1.0 INTRODUCTION

1.1 THE V-TAIL CONTROVERSY

The V-tail Bonanza, introduced by Beech Aircraft Corporation in 1947, is a distinctive airplane in many respects. The empennage configuration, a pair of canted tail surfaces that provide yaw control as well as longitudinal stability and pitch control, assures identification of the Bonanza at a glance. The airplane was an instant success and 1209 airplanes were manufactured the first year. The Bonanza reputation as a high performance airplane with clean aerodynamics and ease of handling has sustained its popularity. Beech Aircraft Corporation continued to manufacture the V-tail Bonanza into 1982, by which time a total of 10,405 had been built. The airplane attracted a sufficient number of enthusiastic followers to prompt the formation of an organization of owners. The American Bonanza Society was formed in 1967 and today has about 7000 active members. This is remarkable since there are only 7207 registered owners of V-tail Bonanzas in the United States.

The growing enthusiasm for the airplane was tempered by a higher than normal incidence of in-flight airframe failures that plagued the original "straight" Model 35. Subsequent models have had improved safety records, but in-flight airframe failure accidents have been the subject of numerous studies and journalistic examinations throughout the entire life-span of the airplane.

The CBS television program "60 Minutes" featured the V-tail Bonanza and in-flight breakup concerns on December 30, 1979. In the last five years, The Aviation Consumer, a semi-monthly newsletter, has published at least six articles which have had the same general theme, suggesting that flying in a V-tail Bonanza may be hazardous. Flying magazine has also had several articles about the V-tail controversy, but they have not taken an editorial position as to whether or not a problem exists. Bonanza owners and pilots are reputed to have extreme loyalty toward their V-tails and were unmoved by the published statistics until recently.

With the ongoing controversy, each incident involving a Bonanza in-flight structural failure renewed the concern of an increasing number of V-tail owners. On June 7, 1984, Donald L. Monday, then President of the American Bonanza Society, wrote to the Federal Aviation Administrator requesting that the FAA conduct a special investigation into the V-tail. The Administrator of the FAA took immediate action to initiate an investigation. The Central Region in Kansas City, Missouri, which is responsible for General Aviation safety and certification, was asked to conduct a study that would produce conclusive data that either proves or refutes the allegations of defective design.

After considering various options, the Central Region elected to have the Transportation Systems Center (TSC) in Cambridge, Massachusetts, conduct the study. TSC is a federal organization in the Department of Transportation (DOT) that provides technical support to all of the administrations in DOT. Mr. Larry Malir was the FAA's project manager for the study. The Task Force effort at TSC was headed by Mr. George Neat. Dr. Pin Tong led the structures and dynamics effort and Mr. Larry Silva led the accident data gathering and analysis effort. Other task force members were Dr. Oscar Orringer, Dr. Herbert Weinstock, Mr. Harvey Lee, Mr. Jeffrey Gordon, Mr. Dick Porcaro and Mr. Wesley Mui, all of TSC. Additional task force members included Dr. James Mar, MIT, Dr. Robert Greif, Tufts University, and

Dr. Alex Harris, Systems Development Corporation. Resumes of the task force members are included in Appendix A.

1.2 TASK FORCE CHARTER

The purpose of this study was to define actions necessary to determine conclusively that there are or there are not deficiencies inherent in the design of the Beechcraft V-tail Bonanza that contribute significantly to in-flight airframe failure accidents. The study was to be completed in six months and the effort began on October 1, 1984. It was expected that a second phase would be required to implement the required actions defined in the six month study documented in this report.

The specific tasks that were covered in this task force effort can be grouped into two areas:

- Evaluation of structural integrity
- Collection and analysis of accident data

The structural integrity evaluation required the task force to establish design requirements including flight envelope, worst case conditions, and safety margins. Information required for this effort was obtained from the FAA and Beech Aircraft Corporation. The task force then reviewed the design, analyses, and test data involving the critical flight regime and the critical components. This task required a cooperative working relationship with Beech Aircraft Corporation.

The accident analysis required the task force to identify, accumulate, and examine all available in-flight structural failure accident data on the V-tail Bonanza starting from the date of aircraft certification through 1984. Data included that available from the FAA, the NTSB, Beech Aircraft Corporation, and from other sources. The task force then developed scenarios for the accidents based on the data available and considering all related factors. These scenarios are limited to factual data and eyewitness accounts and do not include speculation about unavailable information. Similarities in these scenarios were then developed to investigate possible relationships between the accidents and significant design or operational factors.

This report summarizes the results of the task force investigation. Section 2 covers the background of Model 35 Bonanza development history, introduction of Models 33 and 36, and general rules and procedures for type certification of general aviation aircraft. Section 3 reviews in more detail the background of Bonanza flying and handling qualities, which must be understood before structural properties and accident reports can be properly interpreted.

The next three sections summarize the work done by the task force. Section 4 covers the assessment of the Model 35 wing and empennage structural integrity. Comparison is made with the Model 33 "Debonair" because the Debonair is perceived by some to be "the same airplane" except for its conventional tail, and previous analyses of accident rates have tended to emphasize the comparison of the Bonanza and the Debonair. Section 5 deals with aeroelastic effects that might influence structural integrity: various modes of flutter, and the possibility that the wide-chord stabilizers on the C35 and later models might be subject to torsional divergence failure. Section 6 summarizes the available accident data and presents the task force analysis of that data in the light of the different structural characteristics of different models within the 35 series.

The foregoing sections cover large bodies of information which the reader may find difficult to digest. Therefore, Section 7 retraces the ground and integrates the results in a discussion of the risk factors for in-flight airframe failures. Section 8 presents the task force conclusions and recommendations for work required to deal with residual questions that were identified by the six month study.

1.3 APPROACH

The first step in this effort was to gather information about the V-tail Bonanza from its origin to the most recent articles and studies. This search included extensive interviews with a wide variety of people familiar with some part of the V-tail story. In addition to numerous contacts within the government and Beech Aircraft Corporation, aviation consultants, university professors, aviation repair stations and general aviation pilots were included. Gathering information and reviewing the contents proved to be an iterative process that continued throughout the six month study, since the historical search repeatedly uncovered new sources.

The search and data analysis were conducted on two concurrent thrusts with a team led by Dr. Pin Tong concentrating on the area of structural integrity. This effort included investigation of aeroelastic effects and handling characteristics. The parallel activity led by Mr. Larry Silva concentrated on accident data. Continual communications between these two efforts assured effective utilization of limited time and resources.

The conclusions and recommendations of this six month study are based on the documented results of some of the earlier studies as well as on the analyses carried out by the task force. The information gathered in the interview process was used primarily to determine sources of additional data and areas for task force inquiry and analysis. Reference sources relevant to each chapter are listed at the end of Section 8.

2.0 BACKGROUND

2.1 HISTORY OF THE MODEL 35

Introduced in 1947 for the postwar market, Beech's new Model 35 was called the "Bonanza" because its designers wanted a name that would be descriptive of its great economy and high performance. A list of the 100 best-designed mass-produced products of the era, developed by the Illinois Institute of Technology in 1958, included the Beech Bonanza and the Douglas DC-3 as the only aircraft. The Bonanza is referred to as the very first all-new design to be marketed after the war. Its construction embodies many aviation firsts for an airplane in its class, including the distinctive, aerodynamically clean V-tail. Ralph Harmon was the project engineer, and he worked with several other Beech engineers on the new tail design. The team conducted complete wind tunnel testing, a first for a small airplane design, in order to reduce drag to a minimum.

As a result of their drag-reduction efforts, the NACA 23000 airfoil was chosen for the wing and more attempts were made to clean up the tail. As early as 1943 Beech had studied the possibility of using a V-tail on a high speed plane. Drag would be reduced if the V-tail could sit higher on the fuselage away from the turbulence caused by flow separation over the wing at high speeds. Even if these critical speeds were not to be reached with the Beechcraft, moving the tail surfaces out of the wing wake altogether would constitute a significant reduction in drag. The reduction of surface-to-fuselage intersections also contributed to the three mph speed increase compared with a similar conventional-tail prototype. The weight saved by using fewer parts in the tail section of the fuselage was important from the weight and balance point of view because of the long moment arm to the center of gravity. Simplified manufacturing tooling and parts stocking were realized together with an apparent weight saving of 11.6 pounds[1].

Flight tests on an experimental model showed that the V-tail had improved spin recovery characteristics, and even displayed what was called a reluctance to spin entry. Beech tests proved the V-tail, with its 30-degree dihedral angle, to be equivalent to the straight tail in controllability while requiring fewer trim changes with changes in power.

Fabrication and assembly methods of component parts such as wing panels and fuselage sections were streamlined in order to secure a high level of quality automated production. As a result, aerodynamic cleanliness was achieved in that the flush riveting of exterior skins, flush windshield joints and the fully retractable, fully enclosed landing gear became practical. Internal flap tracks, internally hinged control surfaces, flap gap doors, and adjustable cowl flaps for engine cooling contributed to the overall low drag. As a result of these improvements, test planes were observed to accelerate from 200 to about 280 mph in six seconds in steep dives, further substantiating the Bonanza's aerodynamic cleanliness. The savings due to each Beech innovation are summarized in Table 2-1[1].

Safety studies of the proposed design were conducted by Beech Aircraft and Cornell University. The low-wing design and strong, crash-resistant cabin compartment would protect passengers during a forced landing. Five prototypes were constructed, two of which were subjected to the equivalent of 20,000 hours of flying time to assure that fatigue failures would not occur. This testing was in addition to what was then required by the Civil Aeronautics Administration (CAA).

Laboratory landing tests were also conducted, as well as static testing to destruction of major component parts and vibration tests of the control surfaces.

TABLE 2-1. RESULTS OF MODEL 35 DRAG REDUCTION PROGRAM

FEATURE	DRAG REDUCTION
COWL FLAPS	6 mph
RETRACTABLE STEP	3 mph
V-TAIL	3 mph
FLUSH RIVETING	3 mph
INTERNALLY BALANCED CONTROL SURFACES	3 mph
FLAP GAP DOORS	5 mph

Flight testing was conducted with several structural shortcomings being discovered and subsequent modifications incorporated. It was at this time in the development of the Bonanza that an accident killed a test pilot and destroyed his airplane. During a dive test to determine the maximum dive velocity, a landing gear door buckled under the air loads, causing the door to be forced open. Air was then forced into landing gear recess on the underside of the wing, and internal pressure built up to the point where the wing failed. Following the accident, modifications were made and flight testing continued through 1946. Production started in 1947 following the airplane's certification in the Normal Category. During radio-controlled dive testing in 1948, an experimental model reached speeds up to 286 mph (indicated airspeed) at a dive angle of approximately 45 degrees, attaining 3.5 g's during the pullout. Further design changes were made to upgrade the A35 and later models to Utility Category with an airframe at least 15.7 percent stronger than that required for the Normal Category.

2.2 MODEL 35 PERFORMANCE EVOLUTION

Like other airplanes, the Beechcraft Bonanza has evolved seeking increased performance since the original Model 35 was introduced in 1947. Succeeding models have incorporated more installed power, larger gross weight, and higher speed to keep the airplane competitive in the general aviation market. Table 2-2 summarizes this evolution[2]. The Model V35A version of the V-tail Bonanza is shown in Figure 2-1.

The performance evolution also led to both aerodynamic and structural modifications. For example, there were increases in the Model C35 tail chord length of 14.4 percent and tail dihedral from 30 to 33 degrees to provide improved control and yaw damping characteristics of the empennage.

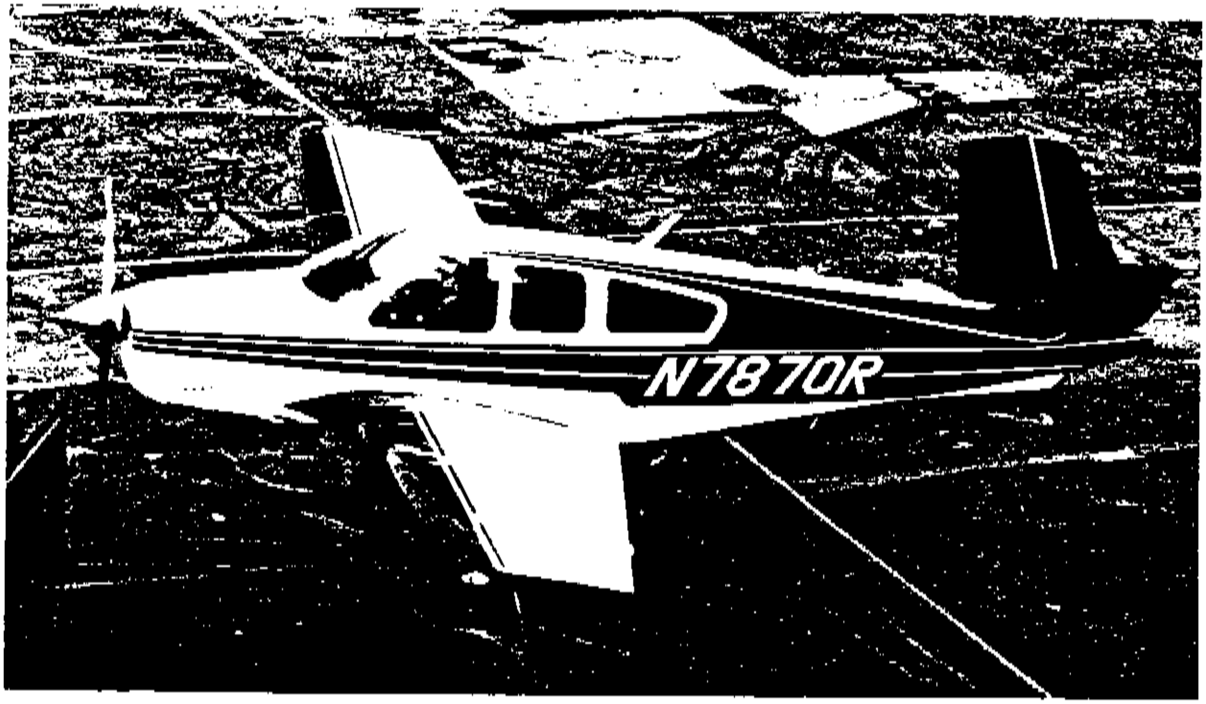

FIGURE 2-1. MODEL V35A V-TAIL BONANZA

The upgrade from Normal to Utility Category at Model A35 and the payload increases in the later models together with the increased thrust of more powerful engines required numerous local design changes to strengthen the airframe. Several of these modifications resulted from observations made during static testing of the aircraft component in question. As documented in several Beech structural analysis reports, when failure was imminent, especially in the wings and stabilizers, the parts were removed from the testing machine, stiffened, and subsequently retested.

2.3 STRUCTURALLY SIGNIFICANT MODIFICATIONS

The category upgrade for the Model A35 involved a major strengthening of the wing and change of its carry-through structure as well as strengthening of the empennage attachments. For Model C35, beaded skin panels were used to simplify the empennage construction concurrent with the change to the wide-chord stabilizer. Subsequent modifications generally involved increases of skin thickness, heavier spar sections, and/or local reinforcement. Table 2-3 summarizes the details of the structurally significant modifications to the wing and tail[2]. The grouping of models in this table reflects structurally similar airplanes.

TABLE 2-2. BONANZA PERFORMANCE EVOLUTION

MODEL	YEAR	MAXIMUM SPEED (mph)		MAX. HP	GROSS WEIGHT (lbs)
		CRUISING	MANEUVERING		
35	1947-48	160	130	185	2550
A35	1949	160	142	185	2650
B35	1950	160	142	196	2650
C35	1951-52	160	142	205	2700
D35	1953	160	130	205	2725
E35	1954	175	142	205*	2725
F35	1955	175	142	205*	2750
G35	1956	175	142	225	2775
H35	1957	175	142	240	2900
J35	1958	185	142	250	2900
K35	1959	185	142	250	2950
M35	1960	185	142	250	2950
N35	1961	185	148	260	3125
P35	1962-63	185	148	260	3125
S35	1964-65	190	152	285	3300
V35	1966-67	190	152	285	3400
V35A	1968-69	190	152	285	3400
V35B	1970-82	190	152	285	3400
Percent increase 35 to V35B		19%	17%	54%	33%

* 225 hp engines were offered as options for Models E35 and F35.

Besides the evolutionary modifications, several retrofit kits have been developed for the V-tail. These kits fall into two categories: stub spar and collar. A stub-spar kit adds a short spar ahead of the front (main) spar and requires internal work in the fuselage for attachment. A collar kit consists of a flanged collar attached to the fuselage skin and fitting around the stabilizer nose. The intended purpose of a stub spar or a collar kit is to restrain the stabilizer nose against excessive deflection under large loads.

Beech Aircraft Corporation studied the effects of a stub spar kit on the strength of the tail in 1959. The test results with and without the kit led Beech to conclude that there was no benefit. The continued occurrence of in-flight breakups later led independent suppliers to develop and market several retrofit kits, which the FAA has authorized by Supplemental Type Certificate. Mike Smith Aero, Inc. now offers a stub spar kit, and collar kits are available from Mike Smith, Knots 2U, and B

& N Industries. Tests of these kits by their suppliers have shown strength improvement under certain types of loading[3].

2.4 THE MODEL 33 AND MODEL 36

In 1959 Beech decided to market a new airplane in order to remain competitive with the other general aviation aircraft manufacturers. The Model 33 "Debonair" emerged from this rivalry as a low-cost Bonanza derivative. The V-tail was replaced by a conventional three-surface tail, with narrow-chord stabilizers for the Debonair. Also, many of the Bonanza's "extras" were removed and the engine was regressed to 225 horsepower. Although much less expensive than the Bonanza, the Debonair lacked customer appeal. In 1960, an effort was made to enhance the Model 33 and by 1968 the two aircraft were almost identical except for the V-tail's longer cabin and the tail configuration. After the production of the C33A, the designation "Debonair" was dropped, and these conventional-tailed airplanes are now referred to as Bonanzas. Table 2-4 summarizes the evolution of the Model 33[2].

The Bonanza 36 was introduced in 1968 as the biggest and most versatile Bonanza ever built. The cabin space was 29 inches longer than the Model E33A and 10 inches longer than the V35A, the other Bonanzas being produced at that time. The fuselage (and occupants) actually moved 10 inches forward over the wing, greatly improving the loading envelope and making it easier to stay within the center of gravity limits. Since its introduction, the Model 36 has been the most popular of the three single engine Bonanzas with 2495 having been manufactured through 1983.

2.5 THE CERTIFICATION PROCESS

Airplane type certification is governed by CAA/FAA regulations and related administrative procedures. The regulations include provisions for assurance that the airframe has sufficient strength to survive the expected flight loads. These structural airworthiness provisions are the focus of this section.

The Civil Aeronautics Regulations, Chapter 3 (CAR 03, later CAR 3) and the Federal Aviation Regulations, Part 23 (FAR-23) govern the airworthiness requirements for general aviation airframes. CAR 3 was in force until 1965 when these regulations were replaced by FAR-23. While CAR 03 was in effect, it was supplemented by the Civil Aeronautics Manual, Chapter 3 (CAM 3). CAM 3 gave detailed guidelines for interpretation and application of CAR 03 regulations and also served as a record of regulatory amendments between updates of the Civil Air Regulations.

The airworthiness provisions require generally that the manufacturer demonstrate by test or engineering calculation the most severe flight loads the airplane is expected to encounter (limit loads) and the ability of the airframe to survive those loads. Loads must be calculated for a variety of flight conditions representing landings, extreme maneuvers, or gust encounters during level flight. In each case the loads are to be conservatively distributed in a manner closely approximating actual flight conditions. Also, if structural deflection under a given load is large enough to change the aerodynamic distribution of the load, this redistribution must be accounted for. Investigation of a variety of conditions is required to assure that the most critical load is identified for each major structural component of the airframe.

TABLE 2-3. SUMMARY OF SIGNIFICANT BONANZA STRUCTURAL MODIFICATIONS

MODEL	DESCRIPTION OF MODIFICATIONS
35	Certificated to 3.8 g's in the Normal Category
A35 B35	Certificated to 4.4 g's in the Utility Category. Sheet metal carrythrough structure replaces welded tube trusses. Increase in some wing skin gages, chordwise formers, fuselage stringer gages, and diameter of wing attach bolt. Strengthened stabilizer attach bulkhead
C35 D35 E35	WING: Strengthened near walkway, increased rivet size in skin panels STABILIZERS: Simplified beaded construction. Chord length increased 14.4%. Dihedral changed from 30 to 33 degrees. Changed from pinned to fixed rear spar attachment
F35	WING: Added 0.020 web to front spar between WS66 and WS108 Added top forward cap angle insert to front spar between WS80 and WS 108. Thickened nose skin, extended spanwise stringers, increased strength of front spar fittings FUSELAGE: Added vertical stiffeners to increase skin shear capacity. Increased some skin thicknesses, strengthened front carrythrough fitting TAIL SURFACES: Changed to Model 45 elevator, increased gage of root rib, increased rear spar channel and doubler, added corner gusset at junction of root rib and rear spar, removed rear spar lightening holes, added angle to rear spar
G35	Added reinforcement to wing root rib, extended stringer from WS59 to WS66, increased wing front spar web(0.020 to 0.032)
H35- M35	WING: Model 50 tee extrusion, fittings and outboard channel, thickened spar webs, added vertical web stiffeners(some removed), landing gear modifications, increased spar cap angles, Model 50 leading edge assembly used, changed to double row of attachments for skin splices. FUSELAGE: Strengthened nose section, increased gages of front spar carrythrough, revised FS151 bulkhead, changed some skins to allow for closer rivet spacing TAIL SURFACES: ELEVATOR-Added intermediate inboard and outboard spar, added extruded tab hinge, added rib at Sta. 62.525, balance horn modifica-tions. STABILIZER: Thicker spar gusset at root rib, added 0.032 "J" section at L.E., added intermediate rib between spars at Sta. 34.57, added flange to main spar doubler. ELEVATOR TAB: increased area due to increased chord length
N35- P35	FUSELAGE: Increased top skin between FS131 and FS207 from 0.016 to 0.032, aft belly structure: heavier longerons, heavier "J" section stringers; floor structure beefed up
S35	WING: New squared tip (adds to wing surface area). TAIL: New elevator balance horn, increased gage of front spar outer channel (0.070 to 0.090) and rear spar outer channel (0.063 to 0.070). FUSELAGE: Extended stringers on sides

TABLE 2-4. MODEL 33 PERFORMANCE EVOLUTION

MODEL	YEAR	MAXIMUM SPEED (mph)		MAX. HP	GROSS WEIGHT (lbs)
		CRUISING	MANEUVERING		
K35	1959	185	142	250	2950
33	1960	185	142	225	2900
A33	1961	185	147	225	3000
B33	1962-64	185	147	225	3000
C33	1965-67	185	147	225	3050
C33A	1966-67	190	152	285	3300
E33	1968-69	185	147	225	3050
E33A	1968-69	190	152	285	3300
E33B	1968-69	190	152/*165*	225	3300/ *2800*
E33C	1968-69	190	152/*165*	285	3300/ *2800*
F33	1970	185	147	225	3050
$F33A_1$	1970-71	190	152	285	3400
F33C	1970	190	152/*165*	285	3400/ *2800*
G33	1972	190	152	260	3300
$F33A_2$	1972	190	152	285	3400

Italics refer to Acrobatic Category version of the same airplane.
$F33A_1$ and $F33A_2$ differ in interior design, corresponding structural changes accomodating improvements; performance unchanged.

The task force has been able to partially reconstruct the history of regulatory changes significant to the Bonanza in particular and V-tail design in general. The original Model 35 through the G35 were certified to CAR 03 under type certificate A- 777 which was issued on March 25, 1947.

A copy of CAR 03 (1946) reviewed by the task force does not contain any specific provision for estimation of V-tail flight loads. CAM 3 (1954) does contain guidelines for V-tail load estimation, but the task force was not able to trace the first appearance of these guidelines. However, similar wording is used in a 1947 CAA memorandum that discusses consideration of a V-tail configuration. CAM 3 (1954) also contains the first appearance known to the task force of Appendix A, an optional set of simplified procedures for estimating tail loads on airplanes weighing less than 6000 lb. Beech did not use these simplified procedures but apparently did follow the V- tail procedures throughout the active period of type certificate A-777.

In early 1956, CAR 03 together with intervening amendments was reorganized as CAR 3. It is presumed that CAR 3 embodied the V-tail guidelines and Appendix A from CAM 3. Beech subsequently received type certificate 3A-15 on May 15, 1956, under CAR 3. Type certificate 3A-15 applies to Model H35 through Model V35B.

The history of regulation after CAR 3 does not apply to the Model 35 series but would be of interest if a new V-tail design were to be certified today. In 1965, CAR 3 together with eight intervening amendments was reorganized as FAR-23. The most recent version, FAR-23 (1984), has no explicit rules for V-tail but does retain the simplified load option in Appendix A. Also, FAR-23 (1984) contains an Appendix B, which embodies the other permissible tail load estimation methods that appeared in CAM 3. Since the adoption of the Federal Aviation Regulations, the Civil Aeronautics Manual has been discontinued. Interpretive guidelines are now issued as Advisory Circulars (AC).

The ability of each major structural component of a new airframe design to survive its critical flight load must be demonstrated by means of a static strength test or by a structural analysis of proven accuracy for the specific type of structure. The analysis option is used when an airframe evolves from a previously certified design for which strength has been demonstrated by test. Whether analytical certification is acceptable or not in a given case depends upon the extent to which the modified design has deviated from the previously certified design.

In either case, the airframe strength must be demonstrated to limit load multiplied by a safety factor (ultimate load). Within the general aviation class, the regulations provide for certification to either Normal, Utility, or Acrobatic category by increasing load factors. The load factor, a dimensionless multiple of g's, measures the required capabilities for pullups and pushdowns in terms of the airplane's acceleration upward or downward with respect to its wing planform. Table 2-5 summarizes the load factor requirement by category[4].

TABLE 2-5. AIRPLANE LOAD FACTOR REQUIREMENTS

LOAD FACTOR (g)*	NORMAL CATEGORY	UTILITY CATEGORY	ACROBATIC CATEGORY
POSITIVE LIMIT LOAD FACTOR	3.8	4.4	6.0
POSITIVE ULTIMATE LOAD FACTOR	5.7	6.6	9.0
NEGATIVE LIMIT LOAD FACTOR	1.5	1.8	3.0
NEGATIVE ULTIMATE LOAD FACTOR	2.2	2.7	4.5

*1g = steady level flight

The CAA/FAA regulations are supplemented by administrative procedures for actions necessary to meet the certification requirements. There are two such procedures for airplane type certification: the designated engineering representative (DER) procedure and the delegation of authority (DOA) procedure. Under either procedure, it is the responsibility of the manufacturer to perform and document all tests and calculations required by the airworthiness provisions of the regulations. Since hundreds of detailed engineering reports are involved for even one light airplane, the role of the FAA is limited in practice to observation of major tests and review of key documents.

Under the DER procedure, a qualified senior member of the manufacturer's engineering staff is formally designated by the FAA as the FAA's engineering representative. The DER keeps closely involved with the airplane's development and keeps the FAA informed of progress toward certification. He must also formally approve and sign the official certification documents and brief FAA engineering staff on the supporting technical results before the certification is approved by the government. The DER procedure is followed for all Transport Category airplane type certifications, and was followed for all general aviation airplanes until the early 1950's.

In the early 1950's the FAA recognized that the available technical staff would soon be unable to accommodate the increasing workload involved with processing certifications under the DER procedure in an expanding general aviation industry. The DOA procedure was devised to reduce the workload per airplane to a manageable level. Under the DOA procedure, the FAA delegates to a general aviation airplane manufacturer the authority to certify airplanes. The manufacturer is then responsible for maintaining as well as preparing all required engineering documents, and for seeing that the type certification requirements are met. The FAA has access to these documents and may request a review or spot check at any time.

Delegation of authority is not granted automatically. Before the FAA grants a DOA, FAA technical staff review the manufacturer's history of performance under the DER procedure and the service history of the manufacturer's existing airplanes. DOA is granted only if, in the judgement of the FAA staff, the manufacturer has an established record of safety consciousness in design and fabrication. An existing DOA may also be revoked for cause.

The Bonanza Models 35 through the early production of the D35 were certified under the DER procedure. In 1954 the Beech Aircraft Corporation was granted a DOA, which the company continues to hold today. The later production of Models D35 and subsequent models were certified under the DOA procedure.