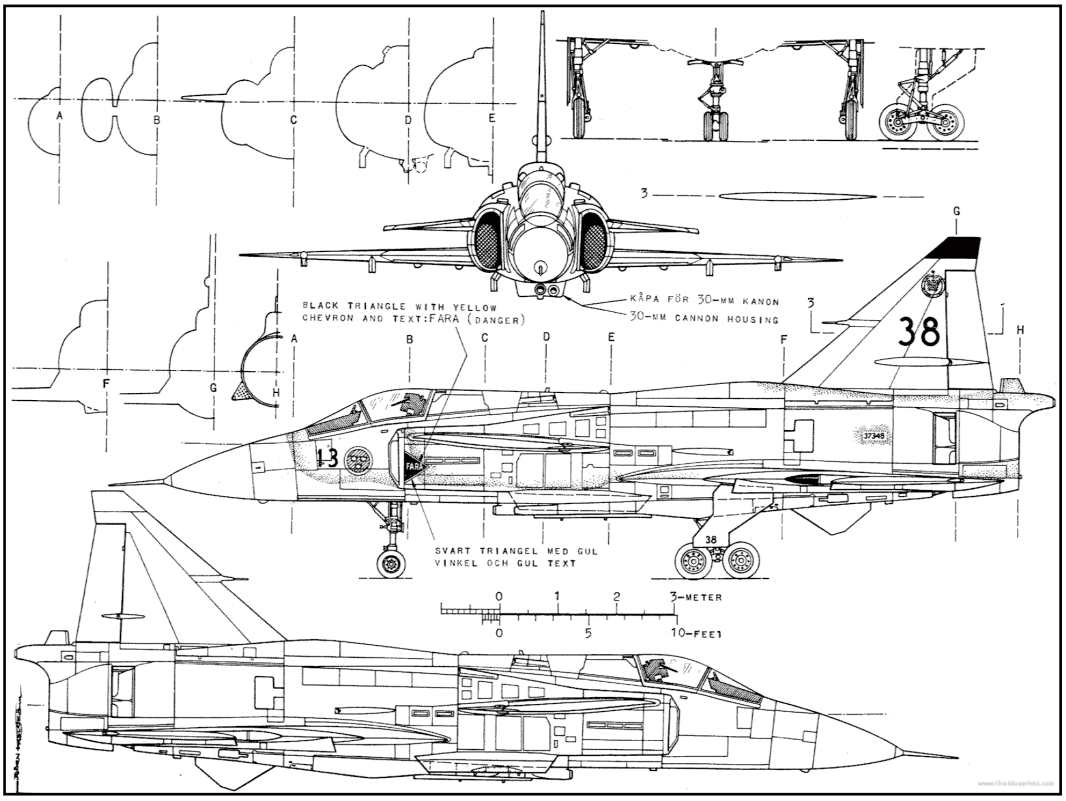
BMS FLIGHT MODEL
JA-37D AIRCRAFT

SAAB Aerospace Corporation.



Manual reference: BMS-A1-JA37D-NFM-000

Changes: Draft Version

CAUTION STATEMENT: This document is to be use only for simulation. Do not try to apply the procedures and or advices contained in it if you have the opportunity to fly this plane in real life. By the way, if you had (or still have) flew this aircraft, your comments, criticism and more are welcome.

PART XI: PERFORMANCE DATA

Contents

PART 1: STANDARD DATA

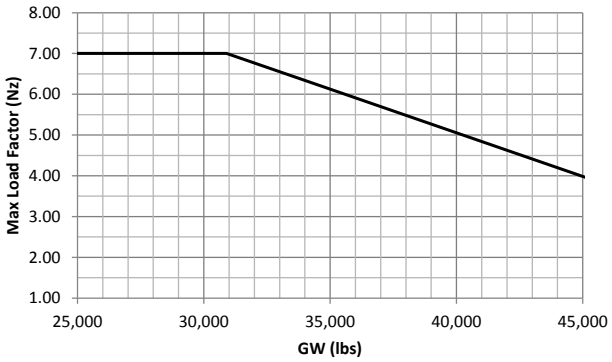
LIMITATIONS

This section deals with angle of attack (AoA) speed and load factor limitations.

The JA-37D is limited to an Angle of Attack (AoA) of 26 degrees (true AoA angle), this limitation is enforced by FLCS in BMS.

The maximum Indicated Air Speed (IAS) or Corrected Air Speed (CAS) is 785 Kts (1,450 Km/h) for a clean aircraft.

Load factor (Nz) is limited to +7g/-3g when gross weight is below 30,900 lbs (14,000 kg), above this value, maximum allowed load factor is reduced as follow:



In next sections, performance will be computed in assuming a load factor limit of 7G, whatever being the configuration gross weight, as it is the only limitation performed by BMS JA37D FLCS.

CONFIGURATION DEFINITION

The performance data are described for various aircraft configurations (loads, weight…). Each configuration is defined by the set of loads (internal or external) and the fuel fraction. For all weapons or loads, contribution to the aircraft configuration is its weight and its drag.

DRAG INDEX SYSTEM

Drag of loads is modeled through the general BMS Drag Index mechanism: each object has its own Drag Index value (DI) that is converted into Drag coefficient (C_D) by a ratio specific to the aircraft and depending form the Mach number. This allows the definition of the Drag coefficient of a given configuration from the one of the reference configuration (clean).

The Drag Index of a configuration is the sum of the Drag Index of each external load of the configuration. This means that the interactions between loads are not managed by BMS DRAG INDEX SYSTEM: if the same load set (pylon, rail, launcher and missile) is installed twice under each wing, the drag contribution is twice the drag contribution of one set installed under each wing.

Let's call

- DI the drag index of the configuration.
- $C_{D\ CONF}$ the Drag coefficient of the aircraft in the identified configuration
- $C_{D\ REF}$ the Drag coefficient of the aircraft in the reference (clean) configuration, depending on Mach number and Angle of Attack (AoA)

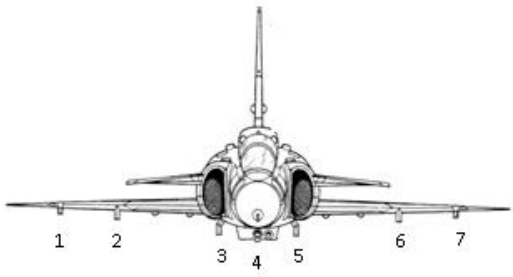
$C_{D\ CONF} = C_{D\ REF} + DI\ .\ R_{(Mach)}$

For the JA-37D, up to Mach 0.9, $R_{(Mach)}$ = 0.0005, over Mach 1.0, $R_{(Mach)}$ = 0.001, between these values, R = 0.0005 + (Mach-0.9).0.005

A consequence of this definition is that the Drag contribution of a configuration does not depend on the angle of attack (AoA).

STATION DEFINITION

The external stores of the JA-37D are located on the 7 available stations described in the figure bellow:



CONFIGURATION 0

This configuration is the reference configuration, without any external loads, but with 50% or the

internal fuel, the equipped pilot, and the internal gun (KCA 30mm Oerlikon) with all its 126 rounds.

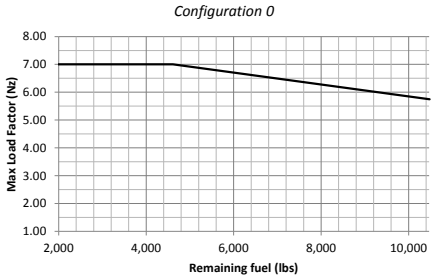
The zero fuel weight of this configuration is 26,289 lbs (11,909 kg).

The 50% internal fuel weight is 5,239 lbs (2,373 kg) with a fuel density of 0.81 kg/l.

The Gross weight of the configuration is 31,528 lbs (14,282 Kg).

By definition, the Drag Index of this configuration is 0.

The recommended load factor limit (Nz max), based on remaining fuel, (initial fuel load is 10,480lbs) is the following:



CONFIGURATION 1

This configuration is the regular combat configuration, with two short range AA missile (AIM-9M or RB-24J) on station 1 and 7, 50% or the internal fuel, the equipped pilot, and the internal gun (KCA 30mm Oerlikon) with all its 126 rounds.

The weight of the two AIM-9M with their pylon, rail and launcher is 654 lbs (296 kg).

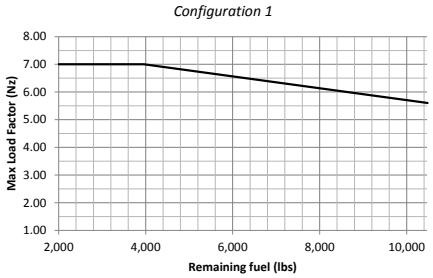
The zero fuel weight of this configuration is 26,943 lbs (12,295 kg).

The 50% internal fuel weight is 5,239 lbs (2,373 kg) with a fuel density of 0.81 kg/l.

The Gross weight of the configuration is 32,182 lbs (14,579 Kg).

The Drag Index of this configuration is 18.

The recommended load factor limit (Nz max), based on remaining fuel, (initial fuel load is 10,480lbs) is the following:



CONFIGURATION 2

This configuration is defined by external stores being two short range AA missile (AIM-9M or RB-24J) on station 1 and 7, two Skyflash (RB-71) missile on stations 2 and 6, 50% or the internal fuel, the equipped pilot, and the internal gun (KCA 30mm Oerlikon) with all its 126 rounds.

The weight of the two AIM-9M with their pylon, rail and launcher is 654 lbs (296 kg).

The weight of the two Skyflash with their pylon, rail and launcher is 1,286 lbs (583 kg).

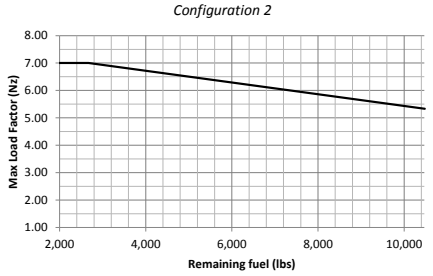
The zero fuel weight of this configuration is 28,229 lbs (12,798 kg).

The 50% internal fuel weight is 5,239 lbs (2,373 kg) with a fuel density of 0.81 kg/l.

The Gross weight of the configuration is 33,468 lbs (15,161 Kg).

The Drag Index of this configuration is 46.

The recommended load factor limit (Nz max), based on remaining fuel, (initial fuel load is 10,480lbs) is the following:



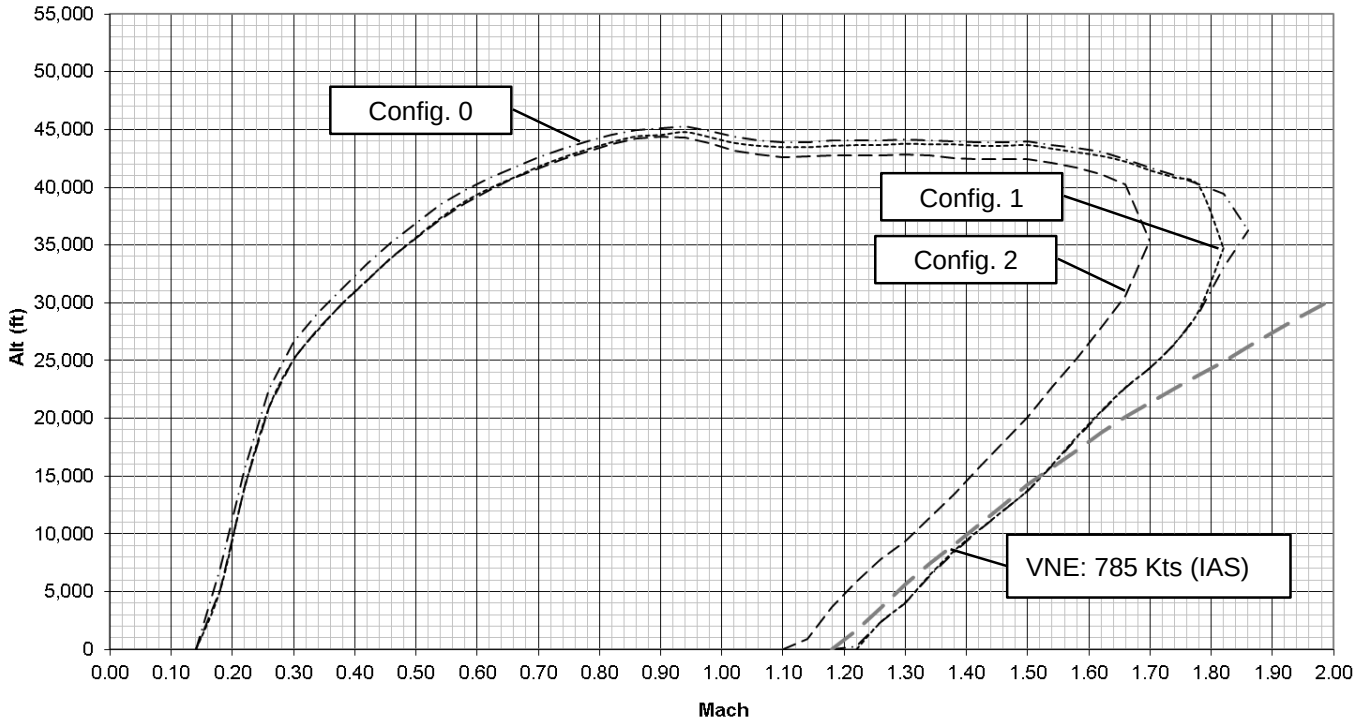
CONFIGURATION 3

TO BE DEFINED.

Level Flight Envelope

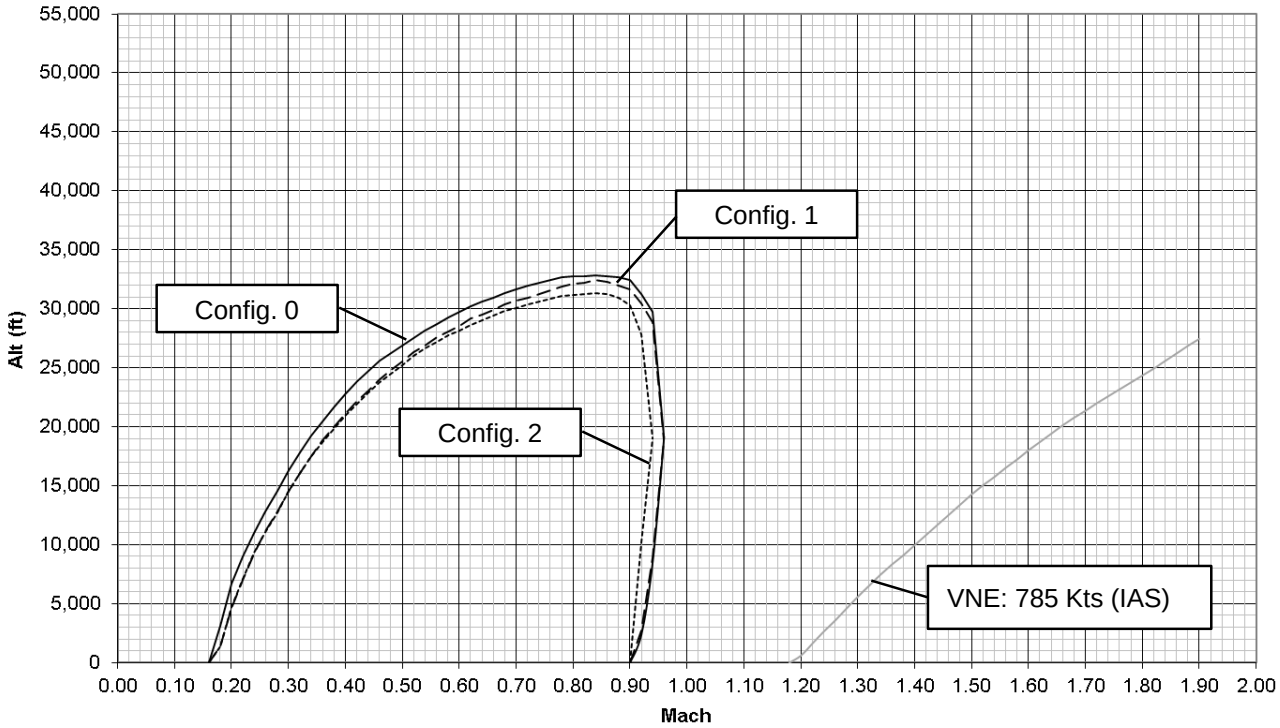
DATA BASIS : COMPUTED
CONDITIONS:
Standard Day - ISA
Max A/B

Aircraft : SAAB JA-37D Viggen
Engine :VOLVO-RM8B



DATA BASIS : COMPUTED
CONDITIONS:
Standard Day - ISA
MILL Power

Aircraft : SAAB JA-37D Viggen
Engine :VOLVO-RM8B



PART 2: CLIMB

INTRODUCTION

This section defines the climb performances of the JA-37D airplane.

CONSTANT TRUE AIR SPEED CLIMB

For each identified configuration, two main climb performances are detailed: Constant true air speed climb rate, and climb angle.

The first one is the vertical velocity (in ft/s), of the aircraft when load factor is 1G and true air speed (TAS) is constant, values are given with Maximum After Burner (Max A/B) and Military Power (MIL).

The second one is the climb angle under the same conditions (angle between the flight path, or velocity vector, and the horizontal), it is materialized in the Head Up Display by the position of the Flight Path Marker (FPM) along the vertical scale.

Note that these values are lower than Constant Mach Number Climb rate and angle below 36,000ft, as sound speed decrease with altitude, a constant Mach number climb means True air speed decreasing, and consequently allow higher climb rates and angles.

On the opposite, a constant Indicated Air Speed (IAS) climb provide a much lower climb rate as it request a True Air Speed increase when climb.

In addition, for each configuration, you will find a Climb Schedule Table giving the best climb speed (Mach number, Indicated Air Speed and True Air Speed) along altitude.

SUBSONIC ISO-MACH CLIMB SCHEDULE

This kind of diagram describe time, distance and fuel required to climb to a given altitude, using maximum A/B thrust and an Iso-Mach flight profile.

This flight profile assumes the climb angle of the flight path is continuously adapted to keep the Mach number constant along the time.

The values displayed in these diagram do not take into account time, distance and fuel required to accelerate to the desired Mach number, nor to rotate from level flight to climb attitude.

These diagrams contain performances for various aircraft configurations, assumed to be effective at the start of the climb.

SUBSONIC ISO-CAS CLIMB SCHEDULE

This kind of diagram describe time, distance and fuel required to climb to a given altitude, using maximum Military Thrust and an Iso-CAS flight profile until a given Mach number is reached, then an iso-Mach flight profile.

This flight profile assumes the climb angle of the flight path is continuously adapted to keep the Corrected Air Speed (CAS) constant along the time, and then Mach number.

The values displayed in these diagram do not take into account time, distance and fuel required to accelerate to the desired Mach number, nor to rotate from level flight to climb attitude.

These diagrams contain performances for various aircraft configurations, assumed to be effective at the start of the climb.

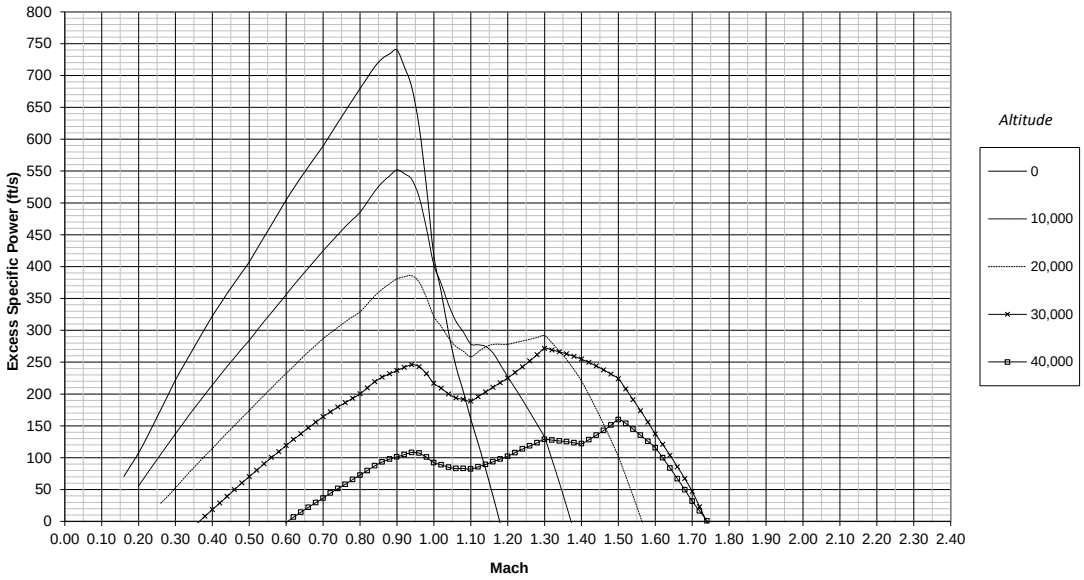
DATA BASIS : COMPUTED

Aircraft : SAAB JA-37D Viggen
Engine :VOLVO-RM8B

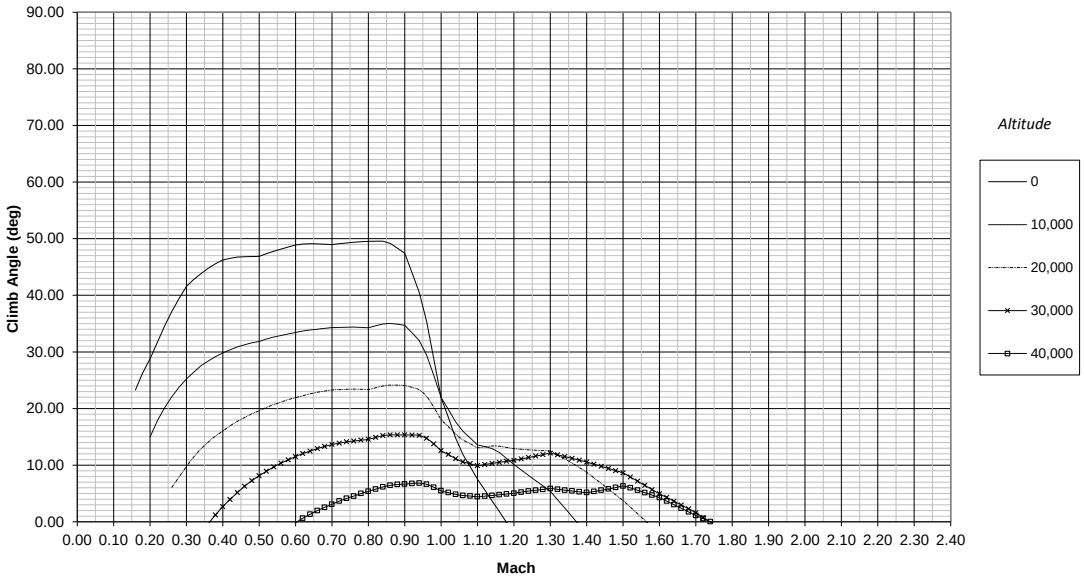
CONDITIONS:
Standard Day - ISA
Max A/B

CONFIGURATION 1
2xAIM-9
GW=32,182 lbs

Climb Rate at Constant True Air Speed



Climb Angle at Constant True Air Speed



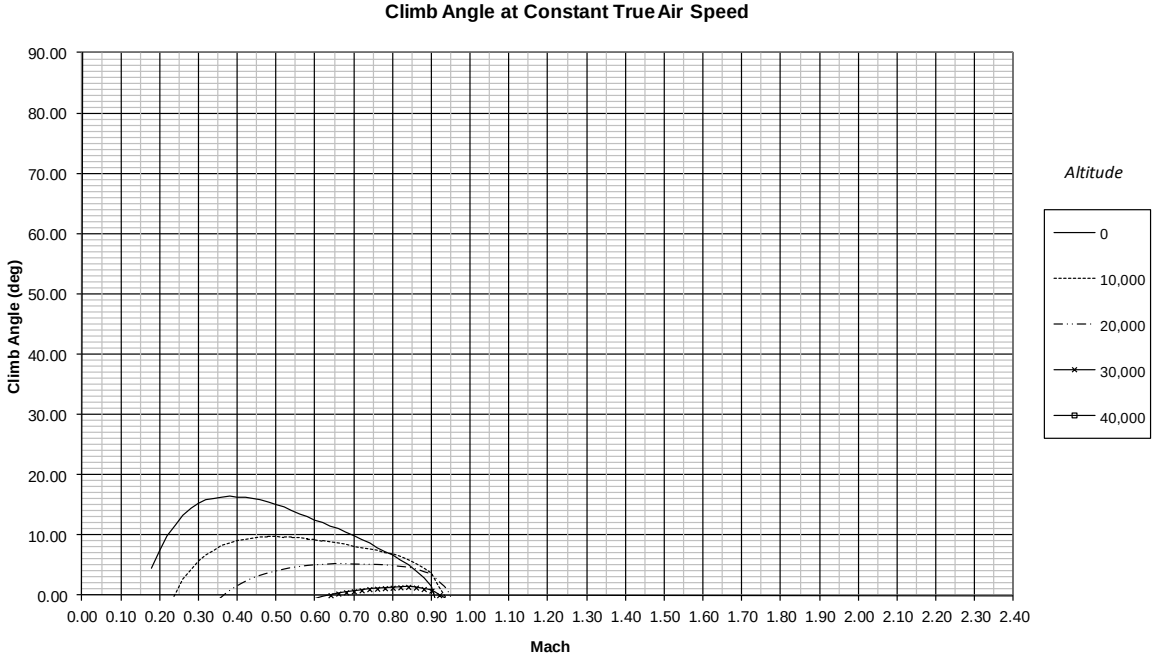
Climb Schedule (maximum climb speed)				
Alt (ft)	CAS	Mach	Vz (ft/s)	TAS
0	594	0.90	740	594
5,000	549	0.90	645	585
10,000	499	0.90	552	575
15,000	477	0.92	464	576
20,000	446	0.94	386	577
25,000	403	0.94	312	566
30,000	497	1.30	272	766
35,000	525	1.50	220	865
40,000	475	1.50	160	860

DATA BASIS : COMPUTED

Aircraft : SAAB JA-37D Viggen
Engine :VOLVO-RM8B

CONDITIONS:
Standard Day - ISA
MIL Power

CONFIGURATION 1
2xAIM-9
GW=32,182 lbs



Climb Schedule (maximum climb speed)				
Alt (ft)	CAS	Mach	Vz (ft/s)	TAS
0	356	0.54	147	356
5,000	390	0.64	125	416
10,000	376	0.68	107	434
15,000	401	0.78	90	489
20,000	377	0.80	71	491
25,000	358	0.84	53	506
30,000	324	0.84	21	495

Iso-Mach Climb Schedule

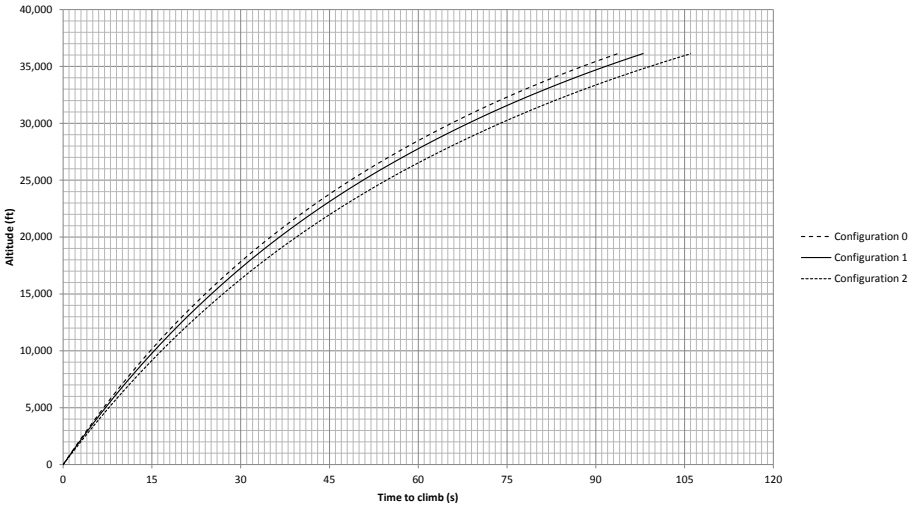
DATA BASIS : COMPUTED

Aircraft : SAAB JA-37D Viggen
Engine :VOLVO-RM8B

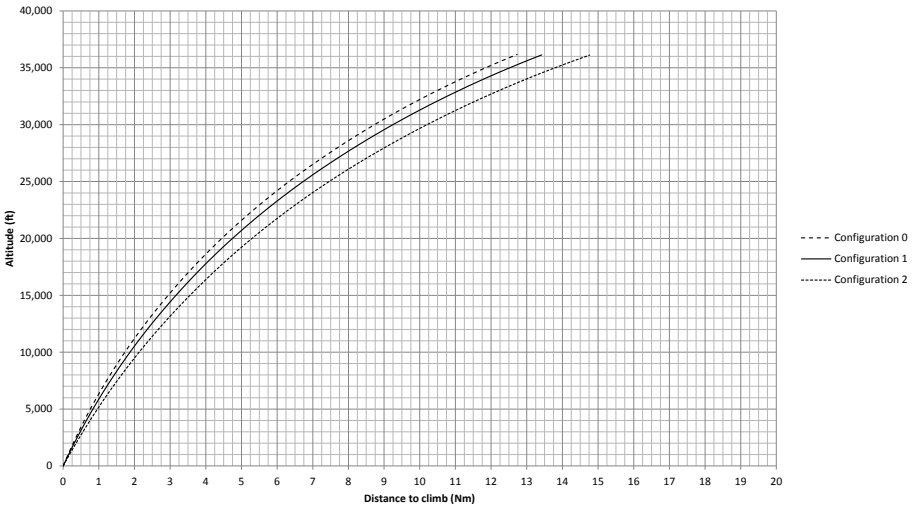
CONDITIONS:
Standard Day - ISA
Max A/B

Constant Mach number : 0.9

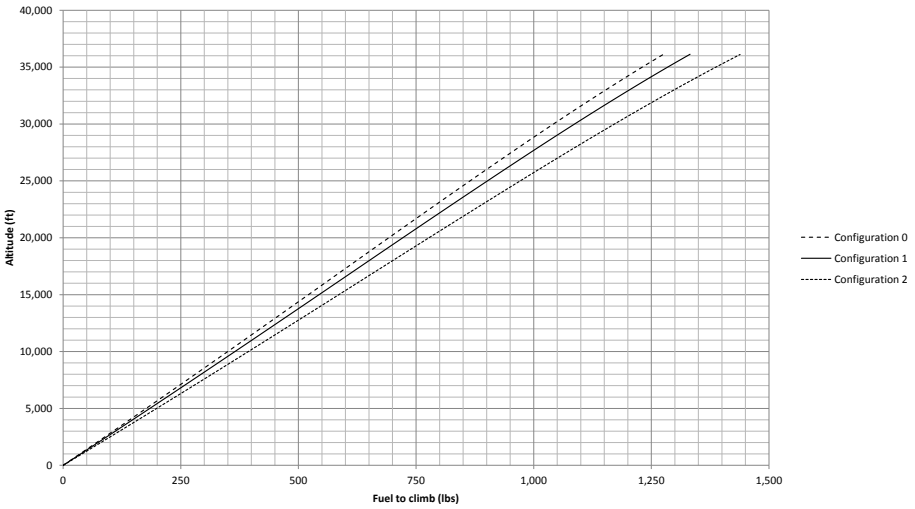
Time to Climb at Iso-Mach



Distance to Climb at Iso-Mach



Fuel to Climb at Iso-Mach



Iso-CAS Climb Schedule

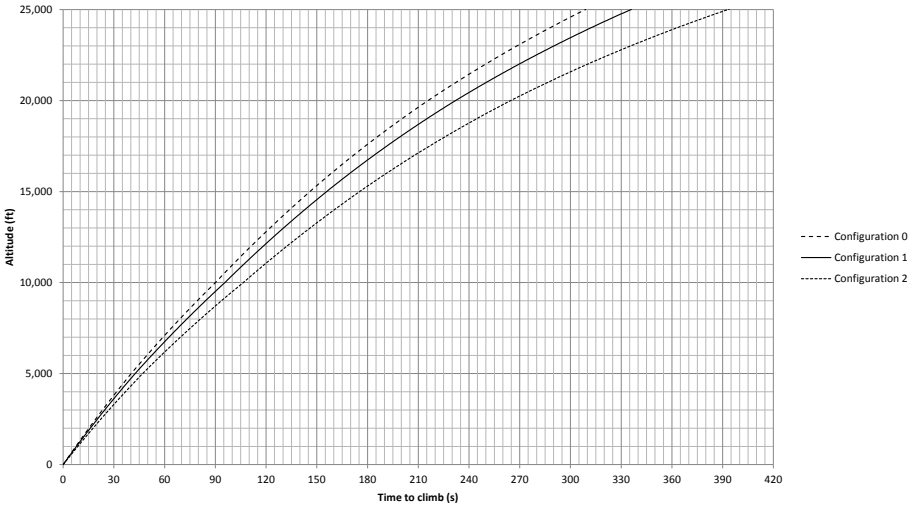
DATA BASIS : COMPUTED

CONDITIONS:
Standard Day - ISA
MIL Thrust

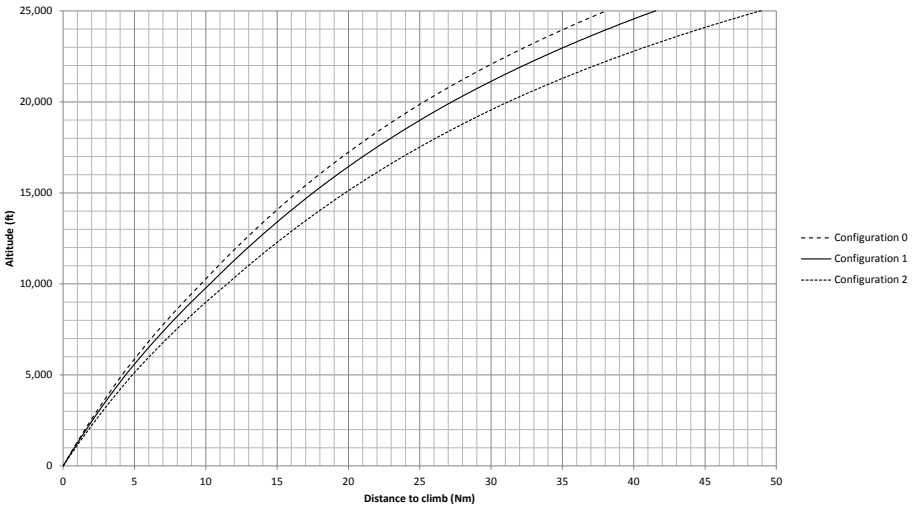
Aircraft : SAAB JA-37D Viggen
Engine :VOLVO-RM8B

Constant CAS : 365Kts until M0.9

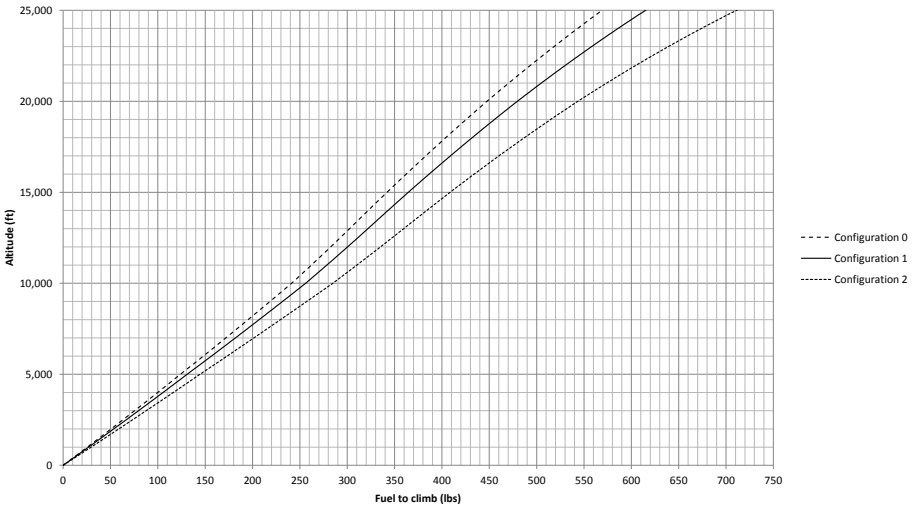
Time to Climb at Iso-CAS until maximum Mach



Distance to Climb at Iso-CAS until maximum Mach



Fuel to Climb at Iso-CAS until maximum Mach



PART 3: CRUISE, RANGE and ENDURANCE

INTRODUCTION

This section presents the fuel management data during cruise flight (constant speed and altitude in Military Thrust). For each aircraft configuration, you will find the instantaneous fuel flow (in lbs/h) required to sustain a given Mach number at a given altitude, the autonomy at a given Mach number and altitude (distance, in Nm that can be covered with a unit amount of fuel: 1,000lbs), and the endurance at a given Mach number and altitude (time in minutes that can be flew with a unit amount of fuel: 1,000lbs).

Fuel Flow – Endurance - Autonomy

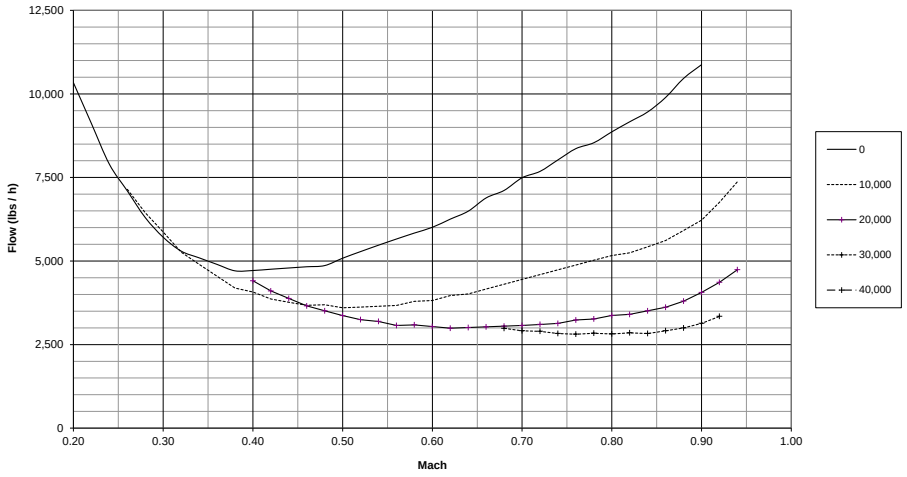
DATA BASIS : COMPUTED

CONDITIONS:
Standard Day - ISA
MIL Thrust

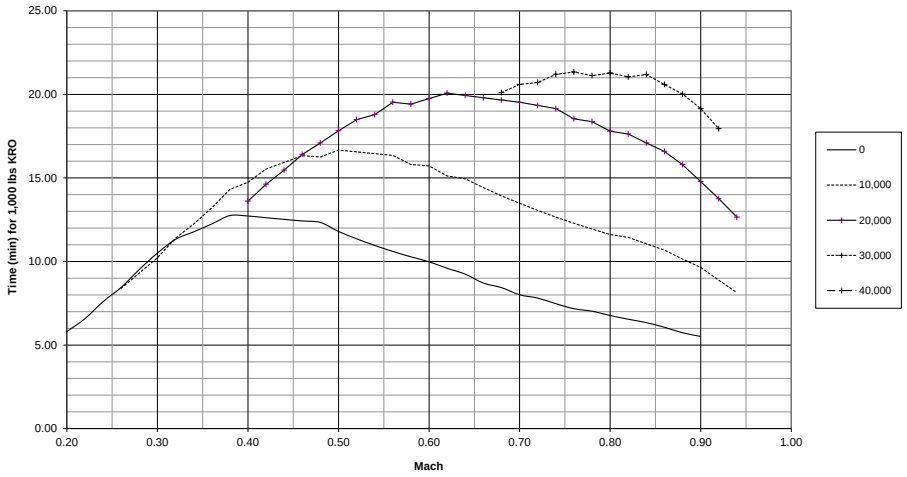
Aircraft : SAAB JA-37D Viggen
Engine :VOLVO-RM8B

CONFIGURATION 1
2xAIM-9
GW=32,182 lbs

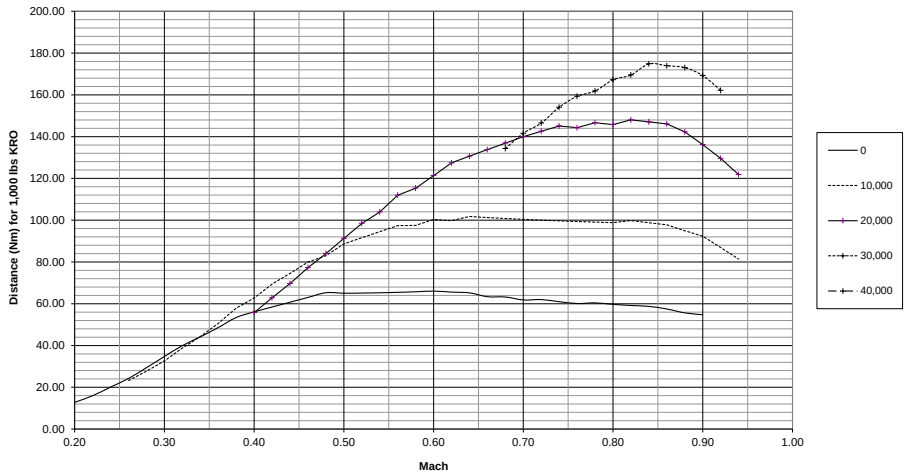
Fuel Flow for Sustained Mach number



Endurance for Sustained Mach number



Autonomy for Sustained Mach number



PART 4: ACCELERATION

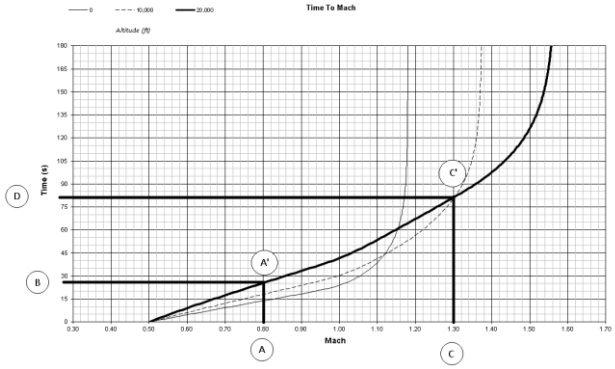
INTRODUCTION

Performances described in this section are related to level flight (1G) acceleration. It's organized by configuration (all data presented on one figures are related to the same configuration). The aircraft configuration is assumed to be the one at the beginning of the acceleration run (specifically the remaining fuel).

Figures present the time, horizontal distance and fuel quantity required to accelerate from a give Mach number to a greater at constant altitude.

SAMPLE PROBLEM

Use case is to accelerate from M0.8 to M1.3 at 20,000ft.



Find initial Mach number (0.8) on horizontal axis (A), go vertical up to the curve related to the desired altitude: 20,000ft (A'), then go horizontal to find the start time (B) : 25s

Find final Mach number (1.3) on horizontal axis (C), go vertical up to the curve related to the desired altitude: 20,000ft (C'), then go horizontal to find the start time (D): 80s.

Compute difference between final and initial values: the time required to accelerate from M0.8 to M1.3 at 20,000 in this configuration is 80 – 25 = 55s.

Same method is to be used to find the horizontal distance (in Nm) and the fuel quantity (in lbs) required to perform the same acceleration.

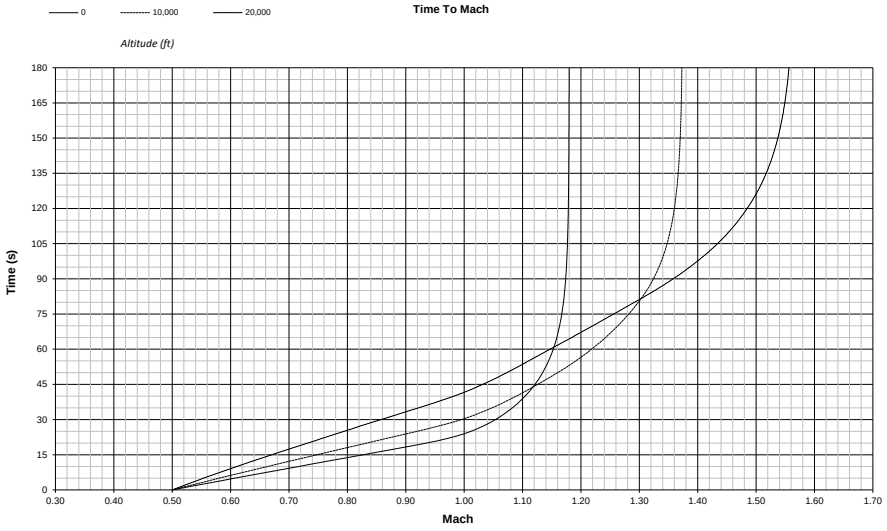
Acceleration Schedule

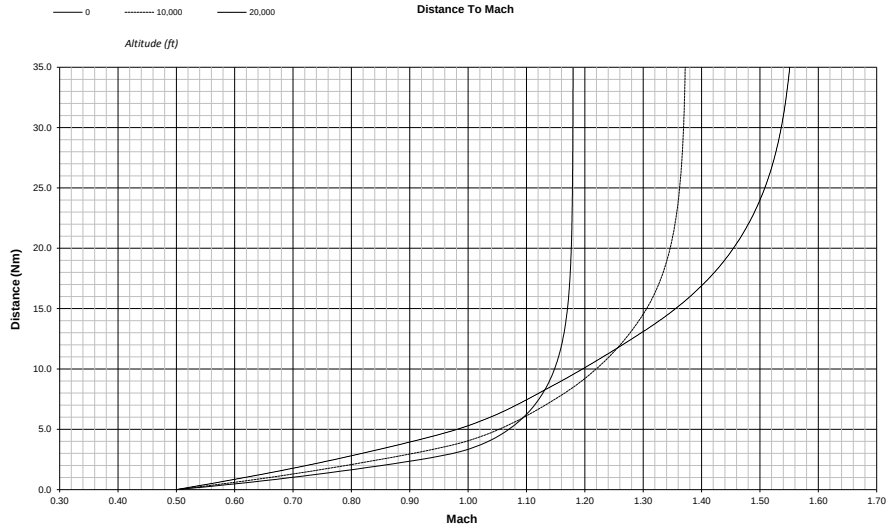
DATA BASIS : COMPUTED

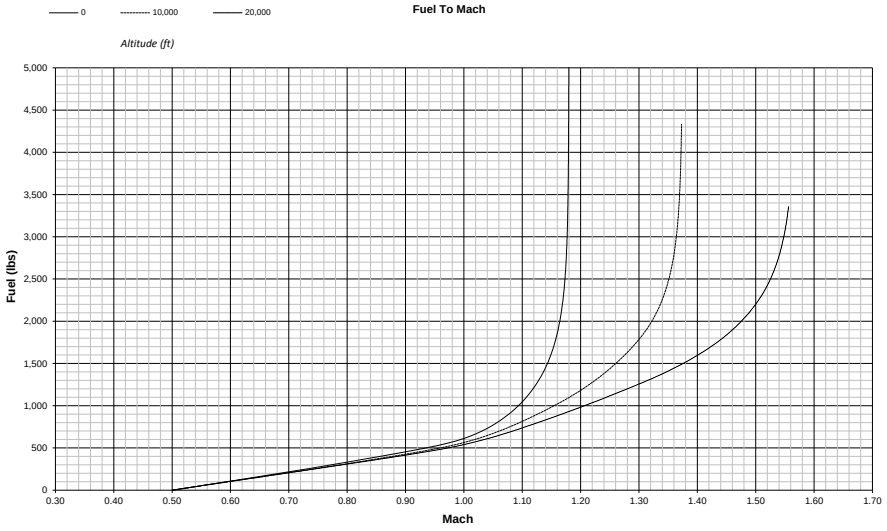
CONDITIONS:
Standard Day - ISA
Max A/B

Aircraft : SAAB JA-37D Viggen
Engine :VOLVO-RM8B

CONFIGURATION 1
2xAIM-9
GW=32,182 lbs







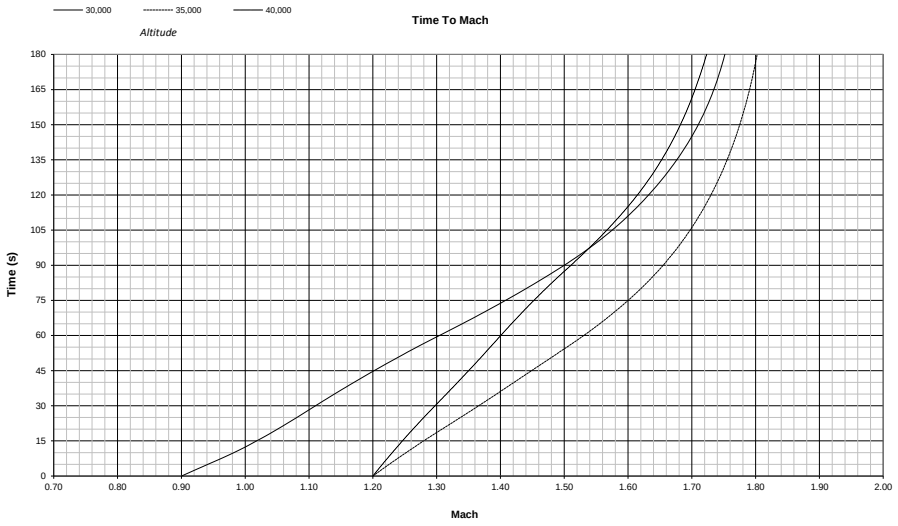
Acceleration Schedule

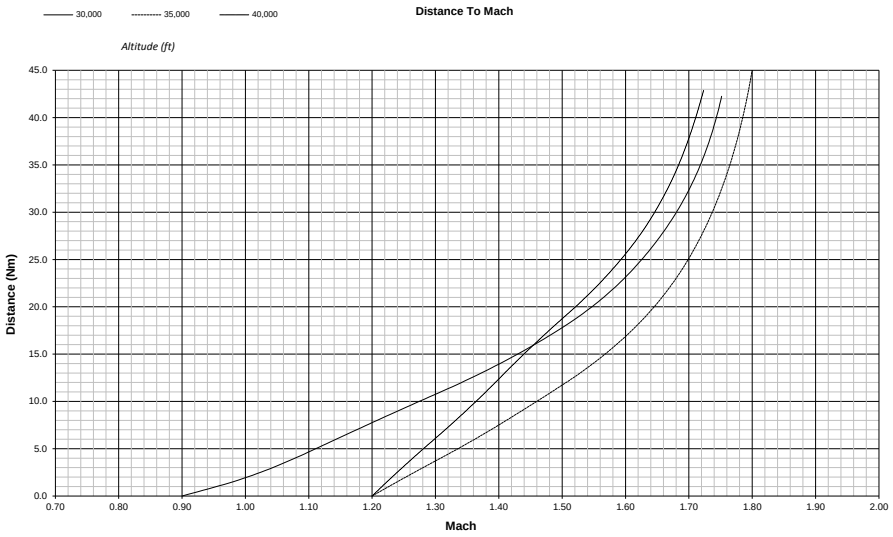
DATA BASIS : COMPUTED

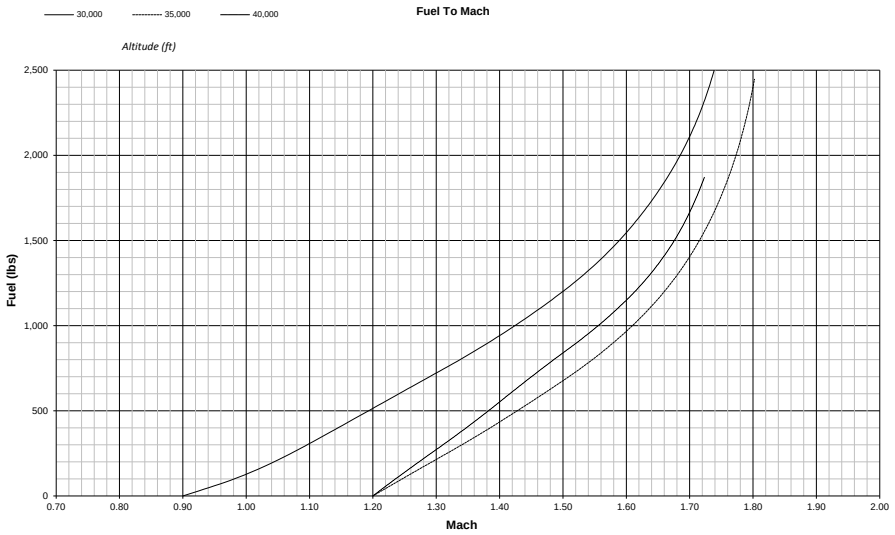
CONDITIONS:
Standard Day - ISA
Max A/B

Aircraft : SAAB JA-37D Viggen
Engine :VOLVO-RM8B

CONFIGURATION 1
2xAIM-9
GW=32,182 lbs







PART 5: TURNING

INTRODUCTION

This section is organized by aircraft configurations. For each of them, you will find the following set of figures:

TURN PERFORMANCE SUMMARY

Sustained Turn Rate summary: three figures giving for different altitudes, the maximum sustainable (constant true air speed and altitude) turn rate (d/s), normal load factor (Ng) and minimum turn radius.

Maximum Turn Rate summary: three figures giving for different altitudes, the maximum reachable (at maximum possible lift) turn rate (d/s), normal load factor (Ng) and minimum turn radius.

ENERGY MACH DIAGRAM

An Energy Mach Diagram is given per altitude (Turn Rate vs Calibrated Air Speed), with Iso-Ps (Extra Specific Power) curves set, and graphical indication of specific performances: maximum reachable (maximum lift and load factor) turn rate, maximum sustainable (Ps=0) turn rate, minimum instantaneous and sustainable (Ps=0) turn radius.

Sustained Turn Summary

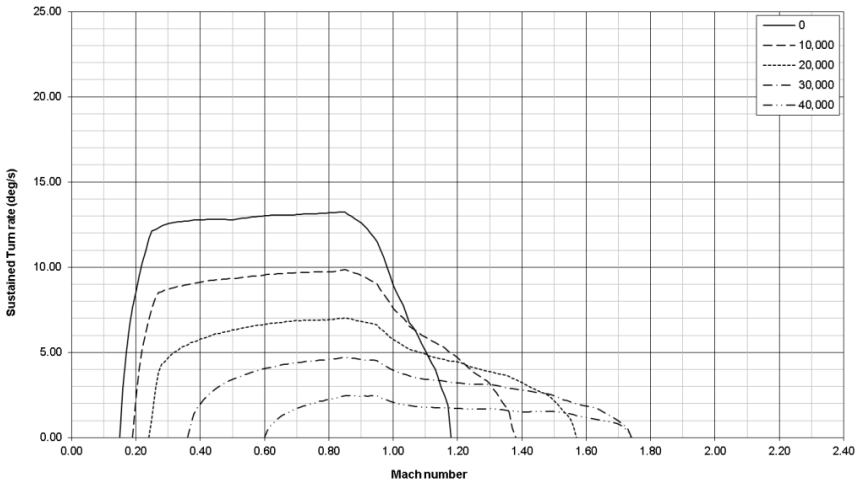
DATA BASIS : COMPUTED

Aircraft : SAAB JA-37D Viggen
Engine :VOLVO-RM8B

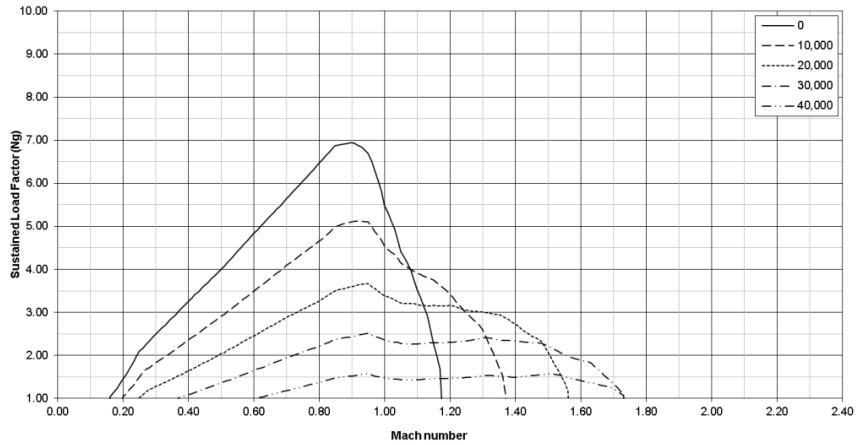
CONDITIONS:
Standard Day - ISA
Max A/B

CONFIGURATION 1
2xAIM-9
GW=32,182 lbs

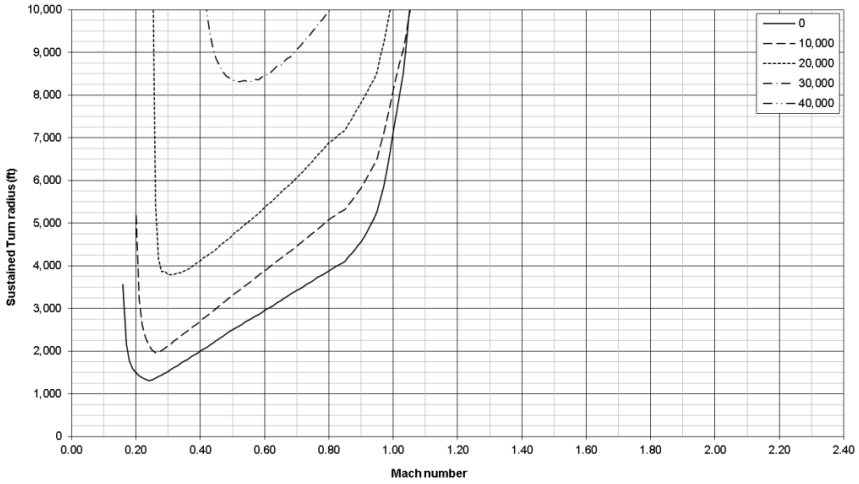
Maximum Sustained Turn rate (deg/s)



Maximum Sustained Load Factor (Ng)



Minimum Sustained Turn Radius (ft)



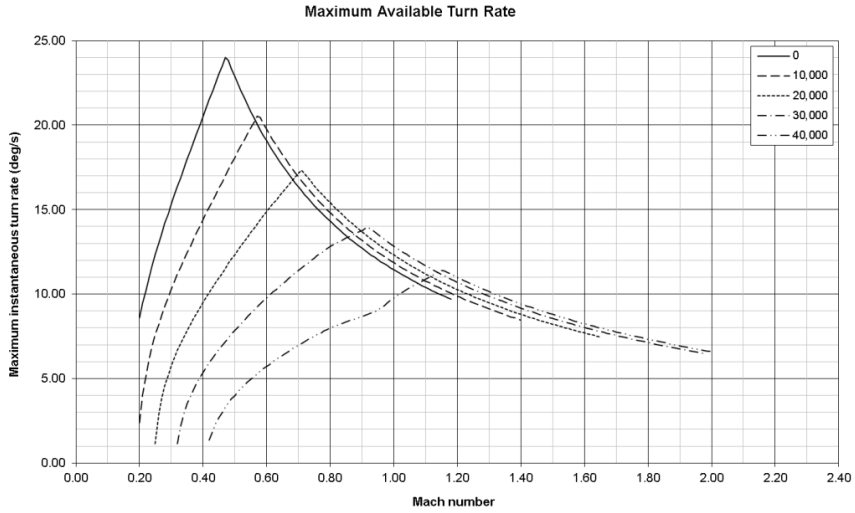
Instantaneous Turn Summary

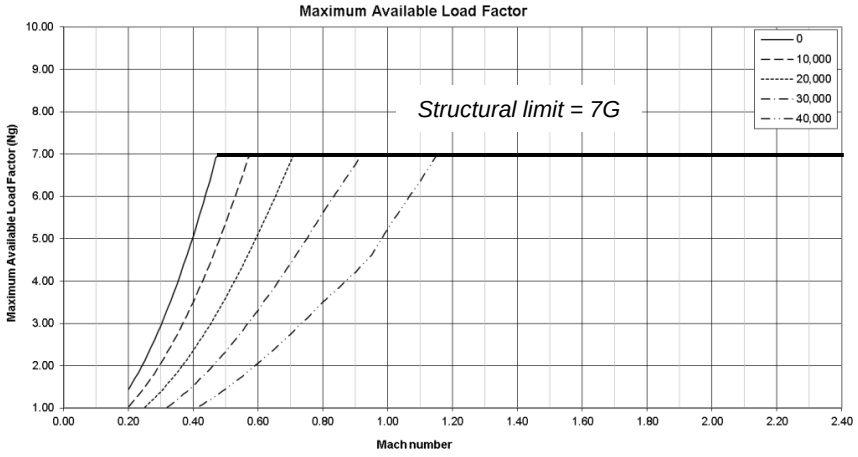
DATA BASIS : COMPUTED

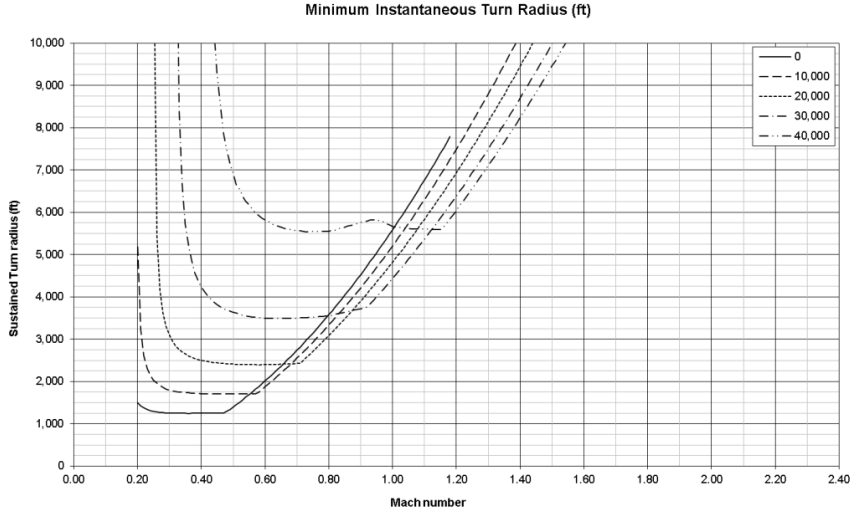
Aircraft : SAAB JA-37D Viggen
Engine :VOLVO-RM8B

CONDITIONS:
Standard Day - ISA
Max A/B

CONFIGURATION 1
2xAIM-9
GW=32,182 lbs







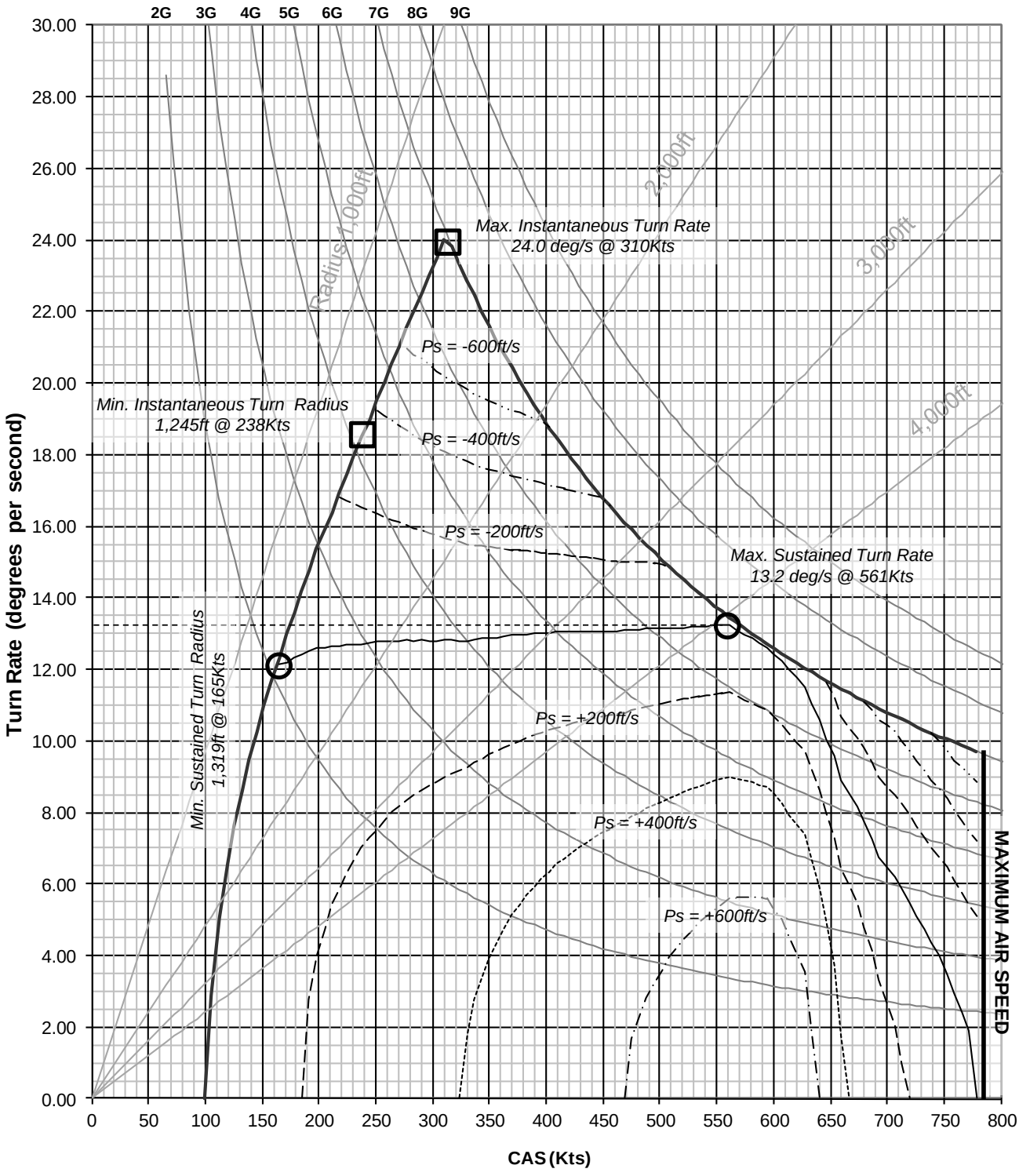
Energy Mach Diagram at 0 ft

DATA BASIS : COMPUTED

Aircraft : SAAB JA-37D Viggen
Engine :VOLVO-RM8B

CONDITIONS:
Standard Day - ISA
Max A/B

CONFIGURATION 1
2xAIM-9
GW=32,182 lbs



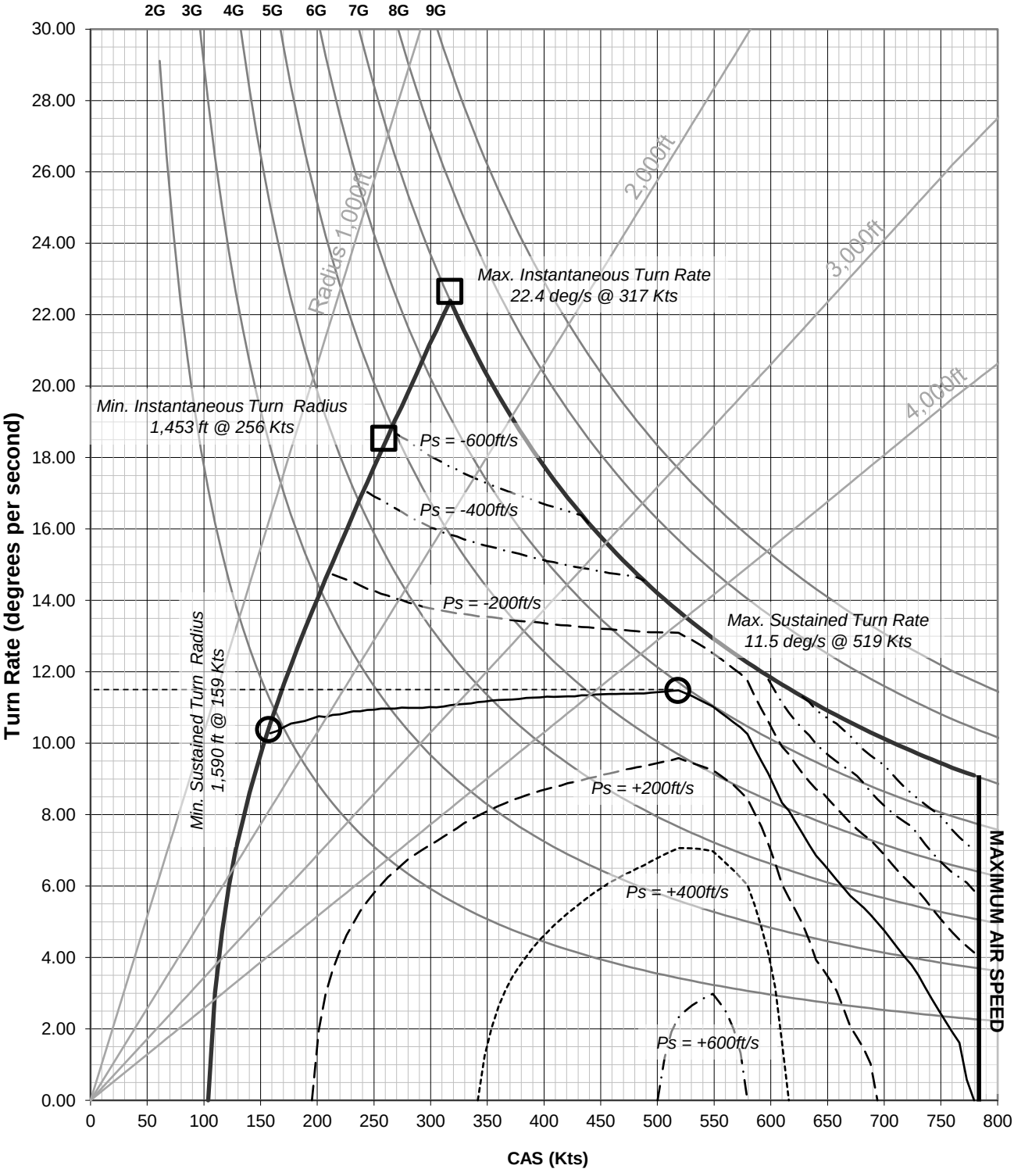
Energy Mach Diagram at 5,000 ft

DATA BASIS : COMPUTED

Aircraft : SAAB JA-37D Viggen
Engine :VOLVO-RM8B

CONDITIONS:
Standard Day - ISA
Max A/B

CONFIGURATION 1
2xAIM-9
GW=32,182 lbs



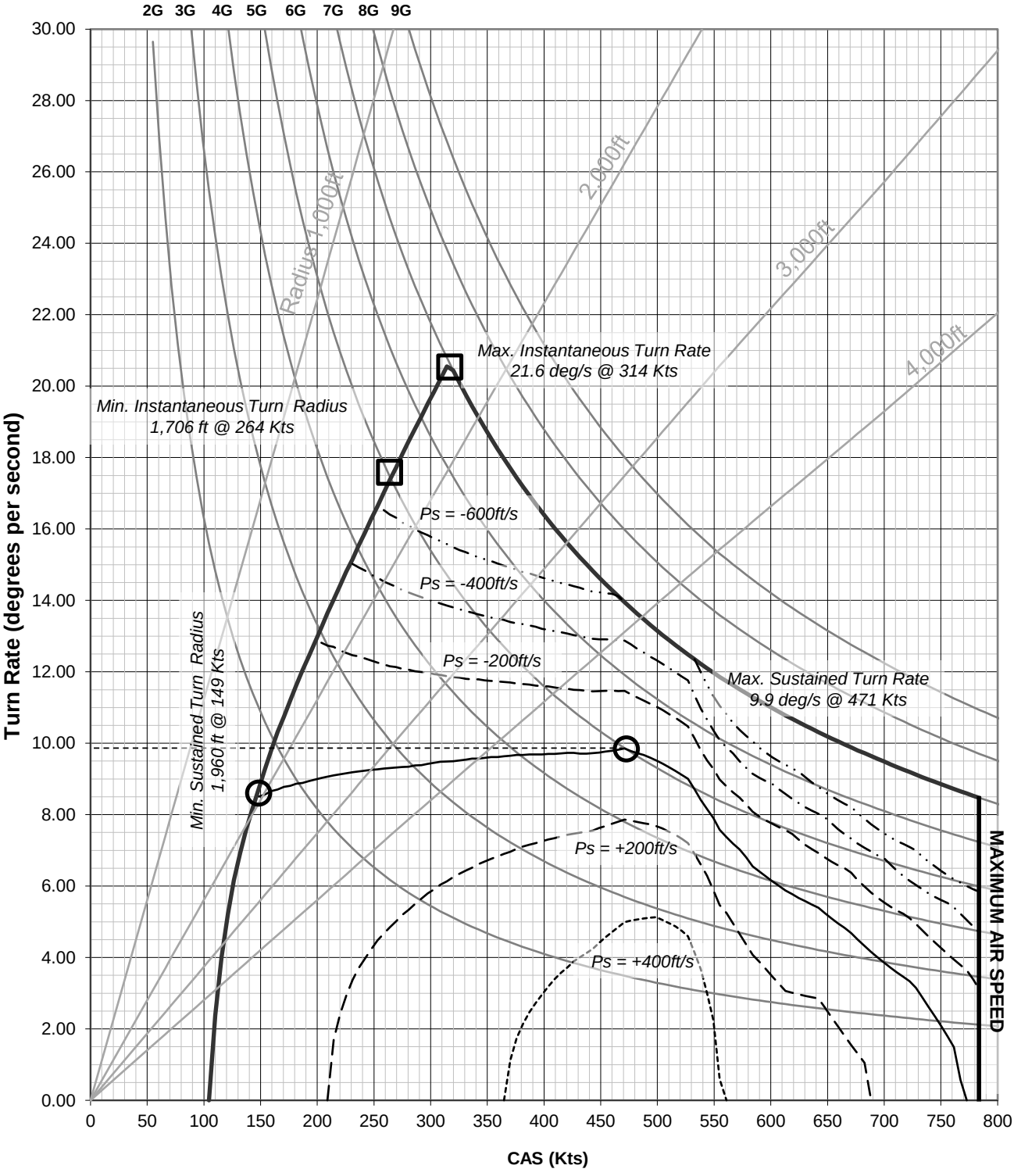
Energy Mach Diagram at 10,000 ft

DATA BASIS : COMPUTED

Aircraft : SAAB JA-37D Viggen
Engine :VOLVO-RM8B

CONDITIONS:
Standard Day - ISA
Max A/B

CONFIGURATION 1
2xAIM-9
GW=32,182 lbs



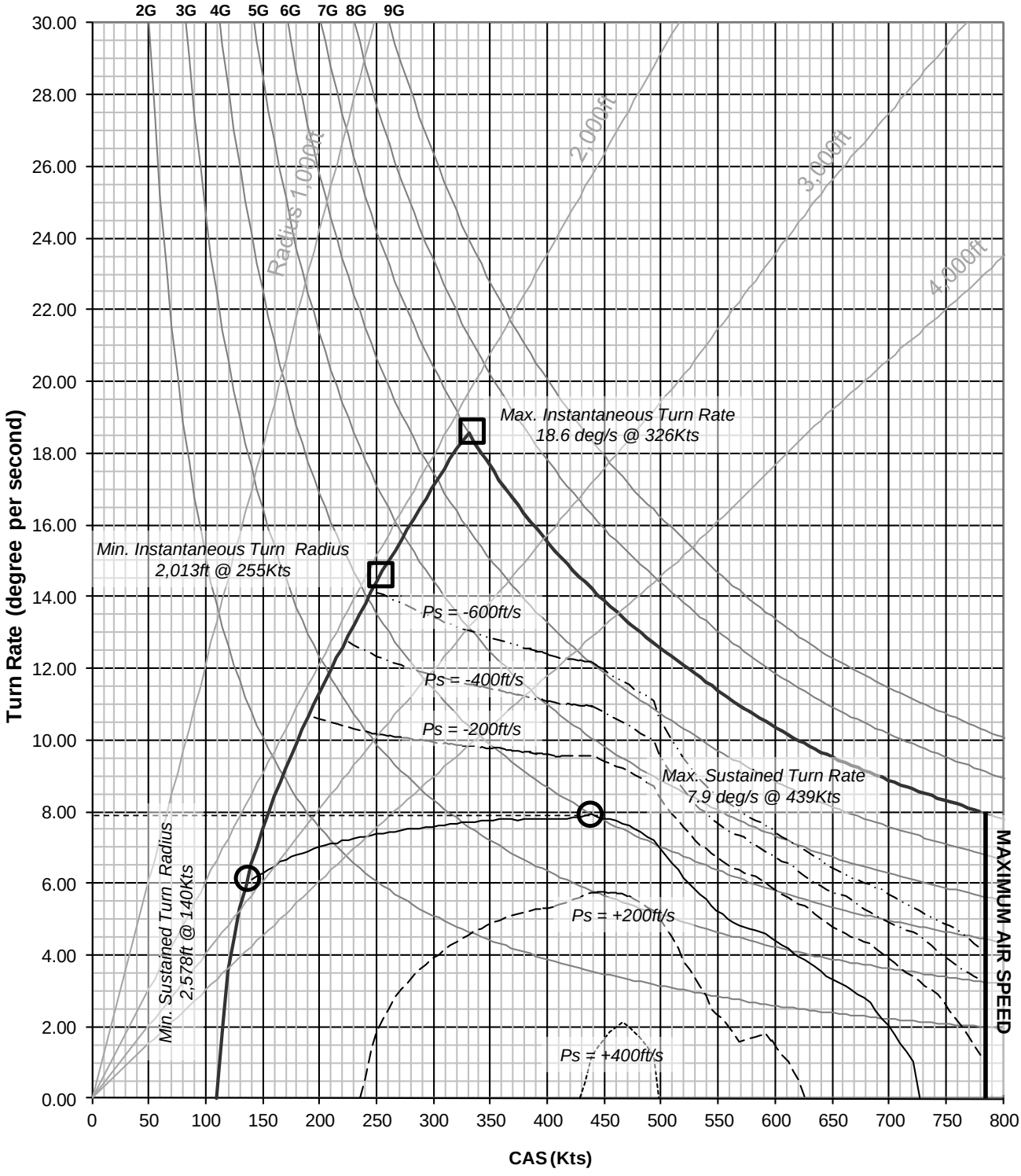
Energy Mach Diagram at 15,000 ft

DATA BASIS : COMPUTED

Aircraft : SAAB JA-37D Viggen
Engine :VOLVO-RM8B

CONDITIONS:
Standard Day - ISA
Max A/B

CONFIGURATION 1
2xAIM-9
GW=32,182 lbs



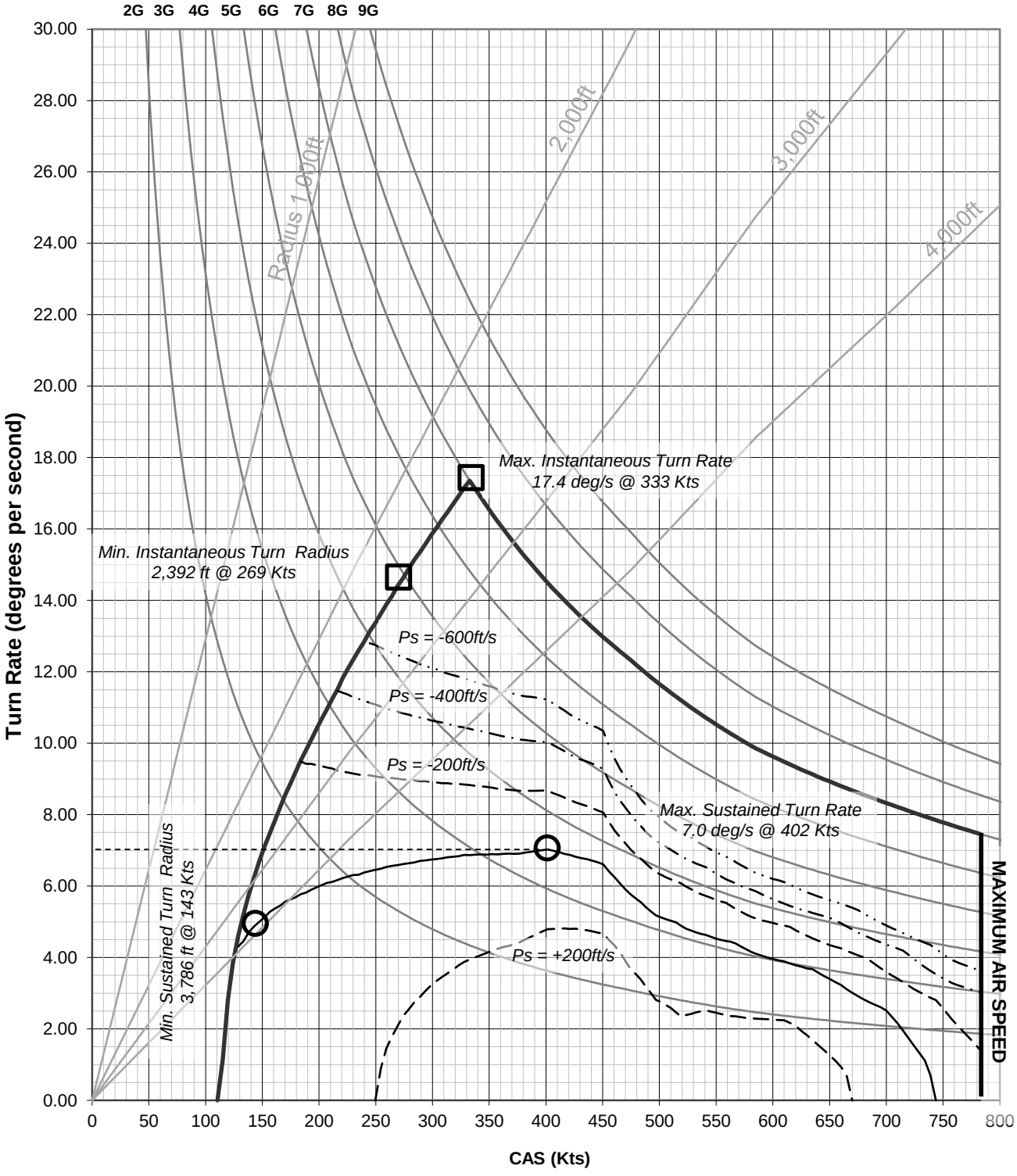
Energy Mach Diagram at 20,000 ft

DATA BASIS : COMPUTED

Aircraft : SAAB JA-37D Viggen
Engine :VOLVO-RM8B

CONDITIONS:
Standard Day - ISA
Max A/B

CONFIGURATION 1
2xAIM-9
GW=32,182 lbs



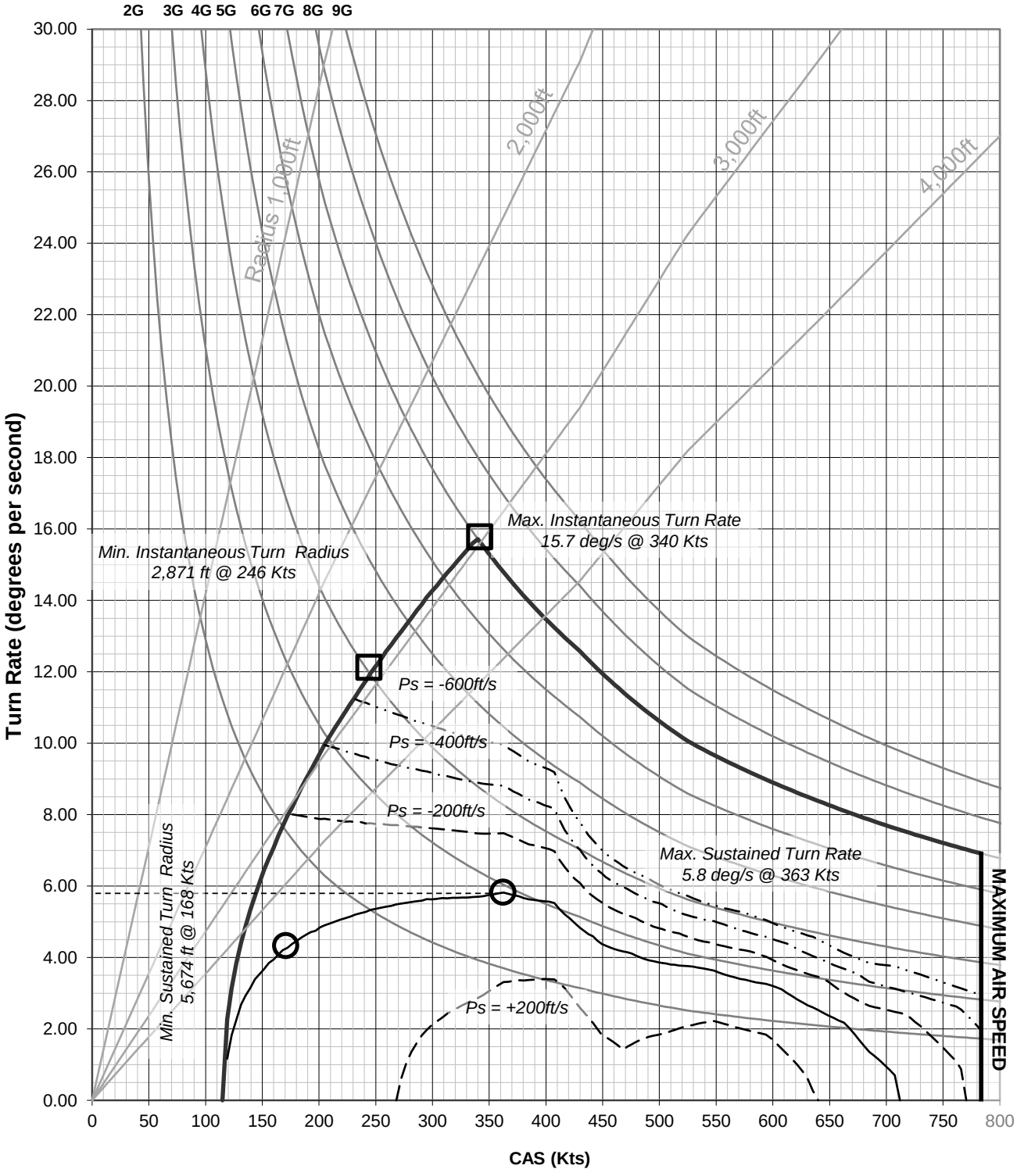
Energy Mach Diagram at 25,000 ft

DATA BASIS : COMPUTED

Aircraft : SAAB JA-37D Viggen
Engine :VOLVO-RM8B

CONDITIONS:
Standard Day - ISA
Max A/B

CONFIGURATION 1
2xAIM-9
GW=32,182 lbs



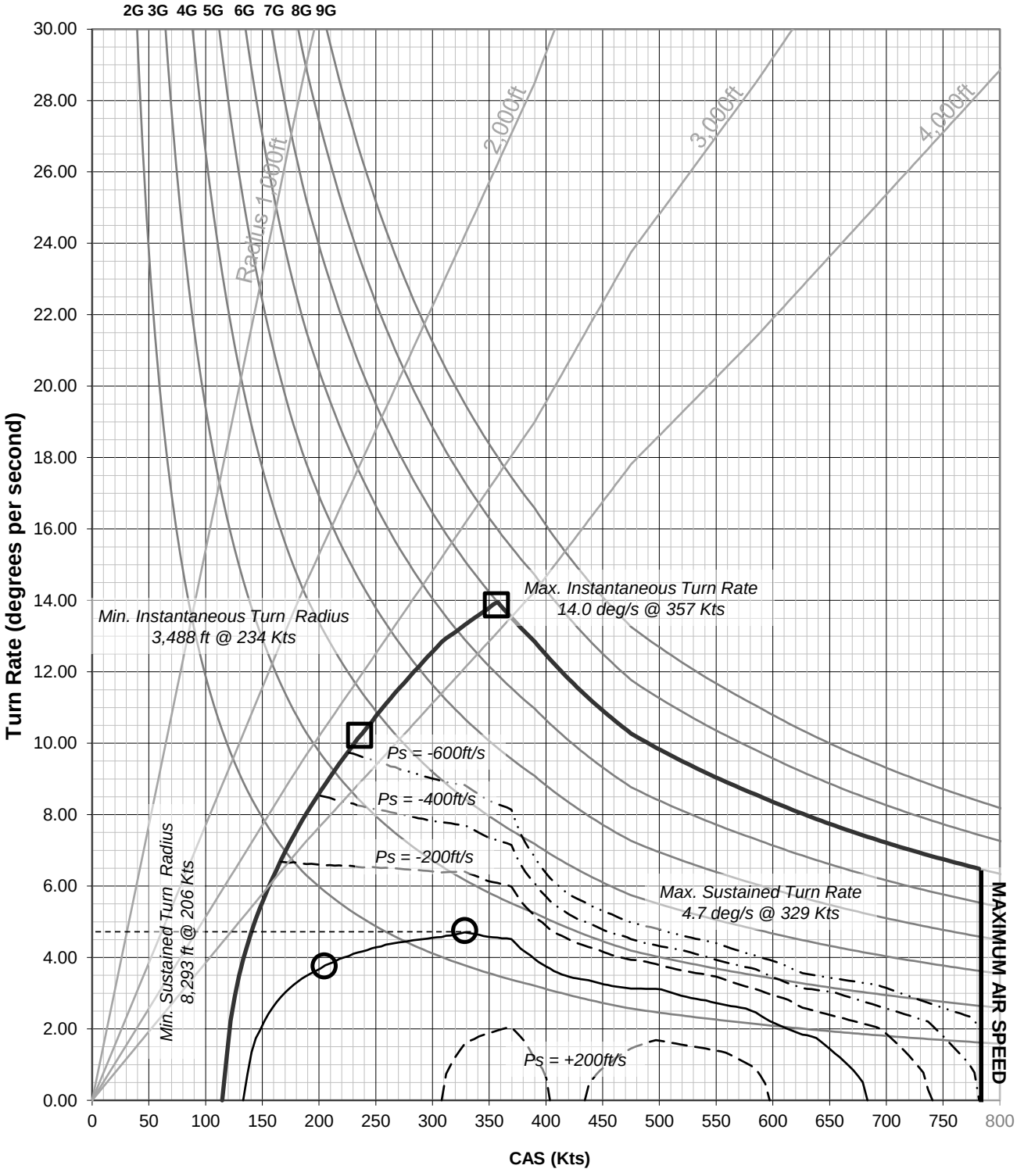
Energy Mach Diagram at 30,000 ft

DATA BASIS : COMPUTED

Aircraft : SAAB JA-37D Viggen
Engine :VOLVO-RM8B

CONDITIONS:
Standard Day - ISA
Max A/B

CONFIGURATION 1
2xAIM-9
GW=32,182 lbs



Energy Mach Diagram at 35,000 ft

DATA BASIS : COMPUTED

Aircraft : SAAB JA-37D Viggen
Engine :VOLVO-RM8B

CONDITIONS:
Standard Day - ISA
Max A/B

CONFIGURATION 1
2xAIM-9
GW=32,182 lbs