INCH-POUND

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DEPARTMENT OF DEFENSE
STANDARD PRACTICE

GLOSSARY OF DEFINITIONS, GROUND RULES, AND MISSION PROFILES TO DEFINE AIR VEHICLE PERFORMANCE CAPABILITY

AMSC N/A FSC 15GP

FOREWORD

1. This standard is approved for use by all Departments and Agencies of the Department of Defense.

2. Microsoft Word® and Adobe Acrobat® versions of this document contain hyperlinks which are identifiable by blue-font characters. Once selected, a hyperlink will take the user to a referenced paragraph, table, figure, and Website. The simplest way to return to the place of origin within a Microsoft Word® document is to click the "back arrow" on the "Web" toolbar. This toolbar can be displayed by selecting "View" and "Toolbars" on the menu bar, and then selecting the "Web" option. This same method can be employed in Adobe Acrobat® versions of a document: select "View" and "Toolbars" on the menu bar, and then select "Navigation." The "back arrow" and "forward arrow" allow the user to return to the place of origin after a hyperlink has been selected.

3. Comments, suggestions, or questions on this document should be addressed to ASC/ENRS, 2530 Loop Road West, Wright-Patterson AFB OH 45433-7101; or e-mailed to Engineering.Standards@wpafb.af.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

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1. SCOPE

1.1 Purpose. This standard establishes the definitions, ground rules, and mission profiles to determine the performance of fixed-wing air vehicles. This document is not intended to impose air vehicle performance requirements. It is intended to provide all conditions and limitations inherent in the definitions and ground rules which must be met when any item of performance included herein is calculated. It is not the purpose of this document to levy required values for these items of performance. Those requirements must be included in the appropriate Program Specifications.

1.2 Applicability. The subject-matter contained in this standard applies to the flight performance of manned and unmanned fixed-wing (non-rotary wing) air vehicles. However, for unmanned air vehicles, the definitions, ground rules, and mission profiles may not be all-inclusive. This standard may be applied to conventional, Short Takeoff and Landing (STOL), and Vertical/Short Takeoff and Landing (V/STOL) capable air vehicles. The sections of this document which specifically address the short takeoff of STOL and V/STOL air vehicles also apply to Short Takeoff Vertical Landing (STOVL) air vehicles. Furthermore, these definitions and ground rules apply equally to operations from large deck carriers and Marine amphibious assault ("L" class) ships.

1.3 Application guidance. When the applicability of the definitions, ground rules, and mission profiles herein are to be determined and tailored to a program, the following principles should be followed:

a. Every program is different.

b. Every design involves compromises among different, desirable characteristics.

c. A program must achieve a balance between operational need, performance, cost, and schedule.

d. The acquisition phase of the program should be considered.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this standard, whether or not they are listed.

2.2 Government documents

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

JSSG-2007	Engines, Aircraft, Turbine
MIL-DTL-5624	Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-DTL-83133	Turbine Fuel, Aviation, Kerosene Type, JP-8 (NATO F-34), NATO F-35, and JP-8+100 (NATO F-37)
MIL-F-83300	Flying Qualities of Piloted V/STOL Aircraft
MIL-DTL-87107	Propellant, High Density Synthetic Hydrocarbon Type, Grade JP-10

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-1797	Flying Qualities of Piloted Aircraft

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or from the Standardization Document Order Desk, 700 Robbins Avenue, Bldg 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NAVAL AIR SYSTEMS COMMAND MANUALS

NAEC-MISC-06900	Aircraft Carrier Reference Data Manual

(Application for copies should be addressed to the Naval Air Warfare Center Lakehurst, Route 547, Lakehurst, NJ 08733; http://www.lakehurst.navy.mil/nlweb/).

UNITED STATES AIR FORCE INSTRUCTIONS

AFI 11-202 Volume 3	General Flight Rules

(This document is available online http://www.e-publishing.af.mil/ or from the Air Force Publishing Distribution Center (AFPDC) Customer Order Desk, 2800 Eastern Blvd., Baltimore, MD 21220-2898; (410) 671-4729 or DSN 584-4729.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

ASTM D910	Standard Specification for Aviation Gasolines
ASTM D1655	Standard Specification for Aviation Turbine Fuels

(Application for copies should be addressed to ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959; www.astm.org. Qualified DoD users may view the documents online at https://login.ihserc.com/login/erc?).

NATIONAL BUSINESS AIRCRAFT ASSOCIATION, INC.

Management Guide, Appendix D, NBAA Range Formats

(Application for copies should be addressed to National Business Aviation Association, 1200 Eighteenth Street NW, Suite 400, Washington DC 20036-2506; www.nbaa.org.)

SOCIETY OF ALLIED WEIGHT ENGINEERS

SAWE-RP7	Mass Properties Management and Control for Military Aircraft

(Application for copies of this recommended practice should be addressed to the Society of Allied Weight Engineers, P.O. Box 60024, Terminal Annex, Los Angeles, CA 90060; http://www.sawe.org/.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS. This section defines the performance terms of fixed-wing air vehicles and qualifications for their use. For the purpose of this document, the following applies:

a. All air vehicle limitations and criteria—including structural, flying qualities, and propulsion system—where more restrictive, take precedence over the performance criteria specified herein. Realistic constraints, to include control surface rates, engine response to throttle transients, and nozzle rotation rates, will be applied.

b. Definitions assume the use of a point mass, flat non-rotating earth, constant gravity, standard day, and zero wind. When conditions other than these are used, care should be taken to ensure the differences introduced by changes are taken into account. For instance, if non-standard day temperatures are used, parameters which are a function of density on standard day will be a function of pressure and temperature. A discussion of non-standard day temperatures and recommended temperature and pressure profiles for both standard and non-standard days are included in appendix A. If winds are used, speed definitions will only be valid for airspeeds. A discussion of wind effects is included in appendix A.

c. When calculations are performed with an engine inoperative, the drag of the devices used to trim the air vehicle, as well as the worst-case engine out drag, will be included. The determination of which inoperative engine is most critical includes both controllability and loss-of-lift considerations.

d. Configuration refers to the center of gravity location, gear and flap position, external configuration of the vehicle, and normal mission segment engine bleeds.

e. Steady-state refers to the instantaneous condition of equilibrium in which all forces and moments are balanced and the change in all velocities and rotational rates is zero.

f. The ground rules of section 4 apply, unless otherwise specified.

g. Many paragraphs include options to be used to calculate various parameters. These are included in sub-paragraphs and "Alternate Design Criteria," and are intended for use if the basic value is inappropriate for a given design or mission.

h. Figure 1 provides a description of the force accounting used and the axis along which each force is assumed to act.

i. Table I is a descriptive list of symbols and acronyms used in this standard.

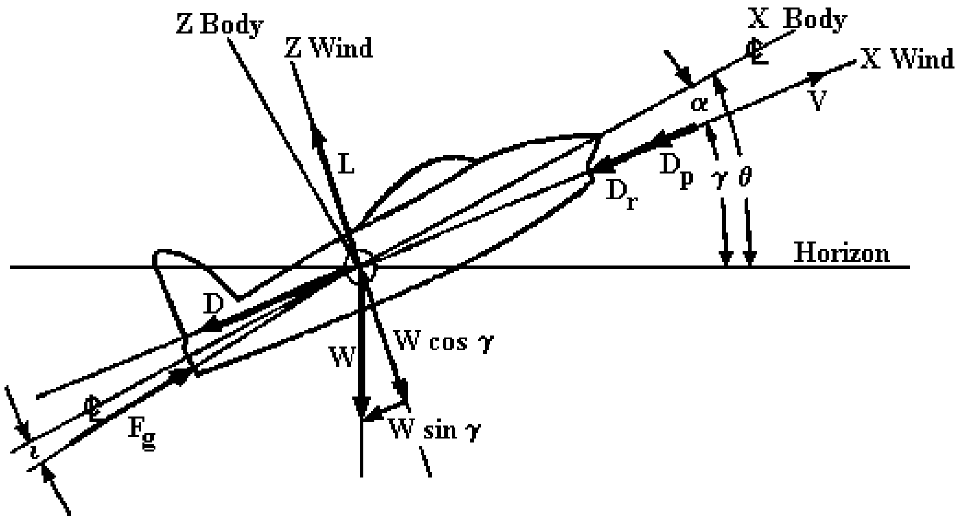


FIGURE 1. Air vehicle force balance diagram

TABLE I. Symbols and abbreviations

A/B	Afterburner
AEO	All Engines Operating
BTU	British Thermal Units
b	Wing Span, ft
CAP	Combat Air Patrol
CAS	Close Air Support
C_D	Air Vehicle Drag Coefficient
CEW	Catapult Equivalent Weight
CFL	Critical Field Length
c.g.	Air Vehicle Center of Gravity
C_L	Air Vehicle Lift Coefficient
$C_{L_{max}}$	Maximum Lift Coefficient
CSV	Constant Selector Valve
CTOL	Conventional Takeoff and Landing
CV	Carrier Vessel
D	Aerodynamic Drag, lbs
D_p	Propulsive Drag
D_r	Ram Drag
DLC	Direct Lift Control
DLI	Deck Launched Intercept
DME	Distance Measurement Equipment
EAF	Expeditionary Air Field
E_s	Specific Energy
ΔE_s	Energy Exchange
F	Fahrenheit
F_g	Gross Thrust
F_n	Net Thrust
FM	Cruise Figure of Merit
ft	Feet
g	Acceleration Due to Earth's Gravity
gal	Gallons
H	Geopotential Altitude
H_d	Density Altitude (geopotential)
H_g	Mercury
H_p	Pressure Altitude (geopotential)
HT_{MAC}	Height of Mean Aerodynamic Chord Above the Ground
HWR	Hover Weight Ratio
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IGE	In-Ground Effect

TABLE I. Symbols and abbreviations – Continued

KCAS	Knots Calibrated Airspeed
KIAS	Knots Indicated Airspeed
KTAS	Knots True Airspeed
kts	Knots
lb	Pounds
LSO	Landing Signal Officer
min	Minutes
n_l	Normal Load Factor (wind axes)
nm	Nautical Mile
n_z	Normal Load Factor (body axes)
OEI	One-Engine Inoperative
OGE	Out-of-Ground Effect
P	Static Pressure
P_s	Specific Excess Power
R	Height to Span Ratio
r	Radius of the Earth
RCR	Runway Condition Reading
R/C	Rate-of-Climb
R/D	Rate-of-Descent
RF	Range Factor
S_c	Catapult Power Stroke
SEAD	Suppression of Enemy Air Defense
sec	Seconds
SR	Specific Range
STO	Short Takeoff
STOL	Short Takeoff and Landing
STOVL	Short Takeoff/Vertical Landing
T	Temperature
TSFC	Thrust Specific Fuel Consumption
V	Velocity
V_A	Catapult Endspeed Including Thrust Effects
V_c	Catapult Minimum End Airspeed
V_{cas}	Calibrated Airspeed
V_{cef}	Critical Engine Failure Speed
V_{co}	Initial Climb True Airspeed
V_D	Dive Speed
V_{DL}	Deadload Velocity
V_e	Shipboard Engaging Speed
V_{eas}	Equivalent Airspeed
V_{end}	Deck Endspeed
$V_{end(m)}$	Deck Minimum End Airspeed
$V_{end(op)}$	Deck Operational Endspeed

TABLE I. Symbols and abbreviations – Continued

VFR	Visual Flight Rules
V_H	Maximum Level Flight Speed
V_{ias}	Indicated Airspeed
V_L	Limit Speed
V_{lo}	Liftoff Speed
V_{mca}	Air Minimum Control Speed
V_{mcad}	Dynamic Air Minimum Control Speed
V_{mcas}	Static Air Minimum Control Speed
V_{mcg}	Ground Minimum Control Speed
V_{obs}	Obstacle Clearance Speed
V_{op}	Catapult Operational End Airspeed
V_{pa}	Approach Speed
V_{ref}	Refusal Speed
V_{rot}	Rotation Speed
V_s	Stall Speed
V_{sl}	Stall Speed (Power-Off, Landing Configuration)
V_{sos}	Speed Of Sound, Mach
V_{sp}	Stall Speed, Power-On
V_{spa}	Stall Speed, Power-On (Power For Level Flight, Landing Configuration)
V_{spo}	Power-Off Stall Speed
V_{tas}	True Airspeed
V_{tdl}	Touchdown Speed For Land Operations
V_{tdc}	Touchdown Speed For Carrier Operations
VL	Vertical Landing
V/STOL	Vertical/Short Takeoff And Landing Air Vehicle
W	Air Vehicle Weight
WOD	Wind-Over-Deck
$\dot{W}_f$	Engine Fuel Flow
$\dot{W}fc$	Fuel Flow At Initial Climb Speed At The Thrust (Power) For Takeoff
$\dot{W}fo$	Static Fuel Flow At The Thrust (Power) For Takeoff
Wfto	Takeoff and Acceleration Fuel
Wsys	System Weight
WTO	Takeoff Weight
Z	Geometric Altitude
Z_d	Density Altitude (geometric)
Z_p	Pressure Altitude (geometric)
α	Angle of Attack (alpha)
αpa	Approach Angle of attack
γ	Flight Path Angle (gamma)
θ	Body Pitch Angle (theta)
ι	Thrust Incidence Angle (iota)
μ	Coefficient of Friction (mu)
ρ	Atmospheric Density (rho)

3.1 Missions

3.1.1 Range. Range is defined as the distance (including the distance covered in climb) attainable on a one-way flight with specified payload and fuel allowances.

3.1.2 Radius. Radius is defined as the distance (including distance covered in climb) to the midpoint of a mission having equal length legs from takeoff point to target and return.

3.1.3 Mission Types. The missions defined below are intended to portray the capabilities of the air vehicle for specific mission conditions. The mission profiles for these missions, and for other representative operational missions, appropriate to each type air vehicle, are given in appendix B.

3.1.3.1 Design Mission. The design mission(s) is defined as the primary mission(s) for which the air vehicle was developed. This mission will normally be defined in procurement documents such as the prime item development specification which will define the flight profile, fuel allowances, and payload.

3.1.3.2 Clean Mission. The clean mission is defined as a radius mission conducted without payload to depict the maximum radius capability of the air vehicle. This mission is usually a high-high-high profile.

3.1.3.3 Ferry Mission. The ferry mission is defined as a range mission conducted without payload to depict the maximum range capability of the air vehicle. When an air vehicle is being ferried as part of a deployment to another operating location, it carries the items of equipment included in operating weight (3.10.3).

3.1.3.3.1 Alternate Design Criteria. The following information is provided to calculate operational trans-oceanic missions. Distances are for the longest legs encountered when the Atlantic and Pacific oceans are crossed. Distances do not include factors to account for winds. When these distances are used, the effects of prevailing winds must be considered.

a. Trans-Atlantic Ferry. The distance from New York to the Azores is 2100 nm (no wind). An alternate route is 1260 nm from St. Johns, Newfoundland to the Azores.

b. Trans-Pacific Ferry. The distance from San Francisco to Honolulu is 2100 nm (no wind).

3.1.3.4 Inflight Refueled Mission. For air vehicles capable of inflight refueling, the range for an inflight refueled mission is defined as the distance (range or radius) attainable through receipt of replacement fuel during flight. Multiple refueling operations may be used, if necessary. The refueling segment starts at the end of the previous segment and ends at the end of the refueling operation. If a climb or descent is required as part of this segment, it is conducted in accordance with 3.3.3. Refueling takes place within the refueling speed/altitude envelope common to both the tanker and receiver aircraft.

3.1.3.4.1 Rendezvous Refuel. Rendezvous refuel is defined as a refueling operation in which the tanker and receiver air vehicles fly independent routes to a prearranged location.

3.1.3.4.2 Buddy Refuel. Buddy refuel is a refueling operation in which the tanker and receiver depart from the same base at the same time and fly the same route at the same airspeed, in close proximity to each other, until the transfer of fuel occurs.

3.1.4 Mission Categories

3.1.4.1 Combat Air Patrol (CAP). The combat air patrol mission is a radius mission to defend a specific area.

3.1.4.2 Close Air Support (CAS). The close air support mission is a radius mission where the primary role is to direct support of ground troops.

3.1.4.3 Suppression of Enemy Air Defenses (SEAD). The suppression of enemy air defenses mission is defined as a radius mission where the primary goal is suppression or destruction of enemy ground-to-air defense systems, such as radar-guided missiles.

3.1.4.4 Interdiction. The interdiction mission is a radius mission performed to destroy enemy supply routes.

3.1.4.5 Intercept. The intercept mission is a radius mission performed to arrive at the combat area as soon as possible and engage enemy air vehicles.

3.1.4.6 Cargo/Troop Transport. Cargo/troop transport missions are radius or range missions in which cargo or a load of troops is transported to or from some location.

3.1.4.7 Observation/Reconnaissance. The observation/reconnaissance mission is a radius mission performed to accomplish observation and reconnaissance of the battlefield, as well as artillery spotting.

3.1.4.8 Anti-Submarine/Anti-Surface Warfare (ASW/ASUW). Anti-Submarine/Anti-Surface Warfare missions are radius missions which consist of transit to a target area; followed by search, localization, and attack; completed by return to base. These missions are based aboard ship.

3.1.4.9 Bomber. The bomber mission is a radius mission to deliver air-to-ground weapons on a target at the mission mid-point.

3.1.4.10 Trainer. Trainer missions are radius or range missions to train aircrews. Missions may be for the purpose of basic training or to emulate the mission to be flown by the parent air vehicle type.

3.1.4.11 Airborne Warning and Control. The airborne warning and control mission is a radius mission to accomplish electronic surveillance at the mid-point of the mission.

3.1.5 Times

3.1.5.1 Mission Time. Mission time is defined as the time in the air, starting at takeoff and ending at touchdown.

3.1.5.2 Cycle Time.

a. Land Operations. Cycle time is defined as the time of flight from the start of initial climb (omitting takeoff time) to the time when the engines are stopped after landing.

b. Carrier Operations. Cycle time is defined as the time from first air vehicle in first group takeoff (starting with catapult launch) to first air vehicle in second group takeoff. (First group lands after second group takeoff.)

For 1 + 45 cycle time (1 hr and 45 min), mission time is 2 hr, with a 15-min allowance for the second group to takeoff.

3.1.5.3 Block Time. Block time is defined as the total time from engine start before takeoff to engine stop after landing.

3.1.5.4 Intercept Time. Intercept time is defined as the time from engine start to initiation of combat at the intercept altitude and range. It includes the time required for takeoff and acceleration to climb speed.

3.2 Takeoff. Takeoff is defined as that phase of flight during which the air vehicle leaves the ground and enters aerodynamic and thrust-supported flight. It extends from starting engines to the start of the initial climb. Terminology used for the different portions of takeoff are shown on figure 2.

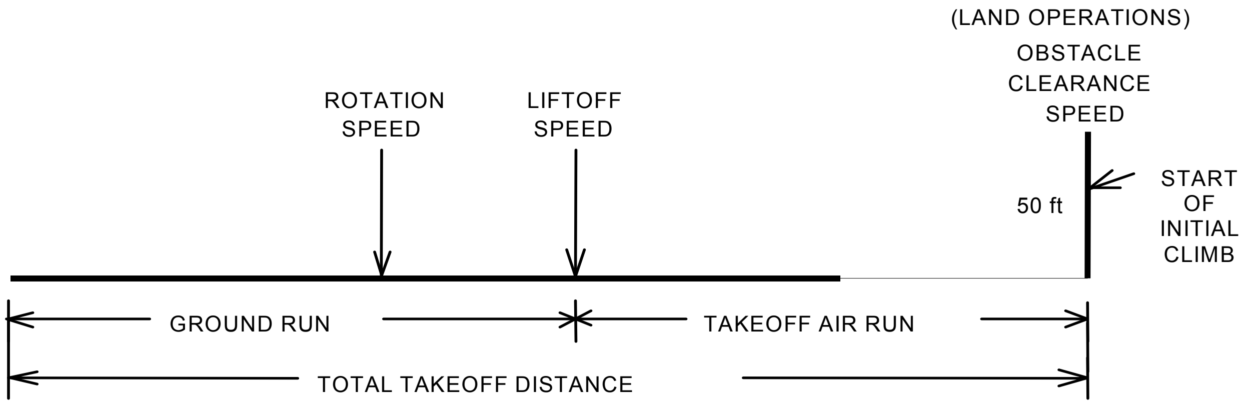


FIGURE 2. Takeoff terminology

3.2.1 Rotation Speed (V_{rot}). Rotation speed is defined as the speed at which body rotation is initiated from the ground run attitude to the liftoff attitude, for a specified altitude, weight, and configuration. Rotation speed must be equal to or greater than the ground minimum control speed. It must also be equal to or greater than the minimum speed at which the controls, including vectored thrust, if applicable, can generate sufficient moments to initiate rotation.

3.2.1.1 Alternate Design Criteria. Subject to approval of the Procuring Activity, consideration may be given to the analysis of Refusal Speed, Rotate Speed, Takeoff Speed, Air Minimum Control Speed, and Maximum Braking Speed (if applicable) when computing Takeoff or Go-Speed. A safe takeoff may be executed if V_{lo} and V_{mca} thresholds have been met even though the V_{mcg} speed is higher than these two speeds.

3.2.2 Stall Speed (V_S). Stall speed is defined (per MIL-STD-1797) at 1G normal to the flight path, for a specified altitude, weight, and configuration, as the highest of:

a. The speed for steady, straight, and level flight at $C_{L_{max}}$, the first local maximum of the curve of lift coefficient versus angle of attack which occurs as lift coefficient is increased from zero

b. The speed at which uncommanded pitching, rolling, or yawing occurs

c. The speed at which intolerable buffet or structural vibration is encountered.

NOTE: Although the local slope of the curve of lift coefficient versus angle of attack should be at least zero or positive at all points less than $C_{L_{max}}$, a slightly negative local slope may be permissible if it can be shown by engineering analysis and simulation, and eventually verified by flight test, that no unsatisfactory flying qualities and/or performance characteristics will result.

3.2.2.1 Power-Off Stall Speed (V_{spo}). Power-off stall speed is defined as the stall speed without thrust (power). For propeller-powered air vehicles, power-off stall speed is defined as the stall speed without power and with propellers feathered.

3.2.2.2 Power-On Stall Speed (V_{sp}). Power-on stall speed is defined as the stall speed accounting for the stated thrust (power).

3.2.3 Liftoff Speed (V_{lo}). Liftoff speed is defined as the speed at which the air vehicle leaves the ground for a specified altitude, weight, and configuration.

3.2.3.1 Land Operations. Liftoff speed is the highest of the following:

a. A speed corresponding to 110-percent (110%) of the out-of-ground effect power-off stall speed in the takeoff configuration for the c.g. position that results in the minimum trimmed lift or highest stall speed. At the discretion of the Procuring Activity, a power-on stall speed will be considered in lieu of, or in addition to, the power-off stall speed. For STOVL air vehicles, 110-percent (110%) of the power-on stall speed is used. For multi-engine STOVL air vehicles, the effects of having the most critical engine inoperative is included.

b. A speed determined by the in-ground effect lift coefficient in the takeoff configuration, power-on, for the maximum angle of attack allowable with the main landing gear oleo in the static position with the air vehicle on the ground

c. The minimum speed at which the air vehicle has a climb gradient potential of $^1/_2$-percent (0.005), with the thrust (power) setting being used for takeoff, flaps in the takeoff position, landing gear extended, out-of-ground effect

d. One-hundred-five-percent (105%) of the out-of-ground effect static air minimum control speed, or if flight test data is available, dynamic air minimum control speed. Both the static and dynamic air minimum control speeds are as defined in MIL-STD-1797.

e. The minimum speed at which the air vehicle can initiate rotation to the appropriate takeoff attitude, plus the speed change during rotation.

f. The minimum speed that permits obstacle clearance speed, as defined in 3.2.4, at or before the air vehicle clears a height of 50 ft above the runway.

g. The minimum speed based on flight control limiting with margins applied as appropriate, subject to the approval of the Procuring Activity.

3.2.3.1.1 Alternate Design Criteria. Subject to approval of the Procuring Activity, consideration may be made of alternate definitions of liftoff speed, such as: a higher or lower percentage of stall speed, a higher climb gradient potential, or other criteria which reflect the specific air vehicle requirements or usage.

3.2.3.2 Carrier Operations

3.2.3.2.1 Catapult Minimum End Airspeed (V_c). Catapult minimum end airspeed is defined as the airspeed required at the end of the catapult stroke to support the air vehicle under the conditions of altitude loss, lift limit, pitch rate limit, and longitudinal acceleration specified for catapulting. The air vehicle launch is configured for an 89.8ºF day, unless otherwise specified.

3.2.3.2.1.1 Computational Ground Rules. Catapult minimum end airspeed is the highest of the following:

a. An endspeed which results in the c.g. position of the air vehicle sinking no more than 10 ft from its position at the end of the power stroke, with a deck run not to exceed 32 ft (distance from the end of the power stroke to round-down), with cockpit control position held either fixed or free or controls active (control position[s] during the catapult launch are specified by the catapult flight control position requirements in MIL-STD-1797 as modified by the Design Specification).

b. The speed represented by 90-percent (90%) of the maximum lift coefficient, power-off, out-of-ground effect.

c. The minimum airspeed at which the air vehicle has a longitudinal acceleration of .065G (2.0913 ft/sec^2) at zero flight path angle.

d. One-hundred-five-percent (105%) of the out-of-ground effect static air minimum control speed, or if flight test data is available, dynamic air minimum control speed. Both the static and dynamic air minimum control speeds are as defined in MIL-STD-1797.

e. The endspeed which results in an air vehicle maximum pitch rate not to exceed 12°/sec to prevent pilot disorientation.

f. The minimum speed based on flight control limiting with margins applied as appropriate, subject to the approval of the Procuring Activity.

3.2.3.2.2 Minimum Wind-Over-Deck (WOD) (Catapult). Minimum catapult wind-over-deck is defined as catapult minimum end airspeed minus catapult endspeed (including thrust effects). (Minimum WOD = $V_c - V_A$)

3.2.3.2.2.1 Operational Wind-Over-Deck (WOD) (Catapult). Operational catapult wind-over-deck is defined as catapult operational end airspeed minus catapult endspeed (including thrust effects). (Operational WOD = $V_{op} - V_A$)

3.2.3.2.3 Catapult Operational End Airspeed (V_{op}). Catapult operational end airspeed is defined as the recommended airspeed required for operational use. Normally, this is V_c + 15 kts.

3.2.3.2.3.1 Catapult Endspeed Including Thrust Effects (V_A). Catapult endspeed with thrust effects, in knots, is derived through the following equation:

$$V_A = \sqrt{\frac{22.5888\dfrac{S_c(F_n - D)}{W_{sys}} + \sqrt{\left[22.5888\dfrac{S_c(F_n - D)}{W_{sys}}\right]^2 + 4V_{DL}{}^4}}{2}}$$

Where:

S_c	=	catapult Power Stroke, ft
	=	302 ft for C13-1 and C13-2 catapults
	=	243 ft for C13 catapult
	=	247 ft for C7 catapult
	=	205 ft for C11-1 catapult
F_n	=	net thrust = ($F_g \cos(\alpha + \iota) - D_r - D_p$), lb
F_g	=	gross thrust, lb
D_r	=	ram drag, lb
D_p	=	propulsive drag (other than ram drag), lb
α	=	angle of attack
ι	=	thrust incidence angle
D	=	aerodynamic drag, lb
W	=	air vehicle weight, lb
CEW	=	catapult equivalent weight, lb
	=	5500 lb (all except C13-2 catapults)
	=	6680 lb (C13-2 catapult)
W_{sys}	=	system weight, lb = W + CEW

V_{DL} = deadload velocity, knots (Catapult endspeed without thrust)

NOTES: 1. V_{DL} is determined from NAEC-MISC-06900.
2. Thrust and drag are to be evaluated at 0.7 V_{DL}.
3. Use minimum engine for thrust calculations.
4. Use primary mission configuration for drag calculations.

3.2.3.2.4 STOVLV/STOL air vehicle

3.2.3.2.4.1 STOVL Minimum Flight Speed ($V_{min(STOVL)}$). STOVL Minimum Flight Speed is defined as the highest of the following:

a. The speed at which the aircraft can maintain a longitudinal acceleration of 0.065G and a vertical acceleration of 0.030G. The vertical acceleration criteria is not applicable from deck exit through maximum c.g. sink point for shipboard Short Takeoffs (STOs).

b. 110 percent (110%) or 5 kts, whichever is greater, than the speed at which uncommanded pitching, rolling, or yawing occurs.

c. 110 percent (110%) or 5 kts, whichever is greater, than the speed at which intolerable buffet or structural vibration is encountered.

d. The airspeed at which Level 1 flying qualities as defined in MIL-STD-1797 can be achieved.

3.2.3.2.4.2 Deck Minimum End Airspeed (Short Takeoff) ($V_{end(m)}$). Deck minimum end airspeed for a short, non-catapulted takeoff is defined as the airspeed required at the end of the deck run to support the air vehicle under the conditions of altitude loss, lift limit, pitch rate limit, and longitudinal acceleration specified for a STO. The air vehicle is configured for launch on an 89.8ºF day, unless otherwise specified.

3.2.3.2.4.2.1 Computational Ground Rules. Unless otherwise specified, deck minimum end airspeed is the lowest airspeed which satisfies all the following conditions:

a. The c.g. position of the air vehicle sinks no more than 10 ft from its position at the end of the deck roll.

b. The air vehicle is limited to an angle-of-attack that corresponds to 0.9 $C_{L_{max}}$ (power off).

c. The air vehicle does not exceed a pitch rate of 10º/sec.

d. The air vehicle has a longitudinal acceleration of 0.065G at the completion of the dynamic maneuver (10 ft sink, air vehicle rotation, flight control and thrust vectoring movement, etc.). Longitudinal acceleration is not negative during any portion of the dynamic maneuver.

e. The air vehicle maintains its minimum control airspeed with margins applied as appropriate, subject to the approval of the Procuring Activity.

f. All propulsion-induced forces and moments and all ground effects are accounted for.

3.2.3.2.4.3 Minimum Wind-Over-Deck (Short Takeoff). Minimum Wind-Over-Deck for a Short Takeoff is defined as deck minimum end airspeed minus deck endspeed. (Minimum WOD = $V_{end(m)} - V_{end}$)

3.2.3.2.4.3.1 Operational Wind-Over-Deck (Short Takeoff). Operational Wind-Over-Deck for a Short Takeoff is defined as deck operational end airspeed minus deck endspeed. (Operational WOD = $V_{end(op)} - V_{end}$)

3.2.3.2.4.4 Deck Endspeed (V_{end}). Deck endspeed for a STO is defined as the speed achieved by the air vehicle accelerating at takeoff thrust from the point of brake (or holdback) release to the beginning of the deck edge round-down.

3.2.3.2.4.4.1 Deck Operational End Airspeed ($V_{end(op)}$). Deck operational end airspeed is defined as the recommended airspeed required for operational use. Normally, this is deck minimum end airspeed +15 kts.

3.2.3.3 STOVL Short Takeoff

3.2.3.3.1 Operational Wind Over Deck (Short Takeoff). Operational Wind Over Deck for a Short Takeoff is defined as Deck Operational End Airspeed minus Deck Endspeed. (Operational WOD = $V_{end(op)} - V_{end}$)

3.2.3.3.1.1 Minimum Wind Over Deck (Short Takeoff). Minimum Wind Over Deck for a Short Takeoff is defined as Deck Minimum End Airspeed minus Deck Endspeed. (Minimum WOD = $V_{end(m)} - V_{end}$)

3.2.3.3.2 Deck Endspeed (Short Takeoff). (V_{end}). Deck Endspeed for a Short Takeoff is defined as the speed achieved by the aircraft accelerating from the point of brake (or holdback) release to the beginning of the deck edge round-down.

3.2.3.3.2.1 Deck Operational End Airspeed ($V_{end(op)}$). Deck Operational End Airspeed is defined as Deck Minimum End Airspeed +15 kts. Deck Operational End Airspeed is defined to include sufficient directional control power to trim in 15-kts headwinds and 10-kts crosswinds.

3.2.3.3.3 STOVL Flat Deck Short Takeoff

3.2.3.3.3.1 Deck Minimum End Airspeed (Short Takeoff) ($V_{end(m)}$). Deck Minimum End Airspeed for a short, non-catapulted takeoff is defined as the minimum airspeed necessary at the end of the deck run which will enable the aircraft to execute a STO. The aircraft is in the launch configuration.

3.2.3.3.3.2 Ship-based Flat Deck Short Takeoff Distance. Ship-based Flat Deck Short Takeoff Distance is defined as the horizontal distance from the location of the nose wheel at brake release (zero velocity) to the main wheel liftoff point at deck edge at Deck Minimum End Airspeed for a specified altitude, weight, and configuration.

3.2.3.3.3.2.1 Computational Ground Rules.

a. The c.g. position of the aircraft may not sink more than 10 ft from its position at the deck edge.

b. The aircraft is at an airspeed greater than STOVL Minimum Flight Speed at the point of maximum c.g. sink.

c. The aircraft pitch rate boundaries do not exceed -2.5 deg/sec to +12 deg/sec throughout the entire takeoff maneuver.

d. The aircraft is to maintain a longitudinal acceleration of .065G, except at peak angle of attack after rotation where a reduction in acceleration for up to 0.2 sec is allowed. The longitudinal acceleration is to be positive throughout the STO maneuver.

e. The engine thrust setting and nozzle configuration at the initiation of the STO (brake release) is to be consistent with the ability to hold position with the aircraft brakes on the operating surface.

f. Controls usage during the STO retains sufficient directional control power to trim in 10-kts winds through 90° off the nose.

g. The aircraft is to maintain Level 1 flying qualities as defined in MIL-STD-1797 throughout the STO maneuver. There is to be sufficient control power in the pitch axis during the flyout, beyond the control power needed to trim the aircraft or account for disturbances of 10 kts in any direction, such that 10° pitch attitude change in either direction can be generated in 1.2 sec after pilot control input.

h. The STOVL air vehicle is to have adequate over the nose field of view for the pilot to track visual cues and sufficient weight on the nose wheel to provide Level 1 ground handling characteristics during the takeoff run, as defined in MIL-STD-1797.

NOTE: Calculation includes all propulsion-induced forces and moments.

3.2.3.3.4 STOVL Ski Jump Short Takeoff

3.2.3.3.4.1 Deck Minimum End Airspeed (Short Takeoff) ($V_{end(m)}$). Deck Minimum End Airspeed for a short, non-catapulted takeoff is defined as the minimum airspeed necessary during ski jump launch maneuver at the point of minimum rate of climb which will enable the aircraft to execute a STO. The aircraft is in the launch configuration.

3.2.3.3.4.2 Ship-based Ski Jump Short Takeoff Distance. Ship-based Ski Jump Short Takeoff Distance is defined as the horizontal distance from the location of the nose wheel at brake release (zero velocity) to the main wheel liftoff point at the end of the ski jump for a specified altitude, weight, and configuration.

3.2.3.3.4.2.1 Computational Ground Rules.

a. The aircraft is at an airspeed greater than STOVL Minimum Flight Speed at the point of minimum rate of climb.

b. The engine thrust setting and nozzle configuration at the initiation of the STO (brake release) is to be consistent with the ability to hold position with the aircraft brakes on the operating surface.

c. Controls usage during the STO retains sufficient directional control power to trim in 10-kts winds through 90° off the nose.

d. The aircraft is to maintain Level 1 flying qualities as defined in MIL-STD-1797 throughout the STO maneuver. There is to be sufficient control power in the pitch axis during the flyout, beyond the control power needed to trim the aircraft or account for disturbances of 10 kts in any direction, such that 10° pitch attitude change in either direction can be generated in 1.2 sec after pilot control input.

e. The STOVL air vehicle is to have adequate over the nose field of view for the pilot to track visual cues and sufficient weight on the nose wheel to provide Level 1 ground handling characteristics during the takeoff run, as defined in MIL-STD-1797.

f. At $V_{end(m)}$, the aircraft rate of climb is greater than 0 ft/min throughout the ski jump takeoff maneuver.

g. The aircraft rate of climb is greater than 400 ft/min when the aircraft is launched at $V_{end(m)}$ +15 kts.

NOTE: Calculation includes all propulsion-induced forces and moments.

3.2.3.4 Austere Site Operations. Austere Site Operations refers to the ability of the STOVL air vehicle to operate from forward-positioned, non-conventional, land-based locations. For purposes of this document, these definitions and computational ground rules are also applicable for the STOVL air vehicle during STOVL operations from conventional, land-based sites.

3.2.3.4.1 STOVL Short Takeoff Speed. The STOVL Short Takeoff Speed is defined as the minimum airspeed necessary at the end of the takeoff ground run which will enable the aircraft to execute a STO. The aircraft is in the launch configuration.

3.2.3.4.2 Land-based Short Takeoff Distance. Land-based Short Takeoff Distance is defined as the horizontal distance from the location of the nose wheel at brake release (zero velocity) to the main wheel liftoff point at Minimum End Airspeed for a specified altitude, weight, and configuration.

3.2.3.4.2.1 Computational Ground Rules.

a. The c.g. position of the aircraft may not sink.

b. The aircraft is at an airspeed greater than STOVL Minimum Flight Speed at takeoff.

c. The aircraft pitch rate boundaries do not exceed -2.5 deg/sec to +12 deg/sec throughout the entire takeoff maneuver.

d. The aircraft is to maintain a longitudinal acceleration of .065G throughout the STO maneuver.

e. The engine thrust setting and nozzle configuration at the initiation of the STO (brake release) is to be consistent with the ability to hold position with the aircraft brakes on the operating surface.

f. Controls usage during the STO retains sufficient directional control power to trim in 10-kts winds up to ±90° off the nose.

g. The aircraft is to maintain Level 1 flying qualities as defined in MIL-STD-1797 throughout the STO maneuver. There is to be sufficient control power in the pitch axis during the flyout, beyond the control power needed to trim the aircraft or account for disturbances of 10 kts in any direction, such that 10° pitch attitude change in either direction can be generated in 1.2 sec after pilot control input.

h. The STOVL air vehicle is to have adequate over the nose field of view for the pilot to track visual cues and sufficient weight on the nose wheel to provide Level 1 ground handling characteristics during the takeoff run, as defined in MIL-STD-1797.

NOTE: Calculation includes all propulsion-induced forces and moments.

3.2.3.4.3 STOVL Vertical Takeoff. A STOVL Vertical Takeoff is defined as a takeoff without longitudinal or lateral translation, conducted using only powered lift and propulsion-induced aerodynamics.

3.2.3.4.3.1 Computational Ground Rules.

a. The initial condition is nozzles configured for Vertical Takeoff and a throttle setting consistent with the ending point of a propulsion system acceleration check.

b. The maneuver initiates when the pilot advances the throttle.

c. Positive vertical acceleration is maintained throughout the maneuver.

d. Control power for vertical takeoff is calculated in accordance with 3.8.8.1.

e. The categories for vertical takeoff are:

Category	Time to 20 ft height (extended gear height)
Good Go	< 5 sec
Go	5-10 sec
Marginal Go	>10 sec
No-Go	unable to achieve

3.2.4 Obstacle Clearance Speed (V_{obs}). Obstacle clearance speed is defined as the flight path speed, with landing gear extended, at which the air vehicle clears a 50-ft height above the runway during climb out, for a specified altitude, weight, and configuration. It is the highest of the following:

a. A speed that corresponds to 120-percent (120%) of the out-of-ground effect power-off stall speed with flaps in the takeoff position for the c.g. position that results in the minimum trimmed lift or highest stall speed. The Procuring Activity has the discretion to consider a power-on stall speed in lieu of, or in addition to, the power-off stall speed.

b. One-hundred-five-percent (105%) of the out-of-ground effect static air minimum control speed, or if flight test data is available, dynamic air minimum control speed. Both static and dynamic air minimum control speeds areas defined by MIL-STD-1797.

c. The minimum speed at which the air vehicle has a climb gradient potential of 2.5-percent (0.025), with flaps in the takeoff position, landing gear retracted, with the thrust (power) setting being used for takeoff, out-of-ground effect. Multi-engine air vehicles must be able to reach this potential with the most critical engine inoperative (engine windmilling, propeller feathered).

d. If gear retraction results in a transient drag increase over that for gear down, the speed at which the air vehicle has a $^{1}/_{2}$-percent (0.005) climb gradient potential with flaps in the takeoff setting, gear in transit (most critical gear drag), with the thrust (power) setting being used for takeoff, out-of-ground effect. For multi-engine air vehicles, the most critical engine will be inoperative (engine windmilling, propeller feathered).

e. The minimum speed based on flight control limiting with margins applied as appropriate, subject to the approval of the Procuring Activity.

3.2.4.1 Alternate Design Criteria. If the Procuring Activity approves, consideration may be given to alternate limitations to the obstacle clearance speed, such as: a higher or lower percentage of the stall speed, an increase in climb gradient potential, or other criteria which reflect the specific air vehicle requirements or usage.

3.2.5 Ground Minimum Control Speed (V_{mcg}). The ground minimum control speed is defined as the minimum speed during the ground takeoff run at which the most critical engine can fail and directional control can be maintained under the conditions and criteria specified by MIL-STD-1797 for a specified altitude, weight, and configuration.

3.2.6 Air Minimum Control Speed (V_{mca})

3.2.6.1 Static Air Minimum Control Speed (V_{mcas}). Static minimum control airspeed is defined as the minimum airborne speed, with one engine inoperative and the remaining engines at Takeoff (Maximum) thrust (power), that balanced controlled flight can be maintained under the conditions specified in MIL-STD-1797, for a specified altitude, weight, and configuration.

3.2.6.2 Dynamic Air Minimum Control Speed (V_{mcad}). Dynamic minimum control airspeed is defined as the minimum airborne speed with Takeoff (Maximum) thrust (power) at which the engine most critical to control can fail and control can be maintained under the conditions and criteria specified by MIL-STD-1797, for a specified altitude, weight, and configuration.

3.2.7 Ground Run Distance. Ground run distance is defined as the distance from brake release (zero velocity) to main wheel liftoff for a specified altitude, weight, configuration, and thrust (power) setting. Calculate ground run distance for zero wind, on a dry, hard-surfaced runway (RCR = 23) with no slope, unless otherwise specified. Use the liftoff speed criteria of 3.2.3. Ground run distance can be dependent on pilot technique. If a technique is developed during flight testing which will be used in normal operations, the Procuring Activity can approve calculation of ground run distance using that technique.

3.2.7.1 Alternate Design Criteria. Subject to approval of the Procuring Activity, consideration may be made of alternate definitions of ground run distance, such as: alternate runway surfaces (sod, wet, ice, etc.), head or tail wind, or other criteria which align with the operational concept of the design or mission.

3.2.8 Total Takeoff Distance. Total takeoff distance is defined as the horizontal distance required for the air vehicle, with the landing gear extended, to clear a 50-ft obstacle height above the runway for a specified altitude, weight, configuration, and thrust (power) setting. It is the sum of the ground run distance of 3.2.7 plus the airborne distance needed to accelerate and climb to clear the 50-ft height at the speed specified in 3.2.4. Total takeoff distance can be dependent on pilot technique. If a technique is developed during flight testing which will be used in normal operations, the Procuring Activity can approve use of that technique to calculate total takeoff distance.

3.2.9 Ground Effect. Ground effect is defined as the alteration of the free air aerodynamic characteristics of the air vehicle due to the presence of the ground.

3.2.9.1 Out-of-Ground Effect (OGE). Out-of-ground effect is defined as free air where the ground does not affect the aerodynamic characteristics of the air vehicle.

3.2.9.2 In-Ground Effect (IGE). In-ground effect is defined as that region where the presence of the ground alters the free air aerodynamic characteristics of the air vehicle. This effect varies dependent on the distance of the wing from the ground. The change in ground effect with height can be calculated using the following method:

$$R = HT_{MAC} / b$$

Where:

R	=	height to span ratio
HT_{MAC}	=	height of the mean aerodynamic chord (MAC) above the ground, measured at the quarter chord. It is the sum of the height of the bottom of the wheels above the ground plus the height of the MAC above the bottom of the wheels, ft.
b	=	wing span, ft .

Ground effect (E) must be calculated twice; once with wheels on the ground (E_1), and once at the appropriate height (E_2).

If $R \leq 0.3$

$$E = 0.56 - 1.3 R + 0.45 / e^{20.75 R}$$

If $R > 0.3$

$$E = 0.45 / e^{3.2 R}$$

Then:

$$C_D = C_{DOGE} (1- (E_2 / E_1)) + C_{DIGE}(E_2 / E_1)$$

and

$$C_L = C_{LOGE} (1- (E_2 / E_1)) + C_{LIGE}(E_2 / E_1) .$$

A graph of E versus R follows.

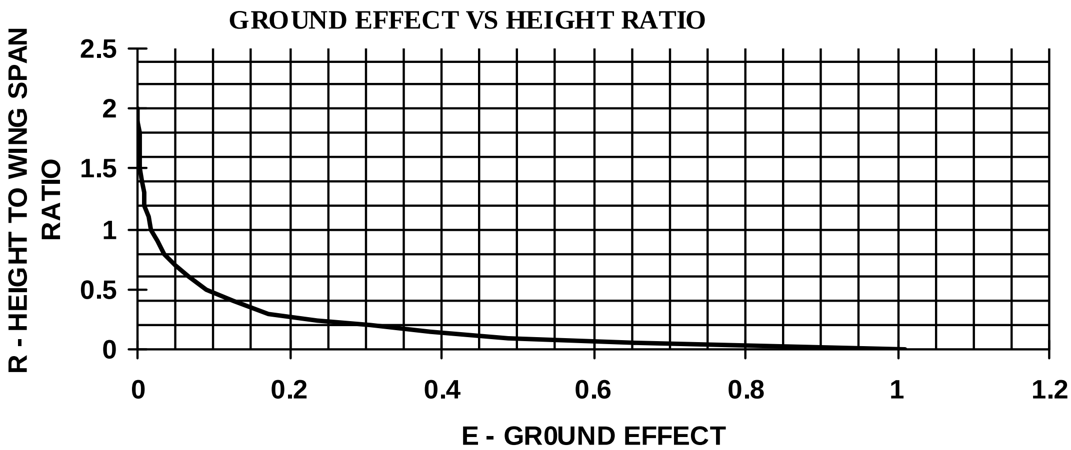


FIGURE 3. Ground effects

3.2.9.2.1 In-Ground Effect (V/STOL air vehicles). Ground effects for V/STOL air vehicles include hot gas re-ingestion, suckdown, fountain effects, and other propulsion-induced forces and moments which may be affected by the presence of the ground. These effects are highly configuration-dependent and vary with forward velocity, height above the ground, thrust vector angle(s), and power setting. Because of this, it is not possible to provide a single, analytical, or empirical method to calculate ground effects for V/STOL air vehicles which would provide accurate results. Ground effects will be estimated for V/STOL air vehicles based on available flight test and wind tunnel test data, or appropriate analytical methods, and may be subject to approval by the Procuring Activity.

3.2.10 Critical Field Length (CFL). Critical field length is defined as the sum of the distance required to accelerate to critical engine failure speed (3.2.11) with all engines operating, plus the distance to accelerate to liftoff speed with the critical engine inoperative or to decelerate to a stop from critical engine failure speed in the same distance for a specified altitude, weight, configuration, and thrust (power) setting (see figure 4).

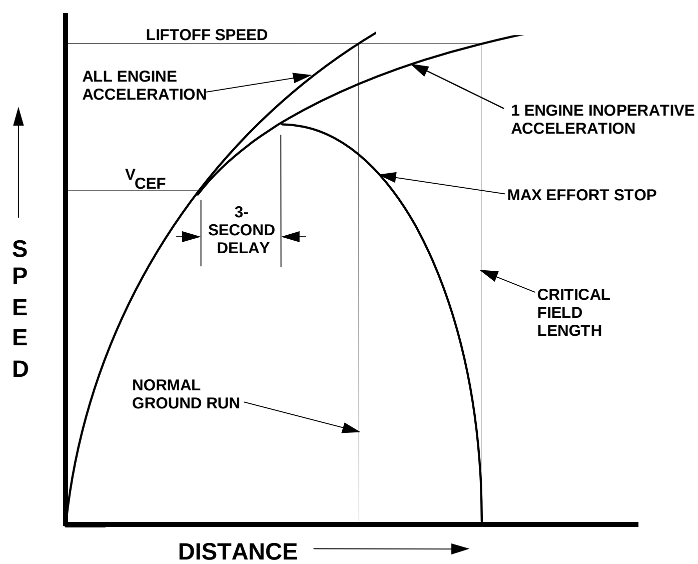


FIGURE 4. Critical field length terminology

3.2.10.1 Computational Ground Rules. The data basis for the computation of the stopping distance for critical field length follows (see figure 5). Use of reverse thrust and deceleration devices must be approved by the Procuring Activity.

a. At engine failure, the air vehicle continues to accelerate for 3 sec with the operating engine(s) at the thrust (power) setting being used for takeoff, while the inoperative engine is at a drag level that represents the most critical engine failure condition. This period is to account for recognition of the engine failure and initiation of a response.

b. At the end of the 3-sec period, brakes are instantly applied (while all brake and tire limits are observed), and action initiated to reduce thrust (power) on the operating engine(s) to idle and to deploy deceleration devices. Sufficient time will be allowed for full deployment of deceleration devices and decay of thrust (power) to idle before including their effects on deceleration. If time response data is available to model their effects more accurately, it will be used, subject to the approval of the Procuring Activity.

c. Action to initiate reverse thrust, if available, will be taken once the engine(s) has reached Idle thrust (power). Sufficient time will be allowed for increase to full reverse thrust before including its effects on deceleration. If time response data is available to model its effect more accurately, it will be used, subject to the approval of the Procuring Activity. If reverse thrust is used, it will be limited to the amount which can be trimmed-out by the rudder, asymmetric braking, nose wheel steering, etc.

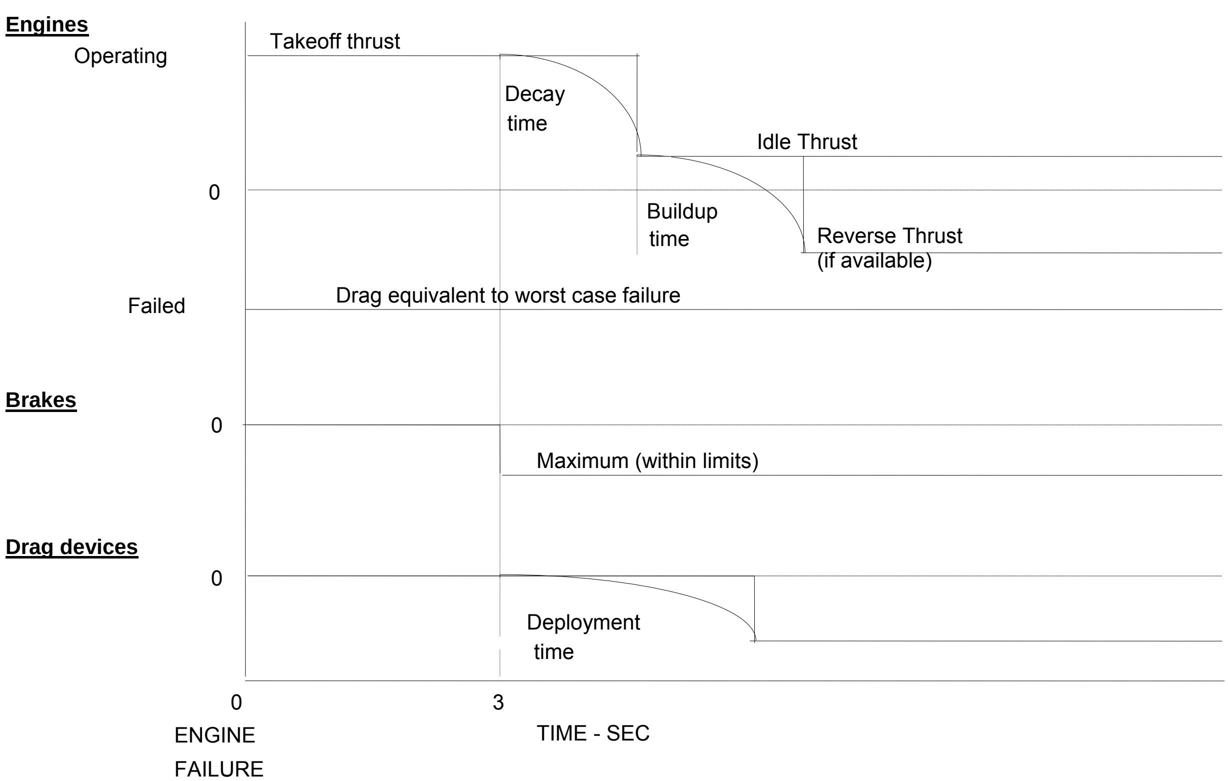


FIGURE 5. Critical field length criteria

3.2.10.2 Alternate Design Criteria. Alternate design criteria are those features which allow use of a shorter period of time for recognition of a failure and initiation of a response, subject to the approval of the Procuring Activity.

3.2.11 Critical Engine Failure Speed (V_{cef}). Critical engine failure speed is defined as the speed during the takeoff run at which an engine can fail and the same distance is required to either liftoff or stop the air vehicle, for a specified altitude, weight, configuration and thrust (power). Critical engine failure speed cannot be less than ground minimum control speed. Conditions for which this speed is calculated are specified in 3.2.10.1.

3.2.12 Refusal Speed (V_{ref}). Refusal speed is the maximum speed during takeoff from which the air vehicle can stop within the available remaining runway length for a specified altitude, weight, and configuration.

3.2.13 Refusal Distance. Refusal distance is the distance required to accelerate to refusal speed for a specified altitude, weight, configuration, and thrust (power) setting.

3.2.14 Coefficient of Friction (μ). The coefficient of friction, as used in this document, is defined as the ratio of the total retardation force of the wheels and braking system to the weight on the wheels (weight minus lift). The following values are used unless air vehicle test data is available:

a. The unbraked rolling coefficient of friction for a dry, hard surface for bias-ply tires is 0.025. A value of 0.015 is used for the same conditions for radial tires.

b. The total braking coefficient of friction for a dry, hard surface without the use of anti-skid is 0.30. The total braking coefficient of friction for a dry, hard surface with the use of anti-skid is 0.38. The maximum braking coefficient of friction with anti-skid is 0.33 for brakes designed to a 10 ft/sec^2 deceleration capability. Brake torque limits and energy absorption rate limits will be observed.

c. Values of coefficient of friction from tests on the specific air vehicle or similar types may be used with the concurrence of the Procuring Activity.

3.2.14.1 Alternate Design Criteria. The coefficient of friction values for a hard-surfaced runway under the conditions specified in table II are supplied for design purposes.

TABLE II. Coefficient of friction

Runway Condition	RCR	Rolling Unbraked	Rolling Braked	Rolling Braked with Anti-Skid
Dry	23	.025*	.30	.38**
Wet	15	.050	.20	.25
Wet Snow	11	.090	.14	.18
Wet Ice	7	.050	.09	.12

* 0.015 for radial tires

** 0.33 for brake-limited systems

NOTES:

1. The value 0.26 is to be used for the total braking Coefficient of Friction for dry, used AM-2 matting (RCR of 20) without the use of anti-skid. The value 0.32 is to be used for the total braking Coefficient of Friction for dry, used AM-2 matting with the use of anti-skid. Brake torque limits and energy absorption rate limits are to be observed.

2. The value 0.24 is to be used for the total braking Coefficient of Friction for wet, used AM-2 matting (RCR of 18) without the use of anti-skid. The value 0.30 is to be used for the total braking Coefficient of Friction for wet, used AM-2 matting with the use of anti-skid. Brake torque limits and energy absorption rate limits are to be observed.

3. A standard US two-lane road is 36 ft wide and constructed of road grade asphalt. Visual cues are available from a painted center stripe and outer painted line 12 ft from the center of the road. Hard surface runway Coefficients of Friction may be used for austere site (asphalt road) operations.

3.3 Climb. Climb is defined as that portion of flight when the air vehicle is ascending from a lower geometric altitude to a higher geometric altitude.

3.3.1 Rate-of-Climb (R/C). Rate-of-climb is defined as a positive time rate of change of geometric altitude. It is equal to the vertical component of the flight path velocity.

3.3.1.1 Maximum Rate-of-Climb. Maximum rate-of-climb is defined as the maximum time rate of change of geometric altitude for a given configuration, weight, altitude, speed, and thrust (power).

3.3.1.2 Dynamic Rate-of-Climb. Dynamic rate-of-climb is defined as the rate-of-climb for which the air vehicle is either accelerating or decelerating (true airspeed is not constant). Rate-of-climb is usually expressed in feet per minute, and is defined as follows:

$$R / C = 101.27 \frac{(F_n - D)V_{tas}}{W\left(1 + \frac{V_{tas}}{g}\frac{dV_{tas}}{dh}\right)}$$

Where:

R / C	=	rate-of-climb, ft/min
F_n	=	net thrust = $(F_g \cos(\alpha + \iota) - D_r - D_p)$, lb
F_g	=	gross thrust, lb
D_r	=	ram drag, lb
D_p	=	propulsive drag (other than ram drag), lb
α	=	angle of attack
ι	=	thrust incidence angle
D	=	aerodynamic drag, lb
V_{tas}	=	true airspeed, knots
W	=	air vehicle weight, lb
g	=	gravitational acceleration, ft/sec^2
$\left(\frac{V_{tas}}{g}\frac{dV_{tas}}{dh}\right)$	=	acceleration factor (V_{tas} and dV_{tas} are in ft per sec)
dV_{tas}/dh	=	change in velocity with altitude, 1/sec .

3.3.1.3 Steady-state Rate-of-Climb. Steady-state rate-of-climb is defined as the rate-of-climb for which the acceleration factor is zero, climbing at a constant true airspeed, ($dV/dt = 0$). The rate-of-climb equation becomes:

$$R/C = dh/dt = 101.27\,V_{tas}\,\sin\gamma = 101.27\,(F_n - D)\,V_{tas}/W$$

Where:

R / C	=	rate-of-climb, ft/min
V_{tas}	=	true airspeed, knots
γ	=	flight path angle
F_n	=	net thrust = $(F_g \cos(\alpha + \iota) - D_r - D_p)$, lb
F_g	=	gross thrust, lb
D_r	=	ram drag, lb
D_p	=	propulsive drag (other than ram drag), lb
α	=	angle of attack
ι	=	thrust incidence angle
D	=	aerodynamic drag, lb
W	=	air vehicle weight, lb
dh/dt	=	time rate of change of altitude, ft/min.

3.3.1.4 Engine Out Rate-Of-Climb. Engine out rate-of-climb is defined as climb with the most critical to control engine out (as defined by MIL-STD-1797) while the air vehicle maintains a constant heading with up to 5° of bank into the failed engine. The engine failure condition (stopped rotor, windmilling, propeller feathered, etc.) is stated, and the resulting drag of the failed engine and trim devices included in the calculation.

3.3.1.4.1 Alternate Design Criteria (Carrier). Subject to operational constraints and approval by the Procuring Activity, satisfactory (adequate) engine out rate-of-climb may be defined as:

a. Catapult. The minimum rate-of-climb which is considered perceptible to the pilot and can provide a safe flyaway is 200 ft/min. This is calculated at a one-engine inoperative emergency catapult end airspeed, which is defined as catapult minimum end airspeed plus 10 kts (the normal catapult operational end airspeed minus 5 kts to account for the loss of engine thrust during the catapult stroke). For new air vehicle designs, one engine out rate-of-climb is calculated with gear and takeoff flaps down. Since this is a stringent requirement for older aircraft, the one engine out rate-of-climb for some aircraft is calculated with takeoff flaps down, gear up, if drag continues to decrease after initiation of gear up. If gear retraction results in a transient drag increase over that for gear down, the Procuring Activity will specify the calculation of one engine inoperative rate-of-climb.

b. Carrier Approach. The minimum rate-of-climb considered adequate to arrest the glide slope sink and provide adequate excess thrust for waveoff is 500 ft/min. The configuration is landing flaps down, gear down, speed brakes (if required for approach) retracted, and the initial conditions are at the normal carrier approach speed on a 4° glide slope.

3.3.2 Climb Gradient. Climb gradient is the change in altitude per unit of horizontal distance traveled, expressed as a percentage. The gradient can also be defined as the tangent of the flight path angle. Climb gradient is given by the following equation:

$$\text{Climb Gradient (percent)} = (\Delta\text{Height} / \Delta\text{Horizontal Distance}) \bullet 100 = (\tan \gamma) \bullet 100 .$$

3.3.3 Flight Path Angle (γ). Flight path angle is defined as the angle between the local horizon and the air vehicle velocity vector.

3.3.4 Initial Climb-Out. Initial climb-out is defined as the transition period beginning at the 50-ft obstacle and ending when the air vehicle reaches climb speed.

3.3.5 Enroute Climb. Enroute climb is defined as any climb enroute to the next flight phase.

3.3.5.1 Minimum Time to Climb. Minimum time to climb is defined as the shortest amount of time to climb from one speed/altitude condition to another. If only initial and final altitudes are specified, the initial and final speeds will be assumed to lie on the minimum time to climb speed schedule.

3.3.5.2 Minimum Fuel to Climb. Minimum fuel to climb is defined as the smallest amount of fuel to climb from one speed/altitude condition to another. If only initial and final altitudes are specified, the initial and final speeds will be assumed to lie on the minimum fuel to climb schedule.

3.3.6 Recovery Climb. Recovery climb is defined as a climb to the cruise conditions after withdrawal from the target has been accomplished.

3.3.7 Zoom Climb. Zoom climb is defined as a climb which converts kinetic energy (speed) to potential energy (altitude).

3.3.8 Combat Climb. Combat climb is defined as a climb at maximum rate-of-climb for combat conditions (weight, configuration, altitude, and thrust [power] setting).

3.3.9 Climb Speed. Climb speed is defined as the speed along the flight path at which climb is conducted for a specified altitude, weight, configuration, and thrust [power] setting.

3.3.9.1 Climb Schedule. Climb schedule is defined as the sequence of speed/altitude combinations to be used during a climb for a specified initial weight, configuration, and thrust (power) setting. The climb schedule is usually calculated to achieve maximum or optimum rates of climb; however, in operational usage, an easily-followed climb schedule of constant speed or Mach number which results in rates of climb close to the maximum or optimum may be desirable.

3.3.9.2 Best Climb Speed. Best climb speed is defined as the steady-state speed that results in the maximum rate-of-climb for a specified altitude, weight, configuration, and thrust (power).

3.3.9.3 Optimum Climb Speed. Optimum climb speed is defined as the climb speed within a climb schedule which optimizes some climb parameter such as minimum time to climb, minimum fuel used in climb, etc., for a specified altitude, weight, configuration, and thrust (power).

3.4 Ceiling. Ceiling is defined as the highest altitude at which a specified steady-state rate-of-climb can be achieved.

3.4.1 Absolute Ceiling. Absolute ceiling is defined as the altitude at which the maximum steady-state rate-of-climb potential is 0 ft per min, for a specified configuration, weight, speed, and thrust (power) setting.

3.4.2 Service Ceiling. Service ceiling is defined as the altitude at which the maximum steady-state rate-of-climb potential is 100 ft per min for a specified configuration, weight, speed, and thrust (power) setting.
(P_s = 1.6667 ft per sec at $\gamma = 0$)

3.4.3 Cruise Ceiling. Cruise ceiling is defined as the altitude at which the maximum steady-state rate-of-climb potential is 300 ft per min at Maximum Continuous (Intermediate for augmented-engine-powered air vehicle) thrust (power), for a specified configuration, weight, and speed.
(P_s = 5.0 ft per sec at $\gamma = 0$)

3.4.4 Combat Ceiling. Combat ceiling is defined as the altitude at which the maximum steady-state rate-of-climb potential is 500 ft per min for a specified configuration, weight, speed, and thrust (power) setting.
(P_s = 8.3333 ft per sec at $\gamma = 0$)

3.5 Cruise

3.5.1 Cruise Altitude. Cruise altitude is defined as the altitude at which the cruise portion of the mission is conducted. For an unpressurized air vehicle, the cruise altitude without oxygen masks will not exceed 10,000 ft (H_p); with oxygen masks, it will not exceed 25,000 ft (H_p). A pressure suit is required for extended periods above 50,000 ft (H_p) in a pressurized air vehicle. In no case will cruise altitude exceed cruise ceiling.

3.5.2 Optimum Cruise Speed/Altitude. Optimum cruise speed/altitude is defined as the speed/altitude combination at which the air vehicle attains the maximum nautical miles per pound of fuel for a specified configuration and weight.

3.5.3 Constant Altitude Cruise. Constant altitude cruise is defined as flight at a constant altitude during the cruise portion of flight.

3.5.4 Cruise Climb. Cruise climb is defined as a cruise performed during a climb to maximize nautical miles per pound of fuel as fuel is consumed.

3.5.5 Step Climb Cruise. Step climb cruise is defined as a cruise technique that is a compromise between constant altitude cruise and a cruise climb. In practice, the desired gradual altitude increase of the cruise climb is approximated by increasing altitude in discrete steps.

3.5.6 Maximum-Range Cruise Speed. Maximum-range cruise speed is defined as the speed at which maximum nautical miles per pound of fuel is attainable at a specified configuration, weight, and altitude.

3.5.7 Long-Range Cruise Speed. Long-range cruise speed is defined as the higher of the two speeds which yields 99-percent (99%) of the maximum nautical miles per pound of fuel for a specified configuration, weight, and altitude. Optimum long-range cruise takes place at the same altitude as the optimum value of maximum range cruise.

3.5.8 Average Cruise Speed. Average cruise speed is defined as the total distance covered in the cruise portion of flight divided by the time for cruise.

3.5.9 Maximum Cruise Speed. Maximum cruise speed is defined as the highest level flight speed that can be maintained at the Maximum Continuous (Intermediate for augmented-engine-powered air vehicles) thrust (power) setting at the specified configuration, weight, and altitude.

3.5.10 Specific Range (SR). Specific range is defined as nautical miles per pound of fuel consumed. It is usually expressed in nm/lb, and is defined as follows:

$$SR = V_{tas} / \dot{W}_f$$

Where:

SR = specific range, nm/lb
V_{tas} = true airspeed, knots
$\dot{W}_f$ = fuel flow, lb/hr.

3.5.11 Range Factor (RF). Range factor is defined as weight multiplied by specific range. This fuel mileage term is another way to measure the air vehicle's cruise range capability. It is usually expressed in nm, and is defined as follows:

$$RF = SR \bullet W$$

Where:

RF = range factor, nm
SR = specific range, nm/lb
W = air vehicle weight, lb.

3.5.12 Cruise Figure of Merit (FM). Cruise figure of merit is a term used to compare the cruise efficiency of air vehicles and is defined as follows:

$$FM = RF \bullet TSFC/V_{tas}$$

Where:

FM = cruise figure of merit
RF = range factor, nm
TSFC = thrust specific fuel consumption (uninstalled), per hour
V_{tas} = true airspeed, knots.

3.5.13 Combat Altitude. Combat altitude is defined two ways:

a. The altitude over the target for an air-to-ground mission

b. The altitude at which combat performance is calculated, for an air-to-air mission.

3.5.14 Penetration Speed. Penetration speed is defined as the speed at which the air vehicle ingresses to the target at a specified altitude.

3.5.15 Withdrawal Speed. Withdrawal speed is defined as the speed at which the air vehicle egresses from the target at a specified altitude.

3.5.16 Maximum Speed

3.5.16.1 Level Flight Maximum Speed (V_H). Level flight maximum speed is defined as the highest speed attainable in steady-state, level flight, at a load factor of 1.0 n_l for a specified altitude, weight, configuration, and thrust (power) setting. Level flight maximum speed is determined by the intersection of the thrust (power) available and thrust (power) required curves with all applicable limitations applied. In the context of mission performance, the specified maximum speed should be set slightly below the speed at which thrust available equals thrust required (such as the speed at which the maximum steady-state rate-of-climb potential is 500 ft per min) since most air vehicles accelerating in level flight at a specified power setting can only asymptotically approach the maximum speed for that power setting.

3.5.16.2 Limit Speed (V_L). Limit speed is defined as the maximum allowable speed of the air vehicle, with all applicable limitations applied, for a specified altitude, weight, and configuration. Limit speed is independent of thrust (power) available since it is not limited to level flight.

3.5.16.3 Dive Speed (V_D). Dive Speed is defined as the maximum authorized speed to dive the air vehicle intentionally. The dive conditions considered are altitude, flight path angle, thrust (power) setting, deceleration device settings, recovery load factor, and any other pertinent factors.

3.6 Endurance. Endurance is defined as the level-flight condition at which an air vehicle holds in a particular portion of airspace (zero range gain) at a minimum fuel burn rate for a specified weight, altitude, and configuration.

3.6.1 Maximum Endurance Speed. Maximum endurance speed is defined as the speed which yields minimum fuel flow attainable for a specified configuration, weight, and altitude.

3.6.2 Maximum Endurance Altitude. Maximum endurance altitude is defined as that altitude at which there is a minimum fuel flow for a specified configuration, weight, and speed.

3.6.3 Combat Loiter Speed. Combat loiter speed is defined as the speed selected to give the maximum endurance to accomplish a given mission task (e.g., search, rendezvous, target acquisition) where configuration and altitude are specified. Combat loiter differs from endurance, in that speeds and altitudes flown are to satisfy mission requirements.

3.6.3.1 Alternate Design Criteria. An alternate design criteria is for loiter speed in or near the combat area to be defined at or slightly below corner speed (3.9.7.2) instead of at maximum endurance speed, so the air vehicle can respond more readily to a threat or combat assignment.

3.7 Descent. Descent is defined as that portion of flight in which the air vehicle is descending from a higher geometric altitude to a lower geometric altitude.

3.7.1 Rate-of-Descent (R/D). Rate-of-descent is defined as a negative time rate of change of altitude (negative rate-of-climb). Rate-of-descent is usually expressed in feet per minute, and is defined as follows:

$$R/D = -{dh}/{dt} = 101.27\, V_{tas} \sin\gamma$$

Where:

R/D	=	rate of descent, ft/min
V_{tas}	=	true airspeed, knots
γ	=	flight path angle (will always be negative)
dh/dt	=	time rate of change of altitude, ft/min.

3.7.2 Descent Speed. Descent speed is defined as the flight path airspeed during a descent to a lower altitude. The particular speed/altitude profile selected is based on the type of descent to be used: e.g., emergency or maximum-range descents.
3.7.3 Enroute Descent. Enroute descent is defined as a descent used in normal operations when there is no emergency. The air vehicle will be configured appropriately—gear retracted; deceleration devices, flaps, and thrust (power) at the prescribed settings; speed schedule specified; etc.

3.7.4 Maximum Range Descent. Maximum range descent is defined as the best use of fuel to attain maximum range when descending from one altitude to another. Maximum range descent is made at or near maximum lift/drag speed. This descent is flown with thrust (power) at the prescribed setting, air vehicle configured as required, gear retracted, deceleration devices retracted, and at a specified speed schedule.

3.7.5 Penetration Descent. Penetration descent is defined as a descent utilized when descending to start terrain following at low altitude and high subsonic speed. This descent is flown at Flight Idle thrust (power) setting, air vehicle configured as required, gear retracted, deceleration devices deployed as required, and at a specified speed schedule. Other applicable placards must be observed during descent.

3.7.6 Emergency (Minimum Time) Descent. Emergency descent is defined as a descent which provides maximum altitude loss in a minimum amount of time, without exceeding airspeed limits, in the event of some type of emergency. Thrust (power) rating is set to Flight Idle, with the speed schedule specified.

3.7.7 Alternate Design Criteria. There may be alternate definitions of descent speed schedules, configurations, and thrust (power) settings which utilize the unique capabilities of a particular design, which are subject to approval of the Procuring Activity.

3.8 Landing. Landing is defined as that phase of flight during which the air vehicle transitions from aerodynamic and thrust-supported flight to being on the ground. It extends from end of descent to when the engines are shut off. Terminology used for the different portions of landing are shown on figure 6.

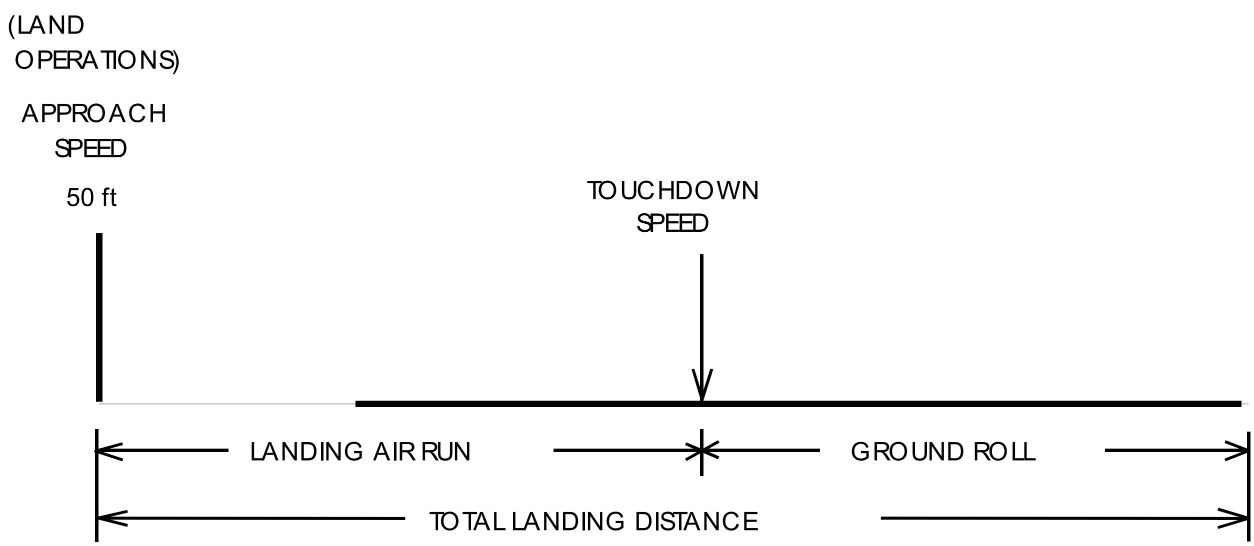


FIGURE 6. Landing terminology

3.8.1 Approach Speed (V_{pa})

3.8.1.1 Land-Based Air Vehicles. Approach speed is defined as the flight path velocity with which the air vehicle clears a 50-ft height above the runway during the approach to a landing for a specified altitude, weight, and configuration. It is the highest of the following:

a. A speed that corresponds to 120-percent (120%) of the out-of-ground effect power-off stall speed in the approach configuration, gear down, for the c.g. position that results in the minimum trimmed lift or highest stall speed

b. One-hundred-five-percent (105%) of static air minimum control speed, or, if flight test data is available, dynamic air minimum control speed as defined by MIL-STD-1797

c. The minimum speed at which the air vehicle has a climb gradient potential of 2.5-percent (0.025), with gear up, in the approach configuration, with Takeoff (Maximum) thrust (power), out-of-ground effect. Multi-engine air vehicles must obtain this potential with the most critical engine inoperative (engine windmilling, propeller feathered).

d. The minimum speed based on flight control limiting with margins applied as appropriate, subject to the approval of the Procuring Activity.

3.8.1.1.1 Alternate Design Criteria. Subject to the approval of the Procuring Activity, consideration may be made of alternate definitions of approach speed, such as: a higher or lower percentage of the stall speed or air minimum control speed, a higher climb gradient potential, alternate go-around power settings, or other criteria which reflect the specific air vehicle requirements or usage.

3.8.1.2 Carrier-Based Air Vehicles. With the air vehicle in the landing configuration and on a 4º glide slope on a 89.8ºF day, zero wind, the approach speed is the highest of the airspeeds defined by the following:

a. The lowest speed at which it is possible to achieve a level flight longitudinal acceleration of .155G (5 ft/sec^2) within 2.5 sec after initiation of throttle movement and speed brake retraction

b. One-hundred-ten-percent (110%) of the power-on stall speed using the thrust (power) required for level flight (V_{spa}) at 115-percent (115%) of V_{sl}, the power-off stall speed in the landing configuration

c. The lowest level flight speed at which the pilot, at the design eye position, can see the stern of the carrier at the waterline when intercepting a 4° optical glide slope at an altitude of 600 ft. The origin of the glide slope is 500 ft forward of the stern and 63 ft above the waterline.

d. The lowest speed at which all stability and control requirements are satisfied (per MIL-STD-1797)

e. The lowest speed at which the air vehicle is able to make a glide path correction from stabilized flight to a new glide path 50 ft above the original glide path within 5 sec after initiation of the maneuver. The maneuver will be performed without change in thrust settings by the pilot, and the air vehicle angle of attack during the maneuver cannot exceed that necessary to achieve 50-percent (50%) of the maximum positive delta lift available, based on static lift coefficient, at the initiation of the maneuver. Control rate input for simulation of V_{pa} cannot exceed control system limits. The maneuver is considered complete when a glide path correction of 50 ft has been reached. After completion of this maneuver, the air vehicle must be able to maintain a new glide path at least 50 ft above and parallel to the initial glide path, with the pilot permitted to change thrust setting, as required.

f. Such throttle inputs must achieve 90-percent (90%) of the commanded acceleration within 1.2 sec to ensure rapid air vehicle response to step throttle commands which correspond to up to ±.120G (±3.86 ft/sec^2) longitudinal acceleration. This requirement applies in the approach configuration throughout the range of all throttle settings required for operations over the usable approach configuration weight/drag levels while trimmed on a 4° glide slope.

g. The minimum speed based on flight control limiting with margins applied as appropriate, subject to the approval of the Procuring Activity.

NOTE: V_{pa} calculation is based on static lift coefficient. If direct lift control (DLC) is a design feature, all approach speed requirements will be met with DLC active except the visibility requirement (3.8.1.2.c), which will be met with DLC inoperable.

3.8.2 Touchdown Speed

3.8.2.1 Land Operations (V_{tdl}). Touchdown speed is defined as the speed at which the air vehicle touches the ground, for a specified altitude, weight, and configuration. It is the highest of the following:

a. A speed that corresponds to 110-percent (110%) of the out-of-ground effect power-off stall speed in the landing configuration, for the c.g. position that results in the minimum trimmed lift or highest stall speed.

b. A speed determined by the in-ground effect lift coefficient in the landing configuration, power-off, for the maximum angle of attack attainable with the main landing gear oleo in the fully compressed position with the air vehicle on the ground.

c. The minimum speed based on flight control limiting with margins applied as appropriate, subject to the approval of the Procuring Activity.

3.8.2.1.1 Alternate Design Criteria. Subject to the approval of the Procuring Activity, consideration may be made of alternate definitions of touchdown speed, such as: geometry limited with oleos in the partial extended position, changes in the percentage of stall speed, or other criteria which reflect the specific air vehicle requirements or usage. Selective use or alteration of the definitions of approach speed to reflect the unique operational features of V/STOL air vehicles may be made with the approval of the Procuring Activity.

3.8.2.2 Carrier Operations (V_{tdc}). For design purposes, touchdown speed is defined as that speed equal to 105-percent (105%) of carrier approach speed (V_{pa}). For operational air vehicles, touchdown speed will be determined using fleet survey data.

3.8.2.2.1 Wind-Over-Deck (Landing). Landing wind-over-deck is defined as the difference between touchdown speed and shipboard engaging speed.

3.8.2.2.2 Waveoff. Waveoff is defined as an aborted landing attempt during which the air vehicle does not touchdown. Waveoffs are divided into two categories, dependant on the air vehicle’s position when the waveoff is initiated: on glide slope, or above glide slope.

3.8.2.2.2.1 Computational Ground Rules. The initial conditions, criteria, and techniques used in the computation of waveoffs are as follow:

a. Initial conditions for waveoff are:

1. on glide slope. The air vehicle will be on a 4º optical glide slope stabilized at V_{pa} and α_{pa}. Thrust will be as required to meet this flight condition. With a 0.7-sec delay to account for pilot reaction time when the waveoff signal is displayed, the throttles are advanced to Intermediate/Maximum-rated thrust (power), and speed brake (if used) retraction is initiated.

2. above glide slope. This condition is intended to represent the most severe environment for a waveoff. It reflects a gross glide slope correction from a high (1 ball) position. The air vehicle will be on a 4º 20.45″ optical glide slope stabilized at V_{pa} and α_{pa}. Thrust will be as required to meet this condition. The throttles are retarded to idle. Two (2.0) sec later, at the initiation of the maneuver, the throttles are advanced to Intermediate/Maximum thrust (power) and speed brake (if used) retraction is initiated.

b. The following criteria must be met for both categories for a waveoff to be considered acceptable:

1. a time to zero sink speed not greater than 3.0 sec with a longitudinal acceleration of 3.0 kts/sec on a 89.8ºF day

2. controllable α change, if required, not to exceed 0.9 $C_{L_{max}}$

3. MIL-STD-1797 Level 1 flying qualities are maintained during all aspects of the waveoff.

4. Engine spool-up characteristics must be considered.

c. The following techniques are options for both categories:

1. The maneuver is flown at constant α with increasing θ. This is the preferred technique.

2. The maneuver is flown at constant θ with decreasing α.

3. The maneuver is flown with simultaneous air vehicle rotation (α and θ) and throttle advancement. α increases by no more than 3º.

The maneuver is complete after positive rate-of-climb has been achieved.

3.8.2.2.2.2 Alternate Design Criteria. Alternate definitions of waveoff, contingent upon approval by the Procuring Activity, include: 3.5º optical glide slope for air vehicles with low wind-over-deck capability, constant angle-of-attack or pitch body angle during waveoff, time for engine spool down to change from high glide slope, etc.

3.8.2.2.3 Shipboard Engaging Speed (V_e). The shipboard engaging speed is defined as the arresting gear engaging speed measured relative to the ship.

3.8.2.2.4 Bolter. Bolter is defined as a missed wire landing attempt in which the air vehicle touches down and then power is applied for a takeoff. It applies to both carrier landing operation and field carrier landing practice. The term, "bolter performance" is used to denote the distance from landing touchdown to liftoff from a carrier/field. (For air vehicle carriers, the distance is from the last cross deck pendant available for arrestment to the round-down and should be the shortest distance of all available ships.)

3.8.2.2.4.1 Computational Ground Rules. The initial conditions and criteria used to compute a bolter follow:

a. The initial conditions of a bolter are:

1. The air vehicle will be on a 4º optical glide slope stabilized at V_{pa} and α_{pa} with the engine(s) stabilized at Flight Idle thrust (power) and the arresting hook point 6 inches above the landing surface. (This corresponds to the location of the last cross deck pendant on carrier flight decks.)

2. The throttles are advanced to Intermediate/Maximum thrust (power) 0.5 sec after the main landing gear touch down.

3. Longitudinal control inputs are to be made 1.0 sec after touchdown to attain the desired fly-away attitude.

b. The following criteria must be met for a bolter to be considered acceptable:

1. The angle-of-attack during fly-away is between α_{pa} and α_{pa} plus 3º, but not beyond 0.9 $C_{L_{max}}$.

2. MIL-STD-1797 Level 1 flying qualities are maintained during all aspects of the waveoff.

3. Engine spool-up characteristics must be considered.

4. Thrust arrestment reduction system logic, if utilized, is reflected during the maneuver.

5. Both the nose and main gear lift-off prior to going over the angle deck round-down.

The maneuver is complete when the air vehicle CG has achieved an altitude 50 ft above the landing height.

3.8.2.2.4.1.1 Alternate Design Criteria. Alternate definitions of bolter, which are subject to the approval of the Procuring Activity, may include: requiring only nose wheel rotation before going over the angle deck round-down, relaxing the liftoff criteria to 0 ft of CG sink after the air vehicle leaves the angle deck, etc.

3.8.3 Ground Roll Distance. Ground Roll Distance is defined as the distance to decelerate from touchdown speed to a full stop. Ground roll is divided into two segments—transition and braking. The transition segment is the ground roll that immediately follows touchdown, which allows for the change from the touchdown attitude to the taxi attitude. During transition, the air vehicle is brought from the landing configuration to the braking configuration (brakes on, deceleration devices deployed, throttles at idle position, drag chute[s] deployed, reverse thrust, etc.). Landing distance is calculated for a specified weight, altitude, and configuration. Unless otherwise specified, ground roll distance is computed for zero wind on a dry, hard-surfaced runway (RCR = 23) with no slope.

3.8.4 Landing Air Run Distance. Landing Air Run Distance is defined, for land-based air vehicles, as the horizontal distance from the 50-ft obstacle height to touchdown. The air vehicle is in the landing configuration, at the specified thrust (power) setting, weight, and altitude.

3.8.5 Total Landing Distance. Total Landing Distance is defined as the sum of the landing air run distance and ground roll distance.

3.8.5.1 Alternate Design Criteria. Alternate definitions of landing distance, which are subject to the approval of the Procuring Activity, may include: alternate runway surfaces (sod, wet, ice, etc.), head or tail wind, maximum brake capacity, or other criteria which reflect the operational concept of the design. Design requirements for V/STOL air vehicles will establish the criteria.

3.8.5.1.1 Short Field Landing Distance. (This definition applies to forward site or Expeditionary Air Field [EAF] landing.) Short Field Landing Distance at an EAF or a forward site, such as a road for V/STOL air vehicles, is the total calculated landing distance when the following primary concerns for the air vehicle/air vehicle landing speed are considered: (1) sufficient margin above stall speed is maintained; (2) energy (speed) at touchdown is minimized; (3) adequate field of view is maintained; (4) adequate handling qualities exist; (5) flight path is chosen to minimize engine damage from foreign debris (FOD); and (6) sufficient capability for waveoff is maintained. The specific technique to be used is highly configuration-dependent and must be tailored for each type air vehicle.

3.8.6 Maximum Brake Energy Speed. Maximum Braking Energy Speed is defined as the highest speed from which the air vehicle can be brought to a stop, with maximum braking, without exceeding the maximum design energy absorption capability of the brakes for a specified altitude, weight, and configuration.

3.8.7 Maximum Vertical Landing Weight (V/STOL Air Vehicles). The Maximum Vertical Landing Weight is defined as the highest weight for which the air vehicle can meet all the following conditions:

a. The weight at which a Vertical Landing can be accomplished, starting from a hover at 50 ft above the landing surface with a 4 ft/sec rate of vertical descent out-of-ground effect. In ground effect, prior to touchdown, the rate of vertical sink must not exceed 5 ft/sec. Thrust (power) margin for both control and station keeping under the conditions specified in 3.8.7.1 will be maintained during the descent. Level 1 flying qualities as specified by MIL-F-83300 and MIL-STD-1797 (or as modified and approved by the Procuring Activity) will be maintained.

b. The weight at which a 4 ft/sec vertical descent can be arrested (waveoff), starting at a decision height of 12 ft and achieving zero vertical velocity at a wheel height of 5 ft above the landing surface. The thrust (power) margin for both control and station keeping under the conditions specified in 3.8.7.1 is maintained. Level 1 flying qualities as specified by MIL-F-83300 and MIL-STD-1797 (or as modified and approved by the Procuring Activity) are maintained.

3.8.7.1 Thrust (Power) Margin - Control and Stationkeeping. (V/STOL air vehicles).

a. Angular Control. Thrust (power) is held in reserve to provide the following attitude changes in 1 sec, following initiation of control input with the air vehicle center-of-gravity at the most critical position. The magnitude of reserve thrust (power) for angular control will be the largest required to satisfy either the single-axis or simultaneous three-axis attitude change.

Single-axis Control Application

Pitch	3º
Roll	6º
Yaw	4º

Simultaneous Three-axis Control Application

Pitch	2º
Roll	3º
Yaw	3º

b. Stationkeeping. Thrust (power) will be held in reserve to provide stationkeeping over a fixed point on the landing surface under the following wind conditions:

Headwind (zero azimuth angle)	40 kts
Wind from the most critical direction*	15 kts.

* Most critical direction means wind from the azimuth direction which is most demanding of thrust (power) margin for stationkeeping.

3.8.8 STOVL Vertical Mode Operations.

3.8.8.1 Control Power for Vertical Operations. Control Power (thrust reserve) for Vertical Operations will be consistent with the greater of that necessary for Level 1 flying qualities as defined in MIL-STD-1797 or 0.97 Hover Weight Ratio (HWR). The HWR is defined as aircraft gross weight/maximum hover weight when out-of-ground effect (OGE).

3.8.8.2 Vertical Landing (VL). Vertical Landing is defined as a landing without longitudinal or lateral translation, conducted using only powered lift and propulsion-induced aerodynamics.

3.8.8.2.1 Computational Ground Rules. The initial conditions and criteria used in the computation of Vertical Landing are defined as follow:

a. Vertical Landing performance is to be calculated as the most critical capability in a wind envelope of up to 15 kts (up to 45° off the nose of the aircraft).

b. Initial condition for a Vertical Landing is from an OGE hover. The OGE hover height is to be consistent with both pilot and Landing Signal Officer (LSO) ability to judge aircraft position relative to the landing spot using available visual cues.

c. A Vertical Landing will be initiated from a hover with a HWR of 0.97 or less. All propulsion-induced lift losses and thrust loss due to aircraft trim or flight/propulsion system control system implementation (if any) should be accounted for.

d. The baseline vertical rate of descent for a Vertical Landing is 4.0 ft/sec. As increased propulsion-induced lift losses and/or thrust loss due to hot gas ingestion are encountered, an increase in vertical rate of descent to not more than 7 ft/sec is allowed.

e. Thrust losses include the highest combined level of those for trim, hot gas ingestion, propulsion-induced lift loss, control power, and cosine losses within the Vertical Landing performance wind envelope.

NOTE: These Vertical Landing ground rules are applicable to all types of basing.

3.8.8.2.2 Lift Budget Description. Figure 7 provides an illustration of these Vertical Landing effects captured in a lift budget.

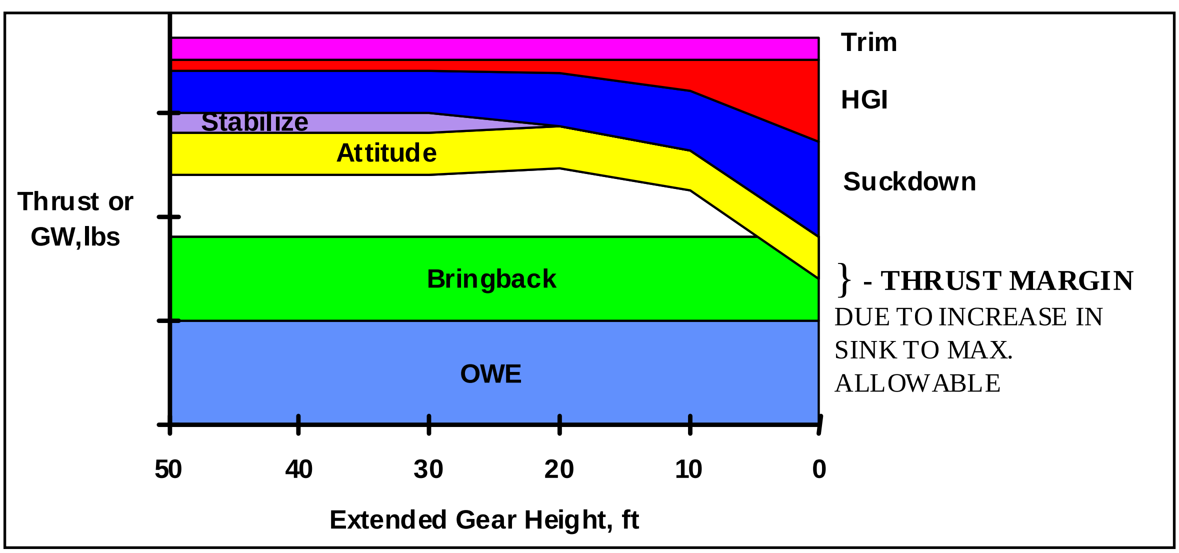


FIGURE 7. Lift budget example

3.8.8.2.3 In-Ground Effect Vertical Landing Waveoff. In-Ground Effect Vertical Landing Waveoff is defined as an aborted Vertical Landing attempt during which the aircraft does not touch down.

3.8.8.2.3.1 In-Ground Effect Vertical Landing Waveoff Weight. In-Ground Effect Vertical Landing Waveoff Weight is defined as the weight which meets the following initial conditions and criteria:

a. Initial conditions for a Vertical Landing Waveoff are: The aircraft is in a 4 ft/sec IGE vertical descent at thrust necessary to meet this flight condition. At an extended wheel height of 12 ft, the pilot advances the throttle to maximum Intermediate thrust. For calculation purposes, the throttle advancement is considered to be instantaneous.

b. Control power necessary to maintain angular control as defined in 3.8.7.1.a is maintained throughout the maneuver.

c. Thrust losses include the highest combined level of those for trim, hot gas ingestion, propulsion-induced lift loss, control power, and cosine losses within the stationkeeping envelope.

d. The maneuver is complete with the aircraft achieving zero vertical velocity at an extended wheel height of 5 ft above the landing surface.

NOTE: It is not intended that this weight be consistent with that necessary to meet the STOVL Vertical Landing performance requirement of the Design Specification.

3.8.8.3 Short Landing. Short Landing is defined as a STOVL air vehicle landing that takes advantage of aerodynamic lift to complement propulsive lift and allow safe recovery at higher landing weights than achievable for a Vertical Landing.

3.8.8.3.1 Short Landing Touchdown Speed. Short Landing Touchdown Speed is defined as the highest speed of the following:

3.8.8.3.1.1 STOVL Minimum Flight Speed. The minimum airspeed to achieve Level 1 flying qualities as defined in MIL-STD-1797.

NOTE: The STOVL air vehicle attitude on the glideslope is to have adequate over the nose field of view for the pilot to view the touchdown point.

3.8.8.3.2 Short Landing Distance. Short Landing Distance is defined as the distance to decelerate from Short Landing Touchdown Speed to a full stop for a specified weight, altitude, and configuration. Short Landing Ground Roll Distance is divided into two segments, transition and braking. The transition segment is the ground roll immediately following touchdown which allows for the change from the touchdown attitude to the taxi attitude. During transition the aircraft is brought from the landing configuration to the braking configuration. The braking segment groundrules are as specified for conventional landing performance. Adequate ground handling characteristics to track the centerline in a 15-kts crosswind, acceptable hot gas ingestion, and minimum potential for foreign object damage are to be maintained while braking.

3.8.8.3.2.1 Computational Ground Rules

a. At the start of the Short Landing Distance calculation, the air vehicle is to be in the landing configuration at the touchdown point at the Short Landing Touchdown Speed, in the approach attitude, and the engine at approach thrust. Landing configuration changes activated by having weight on wheels are allowable.

b. The transition from the touchdown attitude to the 3-point attitude is determined by the physical forces and moments acting on the aircraft. All resultant loads acting upon the aircraft during this transition are to be within the limits of the air vehicle structure. Pilot initiation of engine spooldown to ground idle may begin 0.5 sec after main landing gear touchdown.

c. Pilot initiation of aircraft brakes and deployment of deceleration devices may begin 0.5 sec after the aircraft achieves the 3-point attitude. Braking may not begin until the aircraft has decelerated to a speed below Maximum Brake Energy Speed.

d. The Short Landing maneuver is completed once the aircraft is brought to a complete stop.

3.8.8.4 Rolling Vertical Landing. Rolling Vertical Landing is defined as a STOVL air vehicle Vertical Landing with a very low forward velocity which is utilized to preclude foreign object damage to the aircraft and/or damage to the landing surface.

3.9 Maneuver. Maneuver is defined as the act of changing altitude, airspeed, and/or direction of flight. The maneuver diagram represents the performance capability and limits of an air vehicle for a given set of flight conditions. Maneuverability defines the air vehicle's capability to attain a maneuver state. Agility defines the manner in which an air vehicle transitions from one maneuver state to another.

3.9.1 Flight Envelope. Flight envelope is defined as the boundary of altitude and speed combinations within which flight is possible for a given weight, load factor, and configuration.

3.9.2 Load Factor. Load factor is defined as the resultant force divided by the air vehicle weight. All forces—aerodynamic, propulsive, and weight—must be taken into account in the appropriate axis system.

3.9.2.1 Normal Load Factor (body axis) (n_Z). Normal load factor in the body axis system is defined as the resultant force normal to the xy body axis plane divided by the air vehicle weight. This load factor is used when structural limitations are defined.

3.9.2.2 Normal Load Factor (wind axis) (n_l). Normal load factor in the wind (stability) axis system is defined as the resultant force normal to the xy wind axis plane divided by the air vehicle weight. This load factor is used when maneuver capability is defined.

3.9.2.2.1 Sustained Load Factor. Sustained load factor is defined as the number of G's attainable, without a change in energy ($P_S = 0$), during steady-state flight for a specified configuration, weight, altitude, speed, and thrust (power) setting. Care must be taken when structural limits are applied since they are usually stated in body rather than wind axes.

3.9.2.2.2 Instantaneous Load Factor. Instantaneous load factor is defined as the number of G's attainable, during maneuvering flight allowing for changes in the energy state ($P_S \neq 0$), for a specified configuration, weight, altitude, and speed. Maximum instantaneous load factor, for a given speed, occurs when the maximum usable lift coefficient is achieved, except where limited by structural or other considerations. Care must be taken when structural limits are applied since they are usually stated in body rather than wind axes. Dynamic overshoot(s) is not permitted under this definition. Dynamic overshoot is a condition where lift coefficient is increased for a short time as a result of pitch rate.

3.9.3 Specific Excess Power (P_S). Specific excess power (P_S) is defined as the time rate of change of specific energy and is a measure of the capability of the air vehicle to change energy levels for a specified configuration, altitude, speed, and thrust (power) setting. Specific excess power is usually expressed in feet per second, and is defined as follows:

$$P_s = 1.6878 \frac{(F_n - D)\, V_{tas}}{W}$$

Where:

F_n = net thrust = (F_g cos ($\alpha + \iota$) - D_r - D_p), lb

F_g = gross thrust, lb

D_r = ram drag, lb

D_p = propulsive drag (other than ram drag), lb

α = angle of attack

ι = thrust incidence angle

D = aerodynamic drag, lb

V_{tas} = true airspeed, knots

W = air vehicle weight, lb .

3.9.4 Specific Energy (E_S). Specific energy (also known as energy height) is defined as the total energy (potential plus kinetic) divided by the weight for a specified speed and altitude. Specific energy is usually expressed in feet, and is defined as follows:

$$E_s = H + \frac{V^2_{tas}}{2g}$$

Where:

H = geopotential altitude, ft

V_{tas} = true airspeed, ft/sec

g = gravitational acceleration, ft/sec^2 .

3.9.5 Energy Exchange (ΔE). Energy exchange is defined as the amount of specific energy required during a maneuver to increase from one energy state to another. The calculation for the amount of fuel required to perform an energy exchange is shown in 4.2.5.b.

3.9.6 Combat Speed. Combat speed is defined as the highest speed attainable in level flight at combat weight with Takeoff (Maximum) thrust (power) at combat altitude.

3.9.7 Corner Speed

3.9.7.1 Sustained Corner Speed. Sustained corner speed is defined as the speed at which the maximum sustained rate of turn can be achieved for a specified configuration, weight, altitude, and thrust (power). It occurs where turn rate is the maximum attainable without an accompanying change in energy (P_S = 0), and is shown as point "d" on figure 8.

3.9.7.2 Instantaneous Corner Speed. Instantaneous corner speed is defined as the speed at which the air vehicle attains its highest rate of turn for a specified configuration, weight, altitude, and thrust (power) setting (point "a" on figure 8). Other points on figure 8 are: the lowest speed at which the maximum lift and maximum structural load factor lines intersect (point "b"), and the speed which yields the minimum turn radius (point "c"). This latter point is defined as the largest value of the quantity turn rate divided by speed.

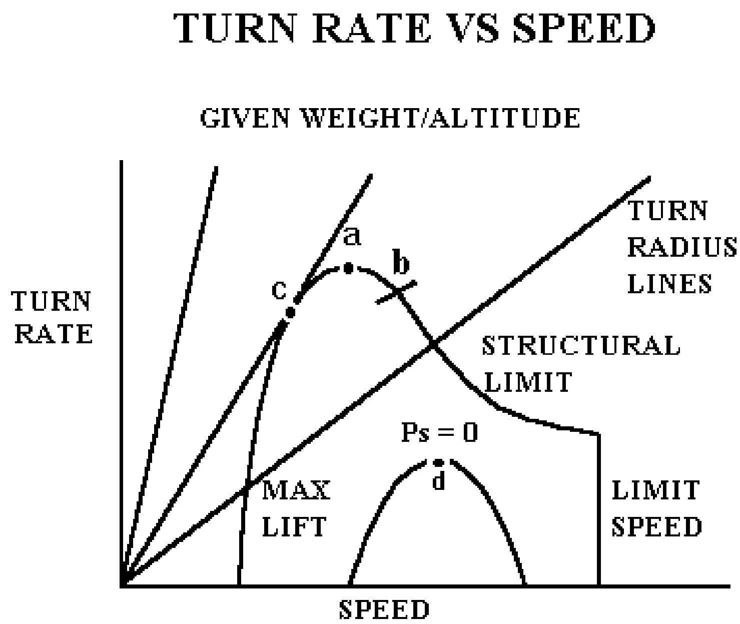


FIGURE 8. Energy maneuver diagram

3.10 Weights. The weight definitions used for air vehicle performance analysis follow. Weight status used will be directed by the Procuring Activity.

3.10.1 Weight Empty. Weight empty is defined as the weight of the air vehicle, complete by model design definitions, dry, clean, and empty, except for fluids in closed systems such as the hydraulic system. Weight empty includes total structure group, propulsion group, flight controls group, avionics group, auxiliary power plant group, electrical group, etc.

3.10.2 Basic Weight. Basic weight is defined as the weight empty adjusted for standard operational items such as unusable fuel, engine oil, oxygen, and all fixed armament.

3.10.3 Operating Weight. Operating weight is defined as the sum of basic weight plus such factors as crew, crew baggage, steward equipment, emergency equipment, special mission fixed equipment, pylons, racks, and other non-expendable items not in basic weight. It is equivalent to takeoff gross weight less usable fuel, payload, and any items to be expended in flight.

3.10.4 Payload. Payload is defined as any item which is being transported and is directly related to the purpose of the mission, as opposed to items necessary for the mission. Payload can include—but not be limited to—passengers, cargo, passenger baggage, ammunition, internal and external stores, and fuel which is to be delivered to another air vehicle or site. Payload may or may not be expended.

3.10.5 Flight Design Gross Weight. Flight design gross weight (basic flight design gross weight) is defined as the highest flight weight authorized for the maximum positive and negative load factors for maneuvering flight.

3.10.6 Maximum Ground Weight. Maximum ground weight (maximum ramp weight/maximum taxi weight) is defined as the highest weight authorized for ramp, taxiway, and runway usage. It is usually a higher weight than the maximum takeoff gross weight defined in 3.10.9.

3.10.7 Maximum Flight Weight. Maximum flight weight is defined as the highest weight authorized for flight. This weight may be greater than maximum takeoff gross weight as specified in 3.10.9 if in-flight refueling is utilized.

3.10.8 Takeoff Gross Weight. Takeoff gross weight is defined as the sum of the operating weight, usable fuel weight, payload items required to perform a particular defined mission, and other items to be expended during flight. Takeoff gross weight is determined prior to engine start for air vehicles which have a maximum ground weight equal to maximum takeoff gross weight. Takeoff gross weight is determined at liftoff for air vehicles which have a maximum ground weight higher than maximum takeoff gross weight. In the latter case, the fuel weight expended during warm-up, taxi, and takeoff are excluded.

3.10.9 Maximum Takeoff Gross Weight. Maximum takeoff gross weight is defined as the highest weight authorized at liftoff. An air vehicle may have more than one maximum takeoff gross weight, such as one for land-based operations and one for carrier/catapult operations.

3.10.10 Mission Landing Weight. Mission landing weight is defined as the weight at the end of the mission as determined by the mission ground rules and includes fuel reserves.

3.10.11 Maximum Landing Weight. Maximum landing weight is defined as the greatest weight authorized for landing. An air vehicle may have more than one maximum landing weight, such as one for land-based operations and one for carrier/arrested operations.

3.10.12 Combat weight. Combat weight is defined as the weight at the target or combat area and includes fuel, air-to-ground ordnance, air-to-air ordnance, ammunition, expendable tanks, and cargo and other payload, except as noted below.

3.10.12.1 Mission-Based Combat Weight. Combat weight for a specified mission is defined as follows:

a. Fighter. A fighter vehicle is defined at two weight conditions: penetration and withdrawal. A penetration condition, which is immediately upon arrival at the combat area, will be presented. A withdrawal condition will be presented with the same fuel weight, with half of all air-to-air missiles (if carried) expended, and half of all ammunition expended.

b. Attack. An attack vehicle is defined at two weight conditions: penetration and withdrawal. A penetration condition, which is immediately upon arrival at the combat area, will be presented. A withdrawal condition will be presented with the same fuel weight, all air-to-air missiles (if carried) and ammunition retained, but all air-to-ground ordnance (if carried) expended.

c. Tanker. The mission-based combat weight for a tanker vehicle is the condition immediately after completion of fuel transfer.

d. Reconnaissance. The mission-based combat weight for a reconnaissance vehicle is the condition immediately after arrival at target (after illumination devices, if carried, are dropped).

e. Others (cargo-trainers). The mission-based combat weight for cargo and trainer vehicles is the condition prior to start of return flight for radius missions, and with reserve fuel only for range missions.

3.10.12.2 Nonmission-Based Combat Weight. Without a specified mission, combat weight is defined as follows, unless otherwise specified:

a. Fighter. A fighter vehicle is defined at two weight conditions: ingress and withdrawal. An ingress condition will be presented with 50-percent (50%) of total initial fuel consumed. A withdrawal condition will be presented with 50-percent (50%) of total initial fuel consumed, with half of all air-to-air missiles (if carried) expended, and half of all ammunition expended.

b. Attack. An attack vehicle is defined at two weight conditions: ingress and withdrawal. An ingress condition will be presented with 50-percent (50%) of total initial fuel consumed. A withdrawal condition will be presented with 50-percent (50%) of total initial fuel consumed, with all air-to-air missiles (if carried) and all ammunition retained, but with all other air-to-ground ordnance (if carried) expended.

c. All others. All other vehicles will be presented with 50-percent (50%) of total initial fuel consumed.

3.10.13 Carrier Bringback Weight. Carrier bringback weight is defined as the maximum combination of fuel and expendable payload an air vehicle can land with, and not exceed its maximum landing weight. This is the maximum carrier/arrested landing weight less the operating weight.

3.10.13.1 Vertical Landing Bringback Weight (STOVL). Bringback capability associated with STOVL Vertical Landing performance is defined to consist of reserve usable fuel and Payload which can be returned to base as specified for a particular mission, configuration, landing maneuver, and operating conditions.

3.10.14 Weight definition guide. For quick reference, the following guide (reference SAWE-RP7) is given to the preceding weight definitions:

WEIGHT EMPTY

+

Unusable fuel, engine oil, oxygen, and all fixed armament

=

BASIC WEIGHT

+

Crew, crew baggage, steward equipment, emergency equipment, special mission-fixed equipment, pylons, racks, and other nonexpendable items not in the basic weight

=

OPERATING WEIGHT

+

Usable fuel and payload items required to perform a particular, defined mission and other items to be expended during flight

=

TAKEOFF GROSS WEIGHT

–

Load items expended in flight; such as fuel, stores, ammunition, cargo, and paratroops

=

LANDING WEIGHT

3.10.15 Maximum Catapult Design Gross Weight. Maximum Catapult Design Gross Weight is defined to be the maximum catapult launch weight used to determine maximum tow force and maximum launch Constant Selector Valve (CSV) settings, and is equal to the Maximum Ground Weight.

3.10.16 Maximum Catapult Weight. Maximum Catapult Weight is defined to be the maximum launch weight for which shipboard launch is performed within the structural limits of the airframe, WOD capability, and launch end speed of the ship system.

3.10.17 Primary Catapult Mission Weight. Primary Catapult Mission Weight is defined to be the minimum weight used to determine the maximum horizontal acceleration used in setting launch bulletin limits.

3.10.18 Landplane Landing Weight. Landplane Landing Weight for each air vehicle is defined to be the highest landing weight allowable for the maximum land-based sink rate.

3.10.19 Maximum Landing Weight. Maximum Landing Weight is defined to be the highest weight allowable for any landing and is equal to Maximum Flight Weight minus droppable fuel tanks, items expended during routine takeoff, and fuel consumed and/or dumped, whichever results in the minimum amount of fuel remaining on the aircraft.

3.10.20 Carrier Landing Design Gross Weight. Carrier Landing Design Gross Weight is defined to be the maximum air vehicle weight at which shipboard recovery can be initiated.

3.10.21 Barricade Design Gross Weight. Barricade Design Gross Weight is defined to be the maximum weight at which shipboard barricade recovery can be initiated and is consistent with Carrier Landing Design Gross Weight.

3.10.22 Vertical Landing Design Gross Weight (STOVL). Vertical Landing Design Gross Weight for a STOVL aircraft is defined to be the highest weight allowed for Vertical Landings.

3.10.23 Maximum Landing Gear Jacking Weight. Maximum Landing Gear Jacking Weight for the aircraft is defined to be the highest weight allowed for landing gear jacking consistent with Maximum Ground Weight.

3.10.24 Maximum Airframe Jacking Weight. Maximum Airframe Jacking Weight for the aircraft is defined to be the highest weight allowed for jacking on the airframe at locations other than the landing gear, consistent with Maximum Ground Weight minus crew.

3.10.25 Hoisting Weight. Hoisting Weight for the aircraft is defined to be the highest weight allowed for hoisting at the designated hoisting points considering combinations of hoisting points and is equal to Maximum Ground Weight minus crew.

3.11 Propulsion. Propulsion performance (thrust, TSFC) prediction data is provided by a thermodynamic cycle computer model that represents a given engine's level of performance. The model simulates engine/component performance at specified altitudes, speeds, ambient conditions, and power settings, when air vehicle installation effects and fuel properties are considered. A description of the propulsion model requires definitions of engine performance level, engine service time, and engine power setting.

3.11.1 Engine Performance Level

3.11.1.1 Engine Performance-Level Definitions

3.11.1.1.1 Specification Performance. Specification performance is defined as the level of performance guaranteed by an engine development or production specification. This is the minimum acceptable performance that must be demonstrated before an engine can be qualified or certified for service use.

3.11.1.1.2 Minimum Performance. Minimum performance is defined as the level of performance that represents a predetermined statistical variation below the status performance of a family of engines at a given time. This statistical variation is usually represented as the number of standard deviations from the average; i.e., minus 2 sigma or minus 3 sigma, which defines the minimum. Performance variation within a family of engines is due to manufacturing and control tolerances.

3.11.1.1.3 Status Performance. Status performance is defined as the statistical average or nominal level of performance for a specified family of engines. This could be the predicted level of performance that represents the average of all component rig and engine test data acquired at a point in time during a development program. Status performance can also be the average level of performance representative of a family of production or fleet engines at a given time.

3.11.1.2 Engine Performance-Level Use Guidelines. It is appropriate during the life of an air vehicle program to update the engine performance-level definition for some tasks, as knowledge of the performance to be expected of its engine(s) increases with increased testing. While some uses of air vehicle performance data require the minimum capability be shown (specification engine), it is more appropriate for others that some value closer to the average be used (minimum or status). Table III provides guidance to determine which engine performance level to use for various tasks throughout the different phases of an air vehicle program. Termination of the use of the specification engine during the Engineering Development portion of the program assumes sufficient data is available from testing to provide an adequate definition of engine performance. If the testing has not provided adequate data, the engine specification's use will be continued.

TABLE III. Engine performance levels

	Pre-Milestone A	Phase 0	Phase I	Phase II				Phase III	Phase IV
		Concept Exploration	Technology Development	System Development and Demonstration				Production and Deployment	Operations and Support
				Engineering & Manufacturing Development Engine Test Milestones					
PERFORMANCE TASKS					PFQ/IFR	LPQ/ISR	FPQ/OCR		
Aircraft Studies	Estimated E&MD Spec	Estimated E&MD Spec	Estimated E&MD Spec	E&MD Spec	E&MD Spec	LPQ Minimum	FPQ Minimum	Production Status w/Endurance Testing	Production Status w/Lead-the-Fleet
Aircraft Specification	Estimated E&MD Spec	Estimated E&MD Spec	Estimated E&MD Spec	E&MD Spec	E&MD Spec	E&MD Spec	E&MD Spec	Production E&MD Spec	N/A
Flight Clearances	N/A	N/A	Calibrated Preliminary Nominal Estimate	E&MD Spec	PFQ Status	LPQ Status	FPQ Status	Production Status w/Endurance Testing	Production Status w/Lead-the-Fleet
Flight Manuals	N/A	N/A	N/A	E&MD Spec	E&MD Minimum	LPQ Minimum	FPQ Minimum	Production Minimum w/Endurance Testing	Production Minimum w/Lead-the-Fleet
Projected Mid-Life Estimates	N/A	N/A	N/A	N/A	N/A	Limited Product Spec w/Endurance Testing	Limited Product Spec w/Endurance Testing	Production Spec w/Endurance Testing and Lead-the-Fleet	Production Status w/Lead-the-Fleet

PFQ/IFR: Preliminary Flight Qualification/Initial Flight Release
LPQ/ISR: Limited Production Qualification/Initial Service Release
FPQ/OCR: Full Production Qualification/Operational Capability Release

NOTE: All non-specification engine data is subject to the approval of the Procuring Activity.

3.11.1.2.1 Lead-the-Fleet. Lead-the-fleet is defined as a program that gathers engine deterioration data from actual fleet engines. This program is defined in the Engines Joint Service Specification Guide, JSSG-2007.

3.11.1.2.2 Endurance Testing. Endurance testing is defined as a program that gathers engine deterioration, durability, and operability data that is based on ground endurance and qualification testing. This program is defined in the Engines Joint Service Specification Guide, JSSG-2007.

3.11.2 Engine Service Time Definitions

3.11.2.1 New Engine. New engine is defined as a "zero time" engine. A new engine's performance is demonstrated during production acceptance, overhaul, etc. This overall level of performance is the best (most efficiency) the engine will deliver during service. An engine may deliver more power (thrust) over time, depending on the engine's control modes; however, specific fuel consumption will deteriorate from the level demonstrated by a new engine.

3.11.2.2 Deteriorated Engine. Deteriorated engine is defined as a "non-zero time" engine that exhibits degraded performance due to a given amount of service usage. Generally, a deteriorated engine will deliver worse (less efficient) performance than a new engine, with the exception of power (thrust), which is dependent on the engine's control modes. Deterioration effects include clearance rub-out, accumulation of foreign matter, bent blades, and seal wear. Service time may be specified by phrases such as "50 hours," or "the end of one hot section life."

3.11.3 Engine Power Setting Definitions. Engine power setting rating definitions, except Idle thrust (power), depend on the type of engine to which they apply. They are defined below and the non-afterburning definitions are illustrated in table III.

3.11.3.1 Idle Thrust (Power). Idle thrust (power) is defined as the minimum thrust (power) setting for stable low thrust (power) operation of the engine. The air vehicle in which an engine is installed may require Idle thrust (power) to be greater than that required by the engine. These additional factors are a function of whether the air vehicle is in the air or on the ground, and are categorized as follow:

a. Ground Idle. While the air vehicle is on the ground, Idle thrust (power) may be further constrained by power extraction requirements or accessory generator speed requirements.

b. Flight Idle. While the air vehicle is in the air, Idle thrust (power) may be further constrained by engine acceleration time requirements (go-around at low altitude), minimum combustor pressure limits (combustor blowout limits or minimum Environmental Control System bleed), or minimum inlet airflow requirements (inlet buzz avoidance at supersonic speeds).

3.11.3.2 Engine Type-Specific Power Settings

3.11.3.2.1 Shaft Power Engines.

a. Maximum Power. Maximum power is defined as the maximum operating condition at which the engine is able to operate for the incremental time duration specified in the engine specification, for a specified speed and altitude.

b. Intermediate Power. Intermediate power is defined as the maximum operating condition at which the engine is able to operate in at least 30-min increments, for a specified speed and altitude.

c. Maximum Continuous Power. Maximum continuous power is defined as the maximum operating condition at which the engine is able to operate continuously, for a specified speed and altitude.

3.11.3.2.2 Nonaugmented Jet Engines.

a. Takeoff (Maximum) thrust (power). Takeoff thrust (power) is defined as the maximum thrust certified for takeoff operation, for a specified speed and altitude. Operation at this rating is usually limited to 5 min per takeoff interval, unless otherwise specified in the engine specification.

b. Intermediate thrust (power). Intermediate thrust (power) is defined as the thrust which the engine will deliver when the power lever is placed in the Intermediate position, for a specified speed and altitude. Engine operation at Intermediate thrust (power) may have an incremental duration time limit, but the minimum is 30 min.

c. Maximum Continuous thrust (power). Maximum Continuous thrust (power) is defined as the thrust which the engine will deliver for continuous operation; i.e., no time limit, when the power lever is placed in the Maximum Continuous position, for a specified speed and altitude.

3.11.3.2.3 Augmented Jet Engines.

a. Maximum Augmentation. Maximum augmentation is defined as the maximum thrust with afterburning, for a specified speed and altitude. This setting may or may not be time-limited.

b. Minimum Augmentation. Minimum augmentation is defined as the lowest thrust at which the engine will operate with afterburning, for a specified speed and altitude. This setting may or may not be time-limited.

c. Intermediate (Military) Power. Intermediate power is defined as the maximum thrust without afterburning, for a specified speed and altitude. The engine must be able to operate continuously at this setting.

TABLE IV. Non-afterburning thrust (power) settings

TIME LIMIT	SHAFT	NON-AUGMENTED JET	AUGMENTED JET
≤30	MAXIMUM	TAKEOFF (MAXIMUM)	——
30	INTERMEDIATE	INTERMEDIATE	——
UNLIMITED	MAXIMUM CONTINUOUS	MAXIMUM CONTINUOUS	INTERMEDIATE (MILITARY)

3.12 Fuel. Fuel grades used for air vehicle performance calculations are specified in the performance ground rules in section 4 of this standard. The density and lower fuel-heating-value properties for the most commonly used fuels are shown below and represent the minimum values for each fuel grade. The densities presented in this paragraph are for 59ºF.

Aviation Fuel		Density	Fuel Heating Value
Gasoline in all grades	(ASTM D910)	6.0 lb/gal	18,700 BTU/lb
JP-5 Jet fuel	(MIL-DTL-5624)	6.6 lb/gal	18,300 BTU/lb
JP-8 Jet fuel	(MIL-DTL-83133)	6.5 lb/gal	18,400 BTU/lb
JP-10 Jet fuel	(MIL-DTL-87107)	7.8 lb/gal	18,100 BTU/lb
Jet A-1 fuel	(ASTM D1655)	6.7 lb/gal	18,400 BTU/lb

Refer to the appropriate military or commercial fuel specification if a design requires special fuels.

3.12.1 Alternate Design Criteria. Consideration may be made, subject to the approval of the Procuring Activity, to use the average fuel characteristics determined from a sampling of the delivered fuel grade. This should be considered when air vehicle performance calculations on operational air vehicles or a comparison analysis between an operational and a conceptual design air vehicle need to be done. The average fuel characteristics for a specified fuel grade are represented below:

Aviation Fuel		Density	Fuel Heating Value
Gasoline in all grades	(ASTM D910)	6.0 lb/gal	18,700 BTU/lb
JP-5 Jet fuel		6.8 lb/gal	18,450 BTU/lb
JP-8/Jet A-1 Jet fuel		6.8 lb/gal	18,570 BTU/lb
JP-10 Jet fuel		7.8 lb/gal	18,200 BTU/lb.

3.13 Surface Damage Criteria

3.13.1 STOVL Operations Surface Compatibility. The STOVL Operations Surface Compatibility is defined as executing any STOVL maneuver on the applicable surface while not exceeding the 50-percent (50%) probability of surface damage criteria as defined on figures 9 through 12.

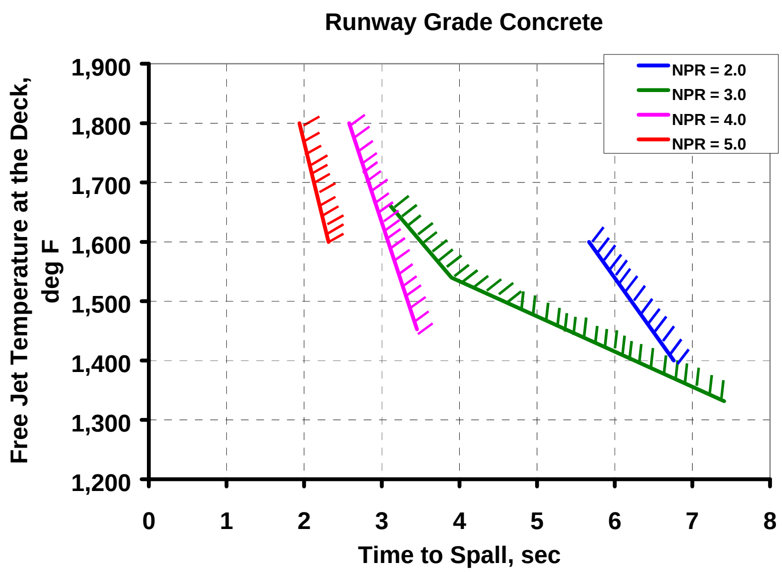


FIGURE 9. Runway grade concrete time to damage as a function of jet conditions

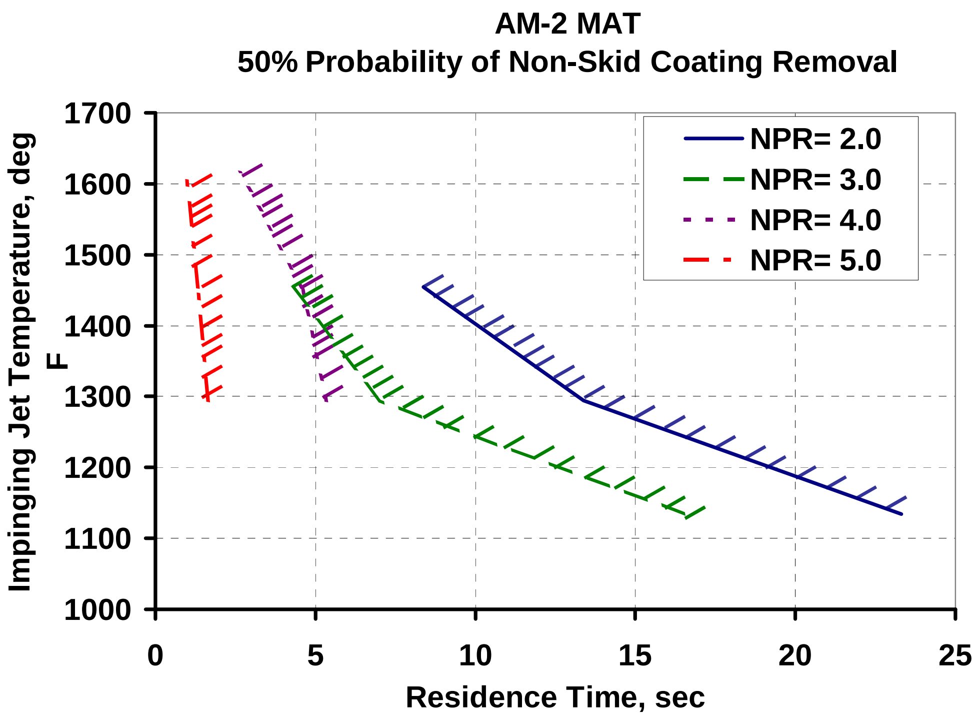


FIGURE 10. AM-2 mat time to damage as a function of jet conditions

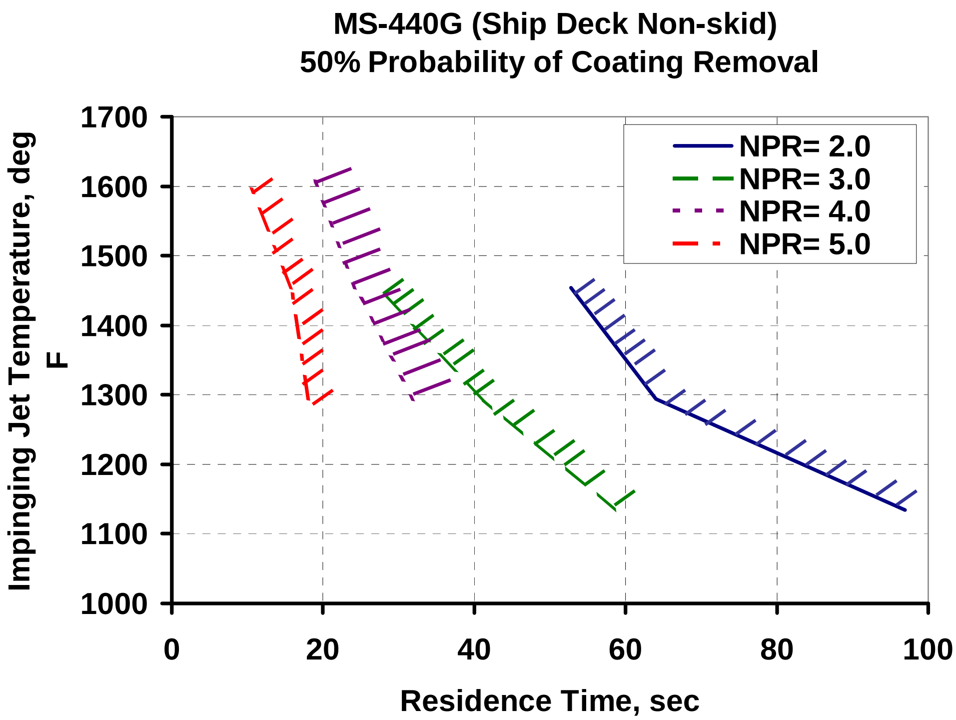


FIGURE 11. Ship deck non-skid (MS-440G) time to damage as a function of jet conditions

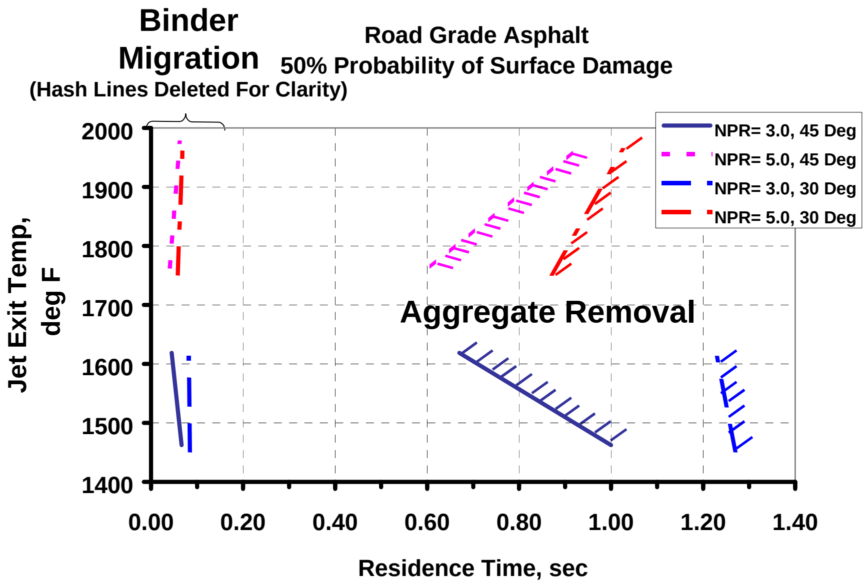


FIGURE 12. Road grade asphalt time to damage as a function of jet conditions

4. GENERAL REQUIREMENTS. The paragraphs within this section contain the ground rules which define the conditions to be applied to calculate air vehicle performance.

4.1 Computational Ground Rules. Unless otherwise specified, the following ground rules shall apply.

4.1.1 Speeds. All speeds defined within this document shall lie on or within the applicable flight envelope boundaries as defined in MIL-STD-1797.

4.1.2 Atmosphere. Unless otherwise specified, air vehicle performance shall be calculated and presented for a standard day. Standard day atmospheric characteristics appear in appendix A, table A-I.

4.1.2.1 Alternate Design Criteria. When required by the Procuring Activity, consideration shall be given to the effect of atmospheric variations on air vehicle performance. While standard day characteristics provide the common atmospheric conditions for which performance comparisons can be made, additional "atmospheres" are needed to determine the variation of performance across the extremes of expected temperatures. Polar and tropical atmospheres are included in appendix A (tables A-III and A-IV) to assist in this determination. These atmospheres provide the needed free air characteristics near the extremes of temperature. Table A-V in appendix A provides these same characteristics for hot conditions near the ground. Unlike the free air atmospheres (tables A-I, A-III, and A-IV), this atmosphere is a boundary of extreme conditions, does not represent a realistic atmosphere, and cannot be used to calculate rate-of-climb. Its primary use is for takeoff calculations.

4.1.3 Wind. Unless otherwise specified, data shall be for a no-wind condition. See appendix A for the effects of winds, when used.

4.1.4 Formation Flight. Data shall be for a single air vehicle only.

4.1.5 Ordnance Expenditure. Unless otherwise specified, the following ground rules shall be used for the purpose of mission calculations:

a. Air-to-Air Missions. Expend half of the ammunition and half of each type of onboard missile at the end of the combat segment.

b. Air-to-Ground Missions. Expend all air-to-ground ordnance at the end of combat. Retain all air-to-air missiles and ammunition.

4.1.6 External Fuel Tanks. Unless otherwise specified, external fuel tanks, when carried, shall be retained.

4.1.7 Pylons/Racks. Pylons, bomb racks, etc., shall always be retained when the external stores are dropped. Unless otherwise specified, pylons shall remain installed on all stations on which stores are normally carried, whether or not stores are carried on them for a particular mission.

4.1.8 Change in Energy State at Intersection of Mission Segments. When the energy state at the start of a new mission segment is greater than at the end of the previous mission segment, one must accounted for fuel to increase the energy state. When the change in energy is negative (a decrease in the energy state), the change is assumed to be instantaneous with no change in time, distance, or fuel. Descents shall follow the guidance in 4.2.8.

4.1.9 Reduced Engine Operation. When applicable, flight with a minimum number of engines in operation may be used to increase range or loiter time if such operation represents normal service usage. Such operation shall conform to 4.1.10.

4.1.10 Authorized Operation. No operational technique shall be utilized that is not included nor intended to be included as recommended procedure in the air vehicle's applicable flight manual. Authorization shall be subject to approval of the Procuring Activity.

4.1.11 Trainer Air Vehicles. The trainer missions defined in appendix B of this standard are applicable to basic and advanced trainer air vehicles. Combat and tactical trainer air vehicles fly the missions for the appropriate parent-type air vehicle.

4.1.12 Variable Geometry Wing Air Vehicles. For air vehicles with variable sweep wings, the automatic sweep program will be clearly defined and used. If not automatic, the air vehicle will be assumed to have wings in the unswept position for takeoff and subsonic flight, and fully swept for supersonic flight, unless otherwise noted.

4.1.13 Fuel Consumption Tolerance. All fuel consumption data for air vehicle/engine combinations that is not based on flight test shall be increased by 5-percent (5%). Subject to approval of the Procuring Activity, once the air vehicle/engine data has been verified by flight test, the 5-percent (5%) tolerance can be removed.

4.1.14 Fuel Consumption Corrections. Corrections to engine fuel flow shall be made for all engine bleeds and accessory drive losses appropriate to each phase of flight.

4.2 Mission Segment Ground Rules. The following paragraphs contain the ground rules and fuel allowances applicable to each phase of flight. Several options are given for each mission segment to allow for design innovations, information available during different phases of a program, different degrees of operational reality, and land-based versus carrier-based operation. It is the responsibility of the Procuring Activity to evaluate/approve the appropriate options. In the case of comparisons between different air vehicles, options which yield comparable performance must be used, and the options chosen must be clearly stated with the performance data presentation. In general, allowances fall into three categories: task-oriented for well-defined requirements, fixed quantities for less well-defined requirements, and others for undefined requirements or unconventional designs.

4.2.1 Warm-up and Takeoff. A quantity of fuel shall allowed for ground operation—including starting engines, warm-up of engines and electronics equipment, taxi, takeoff, and acceleration to either obstacle clearance or enroute climb speed. The quantity shall consist of one of the following:

a. Fuel burned for a specified time at a specified thrust (power) setting and altitude, at 0 Mach, plus an allowance for afterburner, if applicable:

1. 4.6 min at Intermediate thrust (power) at sea level, standard day; plus 30 sec at Maximum thrust (power) at sea level, standard day, if afterburner is used during takeoff; or

2. 5.0 min at Maximum Continuous (Intermediate for augmented-engine-powered air vehicles) thrust (power) at sea level, standard day; plus 30 sec at Maximum thrust (power), at sea level, standard day, if afterburner is used during takeoff; or

3. _____ min at __________ thrust (power) at _____ ft, __________ day, plus _____ sec at Maximum thrust (power) at _____ ft, __________ day, if afterburner is used during takeoff.

b. Estimated fuel required to start the engine(s), warm-up, taxi for a specified time at a specified thrust (power) setting and altitude, at 0 Mach, and accelerate from brake release to obstacle clearance speed at a specified thrust (power) setting:

1. 20 min at Ground Idle, sea level, standard day, plus 30 sec at Takeoff (Maximum) thrust (power) (maximum afterburner [A/B], if applicable); or

2. _____ min at __________ thrust (power) at _____ ft, __________ day, plus _____ sec at __________ thrust (power).

c. Fuel burned for a specified time at a specified thrust-to-weight ratio to account for starting the engine(s) and taxi, plus a quantity of fuel—derived from the following equation—to account for takeoff and acceleration to obstacle clearance speed:

$$W_{fto} = 1.6878 \frac{V_{co} W_{TO}}{2g} \times \frac{\dot{W}_{fo} + \dot{W}_{fc}}{F_n - D}$$

Where:

W_{fto} = takeoff and acceleration fuel, lb

V_{co} = obstacle clearance speed, knots true airspeed

W_{TO} = takeoff weight, lb

$\dot{W}_{fo}$ = static fuel flow at the thrust (power) for takeoff, lb/sec

$\dot{W}_{fc}$ = fuel flow at initial climb speed at the thrust (power) for takeoff, lb/sec

g = gravitational acceleration, ft/sec^2

F_n = thrust at initial climb speed at the thrust (power) for takeoff = $(F_g \cos(\alpha + \iota) - D_r - D_p)$, lb

F_g = gross thrust, lb

D_r = ram drag, lb

D_p = propulsive drag (other than ram drag), lb

α = angle of attack

ι = thrust incidence angle

D = aerodynamic drag at initial climb speed and corresponding angle of attack, lb .

NOTES: If thrust (power) is to be varied between liftoff and obstacle clearance speed, this equation can be so modified.
1. 6 min at a thrust-to-weight ratio of 0.2 at sea level, standard day, plus takeoff and acceleration fuel; or
2. _____ min at a thrust-to-weight ratio of _____ at _____ ft, __________ day, plus takeoff and acceleration fuel

d. A specified quantity of fuel

e. For air vehicles with a STO capability, fuel burned for a specified time at a specified power setting and altitude, at 0 Mach, plus allowances for takeoff acceleration to obstacle clearance speed

1. 10 min at Ground Idle at sea level, standard day, plus 15 sec at Intermediate thrust (power), plus 15 sec at Takeoff (Maximum) thrust (power); or

2. _____ min at __________ thrust (power) at _____ ft, __________ day, plus _____ sec at __________ thrust (power), plus _____ sec at __________ thrust (power)

f. For air vehicles with a vertical takeoff capability, fuel burned for a specified time at a specified power setting and altitude, at 0 Mach, plus an allowance for vertical liftoff and transition to forward flight

1. 2.5 min at Maximum Continuous (Intermediate for augmented-engine-powered air vehicles) thrust (power) at sea level, standard day, plus 15 sec at Takeoff (Maximum) thrust (power); or

2. _____ min at __________ thrust (power) at _____ ft, __________ day, plus _____ sec at __________ thrust (power)

g. Other criteria, or combinations of the above, which may be selected to portray more accurately the operational characteristics of a specific design or mission.

NOTE: Options "a." and "f.", above, contain sufficient fuel to get to enroute climb speed. Options "b.", "c.", and "e.", above, require the addition of an initial climb-out segment. Options "d." and "g.", above, can be specified either way.

4.2.2 Climb. Climb after takeoff may be divided into two segments: initial climb-out and enroute climb.

4.2.2.1 Initial Climb-Out. The time, distance, and fuel to climb and accelerate from obstacle clearance speed (3.2.4) to the appropriate climb speed (3.3.9) shall be calculated with the air vehicle in the clean configuration, using the applicable thrust (power) setting. For calculation purposes, gear and flap retraction shall be assumed to take place instantaneously at the obstacle.

4.2.2.1.1 All Engines Operating (AEO). Initial climb-out with all engines operating shall be based on all engines operating from brake release to liftoff. Acceleration to climb-out speed and climb-out shall be based on the thrust (power) available with all available engines.

4.2.2.1.2 One Engine Inoperative (OEI). Initial climb-out with one engine inoperative shall be based on all engines operating from brake release to critical engine failure speed, and with the critical engine inoperative from critical engine failure speed to liftoff. Acceleration to climb-out speed and climb-out shall be based upon the thrust (power) available with the remaining engines at Takeoff (Maximum) thrust (power) and the drag of the inoperative engine. If means to reduce inoperative engine drag is a design feature, such drag reduction shall be utilized with a time-allowance for activation.

4.2.2.2 Enroute Climb. Except for point intercept missions, all climbs shall be enroute with thrust (power) and speed schedules specified in 3.3.9. Point intercept missions shall be optimized to obtain minimum time to combat altitude, speed, and distance.

4.2.2.2.1 Enroute Climb Data. Enroute climb data (time, distance, and fuel) shall be based on the appropriate configuration, thrust (power), and weight. The air vehicle shall have the landing gear and flaps retracted and have attained the airspeed for best climb for the specified mission.

4.2.2.2.2 Enroute Climb Power. Unless otherwise specified, Intermediate (Military) thrust (power) shall be used for enroute climb to cruise altitude for jet-powered air vehicles (turbojet, turbofan, ramjet, etc.). Maximum Continuous thrust (power) shall be used for propeller-powered air vehicles (internal combustion, turboprop).

4.2.3 Cruise. Unless otherwise specified, all cruise segments shall be performed in a cruise climb, while optimum long-range cruise speed (maximum-range cruise speed for fighter and attack air vehicles) is maintained and altitude for the specified weight and configuration. This altitude shall not exceed cruise ceiling. The changes in cruise speed, altitude, and specific range with weight during each cruise segment shall be taken into account. Constant altitude cruise, step climb, maximum range cruise speed, etc., shall be used, if specified. The specified minimum terrain clearance shall be observed for operationally realistic missions.

4.2.4 Penetration and Withdrawal. The penetration and withdrawal segments consist of entering and leaving a target area for a given distance at conditions of airspeed and altitude which maximize survivability. Time, distance, and fuel expended shall be included in the mission calculations.

4.2.5 Combat. Combat shall be considered by reserving a quantity of fuel to account for the tasks to be performed during this segment. Fuel computation shall be based on the weight at the start of the combat period with benefit due to fuel weight reduction credited. Unless otherwise specified, combat fuel shall be calculated before ammunition and stores—both air-to-air and air-to-ground—are expended. Combat fuel shall consist of one of the following:

a. Fuel required to make a specified number of turns, at a specified load factor, Mach number, and thrust (power) setting, at a specified altitude. If more than one series of turns is to be made at different Mach numbers, the sequence of turns shall also be specified.

1. one 540º turn at the maximum sustained load factor, at the specified Mach number and thrust (power) setting, at combat altitude, standard day; or

2. _____ turns at _____ G's, _____ Mach number, __________ thrust (power), at _____ ft, __________ day

b. Fuel required to perform an energy exchange at a specified Mach number, thrust (power) setting, weight, and altitude. Fuel used shall be determined with the following equation:

$$\text{Combat fuel} = \frac{\Delta E_s \dot{W}_f}{P_s}$$

Where:

ΔE_s = Change in specific energy, ft
P_s = Specific excess power, ft/sec
$\dot{W}_f$ = Fuel flow, lb/sec

1. 40,000 ft change in specific energy, at .9 Mach, 10 000 ft, standard day, at the specified thrust (power) setting; or

2. _____ ft change in specific energy, at _____ Mach, _____ ft, __________ day, at __________ thrust (power).

c. Fuel required for a specified time, at a specified Mach number and thrust (power) setting, at a specified altitude

1. 5 min at Intermediate-rated thrust (power) at the specified Mach number and altitude, standard day; or

2. _____ min at __________ thrust (power), at _____ Mach, at _____ ft, _________ day

d. A specified quantity of fuel

e. Other criteria which may be selected to portray more accurately the operational characteristics of a specific design or mission.

4.2.6 Loiter. Unless otherwise specified, loiter segments shall consist of 1G, level flight at maximum endurance speed and altitude away from the combat area, and at or slightly below corner speed in or near the combat area.

4.2.6.1 Mission-Specific Tasks. Specialized tasks may be included which require maneuvering the air vehicle as part of this mission requirement. These include maneuvers such as banked orbits, flat turns, search, patrol, etc. Fuel required to accomplish these specialized tasks shall be included with overall mission fuel.

4.2.7 Refueling. The refueling segment starts at the end of the previous segment and ends at the end of the refueling operation. If a climb or descent is required as part of this segment, the climb shall be conducted in accordance with 4.2.2, and the descent shall be conducted in accordance with 4.2.8. Refueling shall take place within the refueling speed/altitude envelope common to both the tanker and receiver air vehicles. The following time allowances shall be used for refueling:

a. 15 min for fighter and attack receiver air vehicles

b. 30 min for transports, strategic bombers, and tanker and receiver air vehicles

c. 60 min for tanker air vehicle off-loading fuel

d. _____ min. Time is dependent upon the specific refuel rates.

4.2.7.1 Rendezvous Refuel. Rendezvous and refueling shall commence with no less than _____ pounds of fuel onboard the receiver air vehicle when refueling operations involve a rendezvous between tanker and receiver air vehicles. _____ min shall be allowed for rendezvous and speed/altitude changes, if required. Distance covered during rendezvous and refueling will not be credited to the mission range or radius except for bombers and cargo/transports.

4.2.7.2 Buddy Refuel. When the tanker and receiver cruise together from shortly after takeoff to the refuel point, refueling will commence with no less than _____ pounds of fuel onboard the receiver air vehicle. _____ min shall be allowed for speed/altitude changes, if required. Both distance and time for speed/altitude adjustments prior to refuel shall be credited to the mission range or radius. The distance flown during refueling shall also be credited.

4.2.8 Descent. Time, distance, and fuel shall be credited for descent and deceleration to a specified altitude and speed for air vehicles which start a descent at the end of a supersonic segment. For air vehicles which start a descent at the end of a subsonic segment, no time, distance, or fuel will normally be credited for descent. If realism is required for operational concerns, the descent shall be modelled at Flight Idle thrust (power) using one of the following speed schedules; and time, distance, and fuel shall be credited:

a. The speed for a descent starting at a point 2.5 nm/1000 ft of altitude change from the intended point of arrival

b. Cruise speed or 250 KCAS, whichever is less

c. Speed for maximum lift/drag ratio

d. A specified speed schedule

e. Limit airspeed

f. Other.

4.2.9 Landing Reserves. A quantity of fuel shall be reserved at the end of each mission as a safety factor to allow for more than one landing pass, time in a holding pattern, or flight to an alternate field. The quantity shall consist of one of the following:

4.2.9.1 Land Operations.

a. One measure is a specified percentage of total initial fuel plus fuel consumed for a specified time, at maximum endurance speed, at a specified altitude, standard day. The following table contains the most commonly used examples.

TABLE V. Fuel consumption

% Of Total Initial Fuel	Time - Min.	Altitude - Ft
0	20	Sea Level
5	20	Sea Level
5	20	10,000
5	10	Sea Level
5	30	Sea Level
10	0	—
—	—	—

b. Another measure is a quantity of fuel which would increase the mission time by 10-percent (10%) or 20 min, whichever is greater. Fuel consumption is calculated at maximum endurance airspeed at 10,000 ft for turbine-powered air vehicles, and at cruise altitude for reciprocating-engine air vehicles. (Reference AFI 11-202V3.)

c. A third measure is a quantity of fuel to simulate a missed approach and flight to an alternate airfield a specified distance from the intended landing point. Reserves shall be equal to the sum of the fuel used in the segments shown on figure 13. (Reference National Business Aircraft Association Management Guide, Appendix D, NBAA Range Formats.) Descent shall be in accordance with 4.2.8.

d. A final measure is other criteria to portray more accurately the operational characteristics of a specific design or mission.

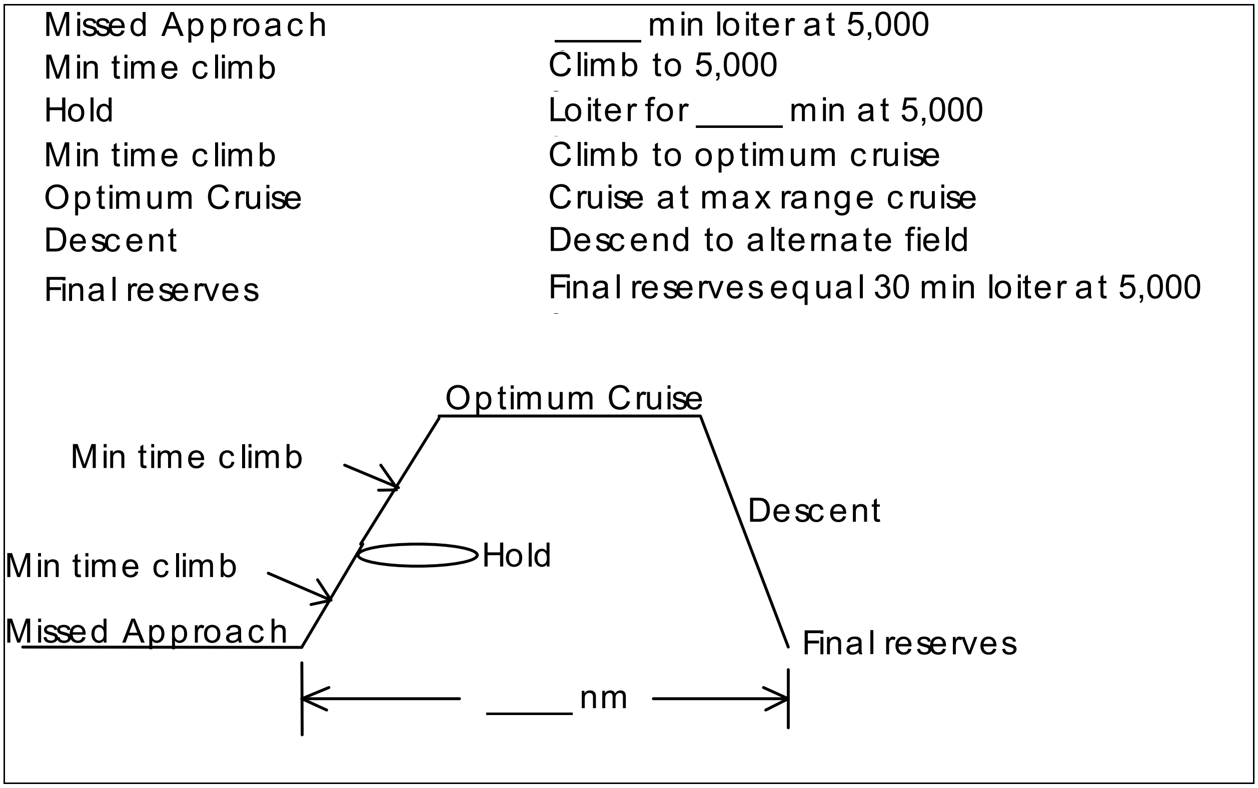


FIGURE 13. Fuel for flight to an alternate field

4.2.9.2 Carrier Operation. The following typical landing reserves are considered for carrier-based missions (carrier operations landing reserves are to be calculated for an 89.8ºF tropical day).

4.2.9.2.1 Visual Flight Rules (VFR). Landing reserve for a carrier-based mission may consist of any number of VFR passes in the landing configuration (flaps and gear down; speedbrake for "d." and "e.", below, as appropriate). (If speedbrakes are required, deploy prior to final turn before approach and retract prior to climb.) One VFR pass is defined as follows:

a. An Intermediate-rated thrust (power) climb from 63 ft to 600 ft at a constant airspeed equivalent to 120-percent (120%) of V_{pa}

b. One 180º turn (20º of bank) at 600 ft, at a constant airspeed equivalent to 120-percent (120%) of V_{pa}

c. Cruise downwind 1 nautical mile at 600 ft at a constant airspeed equivalent to 120-percent (120%) of V_{pa}

d. One 180º turn (20º of bank) at 600 ft at V_{pa}

e. Final straight-in approach, 1 nautical mile at 300 ft at V_{pa}.

4.2.9.2.2 Instrument Flight Rules (IFR). Landing reserve for a carrier-based mission may consist of any number of IFR passes in the landing configuration (flaps and gear down; speedbrake for "d." and "e.", as appropriate). (If speedbrakes are required, deploy prior to final turn before approach and retract prior to climb.) One IFR pass is defined as follows:

a. An Intermediate-rated thrust (power) climb from 75 ft to 1200 ft at a constant airspeed equivalent to 120-percent (120%) of V_{pa}

b. One 180º turn (20º of bank) at 1200 ft at a constant airspeed equivalent to 120-percent (120%) of V_{pa}

c. Cruise downwind for 3 nautical miles at reduced power at 1200 ft at a constant airspeed equivalent to 120-percent (120%) of V_{pa}. (Flaps may be up or down.)

d. One 180º turn (20º of bank) at 1200 ft at a constant airspeed equivalent to V_{pa}. (Flaps may be up or down for this segment.)

e. Final straight-in approach, 4 nautical miles at 600 ft at a constant airspeed equivalent to V_{pa}.

4.2.9.2.3 100 Nautical Mile BINGO: A 100 nautical mile BINGO landing reserve fuel allowance is defined as follows:

a. Intermediate-rated thrust (power) acceleration from an airspeed equivalent to 120-percent (120%) of V_{pa} to best climb speed at sea level

b. Intermediate-rated thrust (power) climb from sea level at best climb speed to best cruise altitude

c. Cruise at altitude(s) and speed(s) which maximize BINGO range

d. Idle-rated thrust (power) descent to 10,000 ft at 250 KCAS

e. Loiter for 10 min at 10,000 ft at maximum endurance speed.

NOTES: 1. "BINGO" is a term for a declared emergency, where an air vehicle attempting to land is directed to divert and land elsewhere.
2. Total distance for segments "a.", "b.", "c.", and "d.", only, above, is credited toward 100 nautical mile BINGO.
3. BINGO fuel is the minimum fuel required to divert to an alternate landing site using an emergency flight profile.

4.2.9.2.4 <u>Other</u>. A landing reserve is a specified quantity of fuel (typically 3000 or 4000 lb).

4.2.9.3 <u>Vertical Landing</u>. The following landing reserves are considered for air vehicles (i.e., STOVL) which have a Vertical Landing capability:

a. fuel required for 10 min of loiter at maximum endurance speed at sea level, standard day (89.8ºF for carrier operations), plus 5-percent (5%) of total fuel onboard at takeoff

b. fuel required for _____ min of loiter at maximum endurance speed at _____ ft, __________ day (89.8ºF for carrier operations), plus _____ % of total fuel onboard at takeoff

c. fuel required for __________ Vertical Landing passes at mission landing weight. A Vertical Landing pass is defined as follows:

1. Transition from wingborne flight (120-percent [120%] of power-off aerodynamic stall speed) to a hover at 50 ft altitude above the landing position.

2. Initiate a 4 ft/sec vertical descent.

3. Arrest the vertical descent with zero descent velocity achieved at a wheel height of no less than 5 ft above the landing surface.

4. Climb vertically to 50 ft, and accelerate into and complete transition to wingborne flight (120-percent [120%] of power-off aerodynamic stall speed) at Takeoff thrust (power). Horizontal acceleration shall be 0.13G or higher. Climb to 600 ft at an airspeed 120-percent (120%) of power-off aerodynamic stall speed at Intermediate thrust (power).

5. one 180º turn (20º of bank) at 600 ft, at a constant airspeed equivalent to 120-percent (120%) of power-off aerodynamic stall speed

6. Cruise downwind 1 nautical mile at 600 ft at constant airspeed equivalent to 120-percent (120%) of power-off aerodynamic stall speed.

7. one 180º turn (20º of bank) at 600 ft at 120-percent (120%) of aerodynamic stall speed

d. <u>100 Nautical BINGO</u>: A 100 nautical mile BINGO landing reserve fuel allowance for vertical-landing air vehicles is defined as follows:

1. from hover at 50 ft altitude accelerate into and complete transition to wingborne flight

2. Intermediate-rated thrust (power) climb from sea level at best climb speed to best cruise altitude

3. cruise at altitude(s) and speed(s) which maximize BINGO range

4. Idle-rated thrust (power) descent to 10,000 ft at 250 KCAS

5. loiter for 10 min at 10,000 ft at maximum endurance speed.

NOTES: 1. Total distance for segments "d.1.", "d.2.", "d.3.", and "d.4.", only, above, is credited toward 100 nautical mile BINGO.
2. BINGO fuel is the minimum fuel required to divert to an alternate landing site using an emergency flight profile.

e. STOVL Bringback Profile. The following profile defines the landing reserve fuel to be included in the STOVL air vehicle shipboard Vertical Landing performance calculation. NOTE: Air Vehicle conversions are conducted from a wings-level attitude and are accomplished prior to intercepting the glideslope.

1. Initiate the IFR pass with a waveoff from 100 kts airspeed at 200 ft on the glideslope at 1/2 nm aft of the ship. (The aircraft is to have sufficient performance to execute a Vertical Landing at this gross weight.)

2. Following the waveoff, accelerate/climb to pattern speed and 1000 ft altitude.

3. Initiate a 30° banked turn to the downwind leg.

4. Continue on the downwind leg to a distance 3.5 nm Distance Measurement Equipment (DME)

5. Execute a 30° banked turn onto final.

6. Continue at 1000 ft to intercept a 3° glideslope.

7. Decelerate down the glideslope to arrive in hover over the landing spot.

8. Hover for 30 sec over the spot.

9. Execute a Vertical Landing.

10. On-deck fuel reserves shall be the greatest of:

1) 500 lbs of usable fuel,

2) 10 min of ground idle fuel in addition to an allowance for fuel system gauge error appropriate for that fuel state, or

3) minimum fuel required for thermal management of critical systems during a 5-min taxi followed by a 5-min ground idle.

5. DETAILED REQUIREMENTS.

This section is not applicable to this standard.

6. NOTES.

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. This standard establishes the definitions, ground rules, and mission profiles to determine the performance of fixed-wing air vehicles developed to perform combat and support missions in environments unique to military weapons systems. The intent of this document is to provide all conditions and limitations inherent in the definitions and ground rules which must be met when any item of performance included herein is calculated.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this standard.

6.3 Subject term (key word) listing.

airspeed
altitude
atmosphere
carrier
ceiling
climb
combat
cruise
descent
distance
dive
drag
engine
fuel
landing
lift
load
range
rate-of-climb
refuel
speed
takeoff
thrust
trainer
weight

6.4 Changes from previous issue. The margins of this standard are marked with vertical lines to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

APPENDIX A

ATMOSPHERIC CHARACTERISTICS

A.1 SCOPE

A.1.1 Scope. This appendix contains the profiles of atmospheric characteristics to be used to calculate air vehicle performance, and the terms and constants used to relate these characteristics to the various performance definitions. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

A.2 APPLICABLE DOCUMENTS

A.2.1 General. The documents listed in this section are specified in this appendix. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples.

A.2.2 Government documents

A.2.2.1 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEFENSE MAPPING AGENCY

World Geodetic System, 1984

(Available through NOS Distribution Branch N/CG33, National Ocean Service, 6501 Lafayette Avenue, Riverdale, MD 20737-1199; 1-800-638-8972; http://www.chartmaker.ncd.noaa.gov.)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Standard Atmosphere, 1976

U.S. Standard Atmosphere Supplements, 1966

(Available online at http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19770009539_1977009539.pdf and through Langley Research Center, NASA Scientific and Technical Information Program, Mail Stop 157A, Hampton, VA 23681-0001.)

INTERNATIONAL CIVIL AVIATION ORGANIZATION

Manual of the ICAO Standard Atmosphere

(Available through ICAO, Document Sales Unit, 999 University Street, Montreal, Quebec H3C 5H7, Canada; www.icao.int.)

A.3 DEFINITIONS

A.3.1 Atmospheric Characteristics

A.3.1.1 Standard Day. As aircraft were developed, it became obvious that since aircraft performance is dependent on the temperature, pressure, and density of the medium through which it flies, a description of those characteristics was necessary to define an aircraft's performance. It was further obvious that unless the same atmospheric description was used time after time, comparison of performance characteristics would be impossible. To fill this need, an arbitrary profile of atmospheric conditions versus altitude was developed which lay part-way between the extremes of possible atmospheric variations and which meets the conditions of continuity exhibited by the atmosphere. This atmospheric model was titled "Standard Day" and has been used basically unchanged since it was published in 1952 as the "Manual of the ICAO (International Civil Aviation Organization) Standard Atmosphere." Since then it has been published in many documents, and the altitude span covered by the profile has been greatly increased. Table A-I contains the standard day model for altitudes from minus 15,000 ft to 150,000 ft, taken from the "U.S. Standard Atmosphere, 1976" prepared under the sponsorship of the National Aeronautics and Space Administration, United States Air Force, and United States Weather Bureau. The equations for standard day pressures and temperatures are presented in table A-II. They can be used to derive pressures and temperatures at intermediate altitudes. The tables were extended down to minus 15,000 ft geopotential altitude so density altitudes for conditions colder than standard day can be obtained.

A.3.1.2 Polar and Tropical Days. While the standard day is used as a common reference to which air vehicle performance can be normalized, additional atmospheric models which describe realistic profiles of extremes of temperature and density are needed to calculate performance parameters under near-worst-case conditions. The atmospheres which have historically been used for this purpose are the Polar and Tropical Atmospheres from MIL-STD-210A, "Climatic Extremes for Military Equipment," dated 2 August 1957. They are included here as tables A-III (Polar Day) and A-IV (Tropical Day). These atmospheres extend to 100,000 ft geopotential altitude. If data is required for altitudes above 100 000 ft, atmospheres from the "U.S. Standard Atmosphere Supplements, 1966" which closely approximate the polar and tropical days at lower altitudes can be used. The 60º North, January (warm) can be substituted for the polar day, and the 15° North annual can be used instead of the tropical day. The conditions given in these tables are applicable to free air conditions. Temperatures close to the surface of the earth, even at high elevations, can be considerably higher than those for free air. Table A-V contains a model of hot day ground-level atmospheric conditions to be used for takeoff and other ground operations at elevations up to 15,000 ft. It was extracted from table VI, "Hot day atmosphere", of MIL-C-005011B(USAF); which, in turn, was taken from MIL-STD-210A.

A.3.2 Tables of Atmospheric Characteristics. These tables contain: 1) basic characteristics of the atmosphere (temperature, pressure, and density), 2) altitude to sea-level ratios of these parameters, and 3) parameters derived from these values (speed of sound, coefficient of viscosity, and the ratio of dynamic pressure to Mach number squared). All tables show data as a function of both geometric and geopotential altitude. The data is shown for 1,000-ft increments (geopotential) below 100,000 ft and 5,000-ft increments above 100,000 ft. Temperature ratio, pressure ratio, and density ratio are referenced to standard day, sea level values (T_o, P_o, and ρ_o) for all atmospheres.

A.3.2.1 Wind. The definitions in the main body of this standard were written for conditions of zero wind. When winds must be taken into account, the proper adjustments must be made to the value of "speed" being used. Wind is the difference between ground speed and the horizontal component of airspeed, and care must be taken to determine whether the speeds used in the definitions are ground speeds, airspeeds, or a mixture of both. Wind speed must be split into components of headwind and crosswind. The effects of headwind are different for each segment of flight and the general effects are outlined below.

A.3.2.1.1 Takeoff and Landing. The air vehicle is affected by ground and air forces while on the ground. Where these forces are a function of speed, ground forces are a function of ground speed and aerodynamic forces are a function of airspeed. Care must be taken to assess wind effects on the other parameters included under the subject of takeoff (ground minimum control speed, critical field length, etc.). Crosswind limits must also be checked to ensure they are not violated.

A.3.2.1.2 Climb and Descent. The distance travelled and the flight path angle will vary with wind speed as altitude changes. Climb speed must be varied to optimize range since optimum climb speed varies with wind speed.

A.3.2.1.3 Cruise. The effect of a headwind is to change both the specific range and the optimum cruise speed of the air vehicle. When tailwind components exist, specific range can be maximized by flight at a somewhat lower airspeed. For headwinds, the cruise airspeed must be increased to maximize specific range.

A.3.2.1.4 Ceiling and Maneuverability. Ceiling and maneuverability are not affected. All parameters are a function of airspeed only.

A.3.2.1.5 Endurance. Endurance is not affected. Position over the same portion of ground can be maintained by longer flight on the upwind leg than on the downwind leg.

A.3.3 Terms Related to the Atmosphere

A.3.3.1 Altitude. In general, altitude refers to the height above some reference surface. More specific definitions of both the height and the reference surface are required to define the altitude at which specific conditions occur. A list of commonly-used altitudes follows.

A.3.3.1.1 Geometric Altitude (Z). Geometric altitude is the tape line height of a point above sea level. This is the altitude which would be measured by an infinitely long ruler with equal divisions of physical length with one end placed at sea level. This is also the altitude which would be measured by an inertial sensor, or a radar set at sea level.

A.3.3.1.2 Geopotential Altitude (H). Geopotential altitude is an altitude in which height is measured in equal divisions of potential energy. As distance from the surface of the earth (sea level) increases, gravity decreases, and the physical distance required to obtain the same quantity of potential energy as at a lower altitudes increases. Thus, a difference in geopotential height of 1 ft at low altitude is physically shorter than a geopotential difference of 1 ft at high altitude. Since air vehicle performance calculations are essentially a study of the energy state of the air vehicle, geopotential is the proper altitude to use and the data in the atmospheric tables in this appendix are given at equal intervals of geopotential altitude. A secondary scale of geometric altitude is also given. The relationship between geometric and geopotential altitude is:

$$H = \frac{rZ}{r + Z}$$

Where:

r = earth radius, ft
Z = geometric altitude, ft.

The difference between geometric and geopotential altitude is small, and for most applications they are assumed to be equal. The proper definitions should be used if extreme precision is needed. Also, since both gravity and the radius of the earth vary with latitude, the relationship between geometric and geopotential altitudes is affected by latitude variations. These variations are shown in table 4.20 of the "U.S. Standard Atmosphere Supplements, 1966."

A.3.3.1.3 Pressure Altitude (H_p or Z_p). Pressure altitude is the altitude in a given atmosphere at which the pressure corresponds to the pressure in the standard day atmosphere. For a standard day (or any atmosphere for which the variation of pressure with altitude is the same as a standard day), equal increments of pressure altitude result in equal increments of height, and may be measured in either geometric or geopotential units. For atmospheres whose pressure/altitude profiles are different than standard day, equal increments of pressure altitude do not result in equal increments of height. Thus, pressure altitude cannot be used directly for climb calculations for these days. Pressure altitude is also the altitude read from an altimeter set at 29.92 in Hg.

A.3.3.1.4 Indicated Altitude. Indicated altitude is the altitude read from the altimeter. It is equal to pressure altitude plus installation error plus instrument error.

A.3.3.1.5 Density Altitude (H_d or Z_d). Density altitude is the altitude in a given atmosphere at which the density corresponds to the density in the standard day atmosphere. For a standard day, pressure altitude and density altitude are equal. Although pressure altitude is the reference altitude at which the air vehicle flies, density altitude is the altitude used for calculations on non-standard days since density is the parameter to which all aerodynamic coefficients are referred.

A.3.3.2 Speed. Speed, in general, refers to the rate of change of distance of one object relative to another. More specific definitions are needed to describe both the object relative to which speed is measured and the method by which speed is calculated. The following is a list of commonly-used speeds.

A.3.3.2.1 Airspeed. Airspeed is the speed of an air vehicle relative to the air mass through which it is in flight.

A.3.3.2.2 Wind Speed. Wind speed is the speed of the air mass relative to the ground.

A.3.3.2.3 Ground Speed. Ground speed is the horizontal component of the speed of the air vehicle relative to the ground over which it is in flight.

A.3.3.2.4 Indicated Airspeed (V_{ias}). Indicated airspeed is the airspeed read from the cockpit airspeed indicator, corrected for instrument error.

A.3.3.2.5 Calibrated Airspeed (V_{cas}). Calibrated airspeed is indicated airspeed corrected for airspeed instrumentation position error. The correction is unique for each model air vehicle.

A.3.3.2.6 Equivalent Airspeed (V_{eas}). Equivalent airspeed is calibrated airspeed corrected for compressibility effects. This correction is the same for all air vehicles.

A.3.3.2.7 True Airspeed (V_{tas}). True airspeed is equivalent airspeed corrected for change in atmospheric density. It is equal to equivalent airspeed divided by the square root of the density ratio. True airspeed is the actual speed of an air vehicle relative to the mass through which it is in flight.

A.3.4 Constants and Relationships. A list of constants commonly used in performance calculations follows:

Acceleration of gravity, sea level, 45º latitude	g_0	=	32.1741 ft/sec^2
Temperature, sea level, standard day	T_0	=	518.67 ºR = 288.2 ºK
Pressure, sea level, standard day, static	P_0	=	2116.22 lb/ft^2
Density, sea level, standard day	ρ_0	=	.002377 slugs/ft^3
Equatorial earth radius	r_e	=	20925646.0 ft
Feet per nautical mile	6076.14 .		

NOTE: The values of equatorial earth radius and the conversion from feet to nautical miles were taken from the "World Geodetic System, 1984" published by the Defense Mapping Agency, Department of Defense.

TABLE A-I. Standard day atmosphere

Geopotential Altitude H, ft	Geometric Altitude Z, ft	Temperature deg F	deg R	deg C	deg K	Temperature Ratio θ	Pressure in Hg	lb/ft^2	Pressure Ratio δ	Density $slugs/ft^3$	Density Ratio σ	Speed of Sound ft/sec	Kts	Q/M2 lb/ft^2	Absolute Viscosity $lb\text{-}sec/ft^2$
-15,000	-14,989	112.49	572.16	44.72	317.87	1.1031	50.1221	3544.95	1.675E-00	3.609E-03	1.519E-00	1172.6	694.7	2481.4	4.029E-07
-14,000	-13,991	108.93	568.60	42.74	315.89	1.0963	48.5018	3430.35	1.621E-00	3.515E-03	1.479E-00	1168.9	692.6	2401.2	4.010E-07
-13,000	-12,992	105.36	565.03	40.76	313.91	1.0894	46.9241	3318.77	1.568E-00	3.422E-03	1.440E-00	1165.3	690.4	2323.1	3.991E-07
-12,000	-11,993	101.79	561.46	38.77	311.92	1.0825	45.3883	3210.15	1.517E-00	3.331E-03	1.401E-00	1161.6	688.2	2247.1	3.972E-07
-11,000	-10,994	98.23	557.90	36.79	309.94	1.0756	43.8935	3104.42	1.467E-00	3.242E-03	1.364E-00	1157.9	686.0	2173.1	3.953E-07
-10,000	-9,995	94.66	554.33	34.81	307.96	1.0688	42.4387	3001.54	1.418E-00	3.154E-03	1.327E-00	1154.2	683.8	2101.1	3.934E-07
-9,000	-8,996	91.10	550.77	32.83	305.98	1.0619	41.0233	2901.43	1.371E-00	3.069E-03	1.291E-00	1150.5	681.6	2031.0	3.914E-07
-8,000	-7,997	87.53	547.20	30.85	304.00	1.0550	39.6463	2804.04	1.325E-00	2.985E-03	1.256E-00	1146.7	679.4	1962.8	3.895E-07
-7,000	-6,998	83.96	543.63	28.87	302.02	1.0481	38.3070	2709.31	1.280E-00	2.903-E03	1.221E-00	1143.0	677.2	1896.5	3.875E-07
-6,000	-5,998	80.40	540.07	26.89	300.04	1.0413	37.0045	2617.19	1.237E-00	2.823E-03	1.188E-00	1139.2	675.0	1832.0	3.856E-07
-5,000	-4,999	76.83	536.50	24.91	298.06	1.0344	35.7382	2527.63	1.194E-00	2.745E-03	1.155E-00	1135.5	672.7	1769.3	3.836E-07
-4,000	-3,999	73.26	532.93	22.92	296.07	1.0275	34.5071	2440.56	1.153E-00	2.668E-03	1.122E-00	1131.7	670.5	1708.4	3.816E-07
-3,000	-3,000	69.70	529.37	20.94	294.09	1.0206	33.3107	2355.94	1.113E-00	2.593E-03	1.091E-00	1127.9	668.3	1649.1	3.797E-07
-2,000	-2,000	66.13	525.80	18.96	292.11	1.0138	32.1480	2273.71	1.074E-00	2.519E-03	1.060E-00	1124.1	666.0	1591.6	3.777E-07
-1,000	-1,000	62.57	522.24	16.98	290.13	1.0069	31.0184	2193.82	1.037E-00	2.447E-03	1.030E-00	1120.3	663.7	1535.7	3.757E-07
0	0	59.00	518.67	15.00	288.15	1.0000	29.9212	2116.22	1.000E-00	2.377E-03	1.000E-00	1116.4	661.5	1481.3	3.737E-07
1,000	1,000	55.43	515.10	13.02	286.17	0.9931	28.8557	2040.86	9.644E-01	2.308E-03	9.711E-01	1112.6	659.2	1428.6	3.717E-07
2,000	2,000	51.87	511.54	11.04	284.19	0.9862	27.8210	1967.68	9.298E-01	2.241E-03	9.428E-01	1108.7	656.9	1377.4	3.697E-07
3,000	3,000	48.30	507.97	9.06	282.21	0.9794	26.8166	1896.64	8.962E-01	2.175E-03	9.151E-01	1104.9	654.6	1327.6	3.677E-07
4,000	4,001	44.74	504.41	7.08	280.23	0.9725	25.8418	1827.70	8.637E-01	2.111E-03	8.881E-01	1101.0	652.3	1279.4	3.657E-07
5,000	5,001	41.17	500.84	5.09	278.24	0.9656	24.8959	1760.80	8.320E-01	2.048E-03	8.617E-01	1097.1	650.0	1232.5	3.636E-07
6,000	6,002	37.60	497.27	3.11	276.26	0.9587	23.9782	1695.89	8.014E-01	1.987E-03	8.359E-01	1093.2	647.7	1187.1	3.616E-07
7,000	7,002	34.04	493.71	1.13	274.28	0.9519	23.0881	1632.94	7.716E-01	1.927E-03	8.106E-01	1089.2	645.4	1143.0	3.596E-07
8,000	8,003	30.47	490.14	-0.85	272.30	0.9450	22.2249	1571.89	7.428E-01	1.868E-03	7.860E-01	1085.3	643.0	1100.3	3.575E-07
9,000	9,004	26.90	486.57	-2.83	270.32	0.9381	21.3881	1512.70	7.148E-01	1.811E-03	7.620E-01	1081.3	640.7	1058.9	3.555E-07
10,000	10,005	23.34	483.01	-4.81	268.34	0.9312	20.5769	1455.33	6.877E-01	1.755E-03	7.385E-01	1077.4	638.3	1018.7	3.534E-07
11,000	11,006	19.77	479.44	-6.79	266.36	0.9244	19.7909	1399.74	6.614E-01	1.701E-03	7.156E-01	1073.4	636.0	979.8	3.513E-07
12,000	12,007	16.21	475.88	-8.77	264.38	0.9175	19.0293	1345.87	6.360E-01	1.648E-03	6.932E-01	1069.4	633.6	942.1	3.492E-07
13,000	13,008	12.64	472.31	-10.76	262.39	0.9106	18.2917	1293.70	6.113E-01	1.596E-03	6.713E-01	1065.4	631.2	905.6	3.472E-07
14,000	14,009	9.07	468.74	-12.74	260.41	0.9037	17.5773	1243.18	5.875E-01	1.545E-03	6.500E-01	1061.4	628.8	870.2	3.451E-07
15,000	15,011	5.51	465.18	-14.72	258.43	0.8969	16.8858	1194.27	5.643E-01	1.496E-03	6.292E-01	1057.3	626.4	836.0	3.430E-07
16,000	16,012	1.94	461.61	-16.70	256.45	0.8900	16.2164	1146.93	5.420E-01	1.447E-03	6.090E-01	1053.2	624.0	802.8	3.409E-07
17,000	17,014	-1.62	458.05	-18.68	254.47	0.8831	15.5687	1101.12	5.203E-01	1.400E-03	5.892E-01	1049.2	621.6	770.8	3.387E-07
18,000	18,016	-5.19	454.48	-20.66	252.49	0.8762	14.9421	1056.80	4.994E-01	1.355E-03	5.699E-01	1045.1	619.2	739.8	3.366E-07
19,000	19,017	-8.76	450.91	-22.64	250.51	0.8694	14.3360	1013.94	4.791E-01	1.310E-03	5.511E-01	1041.0	616.8	709.7	3.345E-07
20,000	20,019	-12.32	447.35	-24.62	248.53	0.8625	13.7501	972.49	4.595E-01	1.266E-03	5.328E-01	1036.8	614.3	680.7	3.324E-07
21,000	21,021	-15.89	443.78	-26.61	246.54	0.8556	13.1836	932.43	4.406E-01	1.224E-03	5.150E-01	1032.7	611.9	652.7	3.302E-07
22,000	22,023	-19.46	440.21	-28.59	244.56	0.8487	12.6362	893.72	4.223E-01	1.183E-03	4.976E-01	1028.5	609.4	625.6	3.281E-07
23,000	23,025	-23.02	436.65	-30.57	242.58	0.8419	12.1074	856.31	4.046E-01	1.142E-03	4.807E-01	1024.4	606.9	599.4	3.259E-07
24,000	24,028	-26.59	433.08	-32.55	240.60	0.8350	11.5967	820.19	3.876E-01	1.103E-03	4.642E-01	1020.2	604.4	574.1	3.237E-07
25,000	25,030	-30.15	429.52	-34.53	238.62	0.8281	11.1035	785.31	3.711E-01	1.065E-03	4.481E-01	1016.0	601.9	549.7	3.216E-07
26,000	26,032	-33.72	425.95	-36.51	236.64	0.8212	10.6274	751.64	3.552E-01	1.028E-03	4.325E-01	1011.7	599.4	526.1	3.194E-07
27,000	27,035	-37.29	422.38	-38.49	234.66	0.8144	10.1680	719.15	3.398E-01	9.919E-04	4.173E-01	1007.5	596.9	503.4	3.172E-07
28,000	28,038	-40.85	418.82	-40.47	232.68	0.8075	9.7249	687.80	3.250E-01	9.567E-04	4.025E-01	1003.2	594.4	481.5	3.150E-07
29,000	29,040	-44.42	415.25	-42.45	230.70	0.8006	9.2974	657.57	3.107E-01	9.225E-04	3.881E-01	999.0	591.9	460.3	3.128E-07
30,000	30,043	-47.98	411.69	-44.44	228.71	0.7937	8.8854	628.43	2.970E-01	8.893E-04	3.741E-01	994.7	589.3	439.9	3.106E-07

TABLE A-I. Standard day atmosphere – Continued.

Geopotential Altitude	Geometric Altitude	Temperature				Temperature Ratio	Pressure		Pressure Ratio	Density	Density Ratio	Speed of Sound		Q/M2	Absolute Viscosity
H, ft	Z, ft	deg F	deg R	deg C	deg K	θ	in Hg	lb/ft^2	δ	$slugs/ft^3$	σ	ft/sec	Kts	lb/ft^2	$lb\text{-}sec/ft^2$
31,000	31,046	-51.55	408.12	-46.42	226.73	0.7869	8.4882	600.34	2.837E-01	8.569E-04	3.605E-01	990.3	586.8	420.2	3.083E-07
32,000	32,049	-55.12	404.55	-48.40	224.75	0.7800	8.1056	573.28	2.709E-01	8.255E-04	3.473E-01	986.0	584.2	401.3	3.061E-07
33,000	33,052	-58.68	400.99	-50.38	222.77	0.7731	7.7370	547.21	2.586E-01	7.950E-04	3.345E-01	981.6	581.6	383.0	3.039E-07
34,000	34,055	-62.25	397.42	-52.36	220.79	0.7662	7.3821	522.11	2.467E-01	7.653E-04	3.220E-01	977.3	579.0	365.5	3.016E-07
35,000	35,059	-65.82	393.85	-54.34	218.81	0.7594	7.0406	497.95	2.353E-01	7.365E-04	3.099E-01	972.9	576.4	348.6	2.993E-07
36,000	36,062	-69.38	390.29	-56.32	216.83	0.7525	6.7119	474.71	2.243E-01	7.086E-04	2.981E-01	968.5	573.8	332.3	2.971E-07
36,089	36,151	-69.70	389.97	-56.50	216.65	0.7519	6.6833	472.68	2.234E-01	7.061E-04	2.971E-01	968.1	573.6	330.9	2.969E-07
37,000	37,066	-69.70	389.97	-56.50	216.65	0.7519	6.3970	452.43	2.138E-01	6.759E-04	2.844E-01	968.1	573.6	316.7	2.969E-07
38,000	38,069	-69.70	389.97	-56.50	216.65	0.7519	6.0968	431.20	2.038E-01	6.442E-04	2.710E-01	968.1	573.6	301.8	2.969E-07
39,000	39,073	-69.70	389.97	-56.50	216.65	0.7519	5.8107	410.97	1.942E-01	6.139E-04	2.583E-01	968.1	573.6	287.7	2.969E-07
40,000	40,077	-69.70	389.97	-56.50	216.65	0.7519	5.5380	391.68	1.851E-01	5.851E-04	2.462E-01	968.1	573.6	274.2	2.969E-07
41,000	41,081	-69.70	389.97	-56.50	216.65	0.7519	5.2781	373.30	1.764E-01	5.577E-04	2.346E-01	968.1	573.6	261.3	2.969E-07
42,000	42,085	-69.70	389.97	-56.50	216.65	0.7519	5.0304	355.78	1.681E-01	5.315E-04	2.236E-01	968.1	573.6	249.0	2.969E-07
43,000	43,089	-69.70	389.97	-56.50	216.65	0.7519	4.7944	339.09	1.602E-01	5.066E-04	2.131E-01	968.1	573.6	237.4	2.969E-07
44,000	44,093	-69.70	389.97	-56.50	216.65	0.7519	4.5694	323.18	1.527E-01	4.828E-04	2.031E-01	968.1	573.6	226.2	2.969E-07
45,000	45,097	-69.70	389.97	-56.50	216.65	0.7519	4.3550	308.01	1.455E-01	4.601E-04	1.936E-01	968.1	573.6	215.6	2.969E-07
46,000	46,102	-69.70	389.97	-56.50	216.65	0.7519	4.1506	293.56	1.387E-01	4.385E-04	1.845E-01	968.1	573.6	205.5	2.969E-07
47,000	47,106	-69.70	389.97	-56.50	216.65	0.7519	3.9558	279.78	1.322E-01	4.180E-04	1.758E-01	968.1	573.6	195.8	2.969E-07
48,000	48,111	-69.70	389.97	-56.50	216.65	0.7519	3.7702	266.65	1.260E-01	3.983E-04	1.676E-01	968.1	573.6	186.7	2.969E-07
49,000	49,115	-69.70	389.97	-56.50	216.65	0.7519	3.5933	254.14	1.201E-01	3.796E-04	1.597E-01	968.1	573.6	177.9	2.969E-07
50,000	50,120	-69.70	389.97	-56.50	216.65	0.7519	3.4246	242.21	1.145E-01	3.618E-04	1.522E-01	968.1	573.6	169.5	2.969E-07
51,000	51,125	-69.70	389.97	-56.50	216.65	0.7519	3.2639	230.85	1.091E-01	3.449E-04	1.451E-01	968.1	573.6	161.6	2.969E-07
52,000	52,130	-69.70	389.97	-56.50	216.65	0.7519	3.1108	220.01	1.040E-01	3.287E-04	1.383E-01	968.1	573.6	154.0	2.969E-07
53,000	53,135	-69.70	389.97	-56.50	216.65	0.7519	2.9648	209.69	9.909E-02	3.132E-04	1.318E-01	968.1	573.6	146.8	2.969E-07
54,000	54,140	-69.70	389.97	-56.50	216.65	0.7519	2.8257	199.85	9.444E-02	2.985E-04	1.256E-01	968.1	573.6	139.9	2.969E-07
55,000	55,145	-69.70	389.97	-56.50	216.65	0.7519	2.6931	190.47	9.000E-02	2.845E-04	1.197E-01	968.1	573.6	133.3	2.969E-07
56,000	56,151	-69.70	389.97	-56.50	216.65	0.7519	2.5667	181.53	8.578E-02	2.712E-04	1.141E-01	968.1	573.6	127.1	2.969E-07
57,000	57,156	-69.70	389.97	-56.50	216.65	0.7519	2.4462	173.01	8.176E-02	2.585E-04	1.087E-01	968.1	573.6	121.1	2.969E-07
58,000	58,161	-69.70	389.97	-56.50	216.65	0.7519	2.3314	164.89	7.792E-02	2.463E-04	1.036E-01	968.1	573.6	115.4	2.969E-07
59,000	59,167	-69.70	389.97	-56.50	216.65	0.7519	2.2220	157.16	7.426E-02	2.348E-04	9.877E-02	968.1	573.6	110.0	2.969E-07
60,000	60,173	-69.70	389.97	-56.50	216.65	0.7519	2.1178	149.78	7.078E-02	2.238E-04	9.414E-02	968.1	573.6	104.8	2.969E-07
61,000	61,179	-69.70	389.97	-56.50	216.65	0.7519	2.0184	142.75	6.746E-02	2.133E-04	8.972E-02	968.1	573.6	99.9	2.969E-07
62,000	62,185	-69.70	389.97	-56.50	216.65	0.7519	1.9237	136.05	6.429E-02	2.032E-04	8.551E-02	968.1	573.6	95.2	2.969E-07
63,000	63,191	-69.70	389.97	-56.50	216.65	0.7519	1.8334	129.67	6.127E-02	1.937E-04	8.150E-02	968.1	573.6	90.8	2.969E-07
64,000	64,197	-69.70	389.97	-56.50	216.65	0.7519	1.7474	123.58	5.840E-02	1.846E-04	7.767E-02	968.1	573.6	86.5	2.969E-07
65,000	65,203	-69.70	389.97	-56.50	216.65	0.7519	1.6654	117.78	5.566E-02	1.760E-04	7.403E-02	968.1	573.6	82.4	2.969E-07
65,617	65,824	-69.70	389.97	-56.50	216.65	0.7519	1.6167	114.34	5.403E-02	1.708E-04	7.186E-02	968.1	573.6	80.0	2.969E-07
66,000	66,209	-69.49	390.18	-56.38	216.77	0.7523	1.5872	112.26	5.305E-02	1.676E-04	7.051E-02	968.3	573.7	78.6	2.970E-07
67,000	67,216	-68.94	390.73	-56.08	217.07	0.7533	1.5128	107.00	5.056E-02	1.595E-04	6.712E-02	969.0	574.1	74.9	2.974E-07
68,000	68,222	-68.39	391.28	-55.77	217.38	0.7544	1.4420	101.99	4.819E-02	1.518E-04	6.388E-02	969.7	574.5	71.4	2.977E-07
69,000	69,229	-67.84	391.83	-55.47	217.68	0.7554	1.3746	97.22	4.594E-02	1.445E-04	6.081E-02	970.4	574.9	68.1	2.981E-07
70,000	70,235	-67.30	392.37	-55.16	217.99	0.7565	1.3104	92.68	4.380E-02	1.376E-04	5.789E-02	971.0	575.3	64.9	2.984E-07
71,000	71,242	-66.75	392.92	-54.86	218.29	0.7576	1.2494	88.36	4.175E-02	1.310E-04	5.512E-02	971.7	575.7	61.9	2.987E-07
72,000	72,249	-66.20	393.47	-54.55	218.60	0.7586	1.1912	84.25	3.981E-02	1.247E-04	5.248E-02	972.4	576.1	59.0	2.991E-07
73,000	73,256	-65.65	394.02	-54.25	218.90	0.7597	1.1358	80.33	3.796E-02	1.188E-04	4.997E-02	973.1	576.5	56.2	2.994E-07
74,000	74,263	-65.10	394.57	-53.94	219.21	0.7607	1.0831	76.60	3.620E-02	1.131E-04	4.758E-02	973.8	576.9	53.6	2.998E-07
75,000	75,270	-64.55	395.12	-53.64	219.51	0.7618	1.0329	73.05	3.452E-02	1.077E-04	4.531E-02	974.4	577.3	51.1	3.001E-07

TABLE A-I. Standard day atmosphere – Continued.

Geopotential Altitude	Geometric Altitude	Temperature				Temperature Ratio	Pressure		Pressure Ratio	Density	Density Ratio	Speed of Sound		Q/M2	Absolute Viscosity
H, ft	Z, ft	deg F	deg R	deg C	deg K	θ	in Hg	lb/ft^2	δ	slugs/ft^3	σ	ft/sec	Kts	lb/ft^2	lb-sec/ft^2
76,000	76,277	-64.00	395.67	-53.34	219.81	0.7628	0.9851	69.67	3.292E-02	1.026E-04	4.316E-02	975.1	577.7	48.8	3.005E-07
77,000	77,285	-63.45	396.22	-53.03	220.12	0.7639	0.9395	66.45	3.140E-02	9.770-E05	4.110E-02	975.8	578.1	46.5	3.008E-07
78,000	78,292	-62.91	396.76	-52.73	220.42	0.7650	0.8961	63.38	2.995E-02	9.306E-05	3.915E-02	976.5	578.5	44.4	3.012E-07
79,000	79,300	-62.36	397.31	-52.42	220.73	0.7660	0.8548	60.46	2.857E-02	8.865E-05	3.729E-02	977.1	578.9	42.3	3.015E-07
80,000	80,308	-61.81	397.86	-52.12	221.03	0.7671	0.8154	57.67	2.725E-02	8.445E-05	3.553E-02	977.8	579.3	40.4	3.019E-07
81,000	81,315	-61.26	398.41	-51.81	221.34	0.7681	0.7779	55.02	2.600E-02	8.045E-05	3.385E-02	978.5	579.7	38.5	3.022E-07
82,000	82,323	-60.71	398.96	-51.51	221.64	0.7692	0.7422	52.49	2.481E-02	7.665E-05	3.225E-02	979.2	580.1	36.7	3.026E-07
83,000	83,331	-60.16	399.51	-51.20	221.95	0.7703	0.7082	50.09	2.367E-02	7.304E-05	3.073E-02	979.8	580.5	35.1	3.029E-07
84,000	84,339	-59.61	400.06	-50.90	222.25	0.7713	0.6757	47.79	2.258E-02	6.960E-05	2.928E-02	980.5	580.9	33.5	3.033E-07
85,000	85,347	-59.07	400.60	-50.59	222.56	0.7724	0.6448	45.61	2.155E-02	6.632E-05	2.790E-02	981.2	581.3	31.9	3.036E-07
86,000	86,356	-58.52	401.15	-50.29	222.86	0.7734	0.6154	43.52	2.057E-02	6.321E-05	2.659E-02	981.9	581.7	30.5	3.040E-07
87,000	87,364	-57.97	401.70	-49.98	223.17	0.7745	0.5873	41.54	1.963E-02	6.024E-05	2.534E-02	982.5	582.1	29.1	3.043E-07
88,000	88,372	-57.42	402.25	-49.68	223.47	0.7755	0.5606	39.65	1.873E-02	5.742E-05	2.416E-02	983.2	582.5	27.8	3.046E-07
89,000	89,381	-56.87	402.80	-49.37	223.78	0.7766	0.5350	37.84	1.788E-02	5.473E-05	2.303E-02	983.9	582.9	26.5	3.050E-07
90,000	90,389	-56.32	403.35	-49.07	224.08	0.7777	0.5107	36.12	1.707E-02	5.217E-05	2.195E-02	984.5	583.3	25.3	3.053E-07
91,000	91,398	-55.77	403.90	-48.76	224.39	0.7787	0.4876	34.48	1.629E-02	4.974E-05	2.093E-02	985.2	583.7	24.1	3.057E-07
92,000	92,407	-55.23	404.44	-48.46	224.69	0.7798	0.4655	32.92	1.556E-02	4.742E-05	1.995E-02	985.9	584.1	23.0	3.060E-07
93,000	93,416	-54.68	404.99	-48.15	225.00	0.7808	0.4444	31.43	1.485E-02	4.521E-05	1.902E-02	986.5	584.5	22.0	3.064E-07
94,000	94,425	-54.13	405.54	-47.85	225.30	0.7819	0.4243	30.01	1.418E-02	4.311E-05	1.814E-02	987.2	584.9	21.0	3.067E-07
95,000	95,434	-53.58	406.09	-47.54	225.61	0.7829	0.4052	28.66	1.354E-02	4.111E-05	1.729E-02	987.9	585.3	20.1	3.071E-07
96,000	96,443	-53.03	406.64	-47.24	225.91	0.7840	0.3869	27.36	1.293E-02	3.920E-05	1.649E-02	988.5	585.7	19.2	3.074E-07
97,000	97,452	-52.48	407.19	-46.93	226.22	0.7851	0.3695	26.13	1.235E-02	3.739E-05	1.573E-02	989.2	586.1	18.3	3.077E-07
98,000	98,462	-51.93	407.74	-46.63	226.52	0.7861	0.3529	24.96	1.179E-02	3.566E-05	1.500E-02	989.9	586.5	17.5	3.081E-07
99,000	99,471	-51.38	408.29	-46.32	226.83	0.7872	0.3370	23.84	1.126E-02	3.401E-05	1.431E-02	990.5	586.9	16.7	3.084E-07
100,000	100,481	-50.84	408.83	-46.02	227.13	0.7882	0.3219	22.77	1.076E-02	3.244E-05	1.365E-02	991.2	587.3	15.9	3.088E-07
105,000	105,530	-48.08	411.59	-44.49	228.66	0.7935	0.2562	18.12	8.561E-03	2.564E-05	1.079E-02	994.5	589.2	12.7	3.105E-07
110,000	110,582	-40.40	419.27	-40.22	232.93	0.8084	0.2044	14.46	6.832E-03	2.009E-05	8.452E-03	1003.8	594.7	10.1	3.153E-07
115,000	115,637	-32.72	426.95	-35.95	237.20	0.8232	0.1638	11.59	5.475E-03	1.581E-05	6.651E-03	1012.9	600.1	8.1	3.200E-07
120,000	120,693	-25.04	434.63	-31.69	241.46	0.8380	0.1318	9.32	4.404E-03	1.249E-05	5.256E-03	1022.0	605.5	6.5	3.247E-07
125,000	125,752	-17.36	442.31	-27.42	245.73	0.8528	0.1064	7.53	3.557E-03	9.914E-06	4.171E-03	1031.0	610.8	5.3	3.293E-07
130,000	130,814	-9.68	449.99	-23.15	250.00	0.8676	0.0863	6.10	2.883E-03	7.898E-06	3.323E-03	1039.9	616.1	4.3	3.339E-07
135,000	135,878	-1.99	457.68	-18.89	254.26	0.8824	0.0702	4.96	2.345E-03	6.317E-06	2.658E-03	1048.7	621.4	3.5	3.385E-07
140,000	140,945	5.69	465.36	-14.62	258.53	0.8972	0.0573	4.05	1.914E-03	5.071E-06	2.133E-03	1057.5	626.6	2.8	3.431E-07
145,000	146,013	13.37	473.04	-10.35	262.80	0.9120	0.0469	3.32	1.568E-03	4.085E-06	1.719E-03	1066.2	631.7	2.3	3.476E-07
150,000	151,085	21.05	480.72	-6.08	267.07	0.9268	0.0385	2.73	1.288E-03	3.303E-06	1.390E-03	1074.8	636.8	1.9	3.521E-07

TABLE A-II. Standard day temperature and pressure equations

Geopotential Altitude Bands H - ft	Temperature Deg - K	Pressure lb/ft^2
-15000 to 36089	288.15*(1-6.87558E-6*H)	2116.22*(1-6.87558E-6*H)^5.25591
36089 to 65617	216.65	2116.22*0.22336*EXP(-4.80637E-5*(H-36089.24))
65617 to 104987	216.65*(1+1.40688E-6*(H-65616.8))	2116.22*0.0540322*(1+1.40688E-6*(H-65616.8))^-34.1634
104987 to 150000	228.65*(1+3.73252E-6*(H-104986.88))	2116.22*0.00856649*(1+3.73252E-6*(H-104986.88))^-12.2012

TABLE A-III. Polar day atmosphere

Pressure Altitude	Temperature				Temperature Ratio	Pressure		Pressure Ratio	Density	Density Ratio	Speed of Sound		Q/M2	Absolute Viscosity	Geopotential Altitude	Geometric Altitude
H, ft	deg F	deg R	deg C	deg K	θ	in Hg	lb/ft^2	δ	slugs/ft^3	σ	ft/sec	Kts	lb/ft^2	lb-sec/ft^2	H, ft	Z, ft
0	-15.70	443.97	-26.5	246.65	0.8560	29.9212	2116.22	1.000E-00	2.777E-03	1.168E-00	1032.9	612.0	1481.3	3.296E-07	272	272
1,000	-12.64	447.03	-24.8	248.35	0.8619	28.8557	2040.86	9.644E-01	2.660E-03	1.119E-00	1036.5	614.1	1428.6	3.315E-07	1,133	1,133
2,000	-9.58	450.09	-23.1	250.05	0.8678	27.8210	1967.68	9.298E-01	2.547E-03	1.071E-00	1040.0	616.2	1377.4	3.333E-07	2,006	2,006
3,000	-6.52	453.15	-21.4	251.75	0.8737	26.8166	1896.64	8.962E-01	2.438E-03	1.026E-00	1043.5	618.3	1327.6	3.352E-07	2,890	2,890
3,243	-5.80	453.87	-21.0	252.15	0.8751	26.5771	1879.70	8.882E-01	2.413E-03	1.015E-00	1044.4	618.8	1315.8	3.357E-07	3,112	3,112
4,000	-6.16	453.51	-21.2	251.95	0.8744	25.8418	1827.70	8.637E-01	2.348E-03	9.878E-01	1044.0	618.5	1279.4	3.354E-07	3,790	3,791
5,000	-6.70	452.97	-21.5	251.65	0.8733	24.8959	1760.80	8.320E-01	2.265E-03	9.527E-01	1043.3	618.2	1232.5	3.351E-07	4,691	4,692
6,000	-7.24	452.43	-21.8	251.35	0.8723	23.9782	1695.89	8.014E-01	2.184E-03	9.187E-01	1042.7	617.8	1187.1	3.348E-07	5,597	5,598
7,000	-7.78	451.89	-22.1	251.05	0.8712	23.0881	1632.94	7.716E-01	2.105E-03	8.857E-01	1042.1	617.4	1143.0	3.344E-07	6,509	6,511
8,000	-8.32	451.35	-22.4	250.75	0.8702	22.2249	1571.89	7.148E-01	2.029E-03	8.536E-01	1041.5	617.1	1100.3	3.341E-07	7,426	7,429
9,000	-8.86	450.81	-22.7	250.45	0.8692	21.3881	1512.70	7.148E-01	1.955E-03	8.224E-01	1040.8	616.7	1058.9	3.338E-07	8,349	8,352
9,882	-9.40	450.27	-23.0	250.15	0.8681	20.6712	1462.00	6.909E-01	1.892E-03	7.958E-01	1040.2	616.3	1023.4	3.335E-07	9,173	9,177
10,000	-9.76	449.91	-23.2	249.95	0.8674	20.5769	1455.33	6.877E-01	1.884E-03	7.928E-01	1039.8	616.1	1018.7	3.332E-07	9,282	9,286
11,000	-12.46	447.21	-24.7	248.45	0.8622	19.7909	1399.74	6.614E-01	1.823E-03	7.671E-01	1036.7	614.2	979.8	3.316E-07	10,213	10,218
12,000	-15.34	444.33	-26.3	246.85	0.8567	19.0293	1345.87	6.360E-01	1.765E-03	7.424E-01	1033.3	612.2	942.1	3.298E-07	11,145	11,151
13,000	-18.22	441.45	-27.9	245.25	0.8511	18.2917	1293.70	6.113E-01	1.707E-03	7.183E-01	1030.0	610.2	905.6	3.281E-07	12,079	12,086
14,000	-21.10	438.57	-29.5	243.65	0.8456	17.5773	1243.18	5.875E-01	1.651E-03	6.947E-01	1026.6	608.3	870.2	3.263E-07	13,013	13,021
15,000	-23.80	435.87	-31.0	242.15	0.8404	16.8858	1194.27	5.643E-01	1.596E-03	6.715E-01	1023.5	606.4	836.0	3.246E-07	13,949	13,958
16,000	-26.68	432.99	-32.6	240.55	0.8348	16.2164	1146.93	5.420E-01	1.543E-03	6.492E-01	1020.1	604.4	802.8	3.228E-07	14,885	14,896
17,000	-29.56	430.11	-34.2	238.95	0.8293	15.5687	1101.12	5.203E-01	1.491E-03	6.275E-01	1016.7	602.4	770.8	3.210E-07	15,823	15,835
18,000	-32.26	427.41	-35.7	237.45	0.8240	14.9421	1056.80	4.994E-01	1.440E-03	6.060E-01	1013.5	600.5	739.8	3.193E-07	16,762	16,775
19,000	-35.14	424.53	-37.3	235.85	0.8185	14.3360	1013.94	4.791E-01	1.391E-03	5.854E-01	1010.1	598.4	709.7	3.175E-07	17,702	17,717
20,000	-38.02	421.65	-38.9	234.25	0.8129	13.7501	972.49	4.595E-01	1.344E-03	5.653E-01	1006.6	596.4	680.7	3.157E-07	18,643	18,660
21,000	-40.90	418.77	-40.5	232.65	0.8074	13.1836	932.43	4.406E-01	1.297E-03	5.457E-01	1003.2	594.4	652.7	3.139E-07	19,585	19,603
22,000	-43.78	415.89	-42.1	231.05	0.8018	12.6362	893.72	4.223E-01	1.252E-03	5.267E-01	999.7	592.3	625.6	3.121E-07	20,529	20,549
23,000	-46.66	413.01	-43.7	229.45	0.7963	12.1074	856.31	4.046E-01	1.208E-03	5.082E-01	996.3	590.3	599.4	3.103E-07	21,473	21,495
24,000	-49.36	410.31	-45.2	227.95	0.7911	11.5967	820.19	3.876E-01	1.165E-03	4.899E-01	993.0	588.3	574.1	3.086E-07	22,419	22,443
25,000	-52.24	407.43	-46.8	226.35	0.7855	11.1035	785.31	3.711E-01	1.123E-03	4.724E-01	989.5	586.3	549.7	3.067E-07	23,366	23,392
26,000	-55.12	404.55	-48.4	224.75	0.7800	10.6274	751.64	3.552E-01	1.082E-03	4.554E-01	986.0	584.2	526.1	3.049E-07	24,314	24,342
27,000	-58.00	401.67	-50.0	223.15	0.7744	10.1680	719.15	3.398E-01	1.043E-03	4.388E-01	982.5	582.1	503.4	3.031E-07	25,263	25,294
28,000	-60.88	398.79	-51.6	221.55	0.7689	9.7249	687.80	3.250E-01	1.005E-03	4.227E-01	979.0	580.0	481.5	3.012E-07	26,214	26,247
29,000	-63.76	395.91	-53.2	219.95	0.7633	9.2974	657.57	3.107E-01	9.676E-04	4.071E-01	975.4	577.9	460.3	2.994E-07	27,166	27,201
30,000	-66.64	393.03	-54.8	218.35	0.7578	8.8854	628.43	2.970E-01	9.315E-04	3.919E-01	971.9	575.8	439.9	2.975E-07	28,119	28,157
30,065	-67.00	392.67	-55.0	218.15	0.7571	8.8595	626.60	2.961E-01	9.296E-04	3.911E-01	971.4	575.5	438.6	2.973E-07	28,225	28,263
31,000	-67.18	392.49	-55.1	218.05	0.7567	8.4882	600.34	2.837E-01	8.911E-04	3.749E-01	971.2	575.4	420.2	2.971E-07	29,119	29,160
32,000	-67.54	392.13	-55.3	217.85	0.7560	8.1056	573.28	2.709E-01	8.517E-04	3.583E-01	970.7	575.1	401.3	2.969E-07	30,084	30,127
33,000	-67.72	391.95	-55.4	217.75	0.7557	7.7370	547.21	2.586E-01	8.133E-04	3.422E-01	970.5	575.0	383.0	2.968E-07	31,056	31,102
34,000	-68.08	391.59	-55.6	217.55	0.7550	7.3821	522.11	2.467E-01	7.767E-04	3.268E-01	970.1	574.8	365.5	2.966E-07	32,037	32,086
35,000	-68.26	391.41	-55.7	217.45	0.7546	7.0406	497.95	2.353E-01	7.411E-04	3.118E-01	969.9	574.6	348.6	2.964E-07	33,025	33,077
36,000	-68.44	391.23	-55.8	217.35	0.7543	6.7119	474.71	2.243E-01	7.069E-04	2.974E-01	969.6	574.5	332.3	2.963E-07	34,023	34,079
37,000	-68.80	390.87	-56.0	217.15	0.7536	6.3970	452.43	2.138E-01	6.743E-04	2.837E-01	969.2	574.2	316.7	2.961E-07	35,024	35,083
38,000	-68.98	390.69	-56.1	217.05	0.7533	6.0968	431.20	2.038E-01	6.430E-04	2.705E-01	969.0	574.1	301.8	2.960E-07	36,025	36,087
39,000	-69.34	390.33	-56.3	216.85	0.7526	5.8107	410.97	1.942E-01	6.134E-04	2.581E-01	968.5	573.8	287.7	2.957E-07	37,026	37,092
40,000	-69.52	390.15	-56.4	216.75	0.7522	5.5380	391.68	1.851E-01	5.848E-04	2.461E-01	968.3	573.7	274.2	2.956E-07	38,026	38,095

TABLE A-III. Polar day atmosphere – Continued.

Pressure Altitude	Temperature				Temperature Ratio	Pressure		Pressure Ratio	Density	Density Ratio	Speed of Sound		Q/M2	Absolute Viscosity	Geopotential Altitude	Geometric Altitude
H, ft	deg F	deg R	deg C	deg K	θ	in Hg	lb/ft^2	δ	slugs/ft^3	σ	ft/sec	Kts	lb/ft^2	lb-sec/ft^2	H, ft	Z, ft
41,000	-69.88	389.79	-56.6	216.55	0.7515	5.2781	373.30	1.764E-01	5.579E-04	2.347E-01	967.8	573.4	261.3	2.954E-07	39,025	39,098
42,000	-70.06	389.61	-56.7	216.45	0.7512	5.0304	355.78	1.681E-01	5.320E-04	2.238E-01	967.6	573.3	249.0	2.953E-07	40,023	40,100
43,000	-70.42	389.25	-56.9	216.25	0.7505	4.7944	339.09	1.602E-01	5.075E-04	2.135E-01	967.2	573.0	237.4	2.950E-07	41,021	41,102
44,000	-70.60	389.07	-57.0	216.15	0.7501	4.5694	323.18	1.527E-01	4.839E-04	2.036E-01	967.0	572.9	226.2	2.949E-07	42,018	42,103
45,000	-70.78	388.89	-57.1	216.05	0.7498	4.3550	308.01	1.455E-01	4.614E-04	1.941E-01	966.7	572.8	215.6	2.948E-07	43,015	43,104
46,000	-71.14	388.53	-57.3	215.85	0.7491	4.1506	293.56	1.387E-01	4.402E-04	1.852E-01	966.3	572.5	205.5	2.946E-07	44,010	44,103
47,000	-71.32	388.35	-57.4	215.75	0.7487	3.9558	279.78	1.322E-01	4.197E-04	1.766E-01	966.1	572.4	195.8	2.945E-07	45,005	45,102
48,000	-71.68	387.99	-57.6	215.55	0.7480	3.7702	266.65	1.260E-01	4.004E-04	1.684E-01	965.6	572.1	186.7	2.942E-07	46,000	46,102
49,000	-71.86	387.81	-57.7	215.45	0.7477	3.5933	254.14	1.201E-01	3.818E-04	1.606E-01	965.4	572.0	177.9	2.941E-07	46,994	47,100
50,000	-72.22	387.45	-57.9	215.25	0.7470	3.4246	242.21	1.145E-01	3.642E-04	1.532E-01	964.9	571.7	169.5	2.939E-07	47,987	48,097
51,000	-72.40	387.27	-58.0	215.15	0.7467	3.2639	230.85	1.091E-01	3.473E-04	1.461E-01	964.7	571.6	161.6	2.938E-07	48,979	49,094
52,000	-72.76	386.91	-58.2	214.95	0.7460	3.1108	220.01	1.040E-01	3.313E-04	1.394E-01	964.3	571.3	154.0	2.935E-07	49,971	50,091
53,000	-72.94	386.73	-58.3	214.85	0.7456	2.9648	209.69	9.909E-02	3.159E-04	1.329E-01	964.0	571.2	146.8	2.934E-07	50,962	51,087
54,000	-73.12	386.55	-58.4	214.75	0.7453	2.8257	199.85	9.444E-02	3.012E-04	1.267E-01	963.8	571.0	139.9	2.933E-07	51,953	52,083
55,000	-73.48	386.19	-58.6	214.55	0.7446	2.6931	190.47	9.000E-02	2.873E-04	1.209E-01	963.4	570.8	133.3	2.931E-07	52,942	53,077
56,000	-73.66	386.01	-58.7	214.45	0.7442	2.5667	181.53	8.578E-02	2.740E-04	1.153E-01	963.1	570.6	127.1	2.929E-07	53,932	54,072
57,000	-74.02	385.65	-58.9	214.25	0.7435	2.4462	173.01	8.176E-02	2.614E-04	1.100E-01	962.7	570.4	121.1	2.927E-07	54,920	55,065
58,000	-74.20	385.47	-59.0	214.15	0.7432	2.3314	164.89	7.792E-02	2.492E-04	1.048E-01	962.5	570.2	115.4	2.926E-07	55,908	56,058
59,000	-74.56	385.11	-59.2	213.95	0.7425	2.2220	157.16	7.426E-02	2.377E-04	1.000E-01	962.0	570.0	110.0	2.924E-07	56,895	57,050
60,000	-74.74	384.93	-59.3	213.85	0.7421	2.1178	149.78	7.078E-02	2.267E-04	9.537E-02	961.8	569.8	104.8	2.922E-07	57,882	58,043
61,000	-74.92	384.75	-59.4	213.75	0.7418	2.0184	142.75	6.746E-02	2.161E-04	9.094E-02	961.6	569.7	99.9	2.921E-07	58,868	59,034
62,000	-75.28	384.39	-59.6	213.55	0.7411	1.9237	136.05	6.429E-02	2.062E-04	8.675E-02	961.1	569.4	95.2	2.919E-07	59,852	60,024
63,000	-75.46	384.21	-59.7	213.45	0.7408	1.8334	129.67	6.127E-02	1.966E-04	8.272E-02	960.9	569.3	90.8	2.918E-07	60,837	61,015
64,000	-75.82	383.85	-59.9	213.25	0.7401	1.7474	123.58	5.840E-02	1.876E-04	7.891E-02	960.4	569.0	86.5	2.915E-07	61,821	62,004
65,000	-76.00	383.67	-60.0	213.15	0.7397	1.6654	117.78	5.566E-02	1.788E-04	7.524E-02	960.2	568.9	82.4	2.914E-07	62,804	62,993
66,000	-76.36	383.31	-60.2	212.95	0.7390	1.5872	112.26	5.305E-02	1.706E-04	7.178E-02	959.8	568.6	78.6	2.912E-07	63,787	63,982
67,000	-76.54	383.13	-60.3	212.85	0.7387	1.5128	107.00	5.056E-02	1.627E-04	6.845E-02	959.5	568.5	74.9	2.911E-07	64,768	64,969
68,000	-76.72	382.95	-60.4	212.75	0.7383	1.4420	101.99	4.819E-02	1.551E-04	6.527E-02	959.3	568.4	71.4	2.909E-07	65,750	65,958
69,000	-77.08	382.59	-60.6	212.55	0.7376	1.3746	97.22	4.594E-02	1.480E-04	6.228E-02	958.9	568.1	68.1	2.907E-07	66,730	66,944
70,000	-77.26	382.41	-60.7	212.45	0.7373	1.3104	92.68	4.380E-02	1.412E-04	5.940E-02	958.6	568.0	64.9	2.906E-07	67,710	67,930
71,000	-77.62	382.05	-60.9	212.25	0.7366	1.2494	88.36	4.175E-02	1.347E-04	5.669E-02	958.2	567.7	61.9	2.904E-07	68,690	68,917
72,000	-77.80	381.87	-61.0	212.15	0.7362	1.1912	84.25	3.981E-02	1.285E-04	5.407E-02	958.0	567.6	59.0	2.902E-07	69,668	69,901
73,000	-78.16	381.51	-61.2	211.95	0.7356	1.1358	80.33	3.796E-02	1.227E-04	5.161E-02	957.5	567.3	56.2	2.900E-07	70,646	70,886
74,000	-78.34	381.33	-61.3	211.85	0.7352	1.0831	76.60	3.620E-02	1.170E-04	4.924E-02	957.3	567.2	53.6	2.899E-07	71,623	71,869
75,000	-78.52	381.15	-61.4	211.75	0.7349	1.0329	73.05	3.452E-02	1.117E-04	4.697E-02	957.1	567.0	51.1	2.898E-07	72,600	72,853
76,000	-78.88	380.79	-61.6	211.55	0.7342	0.9851	69.67	3.292E-02	1.066E-04	4.484E-02	956.6	566.8	48.8	2.895E-07	73,576	73,836
77,000	-79.06	380.61	-61.7	211.45	0.7338	0.9395	66.45	3.140E-02	1.017E-04	4.279E-02	956.4	566.6	46.5	2.894E-07	74,551	74,818
78,000	-79.42	380.25	-61.9	211.25	0.7331	0.8961	63.38	2.995E-02	9.710E-05	4.085E-02	955.9	566.4	44.4	2.892E-07	75,525	75,799
79,000	-79.60	380.07	-62.0	211.15	0.7328	0.8548	60.46	2.857E-02	9.267E-05	3.899E-02	955.7	566.2	42.3	2.891E-07	76,500	76,781
80,000	-79.78	379.89	-62.1	211.05	0.7324	0.8154	57.67	2.725E-02	8.844E-05	3.721E-02	955.5	566.1	40.4	2.889E-07	77,473	77,761
81,000	-80.14	379.53	-62.3	210.85	0.7317	0.7779	55.02	2.600E-02	8.446E-05	3.553E-02	955.0	565.8	38.5	2.887E-07	78,446	78,742
82,000	-80.32	379.35	-62.4	210.75	0.7314	0.7422	52.49	2.481E-02	8.062E-05	3.392E-02	954.8	565.7	36.7	2.886E-07	79,419	79,722
83,000	-80.68	378.99	-62.6	210.55	0.7307	0.7082	50.09	2.367E-02	7.699E-05	3.239E-02	954.3	565.4	35.1	2.883E-07	80,388	80,699
84,000	-80.86	378.81	-62.7	210.45	0.7303	0.6757	47.79	2.258E-02	7.350E-05	3.092E-02	954.1	565.3	33.5	2.882E-07	81,353	81,671
85,000	-81.04	378.63	-62.8	210.35	0.7300	0.6448	45.61	2.155E-02	7.017E-05	2.952E-02	953.9	565.2	31.9	2.881E-07	82,312	82,638

TABLE A-III. Polar day atmosphere – Continued.

Pressure Altitude H, ft	Temperature deg F	deg R	deg C	deg K	Temperature Ratio θ	Pressure in Hg	lb/ft^2	Pressure Ratio δ	Density slugs/ft^3	Density Ratio σ	Speed of Sound ft/sec	Kts	Q/M2 lb/ft^2	Absolute Viscosity lb-sec/ft^2	Geopotential Altitude H, ft	Geometric Altitude Z, ft
86,000	-81.40	378.27	-63.0	210.15	0.7293	0.6154	43.52	2.057E-02	6.703E-05	2.820E-02	953.4	564.9	30.5	2.879E-07	83,268	83,601
86,092	-81.40	378.27	-63.0	210.15	0.7293	0.6051	42.80	2.022E-02	6.591E-05	2.773E-02	953.4	564.9	30.0	2.879E-07	83,363	83,697
87,000	-81.40	378.27	-63.0	210.15	0.7293	0.5873	41.54	1.963E-02	6.397E-05	2.691E-02	953.4	564.9	29.1	2.879E-07	84,229	84,570
88,000	-81.40	378.27	-63.0	210.15	0.7293	0.5606	39.65	1.873E-02	6.106E-05	2.569E-02	953.4	564.9	27.8	2.879E-07	85,177	85,526
89,000	-81.40	378.27	-63.0	210.15	0.7293	0.5350	37.84	1.788E-02	5.828E-05	2.452E-02	953.4	564.9	26.5	2.879E-07	86,120	86,476
90,000	-81.40	378.27	-63.0	210.15	0.7293	0.5107	36.12	1.707E-02	5.563E-05	2.340E-02	953.4	564.9	25.3	2.879E-07	87,059	87,423
91,000	-81.40	378.27	-63.0	210.15	0.7293	0.4876	34.48	1.629E-02	5.311E-05	2.234E-02	953.4	564.9	24.1	2.879E-07	87,995	88,367
92,000	-81.40	378.27	-63.0	210.15	0.7293	0.4655	32.92	1.556E-02	5.070E-05	2.133E-02	953.4	564.9	23.0	2.879E-07	88,927	89,307
93,000	-81.40	378.27	-63.0	210.15	0.7293	0.4444	31.43	1.485E-02	4.841E-05	2.037E-02	953.4	564.9	22.0	2.879E-07	89,855	90,243
94,000	-81.40	378.27	-63.0	210.15	0.7293	0.4243	30.01	1.418E-02	4.622E-05	1.944E-02	953.4	564.9	21.0	2.879E-07	90,779	91,175
95,000	-81.40	378.27	-63.0	210.15	0.7293	0.4052	28.66	1.354E-02	4.413E-05	1.857E-02	953.4	564.9	20.1	2.879E-07	91,699	92,103
96,000	-81.40	378.27	-63.0	210.15	0.7293	0.3869	27.36	1.293E-02	4.214E-05	1.773E-02	953.4	564.9	19.2	2.879E-07	92,616	93,028
97,000	-81.40	378.27	-63.0	210.15	0.7293	0.3695	26.13	1.235E-02	4.025E-05	1.693E-02	953.4	564.9	18.3	2.879E-07	93,530	93,951
98,000	-81.40	378.27	-63.0	210.15	0.7293	0.3529	24.96	1.179E-02	3.844E-05	1.617E-02	953.4	564.9	17.5	2.879E-07	94,440	94,869
99,000	-81.40	378.27	-63.0	210.15	0.7293	0.3370	23.84	1.126E-02	3.671E-05	1.544E-02	953.4	564.9	16.7	2.879E-07	95,345	95,782
100,000	-81.40	378.27	-63.0	210.15	0.7293	0.3219	22.77	1.076E-02	3.506E-05	1.475E-02	953.4	564.9	15.9	2.879E-07	96,249	96,695

TABLE A-IV. Tropical day atmosphere

Pressure Altitude	Temperature				Temperature Ratio	Pressure		Pressure Ratio	Density	Density Ratio	Speed of Sound		Q/M2	Absolute Viscosity	Geopotential Altitude	Geometric Altitude
H, ft	deg F	deg R	deg C	deg K	θ	in Hg	lb/ft^2	δ	slugs/ft^3	σ	ft/sec	Kts	lb/ft^2	lb-sec/ft^2	H, ft	Z, ft
0	89.78	549.45	32.1	305.25	1.0593	29.9212	2116.22	1.000E-00	2.244E-03	9.440E-01	1149.1	680.8	1481.3	3.919E-07	0	0
1,000	85.82	545.49	29.9	303.05	1.0517	28.8557	2040.86	9.644E-01	2.180E-03	9.170E-01	1144.9	678.4	1428.6	3.897E-07	1,058	1,058
2,000	82.04	541.71	27.8	300.95	1.0444	27.8210	1967.68	9.298E-01	2.116E-03	8.903E-01	1141.0	676.0	1377.4	3.876E-07	2,116	2,116
3,000	78.08	537.75	25.6	298.75	1.0368	26.8166	1896.64	8.962E-01	2.055E-03	8.644E-01	1136.8	673.5	1327.6	3.853E-07	3,174	3,174
4,000	74.30	533.97	23.5	296.65	1.0295	25.8418	1827.70	8.637E-01	1.994E-03	8.389E-01	1132.8	671.2	1279.4	3.832E-07	4,232	4,233
5,000	70.34	530.01	21.3	294.45	1.0219	24.8959	1760.80	8.320E-01	1.935E-03	8.142E-01	1128.6	668.7	1232.5	3.810E-07	5,289	5,290
6,000	66.56	526.23	19.2	292.35	1.0146	23.9782	1695.89	8.014E-01	1.877E-03	7.899E-01	1124.6	666.3	1187.1	3.788E-07	6,347	6,349
7,000	62.60	522.27	17.0	290.15	1.0069	23.0881	1632.94	7.716E-01	1.821E-03	7.663E-01	1120.3	663.8	1143.0	3.766E-07	7,404	7,407
8,000	58.82	518.49	14.9	288.05	0.9997	22.2249	1571.89	7.428E-01	1.766E-03	7.430E-01	1116.2	661.4	1100.3	3.744E-07	8,460	8,463
9,000	54.86	514.53	12.7	285.85	0.9920	21.3881	1512.70	7.148E-01	1.713E-03	7.206E-01	1112.0	658.8	1058.9	3.721E-07	9,517	9,521
10,000	50.90	510.57	10.5	283.65	0.9844	20.5769	1455.33	6.877E-01	1.661E-03	6.986E-01	1107.7	656.3	1018.7	3.698E-07	10,573	10,578
11,000	47.12	506.79	8.4	281.55	0.9771	19.7909	1399.74	6.614E-01	1.609E-03	6.769E-01	1103.6	653.9	979.8	3.676E-07	11,630	11,636
12,000	43.16	502.83	6.2	279.35	0.9695	19.0293	1345.87	6.360E-01	1.559E-03	6.560E-01	1099.3	651.3	942.1	3.653E-07	12,685	12,693
13,000	39.38	499.05	4.1	277.25	0.9622	18.2917	1293.70	6.113E-01	1.510E-03	6.354E-01	1095.1	648.8	905.6	3.631E-07	13,741	13,750
14,000	35.42	495.09	1.9	275.05	0.9545	17.5773	1243.18	5.875E-01	1.463E-03	6.154E-01	1090.8	646.3	870.2	3.608E-07	14,797	14,807
15,000	31.64	491.31	-0.2	272.95	0.9472	16.8858	1194.27	5.643E-01	1.416E-03	5.958E-01	1086.6	643.8	836.0	3.586E-07	15,852	15,864
16,000	27.68	487.35	-2.4	270.75	0.9396	16.2164	1146.93	5.420E-01	1.371E-03	5.768E-01	1082.2	641.2	802.8	3.563E-07	16,907	16,921
17,000	23.90	483.57	-4.5	268.65	0.9323	15.5687	1101.12	5.203E-01	1.327E-03	5.581E-01	1078.0	638.7	770.8	3.540E-07	17,962	17,977
18,000	19.94	479.61	-6.7	266.45	0.9247	14.9421	1056.80	4.994E-01	1.284E-03	5.400E-01	1073.6	636.1	739.8	3.517E-07	19,016	19,033
19,000	16.16	475.83	-8.8	264.35	0.9174	14.3360	1013.94	4.791E-01	1.241E-03	5.223E-01	1069.3	633.6	709.7	3.494E-07	20,071	20,090
20,000	12.20	471.87	-11.0	262.15	0.9098	13.7501	972.49	4.595E-01	1.201E-03	5.051E-01	1064.9	630.9	680.7	3.471E-07	21,125	21,146
21,000	8.42	468.09	-13.1	260.05	0.9025	13.1836	932.43	4.406E-01	1.160E-03	4.882E-01	1060.6	628.4	652.7	3.448E-07	22,179	22,203
22,000	4.46	464.13	-15.3	257.85	0.8948	12.6362	893.72	4.223E-01	1.122E-03	4.719E-01	1056.1	625.7	625.6	3.424E-07	23,233	23,259
23,000	0.68	460.35	-17.4	255.75	0.8876	12.1074	856.31	4.046E-01	1.084E-03	4.559E-01	1051.8	623.2	599.4	3.401E-07	24,286	24,314
24,000	-3.10	456.57	-19.5	253.65	0.8803	11.5967	820.19	3.876E-01	1.047E-03	4.403E-01	1047.5	620.6	574.1	3.378E-07	25,339	25,370
25,000	-7.06	452.61	-21.7	251.45	0.8726	11.1035	785.31	3.711E-01	1.011E-03	4.253E-01	1042.9	617.9	549.7	3.354E-07	26,392	26,425
26,000	-10.84	448.83	-23.8	249.35	0.8653	10.6274	751.64	3.552E-01	9.756E-04	4.104E-01	1038.6	615.3	526.1	3.331E-07	27,445	27,481
27,000	-14.80	444.87	-26.0	247.15	0.8577	10.1680	719.15	3.398E-01	9.417E-04	3.962E-01	1034.0	612.6	503.4	3.307E-07	28,497	28,536
28,000	-18.58	441.09	-28.1	245.05	0.8504	9.7249	687.80	3.250E-01	9.084E-04	3.822E-01	1029.6	610.0	481.5	3.284E-07	29,550	29,592
29,000	-22.54	437.13	-30.3	242.85	0.8428	9.2974	657.57	3.107E-01	8.763E-04	3.687E-01	1024.9	607.3	460.3	3.259E-07	30,062	30,105
30,000	-26.32	433.35	-32.4	240.75	0.8355	8.8854	628.43	2.970E-01	8.448E-04	3.554E-01	1020.5	604.6	439.9	3.236E-07	31,653	31,701
31,000	-30.28	429.39	-34.6	238.55	0.8279	8.4882	600.34	2.837E-01	8.145E-04	3.427E-01	1015.8	601.9	420.2	3.211E-07	32,705	32,756
32,000	-34.06	425.61	-36.7	236.45	0.8206	8.1056	573.28	2.709E-01	7.847E-04	3.301E-01	1011.3	599.2	401.3	3.187E-07	33,756	33,811
33,000	-37.84	421.83	-38.8	234.35	0.8133	7.7370	547.21	2.586E-01	7.557E-04	3.179E-01	1006.8	596.5	383.0	3.164E-07	34,807	34,865
34,000	-41.80	417.87	-41.0	232.15	0.8057	7.3821	522.11	2.467E-01	7.279E-04	3.062E-01	1002.1	593.7	365.5	3.139E-07	35,858	35,920
35,000	-45.58	414.09	-43.1	230.05	0.7984	7.0406	497.95	2.353E-01	7.005E-04	2.947E-01	997.6	591.0	348.6	3.115E-07	36,908	36,973
36,000	-49.54	410.13	-45.3	227.85	0.7907	6.7119	474.71	2.243E-01	6.743E-04	2.837E-01	992.8	588.2	332.3	3.090E-07	37,958	38,027
37,000	-53.32	406.35	-47.4	225.75	0.7834	6.3970	452.43	2.138E-01	6.486E-04	2.729E-01	988.2	585.5	316.7	3.066E-07	39,004	39,077
38,000	-57.10	402.57	-49.5	223.65	0.7762	6.0968	431.20	2.038E-01	6.240E-04	2.625E-01	983.6	582.8	301.8	3.041E-07	40,040	40,117
39,000	-60.88	398.79	-51.6	221.55	0.7689	5.8107	410.97	1.942E-01	6.004E-04	2.526E-01	979.0	580.0	287.7	3.017E-07	41,067	41,148
40,000	-64.66	395.01	-53.7	219.45	0.7616	5.5380	391.68	1.851E-01	5.777E-04	2.430E-01	974.3	577.3	274.2	2.993E-07	42,084	42,169
41,000	-68.26	391.41	-55.7	217.45	0.7546	5.2781	373.30	1.764E-01	5.556E-04	2.338E-01	969.9	574.6	261.3	2.969E-07	43,091	43,180
42,000	-72.04	387.63	-57.8	215.35	0.7474	5.0304	355.78	1.681E-01	5.347E-04	2.250E-01	965.2	571.8	249.0	2.945E-07	44,089	44,182
43,000	-75.64	384.03	-59.8	213.35	0.7404	4.7944	339.09	1.602E-01	5.144E-04	2.164E-01	960.7	569.2	237.4	2.921E-07	45,078	45,175
44,000	-79.24	380.43	-61.8	211.35	0.7335	4.5694	323.18	1.527E-01	4.949E-04	2.082E-01	956.2	566.5	226.2	2.898E-07	46,057	46,159
45,000	-82.84	376.83	-63.8	209.35	0.7265	4.3550	308.01	1.455E-01	4.762E-04	2.003E-01	951.6	563.8	215.6	2.874E-07	47,027	47,133

TABLE A-IV. Tropical day atmosphere – Continued.

Pressure Altitude H, ft	Temperature deg F	deg R	deg C	deg K	Temperature Ratio θ	Pressure in Hg	lb/ft^2	Pressure Ratio δ	Density slugs/ft^3	Density Ratio σ	Speed of Sound ft/sec	Kts	Q/M2 lb/ft^2	Absolute Viscosity lb-sec/ft^2	Geopotential Altitude H, ft	Geometric Altitude Z, ft
46,000	-86.26	373.41	-65.7	207.45	0.7199	4.1506	293.56	1.387E-01	4.580E-04	1.927E-01	947.3	561.3	205.5	2.851E-07	47,988	48,098
47,000	-89.68	369.99	-67.6	205.55	0.7133	3.9558	279.78	1.322E-01	4.405E-04	1.853E-01	942.9	558.7	195.8	2.829E-07	48,940	49,055
48,000	-93.28	366.39	-69.6	203.55	0.7064	3.7702	266.65	1.260E-01	4.240E-04	1.784E-01	938.3	556.0	186.7	2.805E-07	49,884	50,003
49,000	-96.70	362.97	-71.5	201.65	0.6998	3.5933	254.14	1.201E-01	4.079E-04	1.716E-01	934.0	553.4	177.9	2.782E-07	50,818	50,942
50,000	-100.12	359.55	-73.4	199.75	0.6932	3.4246	242.21	1.145E-01	3.924E-04	1.651E-01	929.5	550.7	169.5	2.759E-07	51,744	51,872
51,000	-103.36	356.31	-75.2	197.95	0.6870	3.2639	230.85	1.091E-01	3.774E-04	1.588E-01	925.3	548.3	161.6	2.737E-07	52,661	52,794
52,000	-106.78	352.89	-77.1	196.05	0.6804	3.1108	220.01	1.040E-01	3.632E-04	1.528E-01	920.9	545.6	154.0	2.714E-07	53,569	53,707
53,000	-110.02	349.65	-78.9	194.25	0.6741	2.9648	209.69	9.909E-02	3.494E-04	1.470E-01	916.7	543.1	146.8	2.692E-07	54,469	54,611
53,595	-112.00	347.67	-80.0	193.15	0.6703	2.8815	203.80	9.630E-02	3.415E-04	1.437E-01	914.1	541.6	142.7	2.679E-07	55,000	55,145
54,000	-111.10	348.57	-79.5	193.65	0.6720	2.8257	199.85	9.444E-02	3.340E-04	1.405E-01	915.2	542.3	139.9	2.685E-07	55,362	55,509
55,000	-108.94	350.73	-78.3	194.85	0.6762	2.6931	190.47	9.000E-02	3.164E-04	1.331E-01	918.1	543.9	133.3	2.699E-07	56,258	56,410
56,000	-106.78	352.89	-77.1	196.05	0.6804	2.5667	181.53	8.578E-02	2.997E-04	1.261E-01	920.9	545.6	127.1	2.714E-07	57,159	57,316
57,000	-104.62	355.05	-75.9	197.25	0.6845	2.4462	173.01	8.176E-02	2.839E-04	1.194E-01	923.7	547.3	121.1	2.729E-07	58,066	58,228
58,000	-102.46	357.21	-74.7	198.45	0.6887	2.3314	164.89	7.792E-02	2.689E-04	1.131E-01	926.5	548.9	115.4	2.743E-07	58,979	59,146
59,000	-100.30	359.37	-73.5	199.65	0.6929	2.2220	157.16	7.426E-02	2.548E-04	1.072E-01	929.3	550.6	110.0	2.758E-07	59,896	60,068
60,000	-97.96	361.71	-72.2	200.95	0.6974	2.1178	149.78	7.078E-02	2.412E-04	1.015E-01	932.3	552.4	104.8	2.774E-07	60,820	60,998
61,000	-95.80	363.87	-71.0	202.15	0.7015	2.0184	142.75	6.746E-02	2.285E-04	9.615E-02	935.1	554.0	99.9	2.788E-07	61,750	61,933
62,000	-93.64	366.03	-69.8	203.35	0.7057	1.9237	136.05	6.429E-02	2.165E-04	9.110E-02	937.9	555.7	95.2	2.802E-07	62,685	62,874
63,000	-91.30	368.37	-68.5	204.65	0.7102	1.8334	129.67	6.127E-02	2.051E-04	8.627E-02	940.9	557.5	90.8	2.818E-07	63,626	63,820
64,000	-88.96	370.71	-67.2	205.95	0.7147	1.7474	123.58	5.840E-02	1.942E-04	8.171E-02	943.9	559.2	86.5	2.834E-07	64,572	64,772
65,000	-86.80	372.87	-66.0	207.15	0.7189	1.6654	117.78	5.566E-02	1.840E-04	7.742E-02	946.6	560.8	82.4	2.848E-07	65,525	65,731
66,000	-84.46	375.21	-64.7	208.45	0.7234	1.5872	112.26	5.305E-02	1.743E-04	7.333E-02	949.6	562.6	78.6	2.863E-07	66,483	66,695
67,000	-82.12	377.55	-63.4	209.75	0.7279	1.5128	107.00	5.056E-02	1.651E-04	6.946E-02	952.5	564.4	74.9	2.879E-07	67,447	67,665
68,000	-79.78	379.89	-62.1	211.05	0.7324	1.4420	101.99	4.819E-02	1.564E-04	6.580E-02	955.5	566.1	71.4	2.894E-07	68,418	68,643
69,000	-77.44	382.23	-60.8	212.35	0.7369	1.3746	97.22	4.594E-02	1.482E-04	6.234E-02	958.4	567.8	68.1	2.910E-07	69,394	69,625
69,620	-76.00	383.67	-60.0	213.15	0.7397	1.3333	94.30	4.456E-02	1.432E-04	6.024E-02	960.2	568.9	66.0	2.919E-07	70,000	70,235
70,000	-75.46	384.21	-59.7	213.45	0.7408	1.3104	92.68	4.380E-02	1.405E-04	5.912E-02	960.9	569.3	64.9	2.922E-07	70,392	70,630
71,000	-74.20	385.47	-59.0	214.15	0.7432	1.2494	88.36	4.175E-02	1.335E-04	5.618E-02	962.5	570.2	61.9	2.931E-07	71,423	71,668
72,000	-72.76	386.91	-58.2	214.95	0.7460	1.1912	84.25	3.981E-02	1.269E-04	5.337E-02	964.3	571.3	59.0	2.940E-07	72,457	72,709
73,000	-71.32	388.35	-57.4	215.75	0.7487	1.1358	80.33	3.796E-02	1.205E-04	5.070E-02	966.1	572.4	56.2	2.949E-07	73,496	73,755
74,000	-70.06	389.61	-56.7	216.45	0.7512	1.0831	76.60	3.620E-02	1.145E-04	4.819E-02	967.6	573.3	53.6	2.958E-07	74,538	74,805
75,000	-68.62	391.05	-55.9	217.25	0.7539	1.0329	73.05	3.452E-02	1.088E-04	4.579E-02	969.4	574.4	51.1	2.967E-07	75,583	75,857
76,000	-67.18	392.49	-55.1	218.05	0.7567	0.9851	69.67	3.292E-02	1.034E-04	4.351E-02	971.2	575.4	48.8	2.976E-07	76,633	76,915
77,000	-65.92	393.75	-54.4	218.75	0.7592	0.9395	66.45	3.140E-02	9.831E-05	4.136E-02	972.8	576.3	46.5	2.985E-07	77,685	77,975
78,000	-64.48	395.19	-53.6	219.55	0.7619	0.8961	63.38	2.995E-02	9.343E-05	3.931E-02	974.5	577.4	44.4	2.994E-07	78,742	79,040
79,000	-63.04	396.63	-52.8	220.35	0.7647	0.8548	60.46	2.857E-02	8.880E-05	3.736E-02	976.3	578.4	42.3	3.003E-07	79,803	80,109
80,000	-61.60	398.07	-52.0	221.15	0.7675	0.8154	57.67	2.725E-02	8.440E-05	3.551E-02	978.1	579.5	40.4	3.012E-07	80,867	81,181
81,000	-60.16	399.51	-51.2	221.95	0.7703	0.7779	55.02	2.600E-02	8.023E-05	3.375E-02	979.8	580.5	38.5	3.022E-07	81,935	82,258
82,000	-58.90	400.77	-50.5	222.65	0.7727	0.7422	52.49	2.481E-02	7.631E-05	3.210E-02	981.4	581.5	36.7	3.030E-07	83,008	83,339
83,000	-57.46	402.21	-49.7	223.45	0.7755	0.7082	50.09	2.367E-02	7.255E-05	3.052E-02	983.1	582.5	35.1	3.039E-07	84,081	84,421
84,000	-56.02	403.65	-48.9	224.25	0.7782	0.6757	47.79	2.258E-02	6.898E-05	2.902E-02	984.9	583.5	33.5	3.048E-07	85,153	85,502
85,000	-54.58	405.09	-48.1	225.05	0.7810	0.6448	45.61	2.155E-02	6.559E-05	2.759E-02	986.7	584.6	31.9	3.058E-07	86,225	86,582
86,000	-53.14	406.53	-47.3	225.85	0.7838	0.6154	43.52	2.057E-02	6.237E-05	2.624E-02	988.4	585.6	30.5	3.067E-07	87,296	87,662
87,000	-51.70	407.97	-46.5	226.65	0.7866	0.5873	41.54	1.963E-02	5.931E-05	2.495E-02	990.2	586.7	29.1	3.076E-07	88,367	88,742
88,000	-50.26	409.41	-45.7	227.45	0.7893	0.5606	39.65	1.873E-02	5.641E-05	2.373E-02	991.9	587.7	27.8	3.085E-07	89,437	89,822
89,000	-49.00	410.67	-45.0	228.15	0.7918	0.5350	37.84	1.788E-02	5.368E-05	2.258E-02	993.4	588.6	26.5	3.093E-07	90,506	90,900
90,000	-47.56	412.11	-44.2	228.95	0.7946	0.5107	36.12	1.707E-02	5.106E-05	2.148E-02	995.2	589.6	25.3	3.102E-07	91,574	91,977

TABLE A-IV. Tropical day atmosphere – Continued.

Pressure Altitude H, ft	Temperature deg F	deg R	deg C	deg K	Temperature Ratio θ	Pressure in Hg	lb/ft²	Pressure Ratio δ	Density slugs/ft³	Density Ratio σ	Speed of Sound ft/sec	Kts	Q/M2 lb/ft²	Absolute Viscosity lb-sec/ft²	Geopotential Altitude H, ft	Geometric Altitude Z, ft
91,000	-46.12	413.55	-43.4	229.75	0.7973	0.4876	34.48	1.629E-02	4.858E-05	2.044E-02	996.9	590.6	24.1	3.111E-07	92,642	93,055
92,000	-44.68	414.99	-42.6	230.55	0.8001	0.4655	32.92	1.556E-02	4.621E-05	1.944E-02	998.6	591.7	23.0	3.121E-07	93,708	94,130
93,000	-43.24	416.43	-41.8	231.35	0.8029	0.4444	31.43	1.485E-02	4.397E-05	1.850E-02	1000.4	592.7	22.0	3.130E-07	94,775	95,207
94,000	-41.98	417.69	-41.1	232.05	0.8053	0.4243	30.01	1.418E-02	4.186E-05	1.761E-02	1001.9	593.6	21.0	3.138E-07	95,841	96,283
95,000	-40.54	419.13	-40.3	232.85	0.8081	0.4052	28.66	1.354E-02	3.983E-05	1.676E-02	1003.6	594.6	20.1	3.147E-07	96,905	97,357
96,000	-39.10	420.57	-39.5	233.65	0.8109	0.3869	27.36	1.293E-02	3.790E-05	1.595E-02	1005.3	595.6	19.2	3.156E-07	97,970	98,432
97,000	-37.66	422.01	-38.7	234.45	0.8136	0.3695	26.13	1.235E-02	3.607E-05	1.518E-02	1007.1	596.7	18.3	3.165E-07	99,033	99,505
98,000	-36.22	423.45	-37.9	235.25	0.8164	0.3529	24.96	1.179E-02	3.433E-05	1.445E-02	1008.8	597.7	17.5	3.174E-07	100,096	100,578
99,000	-34.78	424.89	-37.1	236.05	0.8192	0.3370	23.84	1.126E-02	3.268E-05	1.375E-02	1010.5	598.7	16.7	3.183E-07	101,159	101,651
100,000	-33.52	426.15	-36.4	236.75	0.8216	0.3219	22.77	1.076E-02	3.112E-05	1.309E-02	1012.0	599.6	15.9	3.191E-07	102,219	102,722

TABLE A-V. Hot day atmosphere for takeoff and ground operations

Pressure Altitude	Temperature				Temperature Ratio	Pressure		Pressure Ratio	Density	Density Ratio	Speed of Sound		Q/M2	Absolute Viscosity	Geopotential Altitude	Geometric Altitude
H, ft	deg F	deg R	deg C	deg K	θ	in Hg	lb/ft²	δ	slugs/ft³	σ	ft/sec	Kts	lb/ft²	lb-sec/ft²	H, ft	Z, ft
0	102.92	562.59	39.40	312.55	1.0847	29.9212	2116.22	1.0000	2.191E-03	0.9219	1162.8	688.9	1481.3	3.992E-07	0	0
1,000	99.14	558.81	37.30	310.45	1.0774	28.8557	2040.86	0.9644	2.128E-03	0.8951	1158.8	686.6	1428.6	3.971E-07	1,000	1,000
2,000	95.36	555.03	35.20	308.35	1.0701	27.8210	1967.68	0.9298	2.065E-03	0.8689	1154.9	684.3	1377.4	3.950E-07	2,100	2,100
3,000	91.58	551.25	33.10	306.25	1.0628	26.8166	1896.64	0.8962	2.004E-03	0.8433	1151.0	681.9	1327.6	3.929E-07	3,100	3,100
4,000	87.62	547.29	30.90	304.05	1.0552	25.8418	1827.70	0.8637	1.945E-03	0.8185	1146.8	679.5	1279.4	3.907E0-7	4,200	4,201
5,000	83.66	543.33	28.70	301.85	1.0475	24.8959	1760.80	0.8320	1.888E-03	0.7943	1142.7	677.0	1232.5	3.885E-07	5,200	5,201
6,000	79.70	539.37	26.50	299.65	1.0399	23.9782	1695.89	0.8014	1.832E-03	0.7706	1138.5	674.5	1187.1	3.863E-07	6,300	6,302
7,000	75.74	535.41	24.30	297.45	1.0323	23.0881	1632.94	0.7716	1.777E-03	0.7475	1134.3	672.1	1143.0	3.840E-07	7,400	7,403
8,000	71.78	531.45	22.10	295.25	1.0246	22.2249	1571.89	0.7428	1.723E-03	0.7249	1130.1	669.6	1100.3	3.818E-07	8,400	8,403
9,000	67.82	527.49	19.90	293.05	1.0170	21.3881	1512.70	0.7148	1.671E-03	0.7029	1125.9	667.1	1058.9	3.795E-07	9,500	9,504
10,000	63.86	523.53	17.70	290.85	1.0094	20.5769	1455.33	0.6877	1.619E-03	0.6813	1121.7	664.6	1018.7	3.773E-07	10,600	10,605
11,000	60.26	519.93	15.70	288.85	1.0024	19.7909	1399.74	0.6614	1.568E-03	0.6598	1117.8	662.3	979.8	3.752E-07	11,600	11,606
12,000	56.48	516.15	13.60	286.75	0.9951	19.0293	1345.87	0.6360	1.519E-03	0.6391	1113.7	659.9	942.1	3.731E-07	12,600	12,608
13,000	52.52	512.19	11.40	284.55	0.9875	18.2917	1293.70	0.6113	1.471E-03	0.6191	1109.4	657.3	905.6	3.708E-07	13,600	13,609
14,000	48.74	508.41	9.30	282.45	0.9802	17.5773	1243.18	0.5875	1.424E-03	0.5993	1105.3	654.9	870.2	3.686E-07	14,700	14,710
15,000	44.96	504.63	7.20	280.35	0.9729	16.8858	1194.27	0.5643	1.379E-03	0.5800	1101.2	652.5	836.0	3.664E-07	15,700	15,712

APPENDIX B

MISSION PROFILES

B.1 SCOPE

B.1.1 Scope. This appendix contains mission profiles to be used to compute the mission capability of military air vehicles. Profiles are presented for a variety of missions for each type air vehicle. A list of these missions, by air vehicle type, is included. The primary use of these profiles is to provide the framework for the comparison of the capabilities of different air vehicles which perform the same mission. All times and distances have been specified except for the segment (or segments) which provides the variability needed to maximize the parameter of interest (radius, range, loiter time, etc.). The variable parameter/segment for each of these profiles has been shaded ( ) to make it easy to recognize. Wherever the distance for a cruise leg has been specified, it includes the climb distance for any preceding or following climbs. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

B.2 APPLICABLE DOCUMENTS. This section is not applicable to this appendix.

B.3 MISSION PROFILES SPECIFIC TO AIR VEHICLE TYPE. Table B-I contains a list of air vehicle types, the missions normally performed by them, and the profile appropriate to each mission. Also included is a list of comments that describes unique features of the profiles.

B.3.1 Mission profiles. Figures B-1 through B-40 contain profiles to be used for each mission for the various air vehicle types. Some mission profiles are further identified by the altitudes at which the different segments (cruise, penetration/egress, combat) are flown: three-segment names being, "outbound cruise-combat-return cruise"; and four-segment names being, "outbound cruise-penetration-egress-return cruise". The term, "combat" is used in these mission profiles to define the mission mid-point task which is the reason for the mission. Combat is defined for each air vehicle type in table B-I if more information is needed than is provided in 4.2.5 in the basic section of this standard.

Parameters for climb and cruise segments of these profiles are defined to produce the maximum range/radius. Even though missions may not normally be flown at these optimum conditions, missions calculated with these ground rules provide the maximum that can be expected of an air vehicle, and provide an achievable estimate of maximum capability early in a development program before operational constraints are defined. All descents are modelled with the cruise segment continued to the range which would be the end of the descent segment, with descent becoming a non-segment consisting of zero time, distance, and fuel. The mission profiles can be tailored to more operationally-realistic conditions when the appropriate parameters are redefined. Minimum time climb-speed schedules can be replaced with operational schedules; cruise may be flown at constant altitude or as a step climb; descents may be modelled with operationally realistic parameters; etc. All radius missions are modelled as equal-length outbound and return legs with takeoff and landing at the same point. Operational missions may sometimes require unequal length legs with different takeoff and landing locations. ***The takeoff fuel allowance and landing fuel reserves shown on these example profiles are for land-based operations. Takeoff power setting will comply with launch requirements when carrier-based mission performance is calculated. Refer to 4.2.9.2, in the basic section of this standard, for landing reserves. In addition, the acceleration to climb-speed after launch from a carrier starts at Mach 0.3 instead of obstacle speed.***

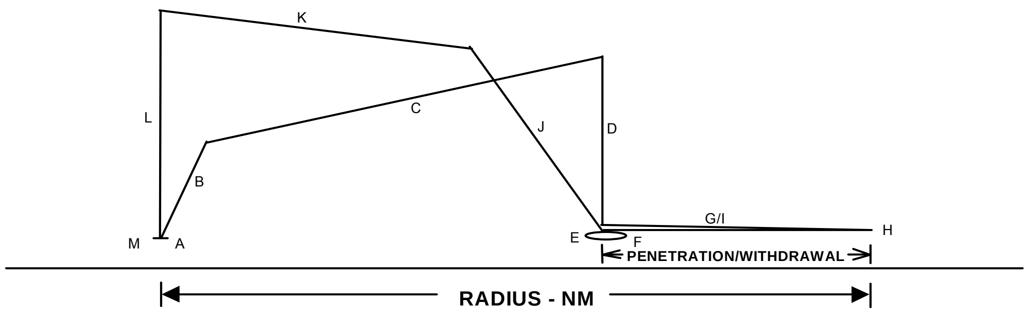
For each profile, all independent variables except one are defined. Warm-up and takeoff fuel, reserves, penetration and egress speeds and altitudes, etc., have been quantified for each specific mission application. The undefined variable for most missions is cruise distance, but for some missions it is loiter time, combat time, or penetration/ withdrawal distance. All values for the parameters in the mission profiles are for guidance only and other values may be used when appropriate. The important point is that when the capability of two or more air vehicles to perform the same mission is compared, care must be taken to ensure the comparison is made to identical mission rules. Also, if the comparison includes different kinds of air vehicles (VTOL versus STOL versus conventional, carrier versus land-based, etc.), the mission rules appropriate to each kind of air vehicle should be used.

TABLE B-I. Mission profiles specific to air vehicle type

AIR VEHICLE TYPE	MISSION	PROFILE	VARIATIONS/COMMENTS
ATTACK			
	CLOSE AIR SUPPORT (CAS)	FIG. B-1 LONG RANGE	Combat consists of dropping/launching onboard weapons.
	CLOSE AIR SUPPORT (CAS)	FIG. B-2 SHORT RANGE	Combat consists of dropping/launching onboard weapons.
	INTERDICTION	FIG. B-3 (LO-LO-LO-LO)	Combat consists of dropping/launching onboard weapons.
	INTERDICTION	FIG. B-4 (LO-LO-LO-HI)	Combat consists of dropping/launching onboard weapons.
	INTERDICTION	FIG. B-5 (HI-LO-LO-HI)	Combat consists of dropping/launching onboard weapons.
	INTERDICTION	FIG. B-6 (HI-MED-MED-HI)	Combat consists of dropping/launching onboard weapons.
	INTERDICTION	FIG. B-7 (HI-HI-HI-HI)	Combat consists of dropping/launching onboard weapons.
	MULTI-ROLE SELF ESCORT INTERDICTION (HI-MED-MED-HI)	FIG. B-8	Combat consists of dropping/launching onboard weapons.
	SURFACE COMBAT AIR PATROL (SUCAP)	FIG. B- 9	SUCAP is the same mission profile as the combat air patrol mission for fighters. Weapons loading consists of air-to-ground weapons instead of air-to-air for the fighters.
	SUPPRESSION OF ENEMY AIR DEFENSES (SEAD)	FIG. B-10	SEAD is the same mission profile as the interdiction mission (FIG. B-6), but weapons will be tailored to a different target set.
BOMBER			
	HIGH LEVEL	FIG. B-11 (HI-HI-HI)	Combat consists of dropping/launching onboard weapons.
	LOW-LEVEL PENETRATION	FIG. B-12 (HI-LO-LO-HI)	Combat consists of dropping/launching onboard weapons.
	MEDIUM-LEVEL PENETRATION	FIG. B-13 (HI-MED-MED-HI)	Combat consists of dropping/launching onboard weapons.
	HIGH-LEVEL PENETRATION	FIG. B-14 (HI-HI-HI-HI)	Combat consists of dropping/launching onboard weapons.
CARGO/ TRANSPORT			
	AIR DROP/ASSAULT TRANSPORT	FIG. B-15 (HI-LO-LO-HI)	
	SUPPLY - RADIUS	FIG. B-16 (HI-LO-HI)	
	SUPPLY - RANGE	FIG. B-17	
ELECTRONIC WARFARE			
	AIRBORNE WARNING AND CONTROL (AWACS)	FIG. B-18	
	SPECIAL ELECTRONICS MISSIONS		
	- CORPS	FIG. B-19	
	- DIVISION	FIG. B-20	

TABLE B-I. Mission profiles specific to air vehicle type – Continued

AIR VEHICLE TYPE	MISSION	PROFILE	VARIATIONS/COMMENTS
FIGHTER			
	COMBAT AIR PATROL (CAP)	FIG. B-21	Combat consists of air-to-air fighting.
	INTERCEPT	FIG. B-22 SUBSONIC INTERCEPT	Combat consists of air-to-air fighting.
	INTERCEPT	FIG. B-23 SUPERSONIC INTERCEPT	Combat consists of air-to-air fighting.
	MEDIUM ALTITUDE FIGHTER SWEEP	FIG. B-24 (HI-MED-HI)	Combat consists of air-to-air fighting.
	HIGH ALTITUDE FIGHTER SWEEP	FIG. B-25 (HI-HI-HI-HI)	Combat consists of air-to-air fighting.
RECONNAISSANCE			
	LOW-LEVEL PENETRATION	FIG. B-26 (HI-LO-LO-HI)	
	HIGH-LEVEL PENETRATION	FIG. B-27 (HI-HI-HI-HI)	
TANKER			
	BUDDY REFUEL	FIG. B-28	
	RENDEZVOUS REFUEL	FIG. B-29	
	RENDEZVOUS REFUEL - NAVY	FIG. B-30	
TRAINER			
	BASIC - FAMILIARIZATION	FIG. B-31	
	BASIC - TASK FAMILIARIZATION	FIG. B-32	
	BASIC - LOW-LEVEL NAVIGATION	FIG. B-33	
	BASIC - HIGH-LEVEL NAVIGATION	FIG. B-34	
	ADVANCED - WEAPONS DELIVERY	FIG. B-35	
	ADVANCED - AIR COMBAT MANEUVERING	FIG. B-36	
MISCELLANEOUS			
	FORWARD AIR CONTROL (FAC)	FIG. B-37	Combat consists of two segments: loiter for a specified period, and weapon drop/launch.
	PATROL/ANTI-SUBMARINE WARFARE (ASW)	FIG. B-38	Combat consists of a variable number or loiter segments, each flown at a lower altitude than the previous.
	MINELAYING	FIG. B-39	Combat consists of jettisoning mines.
	FERRY	FIG. B-40	



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING (1)
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (4)	TAKEOFF TO OPTIMUM CRUISE	INTERMEDIATE
C	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LOITER	
E	LOITER (PARA 4.2.6) (5)		10 MINUTES	NO CREDIT	INSTANTANEOUS CORNER SPEED	2000 FEET PRESS. ALT.	
F	ACCELERATE				LOITER TO PENETRATION	2000 FEET PRESS. ALT.	MAXIMUM/INTERMEDIATE
G	PENETRATION (PARA 4.2.4)			30 NM INCLUDING ACCEL	0.8 MACH OR Virt WHICHEVER IS LOWER	2000 FEET PRESS. ALT.	
H	COMBAT (2) and (3)	ONE 2000 FT ENERGY EXCHANGE PLUS ONE 180 DEG TURN @ (Virt - 50 KTAS) WITH MAX SUSTAINED G's @ MAXIMUM/MAXIMUM A/B. (1) EXPEND HALF OF AIR-TO-GROUND STORES. NO DISTANCE CREDIT.					
I	WITHDRAWAL (PARA 4.2.4)			30 NM	0.8 MACH OR Virt WHICHEVER IS LOWER	2000 FEET PRESS. ALT.	
J	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (4)	2000 FEET PRESS ALT. TO OPTIMUM CRUISE	INTERMEDIATE
K	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
L	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
M	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	

NOTES: (1) THRUST SETTINGS ARE NON-AUGMENTED/AUGMENTED. (SEE PARA 3.11.3.2.)

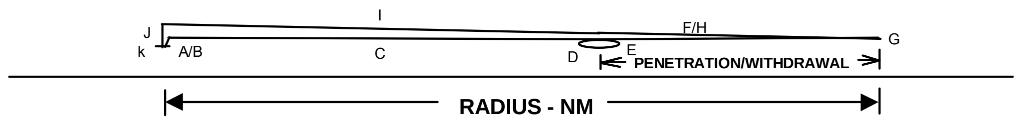
(2) SEE PARA 4.1.5 AND 4.1.7.

(3) INCLUDE ACCELERATION FUEL IF COMBAT SPEED IS GREATER THAN PENETRATION SPEED.

(4) CLIMB SCHEDULE ENDS AT OPTIMUM CRUISE SPEED/ALTITUDE.

(5) REPEAT SEGMENTS E THROUGH I ONCE. SECOND LOITER IS 5 MINUTES.

FIGURE B-1. Close air support (CAS) - long range



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING (1)
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB				MINIMUM TIME CLIMB SCHEDULE	TAKEOFF TO 2000 FEET PRESS ALT.	MAX CONTINUOUS/ INTERMEDIATE
C	CRUISE (PARA 4.2.3)				MAXIMUM RANGE CRUISE	2000 FEET PRESS ALT.	
D	LOITER (PARA 4.2.6) (4)		10 MINUTES	NO CREDIT	INSTANTANEOUS CORNER SPEED	2000 FEET PRESS ALT.	
E	ACCELERATE				LOITER TO PENETRATION	2000 FEET PRESS ALT.	MAXIMUM/INTERMEDIATE
F	PENETRATION (PARA 4.2.4)			30 NM INCLUDING ACCEL	0.8 MACH OR Virt WHICHEVER IS LOWER	2000 FEET PRESS ALT.	
G	COMBAT (2) AND (3)	ONE 2000 FT ENERGY EXCHANGE PLUS ONE 180 DEG TURN @ (Virt - 50 KTAS) WITH MAX SUSTAINED G's @ MAXIMUM/MAXIMUM A/B. (1) EXPEND HALF OF AIR-TO-GROUND STORES. NO DISTANCE CREDIT.					
H	WITHDRAWAL (PARA 4.2.4)			30 NM INCLUDING ACCEL	0.8 MACH OR Virt WHICHEVER IS LOWER	2000 FEET PRESS ALT.	
I	CRUISE (PARA 4.2.3)				MAXIMUM RANGE CRUISE	2000 FEET PRESS ALT.	
J	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		2000 FEET PRESS ALT. TO LANDING	
K	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
L							

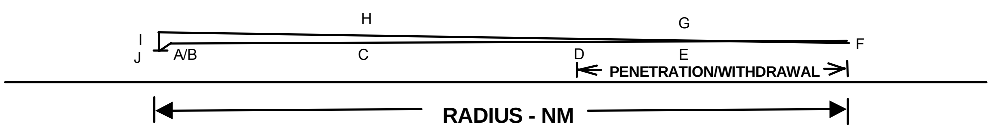
NOTES: (1) THRUST SETTINGS ARE NON-AUGMENTED/AUGMENTED. (SEE PARA 3.11.3.2.)

(2) SEE PARA 4.1.5 AND 4.1.7.

(3) INCLUDE ACCELERATION FUEL IF COMBAT SPEED IS GREATER THAN PENETRATION SPEED.

(4) REPEAT SEGMENTS D THROUGH H ONCE. SECOND LOITER IS 5 MINUTES.

FIGURE B-2. Close air support (CAS) - short range



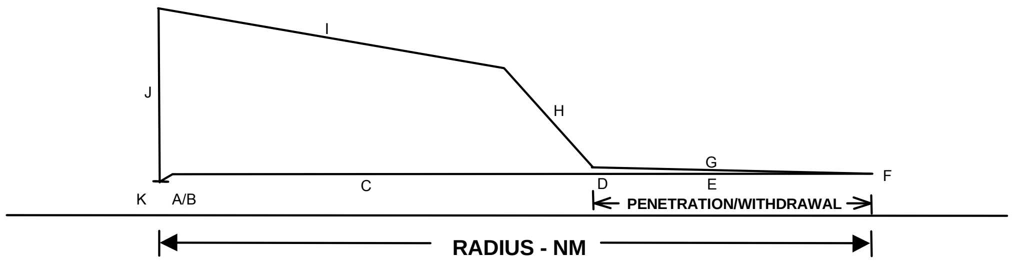
	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING (1)
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE	TAKEOFF TO 2000 FEET PRESS ALT.	INTERMEDIATE
C	CRUISE (PARA 4.2.3)				MAXIMUM RANGE CRUISE	2000 FEET PRESS ALT.	
D	ACCELERATE				CRUISE TO PENETRATION	2000 FEET PRESS ALT.	MAXIMUM/INTERMEDIATE
E	PENETRATION (PARA 4.2.4)			50 NM INCLUDING ACCEL	0.8 MACH OR Virt WHICHEVER IS LOWER	2000 FEET PRESS ALT.	
F	COMBAT (2) AND (3)	ONE 2000 FT ENERGY EXCHANGE PLUS ONE 180 DEG TURN @ (Virt - 50 KTAS) WITH MAX SUSTAINED G's @ MAXIMUM/MAXIMUM A/B. (1) EXPEND AIR-TO-GROUND STORES. NO DISTANCE CREDIT.					
G	WITHDRAWAL (PARA 4.2.4)			50 NM INCLUDING ACCEL	0.8 MACH OR Virt WHICHEVER IS LOWER	2000 FEET PRESS ALT.	
H	CRUISE (PARA 4.2.3)				MAXIMUM RANGE CRUISE	2000 FEET PRESS ALT.	
I	DESCENT (PARA4.2.8)	NONE	NONE	NO CREDIT		2000 FEET PRESS ALT. TO LANDING	
J	RESERVES (PARA 4.2.9)	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
K							
L							

NOTES: (1) THRUST SETTINGS ARE NON-AUGMENTED/AUGMENTED. (SEE PARA 3.11.3.2.)

(2) SEE PARA 4.1.5 AND 4.1.7.

(3) INCLUDE ACCELERATION FUEL IF COMBAT SPEED IS GREATER THAN PENETRATION SPEED.

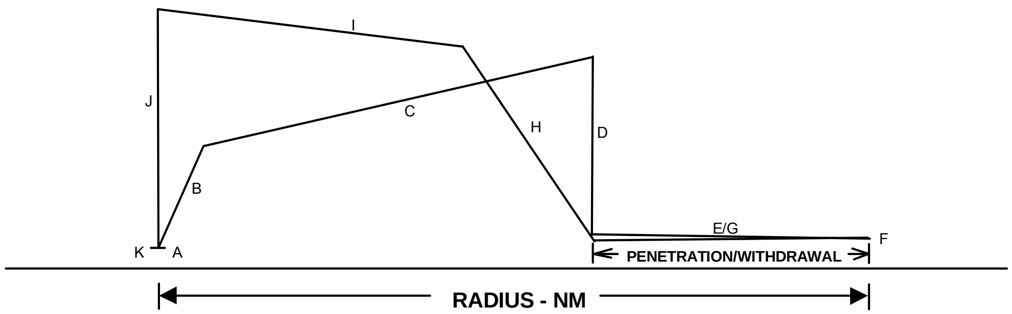
FIGURE B-3. Interdiction (LO-LO-LO-LO)



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING (1)
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE	TAKEOFF TO 2000 FEET PRESS ALT.	INTERMEDIATE
C	CRUISE (PARA 4.2.3)				MAXIMUM RANGE CRUISE	2000 FEET PRESS ALT.	
D	ACCELERATE				CRUISE TO PENETRATION	2000 FEET PRESS ALT.	MAXIMUM/ INTERMEDIATE
E	PENETRATION (PARA 4.2.4)			50 NM INCLUDING ACCEL	0.8 MACH OR Virt WHICHEVER IS LOWER	2000 FEET PRESS ALT.	
F	COMBAT (2) AND (3)	ONE 2000 FT ENERGY EXCHANGE PLUS ONE 180 DEG TURN @ (Virt - 50 KTAS) WITH MAX SUSTAINED G's @ MAXIMUM/MAXIMUM A/B. (1) EXPEND AIR-TO-GROUND STORES. NO DISTANCE CREDIT.					
G	WITHDRAWAL (PARA 4.2.4)			50 NM INCLUDING ACCEL	0.8 MACH OR Virt WHICHEVER IS LOWER	2000 FEET PRESS ALT.	
H	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (4)	2000 FEET PRESS ALT. TO OPTIMUM CRUISE	INTERMEDIATE
I	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
J	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
K	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
L							

NOTES:
(1) THRUST SETTINGS ARE NON-AUGMENTED/AUGMENTED. (SEE PARA 3.11.3.2.)
(2) SEE PARA 4.1.5 AND 4.1.7.
(3) INCLUDE ACCELERATION FUEL IF COMBAT SPEED IS GREATER THAN PENETRATION SPEED.
(4) CLIMB SCHEDULE ENDS AT OPTIMUM CRUISE SPEED/ALTITUDE.

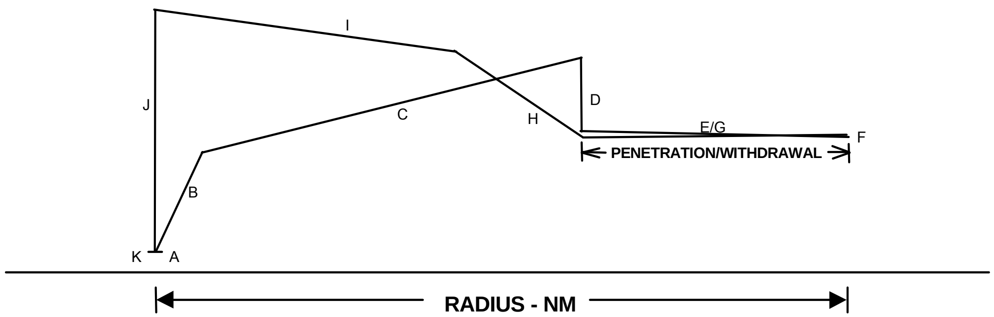
FIGURE B-4. Interdiction (LO-LO-LO-HI)



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (3)	TAKEOFF TO OPTIMUM CRUISE	INTERMEDIATE
C	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO 2000 FEET PRESS ALT.	
E	PENETRATION (PARA 4.2.4)			50 NM	0.8 MACH OR Virt WHICHEVER IS LOWER	2000 FEET PRESS ALT.	
F	COMBAT (1) AND (2)	ONE 2000 FT ENERGY EXCHANGE PLUS ONE 180 DEG TURN @ (Virt - 50 KTAS) WITH MAX SUSTAINED G's @ MAXIMUM/MAXIMUM A/B. (4) EXPEND AIR-TO-GROUND STORES. NO DISTANCE CREDIT.					
G	WITHDRAWAL (PARA 4.2.4)			50 NM INCLUDING ACCEL	0.8 MACH OR Virt WHICHEVER IS LOWER	2000 FEET PRESS ALT.	
H	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (3)	2000 FEET PRESS ALT. TO OPTIMUM CRUISE	INTERMEDIATE
I	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
J	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
K	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
L							

NOTES:
(1) SEE PARA 4.1.5 AND 4.1.7.
(2) INCLUDE ACCELERATION FUEL IF COMBAT SPEED IS GREATER THAN PENETRATION SPEED.
(3) CLIMB SCHEDULE ENDS AT OPTIMUM CRUISE SPEED/ALTITUDE.
(4) THRUST SETTINGS ARE NON-AUGMENTED/AUGMENTED. (SEE PARA 3.11.3.2.)

FIGURE B-5. Interdiction (HI-LO-LO-HI)



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (3)	TAKEOFF TO OPTIMUM CRUISE	INTERMEDIATE
C	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO 20,000 FEET PRESS ALT.	
E	PENETRATION (PARA 4.2.4)			50 NM	540 KTAS OR Virt WHICHEVER IS LOWER	20,000 FEET PRESS ALT.	
F	COMBAT (1), (2)	ONE 180 DEG TURN @ (Virt - 50 KTAS) WITH MAX SUSTAINED G's @ MAXIMUM/MAXIMUM A/B. (4) EXPEND AIR-TO-GROUND STORES. NO DISTANCE CREDIT.					
G	WITHDRAWAL (PARA 4.2.4)			50 NM INCLUDING ACCEL	540 KTAS OR Virt WHICHEVER IS LOWER	20,000 FEET PRESS ALT.	
H	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (3)	20,000 FEET PRESS ALT. TO OPTIMUM CRUISE	INTERMEDIATE
I	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
J	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
K	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
L							

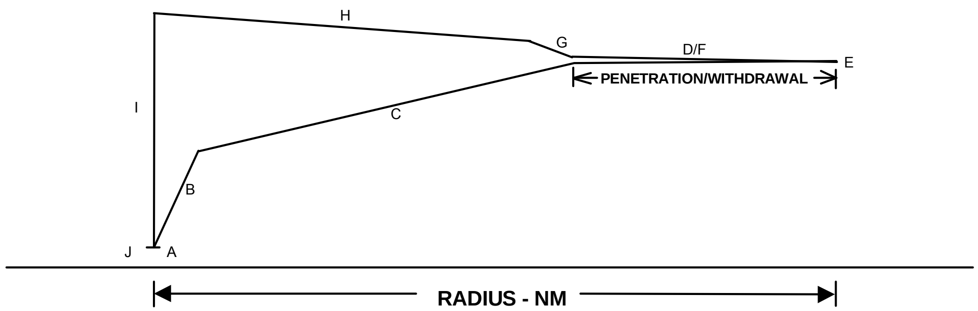
NOTES: (1) SEE PARA 4.1.5 AND 4.1.7.

(2) INCLUDE ACCELERATION FUEL IF COMBAT SPEED IS GREATER THAN PENETRATION SPEED.

(3) CLIMB SCHEDULE ENDS AT OPTIMUM CRUISE SPEED/ALTITUDE.

(4) THRUST SETTINGS ARE NON-AUGMENTED/AUGMENTED. (SEE PARA 3.11.3.2.)

FIGURE B-6. Interdiction (HI-MED-MED-HI)



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING (1)
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (4)	TAKEOFF TO OPTIMUM CRUISE	INTERMEDIATE
C	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
D	ACCELERATE				CRUISE TO PENETRATION	END CRUISE ALT.	MAXIMUM/ INTERMEDIATE
E	PENETRATION (PARA 4.2.4)			50 NM	540 KTAS OR Virt WHICHEVER IS LOWER	END CRUISE ALT.	
F	COMBAT (2) AND (3)	ONE 180 DEG TURN @ (Virt - 50 KTAS) WITH MAX SUSTAINED G's @ MAXIMUM/MAXIMUM A/B. (1) EXPEND AIR-TO-GROUND STORES. NO DISTANCE CREDIT.					
G	WITHDRAWAL (PARA 4.2.4)			50 NM INCLUDING ACCEL	540 KTAS OR Virt WHICHEVER IS LOWER	END CRUISE ALT.	
H	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (4)	WITHDRAWAL ALT.TO OPTIMUM CRUISE	INTERMEDIATE
I	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
J	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
K	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
L							

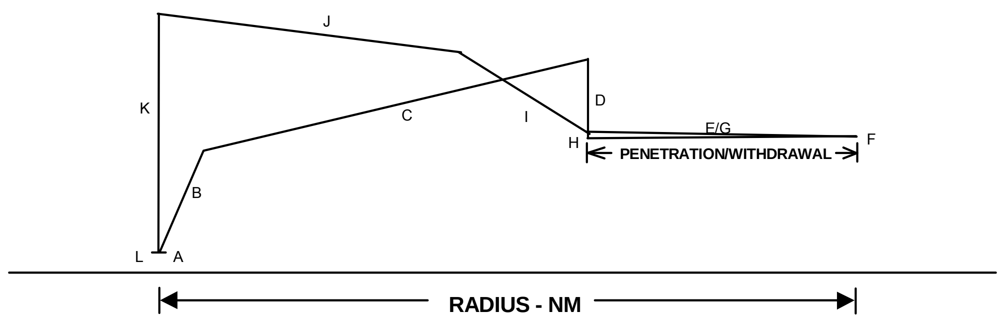
NOTES: (1) THRUST SETTNGS ARE NON-AUGMENTED/AUGMENTED. (SEE PARA 3.11.3.2.)

(2) SEE PARA 4.1.5 AND 4.1.7.

(3) INCLUDE ACCELERATION FUEL IF COMBAT SPEED IS GREATER THAN PENETRATION SPEED.

(4) CLIMB SCHEDULE ENDS AT OPTIMUM CRUISE SPEED/ALTITUDE.

FIGURE B-7. Interdiction (HI-HI-HI-HI)



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (3)	TAKEOFF TO OPTIMUM CRUISE	INTERMEDIATE
C	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO 20,000 FEET PRESS ALT.	
E	PENETRATION (PARA 4.2.4)			50 NM	540 KTAS OR Virt WHICHEVER IS LOWER	20,000 FEET PRESS ALT.	
F	COMBAT (1) AND (2)	ONE 180 DEG TURN @ (Virt - 50 KTAS) WITH MAX SUSTAINED G's @ MAXIMUM/MAXIMUM A/B. (4) EXPEND AIR-TO-GROUND STORES. NO DISTANCE CREDIT.					
G	WITHDRAWAL (PARA 4.2.4)			50 NM INCLUDING ACCEL	540 KTAS OR Virt WHICHEVER IS LOWER	20,000 FEET PRESS ALT.	
H	COMBAT (1)	ONE 360 DEG TURN @ 540 KTAS WITH MAX SUSTAINED G's @ MAXIMUM/MAXIMUM A/B. (4) LAUNCH AIR-TO-AIR MISSILES. NO DISTANCE CREDIT.					
I	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (3)	20,000 FEET PRESS ALT. TO OPTIMUM CRUISE	INTERMEDIATE
J	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
K	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
L	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	

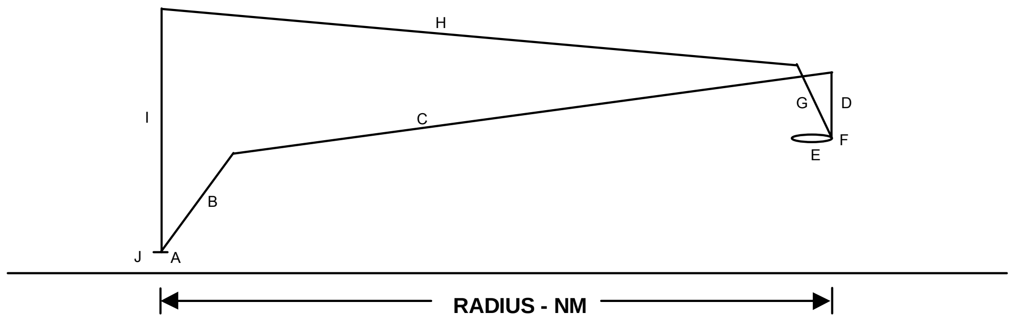
NOTES: (1) SEE PARA 4.1.5 AND 4.1.7.

(2) INCLUDE ACCELERATION FUEL IF COMBAT SPEED IS GREATER THAN PENETRATION SPEED.

(3) CLIMB SCHEDULE ENDS AT OPTIMUM CRUISE SPEED/ALTITUDE.

(4) THRUST SETTINGS ARE NON-AUGMENTED/AUGMENTED. (SEE PARA 3.11.3.2.)

FIGURE B-8. Multi-role self escort interdiction (HI-MED-MED-HI)

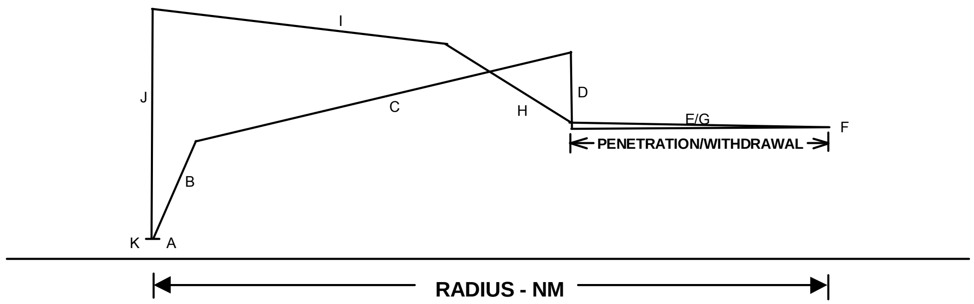


	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (2)	TAKEOFF TO OPTIMUM CRUISE	INTERMEDIATE
C	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO 20,000 FT PRESS. ALT.	
E	LOITER (PARA 4.2.6)			NO CREDIT	COMBAT LOITER	20,000 FT PRESS. ALT.	
F	COMBAT (1)	EXPEND AIR-TO-GROUND STORES. NO DISTANCE CREDIT.					
G	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (2)	20,000 FT PRESS. ALT. TO OPTIMUM CRUISE	INTERMEDIATE
H	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
I	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
J	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
K							
L							

NOTES: (1) SEE PARA 4.1.5 AND 4.1.7.

(2) CLIMB SCHEDULE ENDS AT OPTIMUM CRUISE SPEED ALTITUDE.

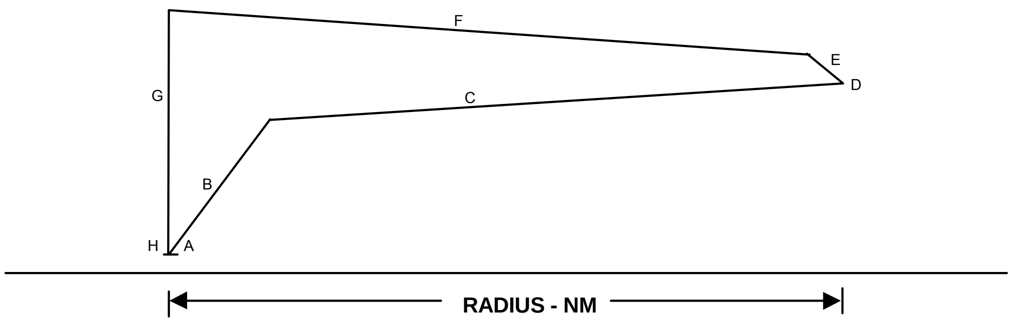
FIGURE B-9. Surface combat air patrol (SUCAP)



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (3)	TAKEOFF TO OPTIMUM CRUISE	INTERMEDIATE
C	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO 20,000 FEET PRESS ALT.	
E	PENETRATION (PARA 4.2.4)			50 NM	540 KTAS OR Virt WHICHEVER IS LOWER	20,000 FEET PRESS ALT.	
F	COMBAT (1) AND (2)	ONE 180 DEG TURN @ (Virt - 50 KTAS) WITH MAX SUSTAINED G's @ MAXIMUM/MAXIMUM A/B. (4) EXPEND AIR-TO-GROUND STORES. NO DISTANCE CREDIT.					
G	WITHDRAWAL (PARA 4.2.4)			50 NM INCLUDING ACCEL	540 KTAS OR Virt WHICHEVER IS LOWER	20,000 FEET PRESS ALT.	
H	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (3)	20,000 FEET PRESS ALT. TO OPTIMUM CRUISE	INTERMEDIATE
I	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
J	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
K	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
L							

NOTES: (1) SEE PARA 4.1.5 AND 4.1.7.
(2) INCLUDE ACCELERATION FUEL IF COMBAT SPEED IS GREATER THAN PENETRATION SPEED.
(3) CLIMB SCHEDULE ENDS AT OPTIMUM CRUISE SPEED/ALTITUDE.
(4) THRUST SETTINGS ARE NON-AUGMENTED/AUGMENTED. (SEE PARA 3.11.3.2.)

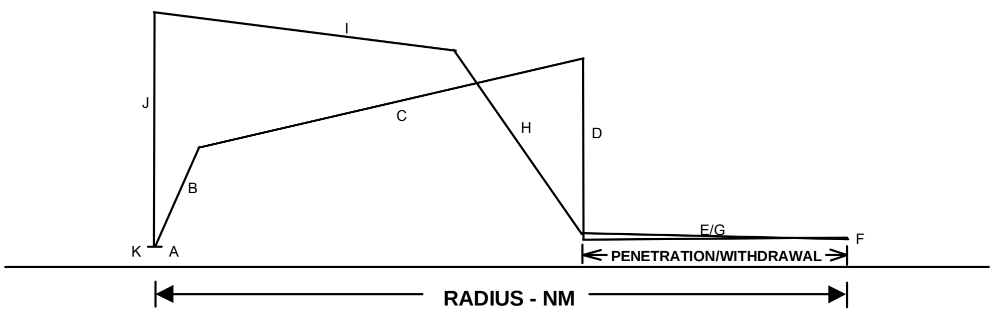
FIGURE B-10. Suppression of enemy air defenses (SEAD)



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING (1)
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT. (4)					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (3)	TAKEOFF TO OPTIMUM CRUISE	MAX CONTINUOUS/ INTERMEDIATE
C	CRUISE (PARA 4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
D	COMBAT (2)	EXPEND AIR-TO-GROUND STORES.					
E	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (3)	COMBAT TO OPTIMUM CRUISE	MAX CONTINUOUS/ INTERMEDIATE
F	CRUISE (PARA 4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
G	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
H	RESERVES	30 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
I							
J							
K							
L							

NOTES: (1) THRUST SETTINGS ARE NON-AUGMENTED/AUGMENTED. (SEE PARA 3.11.3.2.)
(2) SEE PARA 4.1.5 AND 4.1.7.
(3) CLIMB SCHEDULE ENDS AT LONG RANGE CRUISE SPEED/OPTIMUM CRUISE ALTITUDE.
(4) LONGER WARM-UP TIMES MAY BE REQUIRED BY ELECTRONIC EQUIPMENT.

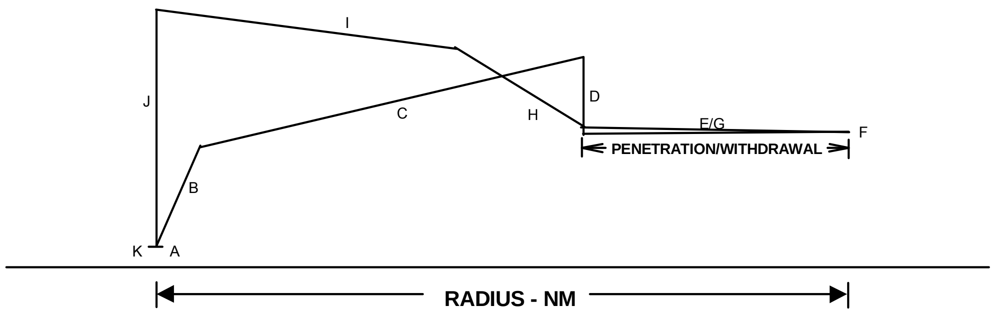
FIGURE B-11. Bomber - high-level



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING (1)
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT. (4)					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (5)	TAKEOFF TO OPTIMUM CRUISE	MAX CONTINUOUS/ INTERMEDIATE
C	CRUISE (PARA 4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO 2000 FEET PRESS ALT.	
E	PENETRATION (PARA 4.2.4)			500 NM	.55/.85 MACH (3)	2000 FEET PRESS ALT.	
F	COMBAT (2)	2 MINUTES @ MAX CONT ($V_{MAX\ CONT}$) / MAX A/B ($V_{MAX\ A/B}$). (1) EXPEND AIR-TO-GROUND STORES. NO DISTANCE CREDIT. (6)					
G	WITHDRAWAL (PARA 4.2.4)			500 NM	.55/.85 MACH (3)	2000 FEET PRESS ALT.	
H	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (5)	2000 FEET PRESS ALT. TO OPTIMUM CRUISE	MAX CONTINUOUS/ INTERMEDIATE
I	CRUISE (PARA 4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
J	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
K	RESERVES	30 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
L							

NOTES:
(1) THRUST SETTINGS ARE NON-AUGMENTED/AUGMENTED. (SEE PARA 3.11.3.2.)
(2) SEE PARA 4.1.5 AND 4.1.7.
(3) SUBSONIC/SUPERSONIC AIRCRAFT
(4) LONGER WARM-UP TIMES MAY BE REQUIRED BY ELECTRONIC EQUIPMENT.
(5) CLIMB SCHEDULE ENDS AT LONG RANGE CRUISE SPEED/OPTIMUM CRUISE ALTITUDE.
(6) INCLUDE ACCELERATION FUEL FROM PENETRATION TO COMBAT SPEED.

FIGURE B-12. Bomber - low -level penetration



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING (1)
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT. (4)					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (3)	TAKEOFF TO OPTIMUM CRUISE	MAX CONTINUOUS/ INTERMEDIATE
C	CRUISE (PARA 4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO 20,000 FEET PRESS ALT.	
E	PENETRATION (PARA 4.2.4)		15 MINUTES		$V_{MAX\ CONT}$ / $V_{MAX\ A/B}$ (1)	20,000 FEET PRESS ALT.	
F	COMBAT (2)	2 MINUTES @ MAX CONT ($V_{MAX\ CONT}$) / MAX A/B ($V_{MAX\ A/B}$). (1) EXPEND AIR-TO-GROUND STORES. NO DISTANCE CREDIT.					
G	WITHDRAWAL (PARA 4.2.4)		15 MINUTES		$V_{MAX\ CONT}$ / $V_{MAX\ A/B}$ (1)	20,000 FEET PRESS ALT.	
H	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (3)	20,000 FEET PRESS ALT. TO OPTIMUM CRUISE	MAX CONTINUOUS/ INTERMEDIATE
I	CRUISE (PARA 4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
J	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
K	RESERVES	30 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
L							

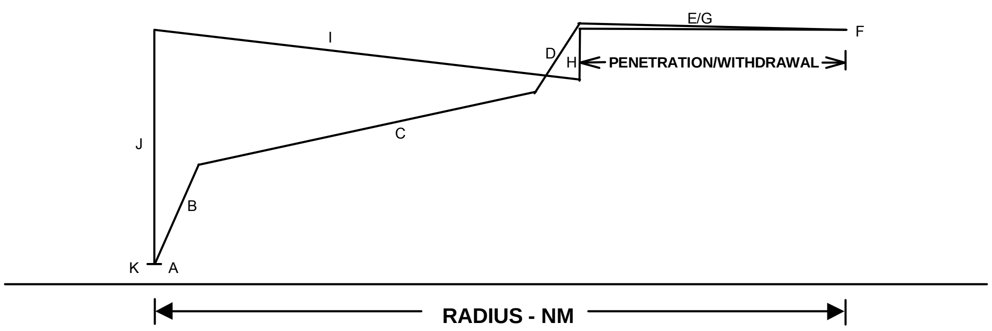
NOTES: (1) THRUST SETTINGS ARE NON-AUGMENTED/AUGMENTED. (SEE PARA 3.11.3.2.)

(2) SEE PARA 4.1.5 AND 4.1.7.

(3) CLIMB SCHEDULE ENDS AT LONG RANGE CRUISE SPEED/OPTIMUM CRUISE ALTITUDE.

(4) LONGER WARM-UP TIMES MAY BE REQUIRED BY ELECTRONICS EQUPMENT.

FIGURE B-13. Bomber - medium-level penetration



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING (1)
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT. (3)					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (4)	TAKEOFF TO OPTIMUM CRUISE	MAX CONTINUOUS/ INTERMEDIATE
C	CRUISE (PARA 4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
D	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (5)	END CRUISE TO COMBAT CEILING	INTERMEDIATE/MAXIMUM A/B
E	PENETRATION (PARA 4.2.4)		15 MINUTES		$V_{MAX\ CONT}$ / $V_{MAX\ A/B}$ (1)	COMBAT CEILING	MAX CONTINUOUS/ MAXIMUM A/B
F	COMBAT (2)	2 MIN @ MAX CONT ($V_{MAX\ CONT}$) / MAX A/B ($V_{MAX\ A/B}$). (1) EXPEND AIR-TO-GROUND STORES. NO DISTANCE CREDIT.					
G	WITHDRAWAL (PARA 4.2.4)		15 MINUTES		$V_{MAX\ CONT}$ / $V_{MAX\ A/B}$ (1)	COMBAT CEILING	MAX CONTINUOUS/ MAXIMUM A/B
H	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		COMBAT CEILING TO OPTIMUM CRUISE	
I	CRUISE (PARA 4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
J	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
K	RESERVES	30 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
L							

NOTES: (1) THRUST SETTINGS ARE NON-AUGMENTED/AUGMENTED. (SEE PARA 3.11.3.2.)

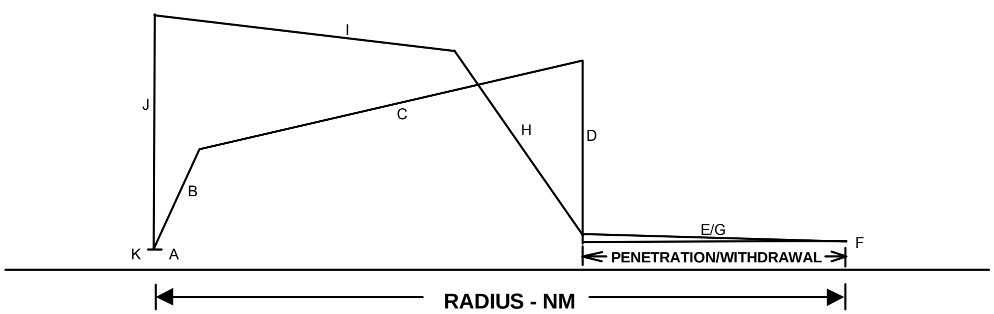
(2) SEE PARA 4.1.5 AND 4.1.7.

(3) LONGER WARM-UP TIMES MAY BE REQUIRED BY ELECTRONICS EQUIPMENT.

(4) CLIMB SCHEDULE ENDS AT LONG RANGE CRUISE SPEED/OPTIMUM CRUISE ALTITUDE.

(5) CLIMB SCHEDULE ENDS AT PENETRATION SPEED/ALTITUDE.

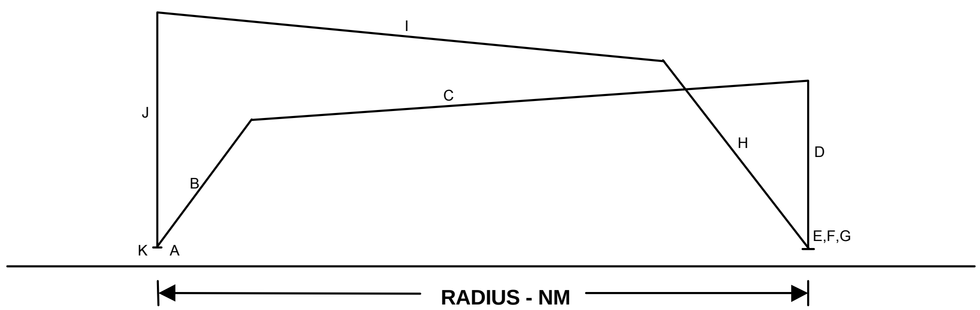
FIGURE B-14. Bomber - high-level penetration



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (1)	TAKEOFF TO OPTIMUM CRUISE	MAX CONTINUOUS
C	CRUISE (PARA 4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO 2000 FEET PRESS ALT.	
E	PENETRATION (PARA 4.2.4)			200 NM	360 KTAS OR $V_{MAX\ CONT}$ WHICHEVER IS LOWER	2000 FEET PRESS ALT.	
F	AIR DROP/AIR ASSAULT	(2)	15 MINUTES	NO CREDIT	DROP SPEED	2000 FEET PRESS ALT.	
G	WITHDRAWAL (PARA 4.2.4) (3)			200 NM	360 KTAS OR $V_{MAX\ CONT}$ WHICHEVER IS LOWER	2000 FEET PRESS ALT.	
H	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (1)	2000 FEET PRESS ALT. TO OPTIMUM CRUISE	MAX CONTINUOUS
I	CRUISE (PARA 4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
J	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
K	RESERVES	30 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
L							

NOTES: (1) CLIMB SCHEDULE ENDS AT LONG RANGE CRUISE SPEED/OPTIMUM CRUISE ALTITUDE.
(2) FUEL BURNED IS FOR IG THRUST REQUIRED IN THE AIR DROP CONFIGURATION.
(3) INCLUDE FUEL TO ACCELERATE FROM DROP SPEED TO 360 KTAS.

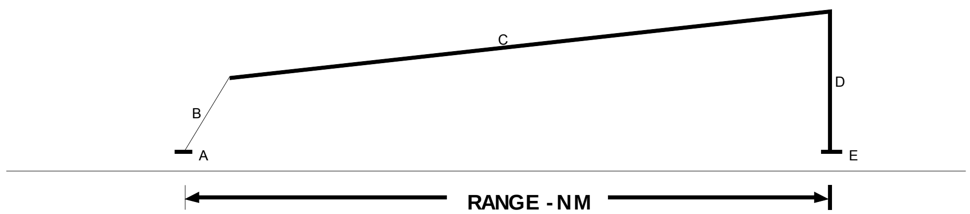
FIGURE B-15. Air drop/air assault



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (1)	TAKEOFF TO OPTIMUM CRUISE	MAX CONTINUOUS
C	CRUISE (PARA 4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
E	LAND	NONE	NONE	NO CREDIT			
F	LOAD/UNLOAD CARGO/PASSENGERS	NONE	NONE	NONE			
G	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
H	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (1)	LANDING TO OPTIMUM CRUISE	MAX CONTINUOUS
I	CRUISE (PARA 4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
J	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
K	RESERVES	30 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
L							

NOTE: (1) CLIMB SCHEDULE ENDS AT LONG RANGE CRUISE SPEED/OPTIMUM CRUISE ALTITUDE.

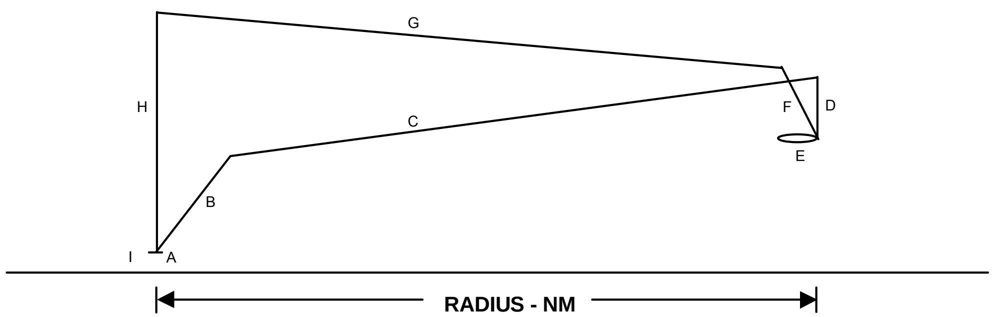
FIGURE B-16. Cargo/transport supply - radius



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF/ MAXIMUM/ IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (1)	TAKEOFF TO OPTIMUM CRUISE	MAX CONTINUOUS
C	CRUISE (PARA 4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
E	RESERVES	30 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
F							
G							
H							
I							
J							
K							
L							

NOTE: (1) CLIMB SCHEDULE ENDS AT LONG RANGE CRUISE SPEED/OPTIMUM CRUISE ALTITUDE.

FIGURE B-17. Cargo/transport supply - range



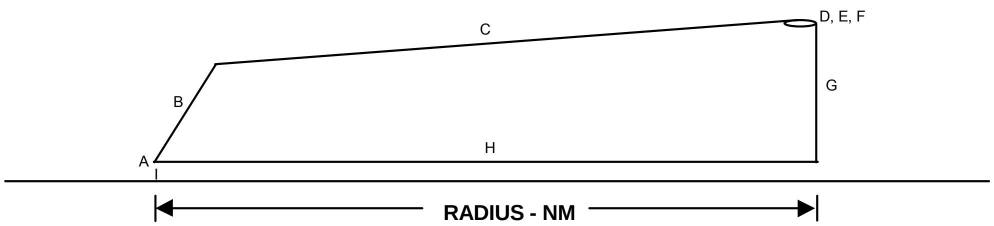
	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)			(2)	MINIMUM TIME CLIMB SCHEDULE (1)	TAKEOFF TO OPTIMUM CRUISE	MAX CONTINUOUS
C	CRUISE (PARA 4.2.3)			600 NM/200 NM (2)	LONG RANGE CRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO MISSION ALTITUDE	
E	LOITER (PARA 4.2.6)			NO CREDIT	MAXIMUM ENDURANCE	MISSION ALTITUDE (3)	
F	CLIMB (PARA 4.2.2)			(2)	MINIMUM TIME CLIMB SCHEDULE (1)	MISSION ALTITUDE TO OPTIMUM CRUISE	MAX CONTINUOUS
G	CRUISE (PARA 4.2.3)			600 NM/200NM (2)	LONG RANGE CRUISE	OPTIMUM CRUISE	
H	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
I	RESERVES	30 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
J							
K							
L							

NOTES: (1) CLIMB SCHEDULE ENDS AT LONG RANGE CRUISE SPEED/OPTIMUM CRUISE ALTITUDE.

(2) CRUISE DISTANCES ARE LAND BASED/CARRIER BASED AND INCLUDE CLIMB DISTANCES.

(3) MISSION ALTITUDE IS THE RADAR OPTIMUM ALTITUDE AS LIMITED BY THE AIRCRAFT.

FIGURE B-18. Airborne warning and control system (AWACS)

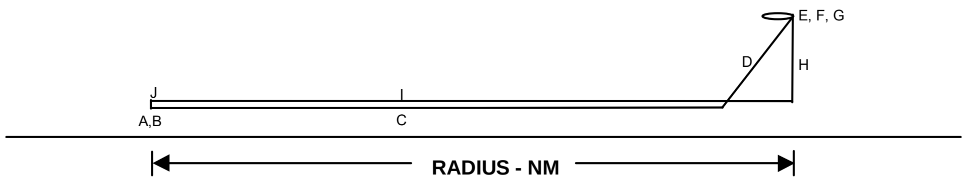


	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)			(2)	MINIMUM TIME CLIMB SCHEDULE (1)	TAKEOFF TO OPTIMUM CRUISE	INTERMEDIATE
C	CRUISE (PARA 4.2.3)			110 NM (2)	MAXIMUM CRUISE	OPTIMUM CRUISE	MAX CONTINUOUS
D	LOITER (PARA 4.2.6)			NO CREDIT	MAXIMUM ENDURANCE	END CRUISE	
E	COMBAT		5 MINUTES	NO CREDIT	MAXIMUM ENDURANCE	END CRUISE	INTERMEDIATE
F	LOITER (PARA 4.2.6)		1 HOUR	NO CREDIT	MAXIMUM ENDURANCE	END CRUISE	
G	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
H	CRUISE (PARA 4.2.3)			110 NM	MAXIMUM CRUISE	LANDING	MAX CONTINUOUS
I	RESERVES	30 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
J							
K							
L							

NOTES: (1) CLIMB SCHEDULE ENDS AT OPTIMUM CRUISE SPEED/ALTITUDE.

(2) DISTANCE INCLUDES CLIMB FROM TAKEOFF.

FIGURE B-19. Corps special electronics mission



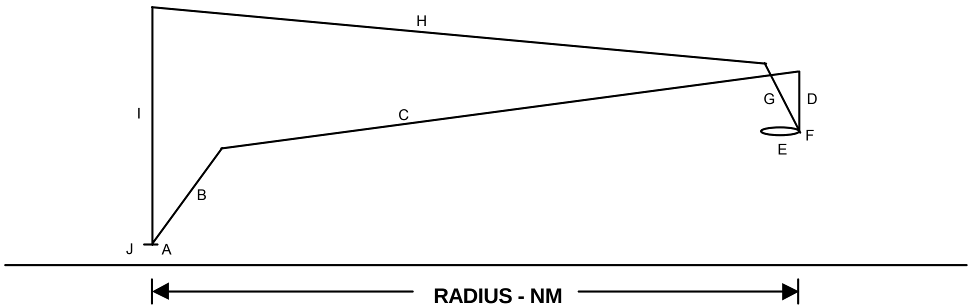
	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB			(3)	MINIMUM TIME CLIMB SCHEDULE (1)	TAKEOFF TO 4000 FEET PRESS ALT.	INTERMEDIATE
C	CRUISE (PARA 4.2.3)			60 NM (3)	MAX RANGE CRUISE	4000 FEET PRESS ALT.	
D	CLIMB (PARA 4.2.2)			(3)	MINIMUM TIME CLIMB SCHEDULE (2)	4000 FEET PRESS ALT. TO 7000 FEET PRESS ALT.	INTERMEDIATE
E	LOITER (PARA 4.2.6)			NO CREDIT	MAXIMUM ENDURANCE	7000 FEET PRESS ALT.	
F	COMBAT	SIX 3000 FT ENERGY EXCHANGES @ MAX ENDURANCE SPEED @ IRT. NO DISTANCE CREDIT.					
G	LOITER (PARA 4.2.6)		1 HOUR	NO CREDIT	MAXIMUM ENDURANCE	7000 FEET PRESS ALT.	
H	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		7000 FEET PRESS ALT. TO 4000 FEET PRESS ALT.	
I	CRUISE (PARA 4.2.3)			60 NM	MAX RANGE CRUISE	LANDING	
J	RESERVES	30 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	4000 FEET PRESS ALT.	
K							
L							

NOTES: (1) CLIMB SCHEDULE ENDS AT MAXIMUM RANGE CRUISE SPEED AT 2000 FEET PRESSURE ALTITUDE.

(2) CLIMB SCHEDULE ENDS AT MAXIMUM ENDURANCE SPEED AT LOITER ALTITUDE.

(3) INCLUDES CLIMB DISTANCE FROM BOTH ENDS OF CRUISE.

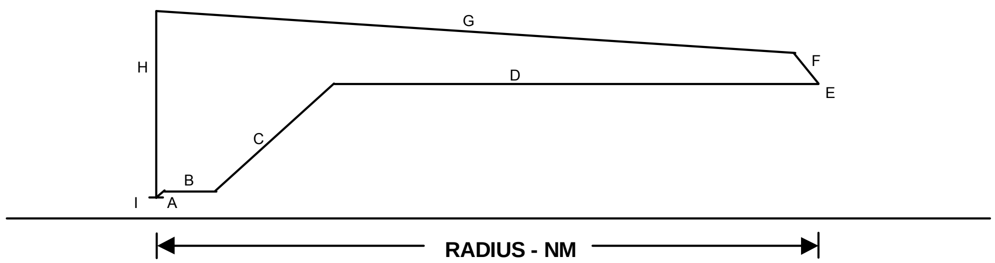
FIGURE B-20. Division special electronics mission



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (3)	TAKEOFF TO OPTIMUM CRUISE	INTERMEDIATE
C	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO 35,000 FEET PRESS ALT.	
E	LOITER (PARA 4.2.6)		1 HOUR	NO CREDIT	MAXIMUM ENDURANCE	35,000 FEET PRESS ALT.	
F	COMBAT (1) AND (2)	ONE 360 DEG TURN @ MACH 1.2 (MAX A/B) + TW0 360 DEG TURNS @ MACH 0.9 (MAX A/B). EXPEND HALF OF AMMO AND MISSILES. NO DISTANCE CREDIT.					
G	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (3)	35,000 FEET PRESS ALT. TO OPTIMUM CRUISE	INTERMEDIATE
H	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
I	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
J	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
K							
L							

NOTES: (1) SEE PARA 4.1.5 AND 4.1.7.
(2) INCLUDE FUEL TO ACCELERATE TO MACH 1.2.
(3) CLIMB SCHEDULE ENDS AT OPTIMUM CRUISE SPEED/ALTITUDE.

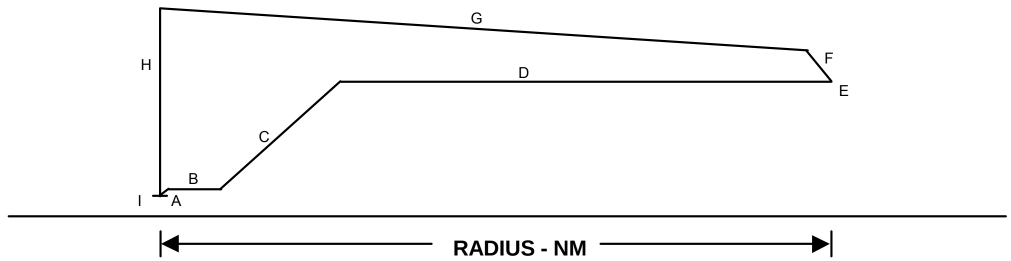
FIGURE B-21. Combat Air Patrol (CAP)



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING (1)
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED). NO DISTANCE CREDIT.					
B	ACCELERATE				OBSTACLE CLEARANCE TO 0.9 MACH	TAKEOFF	MAXIMUM/MAXIMUM A/B
C	CLIMB (PARA 4.2.2)				0.9 MACH	TAKEOFF TO 40,000 FEET PRESS ALT.	INTERMEDIATE
D	CRUISE (5)				0.95 MACH OR Virt WHICHEVER IS LOWER	40,000 FEET PRESS ALT.	
E	COMBAT (2) AND (3)	ONE 180 DEG TURN @ .95 MACH WITH MAX SUSTAINED G's @ MAXIMUM/MAXIMUM A/B. (1) EXPEND HALF OF AMMO AND MISSILES. NO DISTANCE CREDIT.					
F	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (4)	40,000 FEET PRESS ALT. TO OPTIMUM CRUISE	INTERMEDIATE
G	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
H	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
I	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
J							
K							
L							

NOTES:
(1) THRUST SETTINGS ARE NON-AUGMENTED/AUGMENTED. (SEE PARA 3.11.3.2)
(2) SEE PARA 4.1.5 AND 4.1.7.
(3) INCLUDE ACCELERATION FUEL IF COMBAT SPEED IS GREATER THAN CRUISE SPEED.
(4) CLIMB SCHEDULE ENDS AT OPTIMUM CRUISE SPEED/ALTITUDE.
(5) INCLUDE ACCELERATION FUEL FROM 0.9 TO 0.95 MACH.

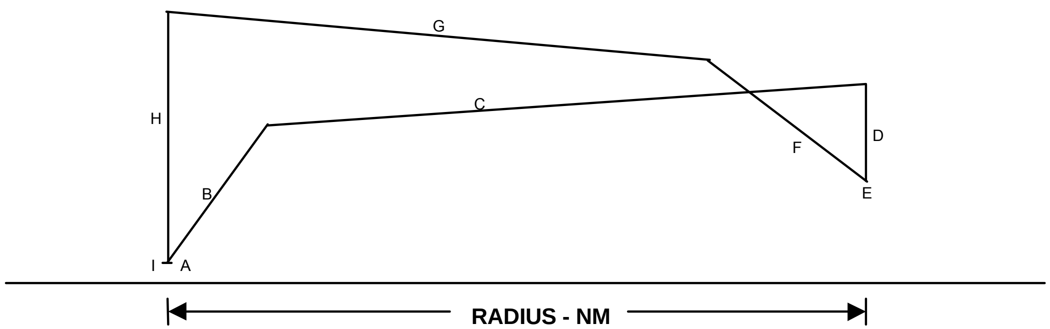
FIGURE B-22. Subsonic intercept



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING (1)
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED). NO DISTANCE CREDIT.					
B	ACCELERATE				OBSTACLE CLEARANCE TO 0.9 MACH	TAKEOFF	MAXIMUM/MAXIMUM A/B
C	CLIMB (PARA 4.2.2)				0.9 MACH	TAKEOFF TO 40,000 FEET PRESS ALT.	MAXIMUM/MAXIMUM A/B
D	CRUISE				1.4 MACH OR $V_{MAX/MAX\ A/B}$ WHICHEVER IS LOWER (3)	40,000 FEET PRESS ALT.	
E	COMBAT (2)	ONE 180 DEG TURN @ 1.2 MACH WITH MAX SUSTAINED G's @ MAXIMUM A/B. EXPEND HALF OF AMMO AND MISSILES. NO DISTANCE CREDIT.					
F	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (4)	40,000 FEET PRESS ALT. TO OPTIMUM CRUISE	INTERMEDIATE
G	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
H	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
I	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
J							
K							
L							

NOTES: (1) THRUST SETTINGS ARE NON-AUGMENTED/AUGMENTED. (SEE PARA 3.11.3.2.)
(2) SEE PARA 4.1.5 AND 4.1.7.
(3) INCLUDE ACCELERATION FUEL TO THE PROPER SPEED.
(4) CLIMB SCHEDULE ENDS AT OPTIMUM CRUISE SPEED/ALTITUDE.

FIGURE B-23. Supersonic intercept



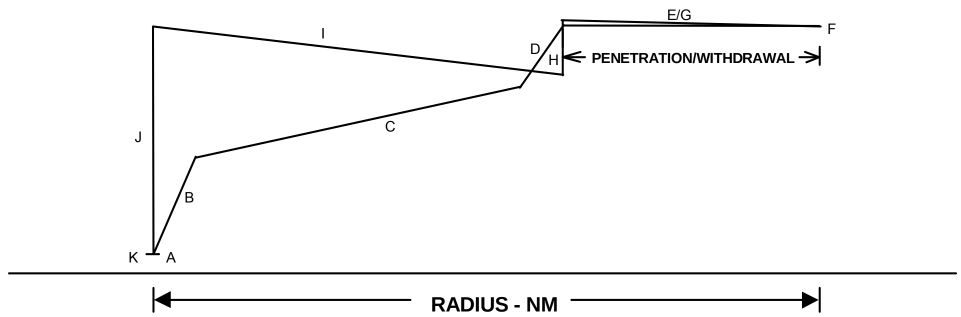
	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (3)	TAKEOFF TO OPTIMUM CRUISE	INTERMEDIATE
C	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO 15,000 FEET PRESS ALT.	
E	COMBAT (1) AND (2)	ONE 360 DEG TURN @ MACH 1.2 (MAX A/B) + TW0 360 DEG TURNS @ MACH 0.9 (MAX A/B). EXPEND HALF OF AMMO AND MISSILES. NO DISTANCE CREDIT.					
F	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (3)	15,000 FEET PRESS ALT. TO OPTIMUM CRUISE	INTERMEDIATE
G	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
H	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
I	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
J							
K							
L							

NOTES: (1) SEE PARA 4.1.5 AND 4.1.7.

(2) INCLUDE ACCELERATION FUEL IF THE ENERGY LEVEL AT THE START OF COMBAT IS GREATER THAN THE ENERGY LEVEL AT THE END OF CRUISE.

(3) CLIMB SCHEDULE ENDS AT OPTIMUM CRUISE SPEED/ALTITUDE.

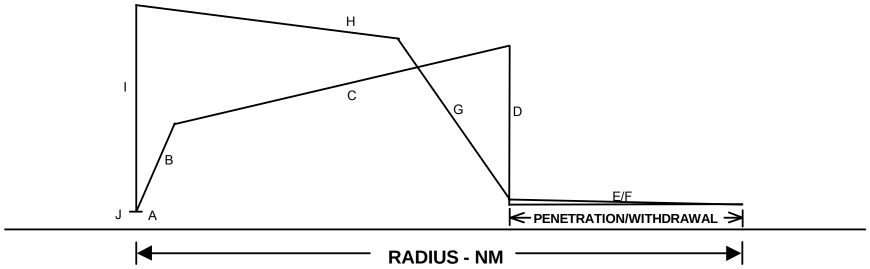
FIGURE B-24. Medium-altitude fighter sweep



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (2)	TAKEOFF TO OPTIMUM CRUISE	INTERMEDIATE
C	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
D	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (3)	END CRUISE TO 40,000 FEET PRESS ALT.	INTERMEDIATE
E	PENETRATION (PARA 4.2.4)			50 NM	Virt	40,000 FEET PRESS ALT.	INTERMEDIATE
F	COMBAT (1)	ONE 180 DEG TURN @END PENETRATION MACH NR WITH MAX SUSTAINED G's @ MAXIMUM/MAXIMUM A/B. (4) EXPEND HALF OF AMMO AND MISSILES. NO DISTANCE CREDIT.					
G	WITHDRAWAL (PARA 4.2.4)			50 NM	Virt	40,000 FEET PRESS ALT.	INTERMEDIATE
H	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		40,000 FEET PRESS ALT. TO OPTIMUM CRUISE	
I	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
J	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
K	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
L							

NOTES:
(1) SEE PARA 4.1.5 AND 4.1.7.
(2) CLIMB SCHEDULE ENDS AT OPTIMUM CRUISE SPEED/ALTITUDE.
(3) CLIMB SCHEDULE ENDS AT Virt/ 40,000 FEET PRESSURE ALTITUDE.
(4) THRUST SETTINGS ARE NON-AUGMENTED/AUGMENTED (SEE PARA 3.11.3.2.)

FIGURE B-25. High-altitude fighter sweep

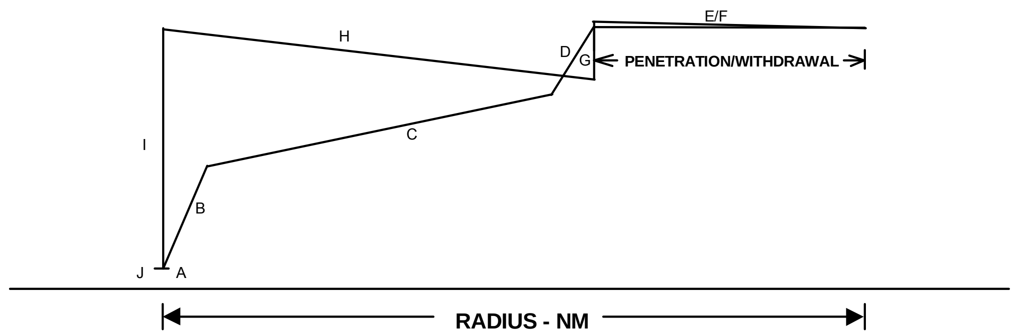


	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING (1)
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (2)	TAKEOFF TO OPTIMUM CRUISE	MAX CONTINUOUS/ INTERMEDIATE
C	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO 2000 FEET PRESS ALT.	
E	PENETRATION (PARA 4.2.4)			50 NM	Virt	2000 FEET PRESS ALT.	INTERMEDIATE
F	WITHDRAWAL (PARA 4.2.4)			50 NM	Virt	2000 FEET PRESS ALT.	INTERMEDIATE
G	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (2)	2000 FEET PRESS ALT. TO OPTIMUM CRUISE	MAX CONTINUOUS/ INTERMEDIATE
H	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
I	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
J	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
K							
L							

NOTES: (1) THRUST SETTINGS ARE NON-AUGMENTED/AUGMENTED (SEE PARA 3.11.3.2.)

(2) CLIMB SCHEDULE ENDS AT OPTIMUM CRUISE SPEED/ALTITUDE.

FIGURE B-26. Reconnaissance - low-level penetration



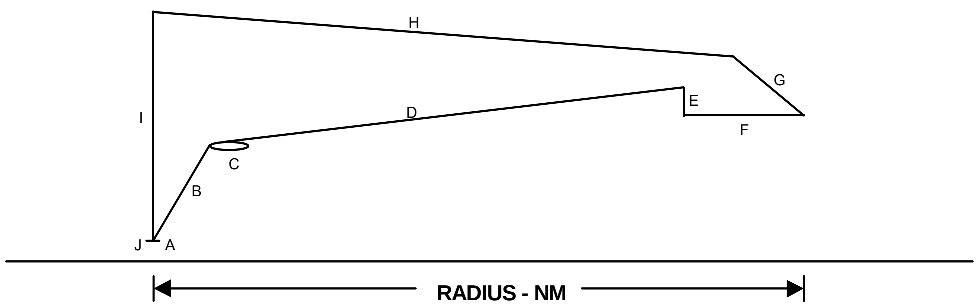
	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING (1)
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (2)	TAKEOFF TO OPTIMUM CRUISE	MAX CONTINUOUS/ INTERMEDIATE
C	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
D	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (3)	END CRUISE TO 40,000 FEET PRESS ALT.	INTERMEDIATE
E	PENETRATION (PARA 4.2.4)			50 NM	Virt	40,000 FEET PRESS ALT.	INTERMEDIATE
F	WITHDRAWAL (PARA 4.2.4)			50 NM	Virt	40,000 FEET PRESS ALT.	INTERMEDIATE
G	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		40,000 FEET PRESS ALT. TO OPTIMUM CRUISE	
H	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
I	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
J	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
K							
L							

NOTES: (1) THRUST SETTINGS ARE NON-AUGMENTED/AUGMENTED (SEE PARA 3.11.3.2.)

(2) CLIMB SCHEDULE ENDS AT OPTIMUM CRUISE SPEED/ALTITUDE.

(3) CLIMB SCHEDULE ENDS AT Virt/ 40,000 FEET PRESSURE ALTITUDE.

FIGURE B-27. Reconnaissance - high-level penetration

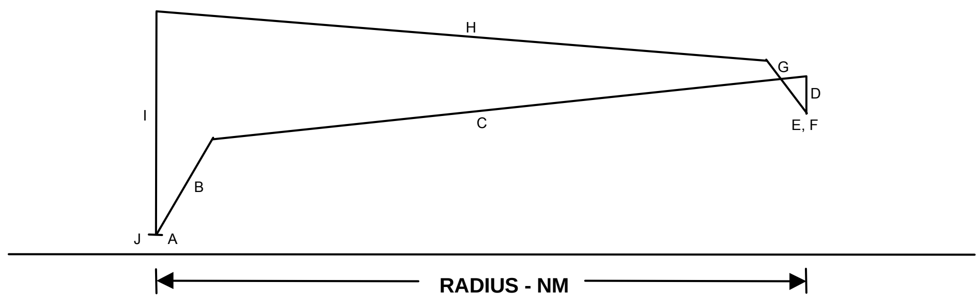


	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (1)	TAKEOFF TO OPTIMUM CRUISE	MAX CONTINUOUS
C	RENDEZVOUS WITH RECEIVER		10 MINUTES	NO CREDIT	MAXIMUM ENDURANCE	OPTIMUM CRUISE	
D	CRUISE (PARA 4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
E	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO REFUEL	
F	HOOKUP AND TRANSFER FUEL		(2)		(2)	(2)	
G	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (1)	REFUEL TO OPTIMUM CRUISE	MAX CONTINUOUS
H	CRUISE (PARA 4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
I	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
J	RESERVES	30 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
K							
L							

NOTES: (1) CLIMB SCHEDULE ENDS AT LONG RANGECRUISE SPEED/OPTIMUM CRUISE ALTITUDE.

(2) REFUELING SPEED, TIME, AND ALTITUDE ARE DEPENDENT ON THE AIRCRAFT BEING REFUELED. THESE CHARACTERISTICS MUST BE KNOWN TO CALCULATE TANKER MISSION PERFORMANCE. DISTANCE FLOWN DURING REFUELING IS CREDITED TO THE OUTBOUND LEG.

FIGURE B-28. Tanker - buddy refuel mission



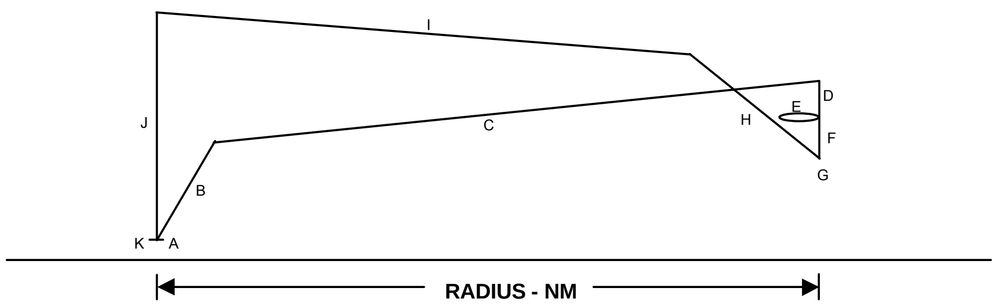
	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (1)	TAKEOFF TO OPTIMUM CRUISE	MAX CONTINUOUS
C	CRUISE (PARA 4.2.3)				LONG RANGECRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO REFUEL	
E	LOITER (PARA 4.2.6)		1 HOUR	NO CREDIT	MAXIMUM ENDURANCE	REFUELING	
F	HOOKUP AND TRANSFER FUEL (PARA 4.2.7)		(2)	NO CREDIT (3)	(2)	(2)	
G	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (1)	REFUEL TO OPTIMUM CRUISE	MAX CONTINUOUS
H	CRUISE (PARA 4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
I	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
J	RESERVES	30 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
K							
L							

NOTES: (1) CLIMB SCHEDULE ENDS AT LONG RANGE CRUISE SPEED/OPTIMUM CRUISE ALTITUDE.

(2) REFUELING SPEED, TIME, AND ALTITUDE ARE DEPENDENT ON THE AIRCRAFT BEING REFUELED. THESE CHARACTERISTICS MUST BE KNOWN TO CALCULATE TANKER MISSION PERFORMANCE.

(3) CREDIT DISTANCE FOR REFUELING BOMBERS AND CARGO/ TRANSPORTS.

FIGURE B-29. Tanker - rendezvous refuel mission

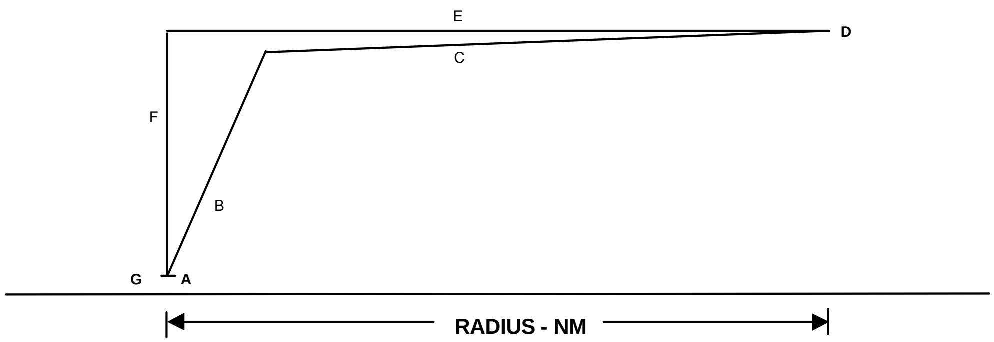


	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (1)	TAKEOFF TO OPTIMUM CRUISE	INTERMEDIATE
C	CRUISE (PARA 4.2.3)				LONG RANGECRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO MAXIMUM ENDURANCE	
E	LOITER (PARA 4.2.6)		1 HOUR	NO CREDIT	MAXIMUM ENDURANCE	MAXIMUM ENDURANCE	
F	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		MAXIMUM ENDURANCE TO 5000 PRESS ALT.	
G	HOOKUP AND TRANSFER FUEL (PARA 4.2.7)		(2)	NO CREDIT	(2)	(2)	
H	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (1)	5000 FEET PRESS ALT. TO OPTIMUM CRUISE	INTERMEDIATE
I	CRUISE (PARA 4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
J	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
K	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
L							

NOTES: (1) CLIMB SCHEDULE ENDS AT LONG RANGE CRUISE SPEED/OPTIMUM CRUISE ALTITUDE.

(2) REFUELING SPEED, TIME, AND ALTITUDE ARE DEPENDENT ON THE AIRCRAFT BEING REFUELED. THESE CHARACTERISTICS MUST BE KNOWN TO CALCULATE TANKER MISSION PERFORMANCE.

FIGURE B-30. Navy tanker - rendezvous refuel mission

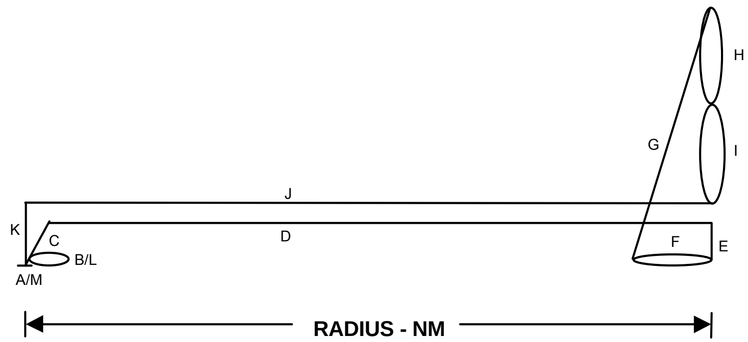


	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)			(2)	MINIMUM TIME CLIMB SCHEDULE (1)	TAKEOFF TO 20,000 FEET PRESS ALT.	INTERMEDIATE
C	CRUISE (PARA 4.2.3)			50 NM (2)	MAXIMUM RANGE CRUISE	20,000 FEET PRESS ALT.	
D	AIRWORK SEGMENT			NO CREDIT	MAXIMUM RANGE CRUISE	20,000 FEET PRESS ALT.	
E	CRUISE (PARA 4.2.3)			50 NM	MAXIMUM RANGE CRUISE	20,000 FEET PRESS ALT.	
F	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
G	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
H							
I							
J							
K							
L							

NOTES: (1) CLIMB SCHEDULE ENDS AT MAXIMUM RANGE CRUISE SPEED AT 20,000 FEET PRESS ALT.

(2) 50 NM INCLUDES CLIMB DISTANCE.

FIGURE B-31. Basic trainer - familiarization



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, & ACCEL TO PATTERN SPEED	20 MIN @ GROUND IDLE + FUEL TO ACCELERATE TO PATTERN SPEED AND CLIMB FROM SL TO 1000 FEET @ MAX THRUST. NO DISTANCE CREDIT. (1)					
B	VFR PATTERN	ONE PATTERN CONSISTING OF FUEL FOR 13 NM @ 1000 FEET PRESS ALT. @ PATTERN SPEED + FUEL TO ACCELERATE TO PATTERN SPEED AND CLIMB FROM SL TO 1000 FEET @ MAX THRUST. NO DISTANCE CREDIT. (1)					
C	CLIMB (PARA 4.2.2)			(3)	MINIMUM TIME CLIMB SCHEDULE (2)	1000 FEET PRESS ALT. TO 5000 FEET PRESS ALT.	INTERMEDIATE
D	CRUISE (PARA 4.2.3)			45 NM (3)	MAXIMUM RANGE CRUISE	5000 FEET PRESS ALT.	
E	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		5000 FEET PRESS ALT. TO 1000 FEET PRESS ALT.	
F	VFR PATTERN	FOUR PATTERNS EACH CONSISTING OF FUEL FOR 13 NM @ 1000 FEET PRESS ALT. @ PATTERN SPEED + FUEL TO ACCELERATE TO PATTERN SPEED AND CLIMB FROM SL TO 1000 FEET @ MAX THRUST. NO DISTANCE CREDIT. (1)					
G	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (2)	1000 FEET PRESS ALT. TO 22,000 FEET PRESS ALT.	INTERMEDIATE
H	MANEUVER		10 MINUTES		MAXIMUM RANGE CRUISE + 20 KCAS	18,500 FEET PRESS ALT. (4)	
I	MANEUVER				MAXIMUM RANGE CRUISE + 20 KCAS	10,500 FEET PRESS ALT. (5)	
J	CRUISE (PARA 4.2.3)			45 NM	MAXIMUM RANGE CRUISE	6000 FEET PRESS ALT.	
K	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		6000 FEET PRESS ALT. TO 1000 FEET PRESS ALT.	
L	VFR PATTERN	TWO PATTERNS EACH CONSISTING OF FUEL FOR 13 NM @ 1000 FEET PRESS ALT. @ PATTERN SPEED + FUEL TO ACCELERATE TO PATTERN SPEED AND CLIMB FROM SL TO 1000 FEET @ MAX THRUST. NO DISTANCE CREDIT. (1)					
M	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	

NOTES: (1) PATTERN SPEED IS 120 PERCENT OF APPROACH SPEED (GEAR AND FLAPS DOWN).

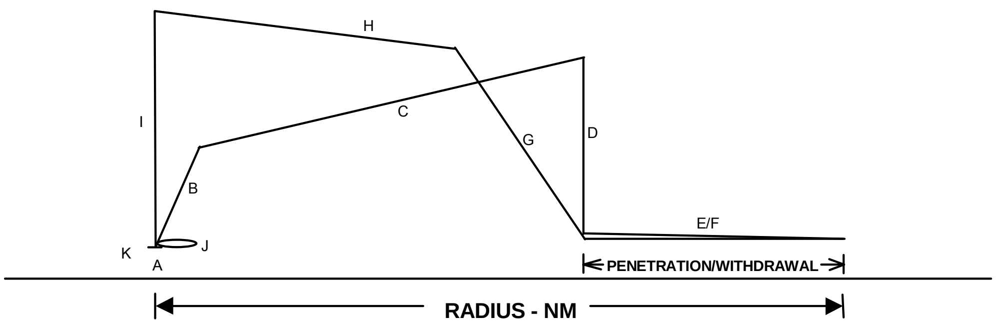
(2) CLIMB SCHEDULE ENDS AT MAX RANGE CRUISE SPEED/CRUISE ALTITUDE.

(3) 45 NM INCLUDES CLIMB DISTANCE.

(4) MANEUVER IS CALCULATED AT THE AVERAGE ALTITUDE AS THEAIRCRAFT DESCENDS THROUGH THE ALTITUDE BAND FROM 22,000 TO 15,000 FEET PRESS ALT.

(5) MANEUVER IS CALCULATED AT THE AVERAGE ALTITUDE AS THE AIRCRAFT DESCENDS THROUGH THE ALTITUDE BAND FROM 15,000 TO 6,000 FEET PRESS ALT.

FIGURE B-32. Basic trainer - task familiarization



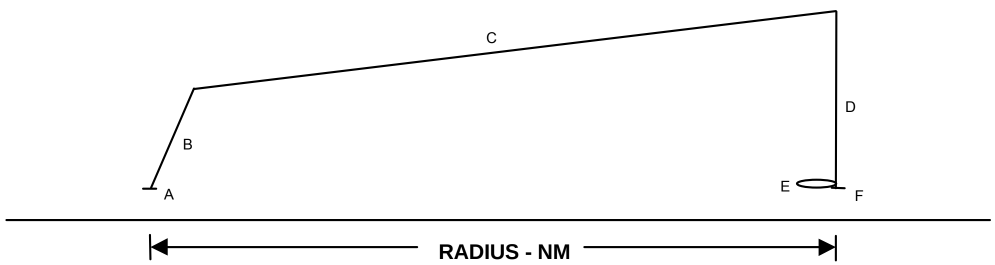
	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + FUEL TO ACCELERATE TO CLIMB SPEED AND CLIMB FROM SL TO 1000 FEET @ MAX THRUST. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)			(2)	MINIMUM TIME CLIMB SCHEDULE (1)	1000 FEET PRESS ALT. TO 5000 FEET PRESS ALT.	INTERMEDIATE
C	CRUISE (PARA 4.2.3)			45 NM (2)	MAXIMUM RANGE CRUISE	5000 FEET PRESS ALT.	INTERMEDIATE
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		5000 FEET PRESS ALT. TO 1000 FEET PRESS ALT.	
E	PENETRATION				250 KTAS	1000 FEET PRESS ALT.	
F	WITHDRAWAL				250 KTAS	1000 FEET PRESS ALT.	
G	CLIMB (PARA 4.2.2)			(2)	MINIMUM TIME CLIMB SCHEDULE (1)	1000 FEET PRESS ALT. TO 5000 FEET PRESS ALT.	INTERMEDIATE
H	CRUISE (PARA 4.2.3)			45 NM (2)	MAXIMUM RANGE CRUISE	5000 FEET PRESS ALT.	
I	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		5000 FEET PRESS ALT. TO 1000 FEET PRESS ALT.	
J	VFR PATTERN	THREE PATTERNS EACH CONSISTING OF FUEL FOR 13 NM @ 1000 FEET PRESS ALT. @ PATTERN SPEED + FUEL TO ACCELERATE TO PATTERN SPEED AND CLIMB FROM SL TO 1000 FEET @ MAX THRUST. NO DISTANCE CREDIT. (3)					
K	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
L							

NOTES: (1) CLIMB SCHEDULE ENDS AT MAX RANGE CRUISE SPEED/CRUISE ALTITUDE.

(2) 45 NM INCLUDES CLIMB DISTANCE.

(3) PATTERN SPEED IS 120 PERCENT OF APPROACH SPEED (GEAR AND FLAPS DOWN).

FIGURE B-33. Basic trainer - low-level navigation

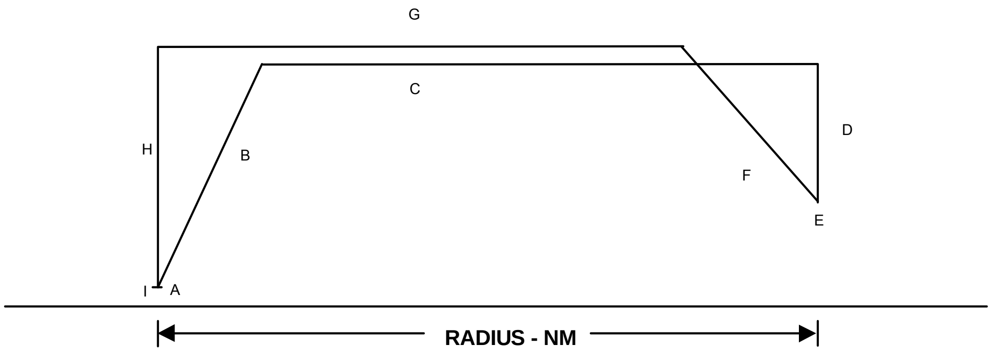


	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + FUEL TO ACCELERATE TO CLIMB SPEED AND CLIMB FROM SL TO 1000 FEET @ MAX THRUST. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (1)	1000 FEET PRESS ALT. TO OPTIMUM CRUISE	INTERMEDIATE
C	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO 4000 FEET PRESS ALT.	
E	IFR PATTERN	THREE PATTERNS EACH CONSISTING OF FUEL FOR 50 NM @ 4000 FEET PRESS ALT. @ PATTERN SPEED + FUEL TO ACCELERATE TO PATTERN SPEED AND CLIMB FROM SL TO 1000 FEET @ MAX THRUST. NO DISTANCE CREDIT. (2)					
F	RESERVES	20 MIN + 5 % OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
G							
H							
I							
J							
K							
L							
M							

NOTES: (1) CLIMB SCHEDULE ENDS AT OPTIMUM CRUISE SPEED/ALTITUDE.

(2) PATTERN SPEED IS 120 PERCENT OF APPROACH SPEED (GEAR AND FLAPS DOWN).

FIGURE B-34. Basic trainer - high-level navigation

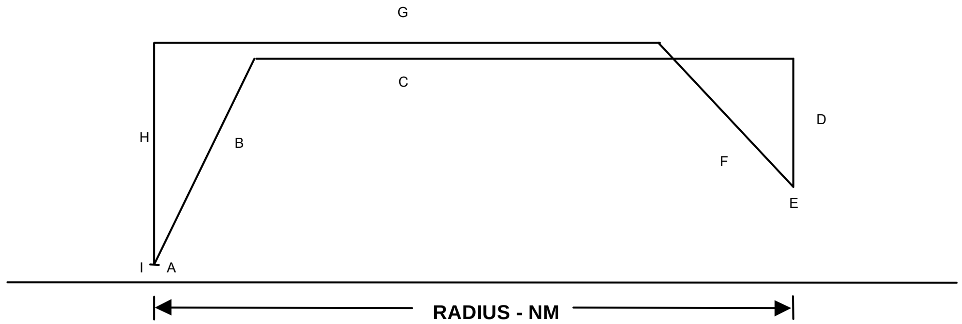


	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)			(2)	MINIMUM TIME CLIMB SCHEDULE (1)	TAKEOFF TO 20,000 FEET PRESS ALT.	INTERMEDIATE
C	CRUISE (PARA 4.2.3)			50 NM (2)	MAXIMUM RANGE CRUISE	20,000 FEET PRESS ALT.	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		20,000 FEET PRESS ALT. TO 1000 FEET PRESS ALT.	
E	COMBAT	A VARIABLE NUMBER OF "RUNS" WHICH EACH CONSIST OF A 360 DEG TURN WITH MAX SUSTAINED G's @ SUSTAINED CORNER SPEED @ INTERMEDIATE THRUST FOLLOWED BY A 5000 FOOT ENERGY EXCHANGE. EXPEND STORES AFTER LAST RUN. NO DISTANCE CREDIT.					
F	CLIMB (PARA 4.2.2)			(2)	MINIMUM TIME CLIMB SCHEDULE (1)	1000 FEET PRESS ALT. TO 20,000 FEET PRESS ALT.	INTERMEDIATE
G	CRUISE (PARA 4.2.3)			50 NM (2)	MAXIMUM RANGE CRUISE	20,000 FEET PRESS ALT.	
H	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		20,000 FEET PRESS ALT. TO LANDING	
I	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
J							
K							
L							

NOTES: (1) CLIMB SCHEDULE ENDS AT MAXIMUM RANGE CRUISE SPEED AT 20,000 FEET.

(2) 50 NM INCLUDES CLIMB DISTANCE.

FIGURE B-35. Advanced trainer - weapons delivery

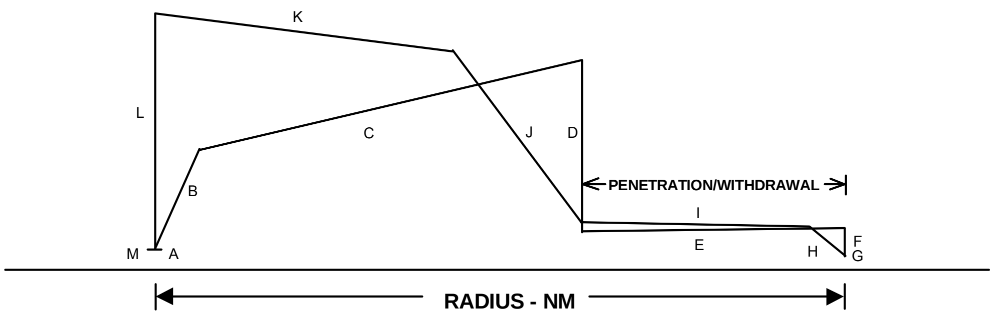


	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)			(2)	MINIMUM FUEL CLIMB SCHEDULE (1)	TAKEOFF TO 20,000 FEET PRESS ALT.	INTERMEDIATE
C	CRUISE (PARA 4.2.3)			50 NM (2)	MAXIMUM RANGE CRUISE	20,000 FEET PRESS ALT.	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		20,000 FEET PRESS ALT. TO 10,000 FEET PRESS ALT.	
E	COMBAT	THREE 360 DEG TURNS WITH MAX SUSTAINED G's @ SUSTAINED CORNER SPEED @ INTERMEDIATE THRUST FOLLOWED BY A VARIABLE HEIGHT ENERGY EXCHANGE.					
F	CLIMB (PARA 4.2.2)			(2)	MINIMUM FUEL CLIMB SCHEDULE (1)	10,000 FEET PRESS ALT. TO 20,000 FEET PRESS ALT.	INTERMEDIATE
G	CRUISE (PARA 4.2.3)			50 NM (2)	MAXIMUM RANGE CRUISE	20,000 FEET PRESS ALT.	
H	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
I	RESERVES	20 MIN + 5 % OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
J							
K							
L							

NOTES: (1) CLIMB SCHEDULE ENDS AT MAXIMUM RANGECRUISE SPEED AT 20,000 FEET.

(2) 50 NM INCLUDES CLIMB DISTANCE.

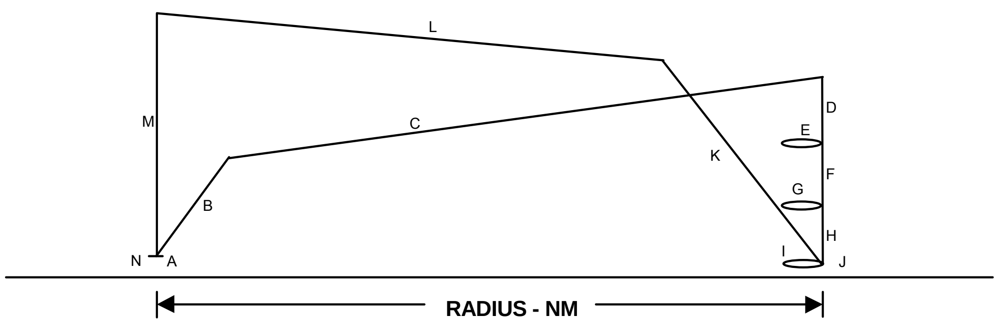
FIGURE B-36. Advanced trainer - air combat maneuvering



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)			(3)	MINIMUM TIME CLIMB SCHEDULE (1)	TAKEOFF TO OPTIMUM CRUISE	INTERMEDIATE
C	CRUISE (PARA 4.2.3)			150 NM (3)	OPTIMUM CRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO 5000 FEET PRESS ALT.	
E	PENETRATION (PARA 4.2.4)				MAXIMUM CRUISE	5000 FEET PRESS ALT.	MAX CONTINUOUS
F	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		5000 FEET PRESS ALT. TO 2000 FEET PRESS ALT.	
G	COMBAT (2)		10 MINUTES	NO CREDIT	Virt	2000 FEET PRESS ALT.	INTERMEDIATE
H	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (4)	2000 FEET PRESS ALT. TO 5000 FEET PRESS ALT.	INTERMEDIATE
I	WITHDRAWAL (PARA 4.2.4)				MAXIMUM CRUISE	5000 FEET PRESS ALT.	MAX CONTINUOUS
J	CLIMB (PARA 4.2.2)			(3)	MINIMUM TIME CLIMB SCHEDULE (1)	5000 FEET PRESS ALT. TO OPTIMUM CRUISE	INTERMEDIATE
K	CRUISE (PARA 4.2.3)			150 NM (3)	OPTIMUM CRUISE	OPTIMUM CRUISE	
L	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
M	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	

NOTES:
(1) CLIMB SCHEDULE ENDS AT OPTIMUM CRUISE SPEED/ALTITUDE.
(2) SEE PARA 4.1.5 AND 4.1.7.
(3) 150 NM INCLUDES CLIMB DISTANCE.
(4) CLIMB SCHEDULE ENDS AT MAX CRUISE SPEED/5000 FEET.

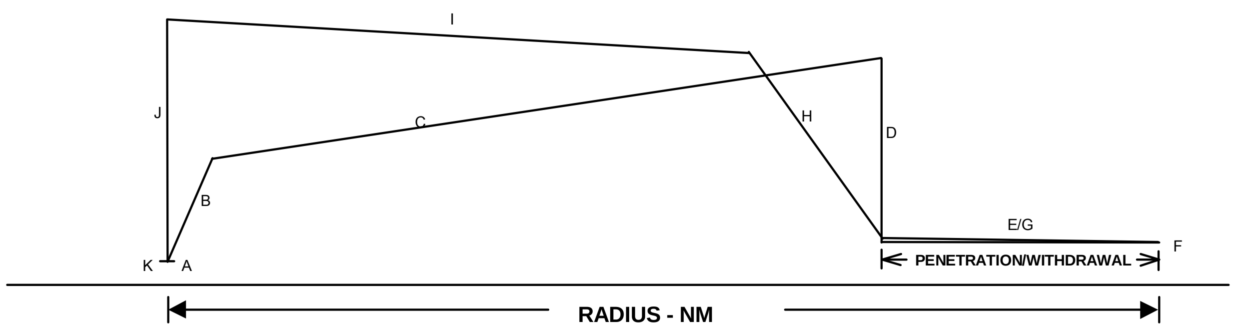
FIGURE B-37. Forward air control (FAC)



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (1)	TAKEOFF TO OPTIMUM CRUISE	INTERMEDIATE
C	CRUISE (PARA 4.2.3)				LONG RANGECRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO 20,000 FEET PRESS ALT.	
E	LOITER (PARA 4.2.6)		1 HOUR	NO CREDIT	MAXIMUM ENDURANCE	20,000 FEET PRESS ALT.	
F	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		20,000 FEET PRESS ALT. TO 5,000 FEET PRESS ALT.	
G	LOITER (PARA 4.2.6)		2 HOUR	NO CREDIT	MAXIMUM ENDURANCE	5,000 FEET PRESS ALT.	
H	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		5,000 FEET PRESS ALT. TO 200 FEET PRESS ALT.	
I	LOITER (PARA 4.2.6)		1 HOUR	NO CREDIT	MAXIMUM ENDURANCE	200 FEET PRESS ALT.	
J	COMBAT	CLIMB TO 5000 FEET PRESS ALT. @ BEST CLIMB SPEED @ INTERMEDIATE THRUST AND DESCEND BACK TO 200 FEET PRESS ALT. CLIMB TIME AND FUEL AND DESCENT TIME ARE ACCOUNTED FOR. ALL STORES ARE RETAINED.					
K	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (1)	200 FEET PRESS ALT. TO OPTIMUM CRUISE	INTERMEDIATE
L	CRUISE (PARA4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
M	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
N	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	

NOTE: (1) CLIMB SCHEDULE ENDS AT LONG RANGE CRUISE SPEED/OPTIMUM CRUISE ALTITUDE.

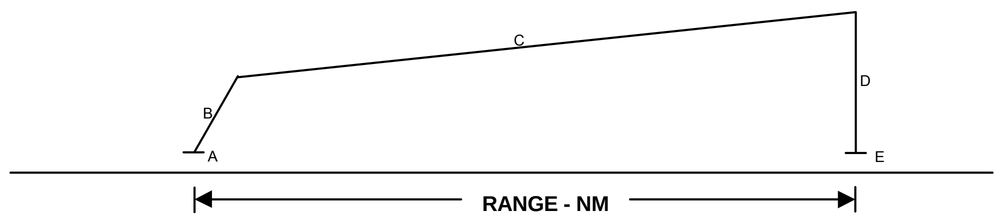
FIGURE B-38. Patrol/Anti-submarine warfare (ASW)



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (1)	TAKEOFF TO OPTIMUM CRUISE	INTERMEDIATE
C	CRUISE (PARA 4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO 200 FEET PRESS ALTITUDE	
E	PENETRATION (PARA 4.2.4)			300 NM/50 NM (4)	MAXIMUM CRUISE	200 FT PRESS ALT.	MAX CONTINUOUS
F	COMBAT (2) AND (3)	TIME AND FUEL FOR A 50 NM RUN @ Virt, 200 FT PRESS ALT. NO DISTANCE CREDITED. EXPEND STORES AFTER COMBAT					
G	WITHDRAWAL (PARA 4.2.4)			300 NM/50 NM (4)	MAXIMUM CRUISE	200 FT PRESS ALT.	MAX CONTINUOUS
H	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (1)	200 FEET PRESS ALT. TO OPTIMUM CRUISE	INTERMEDIATE
I	CRUISE (PARA 4.2.3)				LONG RANGE CRUISE	OPTIMUM CRUISE	
J	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
K	RESERVES	20 MIN + 5% OF INITIAL FUEL		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
L							

NOTES:
(1) CLIMB SCHEDULE ENDS AT LONG RANGE CRUISE SPEED/OPTIMUM CRUISE ALTITUDE.
(2) SEE PARA 4.1.5 AND 4.1.7.
(3) INCLUDE FUEL FOR ACCELERATION TO COMBAT SPEED.
(4) 50 NM IS THE DISTANCE FOR TACTICAL AIRCRAFT.

FIGURE B-39. Minelaying



	SEGMENT	FUEL	TIME	DISTANCE	SPEED	ALTITUDE	THRUST SETTING (1)
A	WARM-UP, TAKEOFF, AND ACCELERATE TO CLIMB SPEED	20 MIN @ GROUND IDLE + 30 SEC @ TAKEOFF / MAXIMUM / IRT (A/B IF REQUIRED) + FUEL TO ACCELERATE FROM OBSTACLE CLEARANCE TO CLIMB SPEED @ IRT. NO DISTANCE CREDIT.					
B	CLIMB (PARA 4.2.2)				MINIMUM TIME CLIMB SCHEDULE (2)	TAKEOFF TO OPTIMUM CRUISE	MAX CONTINUOUS OR IRT / IRT
C	CRUISE (PARA 4.2.3)				OPTIMUM CRUISE (4)	OPTIMUM CRUISE	
D	DESCENT (PARA 4.2.8)	NONE	NONE	NO CREDIT		END CRUISE TO LANDING	
E	RESERVES	20 MIN + 5% OF INITIAL FUEL (3)		NO CREDIT	MAXIMUM ENDURANCE	SEA LEVEL	
F							
G							
H							
I							
J							
K							
L							

NOTES: (1) THRUST SETTINGS ARE NON-AUGMENTED/AUGMENTED.

(2) CLIMB SCHEDULE ENDS AT OPTIMUM CRUISE SPEED/ALTITUDE.

(3) FOR BOMBER AND CARGO/TRANSPORT USE 30 MIN + 5% OF INITIAL FUEL.

(4) FOR BOMBER AND CARGO/TRANSPORT USE LONG-RANGE CRUISE SPEED.

FIGURE B-40. Ferry mission

Custodians:
Army – AV
Navy – AS
Air Force – 11

Preparing activity:
Air Force – 11
(Project 15GP-2008-003)

Review activities:
Army – TE
Navy – CG, SA
DLA – GS

Industry associations:
AIA

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla.mil.