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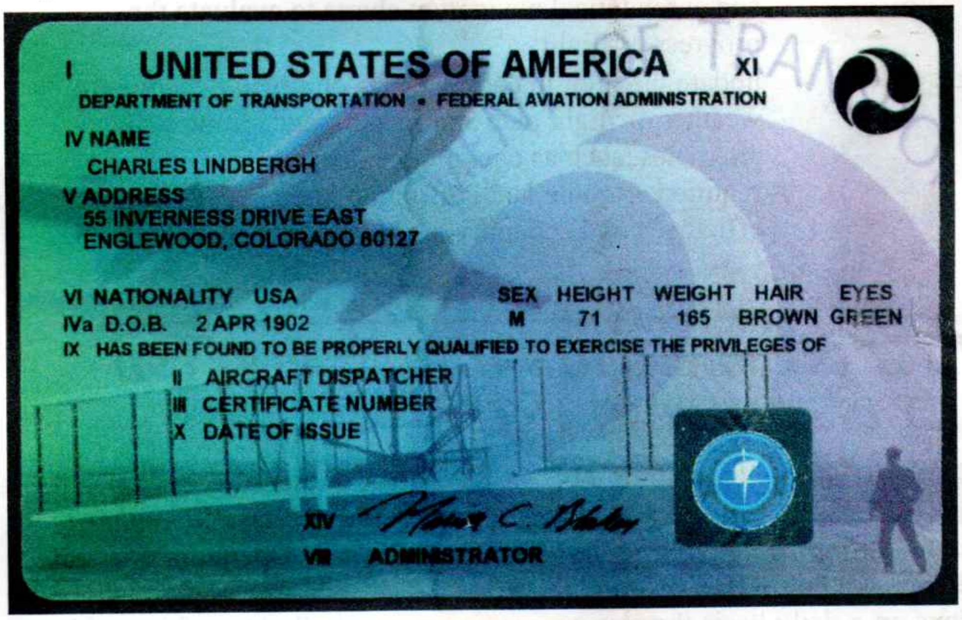
i) Introduction

Welcome to the Jeppesen Academy Flight Operations Management - Level 2 course. This course is designed to prepare you to become a certified aircraft dispatcher.

WHAT IS AN AIRCRAFT DISPATCHER?

An Aircraft Dispatcher is a licensed airman certified by a controlling government agency. In the U. S., the agency is the Federal Aviation Administration (FAA). Other countries will have their own National Aviation Administration (NAA) which may or may not issue a license for dispatchers.



In order to receive the FAA Dispatcher Certificate applicants must graduate from an FAA approved course, pass the FAA written, and pass the FAA Oral and Practical exams. Once dispatchers receive their license they will then attend in-depth airline specific training.

A dispatcher has joint responsibility with the captain for the safety and operational control of flights under his/her control for domestic and Flag carrier operations under 14 CFR Parts 121.533 and 535. A supplemental operator will specify the names of people designated to exercise operational control in their Operations Manual. The Pilot in Command (PIC) and Director of Operations (Ops) are jointly responsible for the initiation, continuation, diversion and termination of a flight. The Director of Ops may delegate the functions for the above but he may not delegate the responsibility for these functions.

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Other common responsibilities include:

- analyze and evaluate meteorological information to determine potential hazards to safety of flight and to select the most desirable and economic route of flight;
- compute the amount of fuel required for the safe completion of a flight
- prepare flight plans containing information such as maximum allowable takeoff and landing weights, weather reports, field conditions, NOTAMS and many other informational components required for the safe completion of flight;
- prepare and sign the dispatch release which is the legal document providing authorization for a flight to depart;
- cancel flights if unsafe conditions threaten the safety of his/her aircraft or passengers.
- monitor weather conditions, aircraft position reports, and aeronautical navigation charts to evaluate the progress of flight;
- update the pilot in command of significant changes to weather or flight plan and recommends flight plan alternates, such as changing course, altitude and, if required, enroute landings in the interest of safety, efficiency and economy.
-

WHAT IS OPERATIONAL CONTROL AND WHY IS IT IMPORTANT?

Federal Aviation Regulation (14 CFR) Part 1.1 defines operational control as: *"...with respect to a flight, means the exercise of authority over initiating, conducting or terminating a flight."* Operators conduct operational control by making those decisions and performing those actions on a daily basis that are necessary to operate flights safely and in compliance with the regulations. The aircraft dispatcher thus has critical safety oversight responsibilities with respect to the conduct of the flight, including terminating the flight if warranted.

In 1995, FAA wrote the following in the opening of their Advisory Circular (AC) 121-32 (now AC 121-32A) "The NTSB and Transportation Safety Board [TSB] of Canada have both found that inadequate operational control and inadequate collaborative decision making have been contributing factors in air carrier accidents."

All commercial airlines, corporate operators, and even military operators can benefit from operational control to ensure the safety of each flight and to operate the aircraft fleet in a legal and efficient manner. Each operator has a business responsibility that requires all flights to be controlled efficiently so as to enhance the business success and profitability of the operator.

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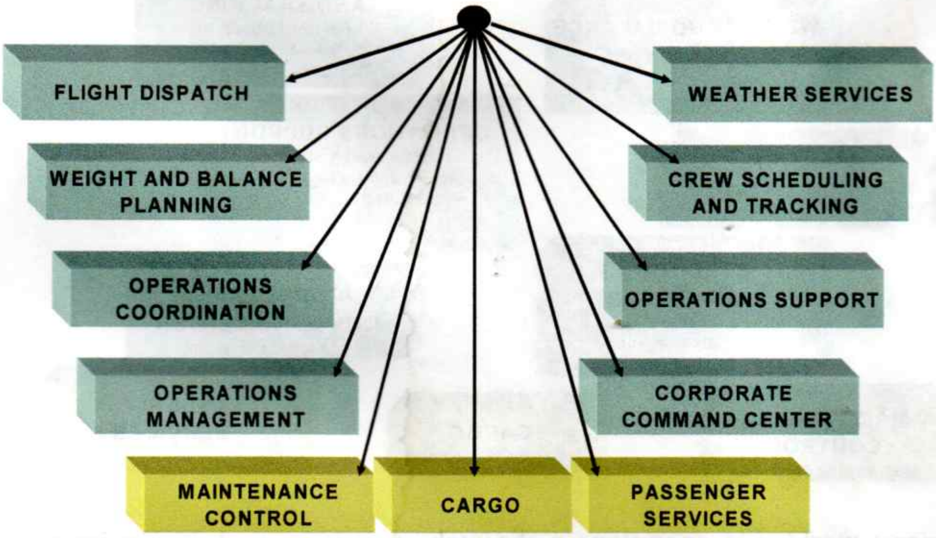
THE AIRLINE OPERATIONS CONTROL (AOC) ENVIRONMENT



Airline Operations Control (AOC)
System Operations Control (SOC)
Operations Control Center (OCC)

The primary business processes within the systems / operations control environment involve communication and coordination with many of the internal and external organizations that are continuously adapting to external events in order to ensure a safe, efficient and cost-effective airline. In an environment where change is constantly occurring and competition intensifying, a centralized and integrated operations control center is becoming a necessity. In order to establish an integrated SOC/AOC, operator processes, procedures and systems must be developed and put in place which maximize safe planning, communications, and real-time information exchange. Each operator is responsible for operational control along with employees to ensure, at the systemic level, that operational processes, procedures, and systems are satisfactory - and enable all employee functions to succeed.

There are many functional positions which encompass all operational processes, procedures, and systems.

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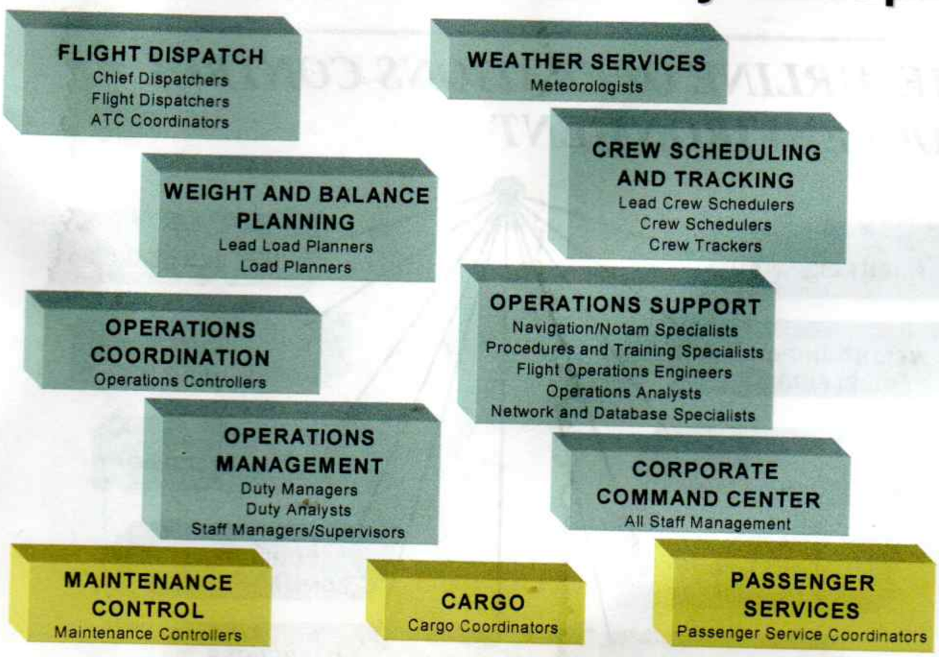
Functional Positions By Group



In many worldwide operations a dispatch system is used as a primary operational control function by allowing information, pertinent to the flight, to be accessed and passed on to the pilot throughout the flight. The dispatch system also provides the pilot with verification of pilot calculations related to weight and balance, fuel load, etc., since these detailed calculations are typically performed by the aircraft dispatcher (dual responsibility). Weather change's enroute, airport and airport facility, and other essential information is made available to the pilot through the dispatcher. If an in-flight emergency occurs, the pilot and the dispatcher can communicate on the safest measures to follow.

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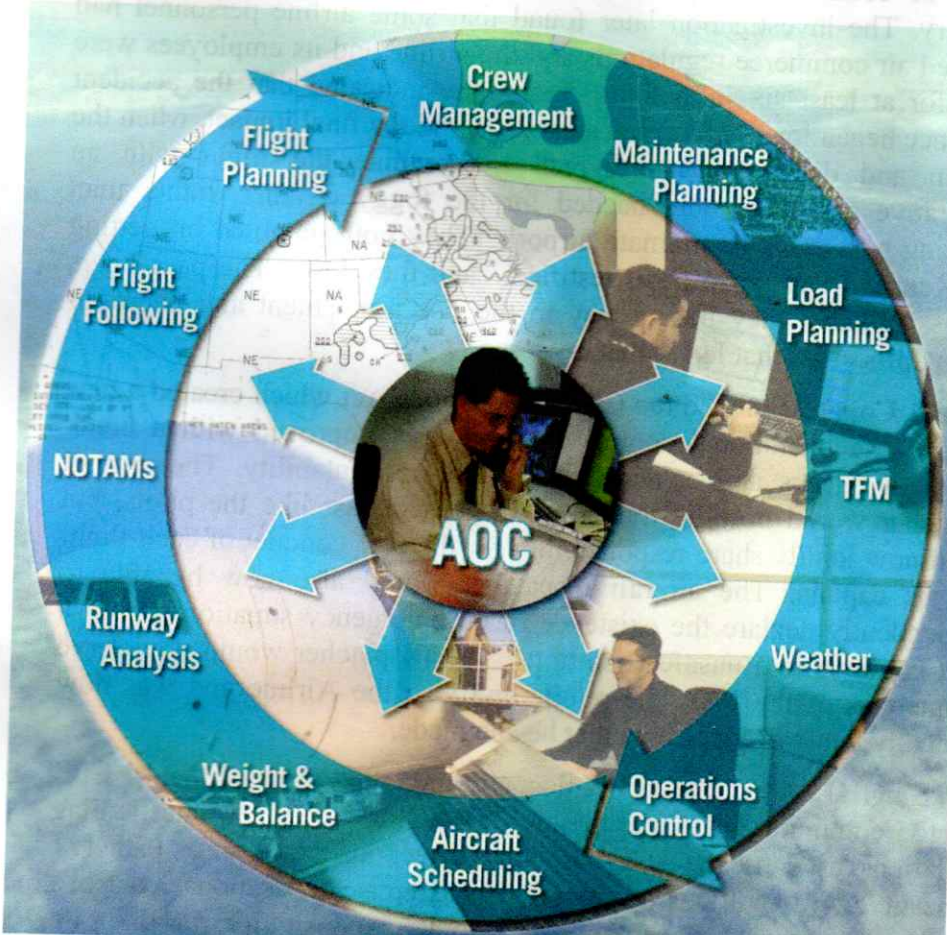
In exercising operational control, the dispatcher coordinates with flight crew members, ATC, and other members of a vast team in order to meet the requirements of daily flight operations. In order to coordinate with all essential functions, the dispatcher often becomes the hub of operational communications.



Aircraft dispatchers employed by each airline are responsible for safe, efficient and economical utilization of their company's aircraft and flight operations.

HISTORY OF THE AIRCRAFT DISPATCHER

The first aircraft dispatchers appeared in 1924 via establishment of the Postal Services' first transcontinental airmail route. Aircraft dispatchers were employed by the airline, and responsible for planning the varied details of each flight, including determining if the flight should even attempt to operate if weather or other factors made it inadvisable.

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In 1935, a Douglas DC-2 crashed near Kirksville, Missouri. This crash killed five people, including the prominent Senator Bronson Cutting of New Mexico. The crash especially angered Congress due to perceived neglect regarding the Government's responsibilities towards air safety in favor of economic and political factors affecting the then-fledgling industry. The investigation later found that some airline personnel had violated air commerce regulations and the airline and its employees were cited for at least six infractions. Testimony indicated that the accident sequence began long before fuel starvation and the final impact, when the captain and dispatcher had agreed to continue the flight with an inoperative aircraft system needed for the foggy weather, rather than diverting to a suitable alternate airport. "They both gambled on getting into Kansas City," an official testified, "and they lost." The passengers lost as well, but they had no say in the risk assessment and decision-making processes that led to that outcome.

In 1938, Congress passed the Civil Aeronautics Act which created a new agency. The operational control structure was improved with a better system of checks and balances, and more accountability. The aircraft dispatcher would now be trained and licensed, just like the pilots, but would now jointly share responsibility for the safe conduct of each flight with its captain. The aircraft dispatcher would also now be able to independently declare the existence of an emergency situation should a flight continue into unsafe conditions. The Dispatcher would now serve the interests of the FAA the public and also the Airline and was now personally liable for decisions that he/she made.

The "Single-Level of Safety" philosophy upgraded most of the 14 CFR Part 135 commuter airlines to the higher 14 CFR Part 121 Domestic/Flag regulations used by the U.S.-based passenger airlines. These Part 121 Domestic/Flag operations are required to exercise "operational control", and the dispatcher and captain share joint responsibility for the safe conduct of the flight, as per 14 CFR 121.533 (Domestic), and 121.535 (Flag).

WEBSITES AND DISPATCHER ORGANIZATIONS

Here are some web sites and dispatcher organizations.

- Airline Dispatchers Federation
- International Federation of Airline Dispatchers Associations
- European Federation of Airline Dispatchers Associations
- www.dispatcher.org

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COURSE CONTENT

This course conforms with CFR 14 Part 65 Subpart C and Appendix A to Part 65.

BOOKS AND MATERIALS

Your Student Kit should contain the following items. Review your kit to ensure you have all required contents:

Flight Operations Management-Level 2 Student Notes

- ☐ Introduction
- ☐ Chapter 1, Meteorology & Appendix
- ☐ Chapter 2, Air Traffic Control
- ☐ Chapter 3, Security & Emergency Procedures
- ☐ Chapter 4, Communications
- ☐ Chapter 5, Aircraft Aerodynamics & Systems
- ☐ Chapter 6, Aircraft Performance
- ☐ Chapter 7, Navigation + Reviews & Appendix
- ☐ Chapter 8, Federal Air Regulations
- ☐ Chapter 9, Practical Dispatch Applications + Appendix
- ☐ Chapter 10 Human Factors/Dispatch Resource Management

Additional kit materials for all students regardless of location.

- ☐ CX-3 Flight Planning Computer
- ☐ Jeppesen Federal Aviation Regulations/Aeronautical Information Manual
- ☐ Instrument Procedures Guide
- ☐ Gleim ATP Test Guide Online
- ☐ Jeppesen Aviation Weather
- ☐ Introduction to Jeppesen Charts Booklet
- ☐ US Hi (1/2) Enroute Navigation Chart
- ☐ FOM-2 Module Review Questions
- ☐ Jeppesen Airlines Flight Operations Manual

INFORM YOUR INSTRUCTOR IF ANY ITEMS ARE MISSING OR DAMAGED, OR CONTACT US BY EMAIL AT jeppesenacademy@boeing.com

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STUDENT EXPECTATIONS

Jeppesen Academy instructors and staff have certain expectations of you, the student. You must understand that a very significant amount of effort on your part is required to successfully complete this course. Jeppesen instructors will make every effort to assist students who are struggling with the material but there are limits to the amount of time that any instructor can devote to an individual student during or after any course.

INDEPENDENT STUDY/HOMEWORK EXPECTATIONS

Normal student preparation time outside of class averages 2-3 hours per day plus 8-10 hours over each weekend. Some students may require more independent study time. Jeppesen will assist students having difficulty with course material during and after the course, based upon instructor availability.

Students demonstrating any of the following may be recommended to attend a future class or portion thereof at no additional charge.

- A lack of sufficient independent study.
- Inattention in class.
- Excessive absences.
- A requirement for significant remedial or one-on-one training.

Additional charges may be incurred by students who desire significant remedial or one-on-one training during or after the course to avoid a future re-take of the course.

MODULE END EXAMINATIONS

Module end exams are for your benefit to prepare you for the FAA or National Aviation Authority (NAA) written examination. Refer to your course calendar (issued separately) and the study guide at the end of this chapter for a description of each Module End Exam and the day of the exam. The study guide assumes that you are participating in a full-time 6-week course. Students participating in an evening class at a U.S. domestic location will have a different testing schedule but the content will be identical.

EXAMINATION FAILURES

Students who fail any Module End Exam will be required to continue learning new material while, at the same time, preparing to retest the failed exam. Students are allowed a maximum of 3 tries to pass a given Module End Exam before remedial training is required. **Students are allowed a maximum of 3 tries to pass the Jeppesen Final Exam. After 3 failures, a retake of the course is required.**

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GRADING POLICY AND PROCEDURES

Each student will be required to pass module end exams and final exams with a minimum score of 75% or greater to graduate from the Jeppesen Academy Flight Operations Management - Level 2 (FOM-2) program. Jeppesen requires 75% because experience has shown that student often score up to 5% lower on NAA exams, usually due to nervousness.

This graduation certificate is valid for 90 days. After 90 days, Jeppesen Academy may revalidate the certificate for an additional 90 days if the student remains proficient in the subject areas of the course.

GROUNDS FOR DISMISSAL

Jeppesen Academy desires that all students successfully complete the program. However, students will be asked to leave the course in any of the following events:

- Failure to act professionally.
- Disruptive behavior.
- Cheating on an examination.
- Excessive tardiness.
- More than one unexcused absence.
- Failure to pass each module end exam with a score of 75% or higher.
- Failure to achieve a passing grade on the FAA (NAA) written exam.

If a student is dismissed from the course, he or she may re-enroll after a period of three months.

COURSE SYLLABUS

The six-week FOM-2 course will be divided into eight main lessons, plus an introduction. The subject areas covered in these lessons are:

- Federal Aviation Regulations.
- Meteorology.
- Navigation.
- Aircraft.
- Communications.
- Air Traffic Control.
- Emergency and Abnormal Procedures.
- Practical Dispatching.

Each lesson presents instructional material, gives students opportunities to apply what they have learned in various exercises, and quizzes students on what they have learned. Each lesson is divided into a number of sub-sections and the list given above does not reflect the order in which the lessons are presented nor is the list comprehensive of all material to be

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covered above and beyond the requirements stated in 14 CFR Part 65, Appendix A.

STUDENT RECORDS

In compliance with 14 CFR 65.70, Jeppesen Academy will maintain each student's training records file for a period of at least 36 months. In addition, Jeppesen Academy will prepare a course transcript, available for forwarding to other schools or prospective employers. Students will be required to sign a daily attendance record to document that they were present for all the required training time.

FAA (NAA) WRITTEN, ORAL AND PRACTICAL EXAMINATIONS

The first chapter of your red Gleim Airline Transport Pilot/Aircraft Dispatcher written test guide contains important information about the format of the FAA knowledge test. Although the text speaks to the ATP exam, the Dispatcher exam is essentially the same. There are 80 questions on the test and you must score a minimum of 70% to pass. You will have 3 hours to complete the test and you need bring only your Jeppesen CX2 Pathfinder flight computer and a clear plastic ruler. Read this chapter to discover the basic requirements and procedures for taking the knowledge test. A computer test supplement containing all the required graphics will be supplied by the test center. For students taking this course outside the United States, the testing procedure is similar but is not done on a computer.

The oral and practical examination tests your ability to put your knowledge to use. It is a one-on-one examination where you meet with a representative of the FAA or a NAA to answer questions posed by the examiner. These oral questions generally fall into one of two categories. A question may address a specific topic such as a particular regulation and be in this format: *"When is a destination alternate not required for a domestic flight?"* Or, questions may be of a more general nature, testing your ability to prioritize tasks and make judgment calls. Questions of this nature take the *"What would you do if ____?"* format. The oral portion of the examination is usually divided into two parts – the first part will be questions of the type just discussed. Following completion of this part, you will be asked to prepare a manual flight plan just as you have practiced in Week 6. The manual flight plan constitutes the "practical" portion of the examination. After the results of the practical are graded, you will proceed to the second part of the oral examination. You will be asked to defend the decisions you made during completion of the practical exercise and will be asked further "What if" questions concerning this flight.

During the oral and practical examination, if you can't immediately recall a specific answer but have a good idea where to locate it in an appropriate

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reference text, it is perfectly acceptable to say, "I don't know, but I know where to find the answer". Bring your student kit with all your reference material to the exam. The examiner will give you a reasonable amount of time (i.e. several minutes) to locate the correct answer. No dispatcher can be expected to know the answer to every question that may arise in the working world but a proficient dispatcher should know where to find the answer fairly quickly.

PASSING WRITTEN EXAMS – EFFECTIVE STUDY TECHNIQUES

Through long experience, the Jeppesen Academy staff has learned effective ways to pass the FAA (or NAA) exams and we will help you to prepare to be successful. First and foremost, you must dedicate yourself to your success. Expect to spend several hours each day after class on homework and do not allow yourself to fall behind in your work.

The lecture and homework materials have been carefully prepared to cover each and every question in the knowledge test. The review exercises and module end exams have been designed to provide answers to all the questions in the Gleim book. Use the following techniques to prepare for the knowledge (written) test.

As you work the review exercises, locate the relevant question or questions in the Gleim book, read the question and see if you can answer it correctly. If you did not understand the question or get the correct answer, read the explanation associated with each question. Then go back to your student notes or other reference material and read the associated reference. Once you are confident that you understand the correct answer, use a colored highlighter to mark the correct answer in the Gleim book. As you review the questions for each section, cover the answers with a card and see if you can recall the correct answer. Then, in the day or two before you take the written test, read each question and <u>only</u> the correct answer. If you use this technique, you will be amazed at how readily the correct answer comes to mind.

Study with a classmate. Ask each other questions from the test book and respond to questions without looking at the book. Many students use the "flash card" technique with great success. Obtain a quantity of small index cards (approximately 3" by 5" or 8 cm by 12 cm) and write a test question on one side and the correct answer on the other. Test yourself by reading the question, answering it in your mind, and checking your answer by reading the other side. Place the questions you answer correctly in one stack and the ones you get incorrect in another. Study only the questions you consistently get wrong! You don't need to waste time re-studying questions for which you know the correct answer. Use the cards when studying with a classmate to ask each other questions.

There are a few mathematical formulas that you must memorize. Write the formula on one side of a card and a question such as, "What is the

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formula for ____?" on the other side. Test yourself by reading the question and reciting the formula until you consistently get it correct. Here is the critical point. Just before you go to take the written test, read each formula at least once and recite it to yourself. As you sit down to take the test, you will be given a blank piece of paper on which you can perform calculations. Before you do anything else, write the formulas on the blank paper while they are fresh in your mind. Then, when you reach a question where you need a formula, you need only refer to your paper, rather than having to remember it while under the pressure of taking the test.

ACRONYMS AND ABBREVIATIONS

During the course, students will be exposed to the acronyms and abbreviations common to aviation. These terms will be defined at the time they are introduced.

THE FAA (NAA) KNOWLEDGE TEST

Students may be taking the Jeppesen Academy Aircraft Dispatcher course under one of two options. Either you are taking the course in the United States and are expecting to test for the dispatcher certificate issued by the FAA or you are taking the course overseas and expecting to be issued a dispatcher certificate by an appropriate National Aviation Authority (NAA) of another State.

The FAA Knowledge Test for Aircraft Dispatchers is coded ADX. Although the body of knowledge is the same as the FAA Air Transport Pilot (ATP) test, the two tests are not interchangeable – do not take the wrong test!

If you are testing in another country under local NAA rules, this problem will not arise. These knowledge tests are commonly referred to a "written tests".

Specific regulatory requirements apply to retesting after failure of a required State written test (either FAA or NAA). An applicant who fails the written test may apply for retesting after 30 days from the date the applicant failed the test or before the 30 days have expired if the applicant presents a signed statement from Jeppesen certifying that the applicant has received additional training in the areas failed.

Students who fail the FAA or NAA dispatcher written test during Week 5 have two options – reschedule Week 6 to a later class date or continue with Week 6 as scheduled and agree to remedial training at night or on weekends.

Jeppesen Academy graduates failing the FAA or NAA knowledge test or the FAA/NAA Oral & Practical exam may require remedial instruction. Remedial training may require additional instruction fees.

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DISPATCHERS AND SITUATIONAL AWARENESS

You need to develop the ability to see airline operations through the eyes of a dispatcher. This means establishing a picture of what is happening in the world and how it impacts flight planning using only data and tools available in the dispatch office (a room without windows to the world). This requires you to correlate the knowledge you gained while studying for the written test to manual flight planning exercises.

If you are a pilot, the difficulty most pilots have in this course is re-learning the fundamentals from the dispatcher's perspective. For example, when studying VOR fundamentals pilots will tend to think of intercepting radials and tuning a frequency while dispatchers need to think of operational service volumes, the impact of NOTAMs, aircraft equipment failures, and general flight planning considerations.

GRADUATION FROM THIS COURSE

Upon completion of this course, and after passing the Jeppesen Academy final exam, you will be awarded a Graduation Certificate.

In order to be eligible to take the Oral and Practical examination to receive an FAA (NAA) Aircraft Dispatcher Certificate, you must present to a FAA (NAA) examiner or a Designated Dispatch Examiner:

- The Jeppesen Academy Graduation Certificate
- A record of successful completion of the Aircraft Dispatcher (ADX or NAA) knowledge test

The graduation certificate is valid for 90 days and must be presented within that time period. (regulatory requirement).

After 90 days, Jeppesen Academy may, at our option, revalidate your graduation certificate for an additional 90 days.

THE DISPATCHER CERTIFICATE

The dispatcher certificate is essentially a 'license to learn'. You may expect that when you are hired by an airline, you will receive both initial and recurrent training – in addition to the implied expectation of continual education over the lifetime of your careers. While the money can be very good, there is a much higher level of education required to be proficient than what may seem obvious to you right now.

The content volume of this course is extremely high. What is most important for students to remember is that basic understanding of all dispatching tools is the priority, along with a comprehensive understanding of how they all fit together. Dispatcher "tools" can be

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everything from an Aircraft Flight Manual, to a flight planning computer system, to a maintenance controller.

Some of what is learned by rote memory will unfortunately be forgotten over time (for example, knowing that "121.189" is where to find information on engine inoperative takeoff performance). What is more critical is to learn where to locate things and how they all fit together (for example 121 Subpart I is where to look for "Airplane Performance Operating Limitations", and to cross reference that with other references like computer flight planning parameters).

Upon completion of this course and the issuance of your certificate, you are essentially an "apprentice dispatcher". When you are hired by an airline, they will provide additional training to you as detailed by 14 CFR 121 Subpart N. Initial, Transition, Recurrent etc. or as specified by the relevant National Aviation Authority. You will then work under supervision for a minimum of several months before you will be qualified to dispatch flights by yourself.

REGULATIONS CHECK SLIDES

Regulations Check slides are added to various presentations to emphasize the importance of certain Federal Air Regulations. Our FAA Inspector has noted that applicants are demonstrating weakness in knowing what regulations apply to various dispatch situations, where to quickly locate an applicable regulation, and what it means in practical terms.

The next slide following a Regs Check slide will answer the two questions. Every student should read the cited regulation at this time. Instructors may choose to have one student read aloud to the class.

Students must highlight the cited regulation and Instructors must emphasize that this regulation is important and that the student can expect to be tested on the content during the Oral and Practical.

Instructors may, at their discretion, discuss what the regulation says and means at this time or defer that discussion until the next slide where it will be covered in greater detail.

14 CFR PART 121.463

Dispatchers must complete company-specific training before they may serve as dispatchers. This consists of initial training and 5 hours of operating familiarization (riding in the cockpit jump seat).

Before dispatching a particular type of airplane, a dispatcher may need to complete differences training.

Every 12 months, a dispatcher must re-complete the 5 hours of operating familiarization.

Dispatchers must be familiar with all essential operating procedures for that segment of the operation over which that person exercises dispatch jurisdiction.

Locate this regulation in your student notes, highlight it, and read it carefully – you may be tested on it!

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QUESTIONS

You are encouraged to ask questions whenever you don't understand something. Your instructor will either answer the question on the spot or defer your question until the next break. You are entitled to an answer that you clearly understand.

Many students are reluctant to ask questions for fear of appearing stupid or being embarrassed. This is particularly true in some cultures.

There is only one stupid question – it is the one you fail to ask! Your question and its answer may clarify a particular point for others in the class.

THIS IS JUST THE BEGINNING

In order to become a successful dispatcher, you should look at the education gained through certification as just the tip of the iceberg.

Airline basic indoctrination, initial and recurrent training will all be provided by your employer; however, dispatchers must strive to learn more… either on the job or off.

Dispatchers must also strive to understand the job functions and knowledge of those around them (mechanics, pilots, performance engineers, managers, etc).

This is the main reason that dispatchers are required to ride jump seat (familiarization flights). If it was financially practical, airlines would also require dispatchers to sit through familiarization for all other departments.

Moral of the story… Whenever possible, take the opportunity to learn from those around you.

THE ROLE OF THE DISPATCH OFFICE

Dispatch is the central point of decision making for an airline. It is the nerve center where the big picture comes into view, for safety and efficiency. This places a great deal of importance on the fact that dispatchers need to be the airlines warehouse of information.

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FOM-2 MODULE END EXAM STUDY GUIDE

Module Exam #1 - Weather Theory Exam (50 questions)

- ADX-Gleim Questions: Chapter 15: all
- ADX-Gleim Questions: Chapter 17: all
- Student Notes: Chapter 1, pages 1 – 64

Module Exam #2 - Aeromedical Factors & ADM Exam (5 questions)

- ADX-Gleim Questions: Chapter 18, Section 1-9 except 3
- Student Notes: Chapter 1, pages 150 &151

Module Exam #3 - Weather Reports, Forecasts, & Graphics Exam (60 questions)

- ADX-Gleim Questions: Chapter 16, all
- Student Notes: Chapter 1, pages 63 - 146
- Student Notes: Chapter 1, Appendix A
- JetPlan Weather Help Files

Module Exam #4 - Air Traffic Control Exam (50 questions)

- ADX-Gleim Questions: Chapter 6, Section 1, 6, 7 & 8
- ADX-Gleim Questions: Chapter 7, all
- ADX-Gleim Questions: Chapter 8, Section 6
- Student Notes: Chapter 2, all

Module Exam #5 - Aerodynamics, Weight & Balance Exam (32 questions)

- ADX-Gleim Questions: Chapter 5, Sections 1 - 13,18, 21
- ADX-Gleim Questions: Chapter 10, Section 1 – 3
- ADX-Gleim Questions: Chapter 11, Section 1, 2, 4
- ADX-Gleim Questions: Chapter 12, Section 2
- ADX-Gleim Questions: Chapter 14, Section 4
- Student Notes: Chapter 5, all besides pages 52 – 56, and 82-84

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Module Exam #6 - Aircraft Performance Exam (31 questions)
- ADX-Gleim Questions: Chapter 1, Section 2
- ADX-Gleim Questions: Chapter 3, Section 1, 3, 6
- ADX-Gleim Questions: Chapter 5, Section 14,15, 18, 23
- ADX-Gleim Questions: Chapter 10, Section 4 - 12
- ADX-Gleim Questions: Chapter 11, Section 3-5
- ADX-Gleim Questions: Chapter 12, Section 1, 3 - 9
- ADX-Gleim Questions: Chapter 14, Section 1-3, 5
- Student Notes: Chapter 6: all

Module Exam #7 - Navigation Exam (37 questions)
- ADX-Gleim Questions: Chapter 8, all except Section 6
- ADX-Gleim Questions: Chapter 9, Section 2-9
- Student Notes: Chapter 7: all

Module Exam #8 - Regulations, & Ground Deice/Anti-ice Exam (50 questions)
- ADX-Gleim Questions: Chapter 1, all
- ADX-Gleim Questions: Chapter 2, all
- ADX-Gleim Questions: Chapter 3, all
- ADX-Gleim Questions: Chapter 5, Section 24
- Student Notes: All material covered from Day 1 thru 22

Module Exam #9 - Transport Aircraft Systems Exam (20 questions)
- ADX-Gleim Questions: Chapter 3, Section 4, 5
- ADX-Gleim Questions: Chapter 5, Sections 16, 17, 19, 20, 22. 25-27
- Student Notes: Chapter 5, pages 17 – 51

Jeppesen Final Exam (90 questions)
- ADX-Gleim Questions: All Chapters listed above.
- Student Notes: Chapters 1 – 8, and 10

FAA/NAA Dispatcher Written Exam- (80/90 questions)
- ADX-Gleim Questions: All Chapters listed above.
- Student Notes: Chapters All Chapters

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CUSTOMER FEEDBACK

In order to improve our courses, we ask that you provide your comments and suggestions during course to your instructor. During the course if you notice errors or have improvement recommendations in this document or other course materials please submit them in either paper form or via screen shots email to jeppesenacademy@boeing.com. If possible, please include module titles, slide numbers, or student notes page numbers with your text description.

At the completion of each course we will administer an online customer satisfaction survey, and ask that you to provide us with additional comments, opinions, and suggestions.

Please contact at any time at jeppesenacademy@boeing.com, or call us at 303-667-3717.

NOTES

1 Meteorology

The study of any physical system, such as an engine or an airplane, usually begins with a description of that system. Information about component parts, their location and dimensions, and terminology is necessary background for later examination and understanding of the system design and operation.

THE ATMOSPHERE

Our study of aviation weather begins in a similar way. The system in this case, is the atmosphere. Meteorology is the study of the physical properties of atmosphere and the weather that occurs within it. This chapter describes atmospheric composition, structure, and properties. Also, it introduces a valuable reference tool—the International Standard Atmosphere (ISA).

COMPOSITION

Air is a mixture of gases and water. It is about 78 percent nitrogen, 21 percent oxygen, and 1 percent other gases. Air always contains some water. Water vapor is a variable gas, up to 4 percent over the ocean, while almost not existent over deserts or at high altitudes. However, it is an important material for weather production as it can exist in the atmosphere as a gas, liquid, or solid.

Although the atmosphere thins out as height increases, the ratio of the gases remain the same.

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VERTICAL STRUCTURE

There is no specific upper limit to the atmosphere; it simply thins to a point where it fades away. As you progress outward from the earth, the atmosphere displays different properties, including a change in temperature distribution.

These temperature variances are the most common basis for classifying the four layers of the atmosphere.

- Troposphere
- Stratosphere
- Mesosphere
- Thermosphere

The great majority of weather occurs in the troposphere.

TROPOSPHERE

The troposphere is the layer extending from the earth's surface to an average height of around 36,000 feet. The average temperature decreases with altitude in this layer. The height of this layer varies with latitude and season; it is higher in the summer than in the winter and higher over the lower latitudes than over the high latitudes.

The word *trope* means change or turning, and this layer is characterized by instability. The majority of weather occurs in this layer and 75 percent of the total weight of the atmosphere is in this layer.

TROPOPAUSE

At the top of the troposphere is a level called the tropopause. This level (note that it is not a layer) is often characterized by an abrupt change in temperature lapse rate. Lapse rate is the name given to the rate of change of temperature with height.

This level is very important to a number of weather phenomena such as jet streams, clear air turbulence, and thunderstorms. It can also act as a lid that traps water vapor in the Troposphere.

Maximum winds generally occur near the tropopause. These winds create narrow zones of wind shear which often generate hazardous turbulence.

STRATOSPHERE

Above the tropopause is the stratosphere. In this layer, temperature tends to change slowly at first and then increase with altitude. Air in this layer, as evidenced by its root word "strata," tends to move in a generally horizontal direction. It is not uncommon, however, for large cumulonimbus clouds to penetrate into this layer.

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ATMOSPHERIC PROPERTIES

So far, we have described the composition of the atmosphere as being one composed of a mixture of gases. We further analyzed the atmospheric structure as one divide into 4 vertical layers according to temperature change with altitude. The two layers of most interest to aviators are the Troposphere and the Stratosphere.

The condition of the atmosphere is commonly given in terms of the state of gases within it. The three fundamental variables used to describe the state of the atmosphere are temperature, pressure and density.

TEMPERATURE

There are two commonly used scales of temperature used in aviation: Fahrenheit and Celsius. The majority of the world uses Celsius as the standard reporting scale. To convert the two, use these formulas:

- Formula to convert Fahrenheit to Celsius—(F° - 32) ÷ 1.8 =C
- Formula to convert Celsius to Fahrenheit—(C° x 1.8) + 32 = F

You can easily convert between Fahrenheit and Celsius using your CX-3 flight computer without having to work with the formula.

Temperature affects every aspect of aviation weather. The primary cause for temperature differences is unequal solar heating of the earth's surface. This unequal heating causes temperature differences, which in turn cause pressure differences that result in changes in weather. Temperature also plays a major role in aircraft performance.

Temperature measures the hotness or coldness of a substance. A molecule possesses kinetic energy proportional to the square of its speed of movement. Kinetic energy is energy that exists by virtue of motion.

Temperature is defined as the average kinetic energy of the molecules that make up a substance: the greater the average kinetic energy, the greater the temperature. The point at which all molecular motion ceases is called absolute zero and has never been reached.

Heat is a measure of the total energy of molecular motion and can be transferred from one object to another by virtue of the temperature difference between the objects. After being transferred, this heat energy is stored as internal energy. This stored heat energy (latent heat) plays a large role in weather when water undergoes state changes.

The intensity of solar energy received at any point on the earth depends upon the position of the sun relative to that point. Each surface absorbs this energy at a different rate. The temperature change of these surfaces depends on the nature of the material.

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The temperature differences set up by this process create pressure differences and affect the type of weather produced. These effects may be either localized or very extensive.

Temperature variations occur for many different reasons. The major causes for this variation are due to differences in solar radiation received by a region. Temperature varies with the time of day (diurnal variation), season, latitude, topography and altitude.

DIURNAL VARIATION

Because the earth's temperature is above absolute zero it is continuously losing heat through terrestrial radiation. This loss is offset by the receipt of solar radiation during the day, so the overall temperature increases. At night, however, there is no solar radiation being received but the Earth continues to lose heat through radiation, the result being a decrease in temperature. These temperature changes over a 24-hour period are known as diurnal variation. Cooling at night continues until after sunrise until solar radiation again exceeds terrestrial radiation.

Minimum temperatures occur as much as one hour after sunrise. This is the reason that temperature inversions and fog often occur just after sunrise.

SEASONAL VARIATION

Since the earth's axis is tilted to the plane of its orbit, the sun is more overhead in one hemisphere than in the other, depending upon the season. The Northern Hemisphere is warmer between June and August due to more solar energy being received than in the Southern Hemisphere. The reverse applies in the months of December through February when the Southern Hemisphere is warmer.

LATITUDINAL VARIATION

In the lower latitudes, sun rays are more nearly vertical to the earth's surface. This tends to concentrate the incoming energy onto a smaller surface area. For example, if the sun is directly overhead, the rays passing through a one-meter square opening fall on one square meter of the surface. At high latitudes, the sun's rays fall at an angle to the surface, so they spread out over a larger area. The rays passing through the same one-meter opening spread out over much more than one meter of surface.

TOPOGRAPHICAL VARIATION

The heat capacity of a substance controls the amount of temperature variation within and around that substance. Water has a greater heat capacity than land and so can absorb larger amounts of solar energy than the ground can with a minimum temperature change. This is because solar radiation can penetrate further into the water than in soil.

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So, if equal amounts of radiation fall on equal areas of water and land, the water temperature will increase much more slowly than the land. At night, the opposite is true—the water will cool more slowly than the land. These temperature differences between land and sea set up wind patterns which we will examine later in this course.

ALTITUDE VARIATION

Temperature normally decreases with an increase in height in the troposphere. This decrease is due to the solar radiation heating the surface of the earth and the earth in turn heating the lower levels of the troposphere through terrestrial radiation. The rate of decrease of temperature with height in the troposphere is around 2ºC per 1000 feet. This is called the average lapse rate. When the temperature increases with height it is called a temperature inversion.

An example of a temperature inversion occurs near the ground on a cool, clear night. The ground and the air next to it cools at a much faster rate than the air a few hundred feet above the ground. Eventually the temperature change is such that for a few hundred feet the temperature will increase with height and then decrease with height above this layer.

Global surface temperatures show large changes in temperature from January to July and fairly large temperature changes from the equator to the poles. These patterns are largely due to changes in solar elevation angle with latitude and season. Surface air temperatures are colder over the continents than over nearby oceans in the winter and warmer than the oceans in the summer.

A temperature gradient is defined as the change of temperature over distance. The temperature gradients revealed by the global average surface temperature chart show areas of transition zones between warm and cold air. These zones are favorite locations for the formation of certain weather phenomena that are discussed later in this chapter.

Note that the lines that connect areas of the same or equal temperature are called isotherms.

DENSITY

The density of a gas refers to the mass of molecules, in this case air molecules, in a given volume. If the mass of molecules increases in this given volume, then the density also increases, if the mass of molecules in this given volume decreases then the density decreases also.

Density is expressed in terms of mass per unit volume. To put it simply, density is an expression of how much stuff (in this case air molecules) is in a given volume.

If the pressure in a container of unit volume is increased, the mass of air increases within that container. Since the mass has gone up but the

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volume has remained the same, the density increases. The reverse is true if the pressure in the container of air is reduced—density decreases. It can be seen that the relationship of density to pressure is such that density is directly proportional to pressure.

If a given volume of air is heated, the temperature of this air rises and the air expands, thus the mass of air in this given volume decreases and the density also decreases. If this given volume of air is allowed to cool, the mass of air will increase and density will also increase. Density is inversely proportional to temperature.

Pressure decreases with an increase in height and so density, being directly proportional to pressure changes, will also decrease. Temperature also decreases with an increase in height and so density should, by rule, increase. The overriding factor is that pressure reduction with height is far greater and has a bigger impact on density, thus, density decreases with an increase in height.

PRESSURE

Pressure and its variations play a very important role in the prediction of winds and weather. Pressure is the force that moving molecules of a gas exert on a given area. Atmospheric pressure is the force per unit area exerted by the atmosphere on any surface in contact with it.

The pressure that the atmosphere exerts on a given surface on the earth is a result of the weight of a column of air above that surface. Therefore, pressure decreases with an increase in height.

PRESSURE MEASURING INSTRUMENTS

The basic instrument used to measure atmospheric pressure is the mercurial barometer. The atmospheric pressure is measured by the height of a column of mercury, in a vacuum, against the weight of the atmosphere. Inches or millimeters are used to measure the height of the mercury in the column and the atmospheric pressure is expressed in terms of this height. Near sea level, this column of mercury rises an average of 29.92 inches, expressed as 29.92 in/Hg. In the metric system, the height of this same column of mercury is about 760 mm. Mercury is used because it is a dense liquid. If a column of water were to be used instead then the barometer would have to be nearly 34 feet in height.

Pressure may also be measured in pounds per square inch. At sea level, the pressure is about 14.7 pounds per square inch (psi). The metric equivalent of this pressure is called a "bar". Since a bar is an inconveniently large unit, it is commonly divided into 1,000 parts or millibars (mb). Recently, this unit of measure was renamed and is now called a hectoPascal (hPa). While this unit replaces the millibar, the older metric measurement is sometimes still used today. Average sea level pressure in hectoPascals is 1013.2 hPa.

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causing the air to rise and generating a surface low-pressuresystem. Dry, sunny regions are the usual location of thermal lows.

WEATHER ASSOCIATED WITH HIGHS (ANTICYCLONES)

The flying conditions in a high-pressure area are generally favorable. Typically, there is not much cloud or precipitation, and winds are generally light. However, visibility can be poor at times. A high is a region of converging, descending air. The air descends to the surface and then blows outwards in a clockwise direction when in the Northern Hemisphere and anti-clockwise in the Southern Hemisphere.

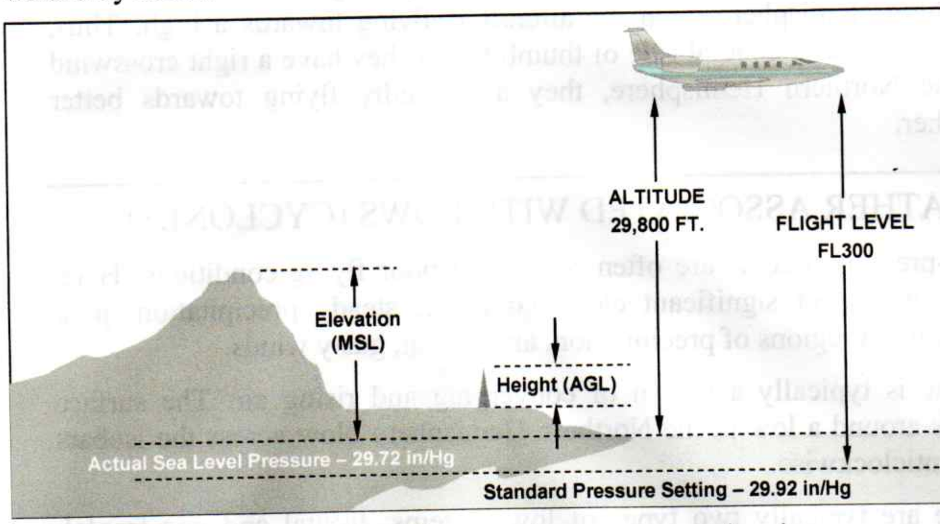
You should note that the general weather conditions for low- and high-pressure areas are just that—general rules of thumb. These general rules should always be appropriately augmented with a complete weather briefing.

ALTIMETRY

An altimeter is an instrument which measures pressure and drives a needle across a dial to indicate altitude or height.

The altimeter is essentially an aneroid barometer that reads in units of altitude or height and is driven by pressure differences between the instrument and the outside environment. The standard used to calibrate the altimeter is the ICAO ISA. Altimeters have a means of adjusting the needle setting to take into account changes in atmospheric pressure on the ground.

Altitude is measure of height. While this may seem simple on the surface, in aviation, there are many different types of altitude measurement and what they mean.



- Altitude is the vertical distance above mean sea level.

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be corrected to a common pressure level known as sea level pressure or mean sea level pressure. Only when this is done can the pressures be compared accurately and a true pressure pattern be discerned.

If the station pressure at Denver was reported as 24.92 inches and the station pressure at New Orleans was reported as 29.92 inches, it would indicate an unrealistic horizontal pressure difference. Because the change in pressure over a given vertical distance is typically much greater than change of pressure over the same horizontal distance, the uncorrected pressure difference between Denver and New Orleans would indicate that there is a strong wind between the two stations. However, when the Denver station pressure is corrected to Mean Sea Level pressure and the New Orleans station pressure is corrected to Mean Sea Level pressure, you find that the pressure difference between the two stations is zero, so there is no horizontal pressure gradient.

THE INTERNATIONAL STANDARD ATMOSPHERE

The International Standard Atmosphere (ISA), also called the standard atmosphere, is an idealized atmosphere with specific vertical distributions of temperature, pressure, and density, prescribed by international agreement. The ISA serves as a reference standard for many scientific measurements. The ISA is used for numerous aviation applications, not least of which is calibrating flight instruments and forecasting aircraft performance.

There have been several different standard atmospheres, but the one in use today is the ICAO ISA created in 1964. It must be remembered that although ISA is a very useful tool for aviation, large differences occur in the real atmosphere.

The ISA is most representative of the average atmosphere at mid latitudes in the troposphere and lower stratosphere. The troposphere is actually lower and colder over the poles and higher and warmer over the equator than the ISA conditions, however the ISA still serves as a very useful reference in aviation applications.

The ICAO ISA is defined as follows:

- Sea Level Temperature: 59°F or 15°C
- Temperature Lapse Rate: 2ºC per 1000'
- Sea Level Pressure: 29.92 in. Hg / 1013.2 hPa
- Pressure Lapse: 1 inch/1000'
- Dry Air: (zero % humidity)

It is usual when making aircraft performance calculations to refer to the atmospheric conditions in terms of deviations from the ISA standards. These are known as ISA deviations.

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A mercurial barometer is not very useful outside of a lab as it is very fragile, must be kept upright, and mercury is a toxic substance. For these reasons another pressure instrument is used to measure atmospheric pressure.

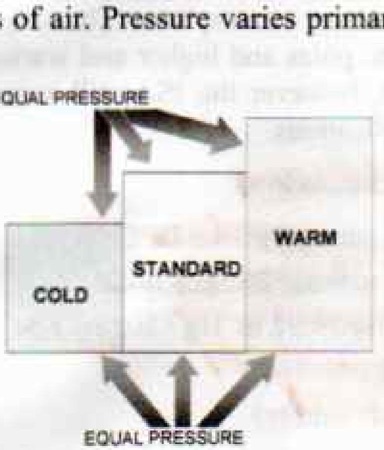
The aneroid barometer is a more compact instrument used to measure atmospheric pressure. This instrument consists of a partially evacuated aneroid capsule (cell) that responds to changes in pressure by either expanding (lower pressure) or contracting (when under high pressure) and via a system of levers and linkages driving a pointer on a pressure scale.

PRESSURE VARIATIONS

There is a change in pressure during the day that, although small in mid and high latitudes, can be quite large in low latitudes. This variation in pressure during a 24-hour period (diurnal variation) is probably due to a natural oscillation of the atmosphere having a period of about 12 hours, this oscillation being maintained by the 24 hour variation of temperature.

As we move upward through the atmosphere, the mass of the atmosphere above us decreases and the weight of the atmosphere also decreases. Therefore, pressure also decreases as altitude increases. The rate of decrease of pressure is around 1 inch per 1,000 feet in the lower atmosphere. The higher we go, the slower is the rate of decrease of pressure.

Air expands as it becomes warmer and contracts as it becomes cooler. Given 3 columns of air of different temperatures but equal amounts of air, the pressure at the top and at the bottom of the columns will be the same. The total decrease in pressure through the columns of air from the bottom to the top will also be the same. However, because the colder column of air is shorter the rate of decrease of pressure in this column is greater than in the warmer columns of air. Pressure varies primarily with altitude and temperature.



In order to compare atmospheric pressure at different stations, the pressure at these stations must be corrected and referenced to a common level. The pressure measured at weather stations or airports is called station pressure. These weather stations are usually at different altitudes and so the respective station pressures measured at these locations must

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volume has remained the same, the density increases. The reverse is true if the pressure in the container of air is reduced—density decreases. It can be seen that the relationship of density to pressure is such that density is directly proportional to pressure.

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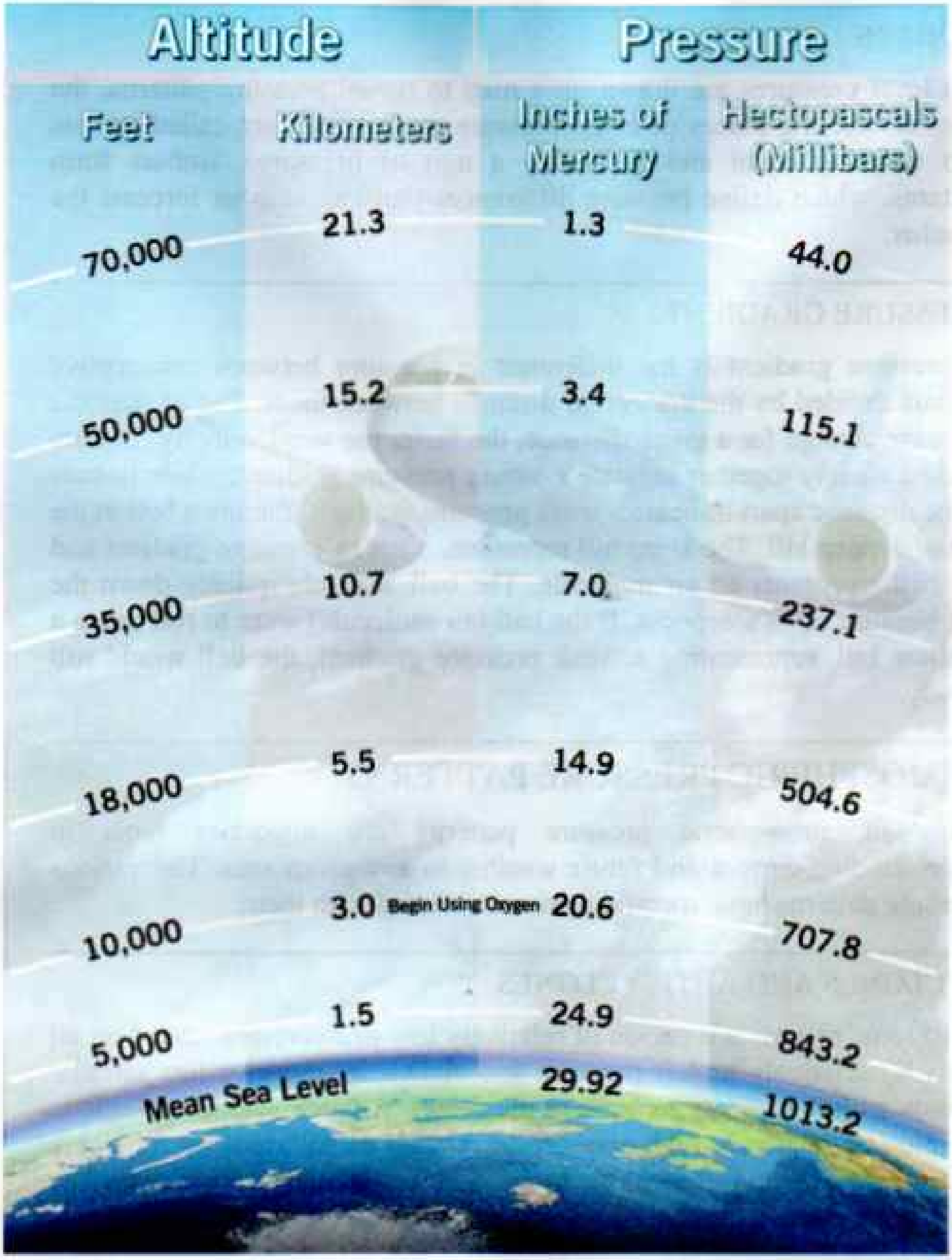

International Standard Atmosphere

ATMOSPHERIC PRESSURE

Pressure and its variations have very important implications on aviation, ranging from measurements of altitude and airspeed to the prediction of winds and weather. This section looks at terms, pressure systems, and the associated weather conditions to be expected within these pressure systems.

The unequal heating of the surface of the earth causes changes in pressure. This is one of the main reasons for different pressure settings between weather reporting stations and airports. Meteorologists plot the pressure information on charts and map.

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ISOBARS

Sea level pressures are drawn on a map to reveal pressure patterns, the lines connecting places of equal pressure on this map are called isobars (iso meaning equal and bar being a unit of pressure). Isobars form patterns, which define pressure differences that can help us forecast the weather.

PRESSURE GRADIENT

A pressure gradient is the difference in pressure between consecutive isobars divided by the horizontal distance between them. The greater the pressure change for a given distance, the faster the wind velocity. Isobars packed closely together indicate a strong pressure gradient, while isobars some distance apart indicate a weak pressure gradient. Picture a ball at the top of a steep hill. The steep hill represents a strong pressure gradient and the ball represents an air molecule. The ball will role quickly down the hill because of its steepness. If the ball (air molecule) were to roll down a shallow hill, representing a weak pressure gradient, the ball would roll slowly.

ATMOSPHERIC PRESSURE PATTERNS

Maps of atmospheric pressure patterns are important tools in understanding current and future weather in any given area. The various pressure patterns have specific names associated with them.

CYCLONES AND ANTICYCLONES

A cyclone, or low, is a region of relatively low-pressuresurrounded on all sides by relatively higher pressure and shown by more or less circular isobars with the lowest pressure in the center. An anticyclone, or high, is a region of relatively high-pressuresurrounded on all sides by relatively lower pressure and shown by more or less circular isobars with the highest pressure in the center.

PRESSURE TERMS

A ridge is an elongated area of relatively high pressure. A ridge is sometimes referred to as a wedge of high pressure.

A trough is an elongated area of relatively low pressure. Pressure is lower in the trough than on either side of the trough.

A col is an area between two highs and two lows. The pressure in a col is almost level; it is an area of stagnation. It is also the intersection of a trough and a ridge.

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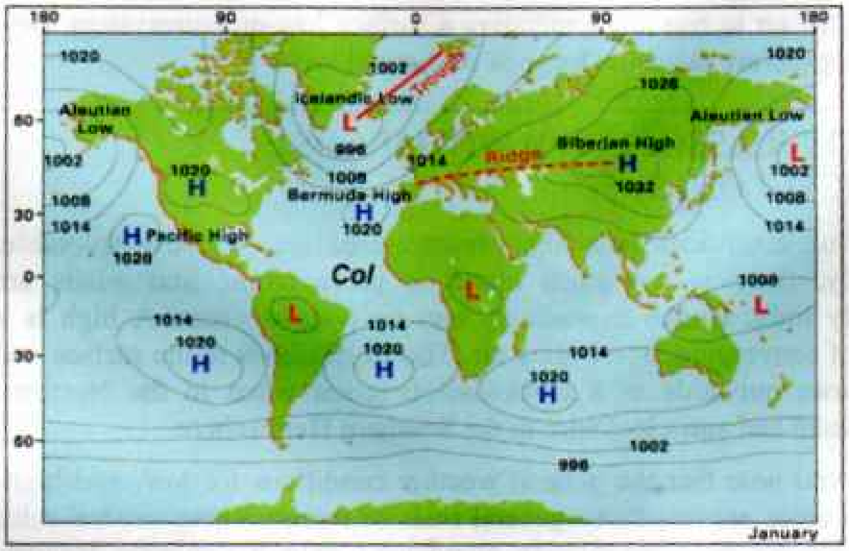

BUYS BALLOTS LAW

In the 19th century, a Dutch meteorologist named Buys Ballot produced a law based on the observation of wind direction and pressure systems. The law states that if an observer stands with his back to the wind, the lower pressure is on his left in the Northern Hemisphere, and on his right in the Southern Hemisphere.

In the Northern Hemisphere, wind blows clockwise around a high and anti-clockwise around a low. The directions are reversed in the Southern Hemisphere.

PRESSURE PATTERN FLYING

Pressure pattern flying is an older and now seldom used means of navigation. What remains of the technique that is currently useful to pilots is the fact that if an aircraft is experiencing a right cross wind, in the Northern Hemisphere, then the aircraft is flying towards a high. Thus, pilots know as a general rule of thumb that if they have a right crosswind in the Northern Hemisphere, they are usually flying towards better weather.

WEATHER ASSOCIATED WITH LOWS (CYCLONES)

Low-pressuresystems are often regions of poor flying conditions. Here, you can expect significant cloud coverage, steady precipitation, poor visibility in regions of precipitation, and strong, gusty winds.

A low is typically a region of converging and rising air. The surface winds around a low in the Northern Hemisphere blow across the isobars and anticlockwise.

There are typically two types of low systems: frontal and non-frontal. Frontal lows are associated with frontal systems. An example of a non-frontal low is a thermal low that develops due to intense surface heating

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causing the air to rise and generating a surface low-pressuresystem. Dry, sunny regions are the usual location of thermal lows.

WEATHER ASSOCIATED WITH HIGHS (ANTICYCLONES)

The flying conditions in a high-pressure area are generally favorable. Typically, there is not much cloud or precipitation, and winds are generally light. However, visibility can be poor at times. A high is a region of converging, descending air. The air descends to the surface and then blows outwards in a clockwise direction when in the Northern Hemisphere and anti-clockwise in the Southern Hemisphere.

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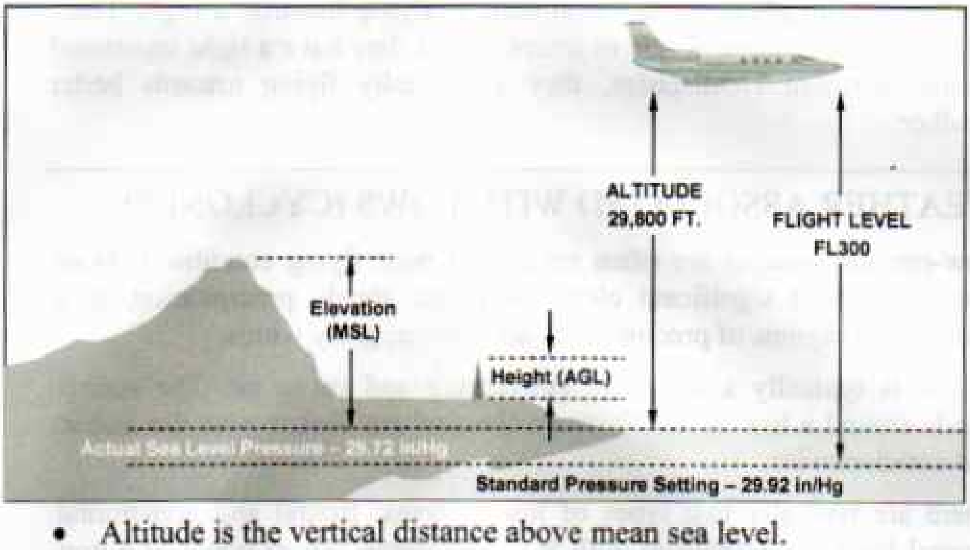

- Altitude is the vertical distance above mean sea level.

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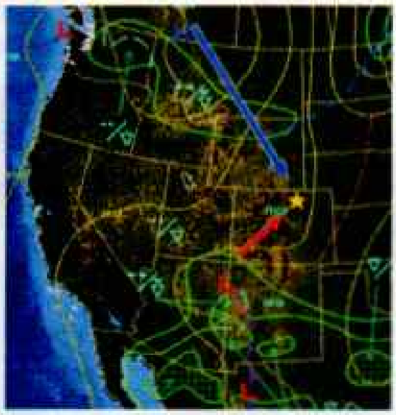
- Height is the vertical distance of a level or point measured above a specific datum, I.E. height above a surface.
- Elevation is height when the datum is MSL.
- Flight level is the surface of constant atmospheric pressure measured from the 29.92 in/Hg datum, measured in hundreds of feet. (i.e. FL 330 = 33,000 ft.)
- True altitude is the actual altitude above mean sea level. Altimeters are calibrated to indicate true altitude under ISA conditions only. Any deviation from ISA results in erroneous readings on the altimeter.
- Pressure altitude is the altitude in the ISA where the pressure is the same as where the aircraft is flying. Pressure altitude can be determined by setting 29.92 in Hg in the altimeter. All flights in the United States above 18,000 feet MSL use pressure altitude also known as flight level. In other countries, flights above a designated transition level use pressure altitude.

As the pressure changes at a given airport, so does the effective pressure altitude. This has a significant effect on aircraft performance. It is as if the airport itself moves to a higher or lower elevation. If the Low moves over Denver, station pressure decreases and aircraft perform as though Denver were higher above sea level. The reverse is true if the High moves over Denver.



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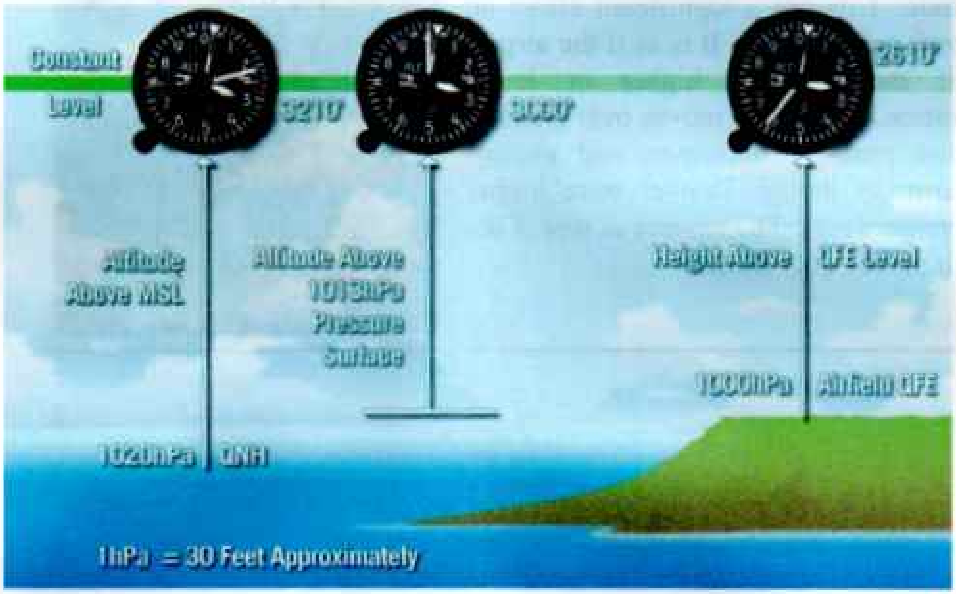
ALTIMETER SETTING

If the actual state of the atmosphere is the same as the standard atmosphere, then the pressure altitude will be equal to the true altitude. However, the real atmosphere and the ISA are usually not the same. An atmospheric pressure of 27.92 in/Hg in the ISA occurs at an altitude of 2,000 feet. In the real atmosphere, however, this pressure may occur at any altitude depending on the state of the atmosphere at that time and place.

Compensation for differences between ISA pressure and actual atmospheric pressure is accomplished by adjusting the altimeter setting correction in the instrument. A barometric setting knob is provided on the instrument so the flight crew can make this correction.



QNE = When standard pressure (1013.2hpa or 29.92") is set on an aircraft altimeter sub scale. Also known as pressure altitude.

QNH = Altimeter setting referenced to airport ambient local pressure. An altimeter set to the airfield QNH reads the elevation of the airfield when on the ground.

QFE = Altimeter setting referenced to airport field elevation. An altimeter set to the particular airfield QFE reads zero when an aircraft is on the ground.

QFF = Altimeter setting corrected to mean sea level, taking into account the actual temperature conditions.

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INDICATED ALTITUDE

Indicated altitude is the altitude above mean sea level indicated on the altimeter when the altimeter setting is set to local sea level pressure. The altimeter does not automatically adjust for variations in surface pressure; the flight crew must ensure that the altimeter setting is kept current by adjusting the setting in the instrument. Local altimeter setting can be obtained from ATC. If this setting is not kept current, then the indicated altitude could have large errors.

If an altimeter is set to standard sea level pressure of 29.92 in/Hg in flight and the setting is not adjusted to local sea level pressure as the flight progresses, then the indicated altitude will be erroneous. If the local pressure is higher than 29.92 in/Hg the altimeter will under-read, and the aircraft will be higher than indicated. If the local pressure is lower than 29.92 in/Hg the altimeter will over-read, and the aircraft will be lower than indicated. This could be a very dangerous situation.

Each 1 inch of mercury equates to approximately 1000 feet, so for every 1 inch above or below standard pressure the aircraft altimeter will over- or under-read by 1,000 feet. For example, if the altimeter is set to 29.92 inches and the local pressure is 30.57 inches, the altimeter will under-read by 650 feet (1,000 x .65 = 650 feet).

A similar rule applies when there are temperature changes. If the aircraft is flying in a region where the temperature is higher than standard temperature in the ISA, then the altimeter will under-read (indicate that you are lower than your actual altitude). If the air is colder than standard, the altimeter will over-read (indicate that you are higher than your actual altitude). This can be a very dangerous situation. The phrase "High to low, hot to cold, look out below" can help you remember this.

Indicated Altitude	5000 ft.	5000 ft.	5000 ft.
True Altitude	5200 ft.	5000 ft.	4800 ft.

CORRECTED ALTITUDE

Corrected altitude is the indicated altitude of an airplane's altimeter corrected for temperature variation from standard temperature as defined by the ISA. Corrected altitude is an approximation of true altitude. Jet transport air data systems automatically correct for temperature.

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DENSITY ALTITUDE

Density altitude is a measure of air density and must not be confused with pressure altitude, true altitude, or absolute altitude. It is not used as a height reference at all; instead it is a critical factor in determining aircraft performance. Air density decreases when pressure decreases and when altitude, temperature and humidity increase. Any decrease in air density produces a higher density altitude resulting in a corresponding decrease in aircraft and powerplant performance. This means that whenever density altitude increases, runway requirements for takeoff and landing increase, a higher true airspeed is required to sustain flight, the aircraft climbs more slowly, engines produce less power, weight must be reduced to compensate for the loss of performance and so forth.

Temperature variations have the greatest effect on air density, so the rule is, if the actual temperature is higher than standard, density altitude is said to be high; if the actual temperature is lower than standard, density altitude is said to be low. High density altitude means poor aircraft performance because there is less air in a given volume available for thrust and lift, low density altitude means better aircraft performance due to the high density of air in a given volume.

For example, on a hot day at an airport with a field elevation of 5,000 feet MSL, the density altitude might be as high as 9,000 feet. Although the airplane is at an actual altitude of 5,000 feet, it performs as though it were flying at 9,000 feet in standard atmospheric conditions. Correspondingly, density increases when the air becomes colder, dryer, or when pressure increases. This means that density altitude decreases. The same aircraft at the same airport might perform as though it were at 3,000 feet on a cold, dry day.

WIND

The motion of the air is very important in many weather processes. Moving air carries heat, moisture, and pollutants from one area to another. Air movements create conditions for cloud formation or dissipation. This section reserves the term "wind" for horizontal air motion.

Wind moves air masses and helps create frontal boundaries. It also affects temperature and pressure changes. Temperature and pressure changes, in turn, modify the wind. In flight, wind can have a significant effect on navigation and passenger comfort.

PRESSURE GRADIENT

A horizontal pressure gradient causes wind. A pressure gradient is simply the difference in pressure between to points divided by the distance between them. A pressure gradient is a result of a temperature gradient set

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up by differential solar heating. The resulting horizontal movement of air is called wind.

The pressure gradient force is the force caused by the pressure gradient which moves air from high-pressureto low pressure. The pressure gradient force is always directed perpendicular to the isobars.

CORIOLIS FORCE

If the pressure gradient force were the only force affecting the movement of the air, wind would always blow directly from the higher-pressure area to the low-pressure area. However, as soon as the air begins to move, it is deflected by a phenomenon known as Coriolis force. This force is named after the French scientist who first described it in 1835.

Coriolis force is not a real force; it's only an apparent force that results from the earth's rotation. Here is how it works. Newton's laws of motion work on any moving body or mass, including air. One of Newton's laws of motion describes inertia and the tendency of a body, a mass of air for example, to stay in its original state of motion.

For example, when in a car and you decide to slow down, your body, before touching the brakes, was moving at the speed of the car. Your body wants to continue moving forward at that speed, so when the car starts to slow down, your body strains forward. Acceleration causes the opposite effect.

Similarly, wind, or a parcel of air, near the North Pole acquires the rotational speed of the earth below. When this air moves south to where the speed of the earth's rotation is faster, it appears as though the air parcel has been deflected to the right. This is because the frame of reference, the earth, is moving faster underneath the air parcel.

For the same reasons, an air parcel in the Southern Hemisphere appears to be deflected to the left. Coriolis deflection is greatest when a mass of air is moving north-south or vice versa, and least when the mass of air is moving east-west or vice versa.

Coriolis force appears to make a moving mass of air deflect to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. As you know, wind blows from high-pressureareas to low-pressureareas, so in the Northern Hemisphere, the wind blows clockwise around a high and counter clockwise around a low. The opposite flow will be found in the Southern Hemisphere where the wind is clockwise around a low and counter clockwise around a high.

The most important characteristics of the effects of Coriolis force on the movement of air (wind) may be summarized as follows:

- It acts perpendicular to the wind direction.
- Deviation is to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.

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- It only affects wind direction, not wind speed.
- Wind speed does affect the magnitude of Coriolis force; the stronger the wind speed the stronger the effect. At zero wind there is no Coriolis force.
- It depends on the latitude: it varies from zero at the equator to a maximum at the poles.
- It has a greater effect over large distances than over short distances.

GEOSTROPHIC WIND

Above the atmospheric boundary layer, around 2,000 feet or so, Coriolis force and the pressure gradient forces tend to balance each other out. This condition is known as geostrophic balance.

The geostrophic wind is the resulting wind when geostrophic balance is achieved. This wind blows parallel to the isobars with the low-pressureon the left, looking downwind.

Geostrophic balance does not occur in small scale circulation. In small scale circulation, the pressure gradient force will be greater. The tendency of the winds above the atmospheric boundary layer to be in geostrophic balance is stronger due to the lack of friction. We will now discuss the effects of friction on winds below the boundary layer.

Prior to modern navigation systems the geostrophic wind was a useful tool for navigation. By determining the pressure gradient along the aircraft's intended track, the cross-track component of the geostrophic wind could be determined and the drift estimated. This is the heart of pressure pattern navigation mentioned earlier.

FRICTION FORCE

Friction between the moving air and the surface of the earth reduces the wind speed near the surface. This reduction also reduces the Coriolis effect that can no longer balance the pressure gradient force. As a result, the winds blow across the isobars at a small angle towards the low pressure. When wind direction changes clockwise the wind is said to veer; when the direction changes counter clockwise, it is said to back. The surface wind over land, due to friction, will back by about 20 degrees from the geostrophic wind and its speed will decrease by about 50 percent. Over the sea, because there is less friction, surface winds are closer to the geostrophic values.

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LOCAL WINDS

A *mountain breeze*, or *katabatic wind*, is caused by the cooling of air next to a mountain slope. The cool air becomes colder and denser than the surrounding air and flows down the mountain side. As this air flows down the mountainside it becomes compressed and becomes warmer and dryer.

In the daytime, air next to a mountain slope is heated. This air usually becomes warmer than the air farther away from the mountain but at the same altitude. The warmer air expands and rises up the mountain slope and the colder denser air will sink and replace the air that flowed up the mountain. This breeze is known as a *valley breeze* or *anabatic wind*.

A *sea breeze* or onshore breeze is a gentle wind that develops over bodies of water near land due to differences in air pressure created by heating and cooling rates. On a sunny day the land heats more quickly than the sea. The air over the land rises and expands so the pressure over the land at about 1,000 feet is greater than the pressure over the sea at the same height. Sea breezes are usually around 5 knots.

A *land breeze* or offshore breeze is the reverse effect, caused by land cooling more quickly than water in the evening. The wind flows from the land towards the sea. This drift of air causes the surface pressure over the land to fall and be less than the surface pressure over the sea. Land breezes tend to be around 10 knots, however, in the Tropics they can be as much as 15-20 knots.

TROPOPAUSE

Earlier, we defined the Tropopause as a level between the Troposphere and the Stratosphere. An abrupt change in temperature lapse rate can occur in the Tropopause. The Tropopause is not continuous; it generally descends step-wise from the Equator to the poles. These steps occur as breaks. Maximum winds generally occur at levels near the Tropopause within these breaks.

JET STREAM

A jet stream is a narrow band of high-speed winds located in the Tropopause where temperature gradients are most intense. Maximum winds typically occur in the vicinity of the breaks in the Tropopause on the polar side of the jet core.

Typical jet stream speeds range between 50 knots and about 240 knots. Jet streams are normally several thousand miles long, several hundred miles wide and a few thousand feet thick.

On average two jet streams are found in the westerlies, the polar jet stream and the subtropical jet stream. The polar jet stream can be found further south in the winter and is much stronger in the winter than in the summer, the subtropical jet stream shows much less fluctuation.

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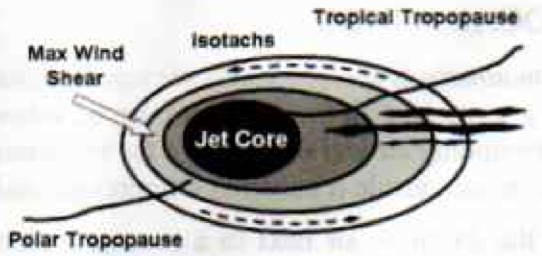
Wind speed decreases outward from the jet stream core, and the rate of decrease is greater on the polar side of the jet stream than on the equatorial or tropical side. A strong wind shear can be expected on the polar side of the jet stream core.



Strong, long trajectory jet streams are usually associated with well-developed surface lows and frontal systems. The jet stream is to the north as the surface low or front develops. The low moves closer to the jet stream as it deepens. The jet stream will eventually cross the frontal system near the point of occlusion.

Air travels in a cork screw path around a jet stream. When moisture is available, cirrus clouds may form on the equatorial side of the jet stream.

WIND MEASUREMENT

Wind velocity is a common term used to describe wind. It is a vector quantity, meaning it has magnitude and direction.

Wind speed, the magnitude of velocity, is commonly reported in knots. Wind direction, the direction from which the wind is blowing, is measured in degrees from true north. The two terms together, wind speed and wind direction, is called the wind velocity.

WIND SHEAR

Wind shear is best described as a change in wind direction and/or speed within a short distance. It can be horizontal or vertical and can occur at any level in the atmosphere. It is most hazardous at low-levels.

Severe wind shear is defined as a rapid change in wind velocity causing airspeed changes greater than 15 knots or vertical speed changes greater than 500 feet per minute (fpm). When the control tower reports different wind conditions at different areas of the airport, it means that wind shear is possible.

If two solid objects rub against each other there is friction, but no exchange of mass. If two fluid objects, such as wind, rub against each, there is an exchange of mass. This exchange of mass creates wind eddies. This zone of induced wind eddies and mixing is called a shear zone.

Two potentially hazardous wind shear situations could occur. First, as wind shears from a headwind to a calm or tailwind component, it could result in:

- An initial decrease in indicated airspeed.
- A pitch down of the aircraft nose.

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- A decrease in altitude.

Second, as wind shears from a tailwind to a calm or headwind component, it could result in the following:

- An initial increase in indicated airspeed.
- A pitch up of the aircraft nose.
- An increase in altitude.

As a tailwind shear increases, aircraft performance during takeoff decreases, and there is a loss of airspeed performance. If airspeed and lift are lost due to wind shear, the pilot should maintain or increase the pitch attitude and accept the lower than normal airspeed indications. Wind shear below 2,000 feet above ground level along the final approach path or along the takeoff and initial climb out path is known as low-level wind shear.

The FAA currently employs an integrated plan for wind shear detection and reporting. The Low-Level Wind Shear Alert System (LLWAS) provides wind data and software processes to detect the presence of wind shear in the vicinity of an airport.

LOW-LEVEL WIND SHEAR ALERT SYSTEM

The Low-Level Wind Shear Alert System compares the wind measured around the airport with the wind measured at the center of the airport. When low-level wind shear conditions exist, the tower controller provides the site's location and wind to aircraft flight crews and may also issue a report for use by a flight dispatch office as well.

A report transmission may sound something like this:

"North Boundary wind one eight zero at two zero, East Boundary wind two six zero at three six."

WIND CIRCULATION

Scales of circulation refer to sizes and lifetimes of individual circulations. There are typically three measurements on this scale:

- Microscale has a lifetime of a few minutes and a scale of up to 1 mile.
- Mesoscale has a lifetime of up to 1 week and a scale of up to 1,000 miles.
- Macroscale has a lifetime of up to 1 year and a scale of over 1,000 miles.

GENERAL CIRCULATION

The general circulation refers to the wind system that extends over the entire globe. This is a macroscale circulation. First, consider an idealized

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Earth, with a smooth surface and a very slow rotation. The equator to pole temperature gradients will create a pressure gradient. At the surface, air will move from the high-pressureover the poles to the low-pressureover the equator.

The reverse will happen aloft. Coriolis force will turn the winds to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.

With a faster rotation rate, the single cell circulation breaks up into a more complicated three cell circulation. Air still rises at the equator and flow towards the poles, however, that branch of circulation only reaches about 30N, where it sinks. This cell is known as the Hadley cell. Northeasterly winds prevail in this cell.

In the latitude belt between 30N and 60N, you will find another circulation cell: the Ferrel cell. Prevailing westerly winds occur in this cell.

The last cell, from 60N to the poles, is called the Polar cell. The Polar Easterly winds prevail in this cell.

Another important feature of the general circulation is the surface pressure distribution which it causes. The convergence of the trade winds at the equator creates a low-pressure area called the ITCZ, Inter Tropical Convergence Zone. Air sinking at 30N, diverging winds, cause a high-pressure area to develop in this area known as the sub-tropical high. At 60N, where the surface winds converge, the pressure is low.

Finally, there are two areas of sinking air masses at the poles. These are areas of high pressure.