This is a revision of the *Learjet 30 Series Pilot Training Manual, Volume 1*.

The portion of the text or figure affected by the current revision is indicated by a solid vertical line in the margin. A vertical line adjacent to blank space means that material has been deleted. In addition, each revised page is marked “Revision .02” in the lower left or right corner.

The changes made in this revision will be further explained at the appropriate time in the training course.
LEARJET 30 SERIES

PILOT TRAINING MANUAL
VOLUME 1

OPERATIONAL INFORMATION
Courses for the Learjet 30 Series are taught at the following FlightSafety learning centers:

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NOTICE

The material contained in this training manual is based on information obtained from the aircraft manufacturer’s pilot manuals and maintenance manuals. It is to be used for familiarization and training purposes only.

At the time of printing it contained then-current information. In the event of conflict between data provided herein and that in publications issued by the manufacturer or the FAA, that of the manufacturer or the FAA shall take precedence.

We at FlightSafety want you to have the best training possible. We welcome any suggestions you might have for improving this manual or any other aspect of our training program.
CONTENTS

EXPANDED CHECKLIST

Normal Procedures
Abnormal Procedures
Emergency Procedures

LIMITATIONS

MANEUVERS AND PROCEDURES

WEIGHT AND BALANCE

PERFORMANCE

CRM
The material covered in this chapter can be found in Section II of the aircraft manufacturer’s FAA-approved *Airplane Flight Manual*.
The material covered in this chapter can be found in Section IV of the aircraft manufacturer’s FAA-approved *Airplane Flight Manual*.
The material covered in this chapter can be found in Section III of the aircraft manufacturer’s FAA-approved *Airplane Flight Manual*. 
The material covered in this chapter can be found in Section I of the aircraft manufacturer’s FAA-approved *Airplane Flight Manual*. 
# MANEUVERS AND PROCEDURES

## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION</td>
<td>MAP-1</td>
</tr>
<tr>
<td>GENERAL</td>
<td>MAP-1</td>
</tr>
<tr>
<td>ABBREVIATIONS</td>
<td>MAP-1</td>
</tr>
<tr>
<td>STANDARD OPERATING PROCEDURES</td>
<td>MAP-2</td>
</tr>
<tr>
<td>General</td>
<td>MAP-2</td>
</tr>
<tr>
<td>Responsibilities</td>
<td>MAP-2</td>
</tr>
<tr>
<td>Checklist Procedures</td>
<td>MAP-2</td>
</tr>
<tr>
<td>Briefing Guides</td>
<td>MAP-3</td>
</tr>
<tr>
<td>Takeoff Procedures</td>
<td>MAP-4</td>
</tr>
<tr>
<td>Climb and Cruise Procedures</td>
<td>MAP-5</td>
</tr>
<tr>
<td>Approach Planning</td>
<td>MAP-5</td>
</tr>
<tr>
<td>Descent Procedures</td>
<td>MAP-6</td>
</tr>
<tr>
<td>Approach Procedures</td>
<td>MAP-6</td>
</tr>
<tr>
<td>Go Around/Balked Landing</td>
<td>MAP-7</td>
</tr>
<tr>
<td>MANEUVERS</td>
<td>MAP-7</td>
</tr>
<tr>
<td>General</td>
<td>MAP-7</td>
</tr>
<tr>
<td>Performance Standards</td>
<td>MAP-8</td>
</tr>
<tr>
<td>Minimum Maneuvering Speeds</td>
<td>MAP-8</td>
</tr>
<tr>
<td>Power Settings</td>
<td>MAP-8</td>
</tr>
<tr>
<td>Takeoff</td>
<td>MAP-10</td>
</tr>
<tr>
<td>Engine Failure below V(_1) Speed</td>
<td>MAP-12</td>
</tr>
<tr>
<td>Engine Failure above V(_1) Speed</td>
<td>MAP-13</td>
</tr>
</tbody>
</table>
Steep Turns.......................................................... MAP-14
Unusual Attitude Recovery, Nose-High, Low Speed........ MAP-16
Unusual Attitude Recovery, Nose-Low, High Speed ....... MAP-17
Slow Flight.......................................................... MAP-18
Approach to Stall.................................................. MAP-20
Emergency Descent.............................................. MAP-22
Visual Traffic Pattern, Two Engines......................... MAP-23
Visual Traffic Pattern, Single Engine....................... MAP-23
Flaps Up Landing.................................................. MAP-24
Precision Instrument Approach............................... MAP-25
Nonprecision Instrument Approach........................ MAP-26
Circling Instrument Approach.............................. MAP-27
Go-Around/Balked Landing.................................... MAP-29
Single-Engine Drift Down...................................... MAP-30
ILLUSTRATIONS

<table>
<thead>
<tr>
<th>Figure</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAP-1</td>
<td>Normal Takeoff</td>
<td>MAP-11</td>
</tr>
<tr>
<td>MAP-2</td>
<td>Rejected Takeoff</td>
<td>MAP-12</td>
</tr>
<tr>
<td>MAP-3</td>
<td>Engine Failure at or above V_1 Speed</td>
<td>MAP-13</td>
</tr>
<tr>
<td>MAP-4</td>
<td>Steep Turns</td>
<td>MAP-15</td>
</tr>
<tr>
<td>MAP-5</td>
<td>Unusual Attitude Recovery, Nose High, Low Speed</td>
<td>MAP-16</td>
</tr>
<tr>
<td>MAP-6</td>
<td>Unusual Attitude Recovery, Nose Low, High Speed</td>
<td>MAP-17</td>
</tr>
<tr>
<td>MAP-7</td>
<td>Slow Flight—Clean Configuration</td>
<td>MAP-18</td>
</tr>
<tr>
<td>MAP-8</td>
<td>Slow Flight—Takeoff Configuration</td>
<td>MAP-19</td>
</tr>
<tr>
<td>MAP-9</td>
<td>Slow Flight—Landing Configuration</td>
<td>MAP-19</td>
</tr>
<tr>
<td>MAP-10</td>
<td>Approach to Stall—Clean Configuration</td>
<td>MAP-20</td>
</tr>
<tr>
<td>MAP-11</td>
<td>Approach to Stall—Takeoff Configuration</td>
<td>MAP-21</td>
</tr>
<tr>
<td>MAP-12</td>
<td>Approach to Stall—Landing Configuration</td>
<td>MAP-21</td>
</tr>
<tr>
<td>MAP-13</td>
<td>Emergency Descent</td>
<td>MAP-22</td>
</tr>
<tr>
<td>MAP-14</td>
<td>Visual Traffic Pattern</td>
<td>MAP-23</td>
</tr>
<tr>
<td>MAP-15</td>
<td>Flaps Up Landing</td>
<td>MAP-24</td>
</tr>
<tr>
<td>MAP-16</td>
<td>Precision Instrument Approach</td>
<td>MAP-25</td>
</tr>
<tr>
<td>MAP-17</td>
<td>Nonprecision Instrument Approach</td>
<td>MAP-26</td>
</tr>
<tr>
<td>MAP-18</td>
<td>Circling Instrument Approach</td>
<td>MAP-28</td>
</tr>
<tr>
<td>MAP-19</td>
<td>Go-Around/Balked Landing</td>
<td>MAP-29</td>
</tr>
<tr>
<td>MAP-20</td>
<td>Single-Engine Drift Down</td>
<td>MAP-30</td>
</tr>
</tbody>
</table>

TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAP-1</td>
<td>Performance Standards</td>
<td>MAP-9</td>
</tr>
</tbody>
</table>
INTRODUCTION

The general pilot information in this chapter is intended to supplement and expand upon information in other sources. It is not intended to supersede any official publication. If there is any conflict between the information in this chapter and that in any official publication, the information in the official publication takes precedence.

GENERAL

General pilot information includes Standard Operating Procedures and the maneuvers normally encountered during Learjet training and operations. The following abbreviations are used in this chapter.

ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFM</td>
<td>Airplane Flight Manual</td>
</tr>
<tr>
<td>AGL</td>
<td>Above Ground Level</td>
</tr>
<tr>
<td>ATA</td>
<td>Airport Traffic Area (Class D Airspace effective 9/16/93)</td>
</tr>
<tr>
<td>ATC</td>
<td>Air Traffic Control</td>
</tr>
<tr>
<td>CDI</td>
<td>Course Deviation Indicator</td>
</tr>
<tr>
<td>COM/NAV</td>
<td>Communication/Navigation</td>
</tr>
<tr>
<td>DH</td>
<td>Decision Height</td>
</tr>
<tr>
<td>FAF</td>
<td>Final Approach Fix</td>
</tr>
<tr>
<td>FL</td>
<td>Flight Level</td>
</tr>
<tr>
<td>HAA</td>
<td>Height Above Airport</td>
</tr>
<tr>
<td>HAT</td>
<td>Height Above Touchdown</td>
</tr>
<tr>
<td>MMO</td>
<td>Mach, Maximum Operational</td>
</tr>
<tr>
<td>MSL</td>
<td>Mean Sea Level</td>
</tr>
<tr>
<td>N1</td>
<td>Fan Speed</td>
</tr>
<tr>
<td>PF</td>
<td>Pilot Flying</td>
</tr>
<tr>
<td>PIC</td>
<td>Pilot in Command</td>
</tr>
<tr>
<td>PNF</td>
<td>Pilot Not Flying</td>
</tr>
<tr>
<td>SOP</td>
<td>Standard Operating Procedure</td>
</tr>
<tr>
<td>VDP</td>
<td>Visual Descent Point</td>
</tr>
<tr>
<td>VFE</td>
<td>Velocity Flaps Extended</td>
</tr>
<tr>
<td>VLE</td>
<td>Velocity Gear Extended</td>
</tr>
<tr>
<td>VLO</td>
<td>Velocity Gear Operation</td>
</tr>
</tbody>
</table>
### STANDARD OPERATING PROCEDURES

#### GENERAL

Standard Operating Procedures (SOPs) are used to supplement the information in the AFM and Federal Air Regulations. Adherence to SOPs enhances individual and crew situational awareness and performance. SOPs may include assignment of responsibilities, briefing guides and procedures to be followed during specific segments of flight. The SOPs in this section are not intended to be mandatory or to supersede any individual company SOPs. They are simply provided as examples of good operating practices.

#### RESPONSIBILITIES

**PIC**—The Pilot in Command is designated by the company for flights requiring more than one pilot. Responsible for conduct and safety of the flight. Designates pilot flying and pilot not flying duties.

**PF**—The Pilot Flying controls the airplane with respect to heading, altitude, and airspeed and accomplishes other tasks as directed by the PIC.

**PNF**—The Pilot Not Flying maintains ATC communications, obtains clearances, accomplishes checklists, makes altitude callouts and other tasks as directed by the PIC.

All crewmembers are responsible for providing advice and counsel to the PIC. The PIC may choose to accept or reject such advice. That is a prerogative of the PIC. But neither the PIC’s acceptance nor rejection of advice relieves other crewmembers of the responsibility of providing it.

#### CHECKLIST PROCEDURES

Normally, the PF initiates all checklists. However, if the PNF thinks a checklist should be accomplished, and the PF has not called for it, the PNF should prompt the PF. For example, “Ready for the Approach checklist, Captain?”

FlightSafety International recommends the use of the checklist challenge and response concept. Using Normal Procedures checklists, the PNF challenges the PF and the PF responds. Using Abnormal or Emergency Procedures checklists, the PNF challenges the PF and, as a memory aid, also gives the checklist item response. The PF then responds.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAF</td>
<td>Initial Approach Fix</td>
</tr>
<tr>
<td>KIAS</td>
<td>Knots, Indicated Airspeed</td>
</tr>
<tr>
<td>MAP</td>
<td>Missed Approach Point</td>
</tr>
<tr>
<td>MDA</td>
<td>Minimum Descent Altitude</td>
</tr>
<tr>
<td>MEA</td>
<td>Minimum Enroute Altitude</td>
</tr>
<tr>
<td>V&lt;sub&gt;MO&lt;/sub&gt;</td>
<td>Velocity Maximum Operational</td>
</tr>
<tr>
<td>V&lt;sub&gt;1&lt;/sub&gt;</td>
<td>Critical Engine Failure Speed</td>
</tr>
<tr>
<td>V&lt;sub&gt;R&lt;/sub&gt;</td>
<td>Rotation Speed</td>
</tr>
<tr>
<td>V&lt;sub&gt;REF&lt;/sub&gt;</td>
<td>Reference Speed</td>
</tr>
<tr>
<td>V&lt;sub&gt;2&lt;/sub&gt;</td>
<td>Takeoff Safety Speed</td>
</tr>
</tbody>
</table>
The PF may elect to have the PNF accomplish some Abnormal or Emergency Procedure checklists on the PF’s command. In this case, the PNF gives the checklist item and response. The PF replies with the response and the PNF accomplishes the action.

When a checklist has been completed, the PNF reports the checklist is complete and that he/she is standing by with the next checklist. For example, “Approach checklist complete. Standing by with the Before Landing checklist.”

If an emergency occurs on takeoff after $V_1$ speed and takeoff is continued, no checklist should be initiated before the airplane reaches a safe altitude above the ground; at least 400 feet.

**BRIEFING GUIDES**

**General**

While the Learjet AFM does not specifically require before takeoff and approach briefings, such briefings are appropriate under some circumstances. The briefing guides presented below should be used when flying with unfamiliar crewmembers or any other time the PIC believes they are necessary.

It should be noted that many of these items can, and should, be briefed well before engine start. Many of them can be discussed before arriving at the airplane.

**Pretakeoff Briefing**

The pretakeoff briefing should address the following items:

- Type of takeoff; rolling or standing, flap setting, etc.
- Review takeoff data to include power setting and speeds
- Procedures to be used in the event of an emergency before or after $V_1$ speed including emergency return procedures
- Headings and altitudes to be flown during the departure including restrictions, if any
- Radio, navigational systems and flight director settings
- Anti-icing requirements, if applicable
- Specific PNF duties and callouts. (See “Takeoff Procedures,” later in this section for additional information.)
- A request for “Any questions?” directed to all cockpit crewmembers
Approach Briefing

The approach briefing should be completed before starting descent and address the following items. The PF normally transfers airplane control to the PNF during the briefing.

- Approach to be used and backup approach, if available
- Special procedures to be used during the approach, such as circling approach procedures, interception of a radial from an arc, VDP, etc.
- Altitudes of IAF, FAF, stepdowns, sector and obstacles
- Minimums (DH, MDA), (HAT, HAA), radio altimeter setting
- Missed approach point and procedures, timing to MAP/VDP
- Radio (COM/NAV) setup desired
- Anti-icing requirements. Specific PNF duties and callouts. (See “Approach Procedures,” later in this section, for additional information.)
- The procedure for transitioning to visual flight
- A request for “Any questions?” directed to all cockpit crewmembers

At the completion of the Approach briefing, the PF announces “Approach briefing complete,” and reassumes control of the airplane if control has been transferred to the PNF.

TAKEOFF PROCEDURES

When cleared for takeoff, the PNF reports “Before Takeoff checklist complete, cleared for takeoff.” The PF advances power toward the takeoff power setting, the PNF taps PF’s hand and makes the final power setting.

At initial airspeed indication, the PNF cross-checks airspeed indicators and reports “Airspeed alive.” PF releases nosewheel steering.

At V₁ speed, the PNF calls “Vee One.” The PF releases the thrust levers and puts both hands on the control column.

At V_R, the PNF calls “Rotate.” The PF rotates airplane to a 9° noseup pitch attitude.

With positive rate of climb, the PF calls “Positive rate, gear up, yaw damper on.” The PNF positions the gear handle to up and calls “Gear selected up, yaw damper engaged.” The PNF monitors the gear while it is retracting and reports “Gear up,” when retraction is complete.

Before V_FE (V₂ plus 30 knots minimum), the PF calls, “Flaps up, After Takeoff checklist.” The PNF positions the flap handle to up and calls “Flaps selected up.” The PNF monitors the flaps while they are retracting and reports “Flaps up,” when retraction is complete. PNF accomplishes the After Takeoff checklist.
CLIMB AND CRUISE PROCEDURES

The PNF announces all assigned altitudes and sets them in the altitude alerter. The PNF also calls out 1,000 feet above, or below, all assigned altitudes and altitude restrictions. These calls normally are made by stating the existing altitude and the assigned altitude or restriction. For example, “Through 9,000 feet, cleared to 8,000,” or “Through flight level 360 for 370.” The PNF also announces other significant altitudes, such as, “Through 18,000 feet, altimeter 29.92,” or, “Flight lever 410, going on oxygen.”

The PF periodically announces his intentions and targets throughout the flight, such as “Accelerating to 250 knots,” “Turning right to 260 degrees and descending to 3,000 feet,” “We’ll hold this heading until intercepting the 090 degree radial and then turn left to the station.”

Any change in cockpit function is announced by the pilot making the change and acknowledged by the other pilot. For example, the PNF announces, “VOR number two set to Springfield and identified.” PF acknowledges, “VOR two on Springfield.” PF announces, “Autopilot engaged and coupled in climb and heading modes.” PNF acknowledges, “Roger.”

Transfer of airplane control is announced by the pilot initiating the change and acknowledged by the pilot assuming control. Specific target values are provided to the pilot assuming control. For example, the PF announces, “Take the airplane for a minute. We’re climbing at 250 knots to 7,000 on a vector to the 045 radial.” PNF acknowledges, “I’ve got the airplane, climbing at 250 to 7,000 on this heading until intercepting the 045 radial.”

APPROACH PLANNING

Approach planning and briefing should be accomplished during cruise. Review hazardous terrain, MEAs, and minimum sector altitudes. Complete and review performance data to include \( V_{REF} \) speed, landing distance, approach climb speed, and power setting.

The PF directs the PNF to obtain destination weather or obtains it himself. If the PNF obtains the weather, the PF normally assumes ATC Communications while the PNF is obtaining weather. In either case, after checking weather, the pilot who did so briefs the other pilot on the destination weather, the expected approach, and any other significant information.

If a VDP has not been published, a “time to see the runway” may be computed as follows. Take the MDA, divided by 10, and subtract that, in seconds, from the time from the FAF to the MAP. For example, assume the MDA is 400 feet and the time from the FAF to the MAP is 1 minute and 45 seconds. Four hundred, divided by 10 equals 40. Subtracting that from 1:45 equals 1:05 from the FAF to see the runway. If the runway is not in sight at the end of that time, either a faster than normal rate of descent is required, or the airplane lands beyond the normal touchdown zone.

Normally, ATC determines when a descent may be started. However, descents may sometimes be started at the PF’s discretion. To determine how far out to start descent for an approach, use 3 times the altitude to be lost, divided by 1,000. For example, to lose 40,000 feet, 3 times 40,000 equals 120,000, divided by 1,000 equals 120 miles out to start descent.
The Descent checklist should be started before, or early in, the descent to permit proper windshield heat and pressurization system operation.

Descent below flight level 180 will not be started before obtaining a local area altimeter setting.

**DESCENT PROCEDURES**

The same procedures used during climb and cruise are used during descent. The PNF accomplishes the Descent checklist, as directed by the PF, and makes altitude callouts to include the transition level and 10,000 feet.

**APPROACH PROCEDURES**

The PF initiates the Approach checklist when descending out of 18,000 feet or when within 50 miles of the destination airport. The checklist is accomplished so as to not interfere with the visual lookout for other traffic.

Configuration changes during the approach are accomplished using the same crew coordination techniques used after takeoff. The PF calls for a configuration change. The PNF acknowledges, selects the switch position, monitors and reports when gear and flaps are in the selected positions.

The Approach checklist is completed and the airplane slowed to $V_{REF} + 40$ knots (minimum) before reaching the IAF.

Over the IAF, for other than a straight-in approach, the PF turns outbound, calls for flaps 8°, slows the airplane to $V_{REF} + 30$ knots (minimum), and begins a descent, if necessary. The PNF starts timing, announces the time to be flown and the outbound course, or heading, and altitude, if an altitude change is required.

If a procedure turn is to be made, any accepted procedure turn maneuver may be used. At the expiration of the procedure turn outbound time, the PNF announces the time is up, the direction of turn, the next heading and altitude, if an altitude change is required. For example, “Time’s up, right turn now to 225° and cleared down to 3,000.”

Approaching the final approach course, the PNF monitors the CDI or bearing pointer and reports “CDI alive,” or “Within 5° of the inbound course.”

Established on final approach, the PF calls for flaps 20°, slows the airplane to $V_{REF} + 20$ knots (minimum), and begins a descent, if necessary. Prior to the FAF, the PF calls “Gear down, Before Landing checklist.” The PNF extends the landing gear, completes the Before Landing checklist up to flaps down and reports, “Before Landing checklist complete to full flaps.”

Over the FAF, on a two-engine, straight-in approach, the PF calls for flaps 40°, slows the airplane to $V_{REF}$ (minimum), and begins a descent. (For a single-engine, or circling approach, the flaps remain at 20° until the landing is assured.) The PNF begins timing, if necessary, extends the flaps and completes the Before Landing checklist. The PNF also confirms that the COM/NAV radios are set properly, checks the flight instruments, airspeed bugs, altitude alerters, radio altimeter setting and MDA or DH. The PNF then reports, “Before Landing checklist complete, no flags, cleared to descend to ________ feet.”
After passing the FAF, the PNF begins looking for visual references outside the airplane. However, he/she also monitors the instruments and calls out significant deviations such as 1 dot, or more, deflection on the CDI or glide slope and airspeed variations greater than -0 to +10 knots from \( V_{REF} \). If the PF does not respond to the callout, the PNF repeats it. If the PF does not respond to the second callout, the PNF assumes the PF has been incapacitated and announces that he/she (the PNF) is taking control of the airplane.

The PNF calls out the time to the VDP/MAP and 1,000, 500, and 100 feet above MDA or DH and when reaching MDA or DH calls out “Minimum descent altitude” or “Decision height.” The PNF also reports visual contact with the ground such as, “Visual contact, no runway yet,” “Approach lights in sight at 11 o’clock,” or “Runway in sight straight ahead.” If the PNF does not call, “Runway in sight,” at the MAP or DH, or reports, “No contact,” the PF will initiate a go around.

Approaching minimums, or the missed approach point, the PF begins cross-checking outside the airplane for visual references. When satisfied that visual references are adequate for landing, the PF announces, “I’m going visual,” or “Going outside.” At this point, the PNF directs his attention primarily inside the airplane, while cross-checking outside, and calls airspeed, descent rate, and altitude. The purpose is to provide the PF, verbally, the same information he/she would have if still on instruments.

Airspeed should be called as plus or minus \( V_{REF} \), descent rate as up or down and altitude above the ground. For example, “Plus 5, down 500, 100 feet,” indicates the airspeed is \( V_{REF} \) plus 5 knots, the airplane is descending at 500 feet per minute and is 100 feet above the ground.

**GO AROUND/BALKED LANDING**

If a go around/balked landing is necessary, the PF calls “Going around, flaps 20°” while simultaneously disengaging the autopilot by selecting flight director go-around mode, establishing a 9° noseup pitch attitude, setting takeoff power, or as required, and checking that the spoilers are retracted. The PNF sets, or confirms, the flaps at 20°, calls out the direction of turn, if one is required, and the missed approach heading and altitude. The PNF also adjusts the power setting, if necessary, and notifies ATC of the missed approach.

**MANEUVERS**

**GENERAL**

This section contains a description of most of the maneuvers that are likely to be encountered during Learjet training and operational flying. While there is always more than one way to fly an airplane, these procedures have been developed over many years of Learjet operations. They have proven to be safe, efficient, and readily manageable. These procedures are consistent with the AFM. However, if a conflict should develop between these procedures and those in the AFM, the AFM procedures should be used.
PERFORMANCE STANDARDS

The performance standards in Table MAP-1 should be maintained during all Learjet flight operations.

MINIMUM MANEUVERING SPEEDS

Minimum maneuvering speeds are expressed in terms of $V_{REF}$ speed which is 1.3 times the stalling speed in the landing configuration.

For maneuvering with up to 30° of bank, the following minimum speeds should be used:

- Spoilers deployed: $V_{REF} + 50$ KNOTS
- Flaps up: $V_{REF} + 40$ KNOTS
- Flaps 8°: $V_{REF} + 30$ KNOTS
- Flaps 20°: $V_{REF} + 20$ KNOTS
- Flaps 40°: $V_{REF} + 10$ KNOTS

For maneuvering with up to 15° of bank, on final approach for landing, for example, the following minimum speeds should be used:

- Spoilers deployed: $V_{REF} + 40$ KNOTS
- Flaps up: $V_{REF} + 30$ KNOTS
- Flaps 8°: $V_{REF} + 20$ KNOTS
- Flaps 20°: $V_{REF} + 10$ KNOTS
- Flaps 40°: $V_{REF}$

POWER SETTINGS

Actual power settings vary depending upon the temperature, pressure altitude, and airplane gross weight. The following target settings are approximate, but may be used to provide a starting point to determine the actual power setting.

Below 10,000 MSL, 60% $N_1$ to maintain 200 KIAS, 70 to 75% $N_1$ to maintain 250 KIAS.

Between 10,000 MSL and FL 250, 75 to 80% $N_1$ to maintain 250 KIAS.
Table MAP-1. PERFORMANCE STANDARDS

<table>
<thead>
<tr>
<th>Category</th>
<th>Parameters</th>
</tr>
</thead>
</table>
| Steep Turns       | Bank angle: 45°, ±5°  
|                   | Altitude: ±100 feet  
|                   | Airspeed: ±10 KIAS  
|                   | Heading: ±10°        |
| Approach to Stall | Initiate recovery at stick shaker onset.  
|                   | Recover with minimum altitude loss.            |
| Holding           | Altitude: ±100 feet  
|                   | Airspeed: ±10 knots                                  |
| Instrument Approaches | Initial: Altitude: ±100 feet  
|                   | Airspeed: ±10 knots                                  |
|                   | Final: Airspeed: -0, +5 knots  
|                   | Localizer: ±1 dot                                       |
|                   | Glide Slope: ±1 dot                                     |
|                   | Bearing Pointer: ±5°                                      |
|                   | MDA: Altitude: -0, +50 feet                             |
| Circling Approaches | Bank Angle: 30° maximum                                 |
|                   | Altitude: -0, +100 feet                                 |
|                   | Airspeed: -0, +5 knots                                  |
| Missed Approach   | DH: Altitude: -0 before initiation of the missed approach |
|                   | MDA: Altitude: -0, unless runway environment had been in sight before the missed approach. |
| Landings          | Traffic Pattern: Airspeed: ±10 knots                  |
|                   | Altitude: ±100 feet                                     |
|                   | Final Approach: Airspeed: -0, +5 knots                 |
TAKEOFF

Either 8° or 20° of flaps may be used for takeoff. The normal, standing takeoff (Figure MAP-1) must be used to achieve the performance specified in the AFM. If the runway available is at least 10 percent longer than the planned takeoff distance, a rolling takeoff may be used. The procedures are the same except for a standing takeoff, power is set before brake release. For a rolling takeoff, the brakes are released before the power is set. During a rolling takeoff, takeoff power must be set before the runway remaining equals the takeoff distance.

Normally, before $V_{FE}$ ($V_2$ plus 30 knots minimum), the flaps are retracted and the After Takeoff checklist is accomplished. However, if traffic conditions warrant, the After Takeoff checklist may be delayed until the airplane is clear of local traffic.

Approaching 200 knots, the PF should adjust power and pitch attitude if necessary, to maintain 200 knots or less within the ATA (Class D Airspace). For passenger comfort and ease of airplane control, it is recommended that the pitch attitude not exceed 20° noseup.

The maximum continuous climb power setting is a variable depending on temperature and pressure altitude. The “Maximum Continuous Thrust ($N_1$)” chart, in the Performance Data section of the checklist, and AFM thrust setting procedures should be used.
Before Takeoff
1. PF holds brakes and advances power
2. PNF sets takeoff power

Initial Airspeed Indication
1. PNF calls "airspeed"
2. PF disengages nosewheel steering

80 KIAS
1. PNF monitors and adjusts takeoff power

Positive Rate of Climb
1. PF calls "gear up, yaw damper on"
2. PNF retracts the landing gear and engages the yaw damper

Clear of ATA/Class D Airspace
1. PF sets maximum continuous climb power and accelerates airplane to 250 KIAS

Approaching 200 KIAS
1. PF adjusts pitch and power to remain below 200 KIAS in airport traffic area (ATA) class D airspace

Before VFE (V2 plus 30 KT minimum)
1. PF calls "flaps up, after takeoff checklist"
2. PNF accomplishes after takeoff checklist

80 KIAS
1. PNF calls "vee one"
2. PF releases thrust levers

V1
1. PF calls "rotate"
2. PF rotates airplane to 9° nose up pitch attitude

Vr
1. PF calls "rotate"
2. PF rotates airplane to 9° nose up pitch attitude

For training purposes only
Figure MAP-1. Normal Takeoff
ENGINE FAILURE BELOW $V_1$ SPEED

If an engine fails below $V_1$ speed (Figure MAP-2), the takeoff must be aborted. The PF simultaneously reduces power to idle, applies maximum braking and deploys the spoilers. The drag chute or thrust reversers (if installed) are deployed if necessary.

Takeoffs may be aborted for malfunctions other than engine failure; however, the same procedures should normally be used.
ENGINE FAILURE ABOVE $V_1$ SPEED

If an engine fails above $V_1$ speed (Figure MAP-3), the takeoff is normally continued. The PF maintains directional control with ailerons and rudder and keeps the nosewheel on the runway until reaching rotate speed. After liftoff, the initial climb is made at $V_2$ speed with takeoff flaps until the airplane is clear of obstacles or, if there are no obstacles, to 1,500 feet AGL. The PF then accelerates the airplane to $V_2$ plus 30 knots (minimum) and directs the PNF to retract the flaps. The PF then accelerates the airplane to single-engine climb speed (normally 200 knots) and climbs to the assigned altitude.

At a safe altitude above the ground (normally, no lower than 400 feet), the memory items for the Engine Failure/Fire Shutdown in Flight checklists are completed. The rest of the Engine Failure During Takeoff checklist along with the Engine Failure/Fire Shutdown in Flight checklists (as appropriate), and the After Takeoff checklist are normally completed at, or above, 1,500 feet AGL. The crew then elects to obtain clearance to return to the departure airport for landing or proceeds to an alternate airport.
STEEP TURNS

Steep turns (Figure MAP-4) are used to build confidence in the airplane and improve instrument cross-check. They may be accomplished at any altitude above 5,000 feet AGL. The higher the altitude, the more difficult the maneuver is to perform correctly. Steep turns are accomplished without flight director steering commands since the flight director does not command 45° of bank.

Power must be increased approximately 2% $N_1$ to maintain airspeed during steep turns. The airplane should be kept in trim and the bank angle should be held constant. If altitude corrections are necessary, they should be made in pitch only. It is not necessary to shallow the bank to climb during a steep turn in a Learjet.

Steep turns of at least 180°, preferable 360°, should be practiced in each direction.
1. Roll into 45˚ of bank
2. Increase power to maintain airspeed
3. Trim — as required

1. Lead roll-out heading by 10˚
2. Reduce power to maintain airspeed
3. Trim — as required

1. Gear and flaps — up
2. Airspeed — 250 KIAS

Figure MAP-4. Steep Turns
UNUSUAL ATTITUDE RECOVERY, NOSE HIGH, LOW SPEED

Recovery from a nose-high, low-speed unusual attitude (Figure MAP-5) should be made while maintaining positive G forces and without stalling the airplane. It is accomplished by increasing power while simultaneously increasing the angle of bank, not to exceed 90°, to allow the nose of the airplane to descend to the horizon without negative G forces. The attitude indicator should be used during the recovery and the angle-of-attack indicator cross-checked to maintain the pointer in the green band.

![Diagram of unusual attitude recovery, nose high, low speed](image-url)

**Figure MAP-5. Unusual Attitude Recovery, Nose High, Low Speed**
UNUSUAL ATTITUDE RECOVERY, NOSE LOW, HIGH SPEED

Recovery from a nose-low, high-speed unusual attitude (Figure MAP-6) should be made with minimum loss of altitude while keeping the airspeed below $V_{MO}$ or $M_{MO}$. It is accomplished by simultaneously reducing power to idle and rolling the wings level. When the bank is less than 90°, elevator and pitch trim (if required) are used to raise the nose to the horizon. Spoilers should not be used during recovery from a nose low unusual attitude.

During training, nose-low, high-speed unusual attitudes are always presented so the airplane can be recovered without exceeding any limitations. However, during recovery from an actual, inadvertent, nose-low, high-speed unusual attitude, an overspeed condition may develop. In this case, the overspeed recovery procedures in the AFM should be used.

Figure MAP-6. Unusual Attitude Recovery, Nose Low, High Speed
SLOW FLIGHT

Slow flight is used to develop the pilot’s sense of feel for the airplane’s low-speed handling characteristics and improve the pilot’s coordination and instrument cross-check. Slow flight is accomplished in the clean, takeoff, and landing configurations (Figures MAP-7, MAP-8 and MAP-9), and is normally accomplished between 10,000 and 15,000 feet MSL. Slow flight should not be accomplished below 5,000 AGL.

Slow flight may be practiced while maintaining a constant altitude and heading or while maintaining a constant altitude and making turns to preselected headings. Slow flight may also be practiced while making constant rate climbs and descents to preselected altitude. Slow flight practice may be terminated by a recovery to normal cruise or an approach to stall.

Figure MAP-7. Slow Flight—Clean Configuration
**APPROACH TO STALL**

<table>
<thead>
<tr>
<th>ENTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. GEAR — UP OR DOWN</td>
</tr>
<tr>
<td>2. FLAPS — 8° OR 20°</td>
</tr>
<tr>
<td>3. AIRSPEED: $V_{REF} + 10$ KT WITH FLAPS 8°</td>
</tr>
<tr>
<td>4. ALTITUDE — 10,000 TO 15,000 FEET</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DURING SLOW FLIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. MAINTAIN ALTITUDE AND HEADING</td>
</tr>
</tbody>
</table>

**OPTIONAL**

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 15° BANK TURNS TO PRESELECTED HEADINGS</td>
</tr>
<tr>
<td>2. CONSTANT RATE CLIMBS AND DESCENTS</td>
</tr>
</tbody>
</table>

**Figure MAP-8. Slow Flight—Takeoff Configuration**

<table>
<thead>
<tr>
<th>ENTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. GEAR — DOWN</td>
</tr>
<tr>
<td>2. FLAPS — 40°</td>
</tr>
<tr>
<td>3. AIRSPEED — $V_{REF} - 10$ KT</td>
</tr>
<tr>
<td>4. ALTITUDE — 10,000 TO 15,000 FEET</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DURING SLOW FLIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. MAINTAIN ALTITUDE AND HEADING</td>
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**OPTIONAL**

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<tbody>
<tr>
<td>1. 15° BANK TURNS TO PRESELECTED HEADINGS</td>
</tr>
<tr>
<td>2. CONSTANT RATE CLIMBS AND DESCENTS</td>
</tr>
</tbody>
</table>

**Figure MAP-9. Slow Flight—Landing Configuration**
Approaches to stall are accomplished in the clean, takeoff, and landing configurations (Figures MAP-10, MAP-11, and MAP-12), and are normally accomplished between 10,000 and 15,000 feet MSL. Approaches to stalls should not be accomplished below 5,000 AGL. Approaches to stalls may be made from level or turning flight with 15 to 30° of bank. Approaches to stalls may also be combined with slow flight practice. All recoveries are made with power and minimum loss of altitude.

Approach to stall recovery is initiated at the first indication of an impending stall. This indication is provided by the stick shaker and stall warning annunciator lights which activate as the angle-of-attack indicator needle moves into the yellow band.

Power should be advanced to maximum continuous and the existing pitch attitude maintained. However, the angle-of-attack indicator should be monitored and the pitch attitude reduced, if necessary, to keep the needle at the line between the green and yellow bands.

To set maximum power in minimum time, the PF should move the thrust levers smoothly forward to the stop. The PNF should monitor and adjust the power setting if necessary. Approaches to stall from the landing configuration are normally terminated by a simulated missed approach (Figure MAP-12).

Figure MAP-10. Approach to Stall—Clean Configuration
RECOVERY
1. ADJUST PITCH ATTITUDE TO MAINTAIN ALTITUDE

ENTRY
1. REDUCE POWER TO IDLE
2. ROLL INTO 15° TO 30° BANK
3. MAINTAIN ALTITUDE
4. TRIM FOR $V_{REF}$

BEFORE ENTRY
1. GEAR — UP OR DOWN
2. FLAPS — 8° OR 20°
3. AIRSPEED — $V_{REF} + 30$ KT
4. ALTITUDE — 10,000 TO 15,000 FT AGL

SHAKER ONSET
1. SIMULTANEOUSLY: APPLY MAXIMUM POWER AND MAINTAIN, OR ROLL, WINGS LEVEL
2. MAINTAIN PITCH ATTITUDE OR ADJUST, IF NECESSARY, TO MAINTAIN ANGLE OF ATTACK INDICATOR AT “GREEN/YELLOW” LINE

ENTRY
1. REDUCE POWER TO IDLE
2. ROLL INTO 15° TO 30° BANK
3. MAINTAIN ALTITUDE
4. TRIM FOR $V_{REF}$

VREF
1. FLAPS — 20°

BEFORE ENTRY
1. GEAR — DOWN
2. FLAPS — 40°
3. AIRSPEED — $V_{REF} + 10$ KT
4. ALTITUDE — 10,000 TO 15,000 FT AGL

SHAKER ONSET
1. SIMULTANEOUSLY: APPLY MAXIMUM POWER AND MAINTAIN, OR ROLL, WINGS LEVEL
2. MAINTAIN PITCH ATTITUDE OR ADJUST, IF NECESSARY, TO MAINTAIN ANGLE OF ATTACK INDICATOR AT “GREEN/YELLOW” LINE

VREF + 30 KT (MIN)
1. FLAPS — UP
2. ACCELERATE TO CLimb SPEED

POSITIVE RATE OF CLimb
1. GEAR — UP
2. CLimb TO MAintAIN ASSIGNED ALTITUDE

Figure MAP-11. Approach to Stall—Takeoff Configuration

Figure MAP-12. Approach to Stall—Landing Configuration
EMERGENCY DESCENT

Emergency descents are accomplished in accordance with AFM procedures as shown in Figure MAP-13. The PF should accomplish the checklist memory items and allow the airplane to pitch down to a 10 to 15° nosedown pitch attitude. This pitch attitude is maintained until the airplane accelerates to $M_{MO}/V_{LE}$. Then the pitch attitude is adjusted to maintain $M_{MO}/V_{LE}$.

After the emergency descent has been established, the crew should determine the desired level-off altitude.

**ENTRY**
1. CREW OXYGEN MASKS — ON
2. POWER — IDLE
3. AUTOPILOT — DISENGAGED
4. SPOILERS — EXTENDED
5. LANDING GEAR — DOWN (BELOW $M_{MO}/V_{LE}$)
6. ESTABLISH APPROXIMATELY 10° TO 15° NOSE DOWN PITCH ATTITUDE

**DESCENT**
1. MAINTAIN PITCH ATTITUDE UNTIL REACHING $M_{MO}/V_{LE}$
2. ADJUST PITCH ATTITUDE TO MAINTAIN $M_{MO}/V_{LE}$

**LEVEL OFF**
1. SPOILERS — RETRACTED
2. GEAR — UP
3. POWER — AS REQUIRED (IF GEAR WAS EXTENDED ABOVE $V_{LO}$, GEAR SHOULD REMAIN DOWN, IF POSSIBLE)

Figure MAP-13. Emergency Descent
VISUAL TRAFFIC PATTERN, TWO ENGINES

A two-engine visual traffic pattern is shown in Figure MAP-14. The airspeeds indicated on the diagram are minimums. Traffic pattern altitude for jet airplanes is normally 1,500 feet AGL. During gusty wind conditions, 1/2 the gust velocity should be added to $V_{REF}$ on final approach. If a crosswind exists, final approach should be flown with a drift correction angle (crab) to maintain alignment with the runway centerline. Approaching touchdown, rudder should be applied to align the airplane with the runway centerline and the upwind wing lowered with aileron to prevent drift.

VISUAL TRAFFIC PATTERN, SINGLE ENGINE

A single-engine visual traffic pattern is flown exactly the same as a two-engine pattern except for the flap setting on final approach. For single-engine approach, maintain flaps 20° and $V_{REF} + 20$ knots (minimum) when maneuvering. When established on final approach, flaps 20° and $V_{REF} + 10$ knots (minimum).
FLAPS UP LANDING

The corrected landing distance for a flaps up landing (Figure MAP-15) is determined by multiplying the normal landing distance by 1.35. Considerations should be given to reducing the airplane’s weight, if possible, to lower the landing speed and reduce landing distance, if the available runway length is marginal.

To avoid excessive floating during the landing flare, the PF should establish the landing attitude as power is reduced to idle, maintain the attitude and allow the airplane to touch down. The use of the drag chute, or thrust reversers, (if installed) is recommended during a flaps up landing.

Figure MAP-15. Flaps Up Landing
PRECISION INSTRUMENT APPROACH

A typical, precision instrument approach is shown in Figure MAP-16. All accepted instrument flying procedures and techniques should be used while making instrument approaches in the Learjet.

Two-engine, precision approaches should be flown with a stabilized airspeed and configuration from the final approach fix (FAF) inbound. Single-engine, precision approaches should be flown with flaps 20° at $V_{REF} + 20$ knots (minimum) if maneuvering is required. When established on final approach, flaps 20° and $V_{REF} + 10$ knots (minimum).

**APPROSSING INITIAL APPROACH FIX (IAF)**
1. GEAR AND FLAPS—UP
2. AIRSPEED—$V_{REF} + 40$ KT (MIN)
3. APPROACH CHECKLIST—COMPLETE

**IAF OUTBOUND**
1. FLAPS—8°
2. AIRSPEED—$V_{REF} + 30$ KT (MIN)
3. DESCEND, IF REQUIRED

**ON COURSE INBOUND**
1. FLAPS—20°
2. GEAR—DOWN
3. AIRSPEED—$V_{REF} + 20$ KT (MIN)
4. BEFORE LANDING CHECKLIST—COMPLETE TO FLAPS 40°

**FINAL APPROACH FIX**
1. FLAPS—40°
2. AIRSPEED—$V_{REF}$ (MIN)

* FOR A STRAIGHT-IN APPROACH, COMPLETE APPROACH AND BEFORE LANDING CHECKLISTS TO FLAPS 40° BEFORE REACHING THE FINAL APPROACH FIX.

** FOR SINGLE-ENGINE APPROACH, MAINTAIN FLAPS 20° AND $V_{REF} + 20$ KT (MIN) WHEN MANEUVERING. ESTABLISHED ON FINAL, FLAPS 20° AND $V_{REF} + 10$ KT (MIN).

Figure MAP-16. Precision Instrument Approach
NONPRECISION INSTRUMENT APPROACH

A typical, nonprecision instrument approach is shown in Figure MAP-17. All accepted instrument flying procedures and techniques should be used while making instrument approaches in the Learjet.

Two-engine, nonprecision approaches should be flown with a stabilized airspeed and configuration from the final approach fix (FAF) inbound. Single-engine, nonprecision approaches should be flown with flaps 20° at $V_{REF} + 20$ knots (minimum) if maneuvering is required. When established on final approach, flaps 20° and $V_{REF} + 10$ knots (minimum).

---

**Figure MAP-17. Nonprecision Instrument Approach**

* FOR A STRAIGHT-IN APPROACH, COMPLETE APPROACH AND BEFORE LANDING CHECKLISTS TO FLAPS 40° BEFORE REACHING THE FINAL APPROACH FIX.

** FOR SINGLE-ENGINE APPROACH, MAINTAIN FLAPS 20° AND $V_{REF} + 20$ KT (MIN) WHEN MANEUVERING. ESTABLISHED ON FINAL, FLAPS 20° AND $V_{REF} + 10$ KT (MIN).
CIRCLING INSTRUMENT APPROACH

Any instrument approach that requires a heading change of 30° or more to line up with the landing runway is a circling approach. An identifiable part of the airport must be distinctly visible to the pilot during the circling approach, unless the inability to see an identifiable part of the airport results only from a normal bank of the airplane. The circling MDA and weather minima to be used are those for the runway to which the approach is flown.

The Learjet is an approach category C airplane. However, category D minimums should be used if the airplane will be maneuvered at speeds over 141 knots (the minimum for category D airplanes) during the circling approach.

There are two types of circling approaches. The first type of circling approach positions the airplane within 90°, or less, of the runway heading on a base leg for landing. With two engines, this type of approach is normally flown with the gear down and 40° of flaps at $V_{REF}$ plus 10 knots (minimum) from the FAF inbound. When landing is assured, airspeed may be reduced to $V_{REF}$ minimum.

The second type of circling approach (Figure MAP-18) requires a heading change of more than 90° to line up with the landing runway. With two engines, this type of approach is normally flown with the gear down and 20° of flaps at $V_{REF}$ plus 20 knots (minimum) from the FAF inbound. On final approach, flaps should be extended to 40° and airspeed reduced to $V_{REF}$ minimum.

All single-engine circling approaches should be flown with flaps 20° at $V_{REF} + 20$ knots (minimum) if maneuvering is required. When established on final approach, flaps 20° and $V_{REF} + 10$ knots (minimum).
APPROACHING INITIAL APPROACH FIX (IAF)
1. GEAR AND FLAPS—UP
2. AIRSPEED—$V_{REF} + 40$ KT
3. APPROACH CHECKLIST—COMPLETE

IAF OUTBOUND *
1. FLAPS—8°
2. AIRSPEED—$V_{REF} + 30$ KT (MIN)
3. DESCEND, IF REQUIRED

ON COURSE INBOUND
1. FLAPS—20°
2. GEAR—DOWN
3. AIRSPEED—$V_{REF} + 20$ KT
4. BEFORE LANDING CHECKLIST—COMPLETE TO FLAPS 40°

FINAL APPROACH
1. AIRSPEED $V_{REF}$ MINIMUM

* FOR A STRAIGHT-IN APPROACH, COMPLETE APPROACH AND BEFORE LANDING CHECKLISTS TO FLAPS 40° BEFORE REACHING THE FINAL APPROACH FIX.

** FOR A SINGLE-ENGINE CIRCLING APPROACH, MAINTAIN FLAPS 20° AND $V_{REF} + 20$ KT (MIN) WHEN MANEUVERING. ESTABLISHED ON FINAL, FLAPS 20° AND $V_{REF} + 10$ KT (MIN).

Figure MAP-18. Circling Instrument Approach
GO-AROUND/BALKED LANDING

The Learjet go-around/balked landing procedure, shown in Figure MAP-19, should be used for all missed approaches. Generally, if a missed approach is started at, or above, MDA or DH, it is considered a go-around. If a missed approach is started below MDA or DH, it is considered a rejected, or balked, landing. During training, rejected, or balked landings will normally be initiated over the runway threshold at an altitude of approximately 50 feet.

In either case, use of the flight director go-around mode is recommended to provide a target 9° nose-high pitch attitude. After the airplane is clear of obstacles and the flaps have been retracted, the pitch attitude and power may be adjusted to maintain the desired airspeed.

If the go-around/balked landing is made from an instrument approach, the published missed approach procedure should be accomplished unless otherwise instructed. If the go-around/balked landing is made during a circling approach, the initial turn to the missed approach heading must be made toward the landing runway. The turn may then be continued until the airplane is established on the missed approach heading.

* SELECTING FLIGHT DIRECTOR GO-AROUND MODE WILL DISENGAGE THE AUTOPILOT AND PROVIDE A 9 DEGREE NOSE-UP PITCH COMMAND.

Figure MAP-19. Go-Around/Balked Landing
SINGLE-ENGINE DRIFT DOWN

The single-engine drift down procedure shown in Figure MAP-20 is used to cover the greatest possible distance while descending to single-engine cruise altitude after an engine failure at high altitude.

As the note on the chart explains, the speed schedule depicted also approximates the best single-engine, rate-of-climb speed below the single-engine service ceiling. This speed schedule may then also be used to climb to single-engine cruise altitude after an engine failure at low altitude.

**Figure MAP-20. Single-Engine Drift Down**
## WEIGHT AND BALANCE

### CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENERAL</td>
<td>WB-1</td>
</tr>
<tr>
<td>PLANNING DATA</td>
<td>WB-1</td>
</tr>
<tr>
<td>Example Conditions</td>
<td>WB-1</td>
</tr>
<tr>
<td>WEIGHT AND BALANCE COMPUTATION</td>
<td>WB-4</td>
</tr>
<tr>
<td>Figure</td>
<td>Title</td>
</tr>
<tr>
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</tr>
<tr>
<td>WB-1</td>
<td>Basic Empty Weight Moment Sources (Weight and Balance Data)</td>
</tr>
<tr>
<td>WB-2</td>
<td>Sample Weight and Balance Worksheet—Model 35</td>
</tr>
<tr>
<td>WB-3</td>
<td>Weight and Balance Worksheet—Model 35</td>
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<tr>
<td>WB-4</td>
<td>Weight and Balance Worksheet—Model 36</td>
</tr>
<tr>
<td>WB-5</td>
<td>Configuration Diagram and Provisions Loading Tables</td>
</tr>
</tbody>
</table>
WEIGHT AND BALANCE

GENERAL

The airplane weight and load arrangement must be within limits of the applicable center-of-gravity (CG) at all times. Prior to each flight, the pilot must make certain that the airplane is loaded within the defined limits to ensure acceptable stability, control, performance, and structural loads. It may also be necessary to adjust fuel load distribution in flight to maintain the airplane’s CG within the CG envelope.

Weight and balance data are supplied in the Weight and Balance Data section of the AFM by the manufacturer when the airplane is delivered.

Before any weight and balance computations can be made, the basic empty weight and resulting moment must be ascertained. This information is available on the first and last pages of the Weight and Balance section of the AFM. (Figure WB-1.) Any changes to the airplane that affect weight and balance must be entered in the airplane records, and a new Aircraft Weighing Record must be prepared. It is advisable to check both pages to make certain that the weights and moments agree (the CG percentage is not required to compute the CG for a given loading situation). The Weight and Balance Data section also contains all charts and tables necessary for CG computations.

It should be noted that there are eight basic interior configurations for the 35 model and six for the 36 model. Diagrams of each configuration are provided in the Weight and Balance Data section, which should help in selecting the correct loading tables for provisions, baggage, passengers, and fuel, and in verifying station locations of the various seating arrangements and storage compartments.

PLANNING DATA

The following information is included to provide an example of the process used to compute weight and balance.

EXAMPLE CONDITIONS

Airplane (Model 35):

- Basic empty weight ................................................................. 9,858 pounds
- CG ........................................................................................................... 28.94%
Figure WB-1. Basic Empty Weight Moment Sources (Weight and Balance Data)
• Moment ........................................................................................................................3,806,239

• Airplane configuration:
  • Executive door
  • Standard seating (swivel seats)
  • Right-hand recognition light only

Load:
• Pilot and copilot weight ..............................................................195 pounds each
• Provisions—forward cabinet ..........................................................25 pounds
• Provisions—aft cabinet .................................................................30 pounds
• Provisions—toilet ...........................................................................4 pounds
• Water—wash basin ........................................................................15 pounds
• Baggage—aft compartment ..............................................................130 pounds
• Passengers—four (4) approx. wt. each .............................................180 pounds
• Passengers—two (2) approx. wt. each ..............................................150 pounds
• Fuel, fuselage tank—kerosene .......................................................1,206 pounds
• Fuel, wing tanks—kerosene ............................................................2,508 pounds
• Fuel, tip tanks—kerosene ...............................................................2,390 pounds
• Planned fuel reserve at destination ...............................................1,500 pounds

A typical weight and balance computation is described in this chapter with the example data entered on Figure WB-2.

Two Airplane Loading Forms for weight and balance computations are provided in the Weight and Balance section of the AFM, one each for the 35 model and the 36 model. Sample worksheets (Figures WB-3 and WB-4) are adaptations for training purposes.

The interior configuration diagram (Figure WB-5) for the example airplane used in the sample problem which follows has been included for illustration.
Instructions for computing weight and balance are also provided in the Weight and Balance section of the AFM.

WEIGHT AND BALANCE COMPUTATION

1. The first step in computing weight and balance is to determine the basic empty weight and moment from the Airplane Weighing Record in the AFM. However, if the airplane has been altered, determine the basic empty weight and moment from the Aircraft Records. The moment may be listed as a seven-digit figure, as shown in Figure WB-1. In this case, the decimal point must be moved three digits to the left when entering the moment on the worksheet. This is because all weight and balance charts and tables are based on moment per 1,000. This reduces the figures in the numerical data to a more manageable size.

Example:

Enter the basic empty weight (9,858) and moment (3,806,304 ÷ 1,000 = 3,806.34) on the worksheet. The CG % may be entered, but does not serve any useful purpose in the computations.

2. Enter the payload weights for the crew, passengers, provisions, baggage, and fuel on the worksheet. Then determine the moment for each entry, using the appropriate Moment/1,000 table in the Weight and Balance Data section of the AFM.

Since there are different tables for each configuration, use care to ensure that the correct table is selected for each item.

Example:

Using the information given for the example conditions, enter the weights for each item in the appropriate block on the worksheet. Select the correct loading tables from the Weight and Balance section, beginning with provisions. Notice that there are several provisions tables provided from which selection of the proper data must be made. Since the example airplane has a standard interior, all data shown for midcabinet and club configurations can be eliminated, leaving only the tables pertaining to the example airplane (Figure WB-6). The correct water load (for the wash basin) is selected by comparing the listed station locations with the configuration diagram. Note that the wash basin is directly opposite the aft provisions cabinet (Sta. 253); therefore the correct water-loading entries for weight and moment/1,000 are 15 and 3.80, respectively.

A similar process is used to select the appropriate crew, passengers, baggage, and fuel entries. Enter each moment/1,000 table with the weight, select the corresponding moment, and enter the data in the appropriate block on the worksheet. Check results with the example (Figure WB-2).
**LEARJET MODEL 35 WEIGHT AND BALANCE WORKSHEET**

<table>
<thead>
<tr>
<th>Interior Configuration:</th>
<th>Station</th>
<th>Quantity</th>
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Figure WB-2. Sample Weight and Balance Worksheet—Model 35
# LEARJET MODEL 35
## WEIGHT AND BALANCE WORKSHEET

**Interior Configuration:**
- Standard (swivel seats)
- Alternate (sidefacing seats)
- Mid-cabinet
- Club

**Executive Door**
- Cargo Door
- Recognition Light(s) __RH only or __Both

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<th>MOM/1,000</th>
<th>C.G.</th>
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<td>Max. 2,390 lbs</td>
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Figure WB-3. Weight and Balance Worksheet—Model 35
**LEARJET MODEL 36 WEIGHT AND BALANCE WORKSHEET**

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**Figure WB-4. Weight and Balance Worksheet—Model 36**
Figure WB-5  Configuration Diagram and Provisions Loading Tables
For the purpose of the example, load the two 150-pound passengers on the divan seat, and the four 180-pound passengers on the forward and aft swivel seats.

When working on the fuel moment tables, be sure to select the correct density columns for all weight, moment, and gallon conversions.

3. Subtotal all weights and moments in the Operating Weight, Wing Bending Weight, and Ramp Weight blocks, making sure the ramp weight does not exceed the maximum airplane certified ramp weight. Also take note of the Wing Bending Weight entry, which should not exceed 13,500 pounds (maximum wing bending weight).

Example:

Compare subtotal results with those given on the sample worksheet. The wing bending weight is below the maximum limit.

4. Compute the takeoff gross weight by subtracting fuel burned during start, taxi, and take-off. Determine the equivalent moment of the fuel burned by referring to the Fuel Used Vs Moment Loss table in the approved AFM. As an average, 3.5 pounds per minute per engine may be used for simplification, which would be furnished by the tip tanks (unless they are empty). The takeoff gross weight must not exceed the certified maximum takeoff weight.

Example:

Assuming a 15-minute burn on two engines (7 pounds per minute), the fuel burn is estimated at 105 pounds. Referring to the Fuel Used Vs Moment Loss table, enter the chart with 112 pounds (for simplification) and read 42.84 moment loss from the tip tank column. Note that the entries on the worksheet are minus (−) entries.

Enter the 112 pounds and 42.84 moment loss in the appropriate blocks and subtract both figures from the ramp weight subtotals. Check results with the sample worksheet. The resulting weight is less than maximum certified takeoff weight.

5. Determine if takeoff weight and moment are within weight and CG limits using the Weight-Moment-CG limits using the Weight-Moment-CG Envelope chart in the Weight and Balance section of the AFM.

The Weight-Moment-CG Envelope chart depicts the flight envelope with heavy dark lines. If the takeoff weight and moment lines intersect within the envelope, the airplane load is within limits for flight. If the lines intersect outside the envelope, reduce weight or rearrange the load to obtain weight and CG within limits. The center of gravity, expressed as a % of MAC, can be read at the bottom or top of the chart, whichever is closer to the point at which the weight and moment lines intersect.

Since the gross weight and moment lines cross at a rather shallow angle, a small error in plotting the intersect point can result in a significant error in computing CG. The point on the envelope charts can be more accurately plotted by mathematically computing CG (% MAC) and then finding the point on the envelope chart where gross weight and CG (% MAC) intersect. This is more accurate since the weight and CG (% MAC) lines cross more nearly at right angles.
The formula to calculate the CG in % MAC is:

\[
CG\ (\%\ MAC) = \left( \frac{\text{Fuselage Station (CG)} - \text{LEMAC}}{\text{MAC}} \right) \times 100
\]

Where:

\[
\text{Fuselage Station (CG)} = \left( \frac{\text{Moment}}{\text{Weight}} \right) \times 1000
\]

LEMAC = 362.17

MAC = 82.75

The values for LEMAC and MAC are constant and may be found in the Weight and Balance section of the AFM. The fuselage station CG varies with the airplane total weight and moment. The formula may be more practically written for computation as follows:

\[
CG\ (\%\ MAC) = \left\{ \left( \frac{\text{Moment}}{\text{Weight}} \times 1,000 \right) - 362.17 \right\} \times \frac{100}{82.75}
\]

Once CG (% MAC) is found, the Weight-Moment-CG Envelope may be entered with CG-% MAC and gross weight to find whether they intersect within the envelope.

The Center-of-Gravity Table in the Weight and Balance section of the AFM may be used as an alternate means of determining whether the airplane load is within the weight and CG limits.

Enter the table with airplane gross weight (100-pound increments). A forward limit moment and an aft limit moment are listed. If the computed moment falls between those listed at the forward and aft limits, the airplane is within limits for flight.

The tables may be used to identify the CG limits more accurately than the CG charts. However, the charts provide a more graphic depiction of the airplane weight and moment in relation to the limits.

**Example:**

Compute CG in % MAC for takeoff weight and moment using the formula given above.

\[
CG\ (\%\ MAC) = \left\{ \left( \frac{6,672.30}{17,464} \times 1,000 \right) - 362.17 \right\} \times \frac{100}{82.75}
\]

Use the Weight-Moment-CG Envelope chart in the AFM and determine if gross weight (17,464 pounds) and CG-% MAC (24.04%) lines cross within the flight envelope. In this example, the lines cross within the envelope and the airplane is within limits for takeoff.

This fact could be determined as well using the Center-of-Gravity Table in the AFM. Find 17,464 (17,500 rounded off) in the Pounds Gross Weight column. The forward moment for this gross weight is 6,591.38 and the aft limit moment is 6,772.50. The actual moment (6,672.30), in the example, falls between the forward limit moment and the aft limit moment. As a result, the airplane load is within limits for flight.
6. Landing weight and moment may be calculated by subtracting the weight and resulting moment loss of fuel burned enroute out of each tank, the resulting subtotals being the planned landing weight and moment. The CG (% MAC) can then be determined using the same process described for the takeoff conditions. Check to ensure that the certified landing weight is not exceeded.

**Example:**

Given an estimated 1,500 pounds of fuel remaining at destination, for operation, the fuel must be located in the wing tanks because all of the fuel loaded in the fuselage and tip tanks has been burned. The 112 pounds burned out of the tip tanks prior to takeoff and the associated 42.84 moment loss already accounted for leaves 2,278 pounds of fuel and a moment loss of 885.91. Since everything loaded in the fuselage tank has also burned, the appropriate form entries are 1,206 pounds and 530.22 moment loss. If 1,500 pounds of fuel remains in the wing tanks, the amount of fuel burned is 1,008 pounds, or the difference between what was serviced (2,508) and what remains (1,500). The resulting moment loss (404.8) can be determined from the Fuel Used Vs Moment Loss chart by using the nearest (1,034 pounds) figure for simplification. All worksheet entries should be minus (–) entries. A final subtotal of the weights and moments results in a landing weight of 12,946 pounds, which is less than maximum certified landing weight, and a moment/1,000 of 4,858.95.

\[
\text{CG (% MAC)} = \left( \frac{4,851.37 \times 1,000}{12,946} - 362.17 \right) \times 100 = 15.19\%
\]

Use the Weight-Moment-CG Envelope chart to ensure that the landing weight (12,946) and the CG (% MAC) intersect within the flight envelope. In this example, the lines intersect within the envelope and the airplane is within limits for landing.

If the airplane is not within CG limits, the load must be adjusted before takeoff or the fuel load adjusted in flight to remain within the envelope. The Center-of-Gravity table can also be used to determine whether the airplane is within CG limits for landing.
# PERFORMANCE

## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
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<tbody>
<tr>
<td>INTRODUCTION</td>
<td>PER-1</td>
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<td>PER-2</td>
<td>Takeoff Profile Example</td>
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INTRODUCTION

This chapter will introduce the various charts, tables, and methods used to compute airplane performance. A set of conditions (airplane load, ambient conditions, etc.) is presented at the beginning of each of the two sections of this chapter. These conditions are used throughout each section in examples which demonstrate the use of charts and tables.

GENERAL

Most performance data for all approved operating conditions is provided in chart form in the Performance section of the approved Airplane Flight Manual. Climb, cruise, and descent data are provided in the Learjet 35/36 Pilot’s Manual. Airplane performance data is also provided in tabular form in the pilot’s manual and the Aircrew Checklist. However, the effects of wind, runway gradient, antiskid-off, and anti-ice-on conditions are not compensated for in the tabular data in the crew checklist or the Pilot’s Manual. Therefore, if any of the above are factors, the AFM charts should be used for flight planning.

PERFORMANCE

GENERAL

Assumed Conditions

The performance data presented for each phase of operation is based on certain assumed conditions. For example, the takeoff distance chart assumes that takeoff power is set before brake release. Assumed conditions, along with the description of the corresponding charts, are given in this chapter.

Standard Conditions

Standard conditions which apply to all performance calculations are:

- Cabin air—on
- Factors for 50% headwind components and 150% tailwind components have been applied to takeoff and landing data as prescribed in pertinent regulations.
- The standard (coplanar) engine exhaust nozzle is installed (no thrust reversers).
NOTE

The performance of airplanes equipped with thrust reversers is equivalent to the performance shown in the approved AFM. However, the power setting charts for thrust-reverser-equipped airplanes are different and are contained in the Aeronca (or Dee Howard) Thrust Reverser Supplement to the AFM, as applicable.

Variable Factors

Variable factors affecting performance are reflected in the charts to which they apply and include:

- Ambient temperature and pressure altitude
- Winds
- Gross weight
- Runway gradient
- Anti-ice—on or off
- Antiskid—on or off
- Flaps 8° or 20° for takeoff and 40° for landing

DEFINITIONS

The following definitions apply to terms used throughout this manual.

Airspeeds

- **CAS** — *Calibrated Airspeed*—The airspeed indicator reading corrected for instrument and position error. KCAS is calibrated airspeed expressed in knots.
- **IAS** — *Indicated Airspeed*—The airspeed indicator reading as installed in the airplane. KIAS is indicated airspeed expressed in knots. The information in this manual is presented in terms of indicated airspeed, unless otherwise stated, and assumes zero instrument error.
- **M** — *Calibrated Mach Number*—The Machmeter reading corrected for instrument and position error.
- **M_I** — *Indicated Mach Number*—The Machmeter reading as installed in the airplane. Zero instrument error is assumed for presentations in this section of the manual.
- **V_A** — *Maneuvering Speed*—**V_A** is the highest speed that full aileron and rudder control can be applied without over-stressing the aircraft, or the speed at which the aircraft will stall with the load factor of 3.0 g’s at maximum gross weight, whichever is less.
- **V_LOF** — *Liftoff Speed*—The actual speed of the aircraft at liftoff.
\( V_{SO} \) is the stalling speed in the landing configuration.

\( V_{SI} \) is the stalling speed in the appropriate gear/flap configuration.

**\( V_{MCA} \)** *Minimum Control Speed, Air*—The minimum flight speed at which the airplane is controllable with 5° of bank when one engine suddenly becomes inoperative and the remaining engine is operating at takeoff thrust.

**\( V_{MCG} \)** *Minimum Control Speed, Ground*—The minimum speed on the ground at which control can be maintained using aerodynamic controls alone, when one engine suddenly becomes inoperative and the remaining engine is operating at takeoff thrust.

**\( V_1 \)** *Critical Engine Failure Speed*—The speed at which, due to engine failure, the pilot is assumed to elect to stop or continue the takeoff. If engine failure occurs at \( V_1 \) the distance to continue the takeoff to 35 feet above the runway surface will be equal to the distance to bring the airplane to a full stop. \( V_1 \) must not be less than the critical minimum control speed (\( V_{MCG} \)) or greater than the rotation speed (\( V_R \)).

**\( V_R \)** *Rotation Speed*—The speed at which rotation is initiated during takeoff to attain \( V_2 \) at or before a height of 35 feet above the runway surface.

**\( V_2 \)** *Takeoff Safety Speed*—The actual speed at 35 feet above the runway surface as demonstrated in flight during single-engine takeoff. \( V_2 \) must not be less than 1.2 times the stalling speed or less than 1.1 times the air minimum control speed (\( V_{MCA} \)), or less than the rotation speed (\( V_R \)) plus an increment in speed attained prior to reaching a 35-foot height above the runway surface.

**\( V_{APP} \)** *Approach Climb Speed*—The airspeed equal to 1.3 \( V_{SI} \) (airplane in the approach configuration).

**\( V_{REF} \)** *Landing Approach Speed*—The airspeed equal to 1.3 \( V_{SO} \) (airplane in the landing configuration).

**Weights**

**Maximum Allowable Takeoff Weight**

The maximum allowable takeoff weight at the start of takeoff roll is limited by the most restrictive of the following requirements:

- Maximum Certified Takeoff Weight.
- Maximum Takeoff Weight (Climb or Brake Energy Limited) for altitude and temperature as determined from the applicable figure entitled TAKEOFF WEIGHT LIMITS.
- Maximum Takeoff Weight for the runway and ambient conditions as determined from the applicable figure entitled TAKEOFF DISTANCE.
- Maximum Takeoff Weight for obstacle clearance as determined from the applicable TAKE-OFF FLIGHT PATH and CLIMB GRADIENT figures. (FAR 121 and 135 as applicable to U.S. registered aircraft.)
Maximum Allowable Landing Weight

The maximum allowable landing weight is limited by the most restrictive of the following requirements:

- Maximum Certified Landing Weight
- Maximum Landing Weight for the runway and ambient conditions as determined from the applicable ACTUAL LANDING DISTANCE and FACTORED LANDING DISTANCE (if applicable) charts
- Maximum Landing Weight (Approach Climb or Brake Energy Limited) for altitude and temperature as determined from the applicable figure entitled LANDING WEIGHT LIMITS

Distances

Accelerate-Stop Distance

The accelerate-stop distance is the horizontal distance traversed from brake release to the point at which the airplane comes to a complete stop on a takeoff during which one engine fails at $V_1$ and the pilot elects to stop.

Engine-Out Accelerate-Go Distance

The engine-out accelerate-go distance is the horizontal distance traversed from brake release to the point at which the airplane attains a height of 35 feet above the runway surface, on a takeoff during which one engine fails at $V_1$ and the pilot elects to continue.

Takeoff Field Length

The takeoff field lengths presented in this section are based on a smooth, dry, paved runway. The takeoff field length given for each combination of airplane weight, atmospheric temperature, altitude, wind, and runway gradient is the greatest of the following:

1. 115% of the all-engine takeoff distance from start to a height of 35 feet above the runway surface
2. The accelerate-stop distance
3. The engine-out accelerate-go distance

No specific identification is made on the charts as to which of the above distances governs a specific case. However, in all cases for which charts are furnished, the field length is governed by either 2 or 3 above as the all-engine takeoff distance is shorter than either.

Actual Landing Distance

The actual landing distances presented in this section are based on a smooth, dry, paved runway. The landing field length is equal to the horizontal distance from a point 50 feet above the runway surface to the point at which the airplane would come to a full stop on the runway.
Factored Landing Distance

The factored landing distances presented in this section are equal to the actual landing distance divided by 0.60 (multiplied by 1.67).

Meteorological

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISA</td>
<td>International Standard Atmosphere</td>
</tr>
<tr>
<td>OAT</td>
<td>Outside Air Temperature—The free air static temperature obtained from either ground meteorological sources or from inflight temperature indications adjusted for instrument error and compressibility effects</td>
</tr>
<tr>
<td>RAT</td>
<td>Ram Air Temperature—The static air temperature corrected for full adiabatic compression rise corresponding to the calibrated Mach number, and multiplied by a recovery factor</td>
</tr>
<tr>
<td>Altitude</td>
<td>All altitudes given in this section are pressure altitudes unless otherwise stated.</td>
</tr>
<tr>
<td>Wind</td>
<td>The wind velocities recorded as variables on the charts of this section are to be understood as the headwind or tailwind components of the actual winds at 20 feet above the runway surface (tower winds).</td>
</tr>
<tr>
<td>Demonstrated Crosswind</td>
<td>The demonstrated crosswind velocity of 24.7 knots is the velocity of the reported tower winds (measured at a 20-foot height) for which adequate control of the airplane during takeoff and landing was actually demonstrated during certification tests. The value shown is not considered to be limiting.</td>
</tr>
</tbody>
</table>

Miscellaneous

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position Correction</td>
<td>Static Position Correction—A correction applied to indicated airspeed or altitude to eliminate the effect of the location of the static pressure source on the instrument reading. Since all airspeeds and altitudes in this section are presented as “indicated” values, no position corrections need be made when reading from the charts. Any change in the airspeed-altitude system external to the airplane, or locating any external object near the pressure pickup sources, requires calibration of the system and revision of the charts.</td>
</tr>
<tr>
<td>Runway Gradient</td>
<td>Change in runway elevation per 100 feet of runway length. The values given are positive for uphill gradients and negative for downhill gradients.</td>
</tr>
<tr>
<td>Gradient of Climb</td>
<td>The ratio of the change in height during a portion of the climb to the horizontal distance traversed in the same time interval.</td>
</tr>
<tr>
<td>Gross Climb Gradient</td>
<td>The climb gradient that the airplane can actually achieve given ideal conditions.</td>
</tr>
</tbody>
</table>
Net Climb Gradient
The gross climb gradient reduced by 0.8% during the takeoff phase and 1.1% enroute. This conservatism is required by FAR 25 for terrain clearance determination to account for variables encountered in service.

First Segment Climb
Climb from the point at which the airplane becomes airborne to the point at which the landing gear is fully retracted. The gross climb gradient must be positive, without ground effect. This requirement is satisfied by observing the TAKEOFF WEIGHT LIMITS Chart. Velocity increase is from $V_{LOF}$ to $V_2$ with gradient calculated at liftoff velocity ($V_{LOF}$).

Second Segment Climb
Climb extending from the end of the first segment to a height of at least 400 feet. The gross climb gradient may not be less than 2.4%. This requirement is satisfied by observing the TAKEOFF WEIGHT LIMITS Chart. Velocity for this segment is $V_2$.

Final Segment Climb
Climb extending from the end of the second segment to a height of at least 1500 feet. The gross climb gradient may not be less than 1.2%. This requirement is satisfied by observing the TAKEOFF WEIGHT LIMITS Chart. Velocity for this segment is $1.25 V_{S1}$.

Enroute Climb
Climb with flaps UP (0°), landing gear retracted and maximum continuous thrust on one engine. There is no minimum requirement for enroute climb gradients. The enroute net climb gradients are presented for pilot’s reference. Velocity is presented in ENROUTE CLIMB SPEED SCHEDULE Chart.

Approach Climb
Climb from a missed or aborted approach with approach (20°) flaps, landing gear retracted, and takeoff thrust on one engine. The gross climb gradient may not be less than 2.1%. This requirement is satisfied by observing the LANDING WEIGHT LIMITS Chart. Velocity for this segment is $1.3 V_{S1}$.

Landing Climb
Climb from an aborted landing with landing flaps DN (40°), landing gear extended, and takeoff thrust on both engines. The gross climb gradient may not be less than 3.2%. This requirement is satisfied by observing the LANDING WEIGHT LIMITS Chart. Velocity for this segment is $1.3 V_{SO}$. 
The configurations referred to by name in the charts correspond to the following settings:

### Table PER-1. CONFIGURATIONS

<table>
<thead>
<tr>
<th>Configuration</th>
<th>No. of Engines Operating</th>
<th>Thrust</th>
<th>Flap Setting</th>
<th>Gear</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Segment Takeoff Climb</td>
<td>1</td>
<td>Takeoff</td>
<td>8° or 20° DN</td>
<td>DN</td>
</tr>
<tr>
<td>2nd Segment Takeoff Climb</td>
<td>1</td>
<td>Takeoff</td>
<td>8° or 20° UP</td>
<td>UP</td>
</tr>
<tr>
<td>Final Segment Climb</td>
<td>1</td>
<td>Max. Cont.</td>
<td>UP–0° UP</td>
<td>UP</td>
</tr>
<tr>
<td>Enroute Climb</td>
<td>1</td>
<td>Max. Cont.</td>
<td>UP–0° UP</td>
<td>UP</td>
</tr>
<tr>
<td>Approach Climb</td>
<td>1</td>
<td>Takeoff</td>
<td>20° UP</td>
<td>UP</td>
</tr>
<tr>
<td>Landing Climb</td>
<td>2</td>
<td>Takeoff</td>
<td>DN–40° DN</td>
<td>DN</td>
</tr>
</tbody>
</table>
FLIGHT PLANNING DATA

The following conditions are provided to compute takeoff, climb, cruise, descent, and landing data for a flight from airport A to airport B. This should not be construed as a complete example of flight planning procedures. Its purpose is to introduce charts and tables most commonly used in flight planning. Sample worksheets for takeoff and landing data and a sample operational planning form for the flight planning problems and solutions are included in this chapter.

Example Conditions:

Departure Airport A

Airplane:
- Basic Operating Weight 9,800 pounds
- Payload +200
- Zero-Fuel Weight 10,000
- Fuel Weight +5,200
- Ramp Weight 15,200
- Fuel: Start, Taxi, Takeoff −200
- Takeoff Gross Weight 15,000

Airplane Takeoff Configuration
- Standard Nozzles (no thrust reversers)
- Flaps—8°
- Antiskid—on
- Anti-ice—off

Airport A Weather
- Ceiling/Visibility—3 OVC ½ H
- Temperature—60° F
- Pressure Altitude—1,300 feet
- Wind—330°/20 knots
Airport A Runway
- Runway 01R, Length—7,300 feet
- Dry
- Gradient—0%
- Obstacle—20,100 feet from departure of RWY 01R, 1,500 feet above runway

Climb Conditions
- Climb Schedule—250 KIAS/0.70 M_1
- Maximum Continuous Thrust (N_1)
- Climb on course
- Climb unrestricted to FL 430 (Long-range Cruise)
- Standard Atmospheric Conditions (ISA)
- Average headwind components—20 kt

Cruise Conditions
- Distance—1,000 miles from Airport A to Airport B
- Use Long-range Cruise
- Standard Atmospheric Conditions (ISA)
- Winds—Average headwind component—20 kt

Descent Conditions
- Winds—Average headwind component—20 kt

Arrival Airport B

Airport B Weather
- Ceiling/visibility—20 OVC 3 H
- Temperature—60° F
- Pressure Altitude—1,300 ft
- Wind—320°/17 kt

Airport B Runway
- Runway 35R Length—13,300 ft
- Gradient—Zero degrees
TAKEOFF PERFORMANCE

Wind Components

Headwind, tailwind, and crosswind components can be calculated by using the Wind Component chart found in the General section of the AFM Performance Data chapter.

Problem:

Using runway 01R at airport A, with a reported surface wind of 330/20, the wind direction is 40° from the runway heading. Use the Wind Components chart to determine the headwind and crosswind components.

Solution:

Find the point on the chart at which the 20-knot arc crosses the 40° line. From this point proceed horizontally to the left margin to read the headwind component (15 knots) or proceed straight down to the bottom margin to read the crosswind component (13 knots). Enter headwind component on Takeoff Worksheet (Figure PER-1).

Maximum Allowable Takeoff Weight

The maximum allowable takeoff weight at the start of takeoff roll is limited by the most restrictive of the following requirements:

- Maximum Certificated Takeoff Weight
- Maximum Takeoff Weight to meet minimum single-engine climb gradient requirements and not exceed brake energy limits (Climb or Brake Energy Limited)
- Maximum Takeoff Weight for runway length available
- Maximum Takeoff Weight for obstacle clearance

Maximum Certificated Takeoff Weight

The maximum certificated takeoff weight for most Learjet 30 series airplanes is 18,300 pounds. Some earlier production airplanes may be limited to 18,000 or 17,000 pounds takeoff weight. If the airplane records indicate that the airplane does not incorporate ECR 1495, ECR 2234, AAK 77-8, or AAK 80-2, the certificated maximum takeoff weight is 17,000 pounds. If the airplane records indicate that the airplane includes optional ECR 1495 or AAK 77-8, the maximum certificated takeoff weight is 18,000 pounds and if AAK 80-2 is included, the airplane is certificated for 18,300 pounds maximum takeoff weight. For the example, enter 18,300 under CERTIFICATED TAKEOFF WT on the Takeoff Worksheet (Figure PER-1).
**TAKEOFF WORKSHEET**

<table>
<thead>
<tr>
<th>TEMP</th>
<th>PA</th>
<th>WIND</th>
<th>RWY LENGTH</th>
<th>RWY GRAD</th>
<th>WEATHER</th>
<th>ANTI-ICE</th>
<th>ANTI-SKID</th>
</tr>
</thead>
<tbody>
<tr>
<td>60°F</td>
<td>1,300 FT</td>
<td>15 KT HEADWIND</td>
<td>7,300 FT</td>
<td>0%</td>
<td>30° C/50° F</td>
<td>OFF</td>
<td>ON</td>
</tr>
</tbody>
</table>

**TAKEOFF WEIGHT LIMITS (POUNDS)**

<table>
<thead>
<tr>
<th>FLAPS</th>
<th>CERTIFIED TAKEOFF WT</th>
<th>CLIMB WT</th>
<th>BRAKE ENERGY WT</th>
<th>TAKEOFF WT FOR RWY LENGTH</th>
<th>PLANNED TAKEOFF WT</th>
<th>TAKEOFF DISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>8° FLAPS</td>
<td>18,300</td>
<td>18,300</td>
<td>18,300</td>
<td>18,300</td>
<td>15,000</td>
<td>3,400</td>
</tr>
<tr>
<td>20° FLAPS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**OBSTACLE CLEARANCE**

<table>
<thead>
<tr>
<th>OBSTACLE HEIGHT</th>
<th>OBSTACLE DISTANCE FROM END OF RWY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,500 FT</td>
<td>20,100 FT</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FLAPS</th>
<th>GROSS WT (From above or estimate)</th>
<th>TO DIST</th>
<th>DIST FROM REF ZERO*</th>
<th>CLIMB GRAD REQUIRED</th>
<th>CLIMB GRAD POSSIBLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>8° FLAPS</td>
<td>15,000</td>
<td>3,400</td>
<td>24,000</td>
<td>6.5%</td>
<td>9.8%</td>
</tr>
<tr>
<td>20° FLAPS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8° FLAPS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20° FLAPS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Distance from Reference Zero = Obstacle distance from end of runway + runway length - takeoff distance.

<table>
<thead>
<tr>
<th>N₁**</th>
<th>V₁</th>
<th>Vᵣ</th>
<th>V₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>97.3</td>
<td>118</td>
<td>130</td>
<td>133</td>
</tr>
</tbody>
</table>

**For aircraft equipped with thrust reversers, refer to T/R Supplement.**

---

Figure PER-1. Sample Takeoff Worksheet (Sheet 1 of 2)
## TAKEOFF WORKSHEET

<table>
<thead>
<tr>
<th>TEMP</th>
<th>RWY LENGTH</th>
<th>WEATHER</th>
<th>P A</th>
<th>RWY GRAD</th>
<th>ANTI-ICE</th>
<th>ANTI-SKID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TAKEOFF WEIGHT LIMITS (POUNDS)

<table>
<thead>
<tr>
<th>Certified Takeoff WT</th>
<th>Climb WT</th>
<th>Brake Energy WT</th>
<th>Takeoff WT for RWY Length</th>
<th>Planned Takeoff WT</th>
<th>Takeoff Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>8° FLAPS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20° FLAPS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### OBSTACLE CLEARANCE

<table>
<thead>
<tr>
<th>Obstacle Height</th>
<th>Obstacle Distance from End of RWY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROSS WT (From above or estimate)</td>
<td>TO DIST</td>
</tr>
<tr>
<td>8° FLAPS</td>
<td></td>
</tr>
<tr>
<td>20° FLAPS</td>
<td></td>
</tr>
<tr>
<td>8° FLAPS</td>
<td></td>
</tr>
<tr>
<td>20° FLAPS</td>
<td></td>
</tr>
</tbody>
</table>

*Distance from Reference Zero = Obstacle distance from end of runway + runway length – takeoff distance.

<table>
<thead>
<tr>
<th>( N_1 )**</th>
<th>( V_1 )</th>
<th>( V_R )</th>
<th>( V_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**For aircraft equipped with thrust reversers, refer to T/R Supplement.

---

Figure PER-1. Sample Takeoff Worksheet (Sheet 2 of 2)
Maximum Takeoff Weight (Climb or Brake Energy Limited)

The takeoff weight limit charts found in the Takeoff section of the *AFM* chapter, “Performance Data,” provides the maximum takeoff weight for a given temperature and pressure altitude (PA) which will allow: (1) the airplane to meet minimum climb gradients if an engine fails at or after $V_1$ speed and takeoff is continued (left side of charts), or (2) braking to a full stop without exceeding brake energy limits if takeoff is rejected at or below $V_1$ speed (right side of charts).

If the temperature and pressure altitude lines intersect to the left of the Engine Temp Limit line, takeoff should *not* be attempted at any gross weight.

**NOTE**

There are separate charts for takeoff with flaps at 8° or 20° and anti-ice off or on.

**Problem:**

Determine takeoff weight limit from the Takeoff Weight Limit (Flaps—8°, Anti-ice—Off) chart, using the example conditions listed previously.

**Solution:**

Enter the chart on the left margin with OAT and proceed horizontally to the right until intersecting the altitude line corresponding to the field pressure altitude. From that point proceed to the bottom margin and read the takeoff climb weight. This is the maximum weight at which the airplane can meet the minimum climb gradients established by FAR 25 should an engine fail at $V_1$.

Using the example of 60° F and 1,300 feet pressure altitude, the 60° F line and the 1,300 altitude lines do not intersect on the takeoff climb portion of the chart. This indicates that the takeoff weight is not limited due to takeoff climb. Enter maximum certificated takeoff weight (18,300 pounds) under Climb Wt on the Takeoff Worksheet (Figure PER-1).

Now, determine if the takeoff weight is limited due to brake energy. Enter the Takeoff Weight Limit chart at the left margin, again at 60° F, and proceed right until intersecting the 1,300-foot altitude line on the brake energy side of the chart. From this point, proceed down to the zero-wind reference line and then diagonally parallel to the guidelines to a point opposite 15 knots wind velocity. Directly below this point, read the brake energy weight.

In this example, the gross weight is found to be above 18,300 pounds, which is the design takeoff weight limit. Therefore, the airplane takeoff weight is not brake energy limited. Enter maximum certificated takeoff weight (18,300 pounds) under Brake Energy Wt on the Takeoff Worksheet (Figure PER-1).

**NOTE**

If the temperature had been 80° and the altitude 6,000 feet in this example, the takeoff weight would have been limited to 17,300 pounds by the takeoff climb weight limit but not limited by the brake energy weight limit.
Maximum Takeoff Weight for Runway Available

If the computed takeoff field length determined from the AFM Takeoff Distance chart is less than the runway length available, takeoff weight is not limited due to runway length. However, if the computed takeoff distance exceeds the runway length available, the airplane gross weight must be reduced or takeoff delayed until atmospheric conditions change (cooler temperature, increased wind velocity, or wind shift to a longer runway, etc.).

The maximum takeoff weight, limited by available runway, can be determined by entering the Takeoff Distance chart on the right side with the runway length available and working backward to the Gross Weight section. Then enter the chart at the left with the temperature and pressure altitude and proceed to the Gross Weight section. Read the gross weight directly below the point at which these two entries intersect in the Gross Weight section. This is the gross weight that will permit takeoff within the runway length available.

Problem:
Determine if the planned gross weight is limited by the runway length available.

Solution:
In the example conditions, the temperature is 60° F, pressure altitude is 1,300 feet, and the planned takeoff gross weight is 15,000 pounds. Using the Takeoff Distance (Flaps 8°) chart, it is determined that the computed takeoff distance (3,400 feet) is less than the runway length available (7,300 feet). As a result, the planned takeoff gross weight is not limited by the runway length available. Takeoff distance is discussed in greater detail later in this chapter under Takeoff Field Length.

Problem:
Determine the maximum takeoff gross weight for the runway available.

Solution:
To determine the maximum takeoff gross weight for the runway available, work backward through the Takeoff Distance chart. Enter the chart on the right margin at the actual field length (7,300 feet) and proceed horizontally to the Wind section. (The Antiskid, Anti-ice, Runway Gradient, and Altitude sections do not apply in this example.) Intersect the 15-knot headwind velocity line and follow the wind lines to the zero-wind reference line. From this point, draw a light pencil line horizontally across the Gross Weight section.

Now, enter the chart at the bottom, left margin with the temperature (60° F) and proceed vertically to the pressure altitude (1,300 feet). Next, proceed horizontally right to the gross weight reference line and follow the guidelines until intersecting the previously drawn pencil line.

In this example, following the gross weight guidelines, the 18,300-pound gross weight limit is reached before intersecting the pencil line. Therefore, takeoff could be made up to 18,300 pounds without exceeding runway length available. Enter 18,300 pounds on the Takeoff Worksheet under Takeoff Wt For Rwy Length.
Maximum Takeoff Weight for Obstacle Clearance

Commercial operators (FAR 121 and 135) of U.S.-registered airplanes are required to determine the maximum takeoff weight which will enable the airplane to clear obstacles in the takeoff flight path in the event an engine fails at or after $V_1$ speed. Although not specifically listed as a requirement for other operators, it would be prudent for all operators to make these computations to ensure safe operation.

Takeoff flight path charts are provided in the Takeoff section of the AFM chapter, “Performance Data,” to enable the operator to determine the net climb gradient required to clear an obstacle in the takeoff flight path. Additionally, climb gradient charts are provided in the same section which enables the operator to determine the net climb gradient possible (one engine inoperative) for airplane gross weight and existing atmospheric conditions.

In the event that the computed climb gradient required exceeds the single-engine climb gradient possible, the airplane takeoff gross weight must be reduced or takeoff delayed until atmospheric conditions change to allow the computed climb gradient possible to exceed the climb gradient required.

Reducing the airplane’s gross weight increases climb gradient possible. At the same time, climb gradient required also decreases because the takeoff distance is reduced, providing more distance from the obstacle. Therefore, an interpolative process is required to find the exact minimum gradient and maximum weight for obstacle clearance. This process will be described further in the example.

Takeoff Flight Path

Takeoff flight path charts are provided for 8° and 20° flap settings and also for close-in and distant obstacles.

The close-in charts are used to determine required climb gradients for obstacle clearance within 10,000 feet of Reference Zero, and the distant charts are used to determine climb gradient requirements for obstacles up to 40,000 feet from Reference Zero.

The origin for each climb gradient line is Reference Zero. This point is a point 35 feet above the runway at the computed takeoff distance. The climb gradient lines are divided into first and second segments. For purposes of flight path calculations, the second segment extends to 1,500 feet AGL, and the final segment flight path is not considered.

Horizontal distance from Reference Zero is calculated by adding the runway remaining beyond Reference Zero to the distance between the end of the runway and the obstacle (Figure PER-2). The appropriate Takeoff Flight Path chart (Close In—Flaps 8°, Distant—Flaps 8°, Close In—Flaps 20°, or Distant—Flaps 20°) is entered at the bottom margin with the calculated horizontal distance from Reference Zero and at the left margin with obstacle height above the runway. Commercial operators must enter the chart at the right margin with obstacle height above Reference Zero.
Problem:
Determine the climb gradient required to clear the obstacle using the previously listed example conditions.

Solution:
First, the horizontal distance from Reference Zero must be determined. In order to calculate this, determine the takeoff distance, the length of the runway, and the distance of the obstacle from the end of the runway. The takeoff distance for the example conditions is computed to be 3,400 feet. Computation of takeoff distance is described under Takeoff Field Length in this chapter.

Calculate horizontal distance from Reference Zero by first subtracting the takeoff distance from the runway length of find the runway remaining beyond the takeoff point (7,300–3,400 = 3,900 feet). Then add the runway remaining beyond takeoff point to the distance the obstacle is from the end of the runway (3,900 + 20,100 = 24,000 feet) (Figure PER-2). Enter 24,000 feet under Dist From Ref Zero on the Takeoff Worksheet.

Now, use the Distant Takeoff Flight Path (Flaps 8°) chart in the AFM to determine the climb gradient required. Enter the chart at the bottom margin with horizontal distance from Reference Zero (24,000 feet) and proceed vertically. (Do not apply winds on this chart.) Now enter the chart at the left margin (noncommercial operator) with obstacle height above the runway (1,500 feet) and proceed to the right. The two lines intersect between the 6.0% and 7.0% gradient lines. Interpolate when the lines intersect between the climb gradient lines. In this example, the climb gradient required is 6.5% (Figure PER-2).

In addition to finding the climb gradient required, note whether the obstacle falls within the first or second segment. If the intersect point is to the left of the Gear Down—gear up line, the obstacle is in the first segment. If the intersect point is to the right of the line, the obstacle is in
the second segment. It is important to note this in order to select the proper climb gradient chart (first segment or second segment) to find the climb gradient possible for this example. Note also that the climb gradient lines on the chart have a different value in the first and second segments.

**Climb Gradients**

First, Second, and Final Segment Climb Gradient charts are provided to determine the climb gradient possible for airplane gross weight and atmospheric conditions. First and Second Climb Gradient charts (Flaps 8° or 20°) are used in conjunction with the Takeoff Flight Path charts, which show required net gradients for obstacle clearance. The Final Segment climb Gradient chart is provided for reference only.

**Problem:**

Using the Second Segment Climb Gradient (Flaps 8°) chart in the *AFM*, find the climb gradient possible for the example conditions.

**Solution:**

Enter the chart at the bottom, left margin with the temperature (60° F) and proceed vertically until intersecting the field pressure altitude (1,300 feet). From this point, proceed horizontally to the right to the reference line on the Gross Weight section. Parallel the curved guidelines until intersecting the planned takeoff gross weight line (15,000 pounds).

From this point, proceed horizontally to the zero-wind reference line. Then, follow the diagonal wind lines until intersecting the wind velocity line (15 knots headwind). From this point, proceed horizontally to the right margin and read second segment net climb gradient (possible).

If anti-ice systems are to be turned on for takeoff, anti-ice system guidelines must be followed to the right margin. In this example, anti-ice systems are not necessary for takeoff, so the climb gradient possible is found to be approximately 9.8%.

It was previously determined that only a 6.5% gradient was required to clear the obstacle. Therefore, the planned takeoff weight of 15,000 pounds is acceptable for obstacle clearance.

If the climb gradient possible was found to be less than the climb gradient required to clear the obstacle, takeoff should not be attempted under the existing conditions.

As previously mentioned, reducing takeoff gross weight reduces climb gradient required and increases climb gradient possible. As a result finding the maximum takeoff gross weight that allows obstacle clearance becomes an interpolative process. A suggested method for accomplishing this is to average the climb gradient possible and climb gradient required and enter the climb gradient chart on the right with this value.

For example, if the climb gradient required is found to be 4.0% and the climb gradient possible is 3.0%, add the two together and divide by 2 to find the average of 3.5%. Enter the climb gradient chart on the right at 3.5% and work backward through the chart to the gross weight section. Then enter the chart on the left with the temperature and pressure altitude and work forward through the chart to the Gross Weight section. From the point at which the two entries intersect in the Gross Weight section, proceed straight down and read the new trial takeoff weight.
With this trial takeoff weight, a new takeoff distance is computed, a new distance from Reference Zero is calculated, and a new climb gradient required is determined. If the new climb gradient required is less than the climb gradient possible for the trial gross weight (3.5%), the obstacle can be cleared at the trial gross weight.

In most cases, this process will provide a new gross weight that will provide obstacle clearance. If, however, the new required gradient is still greater than the possible gradient, the two gradients (possible and required) can be averaged again and the entire process repeated.

**Takeoff Speeds (V₁, Vᵣ, and V₂)**

These speeds are found in the Critical Engine Failure Speed (V₁), Rotation Speed (Vᵣ), and Takeoff Safety Speed (V₂) charts in the AFM. Separate charts are provided for 8° and 20° flap settings. For a review of these abbreviations (V₁, Vᵣ, and V₂), see Definitions in this chapter.

**Critical Engine Failure Speed (V₁)**

Data provided by the Critical Engine Failure Speed chart is based on three assumptions: (1) takeoff power is set before brake release, (2) the takeoff runway is dry, hard, and smooth, and (3) tires and brakes are operating at normal efficiency.

These assumptions are of particular importance anytime the computed takeoff distance approaches the available runway length. When these assumed conditions are not met, there is no assurance of being able to stop the airplane within the computed takeoff distance if takeoff is rejected at V₁ speed.

**Problem:**

Using the Critical Engine Failure Speed (V₁), (Flaps 8°) chart in the AFM, determine V₁ for the example conditions.

**Solution:**

Enter the chart at the bottom left margin with the temperature (60° F) and proceed vertically until intersecting the field pressure altitude (1,300 feet). Then proceed horizontally to the right to the gross weight reference line.

Parallel the guidelines until intersecting the takeoff gross weight (15,000 pounds). From this point, proceed horizontally to the right to the zero-wind reference line. Follow the wind guidelines to the right until intersecting the wind velocity (15 knots headwind).

From this point, proceed horizontally to the right margin and read V₁ (118 KIAS). If the anti-ice systems are on, the antiskid system is off, or if there is a gradient, follow the guidelines in those two sections of the chart.

Enter the computed V₁ speed on the Takeoff Worksheet (Figure PER-1).

**Rotation Speed (Vᵣ)**

Rotation speed is affected only by airplane gross weight and flap setting.
**Problem:**
Determine $V_R$ from the Rotation Speed ($V_R$) (Flaps $8^\circ$) chart, in the *AFM* for the example takeoff gross weight.

**Solution:**
Enter the chart at the left margin with the airplane gross weight (15,000 pounds). Proceed horizontally right to the reference line and then straight down to the bottom margin and read $V_R$ (130 KIAS). Record the computed $V_R$ speed on the Takeoff Worksheet.

**Takeoff Safety Speed ($V_2$)**
Takeoff safety speed ($V_2$), like rotation speed is affected only by airplane gross weight and flap setting.

**Problem:**
Determine $V_2$ from the Takeoff Safety Speed ($V_2$), (Flaps $8^\circ$) in the *AFM* for the example takeoff gross weight.

**Solution:**
Enter the chart at the left margin with the takeoff gross weight (15,000 pounds). Proceed horizontally right to the reference line and then straight down the margin and read $V_2$ (133 KIAS). Enter the $V_2$ value on the Takeoff Worksheet.

**Takeoff Field Length**
Takeoff field length data assumes a smooth, dry, hard-surface runway.

The takeoff distances computed from the takeoff distance charts in the *AFM* are accurate only when the following procedures are used:

1. Set takeoff $N_1$ prior to brake release and adjust $N_1$ to match computed Takeoff $N_1$. Continue to adjust $N_1$ until reaching 80 KIAS.
2. Rotate to approximately $9^\circ$ noseup at $V_R$.
3. For engine failure after $V_1$, accelerate to $V_2$ after liftoff and then adjust pitch, as required, to maintain $V_2$.

The pilot must use these procedures whenever the computed takeoff distance is at or near the actual runway length. Otherwise, the actual takeoff distance may exceed the chart value and runway length available. Takeoff power settings are discussed later under Takeoff Thrust in this section.

The takeoff field length data presented in the *AFM* is governed by the accelerate-stop or the engine-out accelerate-go distance, whichever is greater. Generally, unless $V_1$ is limited by $V_R$ or $V_{MCG}$, the takeoff field lengths are balanced, and the accelerate-stop distance equals the accelerate-go distance.
The Takeoff Distance charts in the AFM are presented for 8° or 20° flaps settings. These charts may be used to determine either of the following:

1. Runway length required for a given airplane weight.

2. Maximum airplane takeoff weight corresponding to a specific runway length. The process for finding the maximum airplane weight for a given runway length was previously described in this section under Maximum Takeoff Weight for Runway Available.

**Problem:**
Using the Takeoff Distance (Flaps 8°) chart in the AFM, find the takeoff field length for the example conditions.

**Solution:**
Enter the chart at the lower left margin with the temperature (60° F) and proceed vertically until intersecting the field pressure altitude (1,300 feet). From this point proceed horizontally to the right to the gross weight reference line and then follow the guideline until intersecting the takeoff gross weight line (15,000 pounds).

Parallel the guidelines until intersecting the takeoff gross weight line (15,000 pounds). Next, proceed horizontally to the right to the zero-wind reference line. Parallel the guidelines until intersecting the wind velocity (15 knots headwind). Then proceed horizontally right to the right margin and read the takeoff field length (3,400 feet).

If takeoff with a gradient is planned with the antiskid system off or the anti-ice systems on, follow the guidelines through the corresponding section of the chart while proceeding to the right margin.

Pressure altitude is compensated for on the right side of the chart. If takeoff is planned at a pressure altitude above 11,000 feet, an additional factor must be applied in the altitude section on the far right side of the chart. For normal takeoffs below a pressure altitude of 11,000 feet, the altitude section can be disregarded.

**NOTE**
Certification for U.S.-registered airplanes limits takeoffs and landings to 10,000 feet pressure altitude.

**THRUST**

**Takeoff Thrust**
Takeoff performance is based on the assumption that the engines will be operating at a specific fan speed (N₁) for a given temperature and pressure altitude (takeoff power). Takeoff power must be maintained from brake release to 35 feet above the runway or until obstacle clearance in the event of engine failure on takeoff.

Takeoff from a standing start (takeoff thrust set before brake release) must be accomplished when the computed takeoff distance is at or near actual runway length. Also, takeoff from a standing start must be accomplished to ensure computed obstacle clearance performance.
The more comfortable rolling takeoff may be accomplished when actual runway length is at least 10% longer than computed takeoff distance and obstacle clearance is not a factor. When takeoff roll is initiated before setting takeoff power, ensure that takeoff thrust is established before reaching the point at which the runway remaining equals the computed takeoff distance.

If N₁ is below that specified in the takeoff power setting charts for the existing temperature and pressure altitude, airplane takeoff performance will not meet the takeoff performance specified in the performance charts. If N₁ is above computed takeoff power, airframe or engine limits may be exceeded. Thus, it is necessary to compute takeoff power and adjust the power levers as necessary to set N₁ equal to chart value. In addition, operation at a specific N₁ should always be within ITT limits.

NOTE

During takeoff, N₁ may decrease slightly from the initial static reading. Therefore, N₁ should be continuously monitored and adjusted until reaching 80 KIAS.

Separate takeoff power setting charts are provided for airplanes equipped with standard nozzles and those equipped with thrust reverser nozzles. Takeoff power setting charts for standard nozzles are found in the “Performance Data” chapter of the AFM. For thrust-reverser-equipped airplanes, the charts are found in the Aeronca or TR 4000 Thrust Reverser supplement to the AFM. Takeoff power setting data is also provided for all three types of exhaust nozzles in tabular form in the Pilot’s Manual and the Checklist.

Problem:
Using the Takeoff Power Setting (Anti-ice off, Standard Nozzle) chart in the AFM, determine the takeoff power setting for the example conditions.

Solution:
Enter the chart at the bottom margin with the temperature (60° F) and proceed vertically until intersecting the field pressure altitude (1,300 feet). From that point, proceed horizontally to the left margin and read fan speed N₁ (97.3%). Enter this value on the Takeoff Worksheet.

Maximum Climb Thrust

The climb performance data (in the Pilot’s Manual) is predicated on adjusting thrust (N₁) after takeoff to the value found in the Maximum Continuous Thrust (N₁) tables in the AFM. As with takeoff thrust, continuous thrust data is presented for standard nozzles (in the Performance section) and thrust reverser nozzles (in the Thrust Reverser supplement). In addition, maximum continuous thrust data is presented for single-engine operation.

The maximum continuous thrust (N₁) setting may be determined before takeoff using estimated temperature and altitude at start of climb. Since the Maximum Continuous Thrust (N₁) table is based on ram-air temperature in degrees Celsius, the reported or estimated OAT must be converted to RAT before entering the chart.

It is more practical to set power at 795° C ITT after takeoff at the beginning of the climb. Later when crew workload permits, compute maximum continuous thrust and set N₁ to match. Adjust N₁ as necessary so that 832° C maximum continuous thrust is not exceeded.
Upon reaching 15,000 feet, an improved climb power management procedure may be employed for the duration of the climb. This is accomplished by setting the required $N_1$ at 15,000 feet and observing the resulting ITT. This ITT setting may be used for the duration of the climb.

**NOTE**

A slightly different $N_1$ and ITT relationship may exist between engines. Each engine, however, should be operated at the ITT which provides the required $N_1$ at 15,000 feet.

Many operators prefer to simply set the engines to 795° C on the ITT gages and adjust power levers as necessary during the climb to maintain 795° C (recommended continuous ITT). This eliminates the need to compute a climb $N_1$ setting and also possibly extends engine component life due to operating at lower engine temperatures. This power management technique does not guarantee the climb performance presented in the *Pilot’s Manual*. 

**Problem:**

Assume the pilot elects to set 795° C on the ITT gages at the beginning of climb and compute maximum continuous thrust ($N_1$) passing through 15,000 feet. The RAT indicator reading at 15,000 feet is –7° C.

**Solution:**

Enter the Maximum Continuous Thrust ($N_1$) (All Engines, Standard Nozzle) chart in the *AFM* and determine power setting ($N_1$) at 15,000 feet and –7° C.

Each block, corresponding to an altitude and temperature combination, contains two $N_1$ settings. The two setting in each block correspond, in order, to the following two conditions: (1) anti-ice off or nacelle heat only, and (2) full anti-ice systems.

Since the example conditions do not require anti-ice equipment, the proper $N_1$ setting is 97.9%.

The corresponding ITT is noted and power levers adjusted to maintain that ITT until reaching the desired cruise altitude and accelerating to cruise speed.

**CLIMB, CRUISE, AND DESCENT PLANNING**

An Operational Planning Form is provided in the Flight Planning Data section of the *Pilot’s Manual*. See Figure PER-3 in this chapter for a sample form.

**Problem:**

Determine fuel at start of climb.

**Solution:**

Enter example conditions on the Operational Planning Form. Zero-fuel weight (10,000 pounds) plus fuel (5,200 pounds) equals ramp weight (15,200 pounds). Subtract 200 pounds of fuel for warmup and takeoff to find takeoff/start climb weight (15,000 pounds). Subtract 200 pounds from fuel load (5,200 pounds) to find fuel at a start climb (5,000 pounds).
# OPERATIONAL PLANNING FORM

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<th>DISTANCE</th>
<th>FUEL</th>
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<td></td>
</tr>
<tr>
<td>FUEL LOAD</td>
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<td></td>
<td>5,200</td>
</tr>
<tr>
<td>RAMP WEIGHT</td>
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<tr>
<td>WARMUP &amp; TAKEOFF</td>
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<td>102</td>
<td>-200</td>
</tr>
<tr>
<td>Altitude</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>START CLimb WEIGHT</td>
<td>15,000</td>
<td>+17</td>
<td>5,000</td>
</tr>
<tr>
<td>CLIMB</td>
<td>-512</td>
<td></td>
<td>-512</td>
</tr>
<tr>
<td>END CLIMB WEIGHT</td>
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<td>101</td>
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<td>Altitude</td>
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<td>START CRUISE WEIGHT</td>
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<td>Altitude</td>
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<td></td>
</tr>
<tr>
<td>START CLIMB WEIGHT</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>CLIMB</td>
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<td></td>
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<td>END CRUISE WEIGHT</td>
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</tr>
<tr>
<td>Altitude</td>
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<tr>
<td>START DESCENT WEIGHT</td>
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<td>END DESCENT WEIGHT</td>
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<td>2466</td>
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<td></td>
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<td>RESERVES</td>
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<td>3+27</td>
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<td>ZERO FUEL WEIGHT</td>
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<td>2,466</td>
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</tbody>
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**NOTES:**
- Trip - 1000 Nautical Miles
- Long Range Cruise
- Standard day (ISA)
- 20-Knot headwind Component

Figure PER-3. Sample Operational Planning Form (Sheet 1 of 2)
## OPERATIONAL PLANNING FORM

<table>
<thead>
<tr>
<th>Event</th>
<th>Weight</th>
<th>Time</th>
<th>Distance</th>
<th>Fuel</th>
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</thead>
<tbody>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Fuel Load</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ramp Weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warmup &amp; Takeoff</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Start Climb Weight</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Climb</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>End Climb Weight</td>
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</tr>
<tr>
<td>Cruise</td>
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<tr>
<td>End Cruise Weight</td>
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<tr>
<td>Zero Fuel Weight</td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**

---

**Figure PER-3. Sample Operational Planning Form (Sheet 2 of 2)**
Climb Performance

A set of climb performance tables are provided in the *Pilot’s Manual* to determine time, distance (no wind), and fuel required for climb from sea level. If climb is initiated at an altitude above sea level, subtraction of performance values for the starting altitude from the values for the cruise altitude results in the time, distance, and fuel required for climb between two altitudes.

Each chart provides the climb performance data for a specific airplane gross weight at the start of climb. The gross weight is specified in the top, left corner of each chart in 1,000-pound increments. The climb performance data assumes that maximum continuous thrust is set for the climb and that the climb speed schedule is maintained (250 KIAS up to 32,000 feet and 0.70 MISA above 32,000 feet). Each chart provides the climb performance data in columns corresponding to different temperatures (variation from ISA).

**Problem:**

Using the example conditions, determine time, distance, and fuel used in the climb from 1,300 feet to planned long-range cruise altitude. For this example, planned cruise altitude is determined to be FL 430. The method of determining this altitude will be described under Long-range Cruise in this chapter.

To determine the required time, distance, and fuel, refer to the Climb Performance (Two-engine, 15,000-pound) chart in the *Pilot’s Manual*. The example gross weight at start climb is 15,000 pounds. For intermediate gross weights, two charts are required for interpolation. To simplify this example, however, only the 15,000-pound table is used.

**Solution:**

Using the ISA column on the 15,000-pound table, interpolate data listed for 1,000 and 3,000 feet to find time, distance, and fuel for 1,300 feet (start climb altitude). The result should be approximately 0.3 min, 1.2 NM, and 16.2 pounds of fuel. Now subtract these values from those listed for 43,000 feet.

<table>
<thead>
<tr>
<th>TIME</th>
<th>DISTANCE</th>
<th>FUEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.5</td>
<td>107.9</td>
<td>528.2</td>
</tr>
<tr>
<td>−0.3</td>
<td>−1.2</td>
<td>−16.2</td>
</tr>
<tr>
<td>17.2 minutes</td>
<td>106.7 NM</td>
<td>512.0 pounds</td>
</tr>
</tbody>
</table>

This computation reflects a 106.7 NM (no-wind) climb distance. The example specifies an average headwind component of 20 knots in the climb. This 20 knots should be subtracted from the average no-wind speed (TAS) to determine an average ground speed (GS) in the climb. Use a navigation computer to determine no-wind speed (TAS):

\[
\text{KTAS} = \frac{106.7}{17.2} = 374 \text{ knots}
\]

374 KTAS - 20 knots headwind = 354 knots GS

354 knots GS x 17.2 min = 101 NM

Thus, the climb performance data with wind applied is found to be 17.2 minutes, 101 NM, and 512 pounds. Enter this data on the Operational Planning Form.
Cruise Performance

Cruise performance tables are provided in the Pilot’s Manual for normal cruise, high-speed cruise, and long-range cruise.

Normal Cruise

Normal cruise tables provide fuel flows and true airspeed for constant 0.77 M\text{\textsubscript{1}} cruise. Engine power is adjusted to maintain the constant Mach as weight decreases. Enter the appropriate table for the average airplane gross weight for each cruise segment.

High-speed Cruise

High-speed cruise tables provide fuel flows, indicated Mach or airspeed, and true airspeed for a M\text{\textsubscript{MO}}/V\text{\textsubscript{MO}} or V\text{\textsubscript{MAX}} cruise. Power for maximum speed cruise is set for the limiting conditions (M\text{\textsubscript{MO}}/V\text{\textsubscript{MO}}, % rpm, or maximum continuous ITT). Enter the appropriate table for the average airplane gross weight during each cruise segment.

Long-range Cruise

In planning long-range cruise, the selected cruise altitude should provide the maximum air nautical miles per pound of fuel for a given airplane weight. This altitude can be determined from the Specific Range chart in the Pilot’s Manual. Enter the chart with the average airplane gross weight for the planned cruise segment. The point (on the appropriate gross weight line) that is furthest to the right provides the highest nautical miles per pound of fuel. The corresponding altitude is read at the chart margin, to the left of the selected point.

It can be seen from the chart that as airplane gross weight decreases, the altitude that provides best fuel economy increases. Therefore, when planning for maximum range, the cruise portion of the flight should be divided into segments, with an appropriately higher cruise altitude planned as airplane gross weight decreases. As a rough guide in planning for changes in cruise altitude, increase cruise altitude 1,000 feet for each 1,000-pound decrease in gross weight (fuel used).

The specific range chart assumes zero wind. If winds are significant, it may be advantageous to select a different altitude to avoid headwinds or take advantage of tailwinds.

Once the initial cruise altitude has been determined, refer to the appropriate long-range cruise chart to determine the indicated Mach or airspeed, true airspeed, and fuel flow for the initial cruise segment. Each chart provides the above data for a different airplane gross weight. The gross weight is specified in the top, left corner of each chart and represents the average gross weight for a cruise segment in 500-pound increments.

Problem:

First, calculate the approximate gross weight at level off. For the rough calculation, subtract 512 pounds from start climb weight (15,000 - 512 = 14,488 pounds). Assuming fuel consumption at cruise to be 1,000 pounds/hour and estimating 2 hours at cruise, the gross weight at end of cruise would be approximately 12,488 pounds. The average gross weight for the cruise segment is therefore estimated to be 13,488 pounds.
Solution:

Now refer to the specific range chart in the *Pilot’s Manual* and determine the maximum range cruise (LRC) altitude. Find the point on the curved 13,000-pound (closest to 13,488) line that is furthest to the right. Proceed horizontally from this point to the left margin and read LRC altitude (43,000 feet).

Since the example profile has a single cruise leg of approximately 2 hours, it would not be necessary to plan a climb to higher altitude as gross weight is reduced.

After establishing the planned cruise altitude, the climb data can be extracted from the climb performance charts as previously described in this chapter under Climb Performance.

Using the Long-Range Cruise (Two-Engine, Weight—13,500-Pound) chart, extract cruise data. In the ISA column, opposite 43,000 feet, find: Mach Ind.—0.736; KTAS—415; and fuel—pounds/hour—905.

Enter this data on the planning form. The example conditions specified an average 20-knot headwind component; therefore, 20 knots should be subtracted from the TAS to determine ground speed (415 – 20 = 395 GS).

Now, find the cruise distance by subtracting climb and descent distances from total trip length. Descent distance is 82 NM, and computation of this distance is described in this chapter under Descent. (1,000 – [101 + 82] = 817 NM.) Enter 817 distance on the example planning form. Now use a navigation computer to find cruise time using 395 knots GS for 817 NM. The time of 2 + 04 (2 hours and 4 minutes) is then entered on the planning form.

Fuel consumption for cruise can now be determined (2 + 04 at 905 pounds/hour = 1,860 pounds). Subtract 1,860 pounds from the airplane start cruise weight on the planning form.

**Low Speed Buffet Boundary (FC 530 AFCS)**

A buffet boundary chart is provided in the "Performance Data" chapter of the *AFM*. This chart may be used to determine the buffet-free speed envelope for high-altitude flight.

**Problem:**

Using the Buffet Boundary chart, determine the buffet-free speed envelope for the example conditions: 0.70 M₁ at 41,000 feet and gross weight 17,000 pounds.

**Solution:**

Enter the chart at the bottom margin with planned cruise Mach (0.70) and proceed vertically to the altitude line (41,000). Estimate 41 between the 40 and 45 lines. From this point, proceed horizontally to the right until intercepting the airplane weight line on the right side of the chart (17,000), halfway between the 16,000- and 18,000-foot line. Directly below this point on the bank angle scale, read the maximum bank angle to avoid buffet in a level turn (approximately 48° of bank).
Now, return to the gross weight line (17,000) above this point and follow it diagonally down to
the left to the vertical 1.0 G reference line. Draw a line horizontally left of this point until it in-
tersects the curved 41,000 altitude line (between 40 and 45 lines). On the Mach scale directly
below the first point, read the Mach number at which low-speed airframe buffet may be encountered
(0.575 M\textsubscript{f}).

**Low Speed Buffet Boundary at 1.5 Gs (FC 200 AFCS)**

A Low Speed Buffet Boundary chart is provided in the "Performance Data" chapter of the AFM.
This chart may be used to determine the speeds at which low-speed buffet will occur at 1.5 g’s.

**Problem:**

Using the Low Speed Buffet Boundary chart, determine the buffet speed at 1.5 g’s for the ex-
ample conditions, altitude 41,000 feet and gross weight 17,000 pounds.

**Solution:**

Enter the chart from the left margin with the altitude (41,000 feet) and proceed horizontally to
intersect the gross weight (17,000 lb). From this intersection, (1) use the dashed lines to find
the calibrated Mach number (.71 M), and (2) proceed straight down the chart to read the indi-
cated airspeed at the bottom margin (210 KIAS).

**Note**

1.5 g = 48 ½° bank in level flight.

**Descent Performance**

Two Descent Performance Schedules are provided in the Pilot’s Manual to provide time, dis-
tance (no wind), and fuel used for descent to sea level—one for minimum fuel descent and one
for normal descent. The tables assume an average descent weight of 12,000 pounds. Subtraction
of performance values for two altitudes results in time, distance, and fuel required for descent
between the two altitudes. The descent speed schedules presented at the bottom of the table should
be followed to achieve the desired results. The power setting for descent is IDLE thrust.

**Problem:**

Using the Minimum Fuel Descent Performance Schedule, extract descent data for descent from
FL 430 to 1,300 feet (destination elevation). The descent might be planned to the initial approach
fix (IAF) altitude if a particular approach is anticipated. In this example it is appropriate to round
off the 1,300 feet to sea level.

**Solution:**

Enter the data for 43,000 feet.

<table>
<thead>
<tr>
<th>TIME</th>
<th>DISTANCE</th>
<th>FUEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.8 minutes</td>
<td>87 NM</td>
<td>162 pounds</td>
</tr>
</tbody>
</table>
This computation reflects an 87 NM (no-wind) descent distance. The example conditions specify an average headwind component of 20 knots in the descent; therefore, 20 knots should be subtracted from the average no-wind speed (TAS) to find an average ground speed (GS) in the descent. Use a navigation computer to determine no-wind speed (TAS):

\[ \frac{87}{13.8} = \text{KTAS} = 378 \]

378 KTAS – 20 knots headwind = 358 knots GS

358 knots GS for 13.8 minutes = 82 NM

Thus, the descent data with wind applied is found to be 13.8 minutes, 82 NM, and 162 pounds. Enter this data on the planning form and subtract fuel used in descent from the start descent gross weight and fuel remaining at start descent. The end descent data is 12,466 pounds gross weight and 2,466 pounds of fuel remaining.

Fuel Reserve

FAR Part 91 requires a fuel reserve (IFR conditions) of 45 minutes at destination or at the alternate airport if an alternate is required. Fuel reserve is computed at normal cruise speed. The Pilot's Manual also contains a Holding Operations table which provides maximum endurance holding speed and fuel flow for the airplane weight and pressure altitude.

Problem:

Note on the example planning form that fuel remaining at destination will be 2,466 pounds.

Solution:

Since an alternate is not required in this example, the reserve equals 3 hours and 27 minutes (cruise fuel flow 715 pounds/hour).

APPROACH AND LANDING PERFORMANCE

Approach and performance data are provided in chart form in the AFM performance station and in tabular form in the Learjet Pilot’s Manual and Checklist (Figure PER-4).

Maximum Allowable Landing Weight

The maximum allowable landing weight is limited by the most restrictive of the following requirements:

- Maximum certificated landing weight (14,300 or 15,300 pounds)
- Maximum landing weight (approach climb or brake energy limited)
- Maximum landing weight for the runway length available
Maximum Landing Weight (Approach Climb or Brake Energy Limited)

The Landing Weight Limit charts (Approach Climb and Brake Energy Limited) provide a maximum approach/landing weight which allows (1) the airplane to meet a minimum climb gradient (single engine) in the event of missed approach or (2) braking to a full stop without exceeding brake energy limits.

If landing distance for existing gross weight is computed to be greater than the runway available, the gross weight must be reduced before using that runway. Landing weight for runway length available may be determined by working through the Landing Distance chart backward. Use the same procedure as previously described for finding maximum takeoff gross weight for a given runway length.

Problem:
Use the Landing Weight Limit (Anti-ice-Off) chart in the AFM to determine the maximum landing weight for the example conditions.

Solution:
Enter the chart on the left margin with temperature (60°F) and proceed horizontally right until intersecting the pressure altitude (1,300-foot) line. If the temperature line intersects the altitude line, read the approach climb weight limit directly below the point at which they intersect.

Figure PER-4. Sample Landing Worksheet (Sheet 1 of 2)
In this example, the 60˚ F temperature line does not intersect the 1,300-foot altitude line. This indicates that a safe missed approach could be made on one engine at any gross weight up to 18,300 pounds at this temperature and pressure altitude. Enter 18,300 pounds under Appr Climb Wt on the Landing Worksheet.

Using the same chart, determine if landing weight is limited by brake energy. Enter the left side of the chart again with temperature (60˚ F) and proceed horizontally until intercepting the altitude line (1,300 feet). Again the lines do not intersect, indicating that the airplane can be stopped at gross weights up to maximum certificated gross weight without exceeding brake energy limits. Enter 18,300 on the Landing Worksheet under Brake Energy Weight.

If the temperature and pressure altitude lines had intercepted, the wind and runway gradients are accounted for at the lower section of the chart.

**Maximum Landing Weight for Runway Available**

This computation is made using the same method as that used to find maximum takeoff weight for runway available. Enter the Landing Distance chart on the right and work backward in the chart to the Gross Weight section and draw a light line through the Gross Weight section.

Now enter the chart on the left with temperature and pressure altitude and proceed to the gross weight section. The maximum landing weight for runway available is read directly below the point at which the two entries intersect in the Gross Weight section.
If the two entries do not intersect in the Gross Weight section and the entry from the left falls above the entry from the right, the runway is too short for landing. If the entry from the left falls below the entry from the right, landing may be made up to 18,300 pounds without exceeding landing distance available. The latter is true in the example conditions; therefore, landing weight is not limited due to runway length under the example conditions. See the example under Landing Distance.

**Landing Distance**

The landing distances computed from the Landing Distance (FAR Part 91 [private] Operations) chart can be achieved when the following procedures are used:

1. Approach through the 50-foot point over the end of the runway at $V_{REF}$ with flaps and gear down, using a 2 1/2 -- 3° glide slope.

2. After passing through the 50-foot point, progressively reduce thrust until thrust levers are at IDLE prior to touchdown.

3. After touchdown, extend spoilers immediately.

4. Apply wheel brakes as soon as practical and continue maximum braking action until the airplane stops.

5. After landing, move the control column full aft and maintain that position until the airplane stops.

**NOTE**

Pulling the control column aft will shift weight to the main wheels and improve braking efficiency. Pull control column as far aft as possible but do not lift the nosewheel.

On wet or icy runway surfaces, full aft control column movement may not be practical due to the possibility of nosewheel liftoff.

The landing distance chart is based upon smooth, dry, hard-surface runways. The landing field length is equal to the horizontal distance from a point 50 feet above the runway surface to the point at which the airplane comes to a full stop on the runway.

Those operators governed by FAR Part 91 determine landing distance from the Landing Distance (FAR Part 91 Operations) chart. When the landing configuration speed is other than normal, the appropriate procedure in the Abnormal Procedures section of the AFM provides a factor to apply to the normal landing distance.

When the runway is other than dry, the following factors should also be applied to the Landing Distance chart.

- Wet—apply a 1.4 factor to the computed landing distance.
- Wet (in the process of freezing)—apply a factor of at least 1.7 to the computed landing distance.
Those operators governed by FAR Part 121 or 135 first determine landing distance from the Landing Distance (FAR Part 91 Operations) chart and then apply the appropriate abnormal landing factor if required. Next, enter the Landing Distance (FAR Part 121 and 135 Operations) chart to compute landing field length for scheduled and alternate stops.

When the runway is wet, commercial operators must apply a 1.15 factor to the landing field length.

**NOTE**

For all operations, corrections to be applied to account for the presence of solid ice, snow, or slush are unknown.

**Problem:**

Use the Landing Distance (FAR Part 91 Operations) chart in the AFM to find landing distance for the example conditions.

**Solution:**

Enter the chart at the bottom left margin with the temperature (60°F) and proceed vertically to the altitude line (1,300 feet). From this point proceed horizontally to the reference line in the center of the Gross Weight section of the chart.

Next, follow the guidelines diagonally up and to the right until intersecting the weight (12,466 pounds) from the Operational Planning Form (Figure PER-3). Move horizontally to the right to the zero-wind reference line.

Follow the wind guidelines until intersecting 15 knots headwind velocity. From this point proceed horizontally through the runway gradient section (zero gradient), antiskid section (antiskid on), and through the altitude section (below 11,000 feet) to the right margin and read landing distance (2,550 feet). Enter 2,550 feet on the Landing Worksheet under Landing Distance.

To determine maximum landing gross weight for the runway available, enter the Landing Distance chart on the right with runway length (13,300 feet) and work backward through the chart to the Gross Weight section.

In this example, the runway available exceeds the chart values for all conditions, indicating that there is no limitation in landing gross weight for runway available. Enter 18,300 pounds on the Landing Worksheet under Landing Wt for Rwy Length.

Approach minimum maneuvering speeds are based on 1.3 times the airplane's stall speed with idle thrust in applicable configuration and a 30-degree bank angle. Minimum maneuvering speeds are as follows:

- No flap configuration \( V_{\text{REF}} + 40 \) KIAS
- FLAPS 8° configuration \( V_{\text{REF}} + 30 \) KIAS
- FLAPS 20° configuration \( V_{\text{REF}} + 20 \) KIAS
- FLAPS 40° configuration \( V_{\text{REF}} + 10 \) KIAS

On final approach (with bank angle no more than 15°), 10 KIAS may be subtracted from the above speeds.
Landing Approach Speed ($V_{REF}$)

$V_{REF}$ is determined from the Landing Approach Speed ($V_{REF}$) chart in the AFM. Since $V_{REF}$ is determined strictly by airplane gross weight, $V_{REF}$ speeds listed in tabular form in the Pilot’s Manual and Checklist may be used with equal accuracy.

Problem:
Use the Landing Approach Speed ($V_{REF}$) chart in the AFM to determine $V_{REF}$ for the planned landing weight in the example (12,466 pounds).

Solution:
Enter the chart at the left margin with gross weight (12,466 pounds) and proceed horizontally until intersecting the reference line, then straight down to the bottom margin of the chart and read $V_{REF}$ (117 KIAS). Enter this value under $V_{REF}$ on the Landing Worksheet.

Approach and Landing Speeds

See Definitions in this chapter for a description of approach climb speed and landing climb speed. Like landing approach speed, $V_{REF}$, approach, and landing climb are based strictly on airplane weight. As a result, the tabular data in the Pilot’s Manual and Checklist is as accurate as the chart in the AFM. Approach climb and landing climb speeds are provided on the same chart in the AFM.

Problem:
Use the Approach and Landing Climb Speeds chart in the AFM to determine these speeds for the example conditions.

Solution:
Enter the chart on the left margin with the gross weight (12,466 pounds) and proceed horizontally to the first reference line. Then move straight down to the bottom margin of the chart to read landing climb speed (117 KIAS). It should be noted that landing climb speed is the same value as landing approach speed ($V_{REF}$). Therefore, if $V_{REF}$ is known, it is not necessary to compute landing climb speed.

Using the same chart and the approach climb speed reference line, find approach climb speed (123 KIAS). It should be noted that approach climb speed computes to be 6 knots greater than $V_{REF}$ at lower gross weights (below 13,000) and 7 knots at higher gross weights. To simplify computations, the Gates Flight Training Manual recommends adding 10 knots to computed $V_{REF}$ for a practical approach climb speed.
# CREW RESOURCE MANAGEMENT

## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREW CONCEPT BRIEFING GUIDE</td>
<td>CRM-3</td>
</tr>
<tr>
<td>Introduction</td>
<td>CRM-3</td>
</tr>
<tr>
<td>Common Terms</td>
<td>CRM-3</td>
</tr>
<tr>
<td>Pretakeoff Briefing (IFR/VFR)</td>
<td>CRM-3</td>
</tr>
<tr>
<td>Crew Coordination during the Approach Sequence</td>
<td>CRM-4</td>
</tr>
<tr>
<td>ALTITUDE CALLOUTS</td>
<td>CRM-5</td>
</tr>
<tr>
<td>Enroute</td>
<td>CRM-5</td>
</tr>
<tr>
<td>Approach—Precision</td>
<td>CRM-5</td>
</tr>
<tr>
<td>Approach—Nonprecision</td>
<td>CRM-6</td>
</tr>
<tr>
<td>Significant Deviation Callouts</td>
<td>CRM-7</td>
</tr>
</tbody>
</table>
# ILLUSTRATIONS

<table>
<thead>
<tr>
<th>Figure</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRM-1</td>
<td>Situational Awareness in the Cockpit</td>
<td>CRM-1</td>
</tr>
<tr>
<td>CRM-2</td>
<td>Command and Leadership</td>
<td>CRM-1</td>
</tr>
<tr>
<td>CRM-3</td>
<td>Communication Process</td>
<td>CRM-2</td>
</tr>
<tr>
<td>CRM-4</td>
<td>Decision Making Process</td>
<td>CRM-2</td>
</tr>
</tbody>
</table>
CREW RESOURCE MANAGEMENT (CRM)

**CLUES TO IDENTIFYING:**
- Loss of Situational Awareness
- Links in the Error Chain

**OPERATIONAL:**
1. Failure to Meet Targets
2. Undocumented Procedure
3. Departure from SOP
4. Violating Minimums or Limitations
5. No One Flying Airplane
6. No One Looking Out Window

**HUMAN:**
7. Communications
8. Ambiguity
9. Unresolved Discrepancies
10. Preoccupation or Distraction
11. Confusion or Empty Feeling
12. ...

**IT'S UP TO YOU!**

Figure CRM-1. Situational Awareness in the Cockpit

**LEADERSHIP STYLES**

<table>
<thead>
<tr>
<th>Leadership Style</th>
<th>Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autocratic Style</td>
<td>Low</td>
</tr>
<tr>
<td>Authoritarian Leadership</td>
<td>High</td>
</tr>
<tr>
<td>Democratic Leadership</td>
<td></td>
</tr>
<tr>
<td>Laissez-Faire Style</td>
<td></td>
</tr>
</tbody>
</table>

Command — Designated by Organization
— Cannot be Shared
Leadership — Shared among Crewmembers
— Focuses on "What's right," not "Who's right"

Figure CRM-2. Command and Leadership
THINK:
- Solicit and give feedback
- Listen carefully
- Focus on behavior, not people
- Maintain focus on the goal
- Verify operational outcome is achieved

ADVOCACY: to increase others’ S/A
* State Position
* Suggest Solutions
* Be Persistent and Focused
* Listen Carefully

INQUIRY: to increase your own S/A
* Decide What, Whom, How to ask
* Ask Clear, Concise Questions
* Relate Concerns Accurately
* Draw Conclusions from Valid Information
* Keep an Open Mind

— REMEMBER —
Questions enhance communication flow
Don’t give in to the temptation to ask questions when Advocacy is required
Use of Advocacy or Inquiry should raise a ‘red flag’.

Figure CRM-3. Communication Process

HINTS:
- Identify the problem:
  — Communicate it
  — Achieve agreement
  — Obtain commitment
- Consider appropriate SOP’s
- Think beyond the obvious alternatives
- Make decisions as a result of the process
- Resist the temptation to make an immediate decision and then support it with facts

Figure CRM-4. Decision Making Process
CREW CONCEPT BRIEFING GUIDE

INTRODUCTION

To a large extent the success of any aircrew depends on how effectively crewmembers coordinate their actions using standardized and approved procedures. In other chapters you have been exposed to standardized maneuvers, procedures and checklists. This chapter is designed to illustrate standard aircrew calls and briefing guidelines that when used in logical sequence with aircrew checklists and flight procedures can improve aircrew efficiency and enhance safety. These callouts and briefings are only recommendations to be used in a larger system of standard operating procedures that when combined become the core of an effective crew resource management program. They are not intended to supersede any individual company SOP, but are examples of good operating practices.

COMMON TERMS

PIC  Pilot in Command
Designated by the company for flights requiring more than one pilot. Responsible for conduct and safety of the flight. Designates pilot flying and pilot not flying duties.

PF  Pilot Flying
Controls the aircraft with respect to assigned airway, course, altitude, airspeed, etc., during normal and emergency conditions. Accomplishes other tasks as directed by the PIC.

PNF  Pilot Not Flying
Maintains ATC communications, copies clearances, accomplishes checklists and other tasks as directed by the PIC.

B  Both

PRETAKEOFF BRIEFING (IFR/VFR)

NOTE

The following briefing is to be completed during item 1 of the Pretakeoff checklist. The pilot flying will accomplish the briefing.

1. Review the ATC clearance and departure procedure (route and altitude, type of take-off, significant terrain features, etc.).
2. Review those items that are not standard procedure to include deferred or MEL items (if applicable).
3. Review required callouts, unless standard calls have been agreed upon, in which case a request for “Standard Callouts” may be used.
4. Review the procedures to be used in case of an emergency on departure.
5. As a final item, ask if there are any questions.

CREW COORDINATION DURING THE APPROACH SEQUENCE

NOTE
The following crew coordination approach sequence should be completed as early as possible, prior to initiating an IFR approach.

PF—Requests the pilot not flying to obtain destination weather. (Transfer of communication duties to the pilot flying may facilitate this task.)
PNF—Advises the pilot of current destination weather, approach in use, and special information pertinent to the destination.
PF—Requests the pilot not flying to perform the approach setup.
PNF—Accomplishes the approach setup and advises of frequency tuned, identified and course set.
PF—Transfers control of the aircraft to the pilot not flying, advising, “You have control, heading ________, altitude ________” and special instructions. (Communications duties should be transferred back to the pilot not flying at this point.)
PNF—Responds, “I have control, heading __________, altitude __________.”
PF—The pilot who will fly the approach will review, then brief the approach procedure.
PF—Advises, “I have control, heading __________, altitude __________.”
PNF—Confirms “You have control, heading __________, altitude __________.”

NOTE
The above sequence should be completed prior to the FAF.
ALTITUDE CALLOUTS

ENROUTE

1000 Feet Prior to Level Off

PNF

State altitude leaving and assigned level off altitude

“200 above/below”

PF

“CHECKED”

“LEVELING”

APPROACH—PRECISION

PNF

At 1,000 ft above minimums

“1,000 feet above”

PF

“DH _________”

At 500 ft above minimums

“500 feet above minimums”

“NO FLAGS”

At 100 ft above minimums

“100 feet above”

At decision height (DH)

“Decision Height, approach lights at (clock position)”

“CONTINUING”

OR

“LANDING”

OR

“Decision Height, runway at (clock position)”

“CONTINUING”

OR

“LANDING”

OR

“Decision Height, runway not in sight”

“MISSED APPROACH”
APPRAOCH—NONPRECISION

PNF

At 1,000 ft above MDA

“1,000 feet above”

At 500 ft above MDA

“500 feet above.”

At 100 ft above MDA

“100 feet above.”

At minimum descent altitude (MDA)

“MDA”

“MAINTAINING MDA”

PF

At 1,000 ft above MDA

“MDA ________”

At 500 ft above MDA

“NO FLAGS”

At 100 ft above MDA

At or Prior to the missed approach point (MAP)

“Approach lights at (clock position)”

“CONTINUING”

OR

“LANDING”

“Runway at (clock position)”

“CONTINUING”

OR

“LANDING”

“Runway not in sight”

“MISSED APPROACH”
SIGNIFICANT DEVIATION CALLOUTS

**PNF**

**PF**

IAS ± 10 KIAS

“VREF ± _________”

“CORRECTING TO _______”

Heading ± 10° enroute, 5° on approach

“Heading _________ degrees left/right”

“CORRECTING TO _______”

Altitude ± 100 ft enroute, +50/-0 ft on final approach

“Altitude _________ high/low”

“CORRECTING TO _______”

CDI left or right one dot

“Left/right of course _________ dot”

“CORRECTING”

RMI course left or right ±5°

“Left/right of course _________ degrees”

“CORRECTING”

Vertical descent speed greater than 1,000 fpm on final approach

“Sink rate _________”

“CORRECTING”

Bank in excess of 30°

“Bank _________ degrees”

“CORRECTING”