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DESIGN, DEVELOPMENT AND MANAGEMENT OF THE SAAB-FAIRCHILD 340 PROGRAM

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Paper No. ICAS-84-2.5.1. Design, Development and Management of the Saab-Fairchild 340 Program. James J. Foody, Fairchild Industries, Inc., Tore R. Gullstrand, Saab-Scania.

The development of the 340 Regional/Executive Transport Aircraft is traced from early exploratory discussions through the certification process. It is the first of the modern generation turboprop transports designed to take advantage of advanced engine technology and to operate in a deregulated regional transport environment. Early program definition was performed by a joint Saab-Fairchild team in the U.S., and detailed design and manufacturing responsibility was split on a roughly 50/50 basis between the partners, with the wing and empennage being completed in the U.S. and fuselage and final assembly being done in Sweden. The single final assembly line is at the Saab-Scania plant in Linköping, Sweden.

The program is managed as a joint venture and the marketing entrusted to a 50/50 partnership between Saab-Scania and Fairchild Industries. All aspects were under the direction of a Management Board.

I. Introduction

The 1970s were a period of turmoil in the aircraft marketplace with wild swings in profitability and the emergence of products that will dominate the airline scene for decades to come. The major events were a dramatic change in fuel prices and the onset in the United States of a deregulated environment, both of which introduced a level of unpredictability that obviously clouds any forecast on future trends. There were also significant traffic increases internationally due to improving economic levels and the increasing demand for business development. Some things, however, were rendered very clear. Key among these were the realization that the world marketplace would be more competitive and less tolerant to inefficiency than in a regulated environment. It seemed that if technology was available to provide more efficient transportation at acceptable levels of safety and comfort, then it would be sought out by the marketplace.

The turboprop was known to have an economic advantage over jets at short-ranges, but this was colored by a regulatory environment which permitted cross-subsidization of short-range turbofan service by longer range legs. Technology also offered the possibility of jet standards of passenger comfort with turboprops, and significantly lower external noise. Thus, there appeared to be an argument saying that these advantages would eventually be translated into market acceptance. This anticipation, together with the desire to offer spacious economic executive transportation over long ranges, gave birth to the 340 program.

Substantial financial commitments over many years are essential to bringing a new aircraft to the marketplace. This simple fact, coupled with the desire of Saab-Scania to complement its military production capability and Fairchild Industries' desire to field a successor to its successful Metro program, led to the establishment of a Saab-Fairchild joint venture. It is the first transatlantic partnership between equal partners aimed at development and production of an aircraft. It is basically a 50/50 arrangement involving a 60/40 split of development activity between Saab and Fairchild and a 50/50 split of production. The aircraft is assembled on a production line in Linköping, Sweden, which is fed by wings, tails, fins and nacelles manufactured in the United States. The total United States content of the aircraft is about 75% by cost when equipment items are included.

The program is controlled by a Management Board consisting of equal representation from the partners, with an independent nonvoting chairman. The board works through a chief executive who has executive control of all aspects of the program, including marketing.

The guiding philosophy of the program is to produce a superior aircraft for the regional airline and corporate aviation marketplace, and develop and grow a consistent and dominant presence in these market segments. Marketing, maintenance and support facilities and capabilities were put in place, and an effort is being made to bring the service levels expected by the major carriers to the regional airline operators. Saab-Fairchild is dedicated to bringing this about and is supported by the full resources of two strong industrial companies with financial and management depth.

II. Requirements and Major Decisions

An historical perspective on the trends in commercial aircraft development over the past 30 years offers some lessons that may be useful in the future. Turboprop development in the 1950s was eclipsed by the jet, and subsequently the fan, because the productivity of speed outweighed fuel economy when fuel was at pre-OPEC price levels. This did not, however, happen in the smaller, shorter range market where speed did not offer significant productivity improvement; hence, available aircraft polarized into larger, longer range fans and smaller, shorter range turboprops.

As fuel prices increased, an interesting phenomenon emerged in that airframe companies attempted to retain operating economics by increasing aircraft size. They were, of course, supported by an increasing market demand and a regulated environment. Deregulation changed this picture and focused competitive attention on the intriguing fact that the smallest modern technology turbofan was envisioned to be at 150 passengers, with the inherent assumption that frequency could be sacrificed to gain the economy of size. The marketplace is now struggling with alternate solutions such as drastic reduction in other elements of direct and indirect cost, but a trend towards reduced size is clearly emerging. However, no realistic proposal has been made to date by the jet transport manufacturers to apply modern technology to a smaller, more economic turbine-powered aircraft.

At the other end of the spectrum (the smaller, shorter range design) the turboprop was never challenged, but because of market size, was starved of development money and lost its appeal to the high flying and dynamic turbofan. Its position, however, was based on a fundamental logic that, even at pre-OPEC oil prices, could not be refuted. As oil prices rose and the turbofan designer decided to solve his problem by increasing the aircraft size, a real vacuum opened in the less than 100-passenger short-range market where the dearth of modern aircraft between 50-and 100-seat capacity was immediately apparent. This focused attention on the fact that powerplants such as the Dart and PT6 were based on 1950s technology and could relatively easily be improved upon in fuel performance and weight ratios. A new generation of turboprop powerplants was born which gave rise not only to the SF 340 but also to the DASH 8, EMB120 and ATR42. This overall situation is depicted in Figure 1.

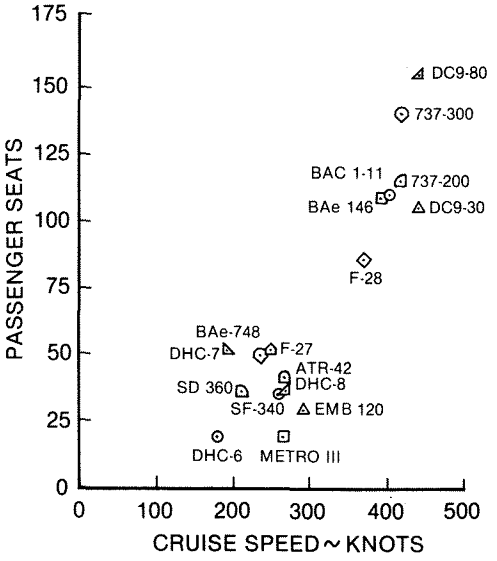

FIGURE 1. POLARIZATION IN THE SUPPLY OF COMMERCIAL TRANSPORT AIRCRAFT

This was the environment observed by a joint Saab-Fairchild team in 1979. Thus, it appeared some product opening was available that would combine available and emerging technology with a marketplace demand. Market surveys in this time frame quickly determined the need for a sophisticated pressurized aircraft in the 30-40 passenger class, and Figure 2 shows some of the considerations that led to the current 340 design.

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It was established from early design effort that both Saab and Fairchild wish to concentrate on the design of a superior aircraft in keeping with the Saab-Scania image as a supplier of quality products in the automotive and aerospace marketplace, and Fairchild's position as the supplier of the dominant 19-passenger design. This aircraft was envisioned as a regional transport interfacing with sophisticated turbofan equipment, and was conceived of as offering the same level of passenger comfort and safety as that of the large turbofan. Figure 3 shows a list of the design elements that were stressed. Specific design action was taken on all of these items, and results will be described in the design section.

- LOW OPERATING COST/SEAT MILE
- JET COMFORT
- ADVANCED DISPLAYS
- SAFETY
- HIGH TECHNOLOGY EFFICIENT ENGINE
- RELIABILITY
- WEIGHT EFFICIENT STRUCTURE
- LOW MAINTENANCE COST
- LONG OPERATING LIFE
- SUPERIOR VISIBILITY
- PRODUCT SUPPORT
- GUARANTEED PERFORMANCE
- LOW CABIN AND EXTERNAL NOISE

FIGURE 3. SUPERIOR FEATURES

Body cross-section is one of the more important elements in the layout of a new aircraft, largely because subsequent changes are extremely difficult. Fuselage fineness ratio dictates that as designs move from the two-abreast, 19-passenger aircraft to the 10-abreast, 400-passenger aircraft, there are some regions of design choice. While a 35-passenger aircraft shows a preference for a three-abreast layout, a 40-passenger design could be configured in either a

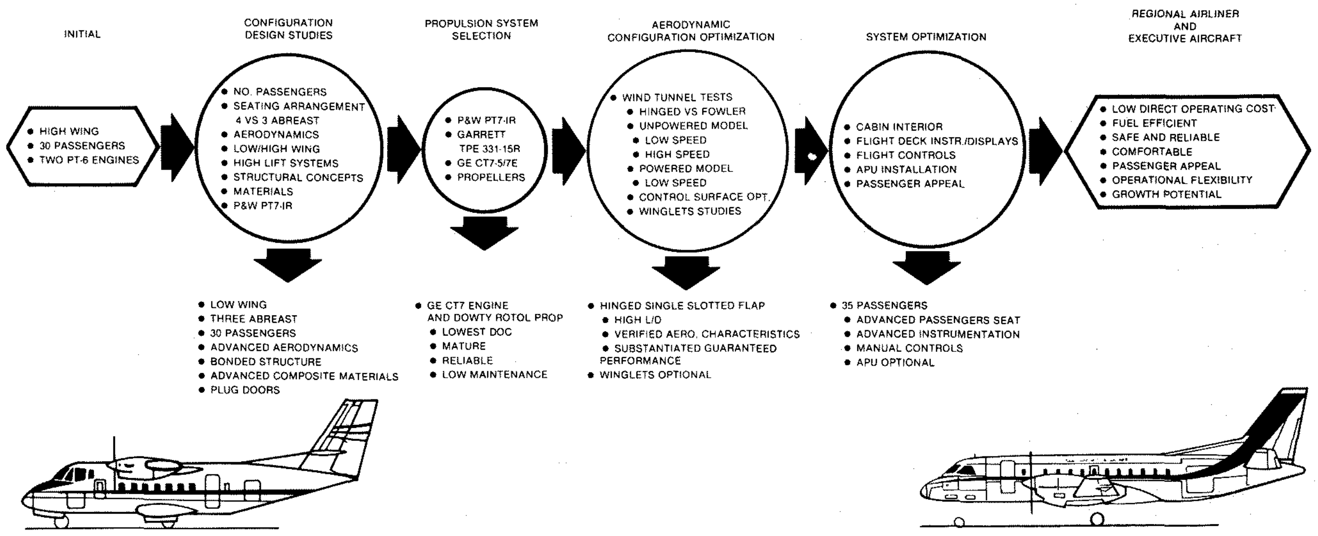


FIGURE 2. HISTORICAL DEVELOPMENT

three-or four-abreast design. It was, however, established from project inception that a dual market would be sought for the product and that the corporate potential would be catered to at all stages in the design. The cross-section that suits a three-abreast regional transport is ideal for a two-abreast corporate layout. Dimensions selected for the aircraft are shown in Figures 4 and 5. Note the stand-up interior and regional transport seating dimensions consistent with comfort levels of larger aircraft. The two-abreast, 85-inch corporate layout resulted from market surveys that indicated the 102-inch exterior width associated with a four-abreast regional transport layout was less attractive. An interior formula was selected which was pioneered by the GI and preserved by the GIII, and is still the corporate aircraft industry standard.

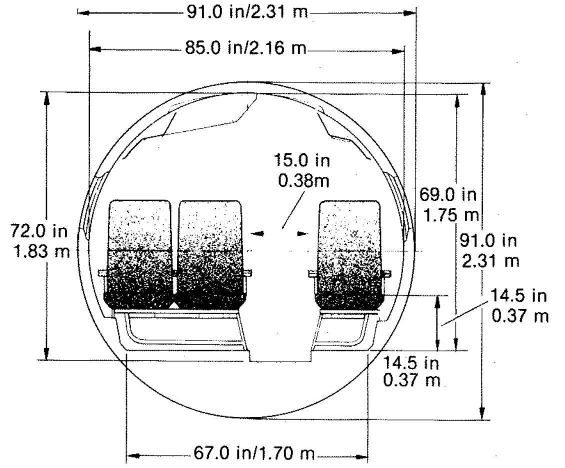


FIGURE 4. BODY CROSS-SECTION (REGIONAL TRANSPORT)

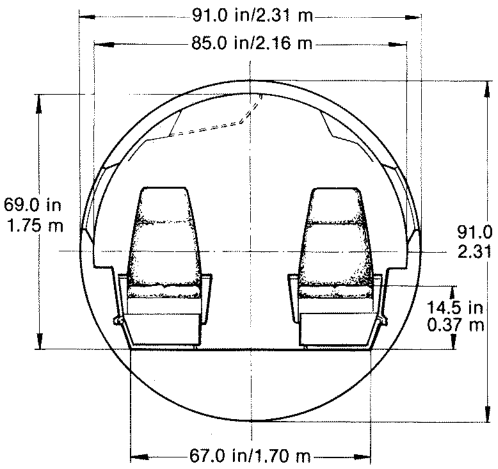


FIGURE 5. BODY CROSS-SECTION (CORPORATE)

Market surveys also indicated that while specialist requirements existed for short field characteristics where unique design action might be required, most targeted operators found a 4,000 foot field length capability at a sea level airport, on an ISA day, to be acceptable. With the primary goal established of carrying a full payload out of such a field, a secondary goal was aimed at operating with less than full fuel, but full passenger load out of a 6,000 foot runway at 5,000 feet altitude on a ISA + 20°C day. Attained performance against these requirements will be shown in the performance section.

Operating economics clearly played a major part in the conception of the 340 regional transport. It was and is the intent of the program to offer operating economics that are second to none at a 35-passenger capacity. The challenge was also accepted to offer better ¢/seat mile costs at short-ranges than any available or projected turbofan in the 75-150-passenger class. Thus, a standard turbofan must go to four times the passenger load to compete on a direct operating cost basis with a 35-passenger turboprop. Figures 6 and 7 show operating economics that were projected and achieved on the 340 at ranges of 150 to 300 statute miles, and compares them with what is anticipated in the marketplace in the 1980's.

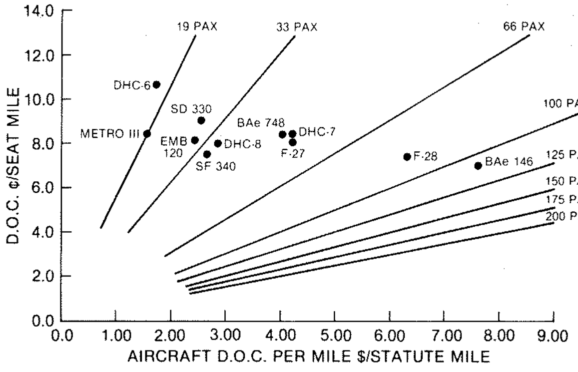


FIGURE 6. ECONOMIC COMPARISON OF TURBOPROP AND TURBOFAN AIRCRAFT (CURRENT DOLLARS, 150 STATUTE MILE MISSION)

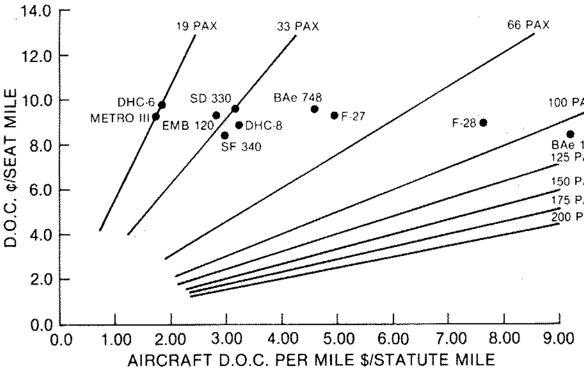


FIGURE 7. ECONOMIC COMPARISON OF TURBOPROP AND TURBOFAN AIRCRAFT (CURRENT DOLLARS, 300 STATUTE MILE MISSION)

Speed was mentioned previously as contributing to productivity on longer range turbofans, but losing its dominance as ranges become shorter. Figure 8 shows block time impact of speed at different ranges. Trade studies indicated that for 150 nautical miles range legs, a 300 mph cruising speed offered minimum DOC with minor impact on block time.

It was the stated intent of the program to establish interior noise levels equivalent to the modern jet transports (Boeing 737) and target levels are shown in Figure 9. Techniques are currently available to reduce the spike in the propeller plane with minimal weight impact, and it is confidently anticipated that future passengers in a 340 will be unaware of noise differences when compared to the smaller turbofans.

Lest the airframe designer take too much credit for performance on either the modern turbofan or turboprop, it should be pointed out that most development has come in the

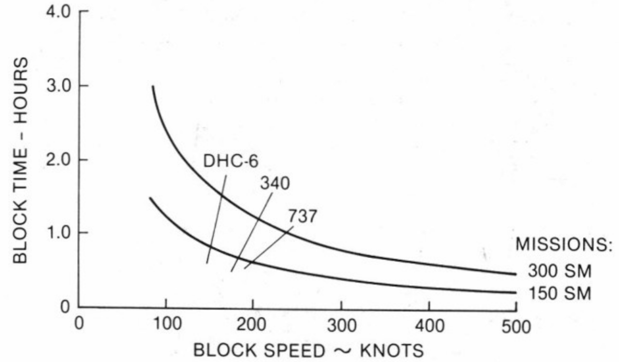


FIGURE 8 – IMPACT OF SPEED ON BLOCK TIME AT TYPICAL REGIONAL AIRCRAFT STAGE LENGTH

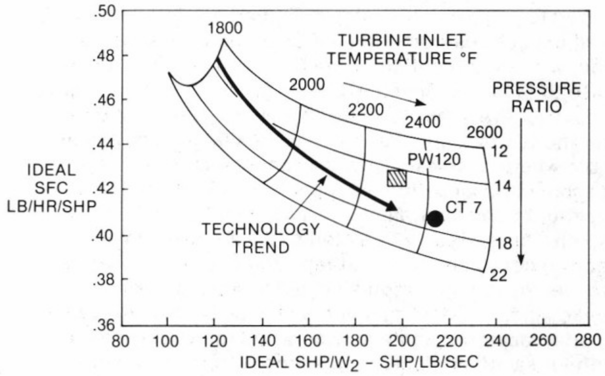


FIGURE 10. PERFORMANCE TRADE-OFFS IN TURBOPROP ENGINE DESIGN

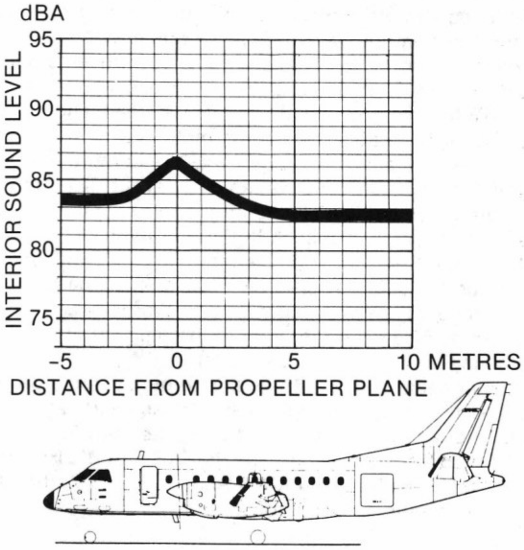


FIGURE 9. AIRCRAFT CABIN NOISE DISTRIBUTION

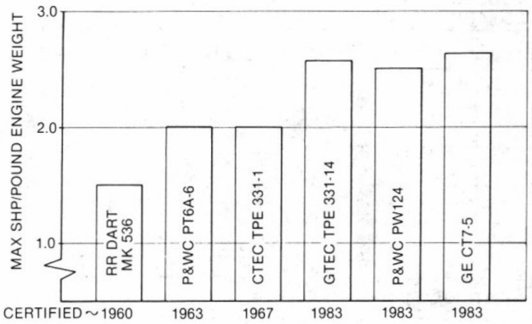


FIGURE 11. ENGINE WEIGHT TREND

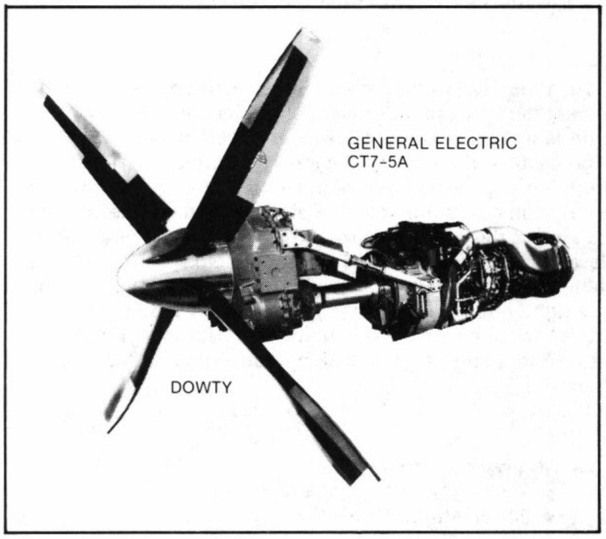


FIGURE 12. POWER PLANT

systems and propulsion areas. The big breakthrough in airframe technology, the application of composites, is coming slowly and the 340 was conceived as establishing a conservative position with the extensive use of bonded aluminum. The application of composites in primary structure is reserved for growth and development applications. The major breakthrough, which gave rise to the aircraft, was actually embodied in the propulsion package.

As cooled turbine blade technology becomes established, operating temperature increases demand higher pressure ratios with obvious advantages in both SFC and weight ratio (Figures 10 and 11). The levels employed in the GE CT7 series would have difficulty gaining commercial acceptance without a durability record and this was provided on the hot sections of the engine by its military background. This military core was matched to a gearbox and composite propeller (Figure 12) providing a step function improvement in operating economics and in noise and vibration levels when compared with the higher rotational speed of earlier turboprop designs.

One of the more controversial configuration issues was the wing placement discussion. Many small regional transports have adhered to the high wing design giving propeller ground clearance. However, Fairchild's experience with the Metro series convinced them that esthetic considerations were significant in airline and corporate preference, and if the objective was to interface with the world turbofan fleet then every effort should be made to adhere to accepted esthetic standards in appearance. Configuration studies showed little to choose from a weight, performance or maintainability point of view. Thus, the decision was turned over to marketing, which opted for the classic lines of the current 340. This is now judged to be a major advantage when compared with subsequent competitive airplanes.

It was noted earlier in this section that the 340 was conceived to serve both the regional transport and the Corporate marketplace. An examination of characteristics of existing corporate aircraft is instructive. Turbofans are now available in all cabin sizes from the Lear 36 to the Challenger, and tend, with the exception of the Citation I and II, to operate close to M = 0.8. Speed is clearly attractive for the higher executive levels, but for other levels, economy will be a factor. The GI set a precedent in having a large comfortable cabin where business could be conducted enroute and economy of acquisition and operation was dramatically superior to any equivalent size turbofan. Fairchild began to explore this market with a Merlin IV size fuselage and became convinced that a GI replacement using modern technology in both propulsion, airframe, and systems was marketable. The development challenge in this area remains to offer faster corporate service with high cabin volume without sacrificing operating economics. This is defined as the challenge of the 1980s, and the position is depicted in Figure 13.

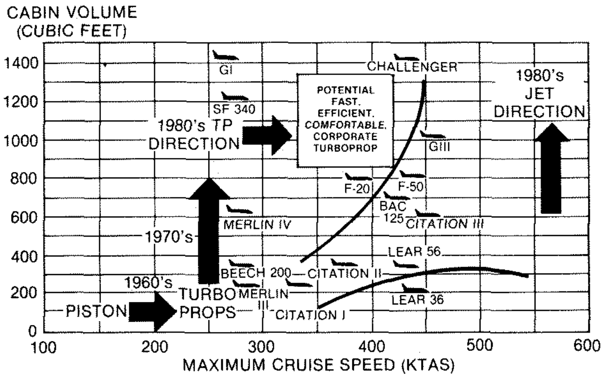


FIGURE 13. BUSINESS AIRCRAFT DEVELOPMENT TRENDS

As a result of initial iterations between engine capability, market desires and airframe design possibilities, design criteria and mission description emerged as shown in Figures 14 and 15. These design flight profiles balance the multi-leg requirements of regional transport operations with long-range corporate use. The airframe and engine combination is optimized at this size. While growth will emerge in development, no additional weight is held on either the airframe or the engine to cope with growth potential. The result is a tightly designed aircraft which, by any historic standards, offers new plateaus in economics, reliability and passenger comfort. This design is described in the next section.

- DESIGN MISSION
  - FOUR STAGES OF 104 N. MILES
  - 800 N. MILES SINGLE STAGE
- SECONDARY MISSION
  - ONE 200 N. MILE STAGE
- PAYLOAD
  - 35 PASSENGERS
- CRUISE SPEED/ALTITUDE
  - 280 KNOTS/15,000 FT. (MAX. CRUISE POWER)
- RESERVES FOR 45 MINUTES CONTINUED CRUISE AND 100-MILE DIVERSION
- FIELD LENGTH
  - 6000 FT. TAKEOFF AT 5,000 FT. ALTITUDE, ISA + 20°C FOR SECONDARY MISSION WEIGHT
  - 4000 FT. LANDING AT S.L., ISA FOR DESIGN MISSION WEIGHT

FIGURE 14. DESIGN CRITERIA

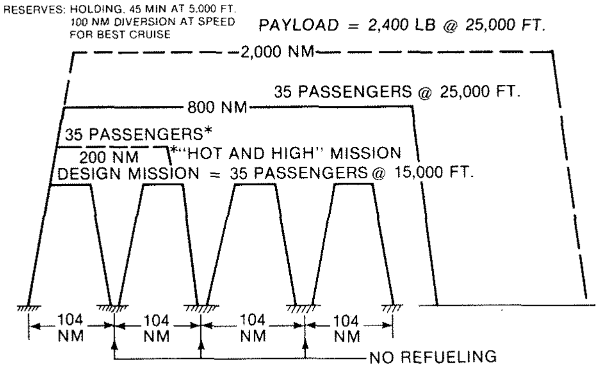


FIGURE 15. DESIGN FLIGHT PROFILES

III. Design Description

The Saab-Fairchild 340 is a twin-engined, low wing, pressurized aircraft designed for the dual role of regional transport or corporate aviation. A general arrangement is shown in Figure 16. It is basically a three-abreast, stand-up height fuselage normally laid out for 35 passengers. A 225-cubic-foot cargo compartment is provided, and the interior layout is flexible and can be matched to different requirements for passenger-cargo mix. The corporate arrangement will normally be in a two-abreast layout. The flight compartment is designed for two-pilot operation and incorporates an observer's seat. A flight attendant's seat is installed in the front of the passenger cabin. A plug-type main entry door is located at the forward end of the passenger cabin. The baggage compartment has a large access door on the left side of the aircraft, also of the plug variety. A Type II emergency door is located at the forward end of the passenger cabin and two Type III emergency doors on each side over the wing. The flight deck has an overhead escape hatch. The aircraft is certified to European JAR 25 and the U.S. FAR 25 Regulations and meets FAR Part 33, FAR Part 35 and JAR-P, FAR 36 and ICAO Annex 16. It is certified for flight in known icing conditions.

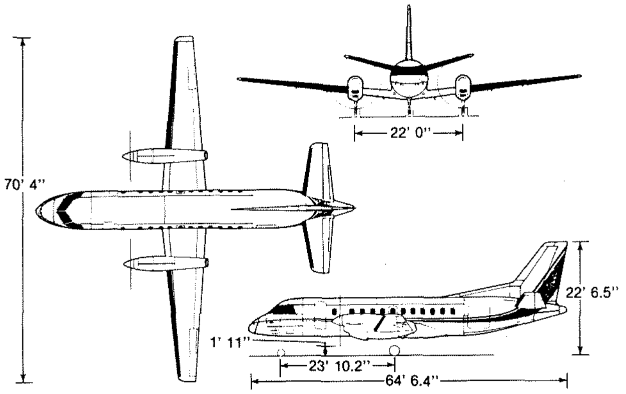


FIGURE 16. GENERAL ARRANGEMENT

Structural Arrangement

The structural arrangement of the fuselage is shown in Figure 17. The radome is a Kevlar fiber reinforced plastic shell with flush mounted hinges on one side and latches on the other side. The flight compartment enclosure is a sheet metal structure with windshield frames milled from heavy plate stock. The forward flight compartment and nose wheelwell bulkhead constitute a pressure wall supported by two vertical beams. The cabin section is divided into top, side and bottom panels. The panels incorporate bonded doublers, window frames and longitudinal stiffeners and riveted frame sections. The cabin floor panels are of sandwich construction with carbon/Kevlar reinforced surfaces and Nomex honeycomb core attached to floor beams. The section aft of the cabin is built-up with partly compound chemically milled curved panels and a rear pressure bulkhead in the extreme tail area. A separate bulkhead can be installed in alternate locations up to the forward limit of the seat tracks for increased cargo volume.

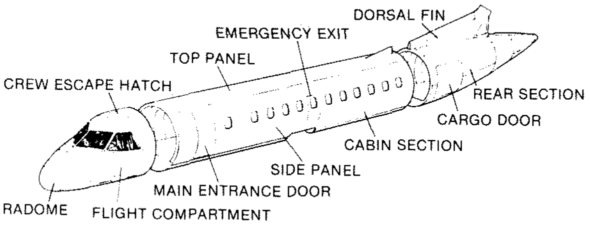


FIGURE 17. FUSELAGE STRUCTURAL ARRANGEMENT

The nacelle consists of a semi-monocoque structure attached to the wing structure at the forward and aft spar locations and by drag angles to the upper and lower wing covers. It houses the engine installation in a fireproof compartment, the exhaust system, the main landing gear with support structure and an optional APU installation (left-hand engine pod only). The layout is shown in Figure 18.

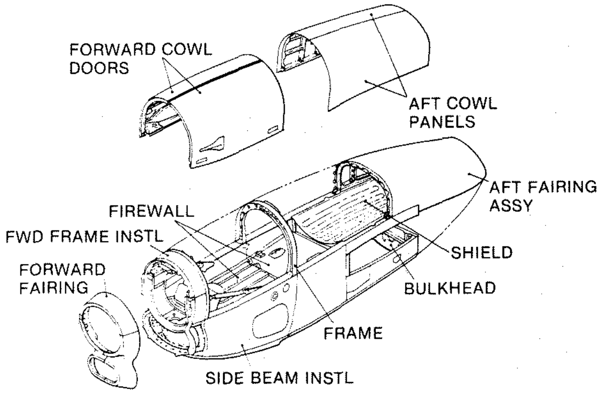


FIGURE 18. NACELLE ARRANGEMENT

The horizontal and vertical stabilizers are fuselage mounted. The horizontal stabilizer is built-up with two main aluminum spars with aluminum ribs at elevator hinge and elevator tip locations. It is covered with aluminum sheet faced honeycomb sandwich panels and the leading edge is a thick aluminum skin with multiple ribs, for bird impact protection (see Figure 19). The vertical stabilizer is similarly designed and is shown in Figure 20.

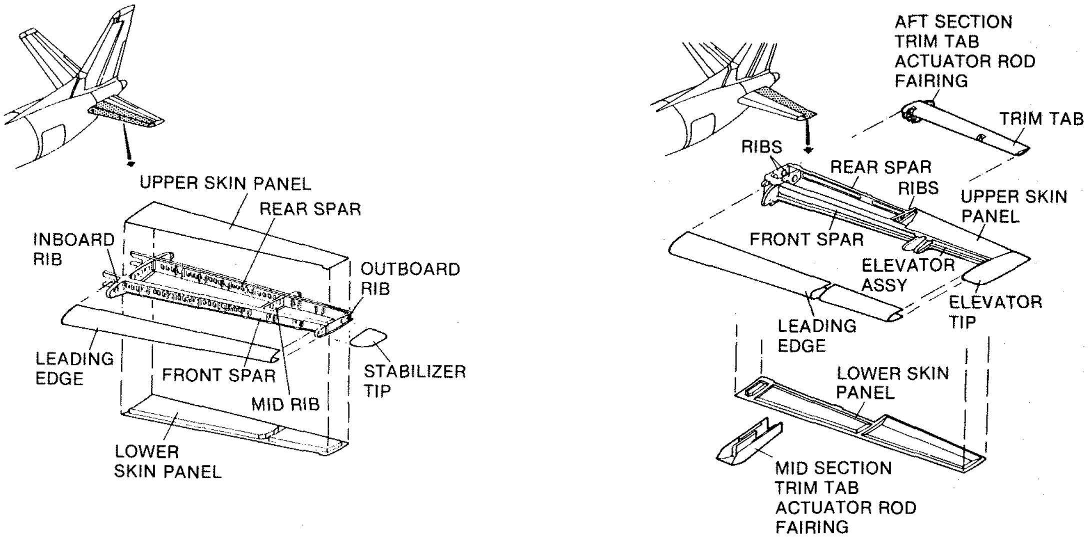


FIGURE 19. HORIZONTAL STABILIZER

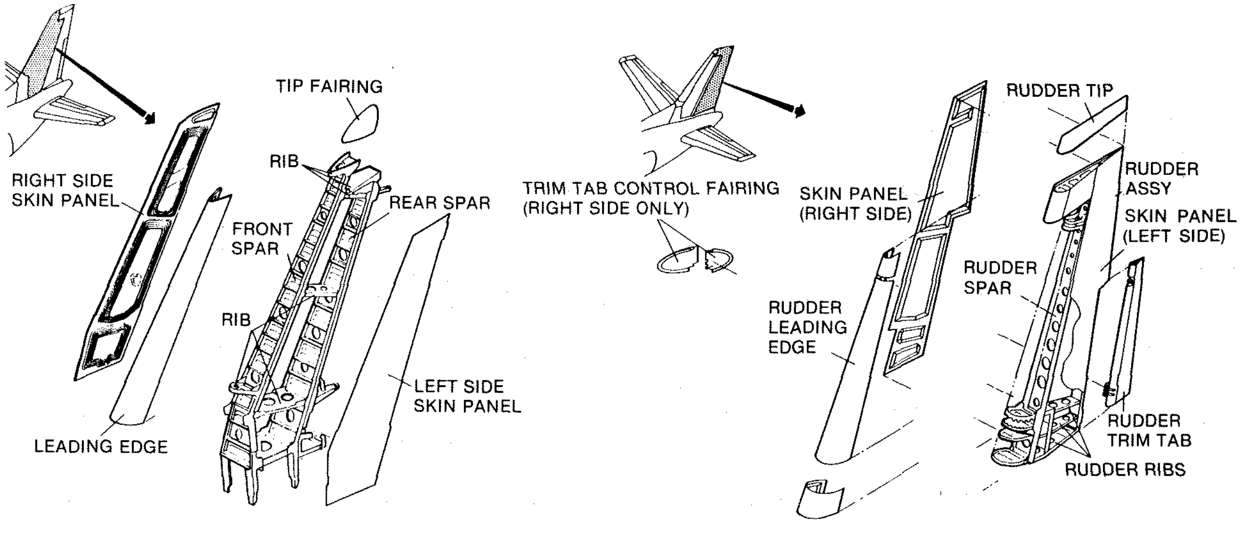


FIGURE 20. VERTICAL STABILIZER

The elevator is built-up from one main spar with ribs and Kevlar fiber/honeycomb sandwich trailing edge box (Figure 19). The rudder is of similar construction (Figure 20).

The wing is constructed in two parts with a manufacturing splice at the aircraft center line. It is conventionally built-up around two spars. The skin panels are stiffened by stringers, and doublers are bonded to the skin. The leading edge is removable and constructed of thick aluminum skin and multiple ribs to protect against possible bird strike. The space between the spars, the rib just outboard of the fuselage side and the aileron root rib constitutes an integral fuel tank with access doors in the upper panel. Additional access doors to wing interior as required for servicing, inspection and assembly are all shown in Figure 21.

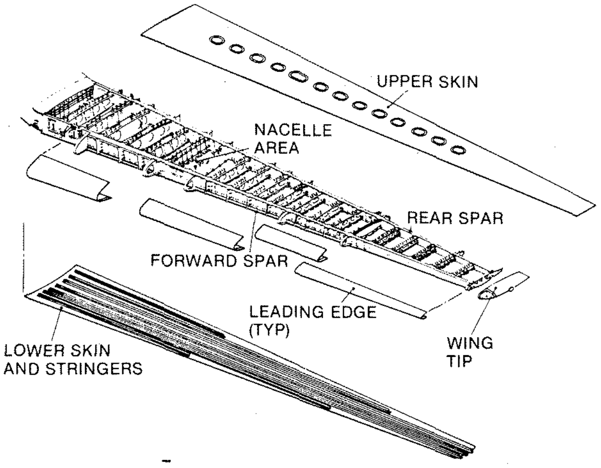


FIGURE 21. WING STRUCTURAL ARRANGEMENT

The flaps are of the single slotted-type, each flap built with two main spars with ribs at the ends and at the hinges. They are covered with aluminum sheet faced honeycomb sandwich panels. The leading edge is a Kevlar sandwich, and the trailing edge is a full depth sandwich covered with Kevlar fiber. The aileron is similar in construction to elevator and rudder.

Power Plant

The aircraft is equipped with two General Electric CT7-5A engines, each mounted in a nacelle integral with the wing. A general arrangement of the propulsion unit is shown in Figure 22. The design features a 1381 RPM propeller gearbox with provision for propeller and over-speed governor, an AC generator and propeller brake.

The compressor has five axial stages and one centrifugal stage producing a 17:1 pressure ratio. The annular combuster is machined from forged rings. The two-stage gas generator turbine is air-cooled while the two-stage power turbine is uncooled with tip shrouds to improve durability.

The engine is modular and most line replaceable units are easily accessible and can be changed in less than 15 minutes. It is approved for on-condition maintenance.

The engine is started with a 24V DC starter/generator installed on the engine accessory gearbox and powered by the aircraft battery or ground source.

The propeller is a Dowty Rotol four bladed, variable pitch, constant speed unit with rotation in the clockwise direction as viewed from the rear of the propeller. The blades are of composite construction with glass and carbon reinforced plastic mating to a metal root and having an ARA-D airfoil section. Pitch change is hydraulic through a two oil line system and there are counterweights at the blade roots to ensure automatic feather operation in event of oil pressure failure.

Landing Gear

The landing gear is a conventional tricycle arrangement, the main gear retracting forward into the landing gear bay in the nacelle and the nose gear forward into the fuselage nose. The nose and main gear are shown in general arrangement on Figures 23 and 24.

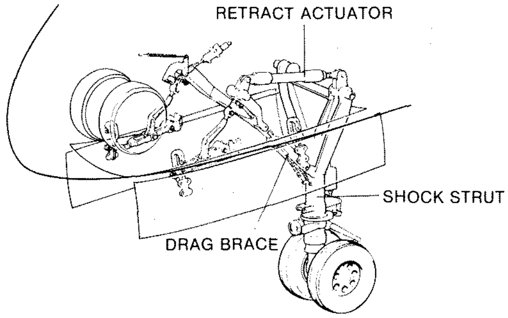


FIGURE 23. NOSE LANDING GEAR ARRANGEMENT

The shock absorber struts are conventional, and each gear carries two wheels. The power operated disc braking system is divided into two independent systems, each including an accumulator. Anti-skid control is provided including dual circuits. The nose gear is equipped with hydraulically powered nosewheel steering combined with shimmy dampening.

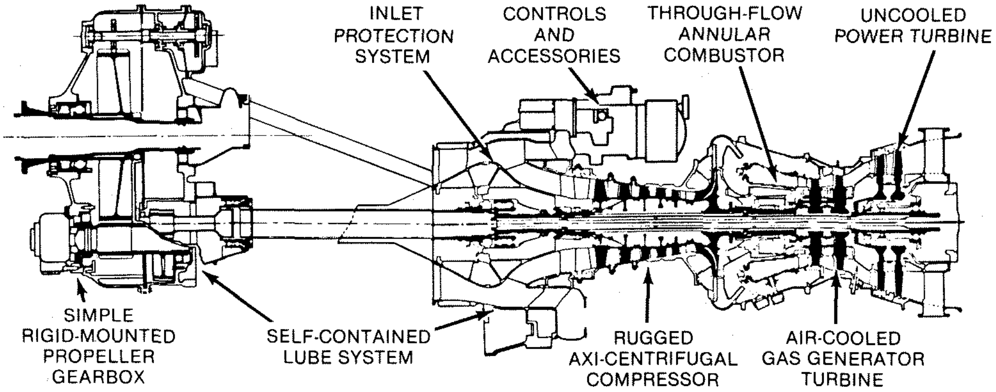


FIGURE 22. GENERAL ARRANGEMENT OF THE PROPULSION SYSTEM

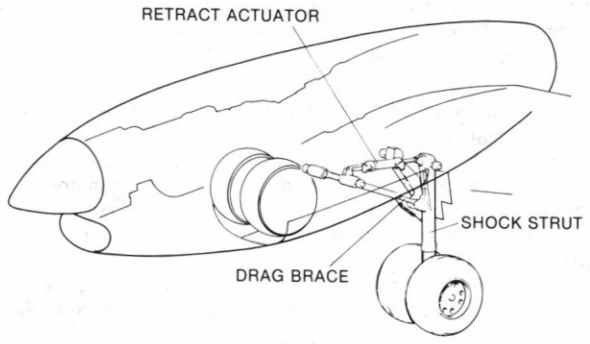


FIGURE 24. MAIN LANDING GEAR ARRANGEMENT

All wheelwell doors enclose the gear when retracted. The main landing gear doors are also in the closed position with gear extended.

Flight Control System

The primary flight control is an all-manual system controlling aerodynamically and mass balanced surfaces. The layout is shown in Figure 25. The elevator is geared tab operated with the tabs located at the inboard end of the surface. The rudder is a single hinged surface manually operated with spring tab assist. The aileron is also manual and contains an assembled geared tab.

Each surface is fitted with a trim input operated by an electric trim actuator.

The single slotted, hinged flap system is driven by hydraulic actuators, one on each side, and positive synchronization is included. The flap selection lever allows selection of any of four positions.

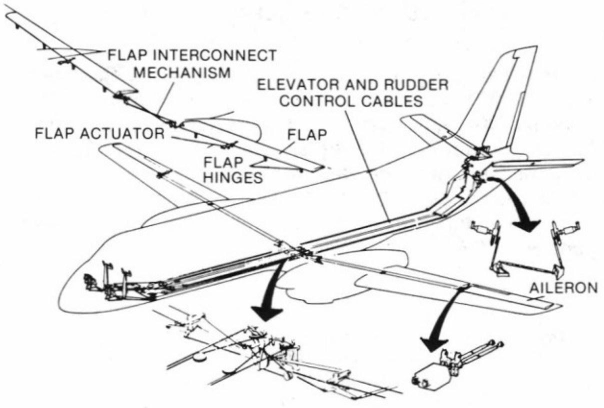


FIGURE 25. LAYOUT OF FLIGHT CONTROLS AND FLAP SYSTEMS

Flight Deck

The Saab-Fairchild 340 flight deck features an advanced Collins digital system with Cathode Ray Tubes as shown in Figures 26 and 27. Standard on the aircraft is a 4 CRT configuration positioned in the cockpit just as an electromechanical system would be. The display formats have been designed specifically for Saab-Fairchild and appear on 5" x 6" tubes. In addition to attitude and flight director information, the EADI-86 Electronic Attitude Director Indicator can display flight control mode annunciations, a traditional glide slope scale, an expanded localizer symbol, radio altitude decision height and marker beacon information. The EHSI-86 Electronic Horizon Situation Indicator provides DME and DIR Data Information and has the traditional system capability of preselecting a second course arrow. All information is in digital form. An expanded 80-degree sector presentation can also be selected, and the radar display can be combined with the EHSI presentation to give a better picture of the navigation situation. An optional fifth tube, the multifunction display, fits in the cockpit in the traditional weather radar position adding redundancy, because of its capability, to display any EHSI presentation. It provides another processing unit which can generate the displays for any of the tubes. The MFD reduces cockpit work load with its added capability of displaying alphanumeric information. Access is provided to a large data bank, including checklists, emergency information and diagnostic data.

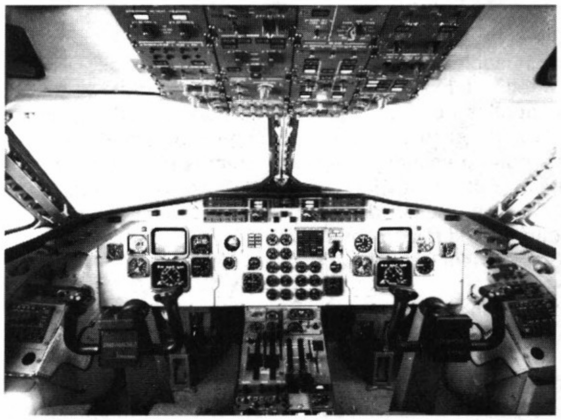
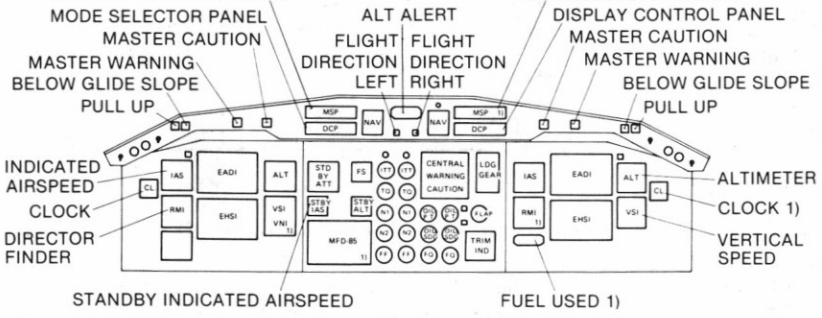


FIGURE 26. COCKPIT DISPLAYS

An APS 85 Autopilot System is provided, supported by ADS 81 Air Data System and AHRS 85 Attitude and Heading Reference System, a strap down replacement for the high maintenance cost gyros and accelerometers of conventional analog avionics.



1) = SPACE FOR OPTIONAL INDICATORS

EADI — ELECTRONIC ATTITUDE DIRECTOR INDICATOR
EHSI — ELECTRONIC HORIZONTAL SITUATION INDICATOR
DCP — DISPLAY CONTROL PANEL
MSP — MODE SELECTOR PANEL
WXP — WEATHER RADAR CONTROL PANEL
MFD — MULTIFUNCTION DISPLAY
RMI — DIRECTION FINDER
CL — CLOCK
IAS — INDICATED AIRSPEED
DCP 55 — DISPLAY CONTROL PANEL
F/D L — FLIGHT DIRECTOR LEFT
F/D R — FLIGHT DIRECTOR RIGHT
NAV — INSTRUMENT LANDING SYSTEM
MSP 1) — MODE SELECTOR PANEL
CL — CLOCK
ALT — ALTIMETER
VSI — VERTICAL SPEED
STBY IAS — STANDBY INDICATED AIRSPEED
BELOW G/S — BELOW GLIDE SLOPE

FIGURE 27. FLIGHT DECK ELEMENTS

It is worth observing that the APS 85 has a climb and cruise capability using the most efficient profiles based on air data inputs and stored aircraft performance data. In combination with a vertical navigation indicator, the vertical navigation mode will also reduce fuel consumption during the letdown phase of the flight by optimizing the top of descent point. This flight management capability is expected to have a significant effect on fuel economics in an environment where half-hour flights are the norm.

Systems

The air-conditioning system has two air cycle packs, each consisting of a heat exchanger, cold air unit, water extractor and temperature control. Air-conditioning on the ground is provided by an external ground connection or by operating the right-hand engine as an APU or by operating the APU. Passenger and crew compartment are ventilated, and a portion of the ventilated air is recirculated. Each passenger and crew member also has an individual outlet, and the air-conditioning system provides airflow for windshield demisting. The pressurization system maintains sea level cabin pressure to an altitude of 12,000 feet. Maximum cabin pressure differential is 7 psi.

An electrically driven hydraulic pump provides power and control to the brakes, nose wheel steering, anti-skid control, flaps and propeller brake. Accumulators for the brake and gear extension are provided as is a hand pump for additional safety. Operating pressure limit is 3,000 psi.

Total usable fuel capacity is 880 U.S. gallons contained in two integral tanks located one in each side of the wing. Each tank supplies its adjacent engine and cross-feed is provided. Standby DC electrically powered pumps are standard. A single point pressure refuelling system is provided with inlet located on the right wing outboard of the engine. Empty tanks can be refilled in less than 12 minutes at 80 gallons per minute and maximum pressure of 80 psi. An automatic shut off system is incorporated.

The aircraft electrical power supply is composed of AC and DC systems with corresponding load distribution. Power is supplied by a 28 volt 400 AMP DC starter/generator on each engine. Each starter/generator is connected to a separate bus bar. Regulated 400 Hz AC power is provided by a solid state inverter supplemented by a standby inverter for essential loads. Heating power is supplied by a secondary 27 KVA AC generator on each engine. Two batteries are included in the system for ground power and to provide engine start capability. An emergency power pack for the supply of standby gyro horizon and other emergency loads is also provided.

Ice protection is provided for the wings, horizontal stabilizer, windshields, engine inlets, propellers and pitot-static tubes, angle of attack transmitters and the outside temperature sensor. The leading edge of the wing and the leading edge of the stabilizer are de-iced by flush type pneumatic boots actuated by engine bleed air. Windshield panels are electrically anti-iced and equipped with electrically driven windshield wipers.

IV. Performance Capability

As described in the Requirements Section, certain goals were set for the program, and the design, as described in Section 3, is aimed at meeting these goals. Capability is always a compromise. The fundamental objective was to provide a capability that would have a broad market appeal and not penalize the majority for a unique requirement of the minority. Neither is it possible to offer a standard aircraft configuration. Optional differences are offered where a unique mission or customer bias can be met within the broad constraints of financial feasibility. Some of these options are described. There will be many more as the program develops and is completely exploited.

The flight envelope, representing the standard aircraft in the flight manual, is shown in Figure 28 at a gross weight of 22,000 pounds. The engine is set up for a cruise altitude of 15,000 feet in the commuter configuration, which is consistent with a 150-nautical-mile leg. As legs vary or as requirement of a particular customer demands, this configuration is obviously subject to change. Maximum cruise is 285 knots in this condition. Maximum cruise altitude is in the region of 30,000 feet, depending on weight. The speed for maximum range is 225 knots.

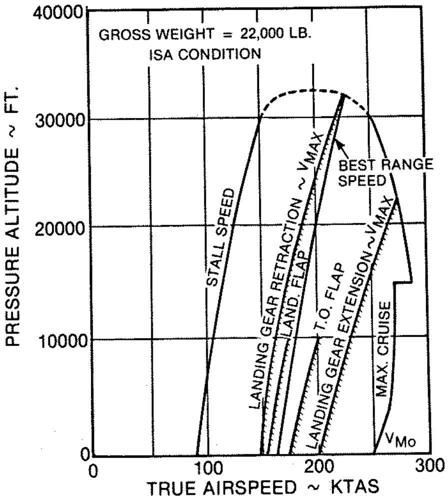


FIGURE 28. TYPICAL FLIGHT ENVELOPE

Achieved specific range is shown in Figure 29, again at a gross of 22,000 pounds. It can be seen that 0.4 nautical mile/pound of fuel at best range speeds is close to possible. This makes it obvious that the simple modern propeller provides a measure of progressive efficiencies beyond the reach of any conceivable turbofan, and the challenge of the future is to maintain this advantage when speed is increased beyond M = 0.6.

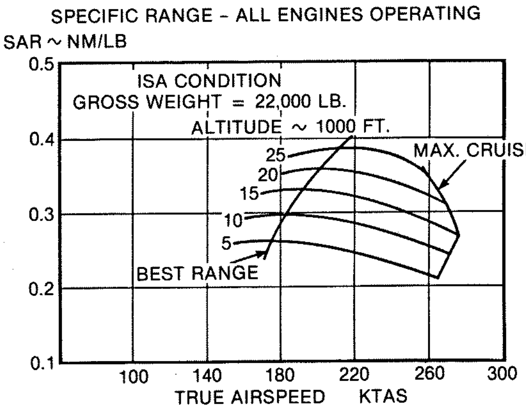


FIGURE 29. SPECIFIC RANGE

Climb capability is shown in Figure 30 at two gross weights and is within the range of acceptance operating perfomance on aircraft of this classification. Single engine ceiling is shown in Figure 31 at two atmospheric conditions, ISA and ISA + 20°C.

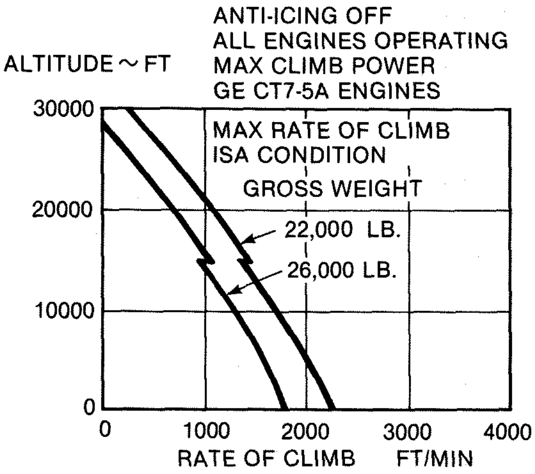


FIGURE 30. CLIMB PERFORMANCE

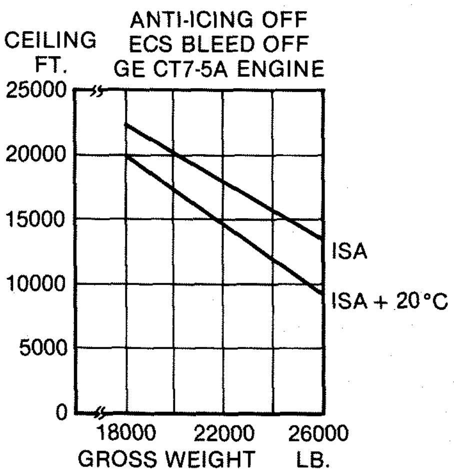


FIGURE 31. ONE ENGINE INOPERATIVE SERVICE CEILING

Propeller aircraft have the reputation of being noisy and subject to tiring vibration. Flight tests to date on the 340 and initial operational observations have confirmed the design expectation that this need not necessarily be so in the modern turboprop. Internal noise goals as shown in Figure 9 (in the Requirements Section) are being met and an option will soon be available to eliminate the spike in the propeller plane for those operators who do not find it convenient to locate coat closets or galleys in this area. The goal still remains to make the 340 as comfortable as the current turbofan at all passenger locations, and this is considered feasible. From an external noise point of view, Figure 32 shows in tabular form how the 340 ranks with various known and projected requirements.

CRITERIA	SF 340 ESTIMATES	FAR36 STAGE 3		IACO ANNEX 16 CH. 5
		EPNdB		
FLYOVER	80	-	89	-
SIDELINE	88	94	-	96
APPROACH	90	-	98	-
AVERAGE	86	93.7	-	94.3

FIGURE 32. COMMUNITY NOISE PROJECTION

Payload range capability of the aircraft is shown in Figure 33. This chart is constructed for single hop operation for convenience and ease of presentation. The flexibility of the aircraft is readily apparent. Range on regional transports is generally less than 500 nautical miles and range on executive aircraft is really governed by a maximum comfortable air time criteria. Long transoceanic flight is clearly another issue and is a mission for which this aircraft is not necessarily marketed. It might be pointed out that statistics confirm that the average stage length on executive jets and turboprops is a surprisingly short 520 nautical miles with the distribution as shown in Figure 34. A block time and fuel chart for this design is shown in Figure 35.

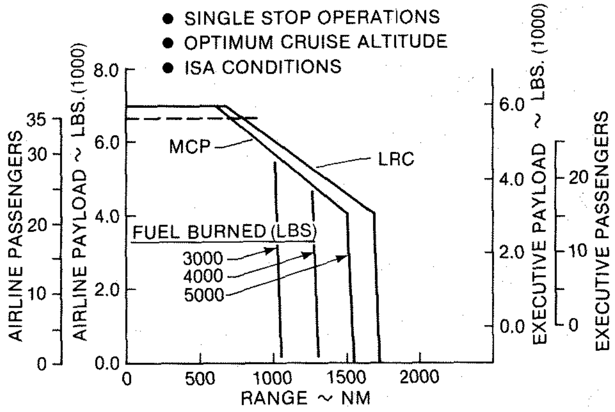


FIGURE 33. PAYLOAD RANGE

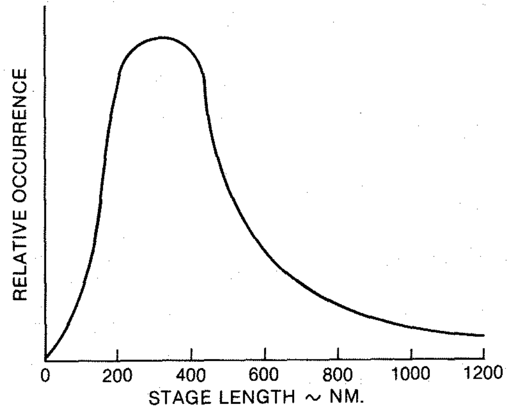


FIGURE 34. EXECUTIVE MISSION STAGE LENGTH FREQUENCY DISTRIBUTION

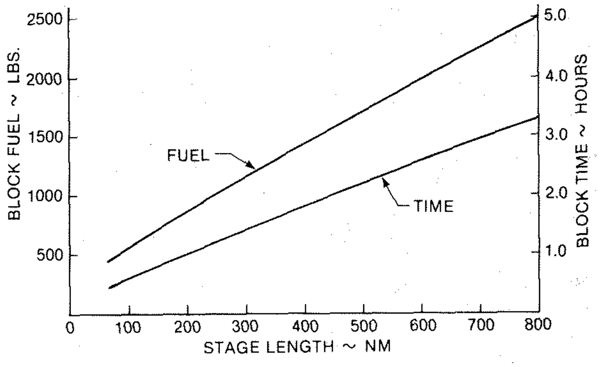


FIGURE 35. BLOCK TIME AND FUEL CHARACTERISTICS OF THE EXECUTIVE AIRCRAFT

Field performance is one of the differentiating characteristics of turboprop equipment. As previously pointed out, no special effort was made to add weight or complication to the 340 to attempt to cater to the operator with very short or unique field requirements. The aircraft does, however, display dramatic capability and flexibility for the average operator. The take-off situation is shown in Figure 36.

Landing conditions, seldom critical on this type of design, are shown in Figure 37.

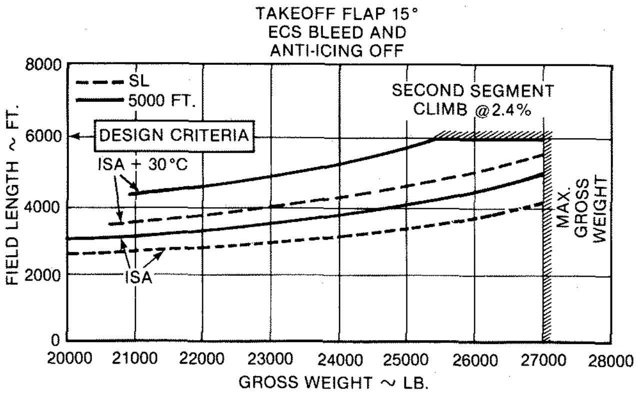


FIGURE 36. TAKE-OFF FIELD LENGTH PERFORMANCE (STANDARD AIRCRAFT)

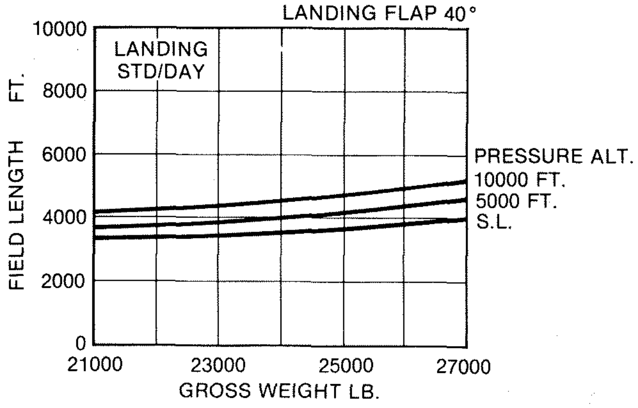


FIGURE 37. LANDING FIELD LENGTH

VI. Management

There are now many examples of international cooperative development of aircraft ranging from the Concorde to the CN235, and each example appears to be unique. Most appear to have a dominant and pacesetting company or country with other participants committed "de facto" to a role not unlike a risk sharing subcontractor. In the past where equality between partners had been attempted, much had been lost, both financially and in terms of program momentum to inter-party rivalry or national pride. With such an historical understanding and a confidence generated by a successful effort to cooperate in the definition of the program, Fairchild and Saab agreed in early 1980 to jointly develop, manufacture, market and support a new commercial transport aircraft and derivative thereof, including corporate versions, using the available resources of both parties. The program was initiated by the establishment of a Management Board to direct, control and coordinate the project. The board, consisting of three representatives with decision making authority from each party, was presided over by an independent chairman. It was charged with establishing policies governing the operation of the project and rules and guidelines for its administration.

This responsibility was exercised by the appointment of a project director who was responsible to the board for project definition, work breakdown structure, work package descriptions, design, development, production and associated schedules. Employees of both partners have filled the position of project director at various stages over the past four years and a deputy project director from the other partner has been consistently selected. The project director has reported extensively on technical, financial and operational aspects of the project at monthly board meetings held alternately in Sweden and the United States.

The project has been implemented and controlled in four basic units:

Unit A	Definition
Unit B	Development
Unit C	Production
Unit D	Marketing (Including Product Support)

Unit A was split on a 50/50 basis between Saab and Fairchild and was performed at the Fairchild Republic Company facility at Farmingdale, New York. Work packages were defined and allocated for the accomplishment of Unit B, split approximately on a 2/1 basis and allocated for accomplishment in either Sweden or the United States. Unit B brought the program through the certification process for worldwide application. Unit C activity was assigned roughly on a 50/50 basis to Saab and Fairchild.

Marketing of the aircraft and derivatives thereof is handled under Unit D, and the management and control of this function have seen more change than elsewhere in the program.

An international marketing entity, Saab-Fairchild International, was established to handle sales in markets outside North America. North American sales were initially envisioned as being handled by a unit of Fairchild Aircraft Corporation staffed by Fairchild and Saab employees with responsibility for both regional transport and Corporate sales. As the program developed, it was found appropriate to relocate North American regional transport sales activity to Dulles Airport, Washington, D.C., under the control of Saab-Fairchild International and to continue corporate sales under the control of Fairchild Aircraft Corporation in San Antonio.

As the development process continued and the emphasis shifted to integrating a major international aircraft program, the board decided to appoint a chief executive officer for the joint venture with wide-ranging responsibilities for all aspects of the activity. The resulting organization is shown in Figure 38. The chief executive officer is domiciled in Sweden.

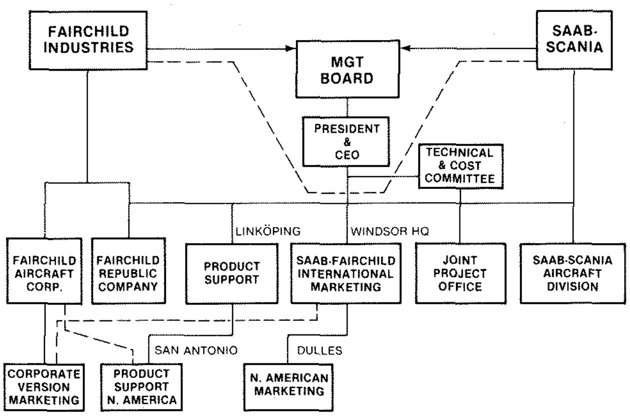


FIGURE 38. THE JOINT VENTURE ORGANIZATION

In addition to the organization as stated, three committees of the board were established to offer the best combined judgment of both partners to the operating organization.

1. Budgets and Economy Committee
2. Production Planning Committee
3. Technical Committee

Each committee tends to operate somewhat differently, but generally on an ad hoc basis, with the exception of the Production Planning Committee which meets at three-month intervals.

Schedule

Subsequent to conceptual studies and inter-party understandings arrived at during 1979, the program was initiated in early 1980 with a target to reach the marketplace with a superior aircraft in the spring of 1984. The Master Schedule as of March 1984 is shown in Figure 39 indicating accomplishment of these initial objectives. Design and development were not without problems. Major equipment suppliers provided many anxious moments. In some cases they demanded work around solutions, but the end product (Figure 40) seems appropriately timed for the increasing demand anticipated in the regional transport market over the next 10 years.

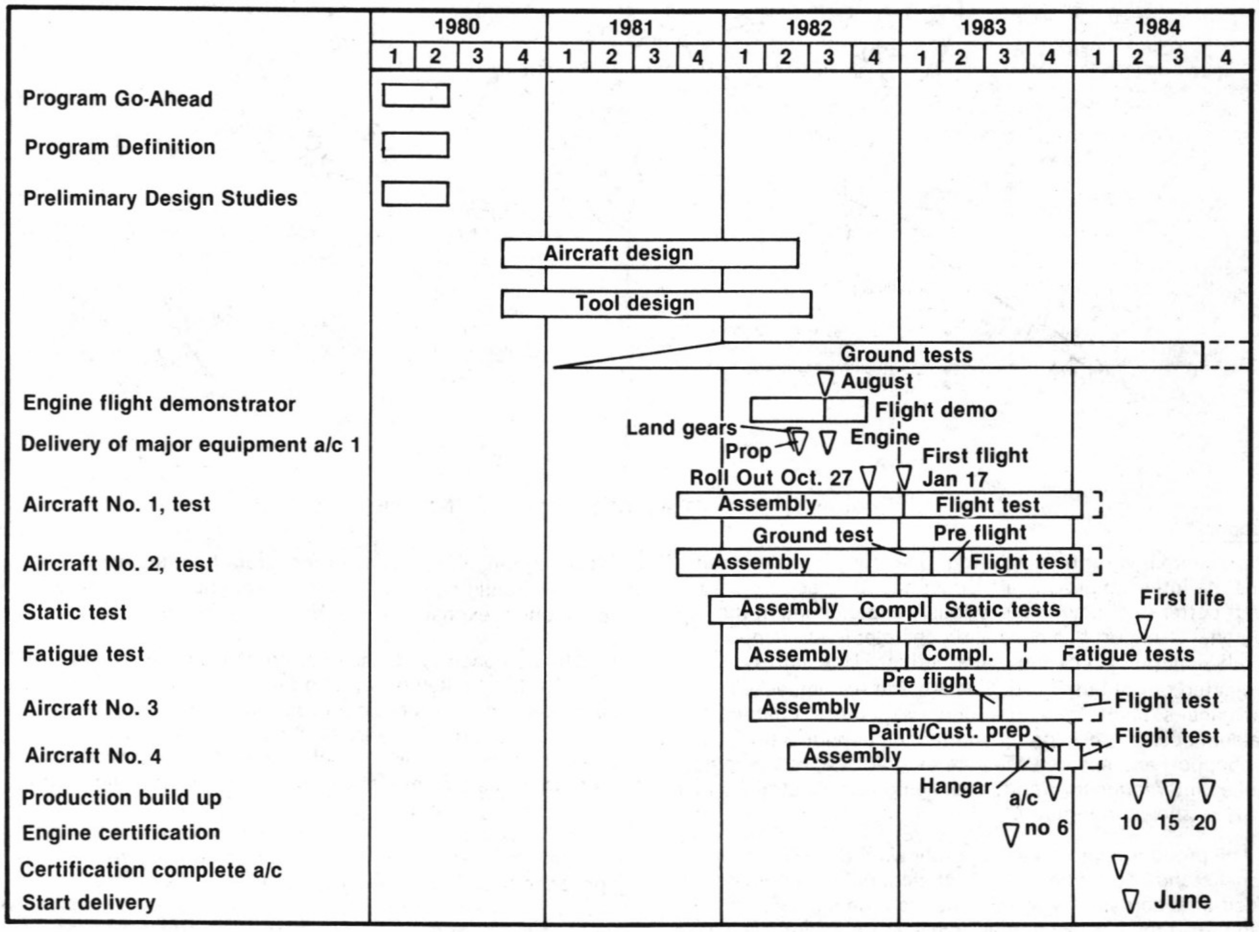


FIGURE 39. MASTER PROGRAM SCHEDULE

FIGURE 40. INFLIGHT PICTURE

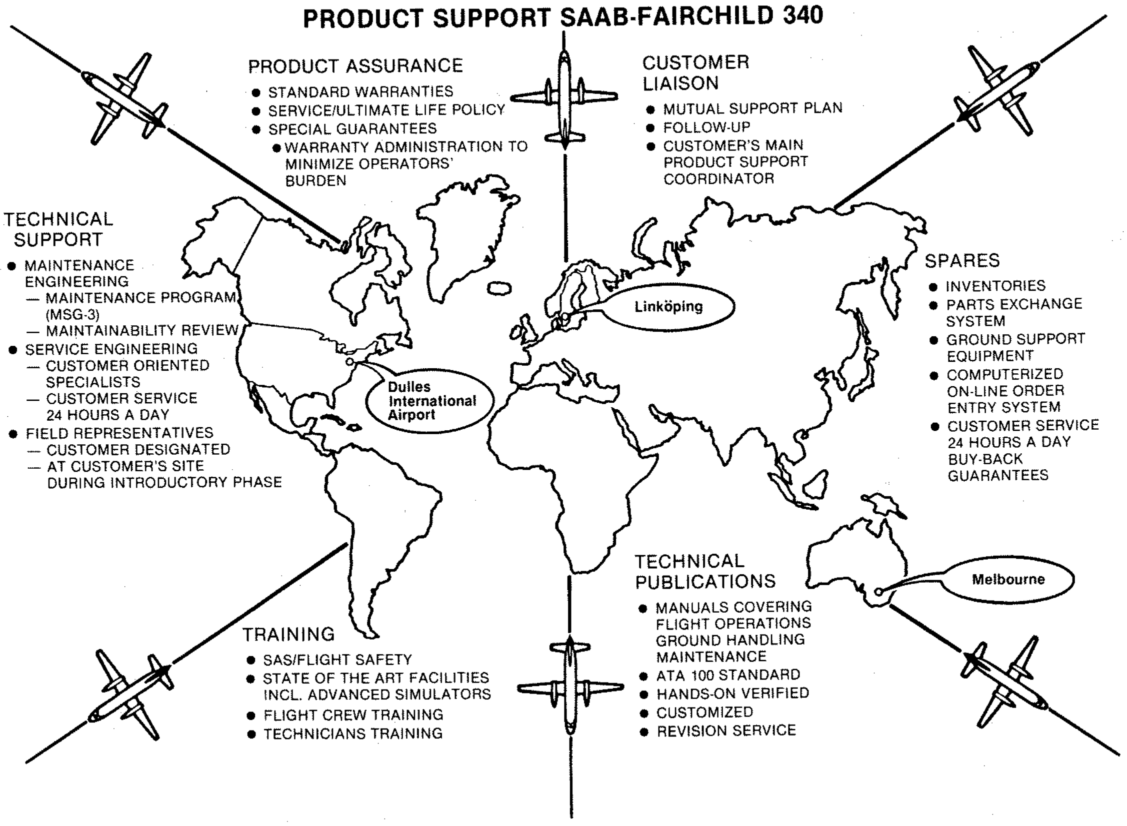


FIGURE 41. PRODUCT SUPPORT SAAB-FAIRCHILD 340

Support

Consistent with the desire to produce a superior aircraft was the intent to provide a product support base for the aircraft better than anything previously experienced in the regional transport business and consistent with support levels experienced by the major airlines. This activity is coordinated out of Linköping, Sweden and encompasses technical support, training, product assurance, customer liaison, spares provisioning and technical publications. Major support and spares bases are established in Linkoping, Dulles International Airport, and Melbourne, Australia and activity is shown in Figure 41.

The product support package follow all available international standards for airliners. Technical publications are provided in accordance with ATA-100 requirements. Technical support to the customer is available 24 hours, 7 days a week. Spares inventories are available at Linkoping, Sweden and Dulles Airport, USA at any time of the day and night. Very fast response time after receipt of order for critical spares is offered. (Response times according to the World Airlines Suppliers Guide).

Training facilities for flight crew and technicians are offered in Stockholm by Scandinavian Airlines System and in San Antonio, Texas by FlightSafety International. The facilities include advanced flight simulator with motion system and CGI display.

The product assurances include standard warranties, life warranty and special guarantees. This package is believed to be the best offered on the market. Warranty administration officers are located at Linköping and at Dulles Airport.

An agreement exists between Saab-Fairchild Joint-Venture and the Swedish firm, FFV, about maintenance support. The agreement enables Saab-Fairchild to offer the operator component maintenances at a guaranteed price per flight hour. FFV will repair and overhaul the aircraft components, and Saab-Fairchild can thereby offer a very fast service through a component exchange program.

The approach to management of the Saab-Fairchild joint-venture has broken new ground in International cooperation and has demonstrated the feasibility of equal partners cooperating effectively in the timely certification and manufacture of a new aircraft system. It is worthy of note that this was accomplished without the establishment of a coordinating infrastructure, and management was performed by the resources of the partners merely with direction from the Management Board. This proved effective perhaps because decision-making capability rested with the Management Board and no external agencies, such as the respective governments of the partners, were involved from either policy or financial point-of-view. The absence of the coordinating infrastructure significantly reduced the overhead charges and this, together with the decision to concentrate on a single assembly line approach, kept program costs at a level that compares favorably with what could be accomplished in a single company.

VII. Conclusion

The Saab-Fairchild cooperative venture to produce a superior, modern-technology, 35-seat regional/executive transport is well into its fifth year of existence and has already achieved its goal of airline and executive operation. Much has been learned and much is yet to be done in establishing the Saab-Fairchild 340 in the image desired by the partnership, that of unqualified commitment to superiority in all aspects of operation. The current aircraft is clearly a starting position. It is the intention of the partners to develop and grow this configuration as larger and different powerplants become available and to respond to unique customer requirements by offering a range of performance and capability options. The regional transport marketplace will, over the next 10 years, present a moving target. All demographic and regulatory trends appear to support a burgeoning of the smaller and shorter range transport requirements. With the demise of major United States point-to-point service, it is also anticipated that Corporate America will see the advantage of private or chartered aircraft for work-team relocation. This is the target market for the 340 executive. As a tertiary market, the utility, military support, or even long endurance military style missions have obvious implications for the 340. While non-quantifiable at this stage, this may emerge as a significant market in the future. The Saab-Fairchild team is dedicated to all aspects of potential growth or utilization of the 340 airframe on a worldwide basis and will make the necessary commitment to retain a significant share of all emerging markets.