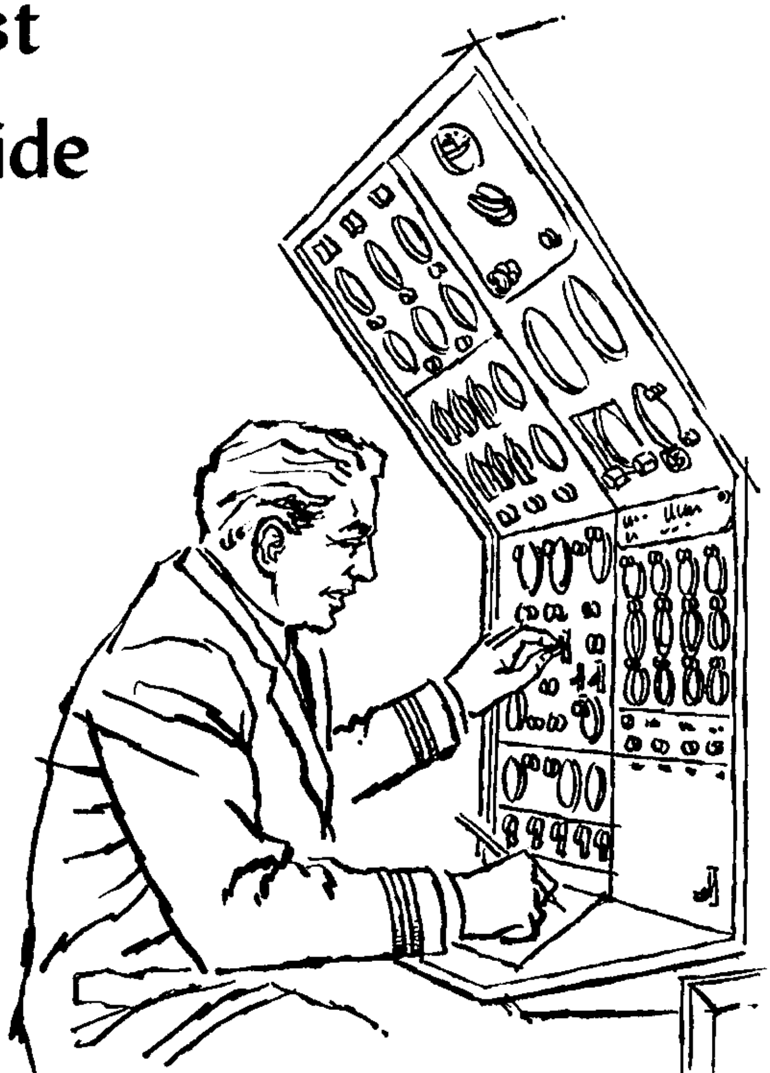
AC 63-1A

FLIGHT ENGINEER

Written Test Guide



Department of Transportation

Federal Aviation Administration

FLIGHT ENGINEER WRITTEN TEST GUIDE

1968

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

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FLIGHT ENGINEER WRITTEN TEST GUIDE

INTRODUCTION

The Flight Standards Service of the Federal Aviation Administration has issued this *Flight Engineer Written Test Guide* as Advisory Circular 63-1A to provide information to prospective flight engineers and others interested in this certification area. It cancels the previous edition, AC 63-1. The new guide contains information about certification requirements and describes the type and scope of the written test. It lists appropriate study and reference material and presents sample questions similar to those found in the official written tests.

As a further convenience to the applicant, those portions of the present Federal Aviation Regulations concerning general eligibility and aeronautical experience requirements have been included. Applicants should be aware, however, that regulations are subject to amendment. Any question regarding the currency of these quoted excerpts should be checked with the appropriate FAA office.

The written tests are designed to measure the aeronautical knowledge of the prospective flight engineer on an air carrier aircraft. The flight engineer is primarily a technical expert, who must be thoroughly familiar with the operation and function of various components of his aircraft. His specific duties vary with different aircraft and with different air carriers. The flight engineer written tests place major emphasis on the normal and emergency duties of an air carrier flight engineer and on his required understanding of systems and components related to a particular powerplant class aircraft.

ELIGIBILITY REQUIREMENTS FOR CERTIFICATION

The following excerpts from the Federal Aviation Regulations, Part 63, pertaining to eligibility, are given for the convenience of the applicant:

§ 63.31 Eligibility requirements: general.

To be eligible for a flight engineer certificate, a person must—

(a) Be at least 21 years of age;

(b) Be able to read, speak, and understand the English language, or have an appropriate limitation placed on his flight engineer certificate;

(c) Hold at least a second-class medical certificate issued under Part 67 of this chapter within the 12 months before the date he applies; and

(d) Comply with the requirements of this Subpart that apply to the rating he seeks.

§ 63.37 Aeronautical experience requirements.

(a) Except as otherwise specified therein, the flight time used to satisfy the aeronautical experience requirements of paragraph (b) of this section must have been obtained on an airplane—

(1) On which a flight engineer is required by this chapter; or

(2) That has at least three engines that are rated at least 800 horsepower each or the equivalent in turbine-powered engines.

(b) An applicant for a flight engineer certificate with a class rating must present, for the class rating sought, satisfactory evidence of one of the following:

(1) At least three years of diversified practical experience in aircraft and aircraft engine maintenance (of which at least one year was in maintaining multiengine aircraft with engines rated at least 800 horsepower each, or the equivalent in turbine engine powered aircraft), and at least five hours of flight training in the duties of a flight engineer.

(2) Graduation from at least a two-year specialized aeronautical training course in maintaining aircraft and aircraft engines (of which at least six calendar months were in maintaining multiengine aircraft with engines rated at least 800 horsepower each, or the equivalent in turbine engine powered aircraft), and at least five hours of flight training in the duties of a flight engineer.

(3) A degree in aeronautical, electrical, or mechanical engineering from a recognized college, university, or engineering school; at least six calendar months of practical experience in maintaining multiengine aircraft with engines rated at least 800 horsepower each, or the equivalent in turbine engine powered aircraft; and at least five hours of flight training in the duties of a flight engineer.

(4) At least 200 hours of flight time in a transport category airplane (or in a military airplane with at least two engines and at least equivalent weight and horsepower) as pilot in command or second in command performing the functions of a pilot in command under the supervision of a pilot in command.

(5) At least 100 hours of flight time as a flight engineer.

(6) Within the 90-day period before he applies, successful completion of an approved flight engineer ground and flight course of instruction as provided in Appendix C of this part [Part 63].

TYPE OF WRITTEN TESTS

An applicant for a flight engineer certificate must pass a Basic Written Test and a Class Rating Written Test appropriate to the class of aircraft on which he desires to be rated.

The Flight Engineer Basic Written Test consists of items pertaining to:

- Federal Aviation Regulations
- Theory of Flight and Elementary Aerodynamics
- Basic Meteorology with respect to engine operations
- Center of Gravity Computations

The Flight Engineer Class Rating Written Tests are related to a particular powerplant class of airplane and are titled:

- Flight Engineer — Reciprocating Engine Written Test
- Flight Engineer—Turboprop Written Test
- Flight Engineer—Turbojet Written Test

The Class Rating Written Test consists of items pertaining to:

- Airplane Systems and Equipment
- Powerplant Systems and Equipment
- Normal Operating Procedures
- Emergency Procedures

Test items are multiple-choice, similar to those in the sample written tests in this guide. Questions are designed to determine whether the applicant has an adequate knowledge of fundamental principles and whether he can apply that knowledge to problems encountered in flight operations. Many items are based upon charts, graphs, and diagrams similar to those found in this study guide.

The applicant marks his answers on a special answer sheet. He should read the instructions very carefully before beginning the test. Incomplete or erroneous personal information entered on the scoring sheet delays the scoring process.

A minimum grade of 70 percent is required to pass a Basic or Class Rating Written Test.

The applicant is notified of his grade on the Airman Written Examination Report, Form 8060–37, which he receives for each test. The report also contains coded indications of the subject matter involved in test items which the applicant missed. A Written Examination Subject Matter Outline is provided to relate the codes to specific topics. The study outlines contained in this Guide are similar to the Subject Matter Outlines the applicant receives with Form 8060–37. An applicant who receives a failing grade must present the appropriate Form 8060–37 when he appears for reexamination.

TAKING THE WRITTEN TESTS

The written tests may be taken at FAA Air Carrier and General Aviation District Offices of the Flight Standards Service, and at selected Flight Service Stations. A test must be started in sufficient time to permit its completion during the normal working day. To save time, applicants should plan to use a computer or slide rule in solving weight and balance problems and in performing other computations. After completing the test, the applicant must surrender the answer sheet to the proctor, together with any papers used for computations or notations, before leaving the examination room.

When taking the test, the applicant should keep the following points in mind:

1. Each question or problem should be read carefully before looking at the possible answers. The applicant should clearly understand the problem before attempting to solve it.

2. After formulating his own answer, the applicant should determine which of the alternative answers most nearly corresponds with his answer. The answer chosen should completely resolve the problem.
3. From the answers given, it may appear that there is more than one possible answer; however, there is only one answer that is correct and complete. The other answers are either incomplete or derived from popular misconceptions.
4. If a particular test item proves difficult, it is best to proceed to another question. After the less difficult questions have been answered, the others should then be reconsidered.
5. There are no "trick" questions in the test.

SCOPE OF THE WRITTEN TESTS

All test items used in official Flight Engineer Written Tests are related to topics in the study outlines in this guide. An applicant who is thoroughly prepared in the subject matter and who follows the procedures recommended in this guide should have no difficulty in satisfactorily completing the written tests. The suggested topics for study are directly associated with the normal and emergency flight engineer duties.

When studying the topics listed in the outline, the prospective flight engineer should be concerned primarily with basic principles underlying the performance and operation of transport aircraft.

It is suggested that the applicant study only the topics listed for the basic test and those indicated for the particular class airplane on which he desires a class rating. Maximum utilization of hours available for study can be obtained by concentrating on applicable topics. Unnecessary study of topics related to other powerplant class airplanes may reduce the applicant's degree of readiness to pass the test on the rating he desires.

RECOMMENDED STUDY MATERIALS

The publications listed in this section will be helpful to persons studying for the flight engineer written tests. A variety of additional textual material which can be helpful in preparing for the written test is available from various publishers, manufacturers, and operators. Textbook publishers will usually furnish a listing of their available publications in a specific area of information. Most public and institutional libraries maintain technical reference sections and will assist interested persons in locating materials for study. Flight manuals, operation manuals, maintenance manuals, and technical booklets concerning transport category airplanes and equipment are also good information sources.

It is the responsibility of each applicant to obtain study materials appropriate to his needs.

FEDERAL AVIATION REGULATIONS

Part 1. *Definitions and Abbreviations*—($0.35). This part lists the official abbreviations and definitions used in the Federal Aviation Regulations.

Part 25. *Airworthiness Standards: Transport Category Airplanes*—($2.25). The applicant should have a general knowledge of the provisions of this part that are concerned with the various systems of the aircraft.

Part 63. *Certification: Flight Crewmembers Other Than Pilots*—($0.35). The applicant should be thoroughly familiar with the provisions of this part pertaining to the flight engineer.

Part 91. *General Operating and Flight Rules*—($0.70). As a flight crewmember, the flight engineer should be generally familiar with general operating and maintenance sections of this part.

Part 121. *Certification and Operations: Air Carriers and Commercial Operators of Large Aircraft*—($1.50). This part provides the source material for most of the test items on Federal Aviation Regulations appearing in the tests.

STUDY MANUALS

Aerodynamics for Naval Aviators, NAVAIR 00-80T-80—($3.50). This textbook is a valuable source of information dealing with the aerodynamics of subsonic and supersonic flight. It also contains excellent chapters on aircraft and engine performance of reciprocating engine, turboprop, and turbojet aircraft.

Aviation Weather, Advisory Circular 00-6—($2.25). This joint FAA-Weather Bureau publication provides an authoritative text on meteorology for the air crewmember. It gives the prospective engineer a practical understanding of those meteorological principles important to aviation and to aircraft operations.

Aircraft Performance, Reciprocating and Turbine Engine Aircraft, AF Manual 51-9—($1.25). Primarily designed as a text for the prospective Air Force Flight Engineer, this manual provides instruction in the techniques of cruise control and information on engine performance, theory of flight, computations, meteorology, and weight and balance.

HOW TO OBTAIN STUDY MATERIALS

The study materials listed previously may be obtained by remitting check or money order to:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402.

Orders for mailing or shipping to foreign countries should include an additional amount of about one-fourth of the purchase price for postage. Remittance for orders from foreign countries should be by International Money Order or by a draft on a U.S. bank.

FLIGHT ENGINEER BASIC STUDY OUTLINE

General and flight engineer regulations

A01. General Definitions—FAR 1.1
A02. Abbreviations and symbols—FAR 1.2
A03. Flight Engineer Certificates—FAR 63.3 through 63.16
A04. Written test requirements—FAR 63.17 and 63.18
A05. Certificate, logbook, and record rules—FAR 63.19 through 63.21
A06. Eligibility requirements—FAR 63.31
A07. Aircraft ratings—FAR 63.33
A08. Knowledge requirements—FAR 63.35
A09. Aeronautical experience requirements—FAR 63.37
A10. Skill requirements—FAR 63.39
A11. Retesting, courses, and exchange—FAR 63.41 and 63.45
A12. Responsibility and authority of the pilot in command—FAR 91.3
A13. Preflight action—FAR 91.5
A14. Flight crewmembers at stations—FAR 91.7
A15. Interference with crewmembers and careless operation—FAR 91.8 and 91.9
A16. Liquor and drugs—FAR 91.11
A17. Maintenance rules—FAR 91.161
A18. Carrying passengers after repairs—FAR 91.167

Airworthiness Standards

B01. Control systems—FAR 25.651 through 25.701
B02. Landing gear—FAR 25.721 through 25.735
B03. Personnel and cargo compartments—FAR 25.771 through 25.787
B04. Emergency provisions—FAR 25.801 through 25.815
B05. Ventilation, pressurization, and fire protection—FAR 25.831 through 25.875
B06. Powerplants—FAR 25.901 through 25.939
B07. Powerplant systems—FAR 25.951 through 25.1127
B08. Controls, accessories, and fire protection—FAR 25.1141 through 25.1205
B09. Required equipment—FAR 25.1301 through 25.1309
B10. Instruments—FAR 25.1321 and 25.1337
B11. Electrical systems—FAR 25.1351 through 25.1401
B12. Safety and miscellaneous equipment—FAR 25.1411 through 25.1459
B13. Operating limitations and markings—FAR 25.1501 through 25.1563
B14. Airplane flight manual—FAR 25.1581 through 25.1587

Certification and operation of air carriers

C01. Airplane performance—FAR 121.171 through 121.207
C02. Cabin interiors—FAR 121.215 through 121.219
C03. Fire precautions, cabin and cargo compartment—FAR 121.221 and 121.223
C04. Powerplant fire precautions—FAR 121.225 through 121.261
C05. Fire detection, extinguishing, and failures—FAR 121.263 through 121.283
C06. Cargo in passenger compartment—FAR 121.285 and 121.287
C07. Landing gear warning devices—FAR 121.289
C08. Demonstration of emergency evacuation—FAR 121.291

Instrument and equipment requirements

D01. Instruments and equipment, flight and navigational—FAR 121.303 and 121.305
D02. Engine instruments—FAR 121.307
D03. Emergency equipment—FAR 121.309 and 121.310
D04. Miscellaneous equipment—FAR 121.311 through 121.321
D05. Equipment for night and IFR—FAR 121.323 and 121.325
D06. Oxygen requirements—FAR 121.327 through 121.337

D07. Overwater and icing equipment—FAR 121.339 through 121.341
D08. Flight recorders—FAR 121.343
D09. Radio and radar—FAR 121.345 through 121.357
D10. Voice recorders—FAR 121.359
D11. Maintenance requirements—FAR 121.363 through 121.379

Airman and crewmember requirements

E01. Limitations on airman services—FAR 121.383
E02. Composition of flight crew—FAR 121.385 and 121.387
E03. Emergency duties—FAR 121.397
E04. Air Carrier Training Programs—FAR 121.411 through 121.415
E05. Crewmember emergency training—FAR 121.416
E06. Flight engineer training—FAR 121.421
E07. Flight engineer qualifications—FAR 121.453
E08. Flight time limitations—FAR 121.471 and 121.483

Flight operations and dispatch

F01. Flight crewmembers at controls—FAR 121.543
F02. Manipulation of controls—FAR 121.545
F03. Admission to flight deck and locks—FAR 121.547 and 121.587
F04. Flying equipment and rules—FAR 121.549 through 121.569
F05. Passenger briefing—FAR 121.571 and 121.573
F06. Passengers in cargo only aircraft—FAR 121.583
F07. Weapons and alcoholic beverages—FAR 121.575 and 121.585
F08. Continuing flight in unsafe conditions—FAR 121.627
F09. Operations in icing conditions—FAR 121.629
F10. Fuel Supply—FAR 121.639, 121.641, and 121.647

Records and reports

G01. Dispatch release—FAR 121.685 and 121.687
G02. Load manifest—FAR 121.691 and 121.695
G03. Maintenance records and logs—FAR 121.699 and 121.701
G04. Mechanical reliability and interruption—FAR 121.703 and 121.705
G05. Repair and airworthiness release—FAR 121.707 and 121.709
G06. Crewmember Certificate—FAR 121.721 and 121.723

Theory of flight wing and airfoil forces

H01. Subsonic airflow, pressure, and velocity
H02. Airspeed measurement
H03. Generation of lift on an airfoil
H04. Airfoil terminology
H05. Angle of attack
H06. Lift characteristics and stall
H07. Drag characteristics and L/D ratio
H08. Effect of high-lift devices
H09. Operation of high-lift devices

Airplane performance

I01. Required thrust and power
I02. Straight and level flight
I03. Climb performance
I04. Range performance
I05. Endurance performance
I06. Maneuvering performance
I07. Takeoff performance
I08. Landing performance
I09. Static and dynamic stability
I10. Controls and trim devices
I11. Operating strength limitations
I12. Flight loads, maneuvers, and gusts

Basic meteorology

J01. Composition of the atmosphere
J02. Standard atmosphere
J03. Troposphere and stratosphere
J04. Pressurre altitude, density altitude, and altimeter setting
J05. Effect of temperature variations on performance
J06. Effect of pressure variations on performance
J07. Effect of humidity variations on performance
J08. Icing conditions and effects
J09. Pressure lapse rates
J10. Temperature lapse rates
J11. Visible moisture, weather
J12. Humidity definitions
J13. Speed of sound

Center of gravity computations

K01. Weight and balance definitions
K02. Calculate C. G. from given weights
K03. Conversion from inches to percent of MAC
K04. Use of reduction factor and index units
K05. Calculate basic index or total index
K06. Adding or removing passengers or cargo
K07. Effect of burning fuel
K08. Fuel dumping
K09. Effect of landing gear retraction or extension
K10. Shifting weight
K11. Maximum weight limitations
K12. Fore and aft C. G. limits
K13. Use of fore and aft limit graphs
K14. Effect of C. G. location on trim
K15. Use of loading charts
K16. Load limits of compartments

FLIGHT ENGINEER CLASS RATING STUDY OUTLINES

The applicant for a Flight Engineer Class Rating needs to be familiar with construction features and component functions; normal operations; trouble analysis; and isolation and correction of faults in the airplane and powerplant systems relevant to the Class Rating which he seeks. He also needs to know the proper procedures for ground and inflight emergencies, as well as the reasons for operating in an approved manner and the possible effects if improper methods are used.

FLIGHT ENGINEER—RECIPROCATING ENGINE

Airplane systems—general

A01. Basic airframe, cabin, and flight deck
A02. Hydraulic reservoirs, accumulators, and general plumbing
A03. Hydraulic pumps, regulators, and valves
A04. Hydraulic systems, principles, and operation
A05. Landing gear, wheels, and tires
A06. Nose wheel steering
A07. Brake system
A08. Flap system
A09. Flight controls and trim systems
A10. Ice control systems operation
A11. Wing and tail ice protection
A12. Windshield ice and rain protection
A13. Pitot-static and miscellaneous ice protection
A14. Fuel system components
A15. Fuel system controls and indicators
A16. Fuel system operation
A17. Fuel dumping, fueling, and defueling
A18. Fuel system management
A19. Fuels and fuel characteristics

Electrical and instrument systems

B01. Theory of DC electricity
B02. DC generators
B03. Generator control and regulating system
B04. Electrical indicating systems
B05. Battery and ground power
B06. Lighting circuits
B07. Miscellaneous circuits
B08. Interpretation of schematic diagrams
B09. DC electrical computations
B10. Theory of AC electricity
B11. Alternators and inverters
B12. AC electrical circuits
B13. Instrument power sources
B14. Flight and navigation instruments
B15. Pitot-static system
B16. Vacuum system
B17. Miscellaneous instruments
B18. Air temperature indications
B19. Airspeed and altitude indications

Emergency systems

C01. Warning indicators and lights
C02. Fire and smoke detection system
C03. Fire extinguisher system
C04. Units actuated by fire handle
C05. Portable fire extinguishers
C06. Crew oxygen system
C07. Passenger oxygen system
C08. Evacuation equipment
C09. Miscellaneous emergency equipment

Pressurization and air conditioning

D01. Pressurization principles
D02. Cabin supercharger and drive
D03. Cabin pressurization, regulation and control
D04. Calculations for cabin pressurization
D05. Adjustment of cabin pressurization settings
D06. Air conditioning and ventilation
D07. Heating systems
D08. Cooling systems
D09. Adjustment of cabin temperature controls

Reciprocating engines

E01. Twin-row radial engine components
E02. Operating principles and characteristics
E03. Factors affecting operation
E04. Supercharging
E05. Power recovery system

E06. Cooling and exhaust systems
E07. Lubrication system
E08. Temperature control and regulation
E09. Engine limitations
E10. Engine computations
E11. Torquemeter system

Engine accessory systems

F01. Ignition principles
F02. Low-tension ignition
F03. Spark plugs, harness, and switch
F04. Induction vibrator system
F05. Spark advance system
F06. Carburetion principles
F07. Pressure carburetor system
F08. Direct injection system
F09. Anti-detonant injection
F10. Ice control system
F11. Starter system
F12. Engine controls
F13. Engine instrument power sources
F14. Power and temperature instruments
F15. Engine analyzer

Propeller systems

G01. Principles of constant speed propellers
G02. Feather and reverse systems
G03. Synchronization system
G04. Auto-feather system
G05. Propeller ice control
G06. Overspeed protection

Powerplant systems operation

H01. Preflight inspection
H02. Adjustment of controls for starting
H03. Starting procedure
H04. Abnormal starting indications and actions
H05. Ground operation check procedures
H06. Analysis of ground check indications
H07. Power and temperature control for takeoff
H08. Climb power and blower shift procedures
H09. Setting cruise power
H10. Monitoring the powerplant during cruise
H11. RPM, manifold pressure, and BMEP control
H12. Effects of density altitude, temperature, and humidity
H13. Ram, icing, and carburetor heat effects
H14. Control adjustments for descent and landing
H15. Shutdown procedures
H16. Effects of exceeding powerplant limitations

Cruise and power computations

I01. Cruise control principles
I02. Fuel consumption in climb
I03. Use of constant power schedules
I04. Use of long-range cruise procedures
I05. Selection of power settings
I06. Calculation of fuel burnout and fuel remaining
I07. Prediction of fuel required
I08. Prediction of landing weight
I09. Fuel consumption with an engine shutdown
I10. RPM, BMEP, and power relationships
I11. Piston displacement and compression ratio
I12. Efficiencies and gear ratios
I13. Specific range
I14. Specific fuel consumption
I15. Power, fuel, and performance charts

Emergency operation of systems

J01. Hydraulic system trouble shooting
J02. Emergency landing gear extension
J03. Emergency brake operation
J04. Emergency flap extension
J05. Asymmetric flaps
J06. Landing gear lock indications
J07. Pressurization and air conditioning troubles
J08. Shutdown of cabin compressors
J09. Manual control of cabin pressure
J10. Manual control of cabin temperature
J11. Emergency depressurization
J12. Emergency descents
J13. Fuel dumping procedure and calculations
J14. Fuselage fire procedure
J15. Smoke evacuation
J16. Landing gear and brake fires
J17. Passenger evacuation
J18. Electrical system trouble analysis
J19. Electrical load reduction procedure
J20. Electrical fire procedure
J21. Generator overheat procedure

Emergency operation of powerplants

K01. Engine fire indications
K02. Engine fire procedure
K03. False fire warning
K04. Engine failure procedure
K05. Engine trouble analysis

K06. Procedures for propeller malfunction
K07. Unfeathering and airstart procedures
K08. Control adjustments for partial failure

FLIGHT ENGINEER—TURBOJET AND TURBOPROP

NOTE.—The following subject matter areas are applicable to Turboprop Engine Airplanes only:
E10, E11, F03, G01, G02, G03, G04, G05, G06, G07, G08, H06, K06

Airplane systems—general

A01. Basic airframe, cabin, and flight deck
A02. Autopilot and yaw damper
A03. Adjustable stabilizer
A04. Hydraulic reservoirs, accumulators, and general plumbing
A05. Hydraulic pumps, regulators, and valves
A06. Landing gear, trucks, wheels, and tires
A07. Brakes and anti-skid system
A08. Nose wheel steering
A09. Trailing edge flaps, leading edge flaps, slats, and slots
A10. Flap asymmetry system
A11. Flight controls, spoilers, speed brakes, and trim system
A12. Cockpit windshield, ice and rain protection
A13. Pitot-static, wing, and tail ice protection
A14. Fuels and fuel characteristics
A15. Fuel system components
A16. Fuel system controls and indicators
A17. Aircraft fueling, defueling, and dumping

Electrical and instrument systems

B01. Theory of DC electricity
B02. Transformer-rectifiers
B03. Electrical indicating systems
B04. Batteries and circuits
B05. DC electrical circuits
B06. DC electrical computations
B07. Interpretation of schematic diagrams
B08. Theory of AC electricity
B09. AC generators
B10. AC generator control and regulating systems
B11. AC bus and distribution systems
B12. Constant speed drive
B13. Ground power system
B14. AC electrical circuits
B15. AC electrical computations
B16. Operation of electrical systems
B17. Instrument power sources
B18. Flight and navigation instruments
B19. Altimeter settings and indications
B20. Pitot-static systems
B21. Air temperature indications
B22. Airspeed and altitude indications

Emergency systems

C01. Warning indicators and lights
C02. Fire and smoke detector systems
C03. Fire extinguisher systems
C04. Portable fire extinguishers
C05. Units actuated by fire handle
C06. Crew oxygen system
C07. Passenger oxygen system
C08. Evacuation equipment
C09. Miscellaneous emergency equipment

Pressurization, air conditioning, and pneumatic systems

D01. Cabin compressor and drive
D02. Turbocompressor systems
D03. Bleed air pressurization
D04. Pressurization principles
D05. Pressurization regulation and control
D06. Calculations for cabin pressurization
D07. Adjustment of cabin pressurization settings
D08. Air conditioning and ventilation
D09. Heating systems
D10. Cooling systems
D11. Adjustment of cabin temperature controls
D12. Pneumatic power sources
D13. Pneumatic system regulation and control
D14. Overheat and malfunction protection
D15. Operation of the pneumatic system

Turbojet and turboprop engines

E01. Basic engine components
E02. Operating principles and characteristics
E03. Accessories and drives
E04. Cooling systems
E05. Fans and bypass
E06. Lubrication system
E07. Temperature control and regulation
E08. Engine limitations
E09. Engine computations
E10. Reduction gear box
E11. Torque-sensing devices
E12. Sensing elements and purposes

Engine accessory systems

F01. Fuel control
F02. Fuel system accessories

F03. Fuel and propeller coordinator
F04. Bleed air system
F05. Anti-icing system
F06. Starter system
F07. Ignition system
F08. Thrust reverser
F09. Engine controls
F10. Engine instrument power sources
F11. Power and temperature instruments
F12. Vibration monitoring

Propeller system

G01. Principles of turboprop propellers
G02. BETA range principles
G03. Constant speed principles
G04. Manual feather and unfeather
G05. Auto-feather
G06. Speed and phase synchronization
G07. Negative thrust sensing
G08. Propeller ice control

Powerplant systems operation

H01. Preflight inspection
H02. Adjustments of controls for starting
H03. Starting procedures
H04. Abnormal starting indications and actions
H05. Effects of exceeding powerplant limitations
H06. BETA range operation
H07. Ground checks and analysis
H08. Setting takeoff power and thrust
H09. Effects of air temperature and density
H10. Effects of using engine bleed air
H11. Control adjustments during climb
H12. Setting cruise power or thrust
H13. Monitoring the powerplant during cruise
H14. Control adjustments for descent and landing
H15. Monitoring the powerplant during ground operation and shutdown

Cruise and power computations

I01. Cruise control principles and definitions
I02. Fuel consumption in climb
I03. Use of constant Mach cruise procedures
I04. Use of constant power or temperature cruise procedures
I05. Use of long-range cruise procedures
I06. Selection of power settings
I07. Calculation of fuel burnout and fuel remaining
I08. Computing fuel required
I09. Fuel consumption with an engine shutdown
I10. Power computations
I11. Performance charts
I12. Gear ratios
I13. Specific range
I14. Specific fuel consumption

Emergency operation of systems

J01. Hydraulic system trouble shooting
J02. Emergency landing gear extension
J03. Emergency brake operation
J04. Emergency flap extension
J05. Asymmetric flaps
J06. Landing gear lock indications
J07. Pressurization and air conditioning troubles
J08. Shutdown of cabin compressors
J09. Manual control of cabin pressure
J10. Manual control of cabin temperature
J11. Emergency depressurization
J12. Emergency descents
J13. Fuel dumping procedure and calculations
J14. Fuselage fire procedure
J15. Smoke evacuation
J16. Landing gear and brake fires
J17. Passenger evacuation
J18. Electrical system trouble analysis
J19. Electrical load reduction procedure
J20. Electrical fire procedure
J21. Generator and CSD malfunction procedure
J22. Emergency operation of flight controls and horizontal stabilizer

Emergency operation of powerplants

K01. Engine fire indications
K02. Engine fire procedure
K03. False fire warning
K04. Engine failure procedure
K05. Engine trouble analysis
K06. Procedures for propeller malfunction
K07. Unfeathering and airstart procedures
K08. Control adjustments for partial failure

High-speed aerodynamics

L01. Aerodynamic definitions
L02. Mach number versus true airspeed
L03. Effect of wing "sweepback," advantages and disadvantages

SAMPLE WRITTEN TESTS

The following sample written tests are provided to familiarize the applicant with the types of questions contained in the official FAA tests. The sample questions do not cover all topics included in the official tests; therefore, the applicant should not necessarily consider himself prepared if he successfully completes the appropriate sample written tests. To be adequately prepared, the applicant should study all the topics for the Basic Test and for the appropriate Class Rating Test included in the sections entitled "Flight Engineer Basic Study Outline" and "Flight Engineer Class Rating Study Outlines." Answers to the sample tests and explanations of questions are given in a separate section at the end of the sample written test.

NOTE.—The reader should be aware that the sample questions are based on regulations and procedures in effect at the time of preparation of this guide. Questions in the official FAA written tests should always be answered in terms of current regulations and procedures.

FLIGHT ENGINEER BASIC TEST

1. A temporary flight engineer certificate remains in effect—

   1—indefinitely unless surrendered or revoked.
   2—a maximum of 60 days.
   3—for 30 days or until a permanent certificate is issued.
   4—for no longer than 90 days.

2. Which class of [illegible] ments requir[illegible] smoke [illegible] warning [illegible]

   1—Cl [illegible]
   2—Cl [illegible]
   3—Cl [illegible]
   4—Class A [illegible]

3. An approv[illegible] ment for FAR Par[illegible]

   1—only those turbine [illegible] tificated for operation [illegible]
   2—all transport category [illegible] cated for operations above [illegible]
   3—all turbine powered [illegible] 12,500 pounds maximum [illegible] off weight.
   4—all piston engine powered aircraft certificated for operations above 20,000 feet.

4. Which of the following examples of "recent experience" qualifies the flight engineer to be assigned to flight engineer duties on a domestic air carrier operating under FAR Part 121?

   1—50 hours of experience in the preceding 6 months as flight engineer on any aircraft which incorporates a flight engineer station.
   2—50 hours of experience in the preceding 6 months as flight engineer on the type of aircraft on which he is to serve.
   3—50 hours of experience in the preceding 12 months as flight engineer on the type of aircraft on which he is to serve.
   4—50 hours of experience in the preceding 12 months as flight engineer on any aircraft which incorporates a flight engineer station.

5. A flight engineer is scheduled [illegible]

[illegible]

speed.

   1—B and D
   2—A and B
   3—C and D
   4—A and C

7. Determine the Density Altitude and the True Airspeed under these conditions:

Pressure Altitude	20,000 ft.
Temperature	−15° C.
EAS	250 kts.

   1—21,000 feet, 347 TAS
   2—22,500 feet, 355 TAS
   3—21,300 feet, 295 TAS
   4—24,000 feet, 365 TAS

To answer test item 7, refer to the Density Altitude Chart, Figure 1.

DENSITY ALTITUDE CHART

NOTE:

$$\frac{1}{\sqrt{\sigma}} = \frac{TAS}{EAS}$$

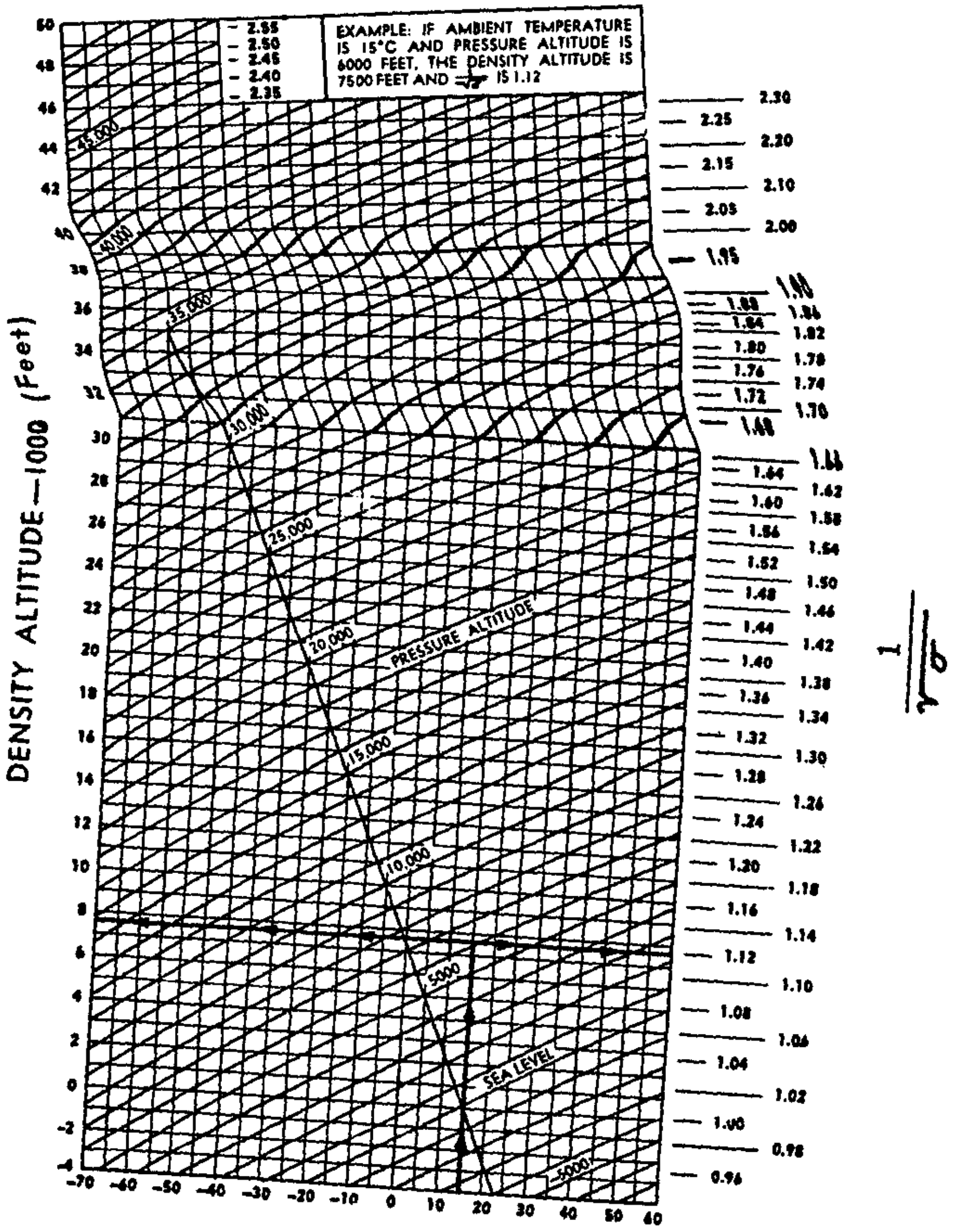


FIGURE 1. Density Altitude Chart

8. Calibrated airspeed is determined by correcting—

1—indicated airspeed for instrument and position error.
2—equivalent airspeed for density altitude.
3—indicated airspeed for compressibility effects.
4—equivalent airspeed for pressure altitude and aircraft gross weight.

9. The load factor developed during a coordinated turn is directly related to the—

1—true airspeed.
2—weight of the aircraft.
3—density altitude.
4—angle of bank.

10. The speed of sound in the atmosphere increases when—

1—temperature decreases.
2—pressure decreases.
3—temperature increases.
4—pressure increases.

11. Icing conditions are reported to begin at altitudes where the temperature is +4°C. The airplane is climbing at 750 feet per minute and the OAT is now +22°C. Assuming standard temperature lapse rate with altitude change, icing conditions can be expected in approximately—

1—twenty-four minutes.
2—six minutes.
3—four minutes.
4—twelve minutes.

12. What will be the effect upon engine power if the relative humidity changes from 90% to 20%?

1—Power will decrease because the air will be hotter.
2—Power will increase because the air will be colder.
3—Power will decrease because the air will be less dense.
4—Power will increase because the air will be more dense.

13. The following information is known about an airplane ready to depart on a scheduled flight:

A. Airplane gross weight—103,000 pounds.
B. C. G. position —23% MAC.
C. Length of MAC —173 inches.
D. Leading edge of MAC—441 inches aft of the reference datum line.

Just before departure an additional 5,000 pounds of cargo is loaded at a point 760 inches aft of the reference datum line. What is the *new* C. G. in percent of MAC?

1—28.3 percent.
2—32.1 percent.
3—27.0 percent.
4—30.5 percent.

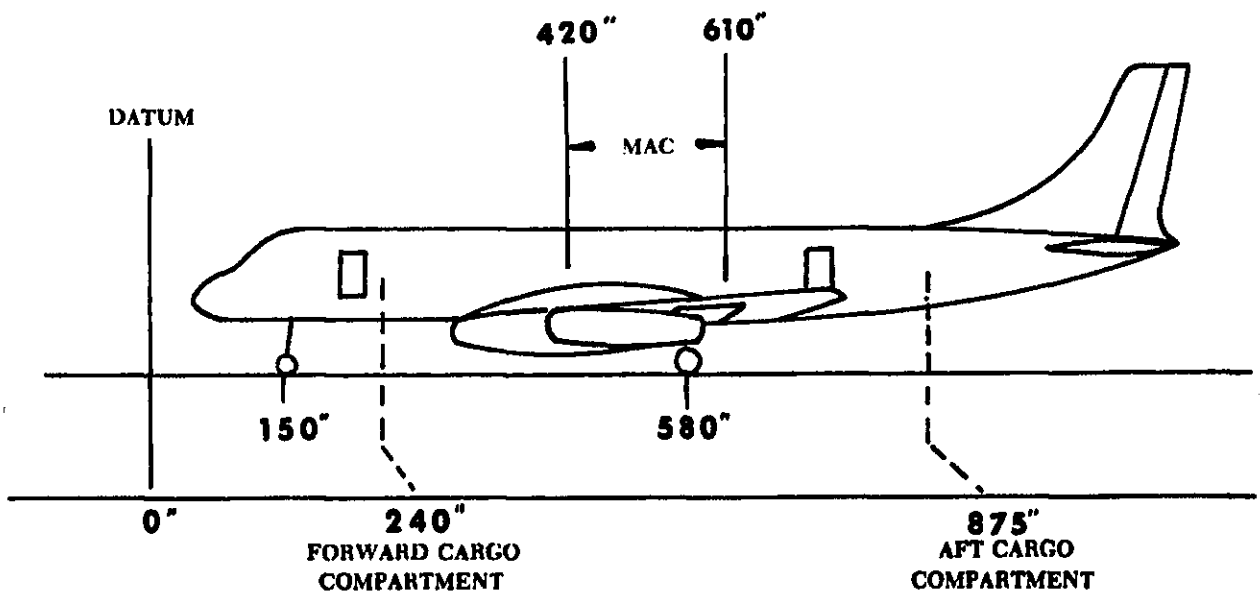


FIGURE 2. Weight and Balance Diagram.

14. The airplane illustrated in Figure 2 is loaded to a gross weight of 110,000 pounds. The C.G. is located at 30% MAC and the aft C.G. limit is located at 33% MAC. Where would the C.G. be located if 1,200 pounds of cargo were moved from the forward to the aft cargo compartment?

1—Exactly on the aft limit.
2—1.23 inches aft of the aft limit.
3—3.91 inches aft of the aft limit.
4—2.58 inches forward of the aft limit.

15. An airplane with an empty weight of 80,000 lbs. has an empty C.G. located 405.0 inches aft of the datum. The airplane is then loaded as follows:

Item		*Index Unit*
Fuel	—18,000 lbs.	572.0
Oil	— 900 lbs.	17.6
Crew	— 800 lbs.	12.3
Passengers	— 4,800 lbs.	241.9

Reduction Factor=10,000
(Moments÷Reduction Factor=Index Unit)

What is the location of the C.G. in inches aft of the datum when the airplane is loaded?

1—318.1" aft of the datum.
2—409.9" aft of the datum.
3—390.8" aft of the datum.
4—378.5" aft of the datum.

16. Which device allows the use of a high angle of attack because it delays air flow separation over the wing?

1—Slotted flap.
2—Fowler flap.
3—Spoiler.
4—Slot.

17. Which of the following is an aircraft class rating appropriate for a Flight Engineer Certificate?

1—Multi-engine land.
2—Propeller driven.
3—3 or 4 engine, fanjet.
4—Turbojet powered.

18. The stall angle of attack of an airplane—

1—varies with the gross weight and the center of gravity location.
2—remains constant regardless of gross weight and density altitude.
3—decreases as density altitude increases.
4—increases as gross weight increases.

19. Abnormally high headwinds or tailwinds have an effect upon the airplane performance with regard to the airspeed necessary to obtain—

1—the maximum rate of climb.
2—maximum range.
3—the maximum angle of climb.
4—maximum endurance.

20. An airplane has a mean aerodynamic chord of 175 inches and has the center of gravity limits illustrated in Figure 3. What is the center of gravity range when this airplane is loaded to a weight of 112,500 lbs.?

1—21.6 inches.
2—38.8 inches.
3—22.9 inches.
4—40.1 inches.

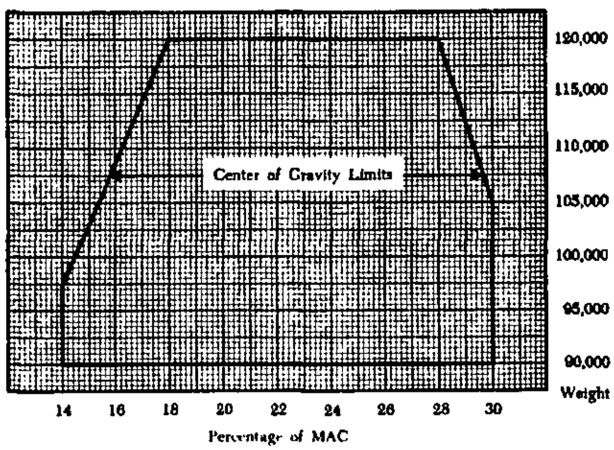


FIGURE 3. Center of Gravity Limit Chart.

FLIGHT ENGINEER RECIPROCATING ENGINE TEST

1. A thermocouple of a typical fire-warning system causes the system to actuate because—

    1—heat increases its electrical resistance.
    2—it expands when heated and forms an electrical ground for the warning light and bell circuit.
    3—heat decreases its electrical resistance.
    4—it generates a small current when it becomes hot.

2. In what position should the mixture control normally be set for starting a reciprocating engine equipped with a *pressure-injection carburetor?*

    1—Manual lean.
    2—Auto-rich.
    3—Idle-cutoff.
    4—Auto-lean or manual lean.

3. What is the function of the lockout cylinder located in the landing gear and brake system?

    1—To reduce the hydraulic system pressure to a value which will minimize nose wheel shimmy.
    2—To ensure that the landing gear will lock in the down position when it has been lowered by gravity in the event of a hydraulic system failure.
    3—To allow the use of a nitrogen cylinder to actuate the brakes in the event of a hydraulic system failure.
    4—To prevent the loss of hydraulic system pressure in the event of a brake line failure.

4. What is the purpose of the bypass valve in the engine-driven fuel pump?

    1—To prevent vapor lock in the section of fuel line between the fuel pump and the fuel tank selector valve.
    2—To control fuel pump pressure thereby compensating for changes of engine RPM.
    3—To bypass fuel which is being returned to the fuel tank by the carburetor vapor vent system.
    4—To allow fuel under booster pump pressure to flow through the fuel pump directly to the carburetor.

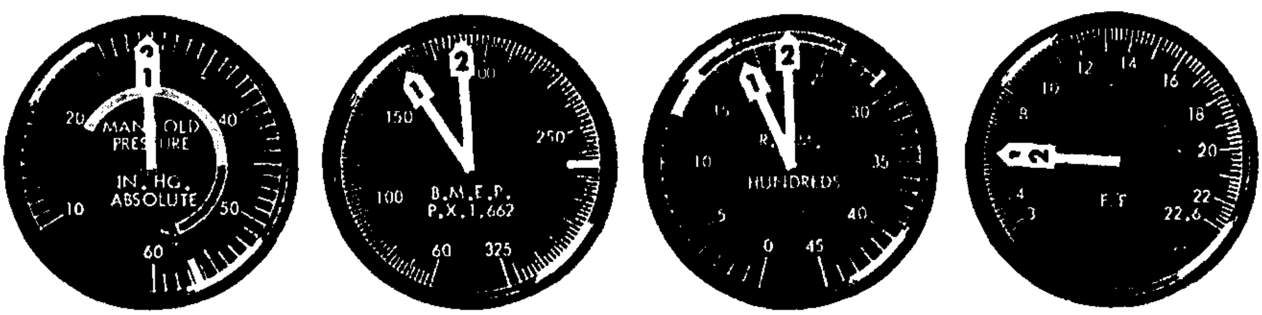


FIGURE 4. Reciprocating Engine Power Check Diagram.

5. When making a power check on number 1 and 2 engines, you set the manifold pressure at local barometric pressure. Number 2 engine responds normally but number 1 engine does not. If number 1 engine responds as shown on the engine power check diagram, it is possible that—

    1—the carburetor is excessively lean.
    2—the propeller is set at too low a blade angle.
    3—several cylinders are not firing.
    4—the propeller is set at too high a blade angle.

To answer test item 5, refer to the Engine Power Check Diagram, Figure 4.

6. You are making a feathering check on a hydromatic reversing propeller. If the RPM increases when the feathering button is depressed, it is an indication that the—

1—auxiliary pump is inoperative.

2—propeller master lever is *not* full forward.

3—propeller is in reverse pitch.

4—engine selector switch is in manual position.

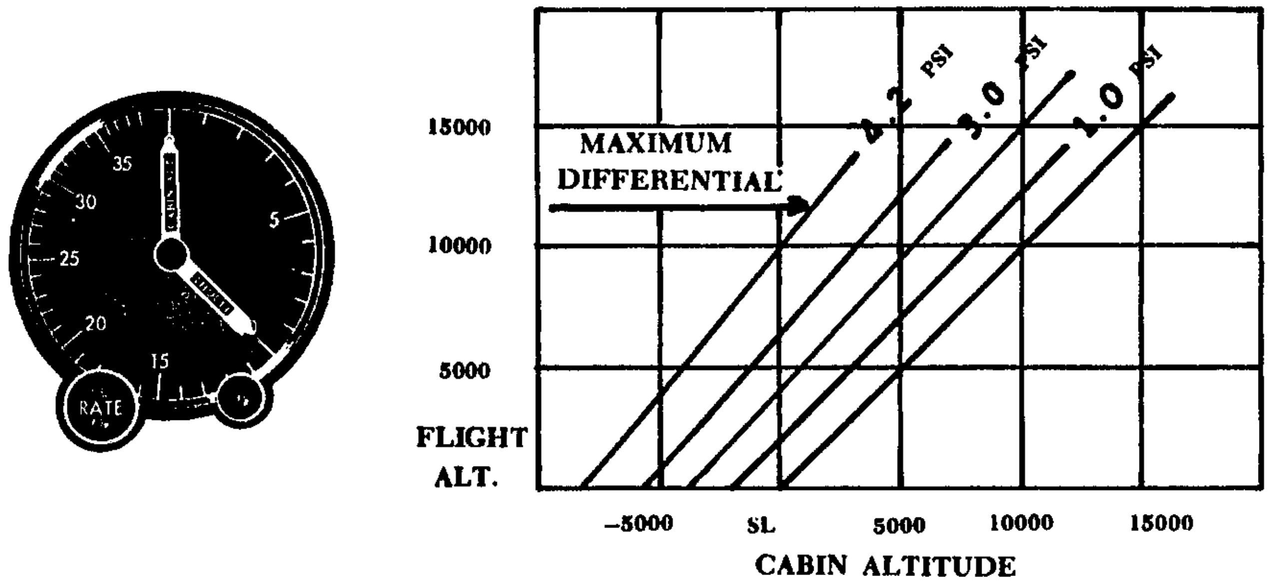


FIGURE 5. Cabin Pressure Control Diagram.

7. The cabin pressurization system is adjusted as shown on the controller illustrated in Figure 5. If the system is performing according to the chart, also illustrated in Figure 5, what will be the differential pressure at a flight altitude of 5,000 feet?

1—3.2 psi.
2—4.2 psi.
3—2.5 psi.
4—0.5 psi.

Refer to the Cabin Pressure Control Diagram, Figure 5, for information relating to test item 7.

8. Assume that there is an unusual drop of BMEP on one engine during takeoff. What action should the flight engineer take if this occurs when the airplane has accelerated beyond V_1 speed but has not yet reached V_2 speed?

1—Advise the pilot-in-command.
2—Increase power on the other three engines.
3—Arm the auto-feathering system.
4—Reduce all throttles to idle in preparation for stopping with reverse thrust.

9. If the right injection pump of a twin-row radial engine is delivering more fuel than the left injection pump, the cylinder head temperatures of the rear row will be—

1—lower than the front row during climb and higher during manual lean cruise.
2—higher than the front row during climb and lower during manual lean cruise.
3—lower than the front row during climb *and* during manual lean cruise.
4—higher than the front row during climb *and* during manual lean cruise.

10. Which of the following are indications of a proper shift from the "Takeoff and Climb" to the "Cruise" spark advance setting?

A. Shift of analyzer pattern to right.
B. Shift of analyzer pattern to left.
C. Decrease in BMEP.
D. Increase in BMEP.

1—A and C
2—B and C
3—B and D
4—A and D

11. What is the piston displacement of an 18 cylinder engine which has a cylinder diameter of 5.875″ and a stroke of 5.875″?

1—2,870 cubic inches
2—1,950 cubic inches
3—2,680 cubic inches
4—2,800 cubic inches

12. What Brake Horsepower will be developed by an engine with a 166 "K" factor, operating at 2,100 RPM and 150 BMEP?

1—1,785 BHP.
2—1,190 BHP.
3—1,898 BHP.
4—2,072 BHP.

13. The log of a four-engine airplane in cruising flight indicates the following:

Time	1:15 p.m.
Pressure Altitude	15,000 feet
Weight	96,000 lbs.
Operation	Four-Engine, Long-Range Cruise

Assuming the airplane continues to operate according to the Four Engine, Long-Range Cruise Performance Table, what will be the airplane weight at 4:45 p.m.?

1—88,230 pounds
2—90,450 pounds
3—89,540 pounds
4—88,870 pounds

Refer to the Cruise Performance Table, Figure 6, for information relating to test item 13.

14. What is a probable source of trouble if a DC generator is producing zero amperage and residual voltage?

1—The main feeder line is disconnected at the bus bar.
2—The voltmeter is faulty.
3—The field circuit breaker is open.
4—The reverse current relay main contactor points are stuck open.

15. What would be the effect if the static pressure line became disconnected inside a pressurized cabin during cruising flight?

1—The altimeter would read high and the airspeed indicator would read low.
2—Both the altimeter and the airspeed indicator would read high.
3—The altimeter would read low and the airspeed indicator would read high.
4—Both the altimeter and the airspeed indicator would read low.

16. Which of the following components are used in 18 cylinder twin-row radial engines?

A. Four-throw dynamic balanced crankshaft.
B. Sixteen articulated connecting rods.
C. Planetary propeller reduction gearing.
D. Eighteen knuckle pins.

1—B and D.
2—A and C.
3—B and C.
4—A and D.

17. The volume output of a variable-displacement, piston-type hydraulic pump is most commonly controlled by a—

1—pressure-operated device which increases or decreases the length of stroke of the pistons according to system demands.
2—pressure regulator which bypasses pump output when system pressure reaches a particular value.
3—pressure-operated, variable-speed drive mechanism which increases or decreases the speed of the pump to meet the variations in system volume demands.
4—bypass valve in the pump housing which routes fluid not required by the system back to the inlet of the pump.

18. Your airplane has a generator on each of four engines. Each generator is rated at 30v and 350a. The following electrical loads are being used in cruising flight.

Radio receivers	1 kilowatt
Air conditioning	220 amperes
Galley equipment	5 kilowatts
Essential pumps	100 amperes
Lighting	90 amperes
Other electrical equipment	350 amperes

If the propeller of one engine is feathered, by how many watts will the total remaining rated generator power exceed the loads being used?

1—3,250 watts.
2—2,700 watts.
3— 30 watts.
4—3,300 watts.

FOUR-ENGINE, LONG-RANGE CRUISE PERFORMANCE

Pressure Altitude	*Gross Weight*	*100,000 to 95,001*	*95,000 to 90,001*	*90,000 to 85,001*	*85,000 to 80,001*
	TAS (IAS) Knots	237 (185)	231 (180)	224 (175)	218 (170)
	BHP	1,186	1,096	1,008	922
	BLOWER	LOW	LOW	LOW	LOW
	RPM	2,250	2,150	2,100	2,000
14,000	SPARK	CRUISE	CRUISE	CRUISE	CRUISE
	B.P. BMEP	161	156	148	142
	BMEP DROP	12	12	12	12
	MAP (approx.)	32.5	31.5	29.5	28.5
	FF lb./hr./eng	545	495	460	420
	TAS (IAS) Knots	240 (185)	235 (181)	228 (176)	221 (171)
	BHP	1,200	1,114	1,025	937
	BLOWER	LOW	LOW	LOW	LOW
	RPM	2,300	2,200	2,150	2,000
15,000	SPARK	CRUISE	CRUISE	CRUISE	CRUISE
	B.P. BMEP	160	155	147	145
	BMEP DROP	12	12	12	12
	MAP (approx.)	33.0	31.0	29.5	28.5
	FF lb./hr./eng	555	510	470	425
	TAS (IAS) Knots		238 (181	232 (176)	225 (171)
	BHP		1,131	1,041	952
	BLOWER		LOW	LOW	LOW
	RPM		2,300	2,200	2,100
16,000	SPARK		CRUISE	CRUISE	CRUISE
	B.P. BMEP		151	146	137
	BMEP DROP		12	12	12
	MAP (approx.)		31.0	29.5	28.0
	FF lb./hr./eng		525	480	440
	TAS (IAS) Knots		243 (181)	236 (176)	229 (171)
	BHP		1,152	1,060	970
	BLOWER		HIGH	HIGH	LOW
	RPM		2,200	2,100	2,150
17,000	SPARK		TO&CL	CRUISE	CRUISE
	B.P. BMEP		160	155	140
	BMEP DROP		12	12	12
	MAP (approx.)		34.0	32.5	28.0
	FF lb./hr./eng		540	495	450
	TAS (IAS) Knots		247 (180)	240 (175)	233 (170)
	BHP		1,173	1,079	987
	BLOWER		HIGH	HIGH	HIGH
	RPM		2,250	2,150	2,100
18,000	SPARK		TO&CL	CRUISE	CRUISE
	B.P. BMEP		160	154	145
	BMEP DROP		12	12	12
	MAP (approx.)		34.5	32.5	30.5
	FF lb./hr./eng		555	510	465

FIGURE 6. Reciprocating Engine Cruise Performance Table.

19. Frequency of the alternating current output of a rotary inverter is determined by the—

1—number of stator fields in the alternator.
2—direct current motor speed.
3—hydromechanical constant-speed drive.
4—transformer-rectifier.

20. Fuel dumping systems usually incorporate—

1—a flowmeter in the dump line to allow calculation of the quantity of fuel dumped in a particular period of time.
2—an electric pump in each tank to accelerate the rate of dumping.
3—float-operated shutoff valves in all tanks to ensure a 45 minute supply of fuel at 75% of METO power after dumping.
4—provisions in the main tanks to prevent dumping all the fuel.

21. The expansion turbine in a cooling system is driven by—

1—the engine through a drive shaft.
2—outside ram air.
3—discharge air from the superchargers.
4—a direct current electric motor.

22. The hopper in the oil tank is installed for the purpose of—

1—maintaining an oil reserve in the event of tank failure.
2—providing sufficient oil for feathering the propeller.
3—quick warming of the oil after starting.
4—providing an expansion space for hot oil.

23. What is the probable trouble if there is a 7 BMEP drop when the ignition switch is moved from "Both" to "Left" and there is no change of BMEP when the switch is moved from "Both" to "Right"?

1—Right magneto ignition switch wire is grounded.
2—Right magneto ignition switch wire is open.
3—Left magneto ignition switch wire is grounded.
4—Left magneto ignition switch wire is open.

24. Which is the correct position for a powerplant control immediately prior to unfeathering?

1—Mixture in auto-lean position.
2—Propeller toggle switch to increase RPM position.
3—Spark control to retard (takeoff) position.
4—Throttle at cruising BMEP position.

25. A four-engine aircraft is to be dispatched under the following conditions:

Takeoff weight	100,000 lbs.
Climb time	45 minutes.
Climb fuel flow	1,400 lbs./hr./eng.
Fuel load	4,000 gals. (6 lbs./gal.)

How much time would be required to reduce weight to 85,000 lbs. at the beginning of cruising flight, using a dumping rate of 600 gals./min.?

1—1.8 minutes.
2—3.0 minutes.
3—2.5 minutes.
4—4.2 minutes.

Applicants who desire to prepare for the Reciprocating Engine Written Test should also attempt to answer the following:

Turboprop Sample Test Items—1, 4, 5, 16, 17, 21, 23, and 24.
Turbojet Sample Test Items—6, 17, and 24.

FLIGHT ENGINEER TURBOPROP TEST

1. While inspecting the control surfaces, you notice that the trailing edges of the trim tabs on the right aileron and on both elevators are turned down. What position would you expect to find on the flight deck trim tab indicators?

 1—Nose up and right wing up.
 2—Nose up and left wing up.
 3—Nose down and left wing up.
 4—Nose down and right wing up.

2. When the starter switch in the flight compartment is activated, the starter is operated because an electric solenoid—

 1—permits the starter air shutoff valve to open.
 2—opens the valve which allows pneumatic system pressure crossover from an operating engine.
 3—engages the ratchet type starter dog to the engine.
 4—closes the starter relay permitting a high amperage flow in the starter field winding.

3. Which of the following receives power from the three-phase, 115v AC system and provides power to the essential DC bus?

 1—Static exciter.
 2—Rotary inverter.
 3—Magnetic amplifier.
 4—Transformer-rectifier.

4. The air cycle machine produces cold air by—

 1—extracting heat energy across the expansion turbine.
 2—utilizing the heat of compression.
 3—forcing the air through a sonic venturi.
 4—circulating the air over cooling coils containing Freon 12.

5. Which oxygen control position should be selected when full face masks are used during smoke evacuation procedures?

 1—Off position unless the cabin is being depressurized.
 2—Normal, or diluter demand position.
 3—Smoke filter position.
 4—100% oxygen position.

6. Which item provides the signal to prevent overfilling the fuel tank with the underwing fueling system?

 1—Pilot valve.
 2—Float-type vent valve.
 3—Boost pump check valve.
 4—Fueling manifold pressure relief valve.

7. Which of the following is an operating feature of an alternating current generator?

 1—The field windings rotate inside the stationary armature.
 2—Alternating current in the field regulates the generator output.
 3—Direct current is used to excite the stationary field.
 4—An air cooling system is not required because brushes are not used.

8. What is the inductive reactance of a coil which has an inductance of .75 Henry when the alternating current frequency is 400 cps?

 1— 300 ohms.
 2— 942 ohms.
 3—1,885 ohms.
 4—2,240 ohms.

9. The turboprop engine utilizes air bleeds in the middle of the compressor section for the purpose of—

 1—directing cooling air to the combustion liners.
 2—preventing stall and surge at low RPM.
 3—extracting hot air for inlet scoop anti-icing.
 4—pressurizing the oil tank.

10. During climbing flight you observe the indications shown on the Engine Instrument Diagram, Figure 7. If number two engine is

performing normally for the particular power lever setting, what is the most likely source of trouble in number one engine if it has the same power lever setting?

1—Turbine damage.
2—Misrigged power lever.
3—Torquemeter malfunction.
4—Bleed valve stuck open.

11. When turning on the engine anti-icing system, the best instrument to watch for positive indications of system operation is the—

1—shaft horsepower indicator.
2—turbine temperature gauge.
3—tachometer.
4—pneumatic duct pressure gauge.

12. When the propeller is in the BETA range, blade angle is controlled by the—

1—negative torque sensing (automatic drag limiting) system.
2—power lever through mechanical linkage.
3—propeller governor spring setting.
4—blade pitch lock mechanism.

13. What is the primary purpose of the propeller phase synchronization system?

1—Synchronize all propellers to the same blade angle during flight operations.
2—Synchronize all engine speeds within 3% of the master engine speed.
3—Maintain a given propeller blade angle relative to power lever position for ground operation.
4—Maintain a preset angular relationship between propeller blades of master and slave engines.

14. When the four-position (AUTO, OFF, INCR, DECR) manual temperature control switch is used to decrease the temperature in the flight station, the switch should be—

1—held in DECR until the flight station air reaches the desired temperature.
2—placed momentarily in DECR and then back to AUTO.
3—placed momentarily in DECR and then back to OFF.
4—held in DECR until the flight station air temperature decreases at least 5°F. and then placed in AUTO.

15. How will the negative torque (automatic drag limiting) system make a correction if an engine fails and the propeller attempts to windmill the engine?

1—By disconnecting the propeller reduction gearing from the engine compressor.
2—By increasing fuel flow.
3—By applying the propeller brake mechanism.
4—By increasing propeller blade angle.

16. An airplane is flying at a true airspeed of 350 kts. The speed of sound (Mach 1.0) is 1,000 ft./sec. What is the airspeed of the airplane expressed in Mach number?

1—Mach .43.
2—Mach .59.
3—Mach .35.
4—Mach .51.

17. An airplane is cruising at 20,000 feet with a cabin pressure altitude of 8,000 feet. The airplane will descend to an approach altitude of 2,000 feet at a rate of descent of 750 feet per minute. What cabin rate of descent must be established to have the cabin completely depressurized when the approach altitude is reached?

1—285 feet per minute.
2—367 feet per minute.
3—250 feet per minute.
4—416 feet per minute.

18. How much torquemeter shaft horsepower should be available under the following conditions?

Pressure Altitude	5,000 feet
OAT	Zero
Turbine Inlet Temperature (T_{T_5})	971°C.
CAS	125 kts.

1—3,540 SHP.
2—3,635 SHP.
3—3,600 SHP.
4—3,300 SHP.

Refer to the Takeoff Power Available Chart, Figure 8, for information relating to test item 18.

19. If the asymmetry system actuates inflight after the flaps have been lowered to the approach position, the flight crew should—

1—raise the flaps by the emergency system.
2—raise the flaps by the normal system.
3—trim the aircraft laterally.
4—lower the flaps to landing position by the electric emergency system.

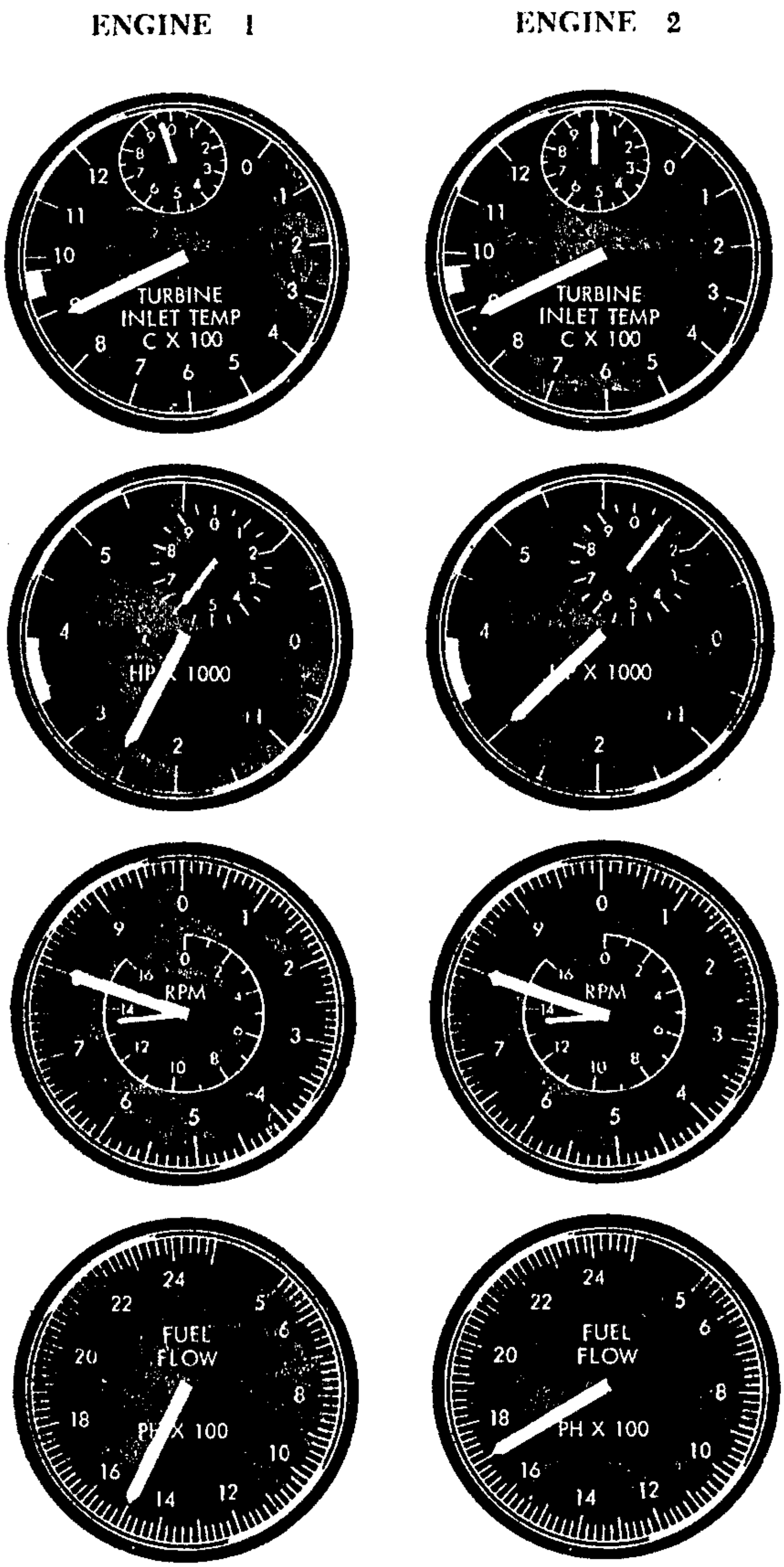
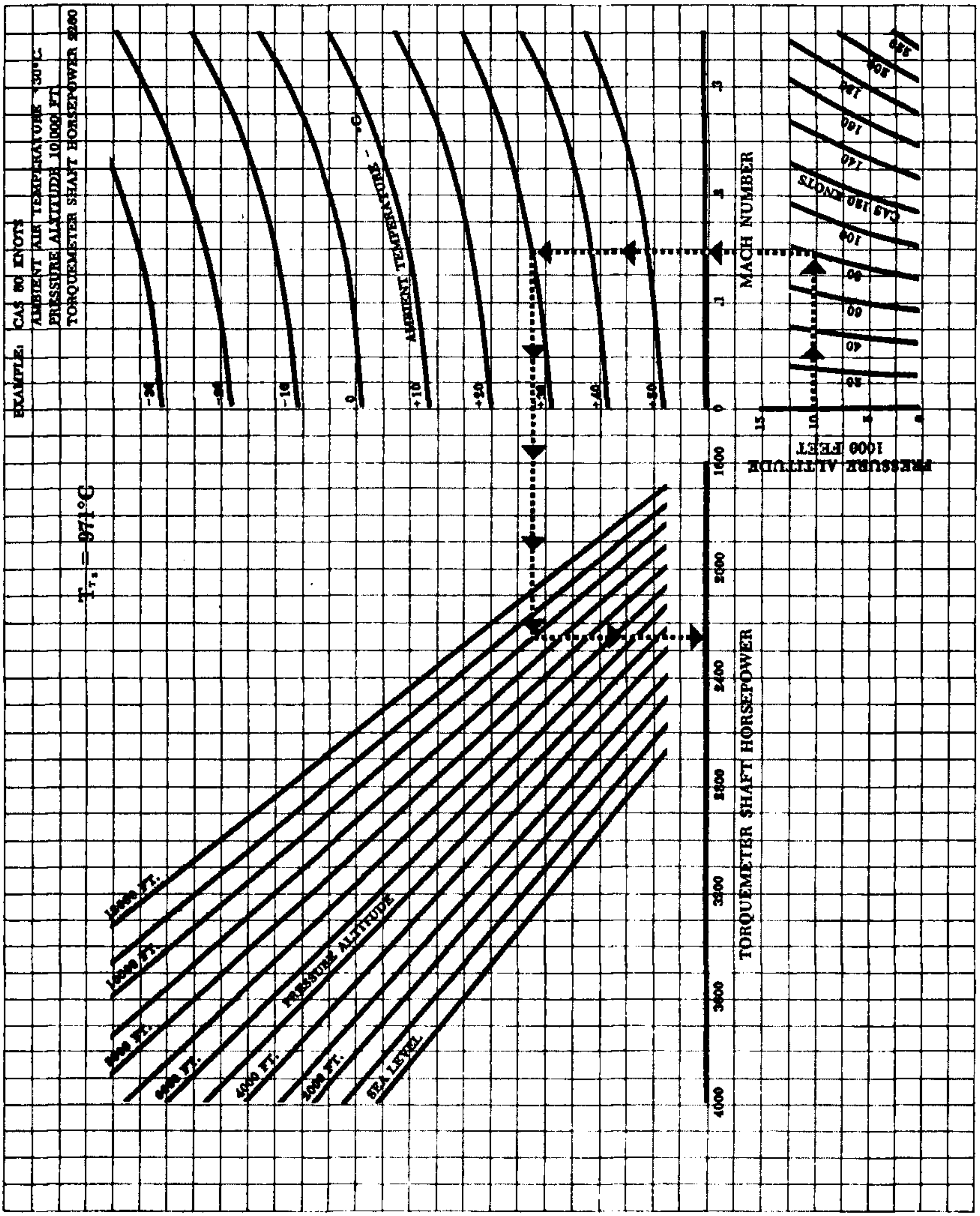


FIGURE 7. Turboprop Engine Instrument Diagram.



TAKE-OFF POWER AVAILABLE 971°C

FIGURE 8. Turboprop Takeoff Power Available Chart.

20. The ice warning system light illuminates when ice—

1—blocks perforations in the detector probe.
2—forms on the nose cowl temperature bulb.
3—forms on the inlet guide vane vent.
4—clogs the static system vent.

21. The hydraulic system contains a piston-type accumulator which has a 1,000 psi air charge when the system is off. What is the air charge when the system is pressurized to 3,000 psi?

1—1,000 psi.
2—2,000 psi.
3—3,000 psi.
4—4,000 psi.

22. At which position should the power lever be placed to properly adjust the propeller for engine starting?

1—Zero blade angle position.
2—Low flight idle position.
3—Maximum reverse position.
4—Minimum drag position.

23. When the test switch for the fuel tank gauge is operated, the gauge should—

1—change toward the zero position.
2—stop at the full tank position.
3—shut off the underwing fueling operation.
4—indicate the fuel used instead of fuel remaining.

24. In the event that the cabin rate of climb is too fast, the controls should be adjusted to cause the—

1—outflow valve to close faster.
2—cabin compressor to increase speed.
3—outflow valve to close slower.
4—cabin compressor to decrease speed.

25. After which type failure will it be impossible to transfer a particular electrical load to an alternative generator in a non-parallel constant frequency AC electrical system?

1—Generator over or under frequency.
2—Generator over voltage.
3—Bus fault.
4—Feeder fault (Generator to Bus).

Applicants who desire to prepare for the Turboprop Class Written Test should also attempt to answer the following:

Reciprocating Engine Sample Test Items—1, 3, 7, 15, 17, 19, and 21.

Turbojet Sample Test Items—5, 6, 8, 10, 11, 17, 19, 20, and 24.

FLIGHT ENGINEER TURBOJET TEST

1. Movement of the speed brake control should ordinarily actuate—

1—trailing edge flaps only.
2—all spoilers and slats simultaneously.
3—all flight spoilers simultaneously.
4—spoilers and ailerons differentially.

2. The anti-skid system is designed to reduce brake pressure if the wheel—

1—decelerates too rapidly.
2—skids sideways.
3—overspeeds.
4—gains heat too rapidly.

3. The slats or other hydraulically operated leading edge devices are normally extended when the—

1—speed brakes are raised.
2—trailing edge flaps are lowered to takeoff position.
3—spoilers are raised.
4—landing gear is lowered for landing.

4. The cabin pressure control setting has a direct influence upon the—

1—outflow valve opening.
2—turbocompressor speed.
3—cabin pressure relief valve setting.
4—bleed air supply system pressure.

5. The continuous loop fire detector system of a typical turbojet aircraft actuates when—

1—smoke is routed to a sight tube in the flight deck.
2—a bimetalic spring expands to make a ground in a detector unit.
3—heat causes sufficient current flow from the thermocouple units.
4—heat reduces the resistance of the insulation surrounding the wire.

6. The tank unit of a capacitance-type fuel level gauge is essentially a—

1—float-actuated variable condenser.
2—condenser with fuel acting as a dielectric.
3—float-actuated variable resistor.
4—capacitor with fuel acting as one plate.

7. What is a function of the generator constant-speed drive system?

1—Maintain a constant generator speed of 4,000 RPM at all engine speeds.
2—Maintain generator voltage within acceptable limits.
3—Make corrections for unbalanced loads of paralleled generators.
4—Automatically disconnect the generator from the engine if an overheat condition occurs.

8. Two alternating current generators must not be connected to the same bus unless—

1—they are operating in phase with each other.
2—a common constant-speed drive is employed.
3—each generator is producing exactly 400 cps.
4—they are both producing exactly 110 volts.

9. The speed of the fan in the forward-fan-type turbojet engine is determined by the—

1—high-pressure turbine speed.
2—high-pressure compressor speed.
3—final stage turbine speed.
4—compressor stator pitch-change mechanism.

10. Jet engine lubrication systems which utilize an air-oil cooler require a special system for ground cooling. The special ground cooling is provided by—

1—a fuel-oil cooler.
2—hot compressed bleed air ejectors.
3—turbofan ground blowers.
4—a pneumatic system air diverter valve.

11. When the engine is being stopped, the function of the pressurizing and dump valve is to—

1—maintain pressure in the fuel control to prevent vapor lock.
2—allow fuel in the manifold to drain.
3—open all bleed valves to dump compressor discharge pressure.
4—maintain pressure in all fuel lines up to the discharge nozzles.

12. How is reverse thrust generated on the turbojet engine during the landing roll?

1—By reversing the pitch of the compressor stator blades.
2—By diverting the exhaust gases forward outside the engine.
3—By reversing the flow of gases in the combustion chambers.
4—By blocking the exhaust gases to cause a reverse reaction force against the turbine blades.

13. What does the EPR gauge measure?

1—The ratio of compressor inlet air pressure to turbine discharge gas pressure.
2—The ratio of combustion chamber discharge gas pressure to compressor discharge gas pressure.
3—The ratio of combustion chamber discharge gas pressure to ambient air pressure.
4—The ratio of ambient air pressure to compressor discharge air pressure.

14. During normal crossfeed operation, when one tank runs dry, it is indicated by—

1—the booster pump operating light going out.
2—reduction of manifold fuel pressure.
3—drop of fuel flow for the engines involved.
4—illumination of the booster pump low pressure light.

15. A four-engine aircraft is performing according to the M .82 Operating Table, Figure 9, with the following conditions:

Gross Weight	238,000 lbs.
SAT	−50°C.
Time	8:45 a.m.

At what time should a change be made to a new power setting?

1— 9:17 a.m.
2—10:47 a.m.
3— 9:32 a.m.
4— 9:45 a.m.

16. During an unsuccessful starting attempt you observe the indications shown on the Engine Instrument Diagram, Figure 10. What is the most likely source of trouble in this event?

1—Malfunction of the engine ignition.
2—No fuel to the engine.
3—Low starter air pressure.
4—Electrical power failure to the EGT and EPR gauges.

17. Assume you have just finished making the following entries in the Flight Engineer's log:

Time	1130Z
Gross Weight	210,000 lbs.
Pressure Altitude	35,000 feet
TAS	485
Mach	.84
NM/1000 lbs.	34.2

After one hour of cruising at this rate, a descent to a landing will be started which you estimate will consume 1,200 lbs. of fuel. What will be the estimated gross weight at landing?

1—201,750 lbs.
2—195,800 lbs.
3—194,600 lbs.
4—193,350 lbs.

18. How can the rate of smoke removal be increased during pressurized flight?

1—Turn off one turbocompressor.
2—Increase cabin differential pressure.
3—Close the cabin air jet pump valves.
4—Increase cabin altitude.

19. What should be done in the event that a wing overheat warning indication occurs?

1—The fire extinguishing systems should be discharged into both nacelles on that side of the aircraft.
2—The pneumatic system in that wing should be shutoff automatically or manually.
3—The bleed air system of both engines on that side of the aircraft should be opened.
4—The cooling system for that wing should be turned on.

20. Compressor stall is caused by—

1—back flow of air from the combustion chambers.
2—insufficient fuel flow during acceleration.

OPERATING TABLE

M .82
29000 FT.

WGT	ITEM	TRUE STATIC AIR TEMP. —°C							STD. TEMP —42.5°C	
1000		—60	—55	—50	—45	—40	—35	—30	—25	—20
	MACH/RAT	.816/-35	.807/-30	.783/-26	.743/-22					
280	IAS/TAS	317/466	313/466	303/458	287/439					
	EPR/N1	2.57/93.4	2.52/93.5	2.48/93.5	2.45/93.5					
	N2/EGT	88.3/440	88.7/445	89.0/445	89.3/450					
270	FF/ENG	4120	3970	3800	3600					
	NM/1000	28.6	29.2	30.0	30.4					
	MACH/RAT	.816/-35	.816/-30	.801/-25	.774/-21	.728/-18				
270	IAS/TAS	317/466	317/472	311/468	299/458	280/435				
	EPR/N1	2.53/92.7	2.51/93.5	2.46/93.5	2.43/93.5	2.40/93.6				
	N2/EGT	87.9/430	88.8/445	89.2/450	89.5/450	89.6/450				
260	FF/ENG	4010	4000	3840	3660	3450				
	NM/1000	29.4	29.4	30.4	31.2	31.4				
	MACH/RAT	.816/-35	.816/-30	.812/-24	.793/-20	.762/-16	.710/-13			
260	IAS/TAS	317/466	317/472	316/475	308/469	294/455	273/429			
	EPR/N1	2.49/92.0	2.49/93.0	2.45/93.5	2.41/93.6	2.38/93.5	2.36/93.5			
	N2/EGT	87.5/425	88.6/440	89.2/450	89.6/450	89.8/455	89.9/455			
250	FF/ENG	3910	3930	3860	3700	3510	3300			
	NM/1000	30.1	30.2	30.6	31.6	32.4	32.4			
	MACH/RAT	.816/-35	.816/-30	.816/-24	.806/-19	.782/-15	.743/-12	.687/-9		
250	IAS/TAS	317/466	317/472	317/477	313/477	303/467	286/449	263/420		
	EPR/N1	2.45/91.3	2.45/92.4	2.45/93.4	2.40/93.6	2.36/93.5	2.33/93.4	2.31/93.4		
	N2/EGT	87.2/415	88.2/430	89.2/450	89.6/450	89.9/455	90.1/455	90.2/455		
240	FF/ENG	3810	3830	3860	3720	3540	3350	3140		
	NM/1000	30.9	31.0	31.1	31.9	32.9	33.4	33.3		
	MACH/RAT	.816/-35	.816/-30	.816/-24	.816/-18	.797/-14	.766/-10	.722/-7	.648/-6	
240	IAS/TAS	317/466	317/472	317/477	317/482	309/477	296/463	278/441	247/400	
	EPR/N1	2.41/90.7	2.41/91.8	2.41/92.8	2.40/93.5	2.35/93.5	2.31/93.4	2.28/93.3	2.28/93.3	
	N2/EGT	86.8/410	87.9/425	88.9/440	89.7/450	90.0/455	90.2/455	90.3/455	90.3/455	
230	FF/ENG	3720	3740	3770	3740	3570	3380	3190	2970	
	NM/1000	31.7	31.8	31.9	32.1	33.3	34.1	34.5	33.5	
	MACH/RAT	.816/-35	.816/-30	.816/-24	.816/-18	.807/-13	.782/-9	.745/-6	.701/-3	.632/-1
230	IAS/TAS	317/466	317/472	317/477	317/482	313/482	303/473	287/455	269/432	241/393
	EPR/N1	2.38/90.2	2.38/91.3	2.38/92.3	2.38/93.3	2.34/93.5	2.30/93.3	2.26/93.2	2.23/93.1	2.22/93.1
	N2/EGT	86.6/400	87.6/420	88.6/435	89.6/450	90.0/455	90.2/455	90.4/455	90.5/455	90.5/455
220	FF/ENG	3640	3670	3690	3710	3590	3400	3210	3030	2840
	NM/1000	32.4	32.5	32.6	32.7	33.5	34.6	35.3	35.6	34.6
	MACH/RAT	.816/-35	.816/-30	.816/-24	.816/-18	.813/-13	.794/-9	.765/-5	.724/-2	.681/-1
220	IAS/TAS	317/466	317/472	317/477	317/482	316/486	308/480	296/467	279/447	261/424
	EPR/N1	2.36/89.8	2.36/90.8	2.36/91.9	2.36/92.9	2.33/93.4	2.28/93.3	2.24/93.1	2.21/93.0	2.18/92.9
	N2/EGT	86.3/395	87.4/415	88.3/430	89.3/445	90.0/455	90.3/455	90.4/455	90.6/455	90.7/455
210	FF/ENG	3580	3600	3630	3640	3600	3420	3240	3050	2880
	NM/1000	32.9	33.0	33.2	33.3	33.7	35.0	35.9	36.5	36.7
	MACH/RAT	.816/-35	.816/-30	.816/-24	.816/-18	.816/-13	.801/-8	.776/-4	.743/-1	.704/-3
210	IAS/TAS	317/466	317/472	317/477	317/482	317/488	311/484	300/474	286/458	270/439
	EPR/N1	2.34/89.4	2.34/90.5	2.34/91.5	2.34/92.5	2.33/93.4	2.28/93.3	2.23/93.1	2.20/93.0	2.16/92.8
	N2/EGT	86.2/395	87.2/410	88.2/425	89.1/440	90.1/455	90.3/455	90.5/455	90.6/455	90.8/455
200	FF/ENG	3520	3550	3570	3590	3600	3430	3250	3070	2900
	NM/1000	33.4	33.5	33.7	33.8	34.1	35.2	36.3	37.1	37.7
	EPR INC		.08	.07	.06	.05	.05	.05	.04	.04

1. If anti-icing on, reduce EPR as follows: Engine & Nacelle —.05, Wing —.05.
2. When operating to left of heavy vertical line, set all engines to chart EPR.
3. When operating to right of heavy vertical line, increase EPR on non-turbo compressor engine(s) by value indicated at bottom of Temp. column.
4. Key to abbreviations: Mach — Mach Number; RAT — RAM Air Temperature °C; IAS — Indicated Airspeed; TAS — True Airspeed; EPR — Engine Pressure Ratio; N_1 and N_2 — Compressor RPM; ECT — Exhaust Gas Temperature °C; FF/Eng — Fuel Flow in Lbs. Per Engine; MM/1000 & Nautical Miles Per 1000 Lbs. of Fuel.

FIGURE 9. Turbojet Mach .82 Operating Table.

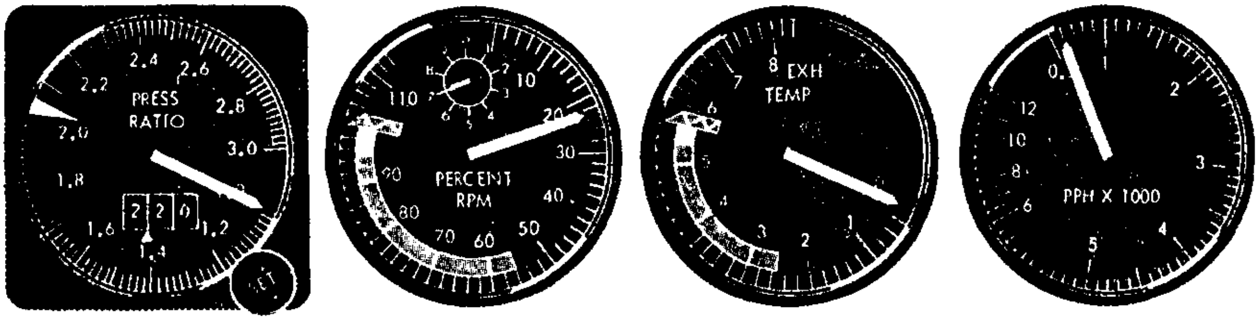


FIGURE 10. Turbojet Engine Instrument Diagram.

3—excessive angle of attack on the compressor blades.
4—excessive EPR for the particular RPM.

21. How is ignition accomplished during a windmilling start?

1—By turning the magneto switch to "Both."
2—By placing the ignition switch to "Air-start" or "Override."
3—By selecting "Windmilling Start" for the induction vibrator.
4—By the heat of compression from the windmilling engine.

22. In comparison to a straight wing of the same wing area, a swept wing has the advantage of—

1—a higher critical Mach number.
2—less tendency to "Dutch Roll."
3—greater wing loading.
4—less wing loading.

23. In the event of cabin decompression, the passenger oxygen masks are automatically dropped when the cabin altitude reaches approximately—

1— 8,000 ft.
2—10,000 ft.
3—12,000 ft.
4—14,000 ft.

24. Which is the preferred method of combating a brake fire on the ground?

1—Completely smother the gear with a foam extinguishing agent.
2—Keep the engine running to blow out the fire.
3—Use a dry chemical fire extinguisher.
4—Allow the tire to burst to blow out the fire.

25. Which of the following would be affected by a blockage or failure of the static pressure system?

A. Machmeter.
B. Cabin Pressure Controller.
C. Cabin Altimeter.
D. Static Air Temperature Indicator.

1—A & C
2—C & D
3—A & B
4—B & D

Applicants who desire to prepare for the Turbojet Class Written Test should also attempt to answer the following:

Reciprocating Engine Sample Test Items—3, 15, 17, and 21. Turboprop Sample Test Items—2, 3, 4, 5, 6, 7, 8, 14, 16, 17, 19, 21, and 23.

ANALYSIS OF ANSWERS TO
FLIGHT ENGINEER BASIC TEST

Area codes refer to the related study outline.

1—(4) Area A03

See Federal Aviation Regulation, Part 63, Section 63.13.

2—(3) Area C03

See Federal Aviation Regulation, Part 121, Section 121.221.

3—(3) Area D08

See Federal Aviation Regulation Part 121, Section 121.343.

4—(2) Area E07

See Federal Aviation Regulation Part 121, Section 121.453.

5—(4) Area E08

See Federal Aviation Regulation, Part 121, Section 121.471.

6—(1) Area A02

See Federal Aviation Regulation, Part 1, Section 1.2.

7—(1) Area J04

Enter chart at −15°C. and proceed upward to the diagonal 20,000 foot pressure altitude line. Read 21,000 feet horizontally to the left and 1.39 to the right. 250 kts. x 1.39 = 347 TAS.

8—(1) Area H02

Calibrated airspeed (CAS) is indicated airspeed (IAS) corrected for errors in the instrument mechanism and for errors of the pitot-static system. Static system errors vary with the location of the static vent and are affected by airspeed and angle of attack changes.

9—(4) Area I06

In a level coordinated turn the load supported by the wing must equal the weight of the airplane plus the centrifugal force caused by the turn. Load factor is this total load divided by the airplane weight. Centrifugal force in a coordinated turn is directly related to angle of bank.

10—(3) Area J13

The speed of sound in the atmosphere is solely a function of temperature and varies in the same direction as the temperature.

11—(4) Area J10

Standard temperature lapse rate is 2°C. per 1,000 ft. 22° − 4° = 18°C. above icing temperature; 18° ÷ 2° = 9; 1,000 ft. x 9 = 9,000 ft.; 9,000 ft. @ 750 ft./min. = 12 minutes.

12—(4) Area J07

Water vapor takes the place of air in any given volume and makes the air less dense. Engine power is directly affected by air density. This effect is more noticeable on reciprocating engines than on turbine engines.

13—(4) Area K06

Original C.G. = 173 x .23 = 39.79 + 441 = 480.79. Distance weight added from original C.G. = 760.00 − 480.79 = 279.21.

$$\text{Change of C.G.} = \frac{\text{Weight x Distance from Old C.G.}}{\text{New Gross Weight}}$$

$$\text{Change of C.G.} = \frac{5{,}000 \times 279.21}{108{,}000} = 12.92$$

New C.G. = 39.79 + 12.92 = 52.71 (aft of LEMAC); C.G. % MAC = 52.71 ÷ 173 = 30.5% MAC.

14—(2) Area K10

Original C.G. = 190 x .30 = 57.0 + 420 = 477.0
Aft limit = 190 x .33 = 62.7 + 420 = 482.7
Distance weight moved = 875 − 240 = 635

$$\text{Change of C.G.} = \frac{\text{Weight Moved x Distance Moved}}{\text{Gross Weight}}$$

$$\text{Change of C.G.} = \frac{1{,}200 \times 635}{110{,}000} = 6.93$$

New C.G. = 477 + 6.93 = 483.93
Distance C.G. is aft of aft limit = 483.93 − 482.7 = 1.23″.

15—(3) Area K04

$$\text{Empty Weight Index} = \frac{405 \times 80{,}000}{10{,}000} = 3240.0$$

Item	*Weight*	*Index Unit*
Empty Weight	80,000	3240.0
Fuel	18,000	572.0
Oil	900	17.6
Crew	800	12.3
Passengers	4,800	241.9
	104,500	4083.8

C.G. = (4083.8 x 10,000) ÷ 104,500 = 390.8″ aft of datum.

16—(4) Area H08

The fixed slot in a wing conducts a flow of high-energy air into the boundary layer on the upper wing surface and delays airflow separation to some higher angle of attack.

17—(4) Area A07

See Federal Aviation Regulation, Part 63, Section 63.33.

18—(2) Area H05

The airplane stalls at the same angle of attack regardless of weight or air density for a given flap setting. However, the stall speed of the airplane is affected by these and many other factors.

19—(2) Area I04

The speed required to obtain maximum range performance increases in a headwind and decreases in a tailwind. The speeds required to obtain maximum endurance, maximum rate of climb, or maximum angle of climb are unaffected by wind.

20—(1) Area K13

The center of gravity limits for 112,500 lbs., as indicated on the chart are 16.7% and 29.0% MAC., 29.0 −16.7 = 12.3% or .123., .123 x 175 inches = 21.6 inches.

ANALYSIS OF ANSWERS TO FLIGHT ENGINEER RECIPROCATING ENGINE TEST

Area codes refer to the related study outline.

1—(4) Area C02

A thermocouple circuit consists of a hot junction (detector) of two dissimilar metals connected by dissimilar metal leads to a cold junction (warning relay). The difference in temperature between the hot and cold junctions produces a proportionate current flow because of the dissimilar atomic structure of the metals.

2—(3) Area H03

An engine equipped with a *pressure-injection carburetor* is started with fuel supplied from the primer. Any mixture position other than idle cutoff will lead to flooding of the induction system.

3—(4) Area A07

The lockout cylinder is located in the brake line between the brake control valve and the wheel cylinder. If the brake line fails below the lockout cylinder, fluid and pressure in the line above the lockout cylinder will not escape through the leak.

4—(4) Area A14

The bypass valve provides a path for fuel through the pump when the pump is not in operation. This allows the booster pump to supply fuel to the carburetor before the engine has started or when the fuel pump drive shaft has failed.

5—(3) Area H06

When several cylinders are not firing, the engine input indications (MAP and F/F) will be normal while the output indications (BMEP and RPM) will be below normal. These dead cylinders are receiving the proper fuel and air but are not producing power.

6—(3) Area G02

When the feathering button is depressed, the blade angle will change toward a higher pitch. If the propeller is in reverse pitch, the RPM will increase as the blade angle approaches flat pitch.

7—(3) Area D03

The cabin pressure controller diagram indicates that the cabin pressure is set for sea level. The performance chart shows that a differential pressure of 2.5 psi will provide a sea level cabin altitude when the flight altitude is 5,000 feet.

8—(1) Area K04

The flight engineer should advise the pilot-in-command immediately and then comply with his orders. Ordinarily the pilot-in-command will make the decision to shut down the engine.

9—(2) Area F08

The left pump supplies the rear row of cylinders, the right pump supplies the front row. A lean mixture will cause high temperatures at climb power but low temperatures at manual lean cruise power.

10—(3) Area H09

As the ignition timing is changed to an advanced setting, the analyzer pattern will shift toward the beginning of the trace at the left side of the scope. Power and BMEP is improved because the early timing is more correct for the relatively slow burning lean cruise mixture.

11—(1) Area I11

$$PD = \frac{\pi}{4} D^2LN$$

PD=.7854 x 5.875 x 5.875 x 5.875 x 18

PD=2866.7 or 2870

12—(3) Area I10

$$BHP = \frac{BMEP \times RPM}{K}$$

$$BHP = \frac{150 \times 2{,}100}{166}$$

BHP=1897.6 or 1898

13—(4) Area I06

Weight	*Fuel Used*	*Fuel Flow*	*Time Used*	*Clock Time*
96,000–95,000	1000	555	:27	1:15–1:42
95,000–90,000	5000	510	2:27	1:42–4:09
90,000–88,870	1130	470	:36	4:09–4:45

14—(3) Area J18
Residual voltage is that low voltage generated by the permanent magnets of the field coils. If the electrical circuit of the field is open, the generator voltage cannot be increased above this low level. A residual voltage output is not sufficient to close the reverse current relay points and therefore there can be no current flow at the ammeter.

15—(4) Area B15
When a relatively high air pressure is sensed by the altimeter, it indicates a relatively low altitude. The airspeed indicator measures the difference between pitot and static pressure. A relatively high static pressure decreases the differential and causes the airspeed indicator to read low.

16—(3) Area E01
B and C are correct. These engines have two throw crankshafts and only sixteen knuckle pins for the sixteen articulated connecting rods. The two master rod cylinders do not require articulated connecting rods or knuckle pins.

17—(1) Area A03
Volume output is controlled by either varying the angle of the wobble plate, or by varying the control unit which opens or closes ports along the pump plungers. Either method results in varying the effective stroke of the plungers and is accomplished by a pressure-sensitive mechanism.

18—(2) Area B09

Radio receivers	1 KW	= 1,000 watts
Air conditioning	220 amps x 30=	6,600 watts
Galley equipment	5 KW	= 5,000 watts
Essential pumps	100 amps x 30=	3,000 watts
Lighting	90 amps x 30=	2,700 watts
Other electrical equipment	350 amps x 30=	10,500 watts
TOTAL		28,800 watts

3 generator rated power 3 x 350 x 30=31,500
31,500 −28,800=2,700 watts

19—(2) Area B11
A rotary inverter consists of a DC motor and an AC generator on a common shaft. The speed and therefore frequency of the AC generator is determined by the DC motor speed.

20—(4) Area A17
Standpipes or similar devices are used in the main tanks—those used for takeoff and landing. These devices are designed to prevent jettisoning fuel below the level which provides 45 minutes of flight at 75% of maximum continuous power. See FAR 25.1001

21—(3) Area D08
The turbine of the cooling unit is rotated by air from the cabin pressurization source. In reciprocating engine airplanes this source is the engine-driven cabin supercharger.

22—(3) Area E07
Return oil enters the hopper in the oil tank and tends to return directly to the engine without mixing with the cold oil in the tank. This action accelerates the heating of the oil which is being used in the engine.

23—(4) Area F03
When the ignition switch wire is grounded, the magneto is off. When the wire is open, the magneto is on. A normal drop of 7 BMEP is noted in the "Left" position where the right magneto is shut off. An indication of no BMEP drop in the "Right" position shows that the left magneto is on and therefore it's switch wire is open.

24—(3) Area K07
The retard (takeoff) spark advance position should be used for all operations except lean cruising. The mixture is kept in idle cutoff until the engine is rotated and then placed in rich for starting. The propeller control should be placed in decrease RPM to guard against a runaway propeller. The throttle should be set to forward idle position.

25—(2) Area J13
45 minutes at 1,400 fuel flow x 4 engines=4,200 lbs. fuel used in climb.
100,000 lbs. −4,200 lbs.=95,800 lbs.
95,800 lbs. −85,000 lbs.=10,800 lbs. to dump.
10,800 lbs. at 3,600 lbs./min.=3.0 min.

ANALYSIS OF ANSWERS TO FLIGHT ENGINEER TURBOPROP TEST

Area codes refer to the related study outline.

1—(2) Area A11
The control surface moves opposite to the tab. The airplane is rotated on its axis opposite to the control surface or in the same direction as the tab.

2—(1) Area F06
Air pressure is used to turn the starter turbine which is connected to the engine. The air pressure may be obtained from an external ground air source or from an operating engine. The starter switch circuit opens the valve in the pneumatic line which admits air to the starter turbine.

3—(4) Area B02
The transformer-rectifier reduces the 115 volt AC input to 28 volts AC by transformer action. The AC is then changed to DC by the use of rectifiers. The 28 volts DC is then routed to various DC units including the essential DC bus.

4—(1) Area D10
High-pressure air from the cabin compressor is used in the air cycle machine to drive a high-speed turbine. The air expands during this process and therefore loses heat. In effect, heat energy of the air is converted into mechanical energy of the turbine. The turbine in turn rotates a compressor to force the air through a heat exchanger.

5—(4) Area C06
It is imperative that flight crewmembers not be incapacitated by the inhalation of smoke during emergencies. Emergency procedures require the use of protective breathing equipment at these times. When the 100% oxygen position of the oxygen control is selected, entrance of flight deck air (or smoke) into the oxygen mask is prevented.

6—(1) Area A17
The pilot valve contains a float-operated mechanism which controls a pressure-sensing line connected to a fuel shutoff valve. When the fuel level reaches a particular preset point the float mechanism causes a reaction in the sensing line which signals the shutoff valve to close.

7—(1) Area B09
Alternative number 1 is correct. The current in the rotating field is DC. Air cooling is required on all generators regardless of the use of brushes.

8—(3) Area B15
Inductive Reactance $= 2\pi$ x Frequency (CPS) x Inductance (Henrys)

$$= 2 \times 3.1416 \times 400 \times .75$$
$$= 1884.9 \text{ or } 1885$$

9—(2) Area E02
The interstage bleed valves are held open by a speed-sensitive device at low speeds. These valves provide an exit for some of the air and therefore unload the compressor. Thus stall and surge are prevented—especially during engine start, acceleration, and low-speed taxi.

10—(4) Area K05
Low airflow because of an open bleed valve produces low power and fuel flow. Misrigged power lever would also affect turbine inlet temperature. Torquemeter malfunction would affect only the horsepower indication. Damaged turbine normally results in high fuel flow.

11—(1) Area H10
The use of compressor hot air for engine anti-icing may cause as much as a 10% reduction of horsepower. In addition to other useful indications, this change of horsepower is an important factor to observe when shifting the anti-icing on or off.

12—(2) Area G02
During normal flight operation the blade angle is controlled by the propeller governor to maintain a certain engine RPM. In BETA, or ground operation range, the blade angle follows power lever setting for both forward and reverse pitch.

13—(4) Area G06
A synchronizer system adjusts the blade of each propeller to obtain a speed the same as a chosen master engine speed. A phase synchronization system goes even further and causes each propeller to arrive at pre-selected points in their rotary movement at exactly the same instant. The RPM of each engine must be identical to satisfy and maintain this condition.

14—(3) Area J10
If the manual temperature control is held in the DECR position too long, the temperature programmer will move to an excessively cold position. Placing the control back to AUTO may cause the original trouble to return. Answer number 3 is correct but may need to be repeated after waiting for results.

15—(4) Area G07
The automatic drag limiting system causes the propeller blade angle to increase. This action will take place when there is a negative torque greater than a certain value during flight. A windmilling propeller on a turboprop engine must be controlled quickly because of the excessive drag which is produced.

16—(2) Area L02
Speed in ft./sec. x .5925=Speed in knots
1,000 ft./sec. x .5925=592.5 knots
TAS÷speed of sound=Mach number
350 knots÷592.5 knots=Mach .59

17—(3) Area D06
18,000 ft. @ 750 ft./min.=24 min.
6,000 ft. (8,000 −2,000) in 24 min.=250 ft./min.

18—(1) Area I11
Enter the Mach number part of the chart at 5,000 ft. pressure altitude, proceed to 125 knots CAS, Zero° C., 5,000 ft., and 3,540 horsepower.

19—(3) Area J05
When the flaps become split, the asymmetry system on most aircraft deactivates the flap-operating system. The aircraft can be trimmed laterally by alternate flaps on some systems and by aileron trim on others. The flaps should not be raised or lowered.

20—(1) Area C01
The perforated ice detector probe ordinarily admits ram air to a pressure-operated switch. When the holes in the probe are iced over, the pressure to the switch is reduced and circuits are energized which illuminate a warning light. The probe is equipped with a heater which melts the ice after the warning light is on. The alternate freezing and melting causes the warning light to flash on intermittently during flight in icing conditions.

21—(3) Area A04
Hydraulic fluid will not enter the fluid side of the accumulator unless the hydraulic pressure is greater than the air charge. At all fluid pressures above the air charge, the air will be compressed to the same pressure as the fluid.

22—(4) Area H02
In ground operation range, blade angle is a direct function of power lever position. The power lever should be set so that the propeller is placed in the blade angle where it will offer the least resistance to the turning efforts of the starter.

23—(1) Area A16
When the test switch is operated, the fuel quantity gauge needle will rotate toward the zero position. When the switch is released, the needle will return to its original setting. This check is accomplished to detect sticking gauges or those which have had a power failure.

24—(1) Area D07
Cabin pressure is controlled by means of the outflow valve. If the cabin is climbing too fast, the outflow valve must be allowing too much air to escape. The outflow valve is gradually closed in a climb, therefore in this case the rate of closing must be increased.

25—(3) Area J18
If there is an electrical failure at a bus, it is not safe for any generator to feed that bus. If the generator or the feeder system has failed, it is safe for the electrical loads to be fed by or transferred to another generator. Automatic circuits ordinarily detect these faults and make the proper transfer or bus isolation, whichever is required.

ANALYSIS OF ANSWERS TO FLIGHT ENGINEER TURBOJET TEST

1—(3) Area A11
The speed brake makes use of the flight spoilers, all move upward as speed brake is applied. Movement of the speed brake handle does not affect ailerons, slots, or flaps.

2—(1) Area A07
Once the wheel has come up to speed during a landing, any unusual deceleration is an indication of an impending skid. The anti-skid system senses the deceleration and causes a corrective action by releasing brake pressure before the skid occurs.

3—(2) Area A09
Leading edge devices such as slots, slats, and flaps are extended for takeoff and landing through movement of the trailing edge flap control system.

4—(1) Area D05
Control of cabin pressurization is accomplished by metering the quantity of air which escapes from the cabin through the outflow valve. The cabin pressure control has no direct effect upon pressurization input devices or upon relief valves.

5—(4) Area C02
The insulation has a negative coefficient of resistance. When the temperature rises to a critical value, the lowered resistance of the insulation allows current to flow to a circuit which actuates the fire warning.

6—(2) Area A16
The tank unit consists of two concentric tubes which are plates of a condenser. Fuel in the tank has access to the fixed space between the tubes and acts as an insulation or dielectric. The capacitance of the tank unit is directly proportional to the level and density of the fuel. Capacitance of the units in the tank is translated into fuel quantity by the quantity gauge system.

7—(3) Area B12
The constant-speed drive primarily maintains a 6,000 RPM generator speed which in turn results in a frequency of 400 cps. The CSD also makes momentary and minor changes in the speed to balance the electrical loads assumed by each generator in parallel operation.

8—(1) Area B10
If the two generators are not operating at the same phase angle, one may be overloaded to the point of mechanical drive failure when they are applied to a common bus. Voltage and frequency requirements are not exact, there are reasonable tolerances. Each generator has its own CSD.

9—(3) Area E05
The fan is an extension of the forward or low-pressure compressor. This part of the engine is driven by the final or low-pressure turbine stage. The fan speed is therefore identical with the final turbine stage speed.

10—(2) Area E06
Engine bleed air is ejected immediately behind the oil cooler for ground operation. This hot air flow does not enter the cooler but it serves to augment cooling by pulling outside air through the oil cooler.

11—(2) Area F02
This valve controls the engine fuel manifold drain. During engine start the valve closes the manifold drain and allows fuel to flow to the engine. At shutdown the valve permits the fuel in the manifold to drain.

12—(2) Area F08
The thrust reverser normally incorporates clam shell doors which block the exhaust gases. The exhaust gases escape out the sides or top and bottom of the tail pipe and are deflected forward at an angle by vanes or doors.

13—(1) Area F11
The EPR gauge indicates the engine pressure ratio as a measure of the thrust being developed by the engine. This is a ratio of the turbine discharge total pressure to the equivalent of the compressor inlet total pressure.

14—(4) Area H13
In crossfeed operation, fuel flow and pressure in the manifold and at the engine would remain normal. The light associated with the fuel pump is normally a "Low Pressure" light rather than a "Normal Operation" light.

15—(1) Area I03
Obtain fuel flow on chart at intersection of 240–230 (x1,000) wgt. and −50°C. SAT=3770 ff/eng.
8,000 lbs. @ 3770 ff/eng.=32 minutes
8:45 a.m.+ :32 minutes=9:17 a.m.

16—(1) Area H04
Normal fuel flow is indicated. Low air pressure would be indicated by slow acceleration but with combustion and probable high EGT. If ignition does not occur, the starter cannot accelerate the engine above approximately 23%. It is improbable that there is a multiple gauge failure.

17—(3) Area I13
485 mi.÷34.2 specific range=14,200 lbs. consumed in cruise
14,200+1,200=15,400 lbs. total consumed
210,000 −15,400=194,600 landing weight.

18—(4) Area J15
The rate of smoke removal can be increased by opening the outflow valve or using additional cabin air outlets. This is done when the cabin altitude is raised. It is desirable to continue operation of the turbo-compressors, unless they are the source of smoke, to promote a high degree of air flow which will carry the smoke overboard.

19—(2) Area D14
An overheat warning for a wing area is an indication of a leaking duct or other types of pneumatic system failure. Alternative answers 1, 3, and 4 will not remove the source of hot air.

20—(3) Area E02
Compressor blades are shaped similar to the airfoil sections of wings or propeller blades. The compressor blade will stall at a particular high angle of attack just as any other airfoil.

21—(2) Area K07
A turbojet engine does not have a magneto or an induction vibrator included in its accessory equipment. The temperature rise due to compression is not sufficient to ignite fuel for a windmilling start. The igniter system must be activated by selection of an inflight start position of the switch.

22—(1) Area L03
The sweep of a wing has the effect of increasing the speed at which supersonic airflow begins, this is the Critical Mach Number. Swept wings have a greater tendency to cause "Dutch Roll." Wings with identical wing areas would have the same wing loading assuming constant aircraft weight.

23—(4) Area C07
A cabin altitude-sensing device opens a valve in the passenger oxygen system at approximately 14,000 feet cabin altitude. When the valve opens, oxygen is permitted to flow from the bottles into the passenger oxygen system. This oxygen pressure is used to actuate a mechanism which trips open the oxygen mask containers.

24—(3) Area J16
The use of a dry chemical extinguisher is considered the preferred method. There is danger of the wheel shattering if other agents are used, this could cause severe damage to the airplane or injuries to nearby personnel. Engine operation or a tire burst would have no effect on the fire.

25—(3) Area A13
The Machmeter is essentially an airspeed indicator and must sense static pressure. The cabin pressure controller must sense ambient air pressure through the static system. The cabin altimeter measures only internal cabin pressure. The Static Air Temperature Indicator has its own temperature probe.

PREPARATION FOR THE PRACTICAL TEST

After you take your Flight Engineer Written Test, you will receive a report of your grade on AC Form 8060–37. The sample report illustrated in Figure 11 indicates the results of a Flight Engineer-Turbojet Written Test taken by Richard C. Roe. The report indicates that Mr. Roe passed a Flight Engineer-Turbojet Written Test which he took on August 25, 1967. The expiration date indicates that he may use the AC Form 8060–37 until the end of August 1969 to apply for the Practical Test. If he does not make use of the AC Form 8060–37 in that time period, he will have to take and pass another written test prior to applying for the Practical Test.

The lower section of the AC Form 8060–37 indicates the subject matter areas on which Mr. Roe missed particular test questions. He may have missed more than one question on any one of the areas indicated. This group of codes can be compared to the outline which Mr. Roe received with his AC Form 8060–37 or the outline on page 13 of this study guide to determine the related subjects. If Mr. Roe had failed the test it would have been advisable for him to do extra study on the subjects related to these codes before applying for retesting. Although Mr. Roe has proven by this passing grade that he meets the minimum aeronautical knowledge requirements of FAR 63.35, he would be wise to review the subject areas where weakness is indicated before he applies for his Practical Test.

Information concerning application for your Practical Test can be obtained at any FAA Flight Standards District Office. Generally, you must have made arrangements for the use of an airplane of the class for which you are seeking a rating. The airplane must be made available, along with the required crew, for the ground and flight test portions of your Practical Test.

As indicated in FAR 63.39, you must be able to show:

(1) That you can satisfactorily perform preflight inspection, servicing, starting, pre-takeoff, and post landing procedures;

(2) Inflight, that you can satisfactorily perform the normal duties and procedures relating to the airplane, airplane engines, propellers (if appropriate), systems and appliances; and

(3) Inflight, in an airplane simulator, or in an approved flight engineer training device, show that you can satisfactorily perform emergency duties and procedures and recognize and take appropriate action for malfunctions of the airplane, engines, propellers (if appropriate), systems and appliances.

DO NOT DESTROY THIS FORM
This form must be presented for reexamination or certification.

DEPARTMENT OF TRANSPORTATION – FEDERAL AVIATION ADMINISTRATION
AIRMAN WRITTEN EXAMINATION REPORT

SSN 999-90-1234

EXAMINATION		GRADES BY SECTION							FAA OFFICE NO.	EXAMINATION DATE	EXPIRATION DATE	PREVIOUS SERIES
NO.	TITLE 1/	1	2	3	4	5	6	7				
15	FEJ	85							EA39	08-25-67	08-31-69	
EXPIRATION DATE (Last day of month)												

1/ See codes on reverse side:

RICHARD C. ROE
127 MAPLE STREET
HOMETOWN, OKLAHOMA 73140

MECHANICS ONLY – EXPIRATION DATE CODES

The first character designates the month; the second and third characters, the year. January through September as shown by numbers 1 through 9; October as "O"; November as "N"; December as "D".

EXAMPLES

5 65 D 65
Month (May)
Year (1965)
Month (December)
Year (1965)

ISSUED BY: ADMINISTRATOR
FEDERAL AVIATION ADMINISTRATION

AC FORM 8060-37 (4-67) SUPERSEDES PREVIOUS EDITION

NOTE: TO FIND THE QUESTIONS YOU MISSED ON THE EXAMINATION (BY KNOWLEDGE AREAS), COMPARE THE CODES SHOWN BELOW WITH THE CODED ITEMS ON THE ENCLOSED SUBJECT MATTER OUTLINE.

SECTION	SUBJECT MATTER CODES
1	A07, A16, B12, C07, E06, F08, I07, J16, L03

FIGURE 11. Airman Written Examination Report

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