MOVE HISAVE  TO HI.
03082    246200 AB. COMPUTE I = (HI + LO) / 2.
03083    246300       IF SEARCH-CODE LESS THAN OP-PH (I)
03084    246400           MOVE I TO HI
03085    246500           GO TO BA.
03086    246600       IF SEARCH-CODE GREATER THAN OP-PH (I)
03087    246700           MOVE I TO LO
03088    246800           GO TO BA.
03089    246900       MOVE '1' TO FOUND-WORD.
03090    247000       GO TO END-OP.
03091    247100 BA. IF I LESS THAN (HI - LO) GO TO AB.
03092    247200 END-OP. EXIT.
03093    247300*
03094    247400******** I IS DEFINED IN OP-SEARCH
03095    247500******** OP IS DEFINED IN LOAD-ARRAY
03096    247600*
03097    247700 SERIOUS-B.
03098    247800       MOVE F08001018 (3,1,OP) TO INJ-01.
03099    247900       IF INJURY NOT = ZERO AND INJURY IS NUMERIC
03100    248000           ADD INJURY TO OP-PH-04 (43, OP)
03101    248100           ADD INJURY TO GTOT-OP (43, OP)
03102    248200           ADD INJURY TO GTOT-OP (I, OP)
03103    248300           ADD INJURY TO OP-PH-04 (I, OP).
03104    248400       IF INJURY NOT = ZERO AND INJURY IS NUMERIC AND
03105    248500           BEEN-THERE = '0'
03106    248600           ADD 1 TO OP-PH-04 (43, 5)
03107    248700           ADD 1 TO GTOT-OP (43, 5)
03108    248800           ADD 1       TO GTOT-OP (I, 5)
03109    248900           ADD 1       TO OP-PH-04 (I, 5)
03110    249000           MOVE '1' TO BEEN-THERE.
03111    249100       DISPLAY 'SERIOUS-B ''INJURY = ' INJURY.
03112    249200 END-SERIOUS-B.  EXIT.
03113    249300 TYPE-SEARCH.
03114    249400       MOVE ZERO TO LO.
03115    249500       MOVE HISAVE TO HI.
03116    249600 AC. COMPUTE I = (HI + LO) / 2.
03117    249700       IF SEARCH-TYPE  LESS THAN TYP-OP (I)
03118    249800           MOVE I TO HI
03119    249900           GO TO CA.
03120    250000       IF SEARCH-TYPE GREATER THAN TYP-OP (I)
03121    250100           MOVE I TO LO
03122    250200           GO TO CA.
03123    250300       MOVE '1' TO FOUND-WORD.
03124    250400       GO TO END-TYPE.
03125    250500 CA. IF I LESS THAN (HI - LO) GO TO AC.
03126    250600 END-TYPE.    EXIT.
03127    250700*
03128    250800******** I IS DEFINED IN TYPE-SEARCH
03129    250900******** OP IS DEFINED IN COLLECT-TYPES
03130    251000*
03131    251100 TYPE-COLLECT.
03132    251200       MOVE F08001018 (3,1,OP) TO INJ-01.
03133    251300       TRANSFORM INJ-01 FROM SPACES TO ZEROS.
03134    251400       IF INJURY NOT = ZERO AND INJURY IS NUMERIC
03135    251500           ADD INJURY TO GTOT-TYP (23, OP)
03136    251600           ADD INJURY TO TYP-TOT (23, OP)
03137    251700           ADD INJURY TO GTOT-TYP (I, OP)
03138    251800           ADD INJURY TO TYP-TOT (I, OP).
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03139   251900      IF INJURY NOT = ZERO AND INJURY IS NUMERIC AND
03140   252000          BEEN-THERE = '0'
03141   252100          ADD 1 TO GTOT-TYP (23, 5)
03142   252200          ADD 1 TO TYP-TOT (23, 5)
03143   252300          ADD 1       TO GTOT-TYP (I, 5)
03144   252400          ADD 1       TO TYP-TOT (I, 5)
03145   252500          MOVE '1' TO BEEN-THERE.
03146   252600 END-COLLECT.    EXIT.
03147   252700 C-F-SEARCH.
03148   252800      MOVE 487 TO HISAVE.
03149   252900      IF F078 (CFF) = SPACES GO TO PRE-END-CF.
03150   253000      IF F07801 (CFF) = '64' OR '65' OR '66' OR '67' OR '70' OR
03151   253100                                                    '88'
03152   253200      DISPLAY 'CFF = ' CFF  '  F07801 =  ' F07801 (CFF)
03153   253300          MOVE F07801 (CFF) TO HOLD-KEY-1
03154   253400          MOVE F07803 (CFF) TO HOLD-KEY-2
03155   253500          PERFORM C-F-ACCESS THRU END-ACCESS
03156   253600          IF FOUND-WORD = '1'
03157   253700          ADD 1 TO CAUSE-492 (I)
03158   253800          ADD 1 TO G-CAUSE (I)
03159   253900      DISPLAY 'I = ' I  '  CAUSE-492 = '  CAUSE-492 (I)
03160   254000          IF F08001018 (3,1,1) NOT = ZERO
03161   254100              ADD 1 TO G-CAUSE-FAT (I)
03162   254200              ADD 1 TO CAUSE-FATAL (I) ELSE
03163   254300              ADD 1 TO G-CAUSE-NONFAT (I)
03164   254400              ADD 1 TO CAUSE-NON-FAT (I).
03165   254500 PRE-END-CF.
03166   254600      MOVE '0' TO FOUND-WORD.
03167   254700      ADD 1 TO CFF.
03168   254800 END-CF-SEARCH.  EXIT.
03169   254900
03170   255000 C-F-ACCESS.
03171   255100      MOVE ZERO TO LO.
03172   255200      MOVE HISAVE  TO HI.
03173   255300 AD. COMPUTE I = (HI + LO) / 2.
03174   255400      IF HOLD-KEY LESS THAN CAUSE-FACTOR-02R (I)
03175   255500          MOVE I TO HI
03176   255600          GO TO DZ.
03177   255700      IF HOLD-KEY GREATER THAN CAUSE-FACTOR-02R (I)
03178   255800          MOVE I TO LO
03179   255900          GO TO DZ.
03180   256000      MOVE '1' TO FOUND-WORD.
03181   256100      GO TO END-ACCESS.
03182   256200 DZ. IF 1 LESS THAN (HI - LO) GO TO AD.
03183   256300 END-ACCESS. EXIT.
03184   256400******** SEARCH FATAL CAUSE FOR TWO OR FOUR LARGEST TOTALS
03185   256500*
03186   256600 SEARCH-FACTOR.
03187   256700      PERFORM SEARCH-SUB THRU END-SUB C-SV-LIMIT TIMES.
03188   256800      MOVE 1 TO C-SV.
03189   256900      MOVE 1 TO C-TEST.
03190   257000*
03191   257100******** OBTAIN THE ENGLISH MEANING HEADERS FOR A FACTOR
03192   257200*
03193   257300 WRITE-FACTOR.
03194   257400      MOVE SPACES TO CAUSE-FACTOR-5.
03195   257500      MOVE ZERO TO CF-FATALS CF-NONFAT.
03196   257600      MOVE '1' TO READER-SWITCH.
03197   257700      MOVE SPACES TO HD-KEY.
03198   257800      MOVE 061766 TO CCC.
03199   257900      IF C-SAVE-02 (C-SV) = ZERO
03200   258000          GO TO WRITE-FACTOR-TOTALS.
03201   258100      MOVE C-SAVE-02 (C-SV) TO C-SAVE.
03202   258200      IF NOT (CAUSE-FATAL (C-SAVE) = ZERO AND
03203   258300          CAUSE-NON-FAT (C-SAVE) = ZERO)
03204   258400          MOVE CAUSE-FACTOR-02R (C-SAVE) TO CODE4
03205   258500          PERFORM READER THRU REXIT
03206   258600          MOVE CAUSE-FATAL (C-SAVE) TO CF-FATALS
03207   258700          MOVE CAUSE-NON-FAT (C-SAVE) TO CF-NONFAT
03208   258800          MOVE HDER TO CAUSE-FACTOR-5.
03209   258900*
03210   259000******** WRITE FACTOR TOTALS
03211   259100*
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03212    259200 WRITE-FACTOR-TOTALS.
03213    259300     MOVE C-SV TO CF-NO.
03214    259400     MOVE PAGE-5 (4) TO P-WORK-02B.
03215    259500     WRITE P-REC FROM P-WORK      AFTER POSITIONING 2.
03216    259600     ADD 1 TO C-SV.
03217    259700     IF C-SV GREATER THAN C-SV-LIMIT
03218    259800         MOVE 1 TO C-SV
03219    259900         GO TO END-FACTOR.
03220    260000     GO TO WRITE-FACTOR.
03221    260100 END-FACTOR.      EXIT.
03222    260200 SEARCH-SUB.
03223    260300     MOVE '0' TO FOUND-WORD.
03224    260400     MOVE C-INITIAL TO F.
03225    260500     MOVE ZERO TO C-SV.
03226    260600     ADD 1 TO C-SAVE.
03227    260700     MOVE CAUSE-FACTOR-02R (C-INITIAL) TO CAUSE-FACTOR-HOLD.
03228    260800     MOVE FACTOR-02 TO FACTOR-77.
03229    260900     MOVE CAUSE-492 (C-INITIAL) TO CAUSE-FACTOR-77.
03230    261000     PERFORM SEARCH-SUB-A THRU END-SEARCH-A
03231    261100         UNTIL FACTOR-02 NOT = FACTOR-77 OR F GREATER THAN 487.
03232    261200     DISPLAY ' C-SAVE-02-CF = '  C-SAVE-01.
03233    261300 END-SUB.      EXIT.
03234    261400 SEARCH-SUB-A.
03235    261500     MOVE CAUSE-FACTOR-02R (F) TO CAUSE-FACTOR-HOLD.
03236    261600     IF FACTOR-02 NOT = FACTOR-77 GO TO END-SEARCH-A.
03237    261700     IF CAUSE-492 (F) GREATER THAN CAUSE-FACTOR-77 OR =
03238    261800                                  CAUSE-FACTOR-77
03239    261900         MOVE ZERO TO C-SV
03240    262000         PERFORM EXAM-SUB-F THRU END-EXAM
03241    262100         IF FOUND-WORD = '1'
03242    262200             MOVE '0' TO FOUND-WORD
03243    262300                         ELSE
03244    262400             MOVE F TO C-SAVE-02 (C-SAVE)
03245    262500             MOVE CAUSE-492 (F) TO CAUSE-FACTOR-77.
03246    262600     ADD 1 TO F.
03247    262700     MOVE F TO C-HI.
03248    262800 END-SEARCH-A.      EXIT.
03249    262900 EXAM-SUB-F.
03250    263000     ADD 1 TO C-SV.
03251    263100     IF C-SV GREATER THAN C-SV-LIMIT GO TO END-EXAM.
03252    263200     IF C-SAVE-02 (C-SV) = F
03253    263300         MOVE '1' TO FOUND-WORD
03254    263400         GO TO END-EXAM.
03255    263500     GO TO EXAM-SUB-F.
03256    263600 END-EXAM.      EXIT.
03257    263700 PAGE-1-P.
03258    263800     ADD 1 TO D.
03259    263900     MOVE PAGE-1 (D) TO P-WORK-02B.
03260    264000     WRITE P-REC FROM P-WORK      AFTER POSITIONING 1.
03261    264100     IF NOT (D = 11 OR 13 OR 15)
03262    264200         WRITE P-REC  FROM SPACE-LINE AFTER POSITIONING 1.
03263    264300 END-PG-1.    EXIT.
03264    264400 PAGE-2-P.
03265    264500     ADD 1 TO D.
03266    264600     MOVE PAGE-2 (D) TO P-WORK-02B.
03267    264700     WRITE P-REC FROM P-WORK      AFTER POSITIONING 1.
03268    264800     IF D = 1 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 10 OR 12 OR 21 OR
03269    264900         23 OR 25 OR 33
03270    265000         WRITE P-REC FROM SPACE-LINE AFTER POSITIONING 1.
03271    265100 END-PG-2.    EXIT.
03272    265200 PAGE-3-P.
03273    265300     ADD 1 TO D.
03274    265400     IF D = 7
03275    265500         MOVE AVG-ANGLE TO AVG-ANGLE-3
03276    265600         MOVE ANGLE-15        TO F0-15
03277    265700         MOVE ANGLE-30        TO F16-30
03278    265800         MOVE ANGLE-45        TO F31-45
03279    265900         MOVE ANGLE-60        TO F46-60
03280    266000         MOVE ANGLE-75        TO F61-75
03281    266100         MOVE ANGLE-90        TO F76-90
03282    266200         MOVE ANGLE-90-PLUS   TO F90.
03283    266300     IF D = 13
03284    266400         MOVE AVG-VEL TO AVG-ANGLE-3
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03285   266500           MOVE VEL-30           TO F0-15
03286   266600           MOVE VEL-60           TO F16-30
03287   266700           MOVE VEL-90           TO F31-45
03288   266800           MOVE VEL-120          TO F46-60
03289   266900           MOVE VEL-120-PLUS     TO F61-75
03290   267000           MOVE ZERO TO F76-90 F90
03291   267100           MOVE PAGE-3 (7) TO P-WORK-02B
03292   267200           WRITE P-REC FROM P-WORK      AFTER POSITIONING 1
03293   267300       WRITE P-REC FROM SPACE-LINE AFTER POSITIONING 1.
03294   267400       IF D = 18
03295   267500           MOVE AVG-DIST         TO AVG-ANGLE-3
03296   267600           MOVE DIST-10          TO F0-15
03297   267700           MOVE DIST-20          TO F16-30
03298   267800           MOVE DIST-30          TO F31-45
03299   267900           MOVE DIST-40          TO F46-60
03300   268000           MOVE DIST-50          TO F61-75
03301   268100           MOVE DIST-60          TO F76-90
03302   268200           MOVE DIST-60-PLUS     TO F90
03303   268300       MOVE PAGE-3 (7) TO P-WORK-02B
03304   268400           WRITE P-REC FROM P-WORK      AFTER POSITIONING 1
03305   268500       WRITE P-REC FROM SPACE-LINE AFTER POSITIONING 1.
03306   268600       MOVE PAGE-3 (D) TO P-WORK-02B.
03307   268700       WRITE P-REC FROM P-WORK      AFTER POSITIONING 1.
03308   268800       IF D = 7
03309   268900       WRITE P-REC FROM SPACE-LINE AFTER POSITIONING 1.
03310   269000       IF NOT (D = 4 OR 5 OR 10 OR 11 OR 15 OR 16 OR 19)
03311   269100           WRITE P-REC FROM SPACE-LINE AFTER POSITIONING 1.
03312   269200 END-PG-3.    EXIT.
03313   269300 PAGE-4-P.
03314   269400       ADD 1 TO D.
03315   269500       MOVE PAGE-4 (D) TO P-WORK-02B.
03316   269600       IF PAGE-4 (D) NOT  = SPACES
03317   269700       WRITE P-REC FROM P-WORK      AFTER POSITIONING 1.
03318   269800       IF NOT (D = 12 OR 13) AND PAGE-4 (D) NOT = SPACES
03319   269900           WRITE P-REC FROM SPACE-LINE AFTER POSITIONING 1.
03320   270000 END-PG-4.    EXIT.
03321   270100 SKIP-TO-HEAD.
03322   270200       WRITE P-REC FROM SPACE-LINE AFTER POSITIONING 0.
03323   270300       WRITE P-REC FROM SPACE-LINE AFTER POSITIONING 3.
03324   270400       WRITE P-REC FROM SPACE-LINE AFTER POSITIONING 3.
03325   270500       MOVE ZERO TO D.
03326   270600 END-HEAD.    EXIT.
03327   270700 BEGIN-SUB-SEARCH.
03328   270800       MOVE ZERO TO FOUND-WORD.
03329   270900       ADD 1 TO SSS.
03330   271000       IF SAVE-SUB (SSS) = ZERO
03331   271100           MOVE ZERO TO SSS
03332   271200           GO TO END-SUB-SEARCH.
03333   271300       IF OP = SAVE-SUB (SSS)
03334   271400           MOVE '1' TO FOUND-WORD
03335   271500           MOVE ZERO TO SSS
03336   271600           GO TO END-SUB-SEARCH.
03337   271700       GO TO BEGIN-SUB-SEARCH.
03338   271800 END-SUB-SEARCH.     EXIT.
03339   271900 LOAD-PG-3.
03340   272000       SET SER-IND TO S-INDEX.
03341   272100       MOVE SPACES TO PAGE-3-03I (SER-IND).
03342   272200       MOVE S (S-INDEX,          SERIOUS-INDEX) TO SEV-FAT (SER-IND).
03343   272300       MOVE S (S-INDEX,          SERIOUS-INDEX + 1) TO
03344   272400           SEV-SER (SER-IND).
03345   272500       MOVE S (S-INDEX,          SERIOUS-INDEX + 2) TO
03346   272600           SEV-MIN (SER-IND).
03347   272700       MOVE S (S-INDEX,          SERIOUS-INDEX + 3) TO
03348   272800           SEV-NON (SER-IND).
03349   272900 END-LOAD-3.    EXIT.
03350   273000 LOAD-PG-4.
03351   273100       MOVE SPACES TO HD-KEY.
03352   273200       MOVE 042222 TO CCC.
03353   273300       MOVE TERRAIN (TERRAIN-INDEX) TO CHAR1.
03354   273400           MOVE '1' TO READER-SWITCH.
03355   273500       PERFORM READER THRU REXIT.
03356   273600       SET TER-IND TO TERRAIN-INDEX.
03357   273700       MOVE SPACES TO PAGE-4-03H (TER-IND).
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03358    273800      MOVE HDER TO TERR-TYP (TER-IND).
03359    273900      IF TOT-AC-TYPE NOT = ZERO
03360    274000      DIVIDE TERRAIN-COUNT (TER-IND) BY TOT-AC-TYPE GIVING
03361    274100          PCNT-OCC ROUNDED ELSE MOVE ZERO TO PCNT-OCC.
03362    274200      MULTIPLY PCNT-OCC BY 100 GIVING PCNTT.
03363    274300      MOVE PCNTT     TO PCT-TER  (TER-IND).
03364    274400      MOVE ZERO TO PCNT-OCC PCNTT.
03365    274500  END-LOAD-4.      EXIT.
03366    274600  SORT-PG-4.
03367    274700      IF ITER-4 GREATER THAN 13
03368    274800          MOVE PAGE 4 WORK TO PAGE-4-03GROUP
03369    274900          GO TO END-SORT.
03370    275000      ADD 1 TO TER-IND.
03371    275100      IF TER-IND GREATER THAN 13
03372    275110          MOVE PCT-TER (1) TO PCT-HOLD
03373    275200          ADD 1 TO ITER-4
03374    275300          MOVE ZERO TO TER-IND
03375    275400          MOVE SPACES TO PAGE-4-03H (INDEX-HOLD)
03376    275500          GO TO SORT-PG-4.
03377    275600      IF PCT-TER (TER-IND) = ZERO OR SPACES
03378    275700          MOVE SPACES TO PAGE-4-03H (TER-IND).
03379    275800      IF PCT-TER (TER-IND) GREATER THAN PCT-HOLD OR
03380    275810          PCT-TER (TER-IND) = PCT-HOLD
03381    275900          MOVE PAGE-4-03H (TER-IND) TO PAGE-4-WO2 (ITER-4)
03382    276000          MOVE TER-IND TO INDEX-HOLD
03383    276100          MOVE PCT-TER (TER-IND) TO PCT-HOLD.
03384    276200      GO TO SORT-PG-4.
03385    276300  END-SORT.    EXIT.
03386    276400  INITIALIZE-COUNTERS.
03387    276500      MOVE ZERO TO
03388    276600      J                   TOT-AC              TOT-OCC             AV-OCC
03389    276700      TOT-FAT             TOT-SER             TOT-MNR             TOT-NON
03390    276800      REC-TOT-OCC         HEAD-COUNT          S-H-INSTALLED       S-H-USED
03391    276900      S-H-FAILED          HELMET-USED         HELMET-UNUSED       TOT-ST-ACC
03392    277000      TOT-ST-FAIL         VEL-30              VEL-60              VEL-90
03393    277100      VEL-120             VEL-120-PLUS        TOT-ACC-VEL         VEL-SUM
03394    277200      AVG-VEL             DIST-10             DIST-20             DIST-30
03395    277300      DIST-40             DIST-50             DIST-60             DIST-60-PLUS
03396    277400      TOT-ACC-DIST        DIST-SUM            AVG-DIST            TOT-STBLT-ACC
03397    277500      TOT-STBLT-FAIL      ANGLE-15            ANGLE-30            ANGLE-45
03398    277600      ANGLE-60            ANGLE-75            ANGLE-90            ANGLE-90-PLUS
03399    277700      TOT-ACC-ANG         ANGLE-SUM           AVG-ANGLE           TOT-T-O
03400    277800      TOT-FLY             TOT-LDG             UP                  UP-PH-TOT
03401    277900      TYP-TOT-01          CAUSE-01            CAUSE-FATAL-01      FAT-TO
03402    278000      CAUSE-NONFAT-01     PG-1-SERIOUS-01     FAT-INFLT           FAT-LOG
03403    278100      TOT-ST-ACC          TOT-ST-FAIL         TERRAIN-001         SERIOUSNESS
03404    278200      TOT-NR              TOT-TS              FAT-TS              FAT-NR
03405    278300      F                   INJ-01              C-SAVE-01           TOT-AC-TYPE
03406    278310      TALLY.
03407    278400      MOVE SPACES TO SAV-CARD.
03408    278500      MOVE 1 TO D.
03409    278600  END-INITIALIZE.      EXIT.
```

```
BLOCK   98   DATA  1600      0731693 C057N8407R    011069NREDDING,CALIF    PIPER      PA-28          2145 A051242812O6AAA1ADYA D
80   M109                                                                  08FZ3 YN                                                  F
                            FA  AA   A  CA   A  A                                    02000AR  A 00210A          ZA      25A
                                                                    F  1          1
                              1          2          2                                                                  1
                            LT.FOLLOWED          HWY INTO VALLEY WITH LOW CLOUDS.NOT INST RATED.                P RECOVERY DATE-1/13/69.LOST ON NITE F
                                                                                                  F0140OGL B103       039
                            B         B C02          X                  D2                 AX                              AKFH  C608
                                                                                    GAF

BLOCK   99   DATA  1600      0731693 0011N8126Y    010469 TOUGHKENAMON,PA  PIPER      PA-30          1150 A381242912J2AAA24S   F
81   M EFF FF                                     CLEMENTCH AVIA          BA  A  A       FN GARDEN          A 00278A      00435C      02933
                            CA  AA   A  BA  AA  A                                                      00011A        51A
                                                                    N  1          1  64C2264L3164L0888K94
                              1          1
                                                                                                  P THIRD SOLO FLT IN MULTI-ENG ACFT.DIV
                            ERTED VISION          FROM RNWY TO INST PANEL TO LOCATE FLAP CONTROL
                                                                    000673                  Z01300IL JB          026293008
                                                                    01   023
                                                                                    GAF

BLOCK   100  DATA  1600      0731695 0001UY0SG     011569 NORTHBROOK,ILL   PIPER      PA-30          1610 F131242912J4AAA24S   F
80   A FENCEF                                     GS FLYYESKOL            BA  I  A       FSKY HARBOR        A 06000A      00680AC  D C02433
                            AA  PA   A  GA  GA  A                                                      00007A        32A
                                                                    N  1          1  64C7980LBC
                              1          2     2                                                                            1
                                                                    000466
                                                                    02   103                F01000EK BB              130010
                                                                                    GAF

BLOCK   101  DATA  1600      1009693 C031N5564J    021069 DALLAS,TEX       PIPER      PA-32          2225 A431243012364AA14S   E
CJ  FN781F 91                                     TRICON INTL AL          DA  A  A       FLOVE FIELD       A 01118A      00485A A    A07751
                            BA  MA   A  CA  GA  A                                                      00013A        23A
                                                                    N  1          1  84CJ 88K9463LH1
                              1          1
                                                                                                  P ACFT WENT DOWN INTO DRAINAGE PIT ARE
                            A.                    PILOT-MISJUDGED EDGE OF TAXI RAMP.
                                                                    000377                  A    UIL J                115009
                                                                    015404   445
                                                                                    GAF
```

A.7 SAMPLE OUTPUT

Typical individual airplane output data is shown in Figures 12 and 13. Typical grand summary data output is shown in Figure 13. Both Figures are contained in this report on pages 42 through 47.

A.8 DISCUSSION OF PROGRAM AND DATA TAPE

Data Processing Information

This tape is 9 track, unlabeled, blocked 3440 with 80 by 6 record length.

Tape layout

The content of this tape is as follows

Program MTSB0001
*****
Program MTSB0002
*****
Program 1325020D
*****
NTSB record used in MTSB0001 and MTSB0002
*****
Full Print Headers
*****
Job Control to catalog and execute the system

The jobs are separated by one record with five (5) asterisks in column 1-5. The tape was tested at Cessna by selection and printing 1325020D and the job control and not the remainder.

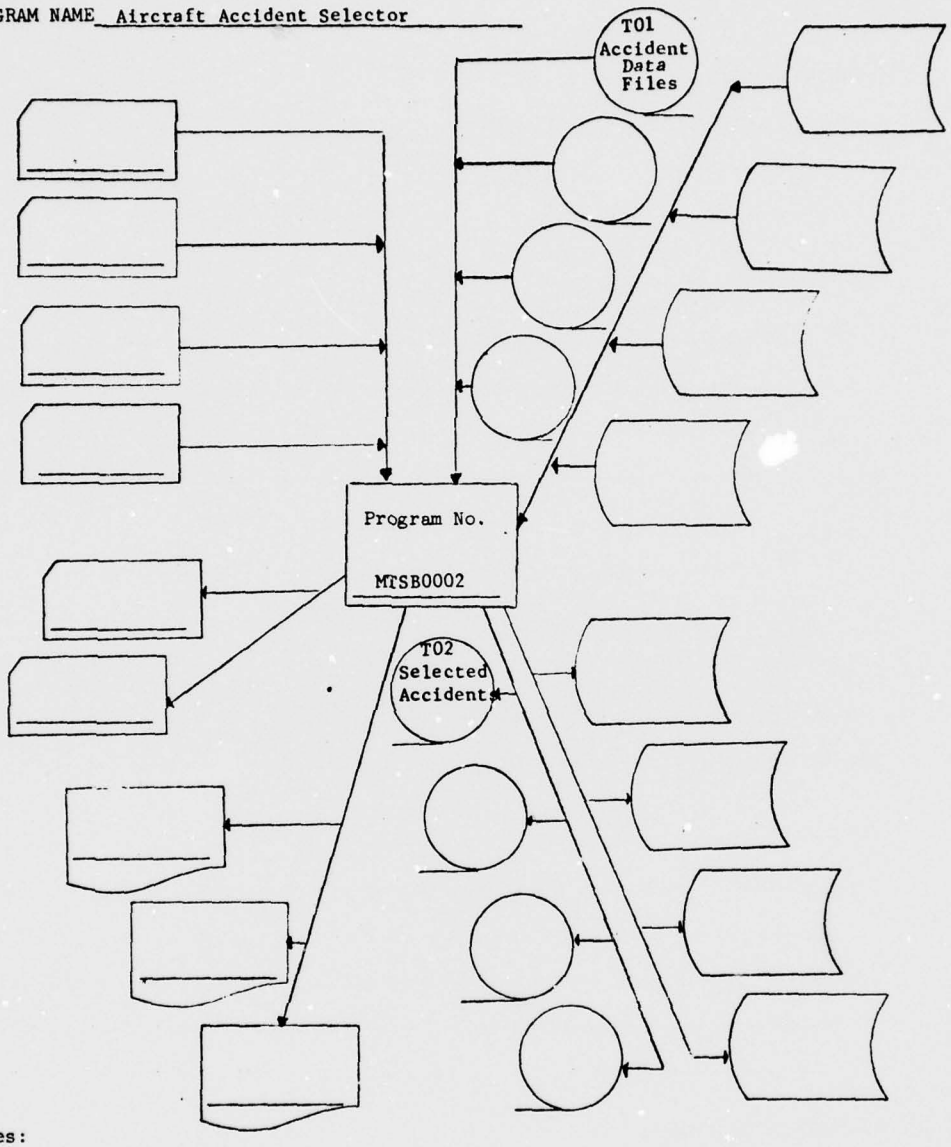
A.9 MACHINE ROOM SET-UP SHEETS

Summary of Three NTSB Accident Data Files

1. MTSB0002 - Aircraft Accident Selector
2. SORT - Sort Accidents
3. 1325020D - Create English Meaning Headers Direct Access File
4. MTSB0001 - Additional Selection and Summarization of Selected Accidents

****
*
* T O T A L R E Q U I R E M E N T S
*
* I-O
*
* Reader
* Printer
* Tape Drives - 3
* Disk Drives - 2 (1 if 3800 Tracks are Available on Single Drive)
*
*
* Core
* 92K
*
****

PROGRAM NAME Aircraft Accident Selector



Files:

Sys No.	File Serial	File Name	Disposition
001	N/A	Accident Data Files	Store
002	N/A	Selected Accidents	To Sort

PRINTER SET-UP

Carriage Tape: 88 Lines/Page

Paper size or form number:

Vertical Alignment: Upper Most — 14 x 11 — 1 Part

Horizontal Alignment: Left

	Name	Disposition
Cards In:		
Cards Out: P1		
P2		
RP3		

CAN JOB BE RESTARTED? ( ) YES (X) NO

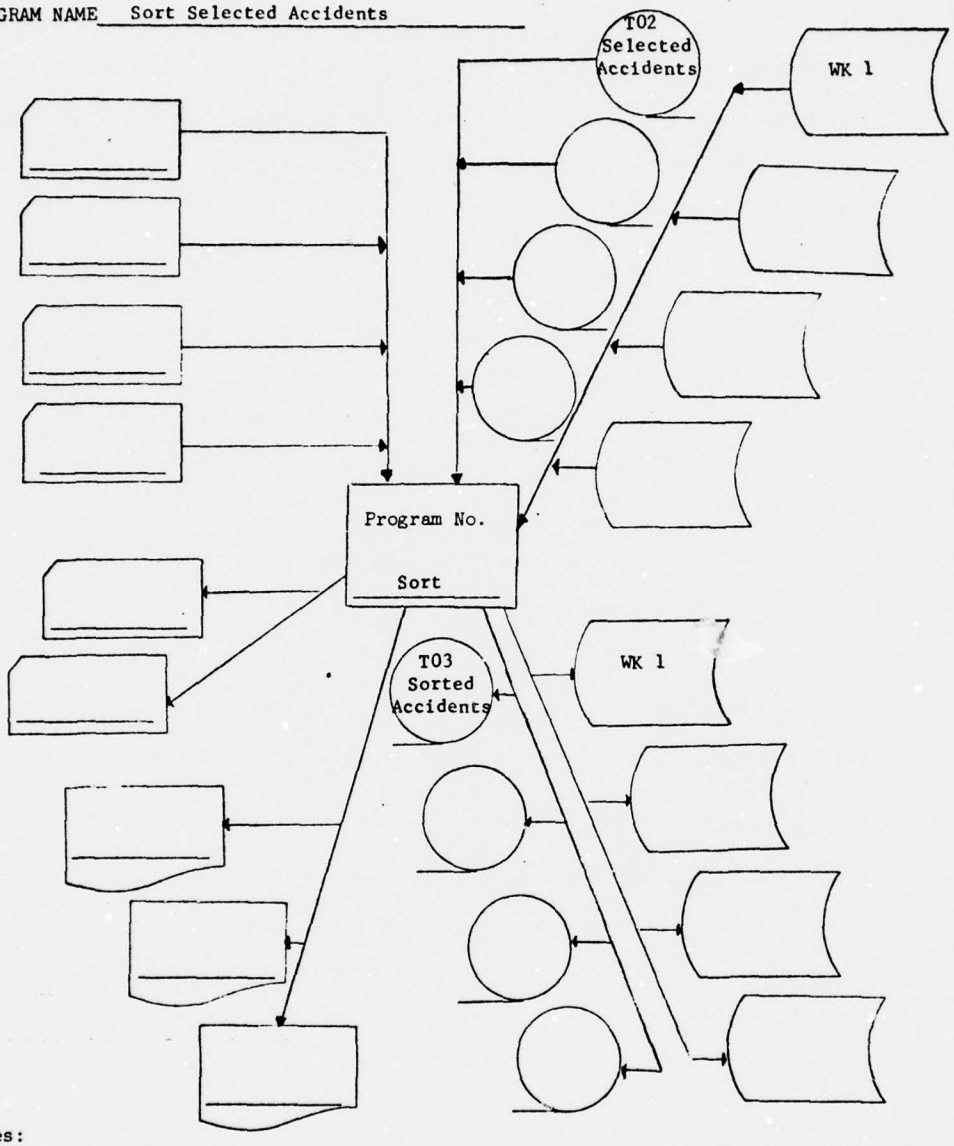
CAN JOB BE RERUN? (X) YES ( ) NO

If no, see special instructions for appropriate action.

CONSOLE MESSAGE:	ACTION
1. N/A	
2.	
3.	
4.	
5.	

Special Instructions:

PROGRAM NAME Sort Selected Accidents



Files:

Sys No.	File Serial	File Name	Disposition
N/A	N/A	N/A	N/A

PRINTER SET-UP

Carriage Tape _____ Paper size or form number: _____

Vertical Alignment _____ _____

Horizontal Alignment _____ _____

	Name	Disposition
Cards In:	_____	_____
	_____	_____
	_____	_____
	_____	_____
Cards Out: P1	_____	_____
P2	_____	_____
RP3	_____	_____

CAN JOB BE RESTARTED? ( ) YES (X) NO

CAN JOB BE RERUN? (X) YES ( ) NO

If no, see special instructions for appropriate action.

CONSOLE MESSAGE:	ACTION
1. See User's Manual	_____
2. _____	_____
3. _____	_____
4. _____	_____
5. _____	_____

Special Instructions:

_____

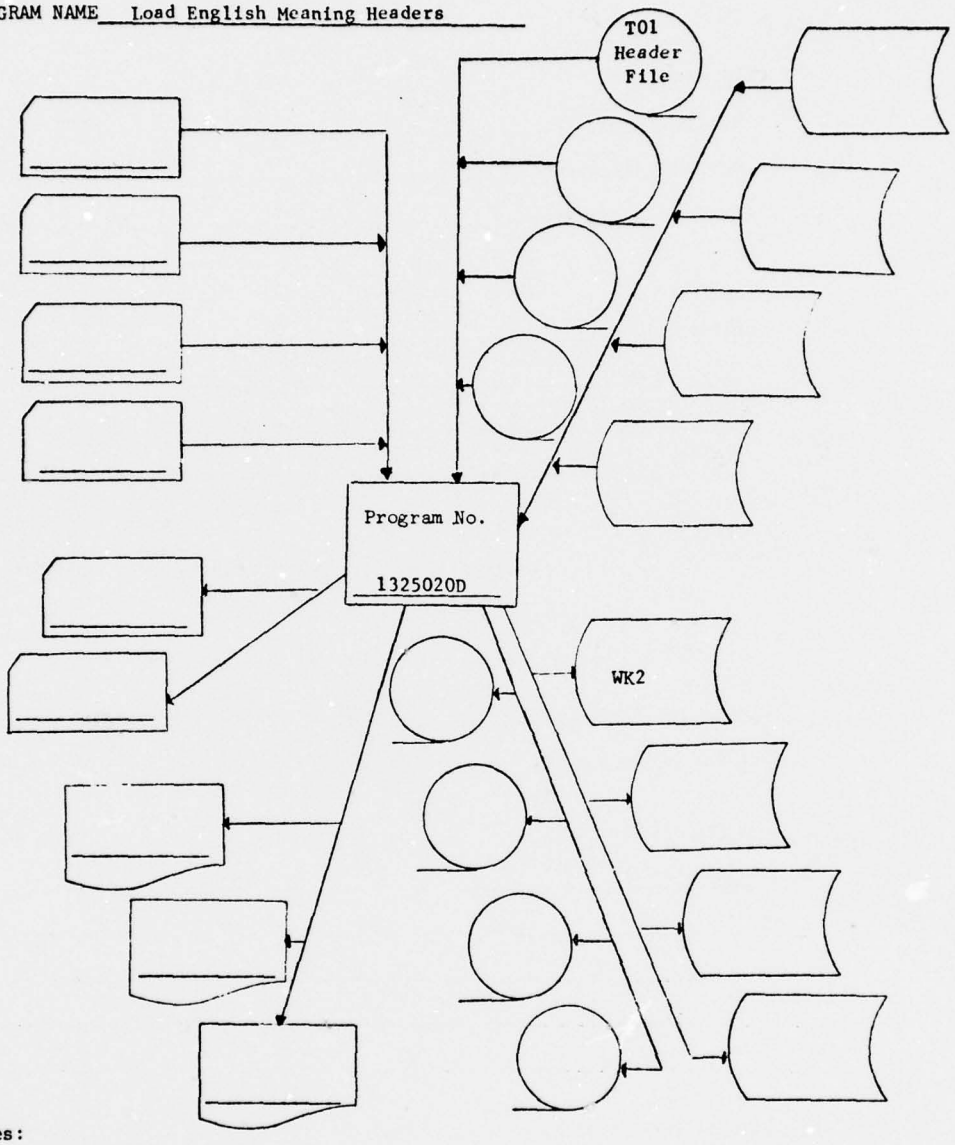
_____

_____

_____

_____

PROGRAM NAME Load English Meaning Headers



Files:

Sys No.	File Serial	File Name	Disposition
010	325020	NTSB Headers	Store

PRINTER SET-UP

Carriage Tape _____ Paper size or form number:

Vertical Alignment _____ _____

Horizontal Alignment _____ _____

	Name	Disposition
Cards In:	_____	_____
	_____	_____
	_____	_____
	_____	_____
Cards Out: P1	_____	_____
P2	_____	_____
RP3	_____	_____

CAN JOB BE RESTARTED? ( ) YES (X) NO

CAN JOB BE RERUN? (X) YES ( ) NO

If no, see special instructions for appropriate action.

CONSOLE MESSAGE:	ACTION
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____
5. _____	_____

Special Instructions:

_____

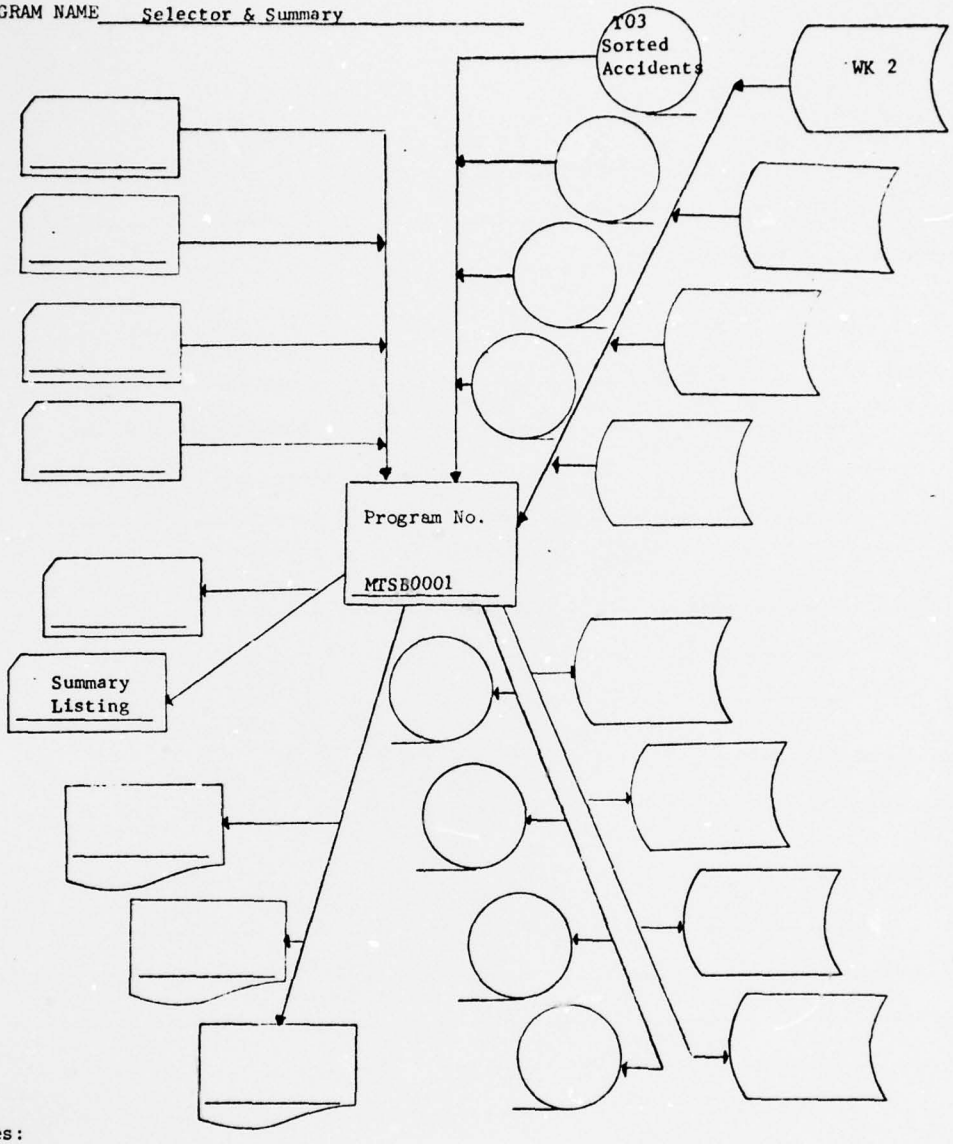
_____

_____

_____

_____

PROGRAM NAME Selector & Summary



Files:

Sys No.	File Serial	File Name	Disposition
018	N/A	N/A	Store or Recycle
019	N/A	NTSB	N/A

PRINTER SET-UP

Carriage Tape: 88 Lines/Page

Vertical Alignment: Upper Most

Horizontal Alignment: Left

Paper size or form number: 14 x 11 1 Part

	Name	Disposition
Cards In:	N/A	
Cards Out: P1	N/A	
P2		
RP3		

CAN JOB BE RESTARTED? ( ) YES (X) NO

CAN JOB BE RERUN? (X) YES ( ) NO

If no, see special instructions for appropriate action.

CONSOLE MESSAGE:	ACTION
1.	
2.	
3.	
4.	
5.	

Special Instructions:

APPENDIX B

REPRESENTATIVE GENERAL AVIATION AIRPLANE STRUCTURE

B.1 INTRODUCTION

This appendix describes the structure that is representative of two different types of general aviation light fixed-wing airplanes. In addition typical cross sections, from which basic area properties (A, I_{yy}, I_{zz}) are obtained, are shown. The structure material properties (E, G), combined with the area properties, are used to determine member stiffnesses.

B.2 AIRPLANE A

Airplane A is a category 1 type of airplane with the following general description:

- Single-engine, high-wing configuration
- Side by side seats (two occupants)
- Used for training, sport or aerobatic purposes
- Stall speed (flaps down) $\leq$ 42 knots
- Cruise speed (75% power) $\leq$ 102 knots
- Flight design load factor of: +4.4g's and -1.76g's (utility)
  +6.0g's and -3.00g's (aerobatic)
- Maximum takeoff weight = 1600 pounds
- Wing span = 384 inches
- Length = 280 inches

Figure B-1a shows an overall view of the airplane and Figure B-1b shows the mathematical model used to represent the structure for crash analysis.

Figures B-2 through B-12 show different structures and approximate cross sections for the respective structure. Table B-1 describes the Airplane A Structure with regard to material properties, strength, design concepts, size and attachments.

B.3 AIRPLANE B

Airplane B is a category 3 type airplane with the following general description:

- o Single engine low wing configuration
- o Single seat
- o Used for application of chemicals or seeding crops
- o Stall speed (flaps down) $\leq$ 50 knots
- o Cruise speed (75% power) $\leq$ 122 knots
- o Flight design load factor of; +3.8g's and -1.52g's
- o Maximum takeoff weight = 3300 pounds (4000 pounds in restricted category)
- o Wing span = 474 inches
- o Length = 273 inches

Figure B-13a shows an overall view of the airplane and Figure 13b shows the mathematical model used to represent the structure for crash analysis. Figures B-14 through B-20 show different structure and approximate cross sections used to represent the structure. Table B-2 describes the airplane B structure with regard to material properties, strength, design concept, size and attachments. Table B-3 presents the cross sectional dimensions of the fuselage tubular framework.

TABLE B-1 DESCRIPTION OF AIRPLANE A STRUCTURE

Structure	Materials and Properties	Concepts and Size	Attachments	Applicable Figures
1. Engine Mount Assembly and Nose Landing Gear	4130 Steel $E = 30 \times 10^6$ psi $G = 11 \times 10^6$ psi $F_{ty} = 75 \times 10^3$ psi $F_{tu} = 95 \times 10^3$ psi	Tubular members .75 in. x .049 in. .50 in. x .049 in. Hydraulic cylinder nose gear	Bolt attachments to fire wall, 4 places, to engine 4 places.	B-2
2. Main Landing Gear	6150H Steel $E = 30 \times 10^6$ psi $G = 11 \times 10^6$ psi $F_{ty} = 205 \times 10^3$ psi $F_{tu} = 245 \times 10^3$ psi	Flat steel spring. Tapered cross section. Average cross section are shown in Figure B-3	Single bolt attachment inboard to fuselage	B-3
3. Landing Gear Bulkhead	2024-T3 $E = 10.5 \times 10^6$ psi $G = 4 \times 10^6$ psi $F_{ty} = 37 \times 10^3$ psi $F_{tu} = 63 \times 10^3$ psi	Two formed bulkheads with skin attachment above and below. Dimensions are shown in Figure B-5	Landing gear forgings attached between bulkheads by means of bolts	B-4, B-5
4. Firewall	Stainless Steel $E = 27 \times 10^6$ psi $G = 11 \times 10^3$ psi $F = 58 \times 10^3$ psi (avg. of F_{ty} and F_{tc}) $F_{tu} = 124 \times 10^3$ psi	Beaded flat aluminized iron sheet, a peripheral stiffener and attaching fuselage skin. Thickness = .025 in.	Steel rivets	B-4, B-5
5. Upper and Lower Engine Mount Stringer	2043-T3 Aluminum $E = 10.5 \times 10^6$ $G = 4. \times 10^6$ psi $F_{ty} = 37 \times 10^3$ psi $F_{tu} = 63 \times 10^3$ psi	Upper mount stringer is a tapered U channel section. Average section shown in Figure B-5, Lower Mount Stringer is a Channel with J edges, as shown in Figure B-5	Rivets	B-4, B-5

TABLE B-1 DESCRIPTION OF AIRPLANE A STRUCTURE (Cont'd)

Structure	Materials and Properties	Concepts and Size	Attachments	Applicable Figures
6. Upper Cabin Area	Same as No. 5	This area is comprised of a root rib-upper door jam, cabin top skin and two stringers. It extends from the forward door post to aft door post. Dimensions are shown in Figure B-5.	Rivets	B-4, B-5
7. Forward Floor Bulkhead	Same as No. 5	Consists of formed bulkhead stiffener on aft side, floor-board on top and skin on bottom. Average cross section, as shown in Figure B-7.	Rivets	B-6, B-7
8. Forward Door Post	Same as No. 5	Assemblage of three pieces, as shown in Figure B-7. Maximum cross-section is shown.	Rivets, screws and bolts	B-6, B-7
9. Fuselage Carry thru Structure	Same as No. 5	Formed channels, same dimension front and rear. Approximate dimensions are shown in Figure B-7	Rivets and bolts	B-6, B-7
10. Rear Door Post	Same as No. 5	Assemblage of three pieces, doorpost, jam and skin. Dimensions along uniform length are shown in Figure B-9.	Rivets, screws and bolts	B-8, B-9
11. Upper and Lower Aft Fuselage	Same as No.5	Upper sections consists of skin-stringer arrangement. Lower section is a semi-monocoque structure. Approximate dimensions are shown in Figure B-9	Rivets	B-8, B-9

TABLE B-1 DESCRIPTION OF AIRPLANE A STRUCTURE (Cont'd)

Structure	Materials and Properties	Concepts and Size	Attachments	Applicable Figures
12. Tail Cone	Same as No. 5	Tapered semi-monocoque section. Approximate average section is shown in Figure B-10	Rivets	B-8, B-10
13. Bulkhead at F.S. 95	Same as No. 5	Formed one piece sheet metal Bulb angle reinforce lower section. Approximate cross-section is shown in Figure B-10.	Bolts at wing attachment. Rivets at forward section.	B-8, B-10
14. Wing	6061-T6 $E = 10.5 \times 10^6$ psi $G = 4 \times 10^6$ psi $F_{ty} = 32 \times 10^3$ psi $F_{tu} = 38 \times 10^3$ psi	Two spar arrangement. Average cross section at constant chord line and for tapered expanse is used.	Bolted to strut and fuselage top	B-11, B-12
15. Wing Strut	Same as No. 14	Extruded tube Uniform cross section	Forged attachment fittings single bolted at each end of strut extrusion	B-11, B-12

F_{ty} = Tensile yield stress

F_{cy} = Compressive yield stress

F_{tu} = Tensile ultimate stress

E = Modulus of Elasticity

G = Modulus of Rigidity

TABLE B-2 DESCRIPTION OF AIRPLANE B STRUCTURE

Structure	Materials and Properties	Concepts and Size	Attachments	Applicable Figures
1. Fuselage	4130 Steel $E = 30 \times 10^6$ psi $G = 11 \times 10^6$ psi $F_{ty} = 75 \times 10^3$ psi $F_{tu} = 95 \times 10^3$ psi	Tubular members of various sizes. See Table B-3.	Pin joints (bolt through clevis) for strut and wing attachments. Bolted joints for Firewall and tail cone attachments	B-14
2. Engine Mounts	4130 Steel $E = 30 \times 10^6$ psi $G = 11 \times 10^6$ psi $F_{ty} = 75 \times 10^3$ psi $F_{tu} = 95 \times 10^3$ psi	Tubular members: .75 inch x .049 inch .875 inch x .049 inch Arrangement and attachments are shown in Figure B-15	Bolted to firewall, 4 places. Isolator mounted to engine, 4 places	B-15
3. Wing Strut	2024-T3 Aluminum $E = 10.5 \times 10^6$ psi $G = 4.0 \times 10^6$ psi $F_{ty} = 37 \times 10^3$ psi $F_{tu} = 63 \times 10^3$ psi	Constant cross section See Figure B-12 for dimensions	Pin joints at fuselage and wing.	B-16
4. Wing	2024-T3 Aluminum $E = 10.5 \times 10^6$ psi $G = 4.0 \times 10^6$ psi $F_{ty} = 37 \times 10^3$ psi $F_{tu} = 63 \times 10^3$ psi	Two spar arrangement Rib spacing is approximately 26 inches. Skin thickness = .035 to .032 inches. Average dimensions are shown in Figure B-17.	Pin joint to the fuselage at front and rear spars	B-17
5. Landing Gear	6150 H Steel $E = 30 \times 10^6$ psi $G = 11 \times 10^6$ psi $F_{ty} = 205 \times 10^3$ psi $F_{tu} = 245 \times 10^3$ psi	Tapered spring. Average section = 4.5 inches wide. Spring provides all landing gear stiffness.	Four bolts at fuselage each side. One bolt to axle.	B-18

TABLE B-2 DESCRIPTION OF AIRPLANE B STRUCTURE (Cont'd)

Structure	Materials and Properties	Concepts and Size	Attachments	Applicable Figures
6. Vertical Tail	2024-T3 Aluminum $E = 10.5 \times 10^6$ psi $G = 4.0 \times 10^6$ psi $F_{ty} = 37 \times 10^3$ psi $F_{tu} = 63 \times 10^3$ psi	Front and rear spar Spar thickness = .040 inches. Shim thickness = .025 inches. Cross section is shown in Figure B-19	Bolt attachment at front and rear spars to tail cone	B-19
7. Fuselage Tailcone	2024-T3 Aluminum $E = 10.5 \times 10^6$ psi $G = 4.0 \times 10^6$ psi $F_{ty} = 37 \times 10^3$ psi $F_{tu} = 63 \times 10^3$ psi	Intermediate bulkheads, stiffened-shim arrangement. Thickness of skin, bulkhead and stiffener = .032 inches. Cross sections and attachments are shown in Figure B-20	Bolted to aft bulkhead, 4 places.	B-20

Notes:

F_{ty} = Tensile yield stress

F_{tu} = Tensile ultimate stress

E = Modulus of Elasticity

G = Modulus of Rigidity

TABLE B-3 AIRPLANE B FUSELAGE STRUCTURE
TUBULAR MEMBER SIZES

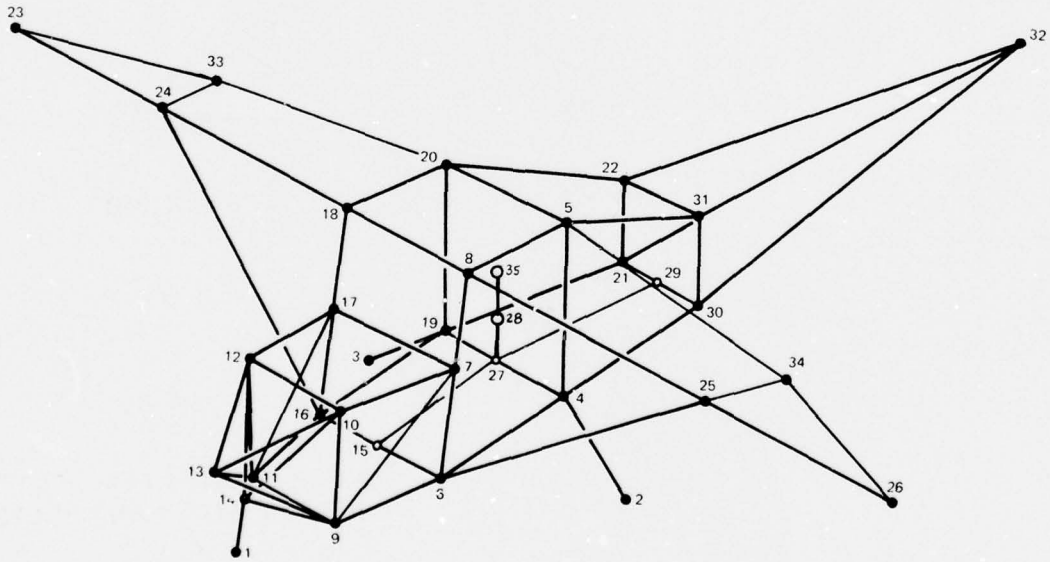
Member	i^{th} Node(a)	j^{th} Node(a)	Tube Size (diameter and thickness), Inches
8	22	32	.750 x .058
9	4	32	.875 x .049
10	32	33	.50 x .035
11	6	33	.875 x .049
12	23	33	1.125 x .049
13	27	33	1.375 x .083
14	5	6	1.375 x .058
15	4	5	.75 x .035
16	5	17	1.0 x .049
17	5	7	1.0 x .049
18	5	17	.625 x .035
19	6	8	1.0 x .049
20	6	18	1.25 x .049
21	6	26	.875 x .049
22	7	8	.875 x .049
23	7	9	1.00 x .065
24	7	37	1.5 x .058
25	24	26	1.0 x .049
26	25	27	1.0 x .049
27	8	10	.625 x .049
28	8	15	1.0 x .049

(a) See Figure B-13 for i^{th} and j^{th} node designations

(b) Tube sizes for left side are shown, right side has same dimensions

(c) Diagonal member sizes are 1.0 inch x .049 inch

(a) OVERALL VIEW



(b) MATH MODEL

Figure B-1. Airplane A

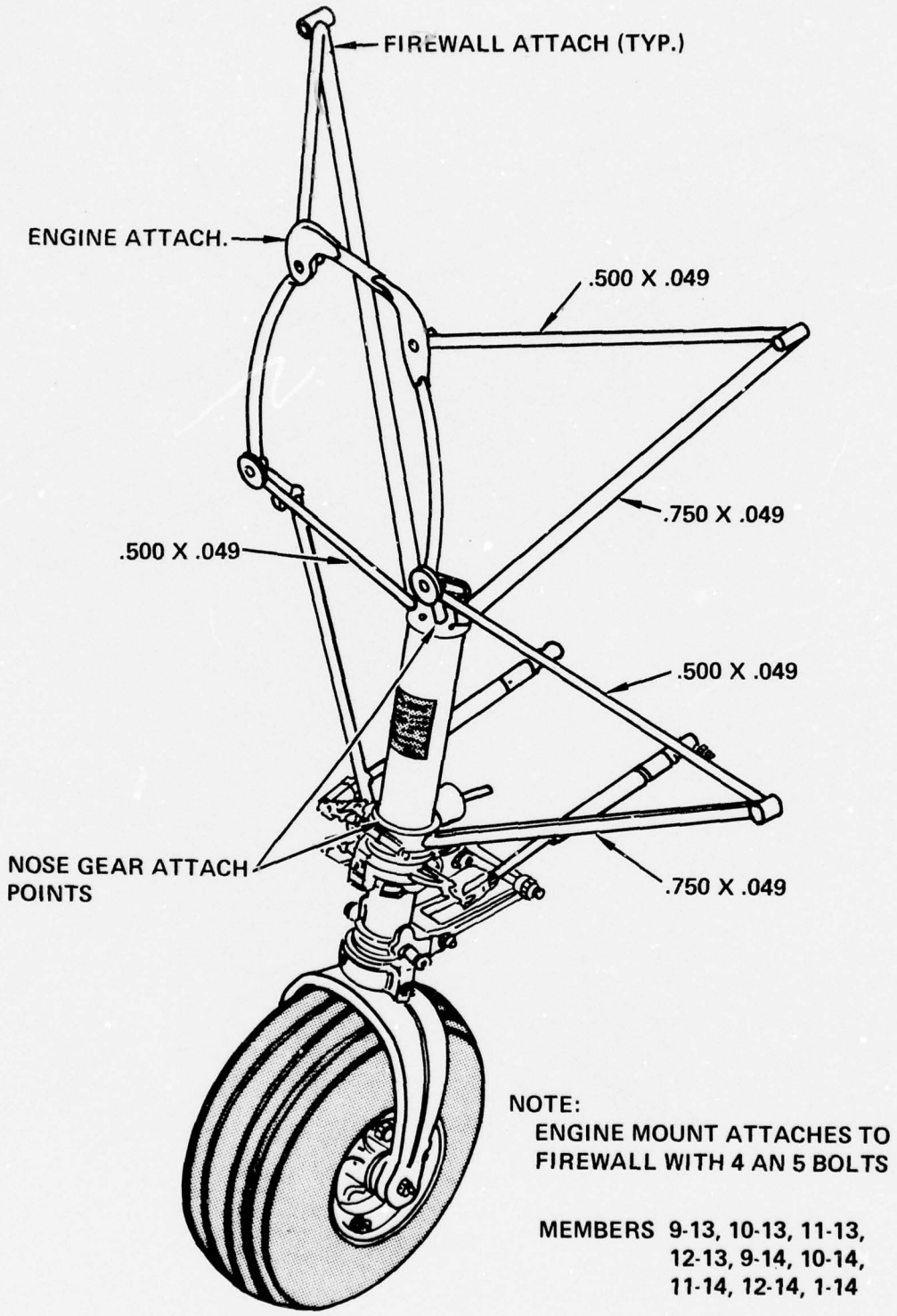


Figure B-2. Engine Mount and Nose Gear Assembly

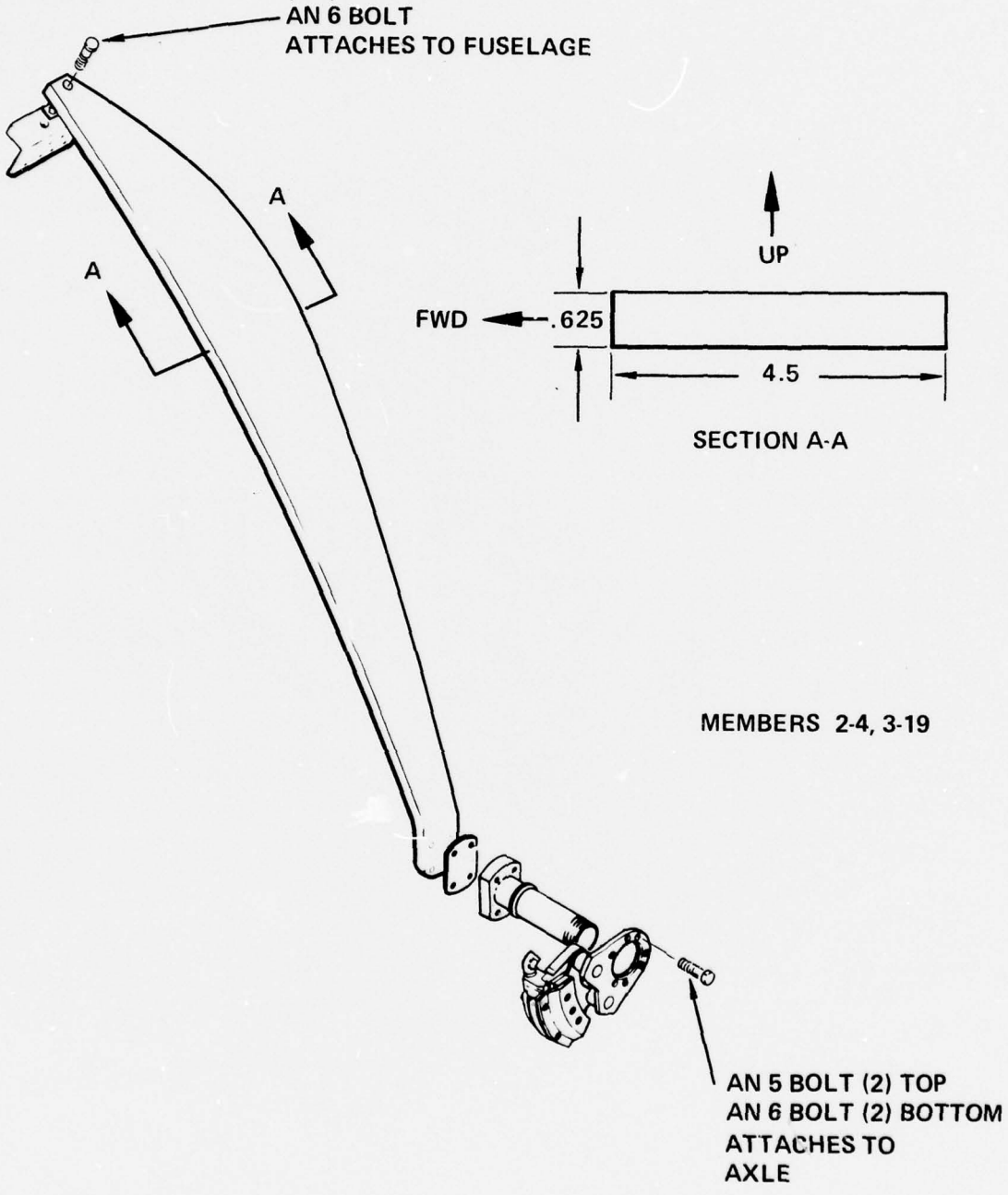


Figure B-3 Main Landing Gear Cantilever Spring Cross-Section

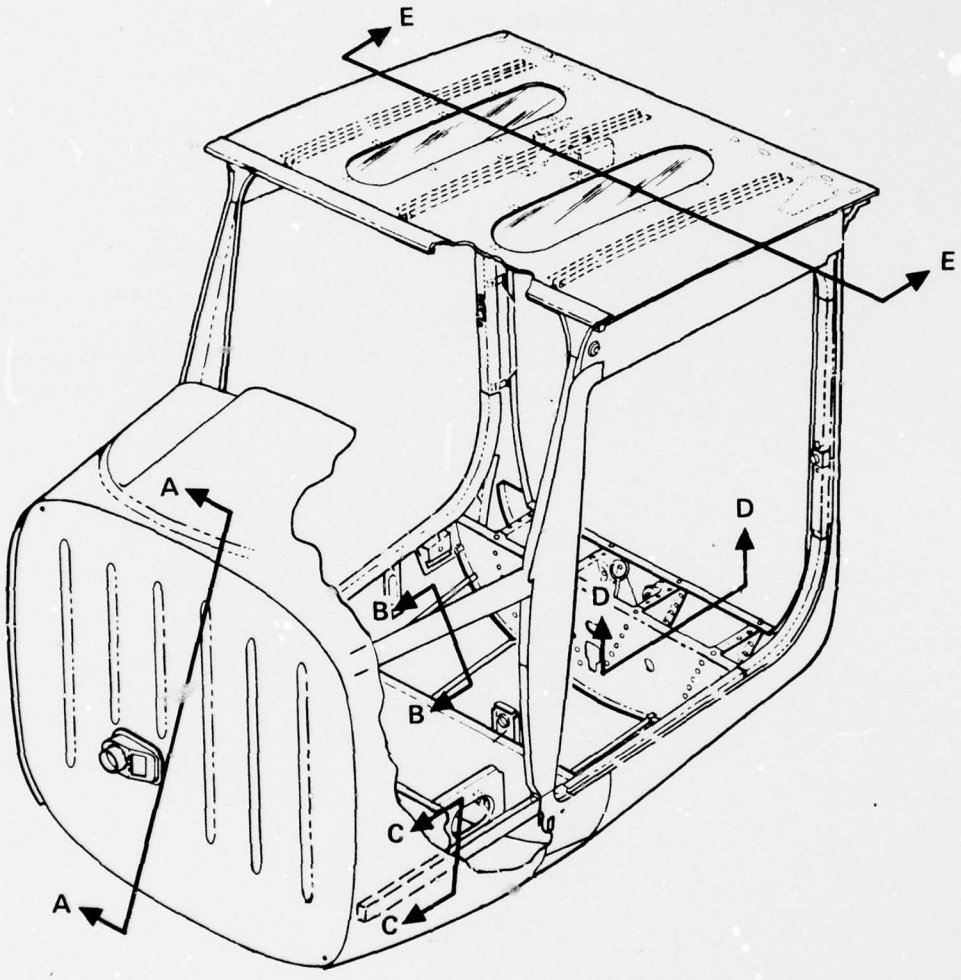
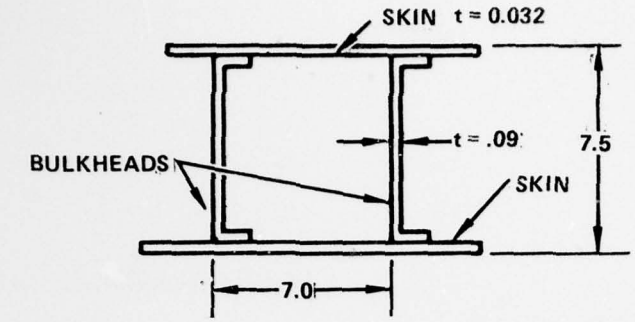
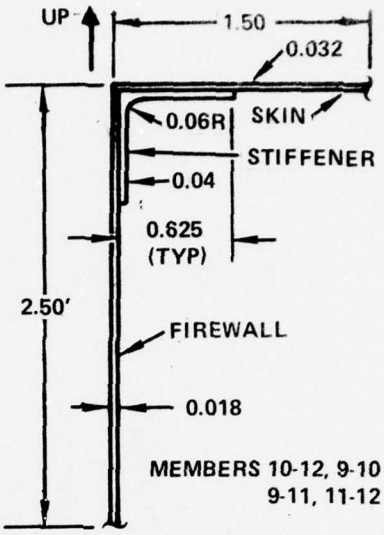


Figure B-4. Fuselage Front and Center Section Assembly



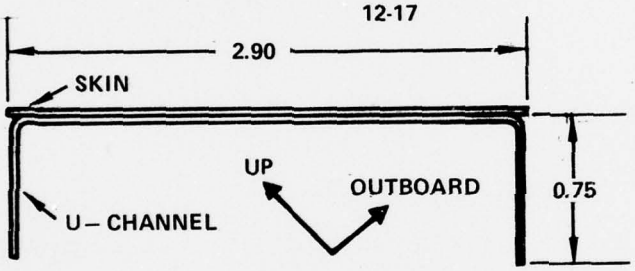
MEMBERS
4-27, 19-27

SECTION DD
(A) LANDING GEAR BULKHEAD



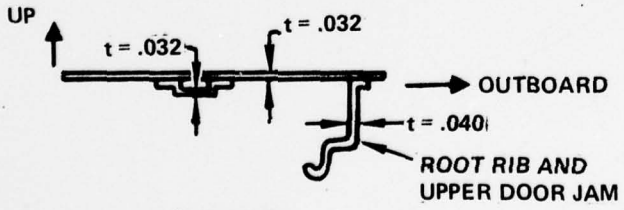
SECTION AA
(B) FIREWALL

MEMBERS
7-10
12-17

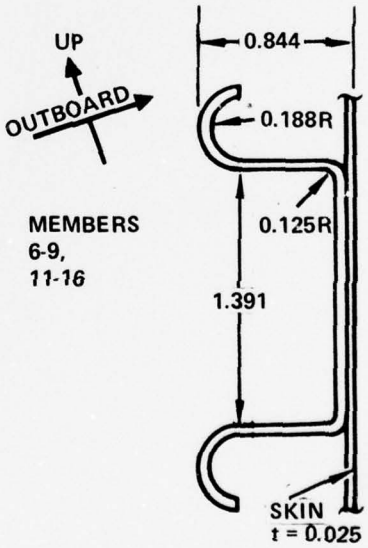


SECTION BB
(C) UPPER ENGINE MOUNT STRINGER

MEMBERS 5-8, 18-20, 31-32, 22-32, 30-32, 21-32



SECTION EE
(E) UPPER CABIN AREA



MEMBERS
6-9,
11-16

SECTION CC
(D) LOWER ENGINE MOUNT STRINGER

Figure B-5 Fuselage Front and Center Structure Cross Sections

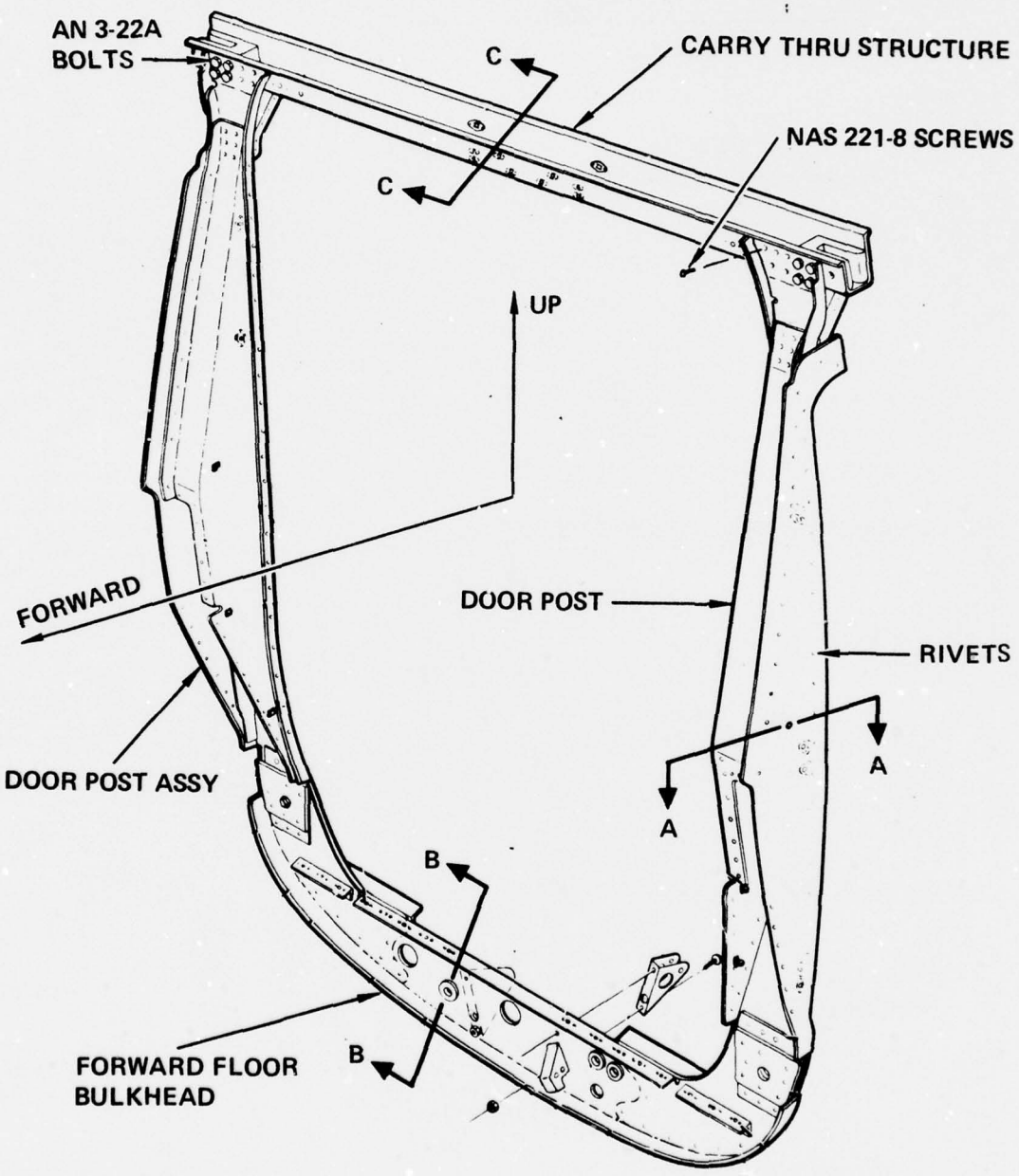
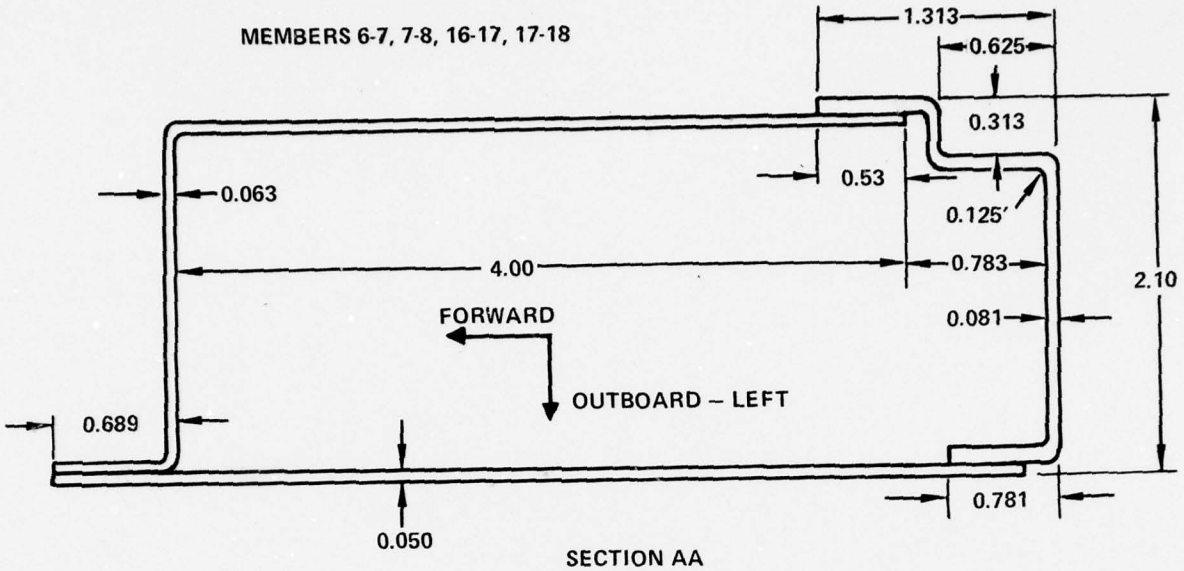
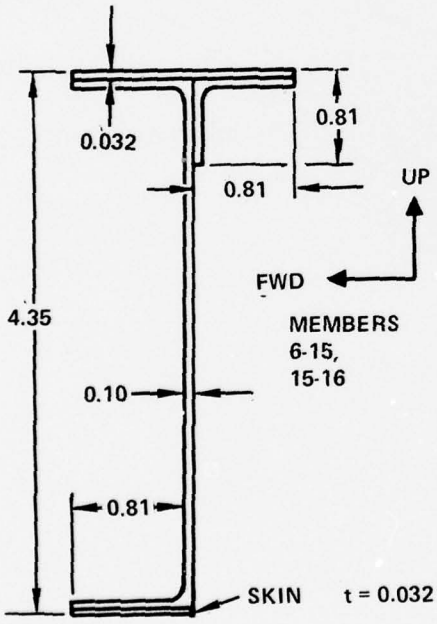


Figure B-6. Forward Door Post, Forward Floor Bulkhead, and Carry Thru Structure



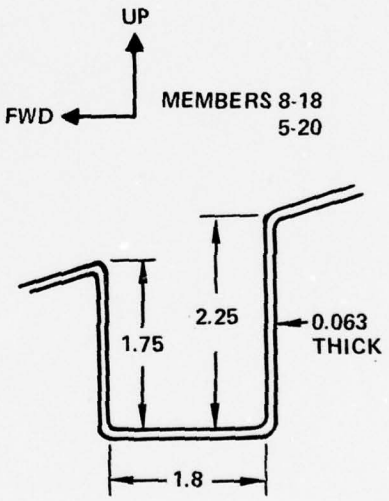
SECTION AA

(A) FORWARD DOOR POST



SECTION BB

(B) FORWARD FLOOR BULKHEAD



SECTION CC

(C) FRONT AND REAR CARRY THRU STRUCTURE

Figure B-7 Forward Door Post, Forward Floor Bulkhead, and Carry Thru Structure Cross Sections

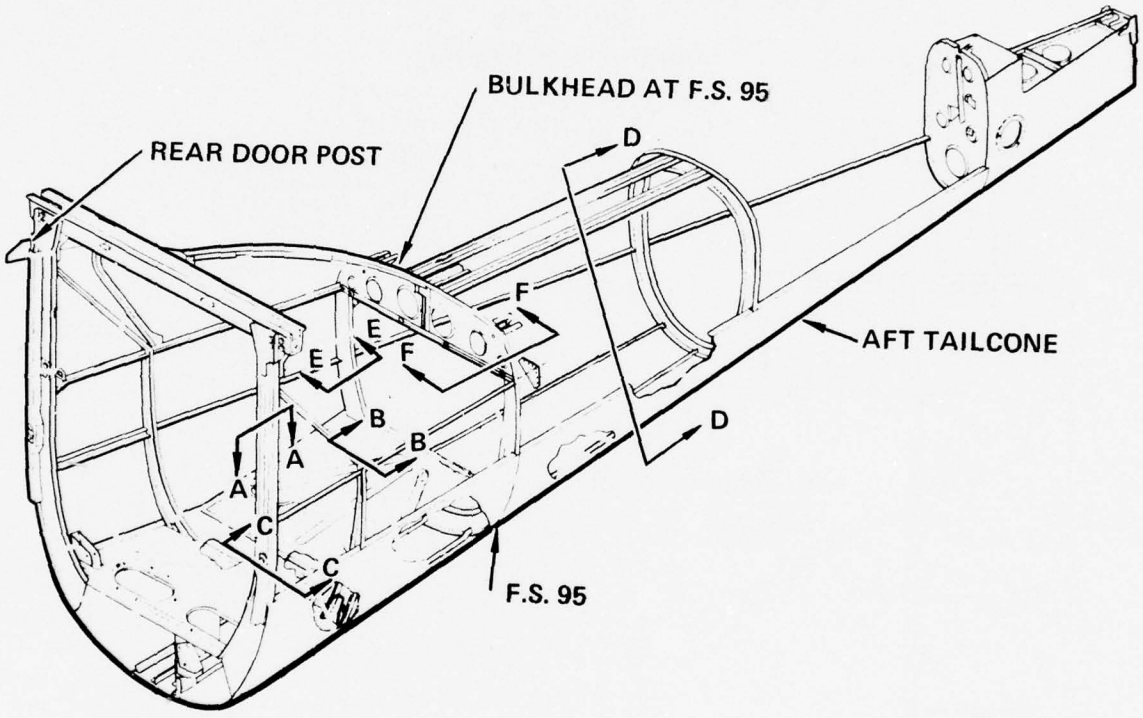
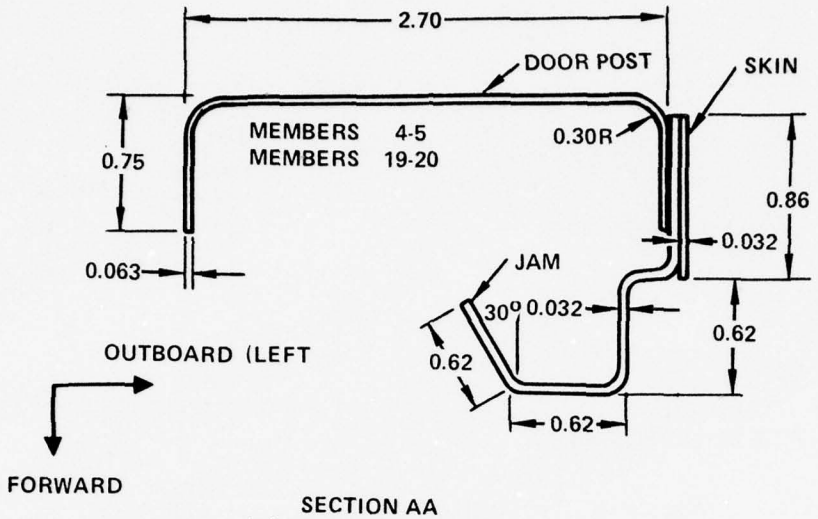
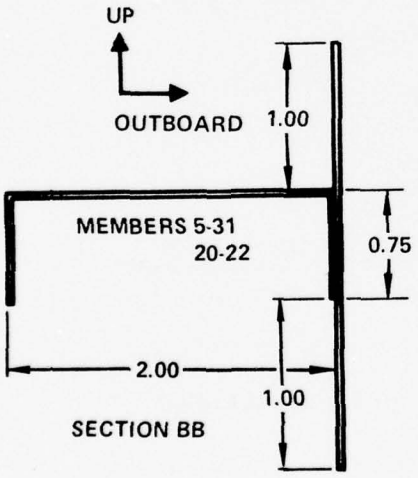


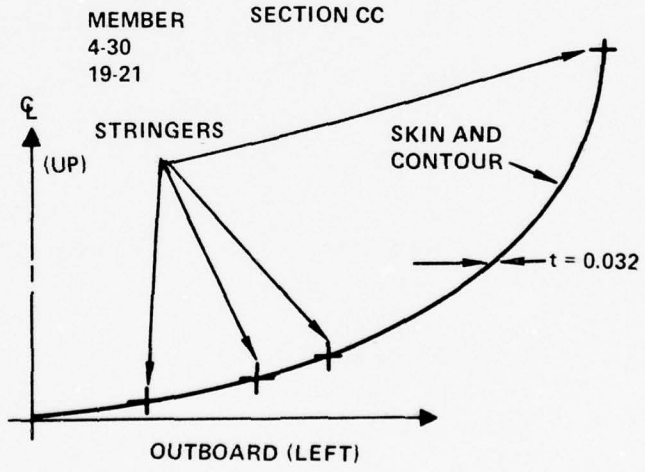
Figure B-8. Aft Fuselage Structure



SECTION AA
(A) REAR DOOR POST



(B) UPPER AFT FUSELAGE



(C) LOWER AFT FUSELAGE

Figure B-9 Aft Fuselge Structure Cross Sections

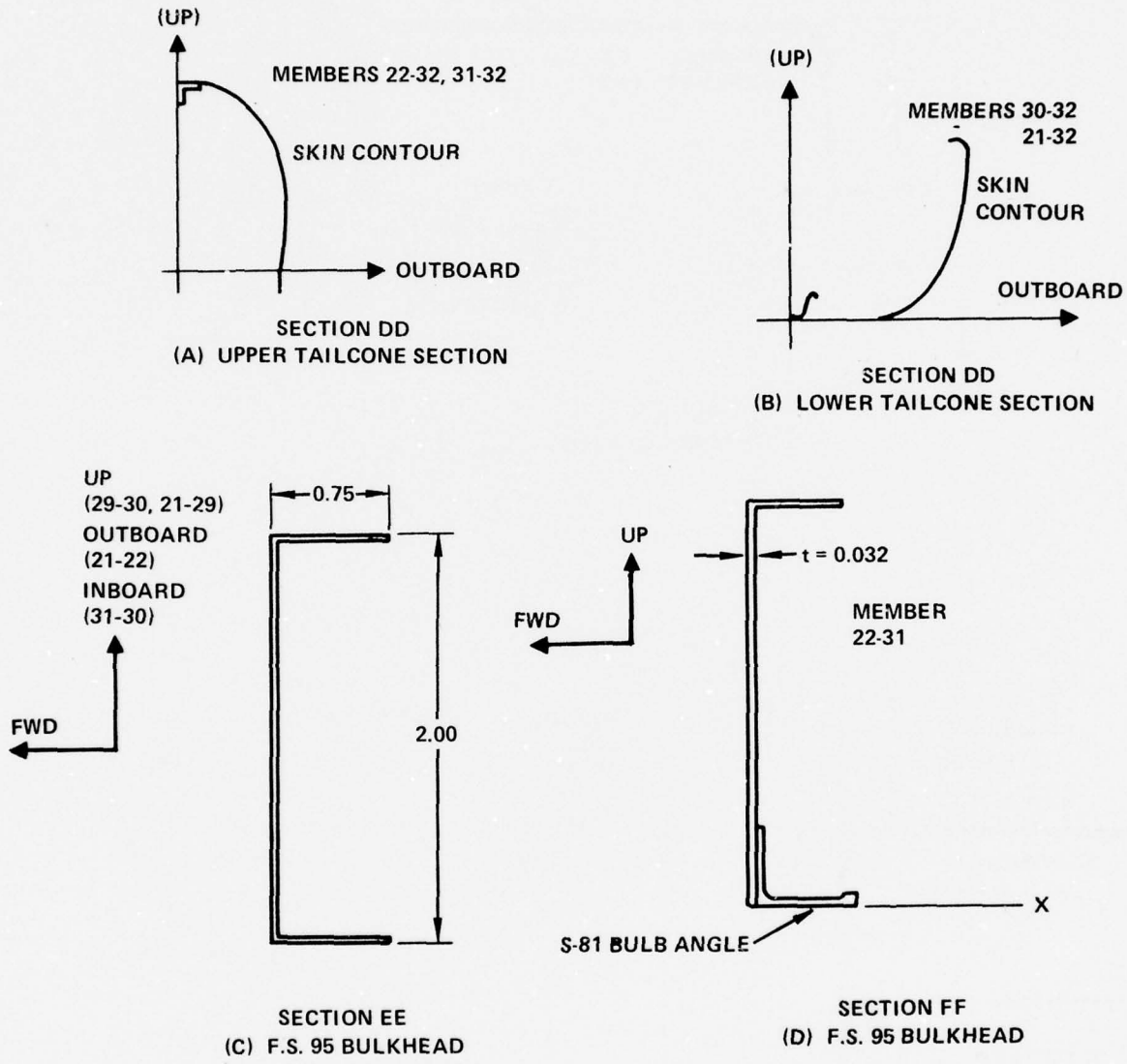


Figure B-10. Tail Cone and F.S. 95 Bulkhead Structure Cross Sections

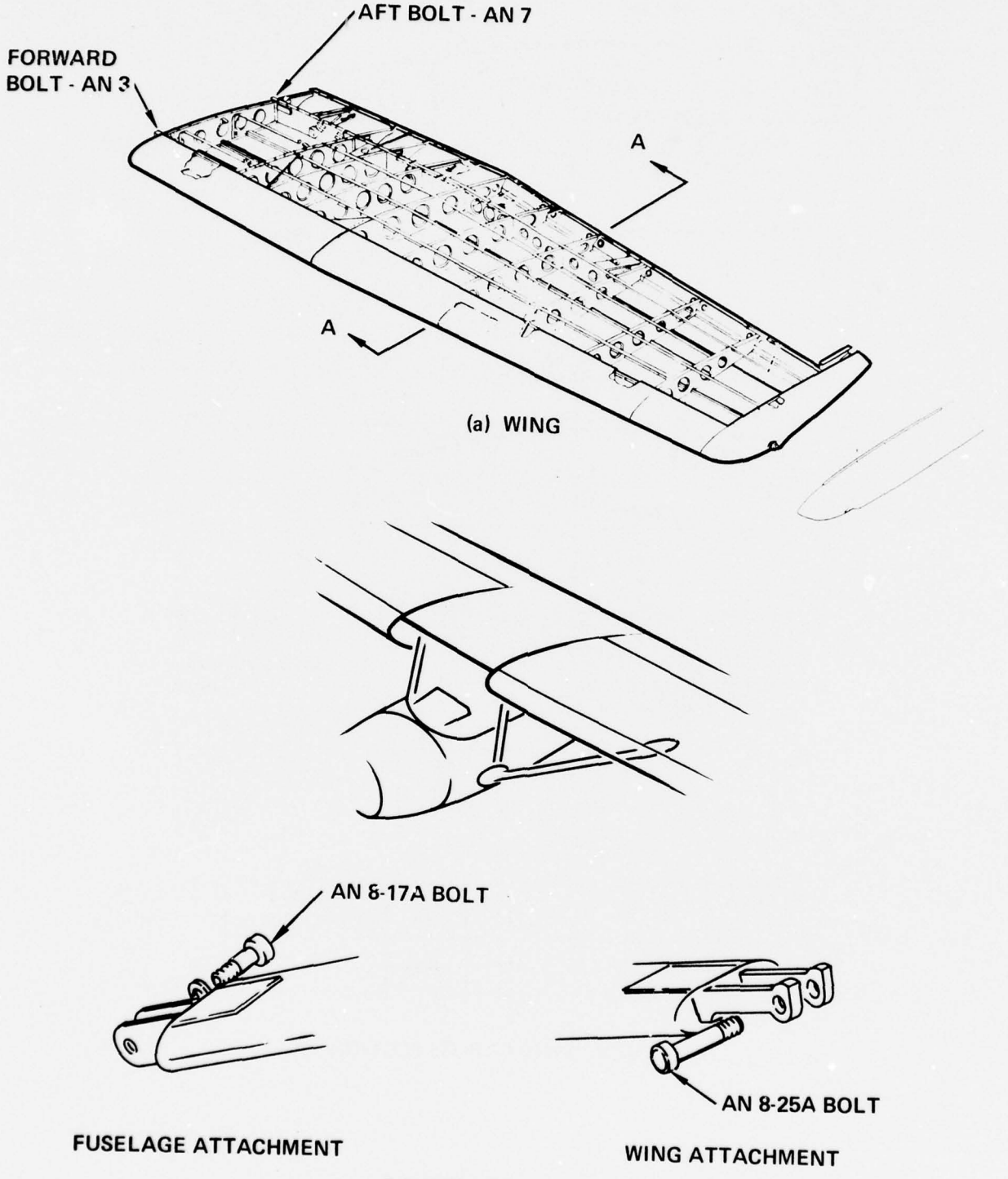
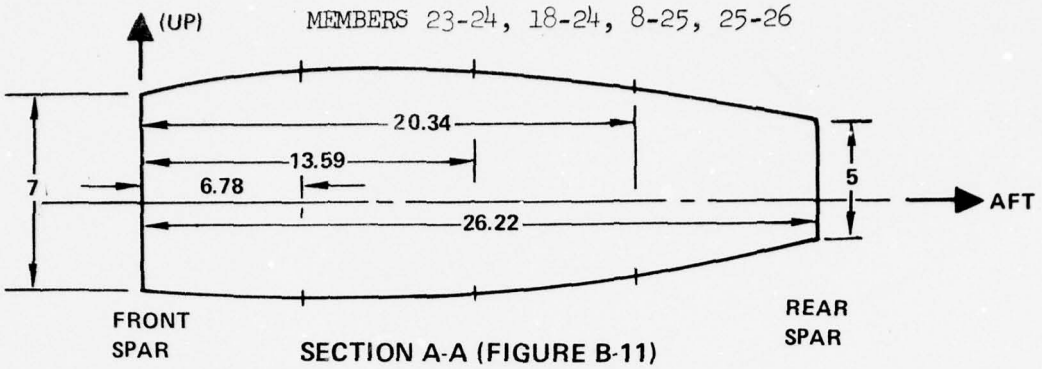
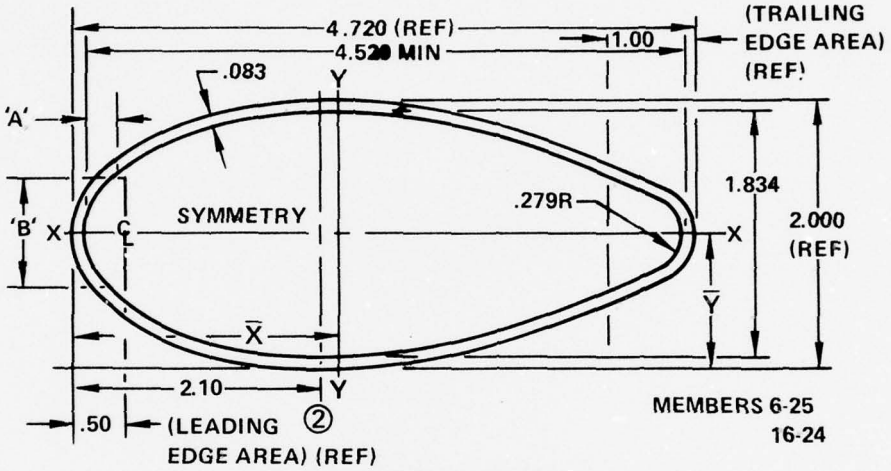


Figure B-11. Wing and Wing Strut Structure



SECTION A-A (FIGURE B-11)
(A) WING CROSS SECTION

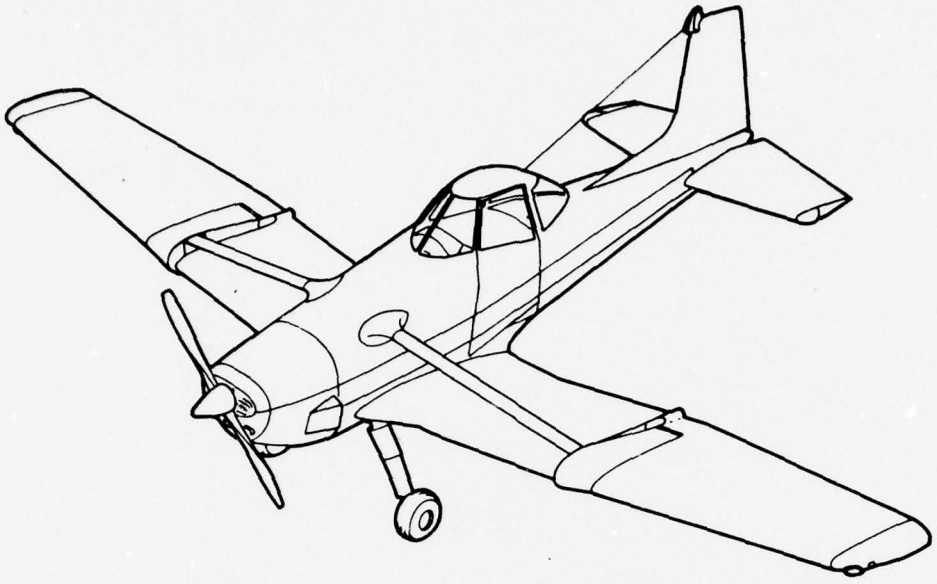


'A'	'B' MIN
.256	.955
.825	1.565
3.040	1.470
3.755	1.070

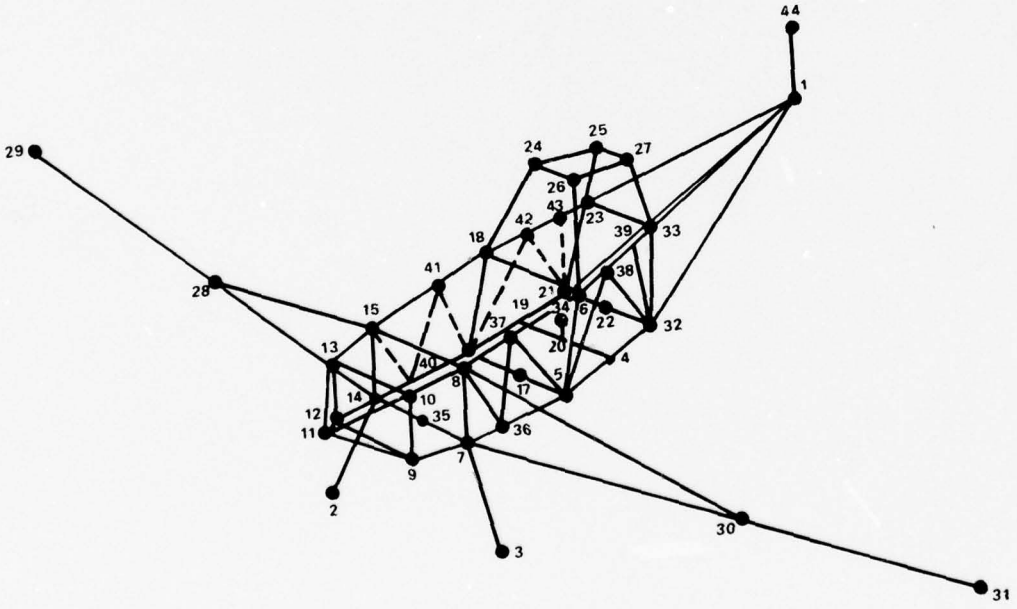
AREA SQ. IN.	$\bar{X}$	$\bar{Y}$	I_{XX}	I_{YY}	WEIGHT LBS. PER 100 IN.
.897	2.27	1.0	.4645	1.8686	8.97

(B) WING STRUT CROSS SECTION

Figure B-12. Wing and Wing Strut Structure Cross Sections



(a) OVERALL VIEW



(b) MATH MODEL

Figure B-13. Airplane B

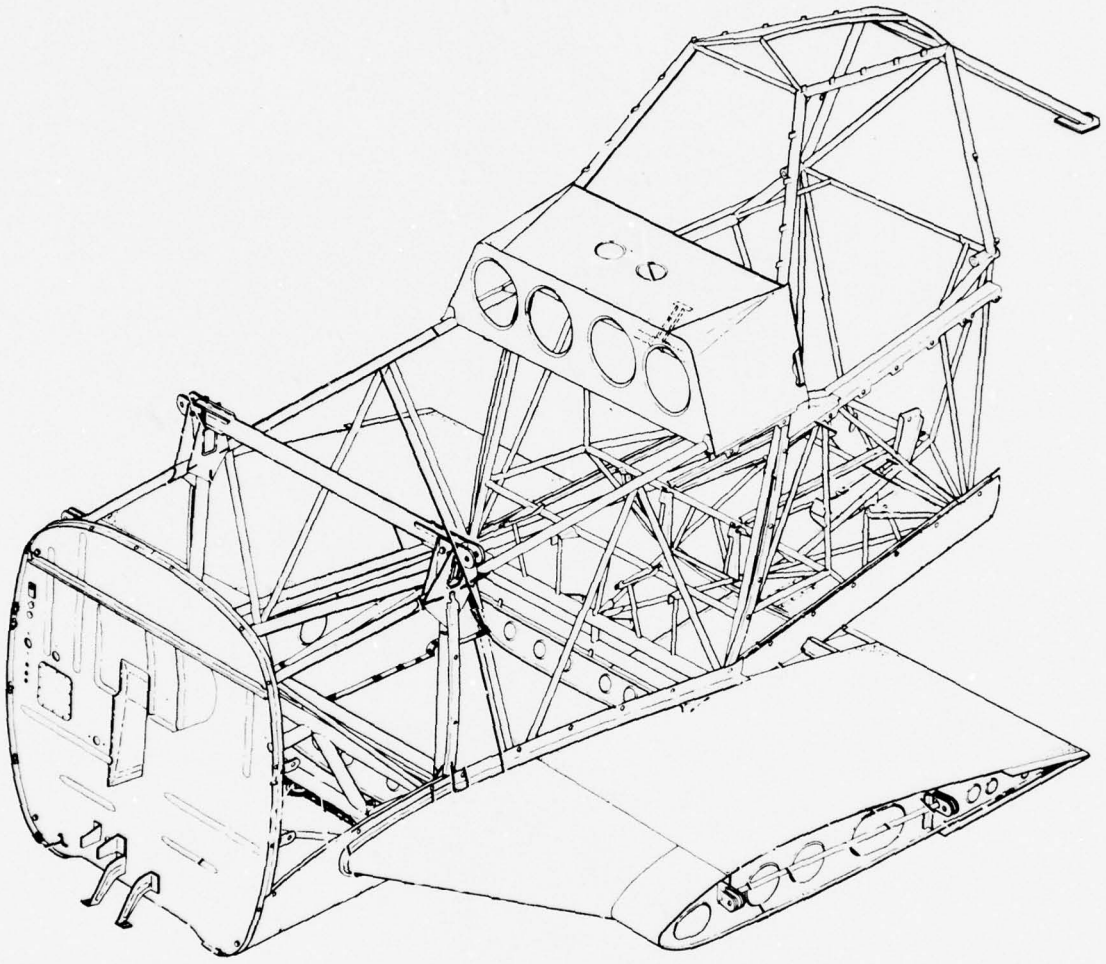


Figure B-14. Fuselage Structure

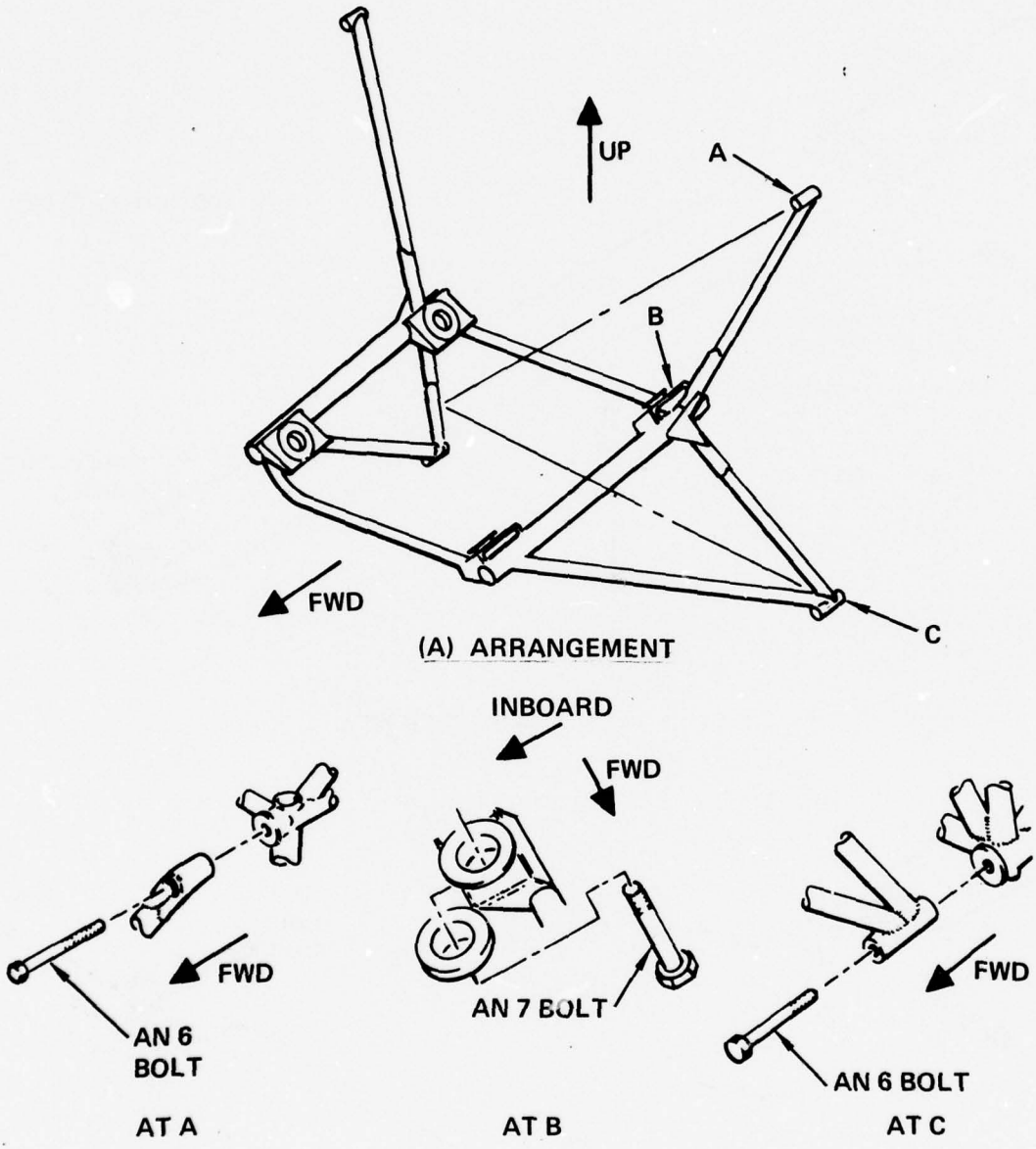


Figure B-15. Engine Mount Arrangement

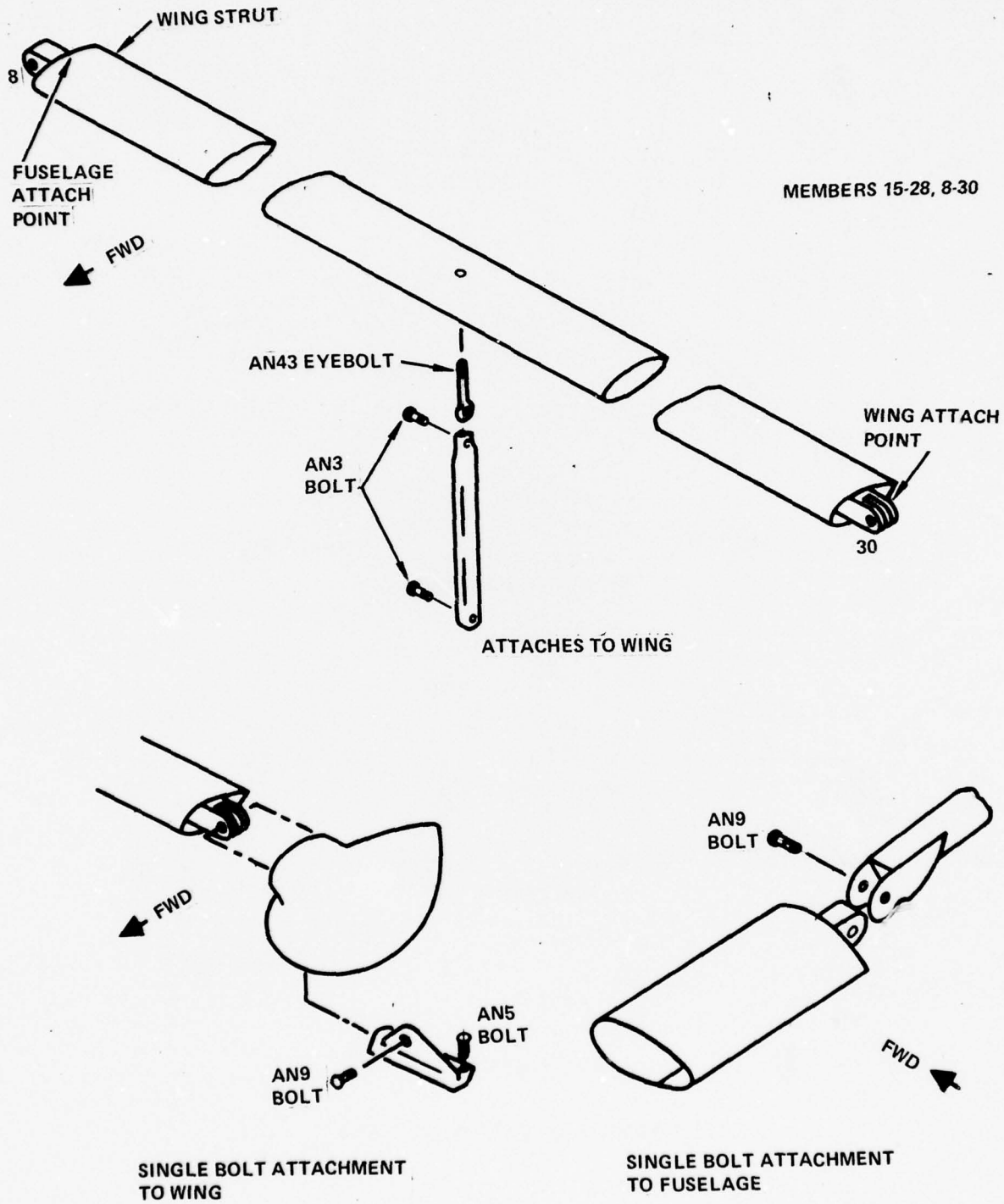


Figure B-16. Wing Strut Structure and Attachments

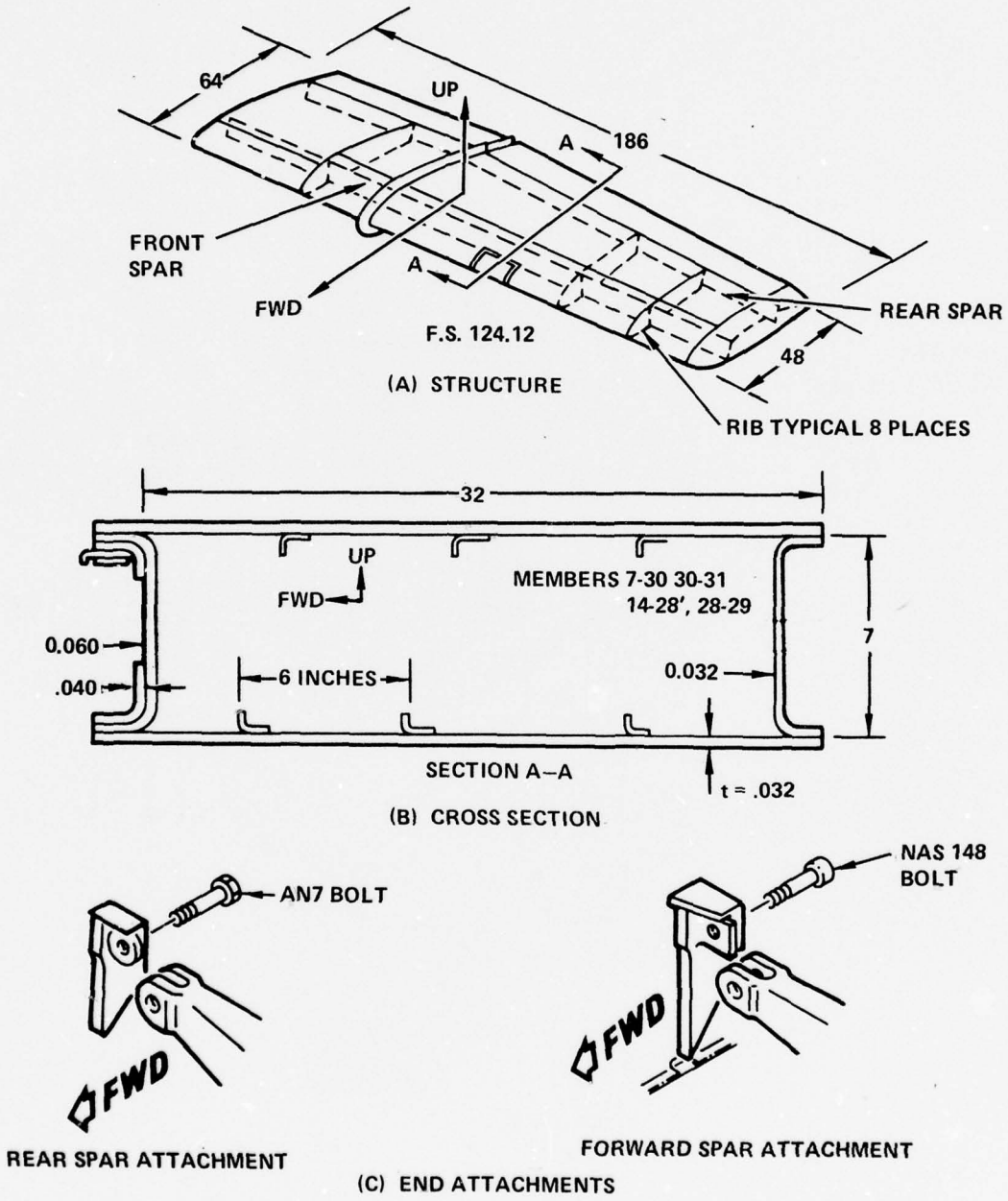


Figure B-17. Wing Structure, Cross Section and Attachments

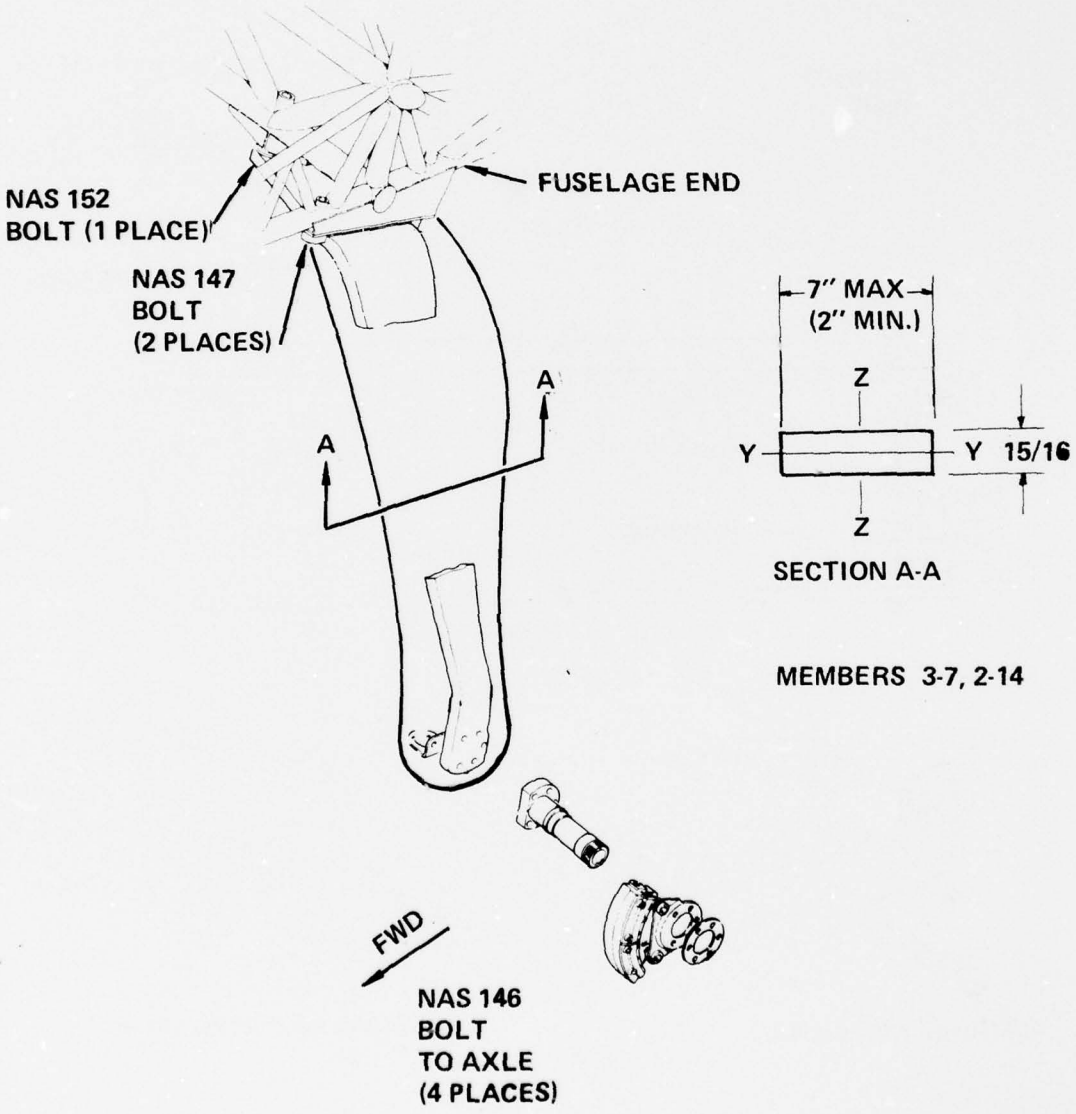


Figure B-18. Main Landing Gear Structure Cantilever Spring Cross Section

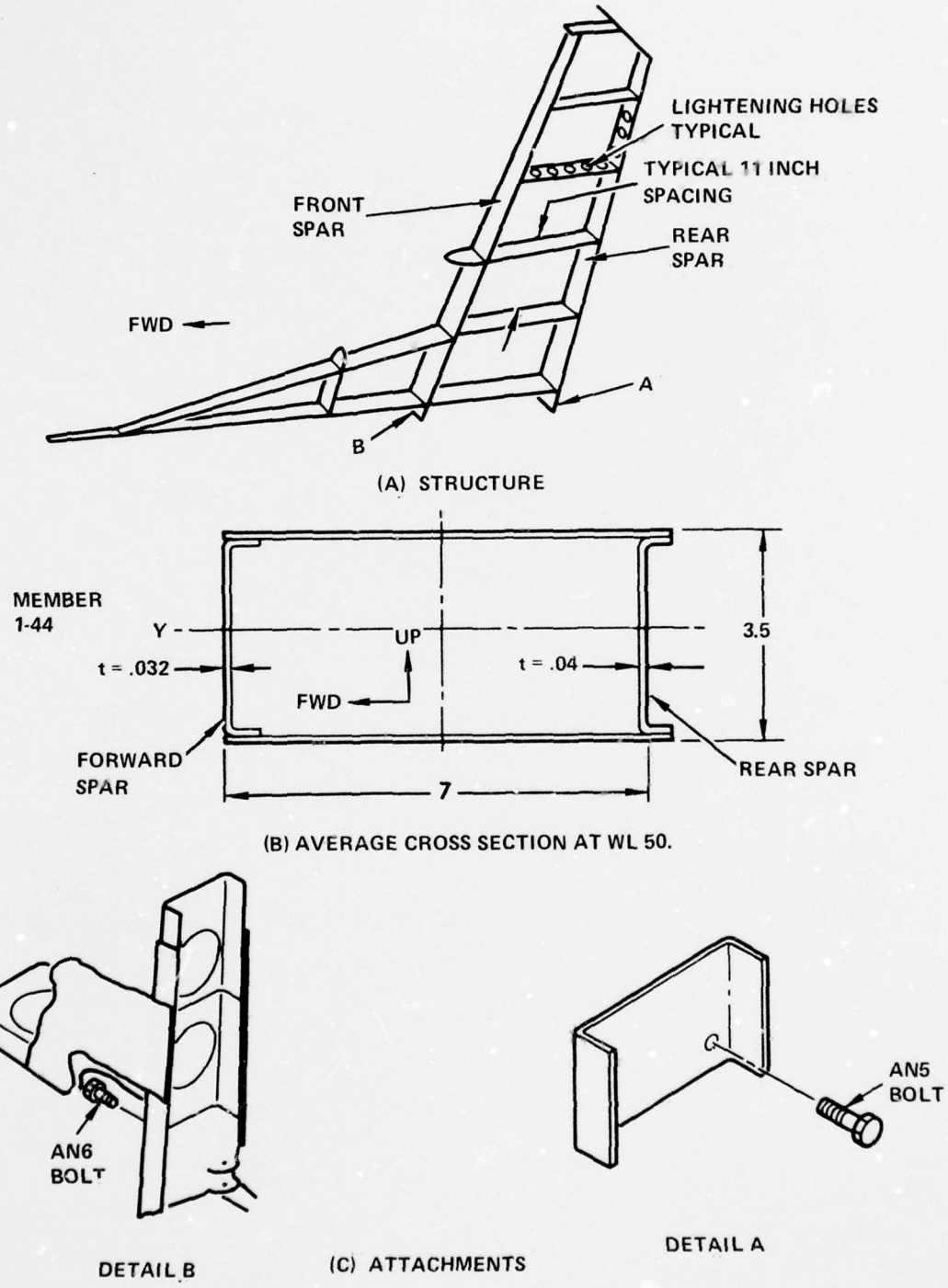


Figure B-19. Vertical Tail Structure, Cross Section and Attachments

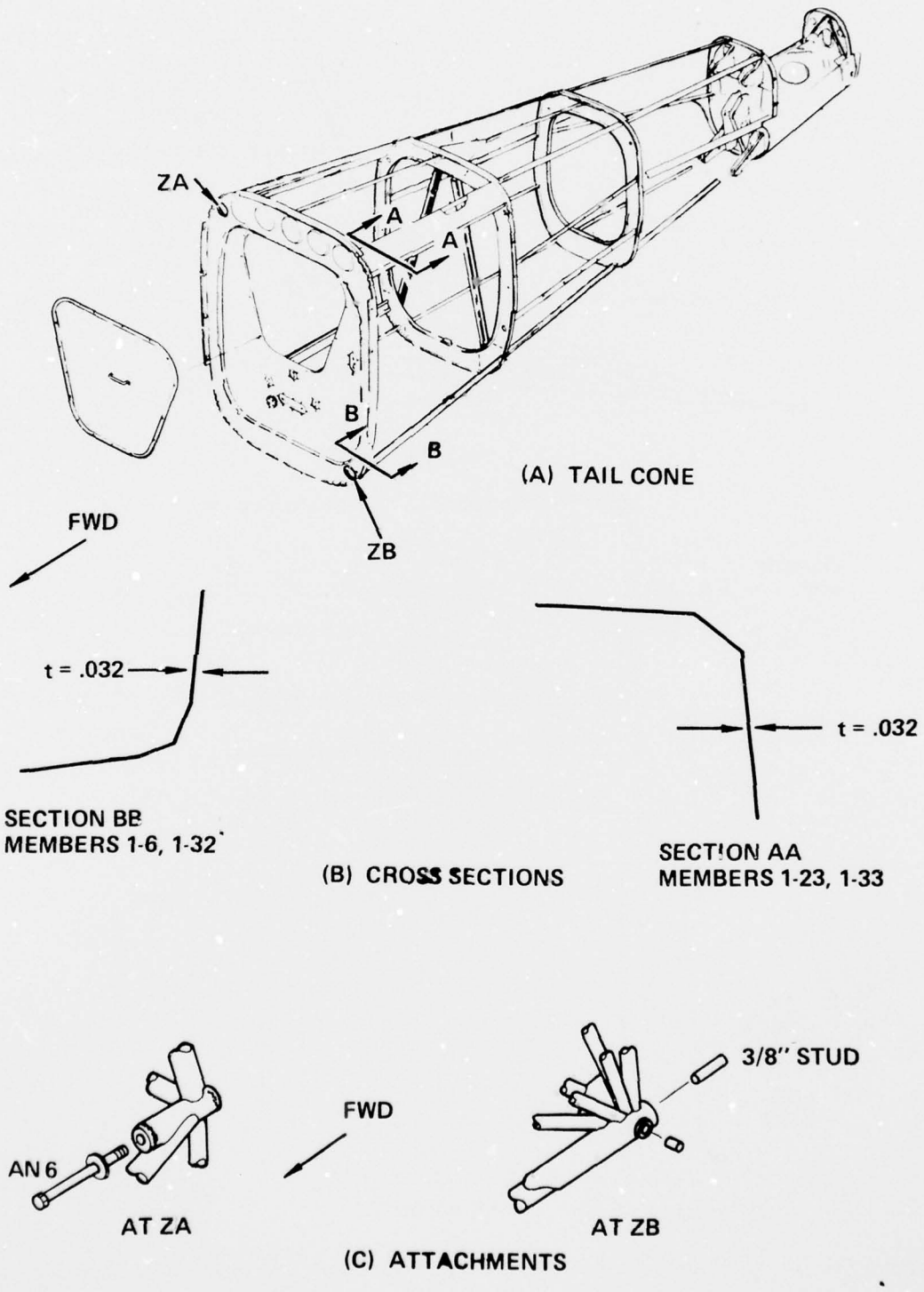


Figure B-20. Fuselage Tail Cone, Cross Section and Attachments

APPENDIX C

AIRPLANE MATH MODEL AND FILM DATA

C.1 INTRODUCTION

This appendix contains three sets of data for each of the two airplanes that were modeled as part of the assessment of program KRASH, modified as described in Section 4.0. Included in this appendix are airplane test data, film analysis data and model mass property, member property and model parameter data.

C.2 AIRPLANE A

C.2.1 Test Data

During the normal course of certifying general aviation airplanes for commercial use a series of tests are performed to show that the airplane is adequately designed to meet FAR 23 requirements. The results of these tests, where available and applicable are presented in Tables C-1 and C-2.

C.2.2 Film Analysis Data

The motion of Airplane A during the crash test was analyzed from 47 frame/second movie film. The test results indicated that the fuselage structure between F.S. 56 and 95 remained intact during the test. Consequently two locations, one located at F.S. 95 and WL 11.50 and the other located at F.S. 56.7 and W.L. 19.10, were used as reference points from which longitudinal and vertical displacements were obtained as a function of time. The change in displacement in a given time frame yields the velocity during that time period. A scale factor is used to translate film measurement into real displacement values. From the displacement data the longitudinal and vertical velocities in feet/second, for the two specified fuselage locations, are calculated. Positive values for displacement and velocity in

the longitudinal direction depict forward motion. Positive values for displacement and velocity in the vertical direction indicate upward motion. Figure C-1 shows a profile view of airplane A and the approximate location of the two fuselage reference points. The film analysis results for the aft door post (Reference point 1 in Figure C-1) are shown in Table C-3. Impact of the airplane with the dirt slope occurs at frame 8 or 9. Each frame represents 21.2 milliseconds of time. The data in Table C-3 indicate a change in forward (longitudinal) velocity of 6.2 ft/sec after nose gear impact. This reduction in speed is due, not to the nose gear impact resulting in the absorption of any significant energy, but to the fact that after the tow cable is released the airplane slows down just before impacting the slope. This is confirmed by the data which shows that the vertical velocity is still zero at spinner impact (frame 8). Table C-4 shows the film analysis results for the aft window (Reference point 2 in Figure C-1). The initial spinner impact velocity is within 2 percent of the value obtained from the aft doorpost film analysis. A 45 ft/sec initial spinner impact velocity was used in the analysis.

Table C-5 shows the results of the film analysis showing the rotation of the tailcone. The data is presented for 600 milliseconds after impact and is substantially more time than is required to evaluate the significant aspects of a crash of this nature. The rotation of the tailcone indicates that a failure occurs after approximately 60 milliseconds.

Table C-6 shows the results of the film analysis depicting fuselage rotation and rotational velocity. The two reference points are joined by a straight line which makes an angle of 11.22 degrees with respect to the airplane water line. The incremental change in this rotational angle is computed for each frame of film analysis. Thus at any instant in time the angle between the aircraft waterline and the ground is determined from the total angle less the reference 11.22 degrees. The rotational velocity is simply the change in rotation divided by the increment in time.

The cabin volume change sequence could not be accurately determined from the film analysis. The deformation of the forward doorpost with

respect to the assumed non-deformed aft doorpost was measured and was considered to represent longitudinal deformation. The upper and lower doorpost deformation was difficult to ascertain due to the absence of a fixed or non-deformable reference point. Consequently, deformation measurements were recorded at two approximate locations; W.L. 2.40 and W.L. 19.1, respectively (See Figure C-1). These locations correspond to the lower aft corner of the doorpost, the door latch and the upper aft corner of the doorpost, respectively. This data is presented in Table C-7.

C.2.2 Math Model Data

Airplane A math model data is presented in Figures C-2 through C-6 for the 35 mass, 69 member model and Figures C-7 through C-11 for the 21 mass, 32 member model. The sequence of presentation for each model is as follows:

- Mass coordinates and properties
- Member properties
- Member damping values
- Member frequencies
- Initial conditions, overall mass and C.G. properties

C.3 AIRPLANE B

C.3.1 Test Data

Applicable test data is presented in Tables C-8 and C-9.

C.3.2 Film Analysis Data

The motion of the Airplane B turnover test was analyzed from 24 frames/second movie film. Two locations on the fuselage, in what is considered non-deformable structure, were selected for performing the film analysis; these locations at F.S. 0.0, W.L. -13.8 and F.S. 110., W.L. 45. are shown in the profile view of Airplane B in Figure C-12. For each frame (every 41.7 milliseconds) longitudinal and vertical displacements were measured with respect to a fixed reference point. A scale factor was established for the purpose of translating film measurements into real displacement values. From the

displacement data the longitudinal and vertical velocities for the two locations on the fuselage were calculated. Positive values for displacement and velocity in the longitudinal direction depict forward motion. Positive values in the vertical direction indicate upward motion. Table C-10 presents the results of the film analysis. The pitch angle at any time of interest can be obtained by taking the rotation value shown in Table C-10 and subtracting 28.19 degrees. Initial impact is shown at time = 0.0. The angle at impact is approximately 38.6 degrees. The c.g. velocity is obtained from rigid body relationships as follows:

$$\dot{X}_{C.G.} = \dot{X}_i - (\cos\theta\, r_{zi} - \sin\theta\, r_{xi})\dot{\theta}$$

$$\dot{Z}_{C.G.} = \dot{Z}_i + (\sin\theta\, r_{zi} + \cos\theta\, r_{xi})\dot{\theta}$$

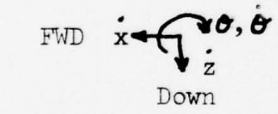
where

$\dot{X}_{C.G.}$, $\dot{Z}_{C.G.}$ = longitudinal and vertical velocity at C.G., respectively

r_x, r_z = longitudinal and vertical distance from c.g. to location of interest, respectively (+ forward, + down, from c.g.)

$\theta, \dot{\theta}$ = pitch angle (radians) and rate (radians/sec), respectively.

Positive coordinates for $\dot{X}$, $\dot{Z}$, θ, $\dot{\theta}$ are shown below.



The position of the camera used for the film analysis, relative to the airplane is such that after the airplane rotates over onto its turnover structure the angle of impact is difficult to judge. For the airplane to be in a position for both the vertical tail and the forward turnover structure to contact the ground simultaneously the angle theta (θ), shown in Table C-10, should be greater than 190 degrees, (when the reference angle is included). The data presented in Table C-10 is intended to include the turnover contact at approximately 1500 milliseconds after impact. However, the angle assiciated with this impact (178.55) is distorted due to the positioning of the 24 frame/second camera relative to the airplane. Consequently, still photographs of the airplane at different positions during the latter stages of the overturn (obtained from 1000 frame/second film) and a geometry layout of the

airplane were used to complement the 24 frame/second analysis. Thus, the second impact was determined to occur at approximately 1.5 seconds after impact with an impact angle of 162 degrees and an initial rotational pitch rate of 89.4 degrees/second. The pitch rate corresponds to the average value between 1460 and 1540 milliseconds after impact.

C.3.3 Math Model Data

Airplane B math model data is presented in Figures C-13 through C-17 for the 44 mass, 81 member model and Figures C-18 through C-22 for the 25 mass, 38 member model. These models were used in analyzing the initial impact condition. The sequence of presentation for each model is as follows:

- o Mass coordinates and properties
- o Member properties
- o Member damping values
- o Member frequencies
- o Initial conditions, overall mass and c.g. properties.

Twenty-four mass (37 member) and 43 mass (80 member) math models were used to analyze the second (turnover structure) impact. The 24 mass model is the same as the 25 mass model except for the representation of mass 25 for the vertical tail. Similarly, the 44 mass model differs from the 43 mass model due to the representation of the vertical tail. Consequently, the data for the 24 and 43 mass models are not presented. The initial conditions, mass and c.g. properties for both the 24 mass and 43 mass models are presented in Figures C-23 and C-24, respectively.

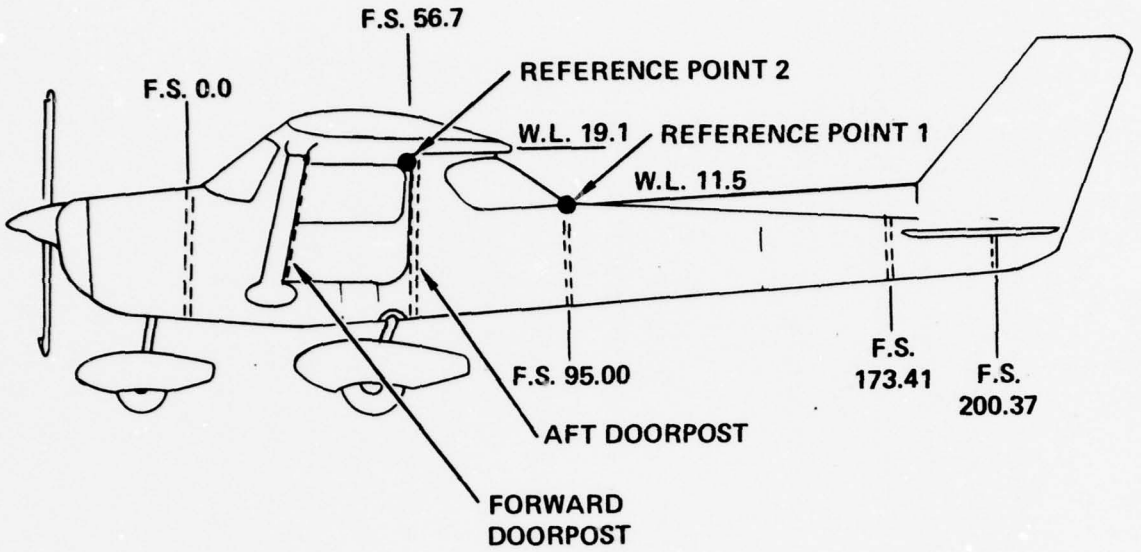


Figure C-1. Profile View of Airplane A

TABLE C-1. AIRPLANE A STRUCTURE TEST LOAD-DEFLECTION DATA

Structure	Design Load (lb.)	Deflection at Design Load (in.)	Rotation at Design Load (deg.)
Engine Mount[e]			
Longitudinal	-	-	-
Side	820	.81	.77 (Yaw)[d]
Vertical	2456	.41	.76 (Pitch)
Main Landing Gear[f]			
Longitudinal	1277	.45	-
Side	1200	-	-
Vertical	3519	5.43	-
Nose Landing Gear[g]			
Longitudinal	908	.69	
Side	794	.32	-
Vertical	1134	-	-
Wing			
Bending [j]	463281[a]	7.56[b]	2.25 (Roll)
Torsion [j]	47826[a]	4.2	5.47
Shear [j]	6155	7.56	2.25 (Roll)
Tailcone[h]			
Vertical	591	1.71	.50 (Pitch)[c]
Side	542	2.55	.68 (Yaw)

(a) Units: in-lb.

(b) Measured at wing station 180 front spar, relative to wing station 100.

(c) Referenced to F.S. 57.

(d) Referenced to F.S. 0.0

(e) Load point (F.S. 18.5, WL 8.6, B.L. 0.0), deflections and rotations measured relative to firewall (F.S. 0.0)

(f) Load point (F.S. 47.25, WL 34.75, B.L. 38.5), deflections and rotations measured relative to firewall.

(g) Load point (F.S. 10.75, W.L. 45.17, B.L. 0.0), deflections and rotations measured relative to firewall

(h) Load point (F.S. 200), deflections and rotations measured relative to F.S. 57.

(i) Airplane axes apply for all structures except wing.

(j) Load applied at wing station 20.5.

TABLE C-2. AIRPLANE A FUSELAGE TEST VERTICAL LOAD-DEFLECTION DATA

Fuselage Station (F.S.)	Design Load (lb)	Deflection at Design Load (in)	Rotation at Design Load (deg)
0	1083	.09	0
18.5	3396	.125	-
56.	3914	.202	-
71	-	.234	-
95	152	.375	.11 (pitch)[a]

(a) Referenced to Firewall F.S. 0.0

TABLE C-3. AIRPLANE A FILM ANALYSIS DATA (Aft Door Post)

Frame	Vertical (g) Displacement	Vertical Velocity (a)	(g) Longitudinal Displacement	Longitudinal Velocity (a)
5	0.00	0.000	0.635	49.107
6	0.00	0.000	0.635	49.107
7(b)	--	--	0.67	51.814
8(c)	0.00	0.000	0.59	45.627
9(d)	0.02	1.547	0.55	42.534
10	0.07	5.413	0.50	38.667
11	0.11	8.507	0.42	32.481
12	0.09	6.960	0.39	30.161
13	0.08	6.187	0.36	27.841
14	0.09	6.960	0.25	19.334
15	0.15	11.600	0.17	13.147
16	0.12	9.280	0.18	13.920
17	0.06	4.640	0.10	7.734
18	0.10	7.734	0.08	6.187
19	0.07	5.413	0.03	2.320
20	0.10	7.734	0.04	3.093
21	0.07	5.413	0.00	0.000
22	0.06	4.640	0.01	0.773
23	0.08	6.187	0.05	3.867
24	0.05	3.867	0.07	5.413
25	0.08	6.187	0.00	0.000
26	0.05	3.867	-0.03	-2.320
27	0.06	4.640	0.01	0.773
28	0.03	2.320	0.05	3.867
29	0.02	1.547	0.04	3.093
30	-0.01	-0.773	0.01	0.773

(a) $V\ (\text{ft/sec}) = \frac{(19.745)(47)\ (\text{Displacement})}{12}$

(b) Nose Gear Impact

(c) Spinner Impact

(d) Forward Lower Cowl Impact

(e) Positive Directions are up and forward

(f) Only Frame 5 through 30 Shown

(g) Incremental values

TABLE C-4. AIRPLANE A FILM ANALYSIS DATA (Aft Window)

Frame	Vertical (g) Displacement	Vertical Velocity (a)	(g)Longitudinal Displacement	Longitudinal Velocity (a)
5	--	--	0.605	46.787
6	0.00	0	0.605	46.787
7(b)	0.00	0	0.60	46.400
8(c)	0.00	0	0.60	46.400
9(d)	0.00	0	0.53	40.987
10	0.05	3.867	0.49	37.894
11	0.02	1.547	0.44	34.027
12	0.29	22.427	0.35	27.067
13	0.43	33.254	0.29	22.427
14	0.32	24.747	0.23	17.787
15	0.31	23.974	0.18	13.920
16	0.30	23.200	0.17	13.147
17	0.26	20.107	0.15	11.600
18	0.16	12.374	0.14	10.827
19	0.20	15.467	0.10	7.734
20	0.17	13.147	0.07	5.413
21	0.17	13.147	0.05	3.867
22	0.08	6.187	0.10	7.734
23	0.08	6.187	0.11	8.507
24	0.13	10.054	0.16	12.374
25	0.08	6.187	0.09	6.960
26	0.06	4.640	0.08	6.187
27	0.04	3.093	0.03	2.320
28	0.04	3.093	0.02	1.547
29	0.01	0.773	0.06	4.640
30	0.06	4.640	0.01	0.773

(a) $V(\text{ft/sec}) = \frac{(19.745)\ (47)\ (\text{Displacement})}{12}$

(b) Nose Gear Impact

(c) Spinner Impact

(d) Forward Lower Cowl Impact

(e) Positive Directions are Up and Forward

(f) Only Frames 5 through 30 Shown

(g) Incremental values

TABLE C-5. AIRPLANE A TAIL CONE FILM ANALYSIS

Time After Spinner Impact(Milliseconds)	Tail Cone Rotation (Degrees) (a)
30	0.0
60	-3.5
90	-13.0
120	-20.5
150	-33.0
180	-42.5
210	-50.5
240	-57.0
270	-62.0
300	-68.5
330	-74.0
360	-80.0
390	-79.0
420	-76.5
450	-76.0
480	-73.0
510	-72.0
540	-72.0
570	-72.0
600	-65.5

(a) Tailcone rotation is with respect to the fuselage. Positive indicates nose down rotation. Negative sign indicates the tail cone angle is below the instantaneous fuselage reference line (water line).

(b) Only Frames 5 through 30 Shown

TABLE C-6. AIRPLANE A FILM ANALYSIS OF FUSELAGE ROTATION AND ROTATIONAL VELOCITY

Frame	Rotation, θ (a) (Degrees) (b)	Rotational Velocity, $\dot{\theta}$, (Degrees/Second)(b)
5	11.22	0
6	11.22	0
7	11.22	0
8(c)	10.64	0
9	10.64	-4.98
10	10.53	22.64
11	11.01	89.94
12	12.92	98.56
13	15.02	-213.43
14	10.48	-494.67
15	-.04	-321.11
16	-6.87	-218.14
17	-11.51	-258.11
18	-17.00	-298.03
19	-23.34	-157.87
20	-26.70	-168.01
21	-30.27	-112.42
22	-32.66	-175.10
23	-36.39	-68.49
24	-37.85	-76.45
25	-39.48	-165.86
26	-43.01	-109.18
27	-45.33	-31.60
28	-46.00	+52.21
29	-44.89	-31.34
30	-45.56	10.03

(a) Fuselage rotation angle = θ - 11.22°

(b) Positive indicates nose down rotation

(c) Spinner Impact

(d) Only Frames 5 through 30 Shown

AD-A032 415 LOCKHEED-CALIFORNIA CO BURBANK F/G 1/2

A METHOD OF ANALYSIS FOR GENERAL AVIATION AIRPLANE STRUCTURAL C--ETC(U)

SEP 76 G WITTLIN, M A GAMON DOT-FA75WA-3707

UNCLASSIFIED LR-27698 FAA-RD-76-123 NL

4 OF 4
AD-A
032 415

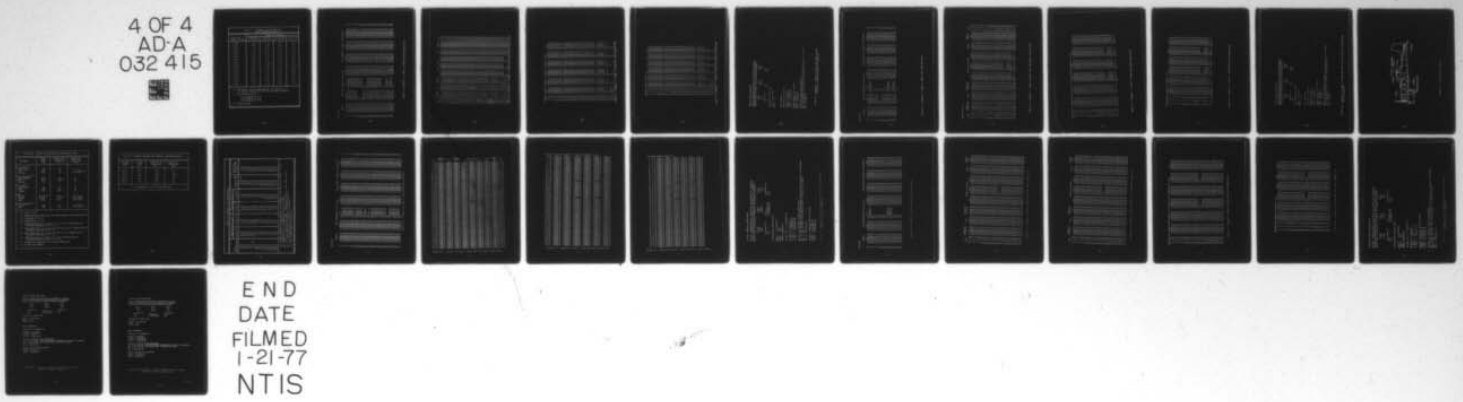


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TABLE C-7. AIRPLANE A FILM ANALYSIS FOR CABIN DEFORMATION CHANGE (a)

Time After Impact (Seconds)	Deflection (inches)			
	Incremental at WL 19.10	Cumulative at WL 19.10	Incremental at WL 2.40	Cumulative at WL 2.40
0.0000	0.00	0.00	0.00	0.00
0.0156	0.21	0.20	2.29	2.29
0.0312	0.76	0.97	3.12	5.42
0.0468	0.38	1.35	1.15	6.56
0.0624	0.22	1.57	0.42	6.98
0.0780	0.16	1.73	0.63	7.61
0.0936	0.22	1.95	0.63	8.24
0.1092	0.22	2.17	0.52	8.76
0.1248	0.27	2.44(c)	0.73	9.49
0.1404	-0.06	2.38	0.73	10.22 (c)
0.1560	-0.16	2.22	-0.42	9.84
0.1716	-0.16	2.06	-0.31	9.49
0.1872	-0.11	1.95	-0.21	9.28
0.2028	-0.11	1.84	-0.10	9.18
0.2184	-0.11	1.73	-0.21	8.97
0.2340	0.00	1.73	-0.10	8.87

(a) Deformation of the forward doorpost with respect to the aft doorpost (assumes negligible aft doorpost deformation)

(b) Final deflections are:

1.20 inches at WL 19.10
7.91 inches at WL 2.40
7.03 inches at WL -8.00

(c) Peak deflection

MASS DATA

I	WEIGHTS W	MASS COORDINATES F.S.,W.L.,B.L. X**	Y**	Z**	MASS MOMENTS OF INERTIA (LB-IN-SEC**2) IX	IY	IZ	I
1	1.030000D 01	-1.075000D 01	0.0	-3.459000D 01	6.400000D-01	1.410000D 00	6.400000D-01	1
2	2.025000D 01	4.760000D 01	3.979000D 01	-3.459000D 01	8.120000D-01	1.797000D 00	8.120000D-01	2
3	2.025000D 01	4.760000D 01	-3.979000D 01	-3.459000D 01	8.120000D-01	1.797000D 00	8.120000D-01	3
4	2.610000D 01	5.313000D 01	1.400000D 01	-1.944000D 01	3.780000D 00	5.820000D 00	5.900000D 00	4
5	4.519500D 01	5.752000D 01	2.125000D 01	2.544000D 01	7.280000D 01	4.640000D 01	5.040000D 01	5
6	1.970000D 01	2.098000D 01	1.628000D 01	-1.766000D 01	4.900000D 00	1.130000D 01	1.190000D 01	6
7	1.970000D 01	2.404000D 01	1.628000D 01	6.440000D 00	4.900000D 00	1.130000D 01	1.190000D 01	7
8	5.165000D 01	2.652000D 01	2.125000D 01	2.615000D 01	8.370000D 01	5.908000D 01	6.545000D 01	8
9	2.274400D 01	0.0	1.450000D 01	-1.972000D 01	7.127000D 00	1.128000D 01	8.850000D 00	9
10	2.274400D 01	0.0	1.450000D 01	6.440000D 00	7.127000D 00	1.128000D 01	8.850000D 00	10
11	2.274400D 01	0.0	-1.450000D 01	-1.972000D 01	7.127000D 00	1.128000D 01	8.850000D 00	11
12	2.274400D 01	0.0	-1.450000D 01	6.440000D 00	7.127000D 00	1.128000D 01	8.850000D 00	12
13	2.774910D 02	-1.692000D 01	0.0	-1.850000D 00	5.800000D 01	7.473000D 01	7.648000D 01	13
14	2.120000D 01	-7.390000D 00	0.0	-2.296000D 01	2.480000D 00	2.740000D 00	4.820000D-01	14
15	3.320000D 01	2.098000D 01	0.0	-1.766000D 01	7.318000D 00	1.699000D 01	1.787000D 01	15
16	1.970000D 01	2.098000D 01	-1.628000D 01	-1.766000D 01	4.900000D 00	1.130000D 01	1.190000D 01	16
17	1.970000D 01	2.404000D 01	-1.628000D 01	6.440000D 00	4.900000D 00	1.130000D 01	1.190000D 01	17
18	5.165000D 01	2.652000D 01	-2.125000D 01	2.615000D 01	8.370000D 01	5.908000D 01	6.545000D 01	18
19	2.610000D 01	5.313000D 01	-1.400000D 01	-1.944000D 01	3.780000D 00	5.820000D 00	5.900000D 00	19
20	4.519500D 01	5.752000D 01	-2.125000D 01	2.544000D 01	7.280000D 01	4.640000D 01	5.040000D 01	20
21	9.637000D 00	9.500000D 01	-1.200000D 01	-1.165000D 01	1.510000D 00	1.975000D 01	1.953000D 01	21
22	9.637000D 00	9.500000D 01	-1.225000D 01	9.500000D 00	1.510000D 00	1.975000D 01	1.953000D 01	22
23	3.897000D 00	2.652000D 01	-1.919700D 02	2.712000D 01	4.500000D-01	1.780000D 00	2.147000D 00	23
24	7.181500D 01	2.652000D 01	-8.224000D 01	2.712000D 01	4.680000D 02	3.540000D 01	5.020000D 02	24
25	7.181500D 01	2.652000D 01	8.224000D 01	2.712000D 01	4.680000D 02	3.540000D 01	5.020000D 02	25
26	3.897000D 00	2.652000D 01	1.919700D 02	2.712000D 01	4.500000D-01	1.780000D 00	2.147000D 00	26
27	6.690000D 01	5.313000D 01	0.0	-1.944000D 01	2.900000D 00	4.500000D 00	4.500000D 00	27
28	1.872000D 02	5.313000D 01	0.0	-7.446000D 00	9.300000D 00	6.700000D 00	1.120000D 01	28
29	4.000000D 01	9.500000D 01	0.0	-1.165000D 01	1.493000D 01	7.310000D 00	1.493000D 01	29
30	9.637000D 00	9.500000D 01	1.200000D 01	-1.165000D 01	1.510000D 00	1.975000D 01	1.953000D 01	30
31	9.637000D 00	9.500000D 01	1.225000D 01	9.500000D 00	1.510000D 00	1.975000D 01	1.953000D 01	31
32	6.340000D 01	2.003800D 02	0.0	5.700000D 00	2.670000D 01	3.436000D 01	4.266000D 01	32
33	6.000000D 01	2.872000D 01	-8.224000D 01	2.712000D 01	3.910000D 02	3.020000D 01	4.195000D 02	33
34	6.000000D 01	2.872000D 01	8.224000D 01	2.712000D 01	3.910000D 02	3.020000D 01	4.195000D 02	34
35	1.360000D 02	5.313000D 01	0.0	9.560000D 00	4.000000D 00	3.700000D 00	3.300000D 00	35

Figure C-2 Airplane A 35 Mass, 69 Member Math Model Mass Data

BEAM			MODULUS OF ELASTICITY	AREA	MODULUS OF RIGIDITY	MOMENTS OF INERTIA			LENGTH	DAMPING RATIO	BEAM		
IJ	I	J	E	A	G	JX	I(YY)	I(ZZ)	XLB	CBAR	IJ	I	J
1	1	14	0.0	1.0000D 00	0.0	2.0000D 00	1.0000D 00	1.0000D 00	1.2104D 01	2.0000D-02	1	1	14
2	2	4	3.0000D 07	2.0700D 00	1.1500D 07	3.0497D 00	6.8400D-02	2.9813D 00	3.0418D 01	2.0000D-02	2	2	4
3	3	19	3.0000D 07	2.0700D 00	1.1500D 07	3.0497D 00	6.8400D-02	2.9813D 00	3.0418D 01	2.0000D-02	3	3	19
4	4	5	1.0500D 07	5.0460D-01	4.0000D 06	7.4380D-01	3.7000D-01	3.7380D-01	4.5673D 01	2.0000D-02	4	4	5
5	4	6	1.0500D 07	1.4750D-01	4.0000D 06	6.9980D 01	4.1760D 01	4.8220D 01	3.2280D 01	2.0000D-02	5	4	6
6	4	27	1.0500D 07	2.4410D 00	4.0000D 06	4.0348D 01	1.4070D 01	2.6278D 01	1.4000D 01	2.0000D-02	6	4	27
7	4	30	1.0500D 07	8.1640D-01	4.0000D 06	6.6660D 01	2.7430D 01	3.9230D 01	4.2635D 01	2.0000D-02	7	4	30
8	5	6	1.0500D 07	6.7270D-01	4.0000D 06	1.9791D 01	1.5000D 01	4.7910D 00	3.1008D 01	2.0000D-02	8	5	8
9	5	20	1.0500D 07	5.2270D-01	4.0000D 06	6.8710D-01	3.2070D-01	3.6640D-01	4.2500D 01	2.0000D-02	9	5	20
10	5	31	1.0500D 07	1.8100D-01	4.0000D 06	1.5730D-01	9.5100D-02	6.2200D-02	4.1711D 01	2.0000D-02	10	5	31
11	6	7	1.0500D 07	8.5850D-01	4.0000D 06	2.6255D 00	5.9860D-01	2.0269D 00	2.4293D 01	2.0000D-02	11	6	7
12	6	9	1.0500D 07	1.8760D-01	4.0000D 06	1.1160D-01	3.4400D-02	7.7400D-02	2.1156D 01	2.0000D-02	12	6	9
13	6	15	1.0500D 07	6.3680D-01	4.0000D 06	1.6114D 00	1.5741D 00	3.7300D-02	1.6285D 01	2.0000D-02	13	6	15
14	6	25	1.0500D 07	8.9700D-01	4.0000D 06	2.3331D 00	1.8686D 00	4.6450D-01	7.9917D 01	2.0000D-02	14	6	25
15	7	8	1.0500D 07	8.5850D-01	4.0000D 06	2.6255D 00	5.9860D-01	2.0269D 00	2.0478D 01	2.0000D-02	15	7	8
16	7	10	1.0500D 07	2.4530D-01	4.0000D 06	2.6630D-01	1.8070D-02	2.4830D-01	2.4106D 01	2.0000D-02	16	7	10
17	7	17	0.0	1.0000D 00	0.0	2.0000D 00	1.0000D 00	1.0000D 00	3.2560D 01	2.0000D-02	17	7	17
18	8	16	1.0500D 07	5.2270D-01	4.0000D 06	6.8710D-01	3.2070D-01	3.6640D-01	4.2500D 01	2.0000D-02	18	8	16
19	8	25	1.0500D 07	1.5830D 00	4.0000D 06	2.3288D 02	1.6380D 01	2.1650D 02	6.0998D 01	2.0000D-02	19	8	25
20	9	10	3.0000D 07	1.4160D-01	1.1000D 07	9.0900D-02	6.6000D-02	2.4900D-02	2.6160D 01	2.0000D-02	20	9	10
21	9	11	3.0000D 07	1.4160D-01	1.1000D 07	9.0900D-02	6.6000D-02	2.4900D-02	2.9000D 01	2.0000D-02	21	9	11
22	9	13	3.0000D 07	6.9400D-02	1.1000D 07	7.2000D-01	3.6000D-01	3.6000D-01	2.8563D 01	2.0000D-02	22	9	13
23	9	14	3.0000D 07	1.0790D-01	1.1000D 07	1.3400D-02	6.7000D-03	6.7000D-03	1.6594D 01	2.0000D-02	23	9	14
24	10	12	3.0000D 07	1.4160D-01	1.1000D 07	9.0900D-02	6.6000D-02	2.4900D-02	2.9000D 01	2.0000D-02	24	10	12
25	10	13	3.0000D 07	6.9400D-02	1.1000D 07	7.2000D-01	3.6000D-01	3.6000D-01	2.3775D 01	2.0000D-02	25	10	13
26	10	14	3.0000D 07	1.0790D-01	1.1000D 07	1.3400D-02	6.7000D-03	6.7000D-03	3.3604D 01	2.0000D-02	26	10	14
27	11	12	3.0000D 07	1.4160D-01	1.1000D 07	9.0900D-02	6.6000D-02	2.4900D-02	2.6160D 01	2.0000D-02	27	11	12
28	11	13	3.0000D 07	6.9400D-02	1.1000D 07	7.2000D-01	3.6000D-01	3.6000D-01	2.8563D 01	2.0000D-02	28	11	13
29	11	14	3.0000D 07	1.0790D-01	1.1000D 07	1.3400D-02	6.7000D-03	6.7000D-03	1.6594D 01	2.0000D-02	29	11	14
30	11	16	1.0500D 07	1.8760D-01	4.0000D 06	1.1160D-01	3.4400D-02	7.7400D-02	2.1156D 01	2.0000D-02	30	11	16
31	12	13	3.0000D 07	6.9400D-02	1.1000D 07	7.2000D-01	3.6000D-01	3.6000D-01	2.3775D 01	2.0000D-02	31	12	13
32	12	14	3.0000D 07	1.0790D-01	1.1000D 07	1.3400D-02	6.7000D-03	6.7000D-03	3.3604D 01	2.0000D-02	32	12	14
33	12	17	1.0500D 07	2.4530D-01	4.0000D 06	2.6630D-01	1.8000D-02	2.4830D-01	2.4106D 01	2.0000D-02	33	12	17
34	15	16	1.0500D 07	6.3680D-01	4.0000D 06	1.6113D 00	1.5740D 00	3.7300D-02	1.6282D 01	2.0000D-02	34	15	16
35	16	17	1.0500D 07	8.5850D-01	4.0000D 06	2.6255D 00	5.9860D-01	2.0269D 00	2.4293D 01	2.0000D-02	35	16	17
36	16	19	1.0500D 07	1.4750D-01	4.0000D 06	8.9980D 01	4.1760D 01	4.8220D 01	3.2280D 01	2.0000D-02	36	16	19
37	16	24	1.0500D 07	8.4700D-01	4.0000D 06	2.3331D 00	1.8686D 00	4.6450D-01	7.9917D 01	2.0000D-02	37	16	24
38	17	18	1.0500D 07	8.5850D-01	4.0000D 06	2.6255D 00	5.9860D-01	2.0269D 00	2.0478D 01	2.0000D-02	38	17	18
39	18	20	1.0500D 07	6.7270D-01	4.0000D 06	1.9791D 01	1.5000D 01	4.7910D 00	3.1008D 01	2.0000D-02	39	18	20
40	18	24	1.0500D 07	1.5830D 00	4.0000D 06	2.3288D 02	1.6380D 01	2.1650D 02	6.0998D 01	2.0000D-02	40	18	24
41	19	20	1.0500D 07	5.0460D-01	4.0000D 06	7.4380D-01	3.7000D-01	3.7380D-01	4.5673D 01	2.0000D-02	41	19	20
42	19	21	1.0500D 07	8.1640D-01	4.0000D 06	6.6660D 01	2.7430D 01	3.9230D 01	4.2635D 01	2.0000D-02	42	19	21
43	19	27	1.0500D 07	2.4410D 00	4.0000D 06	4.0348D 01	1.4070D 01	2.6278D 01	1.4000D 01	2.0000D-02	43	19	27
44	20	22	1.0500D 07	1.8100D-01	4.0000D 06	1.5730D-01	9.5100D-02	6.2200D-02	4.1711D 01	2.0000D-02	44	20	22
45	21	22	1.0500D 07	1.5280D-01	4.0000D 06	1.2090D-01	1.1260D-01	8.3000D-03	2.1151D 01	2.0000D-02	45	21	22
46	21	29	1.0500D 07	1.5280D-01	4.0000D 06	1.2090D-01	1.1260D-01	8.3000D-03	1.2006D 01	2.0000D-02	46	21	29
47	21	32	1.0500D 07	6.8000D-01	4.0000D 06	7.0000D 00	3.5000D 00	3.5000D 00	1.0747D 02	2.0000D-02	47	21	32
48	22	31	1.0500D 07	1.5280D-01	4.0000D 06	1.2090D-01	1.1260D-01	8.3000D-03	2.4500D 01	2.0000D-02	48	22	31
49	22	32	1.0500D 07	6.8000D-01	4.0000D 06	8.5000D 00	3.5030D 00	5.0000D 00	1.0616D 02	2.0000D-02	49	22	32
50	23	24	0.0	1.0000D 00	0.0	2.0000D 00	1.0000D 00	1.0000D 00	1.0973D 02	2.0000D-02	50	23	24
51	25	28	0.0	1.0000D 00	0.0	2.0000D 00	1.0000D 00	1.0000D 00	1.0973D 02	2.0000D-02	51	25	26
52	27	28	3.0000D 07	4.8000D-01	1.1000D 07	2.0339D 01	1.4985D 01	5.3540D 00	1.2000D 01	2.0000D-02	52	27	28
53	29	30	1.0500D 07	1.1370D-01	4.0000D 06	7.5500D-02	6.9600D-02	5.9000D-03	1.2000D 01	2.0000D-02	53	29	30
54	30	31	1.0500D 07	1.1370D-01	4.0000D 06	7.5500D-02	6.9600D-02	5.9000D-03	2.1151D 01	2.0000D-02	54	30	31
55	30	32	1.0500D 07	6.8000D-01	4.0000D 06	7.0000D 00	3.5000D 00	3.5000D 00	1.0747D 02	2.0000D-02	55	30	32
56	31	32	1.0500D 07	6.8000D-01	4.0000D 06	8.5000D 00	3.5000D 00	5.0000D 00	1.0616D 02	2.0000D-02	56	31	32
57	27	29	1.0500D 07	1.4750D 00	4.0000D 06	6.6730D 01	2.7430D 01	3.9300D 01	4.2589D 01	2.0000D-02	57	27	29
58	15	27	1.0500D 07	1.4750D 00	4.0000D 06	6.6730D 01	2.7430D 01	3.9300D 01	3.2149D 01	2.0000D-02	58	15	27
59	20	33	1.0500D 07	1.5830D 00	4.0000D 06	2.3288D 02	1.6380D 01	2.1650D 02	6.7469D 01	2.0000D-02	59	20	33
60	23	33	0.0	1.0000D 00	0.0	2.0000D 00	1.0000D 00	1.0000D 00	1.0975D 02	2.0000D-02	60	23	33
61	26	34	0.0	1.0000D 00	0.0	2.0000D 00	1.0000D 00	1.0000D 00	1.0975D 02	2.0000D-02	61	26	34
62	5	34	1.0500D 07	1.5830D 00	4.0000D 06	2.3288D 02	1.6380D 01	2.1650D 02	6.7469D 01	2.0000D-02	62	5	34
63	24	33	0.0	1.0000D 00	0.0	2.0000D 00	1.0000D 00	1.0000D 00	2.2000D 00	2.0000D-02	63	24	33
64	25	34	0.0	1.0000D 00	0.0	2.0000D 00	1.0000D 00	1.0000D 00	2.2000D 00	2.0000D-02	64	25	34
65	7	9	1.0500D 07	2.0000D-01	4.0000D 06	0.0	0.0	0.0	3.5573D 01	2.0000D-02	65	7	9
66	11	17	1.0500D 07	2.0000D-01	4.0000D 06	0.0	0.0	0.0	3.5573D 01	2.0000D-02	66	11	17
67	5	30	1.0500D 07	3.0000D-01	4.0000D 06	0.0	0.0	0.0	5.3535D 01	2.0000D-02	67	5	30
68	20	21	1.0500D 07	3.0000D-01	4.0000D 06	0.0	0.0	0.0	5.3535D 01	2.0000D-02	68	20	21
69	28	35	1.0500D 07	2.2520D-03	4.0000D 06	2.0000D 00	1.0000D 00	1.0000D 00	1.7000D 01	1.9460D-01	69	28	35

Figure C-3 Airplane A 35 Mass, 69 Member Math Model Member Property Data

DAMPING TERMS (LB/IN/SEC,TRANSLATIONS (1)-(3) AND LB-IN-SEC,ROTATIONS (4)-(6))

IJ	I	J	(1)	(2)	(3)	(4)	(5)	(6)
1	1	14	0.0	0.0	0.0	0.0	0.0	0.0
2	2	4	1.980550 01	2.706890 00	4.100110-01	1.134390 02	4.516650 01	3.591050 02
3	3	19	1.980550 01	2.706890 00	4.100110-01	1.134390 02	4.516650 01	3.617600 02
4	4	5	5.856240 00	3.822250-01	3.802770-01	7.665970 01	1.952730 02	1.802860 02
5	4	6	5.816110 00	5.856150 00	5.449780 00	3.440910 02	1.218470 03	1.335680 03
6	4	27	2.656650 01	2.156790 01	1.578190 01	4.362920 02	6.716700 02	1.145340 03
7	4	30	5.457550 00	3.073800 00	2.570270 00	2.451690 02	1.050470 03	1.237260 03
8	5	6	9.562780 00	2.851030 00	5.044680 00	7.994910 02	1.851730 03	1.096850 03
9	5	20	6.456080 00	4.746980-01	4.441090-01	9.798950 01	2.717190 02	2.416560 02
10	5	31	3.216120 00	1.566730-01	1.937270-01	4.205820 01	1.010110 02	8.403480 01
11	6	7	7.784770 00	1.705660 00	9.269250-01	1.277040 02	1.934470 02	2.370460 02
12	6	9	4.047450 00	4.256910-01	2.837940-01	2.030010 01	4.958880 01	7.128480 01
13	6	15	9.505070 00	4.887240-01	3.174870 00	1.338690 02	2.817560 02	6.770200 01
14	6	25	6.666460 00	2.085670-01	4.183230-01	1.410920 02	6.592780 02	3.742150 02
15	7	8	1.141040 01	2.965870 00	1.611790 00	2.515330 02	4.065390 02	7.045440 02
16	7	10	4.336790 00	6.261690-01	1.667820-01	2.423010 01	3.361770 01	1.198450 02
17	7	17	0.0	0.0	0.0	0.0	0.0	0.0
18	8	18	7.436260 00	5.074670-01	4.747660-01	1.105710 02	2.913520 02	2.753830 02
19	8	25	1.180940 01	7.843210 00	2.157350 00	1.520350 03	3.155270 03	1.103250 04
20	9	10	5.533500 00	3.072760-01	5.002570-01	3.290060 01	1.045360 02	5.103870 01
21	9	11	5.255570 00	2.632570-01	4.286000-01	3.127840 01	7.892090 01	5.401790 01
22	9	13	9.524520 00	2.630840 00	2.630840 00	1.865170 02	4.321290 02	4.429460 02
23	9	14	5.961060 00	3.100920-01	3.100920-01	1.357490 01	2.855340 01	2.712560 01
24	10	12	5.255570 00	2.632570-01	4.286000-01	3.127840 01	7.892090 01	5.401790 01
25	10	13	1.043970 01	3.464370 00	3.464370 00	2.004030 02	4.736490 02	4.941990 02
26	10	14	4.118940 00	1.076050-01	1.076050-01	8.468380 00	2.006490 01	2.190440 01
27	11	12	5.533500 00	3.072760-01	5.002570-01	3.290060 01	1.045380 02	5.103870 01
28	11	13	9.524520 00	2.630840 00	2.630840 00	1.865170 02	4.321290 02	4.415820 02
29	11	14	5.961060 00	3.100920-01	3.100920-01	1.357490 01	2.855340 01	2.706150 01
30	11	16	4.047450 00	4.256910-01	2.837940-01	2.030010 01	4.958880 01	7.128210 01
31	12	13	1.043970 01	3.464370 00	3.464370 00	2.004030 02	4.736490 02	4.938460 02
32	12	14	4.118940 00	1.076050-01	1.076050-01	8.468380 00	2.006490 01	2.135630 01
33	12	17	4.336790 00	6.261690-01	1.667820-01	2.423010 01	3.361770 01	1.198450 02
34	15	16	9.505070 00	4.887240-01	3.174770 00	1.338660 02	2.817470 02	6.770200 01
35	16	17	7.784770 00	1.705660 00	9.269250-01	1.277040 02	1.934470 02	2.370460 02
36	16	19	5.018110 00	5.856150 00	5.449780 00	3.440910 02	1.218470 03	1.335700 03
37	16	24	6.656460 00	2.085670-01	4.183230-01	1.410920 02	6.592780 02	3.741880 02
38	17	18	1.141040 01	2.965870 00	1.611790 00	2.515330 02	4.085390 02	7.010460 02
39	18	20	9.562780 00	2.851030 00	5.044680 00	7.994910 02	1.851730 03	1.096850 03
40	18	24	1.180940 01	7.843210 00	2.157350 00	1.520350 03	3.155270 03	1.103250 04
41	19	20	5.856240 00	3.822250-01	3.802770-01	7.665970 01	1.952730 02	1.784740 02
42	19	21	5.457550 00	3.073800 00	2.570270 00	2.451690 02	1.050470 03	1.237340 03
43	19	27	2.656650 01	2.156790 01	1.578190 01	4.362920 02	6.716700 02	1.145340 03
44	20	22	3.218120 00	1.566730-01	1.937270-01	4.205820 01	1.010110 02	8.407440 01
45	21	22	2.461780 00	4.256910-02	3.460940-01	3.780660 01	3.286900 01	3.227340 01
46	21	29	5.245010 00	3.522810-01	1.299760 00	4.177110 01	1.018160 02	4.062130 01
47	21	32	4.212830 00	3.279650-01	3.279650-01	1.107400 02	3.436660 02	3.663200 02
48	22	31	2.212730 00	7.537700-02	2.776320-01	3.953980 01	3.054040 01	2.981490 01
49	22	32	4.238180 00	3.492540-01	3.340730-01	1.210580 02	3.451570 02	4.435110 02
50	23	24	0.0	0.0	0.0	0.0	0.0	0.0
51	25	26	0.0	0.0	0.0	0.0	0.0	0.0
52	27	28	3.445440 01	3.427670 01	9.734400 01	4.845430 02	1.638650 03	1.022360 03
53	29	30	4.524440 00	2.475220-01	1.021880 00	3.600430 01	8.004740 01	3.374250 01
54	30	31	2.122530 00	7.922550-02	2.721690-01	3.987170 01	2.584180 01	2.721660 01
55	30	32	4.212830 00	3.279650-01	3.279650-01	1.107400 02	3.436060 02	3.663020 02
56	31	32	4.238180 00	3.492540-01	3.340730-01	1.210580 02	3.451570 02	4.435100 02
57	27	29	1.654440 01	5.347850 00	4.452730 00	4.834780 02	7.144510 02	1.006160 03
58	15	27	1.412740 01	7.645270 00	6.554270 00	3.688080 02	1.109160 03	1.353410 03
59	20	33	1.630480 01	8.223500 00	1.711840 00	1.104460 03	2.432790 03	1.006400 04
60	23	33	0.0	0.0	0.0	0.0	0.0	0.0
61	26	34	0.0	0.0	0.0	0.0	0.0	0.0
62	9	34	1.630480 01	8.223500 00	1.711840 00	1.104460 03	2.432790 03	1.006400 04
63	24	33	0.0	0.0	0.0	0.0	0.0	0.0
64	25	34	0.0	0.0	0.0	0.0	0.0	0.0
65	7	9	3.222820 00	0.0	0.0	0.0	0.0	0.0
66	11	17	3.222820 00	0.0	0.0	0.0	0.0	0.0
67	5	30	3.697060 00	0.0	0.0	0.0	0.0	0.0
68	26	21	3.697060 00	0.0	0.0	0.0	0.0	0.0
69	28	35	1.328250 01	5.703460 01	5.703460 01	1.016660 03	1.972830 03	2.231000 03

Figure C-4 Airplane A 35 Mass, 69 Member Math Model Damping Data

BEAM UNCOUPLED,UNDAMPED FREQUENCIES (CPS)

IJ	I	J	(1)	(2)	(3)	(4)	(5)	(6)
1	1	14	0.0	0.0	0.0	0.0	0.0	0.0
2	2	4	6.5625D 02	8.4693D 01	1.3586D 01	7.7498D 01	2.9956D 01	2.1068D 02
3	3	19	6.5625D 02	8.4693D 01	1.3586D 01	7.7498D 01	2.9956D 01	2.1068D 02
4	4	5	1.2613D 02	8.2337D 00	8.1918D 00	4.6418D 00	1.2847D 01	1.2436D 01
5	4	6	1.0121D 02	1.4637D 02	1.8275D 02	1.8038D 02	2.8354D 02	2.9880D 02
6	4	27	4.3672D 02	3.5617D 02	2.0062D 02	2.0408D 02	3.2188D 02	4.3819D 02
7	4	30	2.3454D 02	1.3210D 02	1.1046D 02	1.7305D 02	1.6361D 02	1.9620D 02
8	5	8	1.5165D 02	4.5213D 01	8.0001D 01	2.0328D 01	6.9850D 01	3.7668D 01
9	5	20	1.1819D 02	8.0655D 00	7.5456D 00	3.3542D 00	9.3004D 00	9.5369D 00
10	5	31	9.0137D 01	4.3883D 00	5.4261D 00	2.2676D 00	6.0554D 00	4.7630D 00
11	6	7	3.0345D 02	6.6486D 01	3.6131D 01	3.3427D 01	3.4058D 01	6.1070D 01
12	6	9	1.4645D 02	1.5403D 01	1.0269D 01	6.6723D 00	8.7528D 00	1.3696D 01
13	6	15	2.7545D 02	1.4189D 01	9.2173D 01	2.8650D 01	6.0300D 01	9.0486D 00
14	6	25	1.1221D 02	3.5002D 00	7.0203D 00	2.5010D 00	2.3079D 01	3.4688D 00
15	7	8	2.4561D 02	6.3840D 01	3.4694D 01	1.2109D 01	2.1020D 01	3.6897D 01
16	7	10	1.5689D 02	2.2683D 01	6.1072D 00	9.6471D 00	5.9314D 00	2.2981D 01
17	7	17	0.0	0.0	0.0	0.0	0.0	0.0
18	8	16	1.1056D 02	7.5447D 00	7.0585D 00	3.1282D 00	8.2426D 00	8.3766D 00
19	8	25	1.4496D 02	9.7563D 01	2.6836D 01	2.6479D 01	5.4969D 01	8.1574D 01
20	9	10	1.6683D 02	1.0374D 01	1.6890D 01	8.2416D 00	1.8437D 01	1.2785D 01
21	9	11	1.7744D 02	8.8883D 00	1.4471D 01	7.8276D 00	1.7511D 01	1.2143D 01
22	9	13	4.8721D 01	1.3458D 01	1.3458D 01	1.0385D 01	2.1105D 01	2.1189D 01
23	9	14	2.0833D 02	1.0837D 01	1.0837D 01	4.8395D 00	9.3562D 00	1.1468D 01
24	10	12	1.7744D 02	8.8883D 00	1.4471D 01	7.8276D 00	1.7511D 01	1.2143D 01
25	10	13	5.3402D 01	1.7721D 01	1.7721D 01	1.1363D 01	2.3133D 01	2.3225D 01
26	10	14	1.4640D 02	3.7607D 00	3.7607D 00	3.4008D 00	6.5748D 00	8.0587D 00
27	11	12	1.6683D 02	1.0374D 01	1.6890D 01	8.2416D 00	1.8437D 01	1.2785D 01
28	11	13	4.8721D 01	1.3458D 01	1.3458D 01	1.0385D 01	2.1105D 01	2.1189D 01
29	11	14	2.0833D 02	1.0837D 01	1.0837D 01	4.8395D 00	9.3562D 00	1.1468D 01
30	11	16	1.4645D 02	1.5403D 01	1.0269D 01	6.6723D 00	8.7528D 00	1.3696D 01
31	12	13	5.3402D 01	1.7721D 01	1.7721D 01	1.1363D 01	2.3133D 01	2.3225D 01
32	12	14	1.4640D 02	3.7607D 00	3.7607D 00	3.4008D 00	6.5748D 00	8.0587D 00
33	12	17	1.5689D 02	2.2683D 01	6.1072D 00	9.6471D 00	5.9314D 00	2.2981D 01
34	15	16	2.7545D 02	1.4189D 01	9.2171D 01	2.8645D 01	6.0298D 01	9.0486D 00
35	16	17	3.0345D 02	6.6486D 01	3.6131D 01	3.3427D 01	3.4058D 01	6.1070D 01
36	16	19	1.0121D 02	1.4637D 02	1.8275D 02	1.8038D 02	2.8354D 02	2.9880D 02
37	16	24	1.1221D 02	3.5002D 00	7.0203D 00	2.5010D 00	2.3079D 01	3.4688D 00
38	17	18	2.4561D 02	6.3840D 01	3.4694D 01	1.2109D 01	2.1020D 01	3.6897D 01
39	18	20	1.5165D 02	4.5213D 01	8.0001D 01	2.0328D 01	6.9850D 01	3.7668D 01
40	18	24	1.4490D 02	9.7563D 01	2.6836D 01	2.6479D 01	5.4989D 01	8.1574D 01
41	19	20	1.2613D 02	8.2337D 00	8.1918D 00	4.6418D 00	1.2847D 01	1.2436D 01
42	19	21	2.3454D 02	1.3210D 02	1.1046D 02	1.7305D 02	1.6361D 02	1.9620D 02
43	19	27	4.3672D 02	3.5617D 02	2.0062D 02	2.0408D 02	3.2188D 02	4.3819D 02
44	20	22	9.0137D 01	4.3883D 00	5.4261D 00	2.2676D 00	6.0554D 00	4.7630D 00
45	21	22	1.9616D 02	7.4476D 00	2.7579D 01	1.3848D 01	1.1974D 01	3.2642D 00
46	21	29	1.4226D 02	1.0919D 01	4.0216D 01	7.8759D 00	1.9207D 01	4.6210D 00
47	21	32	2.8586D 01	6.8965D 00	6.8965D 00	1.5295D 01	2.5304D 01	2.5603D 01
48	22	31	1.6226D 02	6.6062D 00	2.2122D 01	1.2867D 01	1.1126D 01	3.0376D 00
49	22	32	8.9133D 01	8.3968D 00	7.0248D 00	1.6958D 01	2.5462D 01	2.6385D 01
50	23	24	0.0	0.0	0.0	0.0	0.0	0.0
51	25	26	0.0	0.0	0.0	0.0	0.0	0.0
52	27	28	1.9616D 02	2.6717D 02	3.4655D 02	1.9875D 02	5.8216D 02	2.9391D 02
53	29	30	1.3999D 02	9.2056D 00	3.1618D 01	8.2270D 00	1.5101D 01	3.8660D 00
54	30	31	1.6921D 02	6.5124D 00	2.1882D 01	1.0943D 01	9.4141D 00	2.7563D 00
55	30	32	8.8596D 01	6.8965D 00	6.8965D 00	1.5295D 01	2.5304D 01	2.5603D 01
56	31	32	8.9133D 01	8.3968D 00	7.0248D 00	1.6958D 01	2.5460D 01	2.6385D 01
57	27	29	1.4226D 02	7.6572D 01	6.3971D 01	5.4366D 01	2.4017D 02	2.2476D 02
58	15	27	2.1675D 02	1.2037D 02	1.0056D 02	1.4335D 02	2.0556D 02	2.4049D 02
59	20	33	1.5132D 02	9.0681D 01	2.4492D 01	2.7460D 01	5.8068D 01	8.5235D 01
60	23	33	0.0	0.0	0.0	0.0	0.0	0.0
61	26	34	0.0	0.0	0.0	0.0	0.0	0.0
62	5	34	1.5132D 02	9.0681D 01	2.4492D 01	2.7460D 01	5.8068D 01	8.5235D 01
63	24	33	0.0	0.0	0.0	0.0	0.0	0.0
64	25	34	0.0	0.0	0.0	0.0	0.0	0.0
65	7	9	1.1662D 02	0.0	0.0	0.0	0.0	0.0
66	11	17	1.1662D 02	0.0	0.0	0.0	0.0	0.0
67	5	30	1.0243D 02	0.0	0.0	0.0	0.0	0.0
68	20	21	1.0243D 02	0.0	0.0	0.0	0.0	0.0
69	28	35	6.4486D 00	2.7854D 01	2.7854D 01	2.9937D 01	7.7572D 01	6.5696D 01

Figure C-5 Airplane A 35 Mass, 69 Member Math Model Frequency Data

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VEHICLE INITIAL CONDITIONS

VEHICLE TRANSLATIONAL VELOCITIES IN GROUND AXES (IN/SEC)
VEHICLE ROTATIONAL VELOCITIES IN VEHICLE AXES (RAD/SEC)
EULER ANGLES OF VEHICLE RELATIVE TO GROUND (RADIANS)

        XGDOT              YGDOT              ZGDOT
          P'                 Q'                 R'
         PHI'              THETA'              PSI'

      5.400000D 02          0.0                0.0
      0.0                   0.0                0.0
      0.0                   0.0                0.0

GENERALIZED SURFACE DATA

BETA =  45.0 DEGREES
XGIN =   0.0
ZGIN =   0.0


MODEL PARAMETERS

VEHICLE WT = 1.601829D 03

VEHICLE CG POSITION
X (FS) =  3.652200 01
Y (BL) =  5.677850-16
Z (WL) =  3.382460 00

VEHICLE INERTIAS (IN-LB-SEC**2)
I(XX) = 9.43552D 03
I(YY) = 1.02132D 04
I(ZZ) = 1.65440D 04

VEHICLE CG INITIAL GROUND COORDINATES
XCG IS THE DISTANCE FROM SLOPE/GROUND INTERSECTION TO VEHICLE CG,+FORWARD
ZCG IS THE DISTANCE FROM GROUND PLANE TO VEHICLE CG,+DOWN
XCG = -2.970240 01
ZCG = -4.297350 01
```

Figure C-6 Airplane A 35 Mass, 69 Member Math Model Initial Conditions, Overall Mass and c.g. Properties

MASS DATA

I	WEIGHTS W	MASS COORDINATES F.S.,W.L.,B.L. X**	Y**	Z**	MASS MOMENTS OF INERTIA (LB-IN-SEC**2) IX	IY	IZ	I
1	1.630000D 01	-1.075000D 01	0.0	-3.459000D 01	6.400000D-01	1.410000 00	6.400000D-01	1
2	2.025000D 01	4.760000D 01	3.979000D 01	-3.459000D 01	8.120000D-01	1.797000 00	8.120000D-01	2
3	2.025000D 01	4.760000D 01	-3.979000D 01	-3.459000D 01	8.120000D-01	1.797000 00	8.120000D-01	3
4	1.191000D 02	5.313000D 01	0.0	-1.744000D 01	1.404000D 01	2.030000D 01	1.818000D 01	4
5	9.039000D 01	5.313000D 01	0.0	2.544000D 01	1.819000D 02	1.159400 02	1.256800 02	5
6	7.260000D 01	2.098000D 01	0.0	-1.566000 01	1.458600D 01	3.384000 01	3.560000D 01	6
7	3.940000D 01	2.404000D 01	0.0	6.440000D 00	1.458600 01	3.384000 01	3.560000D 01	7
8	1.630000D 02	2.652000D 01	0.0	2.615000D 01	1.983400 02	1.390000 02	1.547200 02	8
9	4.545000D 01	0.0	0.0	-1.772000D 01	1.425400 01	2.256000 01	1.770000 01	9
10	4.545000D 01	0.0	0.0	6.440000D 00	1.425400 01	2.256000 01	1.770000 01	10
11	5.927000D 01	9.500000D 01	0.0	-5.650000D 00	3.020000 00	3.904000 01	3.904000 01	11
12	1.927000D 01	9.500000D 01	0.0	9.500000D 00	3.020000 00	3.904000 01	3.904000 01	12
13	2.774900D 02	-1.692000D 01	0.0	-1.850000D 00	5.800000D 01	7.473000 01	7.648000 01	13
14	2.120000D 01	-7.390000D 00	0.0	-2.290000 01	2.480000 00	2.740000 00	4.800000-01	14
15	1.318000D 02	2.652000D 01	8.224000D 01	2.712000D 01	8.590000D 02	6.560000D 01	9.215000 02	15
16	1.318000D 02	2.652000D 01	-8.224000D 01	2.712000D 01	8.590000D 02	6.560000D 01	9.215000 02	16
17	6.340000D 01	2.003800D 02	0.0	5.700000D 00	2.670000D 01	3.436000 01	4.266000 01	17
18	1.672000D 02	5.313000D 01	0.0	-5.440000D 00	9.300000D 00	6.700000 00	1.120000 01	18
19	3.900000 00	2.652000D 01	1.419700D 02	2.712000D 01	4.500000-01	1.780000 00	2.150000 00	19
20	3.900000 00	2.652000D 01	-1.419700D 02	2.712000D 01	4.500000-01	1.780000 00	2.150000 00	20
21	1.360000D 02	5.313000D 01	0.0	1.156000D 01	4.000000 00	3.700000 00	3.300000 00	21

Figure C-7. Airplane A 21 Mass, 32 Member, Math Model Mass Data

INTERNAL BEAM DATA

BEAM			MODULUS OF ELASTICITY	AREA	MODULUS OF RIGIDITY	MOMENTS OF INERTIA			LENGTH	DAMPING RATIO	BEAM		
IJ	I	J	E	A	G	JX	I(YY)	I(ZZ)	XLB	CBAR	IJ	I	J
1	1	14	3.0000D 07	7.2810D-02	1.1000D 07	1.1336D-01	5.6680D-02	5.6680D-02	1.2106D 01	2.0000D-02	1	1	14
2	2	4	3.0000D 07	2.0700D 00	1.1000D 07	3.0497D 00	6.8400D-02	2.9813D 00	4.3680D 01	2.0000D-02	2	2	4
3	3	4	3.0000D 07	2.0700D 00	1.1000D 07	3.0497D 00	6.8400D-02	2.9813D 00	4.3680D 01	2.0000D-02	3	3	4
4	4	5	1.0500D 07	1.0920D 00	4.0000D 06	1.4876D 00	7.4000D-01	7.4760D-01	4.2880D 01	2.0000D-02	4	4	5
5	4	6	1.0500D 07	2.9600D-01	4.0000D 06	1.7996D 02	8.3520D 01	9.6440D 01	3.2199D 01	2.0000D-02	5	4	6
6	4	11	1.0500D 07	1.8300D 00	4.0000D 06	1.3332D 02	5.4860D 01	7.8460D 01	4.2589D 01	2.0000D-02	6	4	11
7	5	8	1.0500D 07	1.3400D 00	4.0000D 06	3.9600D 01	3.0000D 01	9.6000D 00	2.6619D 01	2.0000D-02	7	5	8
8	5	12	1.0500D 07	5.6200D-01	4.0000D 06	3.1400D-01	1.9000D-01	1.2400D-01	4.4802D 01	2.0000D-02	8	5	12
9	6	7	1.0500D 07	1.7170D 00	4.0000D 06	5.2600D 00	1.2000D 00	4.0600D 00	2.2311D 01	2.0000D-02	9	6	7
10	6	9	1.0500D 07	3.7500D-01	4.0000D 06	2.2360D-01	6.8800D-02	1.5480D-01	2.1081D 01	2.0000D-02	10	6	9
11	7	8	1.0500D 07	1.7170D 00	4.0000D 06	5.2540D 00	1.2000D 00	4.0540D 00	1.4865D 01	2.0000D-02	11	7	8
12	7	10	1.0500D 07	4.9600D-01	4.0000D 06	5.3260D-01	3.6000D-02	4.9660D-01	2.4040D 01	2.0000D-02	12	7	10
13	8	15	1.0500D 07	3.1650D 00	4.0000D 06	4.6582D 02	3.2750D 01	4.3307D 02	8.2246D 01	2.0000D-02	13	8	15
14	8	16	1.0500D 07	3.1650D 00	4.0000D 06	4.6582D 02	3.2750D 01	4.3307D 02	8.2246D 01	2.0000D-02	14	8	16
15	9	10	3.0000D 07	2.9200D-01	1.1000D 07	1.8200D-01	1.3200D-01	5.0000D-02	2.4160D 01	2.0000D-02	15	9	10
16	9	13	3.0000D 07	1.4000D-01	1.1000D 07	1.4400D 00	7.2000D-01	7.2000D-01	2.3198D 01	2.0000D-02	16	9	13
17	9	14	3.0000D 07	2.1600D-01	1.1000D 07	2.6800D-02	1.3400D-02	1.3400D-02	9.0592D 00	2.0000D-02	17	9	14
18	10	13	3.0000D 07	1.4000D-01	1.1000D 07	1.4400D 00	7.2000D-01	7.2000D-01	1.6842D 01	2.0000D-02	18	10	13
19	10	14	3.0000D 07	2.1600D-01	1.1000D 07	2.6800D-02	1.3400D-02	1.3400D-02	3.0315D 01	2.0000D-02	19	10	14
20	11	12	1.0500D 07	2.2740D-01	4.0000D 06	1.5200D-01	1.4000D-01	1.2000D-02	1.9150D 01	2.0000D-02	20	11	12
21	11	17	1.0500D 07	6.0000D-01	4.0000D 06	1.4000D 01	7.0000D 00	7.0000D 00	1.0649D 02	2.0000D-02	21	11	17
22	12	17	1.0500D 07	6.0000D-01	4.0000D 06	1.7000D 01	7.0000D 00	1.0000D 01	1.0545D 02	2.0000D-02	22	12	17
23	4	18	3.0000D 07	4.0000D-01	1.1000D 07	2.0300D 01	1.5000D 01	5.3000D 00	1.2000D 01	2.0000D-02	23	4	18
24	6	15	1.0500D 07	1.7400D 00	4.0000D 06	2.3330D 00	0.0	4.6500D-01	9.2867D 01	2.0000D-02	24	6	15
25	6	16	1.0500D 07	1.7940D 00	4.0000D 06	2.3330D 00	0.0	4.6500D-01	9.2867D 01	2.0000D-02	25	6	16
26	15	19	1.0500D 07	3.0980D 00	4.0000D 06	2.6068D 02	1.9920D 01	2.4076D 02	1.0973D 02	2.0000D-02	26	15	19
27	16	20	1.0500D 07	3.0980D 00	4.0000D 06	2.6068D 02	1.9920D 01	2.4076D 02	1.0973D 02	2.0000D-02	27	16	20
28	5	20	1.0500D 07	3.0980D 00	4.0000D 06	3.6340D 02	2.6400D 01	3.3700D 02	1.9381D 02	2.0000D-02	28	5	20
29	5	19	1.0500D 07	3.0980D 00	4.0000D 06	3.6340D 02	2.6400D 01	3.3700D 02	1.9381D 02	2.0000D-02	29	5	19
30	7	9	1.0500D 07	4.0000D-01	4.0000D 06	0.0	0.0	0.0	3.4083D 01	2.0000D-02	30	7	9
31	18	21	1.0500D 07	2.2520D-03	5.0000D 06	2.0000D 00	1.0000D 00	1.0000D 00	1.7000D 01	1.9460D-01	31	18	21
32	5	11	1.0500D 07	6.0000D-01	4.0000D 06	0.0	0.0	0.0	5.4630D 01	2.0000D-02	32	5	11

Figure C-8. Airplane A 21 Mass, 32 Member, Math Model Member Property Data

DAMPING TERMS (LB/IN/SEC,TRANSLATIONS (1)-(3) AND LB-IN-SEC,ROTATIONS (4)-(6))

IJ	I	J	(1)	(2)	(3)	(4)	(5)	(6)
1	1	14	4.853950 00	1.225510 00	1.22551D 00	1.44907D 01	6.10795D 01	5.16359D 01
2	2	4	2.665730 01	2.727470 00	4.13129D-01	1.625490 02	6.71317D 01	5.04581D 02
3	3	4	2.665730 01	2.727470 00	4.13129D-01	1.625490 02	6.71317D 01	5.05127D 02
4	4	5	1.922840 01	1.018580 00	1.01339D 00	1.787210 02	3.974090 02	4.791300 02
5	4	6	8.748230 00	1.760730 01	1.58271D 01	1.013250 03	3.071960 03	3.287690 03
6	4	11	1.723780 01	9.727080 00	8.13417D 00	6.072160 02	2.266420 03	2.630130 03
7	5	8	2.060050 01	7.175520 00	1.268460 01	1.902510 03	4.394050 03	2.607140 03
8	5	12	6.210180 00	2.810540-01	3.47876D-01	9.044330 01	2.101610 02	1.763870 02
9	6	7	1.539690 01	4.624460 00	2.51414D 00	3.259420 02	4.944920 02	6.053120 02
10	6	9	9.562030 00	1.609540 00	6.73024D-01	4.442530 01	1.112180 02	1.618210 02
11	7	8	2.316970 01	6.208270 00	3.37771D 00	5.681290 02	8.376110 02	1.767380 03
12	7	10	8.676240 00	1.258910 00	3.389540-01	6.394710 01	7.533700 01	2.720100 02
13	8	15	1.584400 01	9.778840 00	2.68859D 00	2.724110 03	5.319130 03	1.951340 04
14	8	16	1.584400 01	9.778840 00	2.68859D 00	2.724110 03	5.319130 03	1.951340 04
15	9	10	1.164380 01	6.998120-01	1.12731D 00	6.850860 01	2.175570 02	1.064320 02
16	9	13	1.550920 01	5.272420 00	5.27242D 00	8.032490 02	7.614240 02	7.071650 02
17	9	14	1.400210 01	1.339240 00	1.339240 00	2.994100 01	8.476520 01	7.089210 01
18	10	13	1.727550 01	7.202810 00	7.20281D 00	3.207770 02	8.448720 02	8.123110 02
19	10	14	7.870720 00	2.187940-01	2.187940-01	1.677900 01	4.633800 01	3.778240 01
20	11	12	6.371310 00	2.647560-01	9.043140-01	6.297920 01	1.958550 02	1.594810 01
21	11	17	5.484770 00	6.094040-01	6.094040-01	1.604800 02	5.694070 02	5.967550 02
22	12	17	4.524830 00	6.068430-01	5.077210-01	1.753120 02	5.722180 02	7.212670 02
23	4	18	3.563250 01	3.744280 01	6.299070 01	5.352760 02	2.545580 03	1.406850 03
24	6	15	1.310970 01	2.489660-01	0.0	2.137600 02	0.0	5.109410 02
25	6	16	1.310970 01	2.489660-01	0.0	2.137600 02	0.0	5.109320 02
26	15	19	1.291340 01	3.593830 00	1.033740 00	1.012150 03	3.238000 03	1.166990 04
27	16	20	1.291340 01	3.593830 00	1.033740 00	1.012150 03	3.238000 03	1.166990 04
28	5	20	8.099440 00	1.509860 00	4.225950-01	1.194690 03	1.287630 03	3.864770 03
29	5	19	8.099440 00	1.509860 00	4.225950-01	1.194690 03	1.287630 03	3.864770 03
30	7	9	6.328120 00	0.0	0.0	0.0	0.0	0.0
31	18	21	1.328250 01	5.703460 01	5.70346D 01	1.136660 03	1.972830 03	2.231000 03
32	5	11	6.458370 00	0.0	0.0	0.0	0.0	0.0

Figure C-9. Airplane A 21 Mass, 32 Member, Math Model Damping Data

BEAM UNCOUPLED,UNDAMPED FREQUENCIES (CPS)

IJ	I	J	(1)	(2)	(3)	(4)	(5)	(6)
1	1	14	2.3666D 02	5.9751D 01	5.9751D 01	2.8918D 01	5.8561D 01	1.1273D 02
2	2	4	3.1584D 02	3.0060D 01	4.5532D 00	3.6192D 01	1.4677D 01	1.0452D 02
3	3	4	3.1584D 02	3.0060D 01	4.5532D 00	3.6192D 01	1.4677D 01	1.0452D 02
4	4	5	1.1171D 02	7.4674D 00	7.4294D 00	4.2355D 00	1.1609D 01	1.1355D 01
5	4	6	7.3046D 01	1.3625D 02	1.2680D 02	1.4065D 02	2.2577D 02	2.4341D 02
6	4	11	1.4842D 02	8.3757D 01	7.0037D 01	1.3635D 02	1.5197D 02	1.8508D 02
7	5	8	1.8335D 02	5.6856D 01	1.0058D 02	1.9910D 01	6.8578D 01	3.6991D 01
8	5	12	8.6475D 01	3.9359D 00	4.8721D 00	1.9596D 00	5.3956D 00	4.2280D 00
9	6	7	2.6560D 02	6.3413D 01	3.4475D 01	2.8616D 01	2.9077D 01	5.2145D 01
10	6	9	1.2436D 02	1.3129D 01	8.7529D 00	6.1044D 00	7.8461D 00	1.2107D 01
11	7	8	2.4936D 02	6.6816D 01	3.6352D 01	1.1719D 01	1.9282D 01	3.3775D 01
12	7	10	1.9700D 02	2.2776D 01	8.1323D 00	8.8224D 00	5.3148D 00	2.0306D 01
13	8	15	1.2963D 02	6.3868D 01	1.7563D 01	2.3297D 01	4.5503D 01	7.2147D 01
14	8	16	1.2963D 02	6.3868D 01	1.7563D 01	2.3297D 01	4.5503D 01	7.2147D 01
15	9	10	1.9740D 02	1.1712D 01	1.9030D 01	8.5807D 00	1.9185D 01	1.3330D 01
16	9	13	7.4033D 01	2.5071D 01	2.5071D 01	1.5472D 01	3.1140D 01	3.1650D 01
17	9	14	3.2384D 02	3.0843D 01	3.0843D 01	7.0184D 00	1.3331D 01	1.5726D 01
18	10	13	8.2147D 01	3.4250D 01	3.4250D 01	1.7167D 01	3.4553D 01	3.5119D 01
19	10	14	1.7703D 02	5.0386D 00	5.0386D 00	3.8367D 00	7.2875D 00	8.5969D 00
20	11	12	1.2459D 02	9.1772D 00	1.7683D 01	1.1539D 01	9.9806D 00	2.9220D 00
21	11	17	8.2668D 01	7.6296D 00	7.6296D 00	2.1170D 01	3.0866D 01	2.9257D 01
22	12	17	8.4066D 01	1.1274D 01	9.4322D 00	2.3444D 01	3.1019D 01	3.5141D 01
23	4	18	1.7867D 02	1.8774D 02	3.1584D 02	1.4211D 02	3.7513D 02	2.1376D 02
24	6	15	9.8503D 01	1.8707D 00	0.0	1.7070D 00	0.0	2.3592D 00
25	6	16	9.8503D 01	1.8707D 00	0.0	1.7070D 00	0.0	2.3592D 00
26	15	19	1.4615D 02	4.0674D 01	1.1699D 01	1.6735D 01	5.3538D 01	5.0271D 01
27	16	20	1.4615D 02	4.0674D 01	1.1699D 01	1.6735D 01	5.3538D 01	5.0271D 01
28	5	20	1.3192D 02	2.4593D 01	6.8833D 00	3.2277D 01	3.5086D 01	1.2030D 02
29	5	19	1.3192D 02	2.4593D 01	6.8833D 00	3.2277D 01	3.5086D 01	1.2030D 02
30	7	9	1.1414D 02	0.0	0.0	0.0	0.0	0.0
31	18	21	8.4668D 00	2.7854D 01	2.7854D 01	3.3471D 01	7.7572D 01	6.5696D 01
32	5	11	8.6799D 01	0.0	0.0	0.0	0.0	0.0

Figure C-10 Airplane A 21 Mass, 32 Member Math Model Frequency Data

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VEHICLE INITIAL CONDITIONS

VEHICLE TRANSLATIONAL VELOCITIES IN GROUND AXES (IN/SEC)
VEHICLE ROTATIONAL VELOCITIES IN VEHICLE AXES (RAD/SEC)
EULER ANGLES OF VEHICLE RELATIVE TO GROUND (RADIANS)

        XGDOT                YGDOT                ZGDOT
          P'                   Q'                   R'
         PHI'                THETA'                PSI'

      5.400000 02          0.0                  0.0
      0.0                  0.0                  0.0
      0.0                  0.0                  0.0

GENERALIZED SURFACE DATA

BETA =  45.0 DEGREES
XGIN =   0.0
ZGIN =   0.0


MODEL PARAMETERS

VEHICLE WT = 1.601800D 03

VEHICLE CG POSITION
X (FS) =  3.610930 01
Y (BL) =  0.0
Z (WL) =  4.155810 00

VEHICLE INERTIAS (IN-LB-SEC**2)
I(XX) = 9.049770 03
I(YY) = 1.015880 04
I(ZZ) = 1.018660 04

VEHICLE CG INITIAL GROUND COORDINATES
XCG IS THE DISTANCE FROM SLOPE/GROUND INTERSECTION TO VEHICLE CG,+FORWARD
ZCG IS THE DISTANCE FROM GROUND PLANE TO VEHICLE CG,+DOWN
XCG = -2.928970 01
ZCG = -4.374680 01
```

Figure C-11. Airplane A 21 Mass, 32 Member Math Model Initial Conditions, Overall Mass and c.g. properties

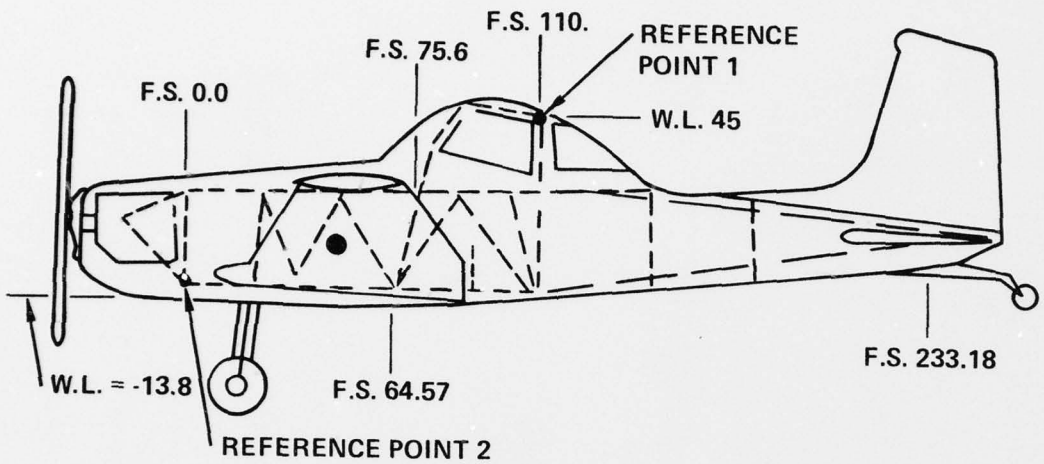

Figure C-12. Profile View of Airplane B

TABLE C-8. AIRPLANE B STRUCTURE TEST LOAD-DEFLECTION DATA

Structure	Design Load (lb.)	Deflection at Design Load (in.)	Rotation at Design Load (deg.)
Engine Mount[e]			
longitudinal	716	NA	
side	1221	.24	.75 (yaw)[d]
vertical	3489	.65	2.03 (pitch)[d]
Main Landing Gear[f]			
longitudinal	2427	2.44[j]	NA
side	2475	NA[j]	NA
vertical	7755	NA	NA
Tail Gear[g]			
longitudinal	542	NA	NA
side	794	4.04	NA
vertical	2364	3.06	NA
Wing[i]			
bending	921,365[a]	10.25[b]	3.17 (roll)
torque	73,200	3.44[b]	6.33 (pitch)
shear	8,616	10.25	3.17 (roll)
Tailcone Bending[h]			
vertical	802	4.75	1.48 (pitch)[c]
side	918	4.04	1.26 (roll)[c]

(a) Units: in-lb

(b) Measured at wing station 238 Front spar, relative to wing station 192

(c) Referenced to F.S. 49

(d) Referenced to F.S. 0.0

(e) Loads points are: (F.S. 18.35, W.L. 3.9, LBL 3.8), deflection and rotations referenced to F.S. 0.0.

(f) Loads points are: (F.S. 17.84, W.L. 44.95, LBL 47.97), deflection and rotations referenced to F.S. 0.0.

(g) Loads points are: (F.S. 26.4, W.L. 4.76, BL 0.0), deflection and rotations referenced to F.S. 0.0.

(h) Loads points are: (F.S. 217.0, W.L. 47.47), deflections and rotations measured relative to F.S. 49.

(i) Airplane axes apply for all structures except wing.

(j) NA means not available

TABLE C-9. AIRPLANE B FUSELAGE TEST VERTICAL LOAD-DEFLECTION DATA

Fuselage Station F.S.	Design Load (lb)	Deflection at Design Load (in)	Rotation at Design Load (deg)
-12.18	7603	1.68	.52
33.58	1544	1.25	.39
59.15	2359	1.81	.56[a]
96.63	1479	2.11	.66
157.61	163	3.00	.93

(a) Referenced to F.S. 49 (pitch direction)

TABLE C-10. AIRPLANE B FILM ANALYSIS DATA

Time, Milliseconds	Reference Point 1(b) V_L (ft/sec)(e)	Reference Point 1(b) V_V (ft/sec)(f)	Reference Point 2(c) V_L (ft/sec)(e)	Reference Point 2(c) V_V (ft/sec)(f)	Rotation, θ Degrees (g)	Rotational Velocity $\dot{\theta}$ (Deg/sec) (g)
875.0	44.55	0.60	44.55	0.60	28.19 (a)	0.0
750.0	39.92	-0.60	39.92	2.34	29.31	14.64
625.0	39.92	1.15	39.92	2.88	30.83	7.92
500.0	34.16	-2.26	37.27	3.39	33.98	33.84
375.0	31.65	-4.98	33.66	3.32	39.87	40.08
250.0	28.21	-3.21	36.78	5.88	46.08	62.88
125.0	22.28	-3.56	35.65	5.08	55.15	80.64
0.0 (d)	13.73	-4.90	35.31	2.45	66.80	119.28
-125.0	14.57	-1.98	27.69	1.98	79.20	72.24
-250.0	6.26	6.99	19.74	6.00	87.65	69.12
-375.0	7.66	7.53	27.24	4.02	94.64	51.36
-500.0	7.19	0.00	16.77	0.00	100.36	48.96
-625.0	3.83	1.02	21.98	-3.57	106.01	46.56
-750.0	0.96	0.51	14.85	-6.13	114.64	81.60
-875.0	4.31	1.53	14.37	-10.22	124.80	82.76
-1000.0	5.75	-4.60	6.23	-11.76	131.39	30.48
-1125.0	5.27	1.53	22.45	-11.25	139.96	93.10
-1250.0	5.27	0.51	11.98	-15.34	153.57	117.60
-1375.0	8.14	-1.53	8.62	-13.80	167.31	84.96
-1500.0	1.92	-7.16	1.44	-18.91	178.55	83.52
-1540.0	0.48	1.02	0.48	-15.85	182.54	95.76

(a) Initial Reference Rotation angle is 28.19 Degrees. Pitch Angle at anytime θ = 28.19°
(b) Reference Point 1 is located at F.S. 0.0, WL -13.80
(c) Reference Point 2 is located at F.S. 110.0, WL 45.0
(d) Time = 0.0 occurs at nose impact. Negative sign refers to post impact period.
(e) V_L = Longtudinal Velocity (positive in forword direction)
(f) V_V = Vertical Velocity (positive in up direction)
(g) Positive $\dot{\theta}$ indicates nose down pitch

MASS DATA

I	WEIGHTS W	MASS COORDINATES F.S.,W.L.,B.L. X**	Y**	Z**	MASS MOMENTS OF INERTIA (LB-IN-SEC**2) IX	IY	IZ	I
1	1.23000D 02	2.33187D 02	0.0	1.50000D 01	2.66930D 01	3.43600D 01	4.26600D 01	1
2	3.97000D 01	1.73770D 01	-4.04250D 01	-4.71650D 01	2.31000D 01	2.47700D 01	1.64670D 01	2
3	3.97000D 01	1.73770D 01	4.04250D 01	-4.71650D 01	2.31000D 01	2.47700D 01	1.64670D 01	3
4	1.69400D 01	8.92500D 01	1.67370D 01	-8.96300D 00	2.95600D 00	4.54200D 00	1.39600D 00	4
5	1.09250D 02	6.45700D 01	2.00000D 01	-1.02750D 01	8.36000D 01	1.73000D 01	9.11300D 01	5
6	4.08800D 01	7.20900D 01	1.97500D 01	2.05000D 01	4.75000D 00	7.21600D 00	6.60000D 00	6
7	7.09400D 01	2.35700D 01	1.80260D 01	-8.91700D 00	1.38600D 02	5.80600D 01	1.16000D 02	7
8	7.92400D 01	2.35700D 01	1.93200D 01	1.45540D 01	1.04330D 02	1.00800D 01	1.04270D 02	8
9	2.20000D 01	8.75000D-01	1.61900D 01	-1.81850D 01	3.31000D 00	1.06870D 01	1.06870D 01	9
10	1.11220D 02	8.75000D-01	1.84400D 01	1.18490D 01	4.83000D 00	2.24040D 01	1.91000D 01	10
11	5.59700D 02	-1.90320D 01	0.0	3.07200D 00	2.28536D 02	2.79388D 02	3.53610D 02	11
12	9.62400D 01	8.75000D-01	-1.61900D 01	-1.81850D 01	2.79700D 01	5.25000D 01	3.14140D 01	12
13	8.92000D 01	8.75000D-01	-1.84400D 01	1.18490D 01	4.16000D 00	1.66100D 01	1.54540D 01	13
14	7.09400D 01	2.35700D 01	-1.80260D 01	-8.91700D 00	1.71710D 02	7.19650D 01	1.42770D 02	14
15	7.92400D 01	2.35700D 01	-1.93200D 01	1.45540D 01	1.69587D 02	1.20630D 01	1.69587D 02	15
16	1.09250D 02	6.45700D 01	-2.00000D 01	-1.02750D 01	1.00367D 02	2.07600D 01	1.09358D 02	16
17	7.92400D 01	6.45700D 01	0.0	-1.02750D 01	3.10000D 00	5.47000D 00	4.77700D 00	17
18	3.08400D 01	7.20900D 01	-1.97500D 01	2.05000D 01	5.71000D 00	8.65800D 00	7.92800D 00	18
19	1.69400D 01	8.92500D 01	-1.67370D 01	-8.96300D 00	2.96000D 00	4.54200D 00	1.36900D 00	19
20	3.00000D 01	8.08700D 01	0.0	-2.38000D 00	2.09200D 01	4.36000D 01	1.85300D 01	20
21	1.38500D 01	1.10180D 02	-1.37580D 01	-7.85000D 00	3.19600D 00	1.07740D 01	9.70800D 00	21
22	1.77900D 01	1.10180D 02	0.0	-7.85000D 00	7.39300D 00	1.70000D 01	1.08630D 01	22
23	1.43800D 01	1.10180D 02	-1.50900D 01	2.48000D 01	2.96300D 00	1.19140D 01	1.01780D 01	23
24	1.56600D 01	8.46300D 01	-8.58000D 00	4.73100D 01	6.84500D 00	6.08300D 00	4.19600D 00	24
25	5.90000D 00	1.10180D 02	-6.74000D 00	4.58100D 01	1.17500D 00	2.31200D 00	2.46200D 00	25
26	1.56900D 01	8.46300D 01	8.58000D 00	4.73100D 01	6.84500D 00	6.08300D 00	4.19600D 00	26
27	5.91000D 00	1.10180D 02	6.74000D 00	4.58100D 01	1.17500D 00	2.31200D 00	2.46200D 00	27
28	9.30600D 01	3.35800D 01	1.21070D 02	-2.50000D 00	4.68000D 02	3.54000D 01	5.02000D 02	28
29	1.77000D 01	4.30000D 01	2.36980D 02	1.04500D 01	4.50000D-01	1.78000D 00	2.15000D 00	29
30	9.30600D 01	3.35800D 01	-1.21070D 02	-2.50000D 00	4.68000D 02	3.54000D 01	5.02000D 02	30
31	1.77000D 01	4.30000D 01	-2.36980D 02	1.04500D 01	4.50000D-01	1.78000D 00	2.15000D 00	31
32	1.32500D 01	1.10180D 02	1.37600D 01	-7.85000D 00	3.19600D 00	1.07740D 01	9.70800D 00	32
33	1.43800D 01	1.10180D 02	1.50900D 01	2.48000D 01	2.96300D 00	1.19140D 01	1.01780D 01	33
34	1.70000D 02	8.08700D 01	0.0	1.20000D 01	4.90000D 01	1.47000D 02	1.33000D 02	34
35	3.45000D 01	2.35700D 01	0.0	-8.91700D 00	1.27200D 00	2.65600D 00	2.65600D 00	35
36	1.65000D 01	3.65700D 01	1.87000D 01	-9.40000D 00	6.63000D 01	1.85370D 01	6.23300D 01	36
37	1.65000D 01	4.35700D 01	1.95000D 01	1.75000D 01	6.63000D 01	1.85370D 01	6.23300D 01	37
38	9.70000D 00	8.15400D 01	1.63000D 01	2.16000D 01	2.30000D 00	8.30000D 00	4.70000D 00	38
39	9.70000D 00	1.00700D 02	1.86000D 01	2.37000D 01	2.30000D 00	8.30000D 00	4.70000D 00	39
40	1.65000D 01	3.65700D 01	-1.87000D 01	-9.40000D 00	6.63000D 01	1.85370D 01	6.23300D 01	40
41	1.65000D 01	4.35700D 01	-1.95000D 01	1.75000D 01	6.63000D 01	1.85370D 01	6.23300D 01	41
42	9.70000D 00	8.15400D 01	-1.63000D 01	2.16000D 01	2.30000D 00	8.30000D 00	4.70000D 00	42
43	9.70000D 00	1.00700D 02	-1.87000D 01	2.37000D 01	2.30000D 00	8.30000D 00	4.70000D 00	43
44	1.47000D 01	2.33200D 02	0.0	7.70000D 01	6.40000D 00	1.42000D 01	6.40000D 00	44

Figure C-13. Airplane B 44 Mass, 81 Member Math Model Mass Data.

BEAM			MODULUS OF ELASTICITY	AREA	MODULUS OF RIGIDITY	MOMENTS OF INERTIA			LENGTH	DAMPING RATIO	BEAM		
IJ	I	J	E	A	G	JX	I(YY)	I(ZZ)	XLB	CBAR	IJ	I	J
1	1	32	1.0500D 07	1.0105D 00	4.0000D 06	3.2[illegible]0D 01	2.5950D 01	6.4900D 00	1.2587D 02	1.0000D-02	1	1	32
2	1	33	1.0500D 07	1.5707D 00	4.0000D 06	5.[illegible]600D 01	4.0716D 01	1.1970D 01	1.2432D 02	1.0000D-02	2	1	33
3	1	21	1.0500D 07	1.0105D 00	4.0000D 06	3.[illegible]400D 01	2.5950D 01	6.4900D 00	1.2587D 02	1.0000D-02	3	1	21
4	1	23	1.0500D 07	1.5707D 00	4.0000D 06	5.2[illegible]600D 01	4.0710D 01	1.1970D 01	1.2432D 02	1.0000D-02	4	1	23
5	2	14	3.0000D 07	3.4362D 00	1.1000D 07	5.31[illegible]D 00	1.8900D-01	5.1216D 00	4.4755D 01	1.0000D-02	5	2	14
6	3	7	3.0000D 07	3.4362D 00	1.1000D 07	5.3166D 00	1.8900D-01	5.1216D 00	4.4755D 01	1.0000D-02	6	3	7
7	4	5	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	2.4929D 01	1.0000D-02	7	4	5
8	4	32	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	2.1170D 01	1.0000D-02	8	4	32
9	4	20	2.9000D 07	1.2610D-01	1.1000D 07	1.5200D-02	7.6000D-03	7.6000D-03	1.9842D 01	1.0000D-02	9	4	20
10	5	6	2.9000D 07	1.7830D-01	1.1000D 07	3.8112D 00	3.4756D 00	3.3560D-01	3.1681D 01	1.0000D-02	10	5	6
11	5	36	2.9000D 07	2.9280D-01	1.1000D 07	2.1005D 00	2.0594D 00	4.1100D-02	2.8044D 01	1.0000D-02	11	5	36
12	5	17	2.9000D 07	6.5550D-01	1.1000D 07	8.4027D 00	7.9837D 00	4.1900D-01	2.0000D 01	1.0000D-02	12	5	17
13	6	37	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	2.8678D 01	1.0000D-02	13	6	37
14	6	18	2.9000D 07	2.1130D-01	1.1000D 07	8.8955D 00	8.4169D 00	4.7860D-01	3.9500D 01	1.0000D-02	14	6	18
15	6	26	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	3.1635D 01	1.0000D-02	15	6	26
16	6	38	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	1.0126D 01	1.0000D-02	16	6	38
17	7	8	2.9000D 07	3.1710D-01	1.1000D 07	3.2151D 00	7.[illegible]000D-02	3.1440D 00	2.3507D 01	1.0000D-02	17	7	8
18	7	9	2.9000D 07	3.1810D-01	1.1000D 07	2.3616D 00	2.3226D 00	3.9000D-02	2.4583D 01	1.0000D-02	18	7	9
19	7	30	1.0500D 07	3.1024D 00	4.0000D 06	6.3667D 02	2.5940D 01	6.1073D 02	1.3960D 02	1.0000D-02	19	7	30
20	7	35	2.9000D 07	1.2446D 00	1.1000D 07	8.6407D 01	2.5[illegible]89D 01	6.1218D 01	1.8026D 01	1.0000D-02	20	7	35
21	8	10	2.9000D 07	2.3510D-01	1.1000D 07	8.7440D-01	6.7800D-01	1.9640D-01	2.2873D 01	1.0000D-02	21	8	10
22	8	15	2.9000D 07	4.6730D-01	1.1000D 07	3.7600D-01	1.8800D-01	1.8800D-01	3.8640D 01	1.0000D-02	22	8	15
23	8	30	2.9000D 07	1.3668D 00	1.1000D 07	5.2627D 00	0.0	4.2171D 00	1.4178D 02	1.0000D-02	23	8	30
24	9	10	2.9000D 07	3.0870D-01	1.1000D 07	3.7600D-02	1.8800D-02	1.8800D-02	3.0116D 01	1.0000D-02	24	9	10
25	9	11	2.9000D 07	3.6230D-01	1.1000D 07	1.9000D-01	9.5000D-02	9.5000D-02	3.3321D 01	1.0000D-02	25	9	11
26	9	12	2.9000D 07	1.2970D-01	1.1000D 07	2.4004D 00	2.3940D 00	6.4000D-03	3.2386D 01	1.0000D-02	26	9	12
27	10	11	2.9000D 07	1.2720D-01	1.1000D 07	1.9000D-01	9.5000D-02	9.5000D-02	2.8519D 01	1.0000D-02	27	10	11
28	10	13	2.9000D 07	7.8600D-02	1.1000D 07	1.0000D-02	5.0000D-03	5.0000D-03	3.6880D 01	1.0000D-02	28	10	13
29	11	12	2.9000D 07	3.6230D-01	1.1000D 07	1.9000D-01	9.5000D-02	9.5000D-02	3.3321D 01	1.0000D-02	29	11	12
30	11	13	2.9000D 07	1.2720D-01	1.1000D 07	1.9000D-01	9.5000D-02	9.5000D-02	2.8519D 01	1.0000D-02	30	11	13
31	12	13	2.9000D 07	1.7920D-01	1.1000D 07	3.6000D-02	1.8000D-02	1.8000D-02	3.0118D 01	1.0000D-02	31	12	13
32	12	14	2.9000D 07	3.1810D-01	1.1000D 07	2.3616D 00	2.3226D 00	3.9000D-02	2.4583D 01	1.0000D-02	32	12	14
33	13	15	2.9000D 07	2.3510D-01	1.1000D 07	8.7440D-01	6.7800D-01	1.9660D-01	2.2873D 01	1.0000D-02	33	13	15
34	14	15	2.9000D 07	3.1710D-01	1.1000D 07	6.3591D 00	3.2151D 00	3.1440D 00	2.3507D 01	1.0000D-02	34	14	15
35	14	40	2.9000D 07	2.9280D-01	1.1000D 07	2.1005D 00	2.0594D 00	4.1100D-02	1.3026D 01	1.0000D-02	35	14	40
36	14	28	1.0500D 07	1.0240D-01	4.0000D 06	6.3667D 02	2.5940D 01	6.1073D 02	1.3960D 02	1.0000D-02	36	14	28
37	15	41	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	2.0217D 01	1.0000D-02	37	15	41
38	15	28	2.9000D 07	1.3668D 00	1.1000D 07	5.2627D 00	0.0	4.2171D 00	1.4178D 02	1.0000D-02	38	15	28
39	16	17	2.9000D 07	6.5500D-01	1.1000D 07	8.4027D 00	7.9837D 00	4.1900D-01	2.0000D 01	1.0000D-02	39	16	17
40	16	18	2.9000D 07	1.7830D-01	1.1000D 07	3.8125D 00	3.4756D 00	3.3690D-01	3.1681D 01	1.0000D-02	40	16	18
41	16	19	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	2.4929D 01	1.0000D-02	41	16	19
42	18	42	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	1.0120D 01	1.0000D-02	42	18	42
43	18	24	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	3.1635D 01	1.0000D-02	43	18	24
44	19	20	2.9000D 07	1.2610D-01	1.1000D 07	1.5200D-02	7.6000D-03	7.6000D-03	1.9842D 01	1.0000D-02	44	19	20
45	19	21	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	2.1170D 01	1.0000D-02	45	19	21
46	21	22	2.9000D 07	6.4900D-02	1.1000D 07	5.6000D-03	2.8000D-03	2.8000D-03	1.3758D 01	1.0000D-02	46	21	22
47	21	23	2.9000D 07	1.2980D-01	1.1000D 07	2.0572D 00	1.9196D 00	1.3760D-01	3.2677D 01	1.0000D-02	47	21	23
48	23	25	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	2.2608D 01	1.0000D-02	48	23	25
49	24	25	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	2.5[illegible]D 01	1.0000D-02	49	24	25
50	24	26	2.9000D 07	2.2500D-01	1.1000D 07	9.0910D-01	6.6420D-01	2.4490D-01	1.7260D 01	1.0000D-02	50	24	26
51	25	27	2.9000D 07	1.1600D-01	1.1000D 07	1.4940D-01	1.4300D-01	6.4000D-03	1.[illegible]480D 01	1.0000D-02	51	25	27
52	26	27	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	2.5[illegible]D 01	1.0000D-02	52	26	27
53	28	29	1.0500D 07	3.1024D 00	4.0000D 06	6.3667D 02	2.5940D 01	6.1073D 02	1.[illegible]02	1.0000D-02	53	28	29
54	30	31	1.0500D 07	3.1024D 00	4.0000D 06	6.3667D 02	2.5940D 01	6.1073D 02	1.[illegible]02	1.0000D-02	54	30	31
55	32	33	2.9000D 07	1.2980D-01	1.1000D 07	2.0572D 00	1.9196D 00	1.3760D-01	3.2677D 01	1.0000D-02	55	32	33
56	22	32	2.9000D 07	6.4900D-02	1.1000D 07	5.6000D-03	2.8000D-03	2.8000D-03	1.3760D 01	1.0000D-02	56	22	32
57	23	33	2.9000D 07	1.4640D-01	1.1000D 07	5.6000D-03	2.8000D-03	2.8000D-03	3.0180D 01	1.0000D-02	57	23	33
58	27	33	2.9000D 07	6.4900D-02	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	2.2608D 01	1.0000D-02	58	27	33
59	14	35	2.9000D 07	1.2446D 00	1.1000D 07	8.6408D 01	2.5189D 01	6.1218D 01	1.8026D 01	1.0000D-02	59	14	35
60	20	34	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	1.4380D 01	1.0000D-02	60	20	34
61	7	36	2.9000D 07	1.7830D-01	1.1000D 07	3.8112D 00	3.4756D 00	3.3560D-01	1.3026D 01	1.0000D-02	61	7	36
62	8	36	2.9000D 07	1.7830D-01	1.1000D 07	3.8112D 00	3.4756D 00	3.3560D-01	2.7261D 01	1.0000D-02	62	8	36
63	36	37	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	2.7807D 01	1.0000D-02	63	36	37
64	5	37	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	3.4824D 01	1.0000D-02	64	5	37
65	8	37	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	2.0217D 01	1.0000D-02	65	8	37
66	38	39	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	1.9411D 01	1.0000D-02	66	38	39
67	33	39	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	1.0169D 01	1.0000D-02	67	33	39
68	32	38	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	4.1158D 01	1.0000D-02	68	32	38
69	32	39	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	3.3297D 01	1.0000D-02	69	32	39
70	5	38	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	3.6300D 01	1.0000D-02	70	5	38
71	18	41	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	2.8678D 01	1.0000D-02	71	18	41
72	16	40	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	2.8044D 01	1.0000D-02	72	16	40
73	15	40	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	2.7261D 01	1.0000D-02	73	15	40
74	40	41	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	2.7807D 01	1.0000D-02	74	40	41
75	16	41	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	3.4824D 01	1.0000D-02	75	16	41
76	42	43	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	1.9424D 01	1.0000D-02	76	42	43
77	23	43	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	1.0204D 01	1.0000D-02	77	23	43
78	16	42	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	3.6300D 01	1.0000D-02	78	16	42
79	21	42	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	4.1158D 01	1.0000D-02	79	21	42
80	21	43	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	3.3312D 01	1.0000D-02	80	21	43
81	1	44	1.0500D 07	9.9600D-01	1.1000D 07	6.8900D 01	1.2000D 00	6.7700D 01	6.7000D 01	1.0000D-02	81	1	44

Figure C-14. Airplane B 44 Mass, 81 Member Math Model Member Property Data.

DAMPING TERMS (LB/IN/SEC,TRANSLATIONS (1)-(3) AND LB-IN-SEC,ROTATIONS (4)-(6))

IJ	I	J	(1)	(2)	(3)	(4)	(5)	(6)
1	1	32	3.45005D 00	2.40637D-01	4.81181D-01	1.12722D 02	3.94560D 02	2.11482D 02
2	1	33	4.34597D 00	3.34311D-01	6.16531D-01	1.42727D 02	5.03212D 02	2.91959D 02
3	1	21	3.45764D 00	2.41167D-01	4.82241D-01	1.12722D 02	3.94561D 02	2.11497D 02
4	1	23	4.34597D 00	3.34311D-01	6.16531D-01	1.42727D 02	5.03212D 02	2.91963D 02
5	2	14	1.62512D 01	1.53568D 00	2.95005D-01	2.74445D 02	1.95134D 02	8.08027D 02
6	3	7	1.62512D 01	1.53568D 00	2.95005D-01	2.50923D 02	1.77882D 02	7.41580D 02
7	4	5	4.71927D 00	2.20820D-01	2.20820D-01	2.23785D 01	2.66308D 01	5.34617D 01
8	4	32	2.50489D 00	1.38020D-01	1.38020D-01	6.61784D 00	2.34657D 01	2.00876D 01
9	4	20	2.99425D 00	1.28337D-01	1.28337D-01	1.17138D 01	2.26006D 01	2.00152D 01
10	5	6	5.03911D 00	7.55918D-01	2.43264D 00	2.26820D 02	3.53769D 02	2.08895D 02
11	5	36	6.28156D 00	2.90708D-01	2.05781D 00	2.22085D 02	3.50637D 02	1.02154D 02
12	5	17	1.36258D 01	1.88688D 00	8.23642D 00	2.05164D 02	1.26723D 03	3.05335D 02
13	6	37	2.96701D 00	1.20681D-01	1.20681D-01	1.90203D 01	2.63014D 01	4.30341D 01
14	6	18	3.39561D 00	4.48176D-01	1.87948D 00	1.25417D 02	3.21590D 02	9.03753D 01
15	6	26	2.80494D 00	1.03425D-01	1.03425D-01	7.20225D 00	1.74769D 01	1.67727D 01
16	6	38	4.68938D 00	5.40515D-01	5.40515D-01	1.08024D 01	3.32436D 01	2.92717D 01
17	7	8	7.80289D 00	3.62075D 00	5.44493D-01	3.63706D 02	1.84646D 02	6.52484D 02
18	7	9	6.01189D 00	2.96630D-01	2.28913D 00	2.42687D 02	5.50874D 02	9.73692D 01
19	7	30	6.29746D 00	2.19248D 00	4.51852D-01	8.42203D 02	1.37308D 03	6.73345D 03
20	7	35	1.47916D 01	1.99357D 01	1.27878D 01	1.13163D 03	3.01148D 03	4.32409D 03
21	8	10	7.67039D 00	1.06179D 00	1.97279D 00	1.35558D 02	2.11748D 02	2.21526D 02
22	8	15	7.58950D 00	4.31567D-01	4.31567D-01	3.07907D 01	2.48673D 02	2.48646D 02
23	8	30	7.06546D 00	3.03238D-01	0.0	9.58246D 01	0.0	9.08627D 02
24	9	10	6.40598D 00	1.81827D-01	1.81827D-01	1.27954D 01	1.53545D 01	3.09496D 01
25	9	11	1.37871D 01	7.33971D-01	7.33971D-01	8.66849D 01	1.87903D 02	2.05758D 02
26	9	12	3.77277D 00	8.96591D-02	1.73407D 00	1.43563D 02	3.27579D 02	1.96497D 01
27	10	11	9.48321D 00	9.95459D-01	9.95459D-01	8.98117D 01	2.04356D 02	2.36720D 02
28	10	13	3.58289D 00	8.48802D-02	8.48802D-02	6.82246D 00	7.52018D 00	1.47434D 01
29	11	12	1.46405D 01	7.79402D-01	7.79402D-01	9.05231D 01	1.99839D 02	2.13553D 02
30	11	13	9.32629D 00	9.78986D-01	9.78986D-01	8.93054D 01	2.03056D 02	2.35515D 02
31	12	13	5.75842D 00	2.09910D-01	2.09910D-01	1.57208D 01	2.98494D 01	4.37382D 01
32	12	14	8.06310D 00	3.97838D-01	3.07016D 00	2.87565D 02	7.40121D 02	1.14380D 02
33	13	15	7.21337D 00	9.99032D-01	1.85525D 00	1.70947D 02	1.99341D 02	2.71542D 02
34	14	15	7.80289D 00	3.62075D 00	3.66146D 00	6.09078D 02	1.47173D 03	7.25099D 02
35	14	40	7.68555D 00	7.65730D-01	5.42032D 00	4.10554D 02	8.16568D 02	1.73300D 02
36	14	28	1.14411D 00	2.19248D 00	4.51852D-01	9.00938D 02	1.41010D 03	6.67786D 03
37	15	41	4.56467D 00	2.63376D-01	2.63376D-01	4.12763D 01	3.41537D 01	9.40164D 01
38	15	28	7.06546D 00	3.03238D-01	0.0	9.85263D 01	0.0	9.56292D 02
39	16	17	1.36206D 01	1.88688D 00	8.23642D 00	2.20201D 02	1.38435D 03	3.33089D 02
40	16	18	4.86770D 00	7.31617D-01	2.34989D 00	2.48525D 02	3.87527D 02	2.29408D 02
41	16	19	4.71927D 00	2.20820D-01	2.20820D-01	2.44491D 01	2.86909D 01	5.84641D 01
42	18	42	4.19825D 00	4.83905D-01	4.83905D-01	1.14639D 01	3.47935D 01	3.09549D 01
43	18	24	2.54306D 00	9.37688D-02	9.37688D-02	7.60284D 00	1.83128D 01	1.81196D 01
44	19	20	2.99425D 00	1.28337D-01	1.28337D-01	1.17135D 01	2.26019D 01	1.99654D 01
45	19	21	2.52964D 00	1.39382D-01	1.39382D-01	6.61992D 00	2.34654D 01	2.00637D 01
46	21	22	2.11792D 00	1.10765D-01	1.10765D-01	7.05280D 00	9.99972D 00	1.39376D 01
47	21	23	1.83577D 00	2.00371D-01	7.48396D-01	7.42279D 01	1.29568D 02	6.65732D 01
48	23	25	1.98662D 00	1.02499D-01	1.02499D-01	9.11420D 00	1.18733D 01	2.18470D 01
49	24	25	1.92271D 00	8.74036D-02	8.74036D-02	6.75585D 00	1.58725D 01	1.41422D 01
50	24	26	3.51478D 00	7.40243D-01	1.21907D 00	5.32534D 01	1.56802D 02	7.45465D 01
51	25	27	1.74765D 00	1.05491D-01	4.98650D-01	1.50164D 01	3.40107D 01	1.04151D 01
52	26	27	1.92449D 00	8.74847D-02	8.74847D-02	6.75585D 00	1.58725D 01	1.41416D 01
53	28	29	5.65288D 00	2.34806D 00	4.83916D-01	6.30721D 02	1.31687D 03	6.61125D 03
54	30	31	5.65288D 00	2.34806D 00	4.83916D-01	6.30721D 02	1.31687D 03	6.61124D 03
55	32	33	1.81615D 00	1.98231D-01	7.40403D-01	7.42279D 01	1.29568D 02	6.65733D 01
56	22	32	2.09759D 00	1.09686D-01	1.09686D-01	7.05229D 00	9.99899D 00	1.39366D 01
57	23	33	2.04763D 00	3.25036D-02	3.25036D-02	4.41067D 00	5.05079D 00	9.36165D 00
58	27	33	1.32304D 00	1.02524D-01	1.02524D-01	9.11420D 00	1.18733D 01	2.18470D 01
59	14	35	1.47916D 01	1.99357D 01	1.27879D 01	1.25454D 03	3.34903D 03	4.78709D 03
60	20	34	7.82763D 00	6.34553D-01	6.34553D-01	3.92342D 01	1.01040D 02	6.11976D 01
61	7	36	5.99743D 00	2.18809D 00	7.04157D 00	5.13112D 02	9.75978D 02	4.61757D 02
62	8	36	4.33806D 00	7.56267D-01	2.43377D 00	3.20937D 02	4.13756D 02	3.11090D 02
63	36	37	2.28504D 00	9.58536D-02	9.58536D-02	2.56347D 01	3.25735D 01	6.02477D 01
64	5	37	3.98596D 00	1.33515D-01	1.33515D-01	2.52627D 01	2.81794D 01	5.78238D 01
65	8	37	4.56467D 00	2.63376D-01	2.63376D-01	3.51031D 01	3.30262D 01	7.96907D 01
66	38	39	2.09695D 00	1.26010D-01	1.26010D-01	6.02558D 00	2.55327D 01	1.92586D 01
67	33	39	3.22786D 00	3.70278D-01	3.70278D-01	1.01398D 01	3.73447D 01	3.34626D 01
68	32	38	1.56632D 00	4.43912D-02	4.43912D-02	5.99036D 00	1.88406D 01	1.35800D 01
69	32	39	1.74143D 00	6.10060D-02	6.10060D-02	7.77647D 00	1.93980D 01	1.40747D 01
70	5	38	3.79705D 00	1.22015D-01	1.22015D-01	1.93384D 01	2.45207D 01	4.20937D 01
71	18	41	2.69497D 00	1.09616D-01	1.09616D-01	1.91490D 01	2.70276D 01	4.34452D 01
72	16	40	4.44174D 00	1.84752D-01	1.84752D-01	2.94409D 01	3.29673D 01	6.86685D 01
73	15	40	3.93089D 00	1.68197D-01	1.68197D-01	3.53130D 01	2.96266D 01	8.14251D 01
74	40	41	2.28504D 00	9.58536D-02	9.58536D-02	2.56347D 01	3.25735D 01	6.01991D 01
75	16	41	3.98596D 00	1.33515D-01	1.33515D-01	2.66913D 01	2.95089D 01	6.16363D 01
76	42	43	2.09630D 00	1.25892D-01	1.25892D-01	6.03285D 00	2.55131D 01	1.92499D 01
77	23	43	3.22233D 00	3.68377D-01	3.68377D-01	1.01853D 01	3.71883D 01	3.34159D 01
78	16	42	3.79705D 00	1.22015D-01	1.22015D-01	2.11051D 01	2.62201D 01	4.67178D 01
79	21	42	1.58666D 00	4.49675D-02	4.49675D-02	5.99037D 00	1.88405D 01	1.36420D 01
80	21	43	1.76365D 00	6.17566D-02	6.17566D-02	7.77606D 00	1.93375D 01	1.47303D 01
81	1	44	4.90618D 00	2.25999D 00	3.00887D-01	4.89783D 02	1.25658D 02	7.79150D 02

Figure C-15. Airplane B 44 Mass, 81 Member Math Model Damping Data.

BEAM UNCOUPLED,UNDAMPED FREQUENCIES (CPS)

IJ	I	J	(1)	(2)	(3)	(4)	(5)	(6)
1	1	32	7.7778D 01	5.4249D 00	1.0848D 01	2.9558D 01	6.9712D 01	3.2365D 01
2	1	33	9.7169D 01	7.4747D 00	1.3785D 01	3.8050D 01	8.6769D 01	4.4031D 01
3	1	21	7.7607D 01	5.4130D 00	1.0824D 01	2.9558D 01	6.9712D 01	3.2365D 01
4	1	23	9.7169D 01	7.4747D 00	1.3785D 01	3.8050D 01	8.6769D 01	4.4031D 01
5	2	14	4.5117D 02	4.2634D 01	8.1900D 00	1.3028D 01	1.1519D 01	4.6738D 01
6	3	7	4.5117D 02	4.2634D 01	8.1900D 00	1.4299D 01	1.2449D 01	5.1244D 01
7	4	5	1.1487D 02	5.3750D 00	5.3750D 00	2.0705D 00	9.4646D 00	4.5985D 00
8	4	32	2.5485D 02	1.4043D 01	1.4043D 01	8.4279D 00	1.2265D 01	1.4405D 01
9	4	20	1.9593D 02	8.3980D 00	8.3980D 00	2.9900D 00	4.8351D 00	7.5155D 00
10	5	6	1.0310D 02	1.5466D 01	4.9771D 01	1.9478D 01	1.1467D 02	1.7846D 01
11	5	36	1.5344D 02	7.1009D 00	5.0265D 01	1.1799D 01	7.7595D 01	5.2973D 00
12	5	17	2.2204D 02	3.0748D 01	1.3422D 02	3.6745D 01	2.2696D 02	2.5335D 01
13	6	37	1.5883D 02	6.4602D 00	6.4602D 00	2.1307D 00	8.1266D 00	4.9673D 00
14	6	18	1.4543D 02	1.9194D 01	8.0494D 01	7.7453D 01	1.9860D 02	4.9503D 01
15	6	26	1.5230D 02	5.6157D 00	5.6157D 00	5.0218D 00	1.0767D 01	1.1950D 01
16	6	38	2.8478D 02	3.2824D 01	3.2824D 01	1.1387D 01	1.7625D 01	2.0653D 01
17	7	8	1.5959D 02	7.4055D 01	1.1136D 01	1.2525D 01	1.1421D 01	4.2239D 01
18	7	9	1.9869D 02	9.8034D 00	7.5654D 01	1.3734D 01	6.3546D 01	6.0659D 00
19	7	30	1.1795D 02	4.1064D 01	8.4629D 00	2.7600D 01	4.5991D 01	8.6782D 01
20	7	35	4.3090D 02	5.8075D 02	3.7253D 02	9.7718D 01	2.6005D 02	2.9000D 02
21	8	10	1.2370D 02	1.7124D 01	3.1816D 01	9.8783D 00	5.1781D 01	1.4301D 01
22	8	15	1.4710D 02	8.3645D 00	8.3645D 00	3.1462D 00	2.5409D 01	7.2252D 00
23	8	30	1.2596D 02	5.4059D 00	0.0	4.2511D 00	0.0	1.2007D 01
24	9	10	1.4770D 02	4.1923D 00	4.1923D 00	6.5371D 00	7.4449D 00	7.8469D 00
25	9	11	7.2802D 01	3.8757D 00	3.8757D 00	2.6178D 00	5.3740D 00	4.7954D 00
26	9	12	9.8008D 01	2.3291D 00	4.5047D 01	2.5697D 01	5.8635D 01	3.7141D 00
27	10	11	4.3416D 01	4.5574D 00	4.5574D 00	2.8204D 00	5.6949D 00	5.1245D 00
28	10	13	5.4911D 01	1.3009D 00	1.3009D 00	2.8990D 00	3.1954D 00	3.3954D 00
29	11	12	6.8558D 01	3.6496D 00	3.6498D 00	2.4888D 00	5.0241D 00	4.6646D 00
30	11	13	4.4147D 01	4.6341D 00	4.6341D 00	2.8244D 00	5.7504D 00	5.1498D 00
31	12	13	9.5382D 01	3.4769D 00	3.4769D 00	3.2196D 00	5.0408D 00	6.1211D 00
32	12	14	1.4814D 02	7.3095D 00	5.6408D 01	1.1578D 01	4.7227D 01	5.1732D 00
33	13	15	1.3154D 02	1.8218D 01	3.3832D 01	7.8308D 00	5.5115D 01	1.1683D 01
34	14	15	1.5959D 02	7.4055D 01	7.4887D 01	1.4861D 01	6.9157D 01	3.5471D 01
35	14	40	2.6998D 02	2.6899D 01	1.9041D 02	1.3739D 01	7.1644D 01	6.7232D 00
36	14	28	2.1428D 01	4.1064D 01	8.4629D 00	2.6876D 01	4.2909D 01	8.4961D 01
37	15	41	1.4645D 02	8.4498D 00	8.4498D 00	1.3928D 00	8.8795D 00	3.2254D 00
38	15	28	1.2596D 02	5.4059D 00	0.0	4.0276D 00	0.0	1.1408D 01
39	16	17	2.2196D 02	3.0748D 01	1.3422D 02	3.3636D 01	2.1146D 02	2.3224D 01
40	16	18	1.0673D 02	1.6041D 01	5.1524D 01	1.7779D 01	1.0468D 02	1.6322D 01
41	16	19	1.1487D 02	5.3750D 00	5.3750D 00	1.8951D 00	8.7937D 00	4.2036D 00
42	18	42	3.1809D 02	3.6664D 01	3.6664D 01	1.0683D 01	1.6859D 01	1.9536D 01
43	18	24	1.6798D 02	6.1940D 00	6.1940D 00	4.8760D 00	1.0277D 01	1.1277D 01
44	19	20	1.9593D 02	8.3980D 00	8.3980D 00	2.9897D 00	4.8351D 00	7.5206D 00
45	19	21	2.5236D 02	1.3905D 01	1.3905D 01	8.4251D 00	1.2265D 01	1.4422D 01
46	21	22	2.0561D 02	1.0753D 01	1.0753D 01	3.2727D 00	4.6401D 00	5.3917D 00
47	21	23	1.9974D 02	2.1802D 01	8.1430D 01	5.3368D 01	8.7224D 01	2.4944D 01
48	23	25	3.0089D 02	1.5524D 01	1.5524D 01	9.9439D 00	1.2315D 01	1.3065D 01
49	24	25	2.7392D 02	1.2452D 01	1.2452D 01	6.7045D 00	1.5047D 01	1.6897D 01
50	24	26	3.4437D 02	7.2528D 01	1.1944D 02	3.2837D 01	9.6687D 01	7.0689D 01
51	25	27	4.5454D 02	2.7437D 01	1.2969D 02	3.6250D 01	8.2104D 01	1.6832D 01
52	26	27	2.7367D 02	1.2441D 01	1.2441D 01	6.7045D 00	1.5047D 01	1.6897D 01
53	28	29	1.5677D 02	6.5117D 01	1.3420D 01	3.4305D 01	7.9646D 01	1.0495D 02
54	30	31	1.5677D 02	6.5117D 01	1.3420D 01	3.4305D 01	7.9646D 01	1.0495D 02
55	32	33	2.0190D 02	2.2037D 01	8.2310D 01	5.3368D 01	8.7224D 01	2.4944D 01
56	22	32	2.0757D 02	1.0854D 01	1.0854D 01	3.2725D 00	4.6398D 00	5.3913D 00
57	23	33	2.1869D 02	3.4714D 00	3.4714D 00	2.9537D 00	3.3824D 00	3.6595D 00
58	27	33	2.0029D 02	1.5521D 01	1.5521D 01	9.9439D 00	1.2315D 01	1.3065D 01
59	14	35	4.3090D 02	5.8075D 02	3.7253D 02	8.7870D 01	2.3457D 02	2.6195D 02
60	20	34	1.2014D 02	9.7455D 00	9.7455D 00	3.0332D 00	4.2185D 00	4.7312D 00
61	7	36	2.1068D 02	7.6864D 01	2.4736D 02	1.9946D 01	1.0117D 02	2.0603D 01
62	8	36	1.3918D 02	2.4263D 01	7.8082D 01	1.5109D 01	1.1441D 02	1.4735D 01
63	36	37	2.1269D 02	8.9220D 00	8.9220D 00	1.5839D 00	6.8784D 00	3.7511D 00
64	5	37	9.7362D 01	3.2613D 00	3.2613D 00	1.3312D 00	6.2517D 00	3.0211D 00
65	8	37	1.4645D 02	8.4498D 00	8.4498D 00	1.6376D 00	9.1820D 00	3.8055D 00
66	38	39	3.3201D 02	1.9951D 01	1.9951D 01	1.0178D 01	1.2303D 01	1.6350D 01
67	33	39	4.1174D 02	4.7232D 01	4.7232D 01	1.3147D 01	1.5404D 01	1.7956D 01
68	32	38	2.0963D 02	5.9413D 00	5.9413D 00	6.3949D 00	7.8823D 00	9.0693D 00
69	32	39	2.3307D 02	8.1650D 00	8.1650D 00	7.1098D 00	8.7635D 00	1.0083D 01
70	5	38	9.8050D 01	3.1508D 00	3.1508D 00	1.7224D 00	7.2449D 00	3.7445D 00
71	18	41	1.7486D 02	7.1123D 00	7.1123D 00	2.1165D 00	7.9083D 00	4.9201D 00
72	16	40	1.0850D 02	4.5128D 00	4.5128D 00	1.4068D 00	6.6528D 00	3.1828D 00
73	15	40	1.2611D 02	5.3962D 00	5.3962D 00	1.1994D 00	7.6466D 00	2.7776D 00
74	40	41	2.1269D 02	8.9220D 00	8.9220D 00	1.5839D 00	6.8784D 00	3.7511D 00
75	16	41	9.7362D 01	3.2613D 00	3.2613D 00	1.2625D 00	5.9701D 00	2.8562D 00
76	42	43	3.3191D 02	1.9933D 01	1.9933D 01	1.0175D 01	1.2299D 01	1.6345D 01
77	23	43	4.1104D 02	4.6990D 01	4.6990D 01	1.3125D 01	1.5378D 01	1.7925D 01
78	16	42	9.8050D 01	3.1508D 00	3.1508D 00	1.5755D 00	6.7999D 00	3.4323D 00
79	21	42	2.0695D 02	5.8651D 00	5.8651D 00	6.3949D 00	7.8823D 00	9.0693D 00
80	21	43	2.3003D 02	8.0549D 00	8.0549D 00	7.1082D 00	8.7616D 00	1.0081D 01
81	1	44	1.0944D 02	5.0413D 01	6.7117D 00	9.6730D 01	2.0592D 01	1.5388D 02

Figure C-16. Airplane B 44 Mass, 81 Member Math Model Frequency Data.

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VEHICLE INITIAL CONDITIONS

VEHICLE TRANSLATIONAL VELOCITIES IN GROUND AXES (IN/SEC)
VEHICLE ROTATIONAL VELOCITIES IN VEHICLE AXES (RAD/SEC)
EULER ANGLES OF VEHICLE RELATIVE TO GROUND (RADIANS)

        XGDOT                YGDOT                ZGDOT
          P'                   Q'                   R'
         PHI'                THETA'                PSI'

     4.550000D 01          0.0                  1.020000D 02
     0.0                  -1.560000D 00         0.0
     0.0                  -2.830000D 00         0.0

GENERALIZED SURFACE DATA

BETA =    0.0 DEGREES
XGIN =    0.0
ZGIN =    0.0
MODEL PARAMETERS

VEHICLE WT = 2.476790D 03

VEHICLE CG POSITION
X (FS) =  4.06266D 01
Y (BL) = -2.44865D-01
Z (WL) =  2.18869D 00

VEHICLE CG INITIAL GROUND COORDINATES
XCG IS THE DISTANCE FROM SLOPE/GROUND INTERSECTION TO VEHICLE CG,+FORWARD
ZCG IS THE DISTANCE FROM GROUND PLANE TO VEHICLE CG,+DOWN
XCG =  0.0
ZCG = -4.08812D 01

VEHICLE INERTIAS (IN-LB-SEC**2)
I(XX) = 1.76551D 04
I(YY) = 2.60677D 04
I(ZZ) = 3.95496D 04
```

Figure C-17. Airplane B 44 Mass, 81 Member, Math Model Initial Conditions, Overall Mass, and c.g. Properties

MASS DATA

	WEIGHTS	MASS COORDINATES F.S.,W.L.,B.L.			MASS MOMENTS OF INERTIA (LB-IN-SEC**2)		
I	W	X''	Y''	Z''	IX	IY	IZ
1	1.23300D 02	2.33187D 02	0.0	1.50000D 01	2.66930D 01	3.43600D 01	4.26600D 01
2	3.97000D 01	1.73770D 01	-4.04250D 01	-4.71650D 01	2.31000D 01	2.47700D 01	1.64670D 01
3	3.97000D 01	1.73770D 01	4.04250D 01	-4.71650D 01	2.31000D 01	2.47700D 01	1.64670D 01
4	6.39000D 01	8.92500D 01	0.0	-8.96300D 00	2.68390D 01	5.26800D 01	2.12660D 01
5	3.07700D 02	6.45700D 01	0.0	-1.02750D 01	1.87060D 02	4.35300D 01	2.05700D 01
6	8.17600D 01	7.20900D 01	0.0	2.05000D 01	1.04600D 01	1.58660D 01	1.45280D 01
7	1.53380D 02	2.35700D 01	0.0	-1.15000D 01	3.11592D 02	1.32680D 02	2.61430D 02
8	1.58480D 02	2.35700D 01	0.0	1.45540D 01	2.73917D 02	2.21430D 01	2.73857D 02
9	1.18240D 02	8.75000D-01	0.0	-1.81850D 01	3.12800D 01	6.31870D 01	4.21010D 01
10	2.00420D 02	8.75000D-01	0.0	1.18490D 01	8.99000D 00	3.90140D 01	3.45540D 01
11	5.59700D 02	-1.50320D 01	0.0	4.07200D 00	2.28536D 02	2.79388D 02	3.53610D 02
12	4.48000D 01	1.10180D 02	0.0	-7.85000D 00	1.37850D 01	3.85520D 01	3.02790D 01
13	3.13800D 01	8.46300D 01	0.0	4.73100D 01	1.36890D 01	1.21670D 01	8.39300D 00
14	1.18200D 01	1.10180D 02	0.0	4.58100D 01	2.34900D 00	4.62400D 00	4.92400D 00
15	9.30600D 01	3.35800D 01	1.21066D 02	-2.50000D 00	4.68000D 02	3.54000D 01	5.02000D 02
16	1.77000D 01	4.30000D 01	2.36980D 02	1.04500D 01	4.50000D-01	1.78000D 00	2.15000D 00
17	9.30600D 01	3.35800D 01	-1.21066D 02	-2.50000D 00	4.68000D 02	3.54000D 01	5.02000D 02
18	1.77000D 01	4.30000D 01	-2.36980D 02	1.04500D 01	4.50000D-01	1.78000D 00	2.15000D 00
19	3.30000D 01	3.65700D 01	0.0	-9.40000D 00	1.32600D 02	3.70740D 01	1.24660D 02
20	3.30000D 01	4.35700D 01	0.0	1.75000D 01	1.32600D 02	3.70720D 01	1.24660D 02
21	1.94000D 01	8.15400D 01	0.0	2.16000D 01	4.60000D 00	1.66000D 01	9.40000D 00
22	1.94000D 01	1.00700D 02	0.0	2.37000D 01	4.60000D 00	1.66000D 01	9.40000D 00
23	1.70000D 02	8.08700D 01	0.0	1.20000D 01	4.90000D 01	1.47000D 02	1.33000D 02
24	2.86000D 01	1.10180D 02	0.0	2.48000D 01	5.92500D 00	2.38280D 01	2.03550D 01
25	1.47000D 01	2.33200D 02	0.0	7.70000D 01	6.40000D 00	1.42000D 01	6.40000D 00

Figure C-18. Airplane B 25 Mass, 38 Member Math Model Mass Data

BEAM			MODULUS OF ELASTICITY	AREA	MODULUS OF RIGIDITY	MOMENTS OF INERTIA			LENGTH	DAMPING RATIO
IJ	I	J	E	A	G	JX	I(YY)	I(ZZ)	XLB	CBAR
1	1	12	1.0500D 07	2.0200D 00	4.0000D 06	6.4880D 01	5.1900D 01	1.2980D 01	1.2511D 02	1.0000D-02
2	1	24	1.0500D 07	3.1414D 00	4.0000D 06	1.0536D 02	8.1420D 01	2.3940D 01	1.2340D 02	1.0000D-02
3	2	7	3.0000D 07	3.4362D 00	1.1000D 07	5.3106D 00	1.8900D-01	5.1216D 00	5.4263D 01	1.0000D-02
4	3	7	3.0000D 07	3.4362D 00	1.1000D 07	5.3106D 00	1.8900D-01	5.1216D 00	5.4263D 01	1.0000D-02
5	4	5	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	2.4715D 01	1.0000D-02
6	4	12	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	2.0960D 01	1.0000D-02
7	4	23	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	2.2576D 01	1.0000D-02
8	5	6	2.9000D 07	3.5660D-01	1.1000D 07	7.6224D 00	6.9512D 00	6.7120D-01	3.1680D 01	1.0000D-02
9	5	19	2.9000D 07	5.8560D-01	1.1000D 07	4.2000D 00	4.1188D 00	8.1200D-02	7.8014D 01	1.0000D-02
10	5	20	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	3.4820D 01	1.0000D-02
11	5	21	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	3.6111D 01	1.0000D-02
12	6	13	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	2.9598D 01	1.0000D-02
13	6	20	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	2.8677D 01	1.0000D-02
14	6	21	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	9.5138D 00	1.0000D-02
15	7	8	2.9000D 07	6.3400D-01	1.1000D 07	3.2111D 00	7.1100D-02	3.1400D 00	2.6054D 01	1.0000D-02
16	7	9	2.9000D 07	6.3400D-01	1.1000D 07	4.7232D 00	4.6452D 00	7.8000D-02	2.3659D 01	1.0000D-02
17	7	15	1.0500D 07	3.1024D 00	4.0000D 06	6.3667D 02	2.5940D 01	6.1073D 02	1.2181D 02	1.0000D-02
18	7	17	1.0500D 07	3.1024D 00	4.0000D 06	6.3667D 02	2.5940D 01	6.1073D 02	1.2181D 02	1.0000D-02
19	7	19	2.9000D 07	3.5660D-01	1.1000D 07	7.6242D 00	6.9512D 00	6.7300D-01	1.3169D 01	1.0000D-02
20	8	10	2.9000D 07	4.7020D-01	1.1000D 07	1.7498D 00	1.3560D 00	3.9380D-01	2.2856D 01	1.0000D-02
21	8	15	2.9000D 07	1.3700D 00	1.1000D 07	5.2626D 00	0.0	4.2170D 00	1.2267D 02	1.0000D-02
22	8	17	2.9000D 07	1.3700D 00	1.1000D 07	5.2626D 00	0.0	4.2170D 00	1.2267D 02	1.0000D-02
23	8	20	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	2.0210D 01	1.0000D-02
24	9	10	2.9000D 07	6.1740D-01	1.1000D 07	7.5200D-02	3.7600D-02	3.7600D-02	3.0034D 01	1.0000D-02
25	9	11	2.9000D 07	7.2460D-01	1.1000D 07	1.1400D 00	5.7000D-01	5.7000D-01	2.7357D 01	1.0000D-02
26	10	11	2.9000D 07	7.2460D-01	1.1000D 07	1.1400D 00	5.7000D-01	5.7000D-01	1.7766D 01	1.0000D-02
27	12	21	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	4.1080D 01	1.0000D-02
28	12	22	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	3.2943D 01	1.0000D-02
29	12	24	2.9000D 07	2.5960D-01	1.1000D 07	4.1144D 00	3.8392D 00	2.7520D-01	3.2650D 01	1.0000D-02
30	13	14	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	2.5594D 01	1.0000D-02
31	14	24	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	2.1010D 01	1.0000D-02
32	15	16	1.0500D 07	3.1024D 00	4.0000D 06	6.3667D 02	2.5940D 01	6.1073D 02	1.1701D 02	1.0000D-02
33	17	18	1.0500D 07	3.1024D 00	4.0000D 06	6.3667D 02	2.5940D 01	6.1073D 02	1.1701D 02	1.0000D-02
34	19	20	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	2.7796D 01	1.0000D-02
35	21	22	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	1.9275D 01	1.0000D-02
36	8	19	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	2.7254D 01	1.0000D-02
37	22	24	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	9.5436D 00	1.0000D-02
38	1	25	1.0500D 07	9.9060D-01	4.0000D 06	7.0120D 01	1.2000D 00	6.8920D 01	6.2000D 01	1.0000D-02

Figure C-19. Airplane B 25 Mass, 38 Member Math Model Member Property Data

BEAM			MODULUS OF ELASTICITY	AREA	MODULUS OF RIGIDITY	MOMENTS OF INERTIA			LENGTH	DAMPING RATIO
IJ	I	J	E	A	G	JX	I(YY)	I(ZZ)	XLB	CBAR
1	1	12	1.0500D 07	2.0200D 00	4.0000D 06	6.4880D 01	5.1900D 01	1.2980D 01	1.2511D 02	1.0000D-02
2	1	24	1.0500D 07	3.1414D 00	4.0000D 06	1.0536D 02	8.1420D 01	2.3940D 01	1.2340D 02	1.0000D-02
3	2	7	3.0000D 07	3.4362D 00	1.1000D 07	5.3106D 00	1.8900D-01	5.1216D 00	5.4263D 01	1.0000D-02
4	3	7	3.0000D 07	3.4362D 00	1.1000D 07	5.3106D 00	1.8900D-01	5.1216D 00	5.4263D 01	1.0000D-02
5	4	5	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	2.4715D 01	1.0000D-02
6	4	12	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	2.0960D 01	1.0000D-02
7	4	23	2.9000D 07	1.4640D-01	1.1000D 07	3.3200D-02	1.6600D-02	1.6600D-02	2.2576D 01	1.0000D-02
8	5	6	2.9000D 07	3.5660D-01	1.1000D 07	7.6224D 00	6.9512D 00	6.7120D-01	3.1680D 01	1.0000D-02
9	5	19	2.9000D 07	5.8560D-01	1.1000D 07	4.2000D 00	4.1188D 00	8.1200D-02	2.8014D 01	1.0000D-02
10	5	20	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	3.4820D 01	1.0000D-02
11	5	21	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	3.6111D 01	1.0000D-02
12	6	13	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	2.9598D 01	1.0000D-02
13	6	20	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	2.8677D 01	1.0000D-02
14	6	21	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	9.5138D 00	1.0000D-02
15	7	8	2.9000D 07	6.3400D-01	1.1000D 07	3.2111D 00	7.1100D-02	3.1400D 00	2.6054D 01	1.0000D-02
16	7	9	2.9000D 07	6.3400D-01	1.1000D 07	4.7232D 00	4.6452D 00	7.8000D-02	2.3659D 01	1.0000D-02
17	7	15	1.0500D 07	3.1024D 00	4.0000D 06	6.3667D 02	2.5940D 01	6.1073D 02	1.2181D 02	1.0000D-02
18	7	17	1.0500D 07	3.1024D 00	4.0000D 06	6.3667D 02	2.5940D 01	6.1073D 02	1.2181D 02	1.0000D-02
19	7	19	2.9000D 07	3.5660D-01	1.1000D 07	7.6242D 00	6.9512D 00	6.7300D-01	1.3169D 01	1.0000D-02
20	8	10	2.9000D 07	4.7020D-01	1.1000D 07	1.7498D 00	1.3560D 00	3.9380D-01	2.2856D 01	1.0000D-02
21	8	15	2.9000D 07	1.3700D 00	1.1000D 07	5.2626D 00	0.0	4.2170D 00	1.2267D 02	1.0000D-02
22	8	17	2.9000D 07	1.3700D 00	1.1000D 07	5.2626D 00	0.0	4.2170D 00	1.2267D 02	1.0000D-02
23	8	20	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	2.0216D 01	1.0000D-02
24	9	10	2.9000D 07	6.1740D-01	1.1000D 07	7.5200D-02	3.7600D-02	3.7600D-02	3.0034D 01	1.0000D-02
25	9	11	2.9000D 07	7.2460D-01	1.1000D 07	1.1400D 00	5.7000D-01	5.7000D-01	2.7357D 01	1.0000D-02
26	10	11	2.9000D 07	7.2460D-01	1.1000D 07	1.1400D 00	5.7000D-01	5.7000D-01	1.7766D 01	1.0000D-02
27	12	21	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	4.1080D 01	1.0000D-02
28	12	22	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	3.2943D 01	1.0000D-02
29	12	24	2.9000D 07	2.5960D-01	1.1000D 07	4.1144D 00	3.8392D 00	2.7520D-01	3.2650D 01	1.0000D-02
30	13	14	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	2.5594D 01	1.0000D-02
31	14	24	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	2.1010D 01	1.0000D-02
32	15	16	1.0500D 07	3.1024D 00	4.0000D 06	6.3667D 02	2.5940D 01	6.1073D 02	1.1701D 02	1.0000D-02
33	17	18	1.0500D 07	3.1024D 00	4.0000D 06	6.3667D 02	2.5940D 01	6.1073D 02	1.1701D 02	1.0000D-02
34	19	20	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	2.7796D 01	1.0000D-02
35	21	22	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	1.9275D 01	1.0000D-02
36	8	19	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	2.7254D 01	1.0000D-02
37	22	24	2.9000D 07	2.9280D-01	1.1000D 07	6.6400D-02	3.3200D-02	3.3200D-02	9.5436D 00	1.0000D-02
38	1	25	1.0500D 07	9.9060D-01	4.0000D 06	7.0120D 01	1.2000D 00	6.8920D 01	6.2000D 01	1.0000D-02

Figure C-19. Airplane B 25 Mass, 38 Member Math Model Member Property Data

DAMPING TERMS (LB/IN/SEC,TRANSLATIONS (1)-(3) AND LB-IN-SEC,ROTATIONS (4)-(6))

IJ	I	J	(1)	(2)	(3)	(4)	(5)	(6)
1	1	12	5.43588D 00	3.81527D-01	7.62907D-01	1.85699D 02	7.12836D 02	3.53896D 02
2	1	24	6.49108D 00	5.03042D-01	9.27700D-01	2.11713D 02	8.03128D 02	4.52507D 02
3	2	7	1.94968D 01	1.51953D 00	2.91902D-01	3.01993D 02	2.35108D 02	1.01564D 03
4	3	7	1.94968D 01	1.51953D 00	2.91902D-01	3.01993D 02	2.35108D 02	1.01535D 03
5	4	5	1.15025D 01	5.42884D-01	5.42884D-01	5.02277D 01	7.74389D 01	5.13614D 01
6	4	12	6.75827D 00	3.76121D-01	3.76121D-01	2.38054D 01	8.18861D 01	6.15331D 01
7	4	23	6.75165D 00	3.48850D-01	3.48850D-01	3.04678D 01	8.25387D 01	5.43704D 01
8	5	6	1.14782D 01	1.72190D 00	5.54130D 00	2.16437D 02	7.77628D 02	4.30322D 02
9	5	19	1.46301D 01	6.73669D-01	4.79793D 00	4.59086D 02	7.41545D 02	1.39841D 02
10	5	20	9.27902D 00	3.10845D-01	3.10845D-01	4.18436D 01	5.97152D 01	1.06467D 02
11	5	21	8.92798D 00	2.88396D-01	2.88396D-01	2.30517D 01	5.06471D 01	8.15650D 01
12	6	13	5.79977D 00	2.28574D-01	2.28574D-01	1.51139D 01	3.81974D 01	3.52904D 01
13	6	20	5.93414D 00	2.41375D-01	2.41375D-01	3.81712D 01	5.33264D 01	8.64819D 01
14	6	21	9.67296D 00	1.18599D 00	1.18599D 00	2.15898D 01	7.25045D 01	6.20905D 01
15	7	8	1.51020D 01	4.46859D 00	6.72420D-01	5.38777D 02	1.40015D 02	1.80948D 03
16	7	9	1.47902D 01	7.59571D-01	5.86170D 00	5.46277D 02	1.33560D 03	2.16593D 02
17	7	15	8.26422D 00	3.29745D 00	6.79576D-01	1.21132D 03	1.66559D 03	8.00201D 03
18	7	17	8.26422D 00	3.29745D 00	6.79576D-01	1.21132D 03	1.66559D 03	8.00200D 03
19	7	19	1.23160D 01	4.45081D 00	1.43041D 01	1.06198D 03	2.03906D 03	9.56675D 02
20	8	10	1.48963D 01	2.06620D 00	3.83410D 00	3.08901D 02	4.10313D 02	4.96265D 02
21	8	15	9.18842D 00	4.55232D-01	0.0	1.19761D 02	0.0	1.10252D 03
22	8	17	9.18842D 00	4.55232D-01	0.0	1.19761D 02	0.0	1.10252D 03
23	8	20	9.12953D 00	5.26783D-01	5.26783D-01	7.66326D 01	6.71735D 01	1.74300D 02
24	9	10	1.40310D 01	3.99370D-01	3.99370D-01	2.90602D 01	7.70502D 01	4.83657D 01
25	9	11	2.32304D 01	2.60896D 00	2.60896D 00	2.53240D 02	5.75493D 02	5.43692D 02
26	10	11	3.05754D 01	5.30546D 00	5.30546D 00	2.74810D 02	6.89636D 02	7.32389D 02
27	12	21	3.71099D 00	1.05374D-01	1.05374D-01	1.44425D 01	4.54773D 01	3.28262D 01
28	12	22	4.14399D 00	1.46732D-01	1.46732D-01	1.83373D 01	5.07836D 01	3.06947D 01
29	12	24	4.19625D 00	4.58396D-01	1.71213D 00	1.67556D 02	5.83392D 02	8.77980D 01
30	13	14	3.85394D 00	1.75647D-01	1.75647D-01	1.35266D 01	3.17965D 01	2.83214D 01
31	14	24	4.12467D 00	2.29001D-01	2.29001D-01	1.87490D 01	4.56742D 01	2.48305D 01
32	15	16	5.65278D 00	2.34794D 00	4.83891D-01	6.30706D 02	1.31685D 03	6.61114D 03
33	17	18	5.65278D 00	2.34794D 00	4.83891D-01	6.30706D 02	1.31685D 03	6.61113D 03
34	19	20	4.57103D 00	1.91826D-01	1.91826D-01	5.12949D 01	6.41035D 01	1.21004D 02
35	21	22	4.20876D 00	2.54706D-01	2.54706D-01	1.18818D 01	5.15113D 01	3.86449D 01
36	8	19	7.86279D 00	3.36525D-01	3.36525D-01	6.55098D 01	5.78541D 01	1.51243D 02
37	22	24	6.66652D 00	8.14819D-01	8.14819D-01	1.81666D 01	8.07817D 01	6.90048D 01
38	1	25	4.89819D 00	2.28275D 00	3.01214D-01	2.97954D 02	1.25658D 02	7.86139D 02

Figure C-20. Airplane B 25 Mass, 38 Member Math Model Damping Data

BEAM UNCOUPLED,UNDAMPED FREQUENCIES (CPS)

IJ	I	J	(1)	(2)	(3)	(4)	(5)	(6)
1	1	12	9.9274D 01	6.9677D 00	1.3933D 01	3.6029D 01	7.7800D 01	3.8900D 01
2	1	24	1.3109D 02	1.0159D 01	1.8735D 01	5.1500D 01	1.0984D 02	5.7231D 01
3	2	7	3.1016D 02	2.4173D 01	4.6437D 00	9.0263D 00	8.2000D 00	3.2131D 01
4	3	7	3.1016D 02	2.4173D 01	4.6437D 00	9.0263D 00	8.2000D 00	3.2131D 01
5	4	5	9.5078D 01	4.4874D 00	4.4874D 00	1.8708D 00	6.4051D 00	9.7130D 00
6	4	12	1.9082D 02	1.0620D 01	1.0620D 01	4.6614D 00	7.1426D 00	9.5022D 00
7	4	23	8.8664D 01	4.5811D 00	4.5811D 00	2.3244D 00	3.2894D 00	3.7423D 00
8	5	6	9.0527D 01	1.3580D 01	4.3703D 01	1.8423D 01	1.0418D 02	4.2115D 01
9	5	19	1.3190D 02	6.0735D 00	4.3256D 01	1.1432D 01	7.3210D 01	7.6580D 00
10	5	20	8.3655D 01	2.8025D 00	2.8025D 00	1.2893D 00	5.8956D 00	4.3921D 00
11	5	21	8.3838D 01	2.7082D 00	2.7082D 00	1.6350D 00	6.7028D 00	9.4941D 00
12	6	13	1.5746D 02	6.2055D 00	6.2055D 00	5.0877D 00	1.0643D 01	1.1991D 01
13	6	20	1.5883D 02	6.4605D 00	6.4605D 00	2.1236D 00	8.0161D 00	4.9437D 00
14	6	21	2.9371D 02	3.6011D 01	3.6011D 01	1.1363D 01	1.7772D 01	2.0701D 01
15	7	8	1.4874D 02	4.4013D 01	6.6229D 00	7.6584D 00	7.1966D 00	2.5721D 01
16	7	9	1.6725D 02	8.5896D 00	6.6287D 01	1.2737D 01	5.4271D 01	5.6493D 00
17	7	15	1.0300D 02	4.1099D 01	8.4702D 00	2.6063D 01	3.6714D 01	8.3587D 01
18	7	17	1.0300D 02	4.1099D 01	8.4702D 00	2.6063D 01	3.6714D 01	8.3587D 01
19	7	19	2.0297D 02	7.3351D 01	2.3574D 02	1.9057D 01	9.5567D 01	1.9722D 01
20	8	10	1.2749D 02	1.7683D 01	3.2814D 01	8.6834D 00	5.3390D 01	1.2812D 01
21	8	15	1.1220D 02	5.5589D 00	0.0	4.0139D 00	0.0	1.1410D 01
22	8	17	1.1220D 02	5.5589D 00	0.0	4.0139D 00	0.0	1.1410D 01
23	8	20	1.4645D 02	8.4503D 00	8.4503D 00	1.5004D 00	9.0273D 00	3.4798D 00
24	9	10	1.3525D 02	3.8496D 00	3.8496D 00	4.1622D 00	5.9994D 00	6.9273D 00
25	9	11	1.0525D 02	1.1821D 01	1.1821D 01	6.6850D 00	1.3368D 01	1.2438D 01
26	10	11	1.2355D 02	2.1439D 01	2.1439D 01	8.6906D 00	1.7236D 01	1.5610D 01
27	12	21	1.7730D 02	5.0345D 00	5.0345D 00	4.9494D 00	6.5618D 00	7.7361D 00
28	12	22	1.9799D 02	7.0105D 00	7.0105D 00	5.5269D 00	7.3274D 00	8.6388D 00
29	12	24	1.7491D 02	1.9107D 01	7.1367D 01	4.2207D 01	7.4423D 01	2.2116D 01
30	13	14	2.7402D 02	1.2489D 01	1.2489D 01	6.7136D 00	1.5066D 01	1.6918D 01
31	14	24	3.1190D 02	1.7317D 01	1.7317D 01	1.0316D 01	1.2775D 01	1.3553D 01
32	15	16	1.5676D 02	6.5113D 01	1.3419D 01	3.4305D 01	7.9644D 01	1.0495D 02
33	17	18	1.5676D 02	6.5113D 01	1.3419D 01	3.4305D 01	7.9644D 01	1.0495D 02
34	19	20	2.1273D 02	8.9275D 00	8.9275D 00	1.5842D 00	6.8799D 00	3.7519D 00
35	21	22	3.3319D 02	2.0164D 01	2.0164D 01	1.0214D 01	1.2347D 01	1.6408D 01
36	8	19	1.2613D 02	5.3983D 00	5.3983D 00	1.2922D 00	7.7746D 00	2.9969D 00
37	22	24	4.2483D 02	5.1925D 01	5.1925D 01	1.3572D 01	1.5901D 01	1.8535D 01
38	1	25	1.0902D 02	5.0809D 01	6.7044D 00	5.8845D 01	2.0592D 01	1.5526D 02

Figure C-21. Airplane B 25 Mass, 38 Member Math Model Frequency Data

```
VEHICLE INITIAL CONDITIONS

VEHICLE TRANSLATIONAL VELOCITIES IN GROUND AXES (IN/SEC)
VEHICLE ROTATIONAL VELOCITIES IN VEHICLE AXES (RAD/SEC)
EULER ANGLES OF VEHICLE RELATIVE TO GROUND (RADIANS)

        XGDOT                YGDOT                ZGDOT
          P'                   Q'                   R'
         PHI'                THETA'                PSI'

      4.550000D 01          0.0                  1.020000D 02
      0.0                  -1.560000D 00         0.0
      0.0                  -2.830000D 00         0.0

GENERALIZED SURFACE DATA

BETA =    0.0 DEGREES
XGIN =    0.0
ZGIN =    0.0
MODEL PARAMETERS

VEHICLE WT = 2.474190D 03

VEHICLE CG POSITION
X (FS) =   4.20414D 01
Y (BL) =   0.0
Z (WL) =   2.30509D 00

VEHICLE INERTIAS (IN-LB-SEC**2)
I(XX) = 1.67144D 04
I(YY) = 2.55400D 04
I(ZZ) = 3.78100D 04

VEHICLE CG INITIAL GROUND COORDINATES
XCG IS THE DISTANCE FROM SLOPE/GROUND INTERSECTION TO VEHICLE CG,+FORWARD
ZCG IS THE DISTANCE FROM GROUND PLANE TO VEHICLE CG,+DOWN
XCG =  0.0
ZCG = -4.12043D 01
```

Figure C-22. Airplane B 25 Mass, 38 Member Math Model Initial Conditions, Overall Mass and c.g. Properties

```
VEHICLE INITIAL CONDITIONS

VEHICLE TRANSLATIONAL VELOCITIES IN GROUND AXES (IN/SEC)
VEHICLE ROTATIONAL VELOCITIES IN VEHICLE AXES (RAD/SEC)
EULER ANGLES OF VEHICLE RELATIVE TO GROUND (RADIANS)

        XGDOT                  YGDOT                  ZGDOT
          P'                     Q'                     R'
         PHI'                  THETA'                  PSI'

      2.590000D 02           0.0                    1.950000D 01
      0.0                   -1.353000D 00           0.0
      0.0                   -6.733000D-01           0.0

GENERALIZED SURFACE DATA

BETA =  90.0 DEGREES
XGIN =   0.0
ZGIN = 100.0


MODEL PARAMETERS

VEHICLE WT = 2.474190D 03

VEHICLE CG POSITION
X (FS) =  4.11364D 01
Y (BL) =  0.0
Z (WL) =  1.93672D 00

VEHICLE CG INITIAL GROUND COORDINATES
XCG IS THE DISTANCE FROM SLOPE/GROUND INTERSECTION TO VEHICLE CG,+FORWARD
ZCG IS THE DISTANCE FROM GROUND PLANE TO VEHICLE CG,+DOWN
XCG = -6.40201D 01
ZCG = -1.48303D 02

VEHICLE INERTIAS (IN-LB-SEC**2)
I(XX) = 1.650070 04
I(YY) = 2.599840 04
I(ZZ) = 3.848350 04
```

Figure C-23. Airplane B 24 Mass, 37 Member Math Model Initial Conditions and Model Parameter Data

```
VEHICLE INITIAL CONDITIONS

VEHICLE TRANSLATIONAL VELOCITIES IN GROUND AXES (IN/SEC)
VEHICLE ROTATIONAL VELOCITIES IN VEHICLE AXES (RAD/SEC)
EULER ANGLES OF VEHICLE RELATIVE TO GROUND (RADIANS)

        XGDOT                YGDOT                ZGDOT
          P'                   Q'                   R'
         PHI'                THETA'               PSI'

      2.59000D 02          0.0                  1.95000D 01
      0.0                 -1.85000D 00          0.0
      0.0                 -6.73000D-01          0.0

GENERALIZED SURFACE DATA

BETA =  90.0 DEGREES
XG IN =   0.0
ZG IN = 100.0


MODEL PARAMETERS

VEHICLE WT = 2.477090D 03

VEHICLE CG POSITION
X (FS) =  4.15536D 01
Y (BL) = -2.44836D-01
Z (WL) =  1.82251D 00

VEHICLE CG INITIAL GROUND COORDINATES
XCG IS THE DISTANCE FROM SLOPE/GROUND INTERSECTION TO VEHICLE CG,+FORWARD
ZCG IS THE DISTANCE FROM GROUND PLANE TO VEHICLE CG,+DOWN
XCG = -6.06684D 01
ZCG = -1.46762D 02

VEHICLE INERTIAS (IN-LB-SEC**2)
I(YX) = 1.74411D 04
I(YY) = 2.52001D 04
I(ZZ) = 3.88975D 04
```

Figure C-24. Airplane B 40 Mass, 80 Member Math Model Initial Conditions and Model Parameter Data

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