Deliverable Number: PD010

Title: Recommendations for UAS Crew Ratings

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Abstract:
This position paper is intended to recommend the minimum certificate and rating requirements for a pilot to operate an Unmanned Aircraft System (UAS) in the National Airspace System. The paper will recommend the minimum requirements based on the Knowledge, Skills, and Abilities (KSA) required of a UAS pilot and show how those compare to the KSAs required by regulation for manned-aircraft pilots. The paper will provide substantiation based on studies conducted using analyses, simulation and flight experience. The paper is not yet complete; only initial working material is included. The material provided describes the body of work completed thus far and the plan for remaining tasks to complete the recommendation.

The HSI Pilot KSA document provides an analysis of the knowledge, skills, and abilities required for UAS operation in the NAS. It is the source document used for the position paper.

Status:

WP – Work in Progress
Draft

Limitations on use:
The position paper consists of internal working memoranda of Access 5 and has not been subjected to a formal review process. Access 5 makes no claims for the validity of this information. The HSI Pilot KSA document has been reviewed, and represents a substantially complete analysis. Updates may be needed depending on the results of additional analyses, simulations, and flight tests. These documents lay the groundwork for the process that should follow to substantiate a pilot rating recommendation for UAS.
Statement of Question/Issue:
The qualifications required for pilots operating Unmanned Aircraft System(s) (UAS) have not been defined. Establishment of pilot qualification is required before pilots will be allowed to operate UAS routinely in the National Airspace System (NAS).

Discussion:
Background
Pilots who act as pilot-in-command of an aircraft in the NAS must meet qualification standards described in 14 CFR § 61. Practical Test Standards, issued as Advisory Circulars which support 14 CFR § 61, further detail the knowledge, skills, and abilities that pilot applicants must demonstrate in written and practical tests prior to receiving the required ratings. These rating criteria are well established for manned-aircraft categories and classes, but similar ratings for UAS have not been defined.

Access 5 has been following a process to establish a UAS pilot rating recommendation, as described below.

Access 5 Plan to Validate the Pilot Rating Recommendation

The Access 5 Policy IPT believes that a multi-step process will be required in order to validate the requirements for UAS pilot qualifications. The seven-step process that Access 5 is planning to follow is detailed below. Steps 1. and 2. were completed in CY 2005. The follow-on plan was to complete the remaining steps within one year and then issue a proposal for UAS pilot qualifications.

1. KSA Analysis
   Access 5 studied and documented the pilot Knowledge, Skills and Abilities (KSA) typically expected during operation of a low-autonomy UAS (reference HSI004_Pilot KSA_v2). It drew on the experience of several UAS pilots and referenced a number of military and FAA documents, identifying specific required KSAs by phase of operation, from preflight, through all phases of a ferry scenario, through postflight after landing and shutdown. The complete study provides a fairly detailed basis for analysis of UAS pilot skills and comparison of those skills with existing manned requirements. After review and discussion about the document, we decided to add to the study the specific operational phase representing mission operations – the long-term “loiter” at high altitude inherent in UAS applications – at a high level of autonomy anticipated for equipment operating at high altitudes for long durations. The complete study provided a fairly detailed basis
for analysis of UAS pilot skills and comparison of those skills with existing manned requirements, item 2 below.

After reviewing the required KSAs for UAS, Access 5 concluded that a reasonable starting point for a minimum manned-aircraft rating for a HALE UAS pilot would be a Private Pilot License with an Instrument Rating. One of the reasons for this conclusion was that this license and rating can provide an entry level for UAS pilots under the current regulatory structure.

2. Comparison of KSA Analysis with Manned Aircraft Regulations

The UAS KSA document was developed for the purpose of identifying all knowledge, skills, and abilities essential to a UAS pilot in performance of a typical mission. By comparing the KSAs of the UAS pilot with the KSAs required of certificated FAA pilots, any excess or deficient training and proficiency of a manned aircraft pilot relative to a UAS pilot should be readily identifiable.

In order to accomplish this comparison, Access 5 broke out the manned aircraft pilot requirements for a Private Pilot with Instrument Rating, since this was a logical starting point for HALE UAS IFR operations, as described above. The manned aircraft regulation that specifies pilot qualifications is 14 CFR 61. Greater detail of expected KSAs is provided in the Practical Test Standards (PTS) that are issued to describe the minimum standards for obtaining a certificate or rating in a practical test. The KSAs derived from the HSI document were compared against the requirements contained within 14 CFR 61 and the associated PTS, starting with requirements for Private Pilot and Instrument Rating.

Access 5 considered whether a separate UA rating should be required for UA pilots. The benefits of a separate UA rating would be as follows:

- UA pilots wouldn’t have to meet manned-aircraft currency requirements.
- Manned aircraft training which has no direct correlation to UA pilot skills could be eliminated (such as Ground Reference Maneuvers).
- The stick-and-rudder skills required for manned-aircraft training may not be directly transferable to most UAS anyway.

The impacts of a separate UA rating would be as follows:

- 14 CFR 61 would have to be rewritten.
- Standards for UA pilot rating would have to be developed.
- Manufacturers and operators may have more difficulty hiring or training qualified UA pilots.

As a result of the comparison of the KSA study with 14 CFR 61, Access 5 believes that there are not sufficient gaps that would require a separate pilot rating for Unmanned Aircraft. However, it may be necessary to develop some documentation of the extra training required of a manned-aircraft pilot transitioning to UA such as a UAS CFI sign-off.

Another conclusion that Access 5 drew from the comparison of the KSA study to 14 CFR 61 is that, although there is some training that does not transfer from the manned-aircraft realm to UA, there is not a huge excess of such training in the requirements for a Private Pilot with an Instrument Rating.

Therefore, one conclusion drawn by Access 5 from this study is that a Private/Instrument rated pilot, given sufficient training on the differences in operation between manned aircraft and the UAS which the pilot wants to operate, should equate to a qualified UAS pilot. No conclusions were drawn about what the training would consist of (whether academics, simulation, flight experience, or all three). This training would have to be designed based on an examination of the gaps in training identified by comparing the KSA study to the knowledge and skills achieved through 14 CFR 61 training.
The question may arise as to how safe the UAS pilot is to operate in the Class A environment with only the limited experience provided by the Private Pilot with Instrument rating coupled with UAS-specific training. While the question of competence due to lack of experience is legitimate, the fact is that the same pilot is qualified to operate a manned aircraft in Class A airspace with the same lack of experience. As such, this becomes a standards issue rather than a manned-aircraft versus UAS issue.

The analysis completed so far by Access 5 has not addressed the issue of whether UAS should be in a separate class of aircraft. In order to perform that analysis, Access 5 would need to develop a list of differences between manned aircraft and UAS and compare those differences with the differences in classes of manned aircraft and determine whether the differences in UAS were sufficient to justify a new class. For instance, it might make sense to have a Private Pilot, Single-Engine Land UAS certificate. Access 5 would have to develop substantiation for this new class before recommending it. The same process would apply to whether UAS should require a type rating to account for individual UAS differences.

As a result of the work completed thus far, Access 5 believes that a Private Pilot certificate with an Instrument rating, coupled with UAS-specific training, provides sufficient qualification for a pilot to operate a HALE UAS in the NAS. Further evaluation needs to be accomplished to determine the training required to qualify a UAS pilot independent of existing pilot qualifications, in particular for non-HALE UAS. Access 5 also believes that the Private Pilot/Instrument with additional UAS training recommendation must be validated before a final recommendation on pilot rating can be made. The Access 5 plan for completing this testing is presented in the next section.

3. Survey of UAS Pilot Qualification Current Practice
   The Access 5 will conduct a survey of pilot qualifications in current UAS to gain further insight into the training and proficiency required for operating UAS. The survey will include the HALE UAS manufacturers that are part of UNITE and other foreign and governmental entities with experience in HALE operations. The survey will gather data on the hiring, training, and currency requirements for each operation. The survey will also examine accident and mishap reports in an effort to determine if training or experience was a factor. This survey will capture present practice in UAS operations. This survey will be done with a recognition that current HALE UAS experience is limited to military and research operations.

   The information to be gleaned from this survey would include the following:
   - What are the minimum flying experience requirements, and how were those developed?
   - What data was used for substantiation of the requirements?
   - What additional training is required of pilots immediately after hiring/assignment.
   - What are the requirements for the pilots to maintain proficiency?
   - Mishap analysis as relates to training and experience.

   Some of the information required may already be available and should be identified concurrently with step 7.

4. Simulation
   Access 5 will perform UAS pilot KSA simulations that will focus on validating UAS unique skills/abilities identified in the KSA analysis. In addition, the task synergy and more realistic task execution timing provided in simulation will assist in identifying any additional, UAS unique, KSA requirements.

   The simulations will consist of both scripted, partial flight scenarios designed to isolate selected KSA(s), and multi-flight phase IFR scenarios to look for task synergy issues and some indications of workload-related issues. The scripted scenarios could be accomplished on partial or full-capability control station simulators using a mix of minimally-qualified to highly-experienced UAS pilots, and prerecorded and/or staged external inputs (ATC interaction, aircraft
performance/response, etc.). The control station simulations will not necessarily be representative of an existing UAS, since the focus is on the pilot KSAs, and not on a specific man-machine interface. The multi-flight phase scenarios will be conducted using full-capability control station simulators using a similar mix of minimally-qualified to highly-experienced UAS pilots, and real-time or near-real time external inputs, including realistic ATC interactions and a selected set of normal and abnormal/emergency UA performance/response. The multi-flight phase simulations should be minimally scripted to expose the dynamics of real-world operations.

The results of the simulations will provide data to validate UAS pilot KSAs and the minimum UAS pilot certificate/rating recommendation. The simulations will also assist in identifying specific KSAs and flight scenarios for flight demonstrations.

The simulations may also be used to validate the unique aspects of class or type difference requirements. In order for this validation to occur, a list will need to be developed that identifies the expected unique characteristics of UAS. The extent of the simulations will depend on the number and type of unique characteristics identified in order to establish a statistically valid sample.

2. Flight Demonstrations
The actual flight environment provides unique situation/aircraft dynamics that can be difficult to accurately capture/portray with simulations. Data from actual flights of UAS, or optionally-piloted vehicles (OPV) in their UAS mode, will be used to demonstrate specific UAS pilot KSAs that could not be adequately addressed in the simulations and to provide a limited validation of the simulations.

The flight data will be obtained from UAS or OPV flights dedicated to obtaining KSA/scenario data or from other non-dedicated UAS flights such as operational missions. Some of the flight data could be historical and not from current operations. At a minimum, flight data should be obtained for each flight phase where UAS-unique pilot KSAs have been identified, with a special emphasis in flight phases where the UAS pilot KSAs differ significantly from manned aircraft pilot KSAs. Identification of significant differences in this case could justify a different UAS pilot certificate/rating than manned aircraft.

The flight environment is more complex than can be practically simulated. Therefore, it is critical prior to flight to establish specific points of interest that can be used as “spot checks” to validate simulation that has been or will be performed.

3. Operational Analysis
In the aviation sector, the Operational Analysis (OA) is a safety risk assessment technique that focuses on operations carried out by the pilot (operator) during established phases of flight. Each phase of flight becomes an operation to be decomposed into a hierarchy of expected pilot behavior. For Access 5, this hierarchy of expected pilot behavior is to be provided through the development of the HALE UAS pilot Knowledge, Skill and Ability (KSA) requirements applicable to a pilot located in a pseudo-cockpit, i.e.; a Ground Control Station (GCS). This effort will identify the major tasks and subtasks the pilot is expected to perform during a given phase of flight.

Given this set of behavior for each flight operation, the OA risk assessment process can identify the level of risk based on the set of hazards the pilot may encounter, as well as the accompanying set of potential events the pilot may have to respond to during a given phase of flight. While it is the intent for the UAS to avoid hazards while operating in the NAS, the reality is that an encounter may occur that places additional behavioral demands on the pilot. For higher level risks, the behavior may need to be reassessed, potentially leading to a behavior that has to be supplemented with additional training, a technology solution, and/or perhaps an automated hardware/software solution that takes the pilot out of the loop for a given response. As such, it
provides a reliable cross-check on the skills and abilities deduced by other analyses (particularly the HSI KSA analysis).

4. Survey of UAS Pilot Qualification Studies
A survey will be conducted to identify research that has already been conducted on the question of what qualifications a UAS pilot will be required to have. For instance, the Air Force Research Laboratory has conducted three studies since 1998 specifically addressing this topic:

- **USAF Air Vehicle Operator Training Requirement Study (AFRL-HE-BR-SR-1998-0001):** A survey of RQ-1 Predator pilots which concluded initial qualification training for Predator should approximate Air Force undergraduate pilot training (UPT). The surveyed subjects felt prior manned flight experience was important.

- **Unmanned Aerial Vehicle Operator Qualifications (AFRL-HE-AZ-TR-2000-0002):** A survey of the military services’ qualification and training requirements for UAS pilots. The author concluded differences in qualification and training resulted from differing UAS vehicle performance capabilities which resulted in utilization of different airspaces and thus different regulatory requirements.

- **Impact of Prior Flight Experience on Learning Predator UAV Operator Skills (AFRL-HE-AZ-TR-2002-0026):** Prospective laboratory study which found 150-200 hours of prior flight training was required to learn the necessary stick and rudder skills to fly Predator. The type of prior flight training had some impact on performance on the laboratory tasks.

The particular studies listed were all performed with manned pilots. Other studies may give different results from those shown. These and similar studies will be identified and evaluated to help form an overall picture of UAS pilot qualifications as viewed by military, government, and private industry. The results will be compared with the other six methods of validation and factored into the overall pilot qualification recommendation that Access 5 will make.

While this document makes an initial recommendation involving qualification of pilots using manned-aircraft certificates/ratings as a basis, it is not the purpose of this paper to limit the training and qualification of UAS pilots to manned-aircraft only. The qualifications can be met with any training program that results in an acceptable level of pilot qualification.

Attachments:
Matrix of KSA to 14 CFR 61 and PTS Comparison
High Altitude Long Endurance (HALE) Unmanned Aircraft System (UAS) Pilot Knowledge, Skills and Abilities

**Project Coordination:**

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This document was prepared by a collaborative effort through the Policy work package. This was a funded effort under the Access 5 Project.
### Appendix A – Private / Instrument Part 61 Requirements & Practical Test Standards

#### Part 61 Pilot requirements

<table>
<thead>
<tr>
<th>Paragraph</th>
<th>UAS Knowledge/ Skill/ Ability</th>
<th>Requirement</th>
<th>Corresponding UAS KSA</th>
<th>Applicability (NC means Not Covered)</th>
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<tr>
<td>1 61.57(c)</td>
<td>Instrument experience for IFR - 6 instrument approaches, holding, intercepting/tracking courses in 6 cal months or Instrument Proficiency Check</td>
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<tr>
<td>2 61.65(a)</td>
<td>Hold at least a current private pilot certificate with a ... rating appropriate to the instrument rating sought</td>
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<tr>
<td>3 61.65(b)</td>
<td>Aeronautical knowledge for Instrument rating</td>
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<td></td>
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<tr>
<td>4</td>
<td>(1) Federal Aviation Regulations of this chapter that apply to flight operations under IFR</td>
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<td>5</td>
<td>(2) Appropriate information that applies to flight operations under IFR in the “Aeronautical Information Manual”</td>
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<td>6</td>
<td>(3) Air traffic control system and procedures for instrument flight operations</td>
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<td>(4) IFR navigation and approaches by use of navigation systems</td>
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<td>(5) Use of IFR en route and instrument approach procedure charts</td>
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<td>9</td>
<td>(6) Procurement and use of aviation weather reports and forecasts ... forecasting weather trends ... and personal observation of weather conditions</td>
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<td>(7) Safe and efficient operation of aircraft under instrument flight rules and conditions</td>
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<td>11</td>
<td>(8) Recognition of critical weather situations and windshear avoidance</td>
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<td>12</td>
<td>(9) Aeronautical decision making and judgment</td>
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<td>13</td>
<td>(10) Crew resource management, including crew communication and coordination</td>
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<tr>
<td>14 61.65(c)</td>
<td>Instrument flight proficiency</td>
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<td>15</td>
<td>(1) Preflight preparation</td>
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<tr>
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<td>(2) Preflight procedures;</td>
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<tr>
<td>17</td>
<td>(3) Air traffic control clearances and procedures</td>
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*This document was prepared by a collaborative effort through the Policy work package. This was a funded effort under the Access 5 Project.*
(4) Flight by reference to instruments


(5) Navigation systems

18,22,170,261,275,315

(6) Instrument approach procedures

26, 171, 256, 259, 270, 272, 275, 276, 277, 283, 291, 296, 304, 306

(7) Emergency operations

300,306

(8) Postflight procedures

324,326,329,335

61.65(d)

Aeronautical experience

(1) At least 50 hours of cross-country flight time as pilot in command, of which ... 10 hours must be in airplanes for an instrument -- airplane rating

(2) A total of 40 hours of actual or simulated instrument time on the areas of operation of this section, to include--

(i) At least 15 hours of instrument flight training from an authorized instructor in the aircraft category for which the instrument rating is sought;

(ii) At least 3 hours of instrument training ... from an authorized instructor in preparation for the practical test within 60 days...

(iii) For an instrument -- airplane rating, instrument training ... that includes at least one cross-country flight in an airplane that is performed under IFR: 250 nm, 3 kinds of instrument approaches, instrument approach each airport

61.65(e)

Use of flight simulators or flight training devices ... provided by an authorized instructor...

61.103(a)

17 years of age for Private Pilot certificate

6,54,55,74,75,156,291,129,130,177

61.103(c)

Be able to read, speak, write, and understand the English language.

11,96,97,113,328,190,191,97,328

61.105(b)

Aeronautical knowledge for Private Pilot certificate

1

(1) Applicable Federal Aviation Regulations of this chapter that relate to private pilot...

(2) Accident reporting requirements of the National Transportation Safety Board

6,8,9,20,27,102,107,152,153,163,96,129,130,132,138,177

(3) Use of the applicable portions of the "Aeronautical Information Manual" and FAA advisory circulars

(4) Use of aeronautical charts for VFR navigation using pilotage, dead reckoning, and navigation systems
(5) Radio communication procedures

(6) Recognition of critical weather situations from the ground and in flight, windshear avoidance, and ... weather reports and forecasts

(7) Safe and efficient operation of aircraft, including collision avoidance, and recognition and avoidance of wake turbulence

(8) Effects of density altitude on takeoff and climb performance

(9) Weight and balance computations

(10) Principles of aerodynamics, powerplants, and aircraft systems

(11) Stall awareness, spin entry, spins, and spin recovery techniques for the airplane and glider category ratings

(12) Aeronautical decision making and judgment

(13) Preflight action that includes--

(i) How to obtain information on runway lengths ..., data on takeoff and landing distances, weather reports and forecasts, and fuel requirements

(ii) How to plan for alternatives if the planned flight cannot be completed or delays are encountered.

Flight Proficiency for Private Pilot certificate

(1) For an airplane category rating with a single-engine class rating:

(i) Preflight preparation;

(ii) Preflight procedures;

(iii) Airport and seaplane base operations;

(iv) Takeoffs, landings, and go-arounds;

(v) Performance maneuvers;

(vi) Ground reference maneuvers;

(vii) Navigation;
(viii) Slow flight and stalls; 144, 149, 208
(ix) Basic instrument maneuvers; 144, 145, 146, 148?, 149, 183, 184, 208, 268
(x) Emergency operations; 78, 144, 147, 150, 183, 184, 199, 203, 207, 208, 111,300
(xi) Night operations 74, 144, 183, 208
(xii) Postflight procedures Look for this
(2) Additionally for an airplane category rating with a multiengine class rating: Multiengine operations

61.109(a) Aeronautical experience for Private Pilot single-engine
Log at least 40 hours of flight time that includes at least 20 hours of flight training ... and 10 hours of solo flight training including:
(1) 3 hours of cross-country flight training in a single-engine airplane;
(2) 3 hours of night flight training in a single-engine airplane that includes--
(i) One cross-country flight of over 100 nautical miles total distance; and
(ii) 10 takeoffs and 10 landings to a full stop (with each landing involving a flight in the traffic pattern) at an airport.
(3) 3 hours ... maneuvering an airplane solely by reference to instruments ..., radio communications ..., navigation systems/facilities and radar services...
(4) 3 hours of flight training in preparation for the practical test ... within 60 days preceding the date of the test
(5) 10 hours of solo flight time in a single-engine airplane, consisting of at least--
(i) 5 hours of solo cross-country time;
(ii) One solo cross-country flight of at least 150 nautical miles total distance, with full-stop landings at a minimum of three points...
(iii) Three takeoffs and three landings to a full stop (with each landing involving a flight in the traffic pattern) at an airport with an operating control tower.

61.109(b) Aeronautical experience for Private Pilot multiengine - same as single-engine except in a multiengine aircraft

Practical Test Standards - Private Pilot

Special Emphasis Areas - Examiners shall place special emphasis upon areas of aircraft operations considered critical to flight safety.

1. positive aircraft control; 99, 100, 114, 144, 149, 183, 204, 205
2. procedures for positive exchange of flight controls (who is flying the airplane); 144, 183, 204, 205, 206, 207
3. stall/spin awareness; 135, 144, 180
4. collision avoidance; Look for this
5. wake turbulence avoidance; 269, 271, 290, 295
6. Land and Hold Short Operations (LAHSO); 153, 159, 173, 288
7. runway incursion avoidance;
8. controlled flight into terrain (CFIT); 132
9. aeronautical decision making (ADM); 121, 141, 208, 35
10. checklist usage; and 113, 125
11. other areas deemed appropriate to any phase of the practical test

I. PREFLIGHT PREPARATION

A. Certificates and Documents
1. Explaining—
a. private pilot certificate privileges, limitations, and recent 1 flight experience requirements.
b. medical certificate class and duration. 2
c. pilot logbook or flight records. 3
2. Locating and explaining—
a. airworthiness and registration certificates.
b. operating limitations, placards, instrument markings, and 4, 73 POH/AFM.
c. weight and balance data and equipment list.

B. Airworthiness Requirements
1. Explaining—
a. required instruments and equipment for day/night VFR. 74
b. procedures and limitations for determining airworthiness of 9, 75 the airplane with inoperative instruments and equipment with and without an MEL.
c. requirements and procedures for obtaining a special flight permit.
2. Locating and explaining—
a. airworthiness directives.
b. compliance records.
c. maintenance/inspection requirements.
d. appropriate record keeping.

C. Weather Information
1. Exhibits knowledge of the elements related to weather information by analyzing weather reports, charts, and forecasts from various sources with emphasis on—
   a. METAR, TAF, and FA.
   b. surface analysis chart.
   c. radar summary chart.
   d. winds and temperature aloft chart.
   e. significant weather prognostic charts.
   f. convective outlook chart.
   g. AWOS, ASOS, and ATIS reports.

2. Makes a competent “go/no-go” decision based on available weather information.

D. Cross-Country Flight Planning

1. Exhibits knowledge of the elements related to cross-country flight planning by presenting and explaining a pre-planned VFR cross-country flight, as previously assigned by the examiner. On the day of the practical test, the final flight plan shall be to the first fuel stop, based on maximum allowable passengers, baggage, and/or cargo loads using real-time weather.

2. Uses appropriate and current aeronautical charts.

3. Properly identifies airspace, obstructions, and terrain features.

4. Selects easily identifiable en route checkpoints.

5. Selects most favorable altitudes considering weather conditions and equipment capabilities.

6. Computes headings, flight time, and fuel requirements.

7. Selects appropriate navigation system/facilities and communication frequencies.

8. Applies pertinent information from NOTAMs, AF/D, and other flight publications.

9. Completes a navigation log and simulates filing a VFR flight plan.

E. National Airspace System

1. Basic VFR weather minimums—for all classes of airspace.

2. Airspace classes—their operating rules, pilot certification, and airplane equipment requirements for Class A, B, C, D, E, and G.

3. Special use and other airspace areas.

F. Performance and Limitations
1. Exhibits knowledge of the elements related to performance and limitations by explaining the use of charts, tables, and data to determine performance and the adverse effects of exceeding limitations.

2. Computes weight and balance. Determines the computed weight and center of gravity is within the airplane’s operating limitations and if the weight and center of gravity will remain within limits during all phases of flight.

3. Demonstrates use of the appropriate performance charts, tables, and data.

4. Describes the effects of atmospheric conditions on the airplane's performance.

G. Operation of Systems

1. Primary flight controls and trim.

2. Flaps, leading edge devices, and spoilers.

3. Water rudders (ASES).

4. Powerplant and propeller.

5. Landing gear.

6. Fuel, oil, and hydraulic.

7. Electrical.

8. Avionics


10. Environmental.

11. Deicing and anti-icing.

J. Aeromedical Factors

1. The symptoms, causes, effects, and corrective actions of the following—

   a. hypoxia.

   b. hyperventilation.

   c. middle ear and sinus problems.

   d. spatial disorientation.

   e. motion sickness.

   f. carbon monoxide poisoning.
2. The effects of alcohol, drugs, and over-the-counter medications.
3. The effects of excess nitrogen during scuba dives upon a pilot or passenger in flight.

II. PREFLIGHT PROCEDURES

A. Preflight Inspection
1. Exhibits knowledge of the elements related to preflight inspection. This shall include which items must be inspected, the reasons for checking each item, and how to detect possible defects.
2. Inspects the airplane with reference to an appropriate checklist.
3. Verifies the airplane is in condition for safe flight.

B. Cockpit Management
1. Exhibits knowledge of the elements related to cockpit management procedures.
2. Ensures all loose items in the cockpit and cabin are secured.
3. Organizes material and equipment in an efficient manner so they are readily available.
4. Briefs occupants on the use of safety belts, shoulder harnesses, doors, and emergency procedures.

C. Engine Starting
1. Exhibits knowledge of the elements related to recommended engine starting procedures. This shall include the use of an external power source, hand propelling safety, and starting under various atmospheric conditions.
2. Positions the airplane properly considering structures, surface conditions, other aircraft, and the safety of nearby persons and property.
3. Utilizes the appropriate checklist for starting procedure.

D. Taxiing
1. Exhibits knowledge of the elements related to safe taxi procedures.
2. Performs a brake check immediately after the airplane begins moving.
3. Positions the flight controls properly for the existing wind conditions.
4. Controls direction and speed without excessive use of...
5. Complies with airport/taxiway markings, signals, ATC clearances, and instructions. 98, 103, 106, 319
6. Taxies so as to avoid other aircraft and hazards. 98, 105, 319, 103

F. Before Takeoff Check
1. Exhibits knowledge of the elements related to the before takeoff check. This shall include the reasons for checking each item and how to detect malfunctions. 76, 79, 84, 87, 108, 110, 157, 109
2. Positions the airplane properly considering other aircraft/vessels, wind and surface conditions. 108
3. Divides attention inside and outside the cockpit. 108
4. Ensures that engine temperature and pressure are suitable for runup and takeoff. 108, 161
5. Accomplishes the before takeoff checklist and ensures the airplane is in safe operating condition. 85, 88, 108, 151, 157
6. Reviews takeoff performance airspeeds, takeoff distances, departure, and emergency procedures. 108, 111, 155
7. Avoids runway incursions and/or ensures no conflict with traffic prior to taxiing into takeoff position. 108, 112, 119, 84

III. AIRPORT AND SEAPLANE BASE OPERATIONS
A. Radio Communications and ATC Light Signals
1. Exhibits knowledge of the elements related to radio communications and ATC light signals. 115-118, 120, 152, 91
2. Selects appropriate frequencies. 115-118, 120, 152, 166, 92
3. Transmits using recommended phraseology. 115-118, 120, 152, 94
4. Acknowledges radio communications and complies with instructions. 115-118, 120, 152, 158, 163?, 118, 95?

B. Traffic Patterns
1. Exhibits knowledge of the elements related to traffic patterns. This shall include procedures at airports with and without operating control towers, prevention of runway incursions, collision avoidance, wake turbulence avoidance, and wind shear. 107, 153?, 156?, 159?, 173? 16?
2. Complies with proper traffic pattern procedures. 107
3. Maintains proper spacing from other aircraft. 141, 142
4. Corrects for wind drift to maintain the proper ground track. 142
5. Maintains orientation with the runway/landing area in use. 142
6. Maintains traffic pattern altitude, ±100 feet (30 meters), and the appropriate airspeed, ±10 knots. 144
### C. Airport/Seaplane Base, Runway, and Taxiway Signs, Markings, and Lighting

1. Exhibits knowledge of the elements related to airport/seaplane base, runway, and taxiway operations with emphasis on runway incursion avoidance.

2. Properly identifies and interprets airport/seaplane base, runway, and taxiway signs, markings, and lighting.

### IV. TAKEOFFS, LANDINGS, AND GO-AROUNDS

#### A. Normal and Crosswind Takeoff and Climb

1. Exhibits knowledge of the elements related to a normal and crosswind takeoff, climb operations, and rejected takeoff procedures.

2. Positions the flight controls for the existing wind conditions.

3. Clears the area; taxies into the takeoff position and aligns the airplane on the runway center/takeoff path.

4. Retracts the water rudders, as appropriate, (ASES) and advances the throttle smoothly to takeoff power.

5. Establishes and maintains the most efficient planing/lift-off attitude and corrects for porpoising and skipping (ASES).

6. Lifts off at the recommended airspeed and accelerates to VY.

7. Establishes a pitch attitude that will maintain VY +10/-5 knots.

8. Retracts the landing gear, if appropriate, and flaps after a positive rate of climb is established.

9. Maintains takeoff power and VY +10/-5 knots to a safe maneuvering altitude.

10. Maintains directional control and proper wind-drift correction throughout the takeoff and climb.

11. Complies with noise abatement procedures.

12. Completes the appropriate checklist.

#### B. Normal and Crosswind Approach and Landing

1. Exhibits knowledge of the elements related to a normal and crosswind takeoff, climb operations, and rejected takeoff procedures.

2. Adequately surveys the intended landing area (ASES).

3. Considers the wind conditions, landing surface, obstructions, and selects a suitable touchdown point.

4. Establishes the recommended approach and landing configuration and airspeed, and adjusts pitch attitude and
power as required.

5. Maintains a stabilized approach and recommended airspeed, or in its absence, not more than 1.3 VSO, +10/-5 knots, with wind gust factor applied.

6. Makes smooth, timely, and correct control application during the roundout and touchdown.

7. Contacts the water at the proper pitch attitude (ASES).

8. Touches down smoothly at approximate stalling speed (ASEL).

9. Touches down at or within 400 feet (120 meters) beyond a specified point, with no drift, and with the airplane’s longitudinal axis aligned with and over the runway center/landing path.

10. Maintains crosswind correction and directional control throughout the approach and landing sequence.

11. Completes the appropriate checklist.

C. Soft-Field Takeoff and Climb

1. Exhibits knowledge of the elements related to a soft-field takeoff and climb.

2. Positions the flight controls for existing wind conditions and to maximize lift as quickly as possible.

3. Clears the area; taxies onto the takeoff surface at a speed consistent with safety without stopping while advancing the throttle smoothly to takeoff power.

4. Establishes and maintains a pitch attitude that will transfer the weight of the airplane from the wheels to the wings as rapidly as possible.

5. Lifts off at the lowest possible airspeed and remains in ground effect while accelerating to VX or VY, as appropriate.

6. Establishes a pitch attitude for VX or VY, as appropriate, and maintains selected airspeed +10/-5 knots, during the climb.

7. Retracts the landing gear, if appropriate, and flaps after clear of any obstacles or as recommended by the manufacturer.

8. Maintains takeoff power and VX or VY +10/-5 knots to a safe maneuvering altitude.

9. Maintains directional control and proper wind-drift correction throughout the takeoff and climb.

10. Completes the appropriate checklist.

D. Soft-Field Approach and Landing
### Knowledge vs. Skill

<table>
<thead>
<tr>
<th>NC</th>
<th>Knowledge of the elements related to a soft-field approach and landing.</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC</td>
<td>Considers the wind conditions, landing surface and obstructions, and selects the most suitable touchdown area.</td>
</tr>
<tr>
<td>NC</td>
<td>Establishes the recommended approach and landing configuration, and airspeed; adjusts pitch attitude and power as required.</td>
</tr>
<tr>
<td>NC</td>
<td>Maintains a stabilized approach and recommended airspeed, or in its absence not more than 1.3 VSO, +10/-5 knots, with wind gust factor applied.</td>
</tr>
<tr>
<td>NC</td>
<td>Makes smooth, timely, and correct control application during the roundout and touchdown.</td>
</tr>
<tr>
<td>NC</td>
<td>Touches down softly with no drift, and with the airplane's longitudinal axis aligned with the runway/landing path.</td>
</tr>
<tr>
<td>NC</td>
<td>Maintains crosswind correction and directional control throughout the approach and landing sequence.</td>
</tr>
<tr>
<td>NC</td>
<td>Maintains proper position of the flight controls and sufficient speed to taxi on the soft surface.</td>
</tr>
<tr>
<td>NC</td>
<td>Completes the appropriate checklist.</td>
</tr>
</tbody>
</table>

### Short-Field Takeoff and Maximum Performance Climb

| 151, 154, 155 | Exhibits knowledge of the elements related to a short-field (confined area ASES) takeoff and maximum performance climb. |
| 160, 161, 162 | Positions the flight controls for the existing wind conditions; sets the flaps as recommended. |
| 160, 161, 162 | Clears the area; taxies into takeoff position utilizing maximum available takeoff area and aligns the airplane on the runway center/takeoff path. |
| 160, 161, 162 | Selects an appropriate takeoff path for the existing conditions (ASES). |
| 160, 161, 162 | Applies brakes (if appropriate), while advancing the throttle smoothly to takeoff power. |
| 160, 161, 162 | Establishes and maintains the most efficient planing/lift-off attitude and corrects for porpoising and skipping (ASES). |
| 160, 161, 162 | Lifts off at the recommended airspeed, and accelerates to the recommended obstacle clearance airspeed or VX. |
| 160, 161, 162 | Establishes a pitch attitude that will maintain the recommended obstacle clearance airspeed, or VX, +10/-5 knots, until the obstacle is cleared, or until the airplane is 50 feet (20 meters) above the surface. |
9. After clearing the obstacle, establishes the pitch attitude for VY, accelerates to VY, and maintains VY, +10/-5 knots, during the climb.

10. Retracts the landing gear, if appropriate, and flaps after clear of any obstacles or as recommended by manufacturer.

11. Maintains takeoff power and VY +10/-5 to a safe maneuvering altitude.

12. Maintains directional control and proper wind-drift correction throughout the takeoff and climb.

13. Completes the appropriate checklist.

! F. Short-Field Approach and Landing

1. Exhibits knowledge of the elements related to a short-field (confined area ASES) approach and landing.

2. Adequately surveys the intended landing area (ASES).

3. Considers the wind conditions, landing surface, obstructions, and selects the most suitable touchdown point.

4. Establishes the recommended approach and landing configuration and airspeed; adjusts pitch attitude and power as required.

5. Maintains a stabilized approach and recommended approach airspeed, or in its absence not more than 1.3 VSO, +10/-5 knots, with wind gust factor applied.

6. Makes smooth, timely, and correct control application during the roundout and touchdown.

7. Selects the proper landing path, contacts the water at the minimum safe airspeed with the proper pitch attitude for the surface conditions (ASES).

8. Touches down smoothly at minimum control airspeed (ASEL).

9. Touches down at or within 200 feet (60 meters) beyond a specified point, with no side drift, minimum float and with the airplane’s longitudinal axis aligned with and over the runway center/landing path.

10. Maintains crosswind correction and directional control throughout the approach and landing sequence.

11. Applies brakes, (ASEL) or elevator control (ASEs), as necessary, to stop in the shortest distance consistent with safety.

12. Completes the appropriate checklist.

! K. Forward Slip to a Landing
1. Exhibits knowledge of the elements related to forward slip to a landing.

2. Considers the wind conditions, landing surface and obstructions, and selects the most suitable touchdown point.

3. Establishes the slipping attitude at the point from which a landing can be made using the recommended approach and landing configuration and airspeed; adjusts pitch attitude and power as required.

4. Maintains a ground track aligned with the runway center/landing path and an airspeed, which results in minimum float during the roundout.

5. Makes smooth, timely, and correct control application during the recovery from the slip, the roundout, and the touchdown.

6. Touches down smoothly at the approximate stalling speed, at or within 400 feet (120 meters) beyond a specified point, with no side drift, and with the airplane's longitudinal axis aligned with and over the runway center/landing path.

7. Maintains crosswind correction and directional control throughout the approach and landing sequence.

8. Completes the appropriate checklist.

**L. Go-Around/Rejected Landing**

1. Exhibits knowledge of the elements related to a go-around/rejected landing.

2. Makes a timely decision to discontinue the approach to landing.

3. Applies takeoff power immediately and transitions to climb pitch attitude for \( V_Y \), and maintains \( V_Y + 10/-5 \) knots.

4. Retracts the flaps as appropriate.

5. Retracts the landing gear, if appropriate, after a positive rate of climb is established.

6. Maneuvers to the side of the runway/landing area to clear and avoid conflicting traffic.

7. Maintains takeoff power \( V_Y + 10/-5 \) to a safe maneuvering altitude.

8. Maintains directional control and proper wind-drift correction throughout the climb.

9. Completes the appropriate checklist.

**V. PERFORMANCE MANEUVER**

**Steep Turns**

1. Exhibits knowledge of the elements related to steep turns.
2. Establishes the manufacturer’s recommended airspeed or if one is not stated, a safe airspeed not to exceed VA.

3. Rolls into a coordinated 360° turn; maintains a 45° bank. Max bank for particular UAS, 144, 149, 183

4. Performs the task in the opposite direction, as specified by the examiner.

5. Divides attention between airplane control and orientation.

6. Maintains the entry altitude, ±100 feet (30 meters), airspeed, ±10 knots, bank, ±5°; and rolls out on the entry heading, ±10°.

VI. GROUND REFERENCE MANEUVERS

A. Rectangular Course

1. Exhibits knowledge of the elements related to a rectangular course.

2. Selects a suitable reference area.

3. Plans the maneuver so as to enter a left or right pattern, 600 to 1,000 feet AGL (180 to 300 meters) at an appropriate distance from the selected reference area, 45° to the downwind leg.

4. Applies adequate wind-drift correction during straight-and-turning flight to maintain a constant ground track around the rectangular reference area.

5. Divides attention between airplane control and the ground track while maintaining coordinated flight.

6. Maintains altitude, ±100 feet (30 meters); maintains airspeed, ±10 knots.

B. S-Turns

1. Exhibits knowledge of the elements related to S-turns.

2. Selects a suitable ground reference line.

3. Plans the maneuver so as to enter at 600 to 1,000 feet (180 to 300 meters) AGL, perpendicular to the selected reference line.

4. Applies adequate wind-drift correction to track a constant radius turn on each side of the selected reference line.

5. Reverses the direction of turn directly over the selected reference line.

6. Divides attention between airplane control and the ground track while maintaining coordinated flight.

7. Maintains altitude, ±100 feet (30 meters); maintains airspeed, ±10 knots.

C. Turns Around a Point

1. Exhibits knowledge of the elements related to turns around a point.

2. Selects a suitable ground reference point.
3. Plans the maneuver so as to enter left or right at 600 to 1,000 feet (180 to 300 meters) AGL, at an appropriate distance from the reference point.

4. Applies adequate wind-drift correction to track a constant radius turn around the selected reference point.

5. Divides attention between airplane control and the ground track while maintaining coordinated flight.

6. Maintains altitude, ±100 feet (30 meters); maintains airspeed, ±10 knots.

VII. NAVIGATION

A. Pilotage and Dead Reckoning

1. Exhibits knowledge of the elements related to pilotage and dead reckoning.

2. Follows the preplanned course by reference to landmarks.

3. Identifies landmarks by relating surface features to chart symbols.


5. Corrects for and records the differences between preflight groundspeed and heading calculations and those determined en route.

6. Verifies the airplane’s position within three (3) nautical miles of the flight-planned route.

7. Arrives at the en route checkpoints within five (5) minutes of the initial or revised ETA and provides a destination estimate.

8. Maintains the appropriate altitude, ±200 feet (60 meters) and headings, ±15°.

B. Navigation Systems and Radar Services

1. Exhibits knowledge of the elements related to navigation systems and radar services.

2. Demonstrates the ability to use an airborne electronic navigation system.

3. Locates the airplane’s position using the navigation system.

4. Intercepts and tracks a given course, radial or bearing, as appropriate.

5. Recognizes and describes the indication of station passage, if appropriate.

6. Recognizes signal loss and takes appropriate action.

7. Uses proper communication procedures when utilizing radar services.

8. Maintains the appropriate altitude, ±200 feet (60 meters) and headings ±15°.
### C. Diversion

1. Exhibits knowledge of the elements related to diversion. 137, 200, 201
2. Selects an appropriate alternate airport and route. 193, 197, 198
3. Makes an accurate estimate of heading, groundspeed, arrival time, and fuel consumption to the alternate airport. 200, 203
4. Maintains the appropriate altitude, ±200 feet (60 meters) and heading, ±15°. 203

### D. Lost Procedures

1. Exhibits knowledge of the elements related to lost procedures. 200
2. Selects an appropriate course of action. 200
3. Maintains an appropriate heading and climbs, if necessary. 203
4. Identifies prominent landmarks.
5. Uses navigation systems/facilities and/or contacts an ATC facility for assistance, as appropriate. 137, 202

### VIII. SLOW FLIGHT AND STALLS

#### A. Maneuvering During Slow Flight

1. Exhibits knowledge of the elements related to maneuvering during slow flight. 128
2. Selects an entry altitude that will allow the task to be completed no lower than 1,500 feet (460 meters) AGL.
3. Establishes and maintains an airspeed at which any further increase in angle of attack, increase in load factor, or reduction in power, would result in an immediate stall.
4. Accomplishes coordinated straight-and-level flight, turns, climbs, and descents with landing gear and flap configurations specified by the examiner.
5. Divides attention between airplane control and orientation.
6. Maintains the specified altitude, ±100 feet (30 meters); specified heading, ±10°; airspeed, +10/-0 knots; and specified angle of bank, ±10°.

#### B. Power-Off Stalls

1. Exhibits knowledge of the elements related to power-off stalls. 128, 135
2. Selects an entry altitude that allows the task to be completed no lower than 1,500 feet (460 meters) AGL.
3. Establishes a stabilized descent in the approach or landing configuration, as specified by the examiner.
4. Transitions smoothly from the approach or landing attitude to a pitch attitude that will induce a stall.
5. Maintains a specified heading, ±10°, in straight flight; maintains a specified angle of bank not to exceed 20°, ±10°; in turning flight, while inducing the stall.

6. Recognizes and recovers promptly after the stall occurs by simultaneously reducing the angle of attack, increasing power to maximum allowable, and leveling the wings to return to a straight-and-level flight attitude with a minimum loss of altitude appropriate for the airplane.

7. Retracts the flaps to the recommended setting; retracts the landing gear, if retractable, after a positive rate of climb is established.

8. Accelerates to VX or VY speed before the final flap retraction; returns to the altitude, heading, and airspeed specified by the examiner.

C. Power-On Stalls

1. Exhibits knowledge of the elements related to power-on stalls.

2. Selects an entry altitude that allows the task to be completed no lower than 1,500 feet (460 meters) AGL.

3. Establishes the takeoff or departure configuration. Sets power to no less than 65 percent available power.

4. Transitions smoothly from the takeoff or departure attitude to the pitch attitude that will induce a stall.

5. Maintains a specified heading, ±10°, in straight flight; maintains a specified angle of bank not to exceed 20°, ±10°, in turning flight, while inducing the stall.

6. Recognizes and recovers promptly after the stall occurs by simultaneously reducing the angle of attack, increasing power as appropriate, and leveling the wings to return to a straight-and-level flight attitude with a minimum loss of altitude appropriate for the airplane.

7. Retracts the flaps to the recommended setting; retracts the landing gear if retractable, after a positive rate of climb is established.

8. Accelerates to VX or VY speed before the final flap retraction; returns to the altitude, heading, and airspeed specified by the examiner.

D. Spin Awareness

1. Aerodynamic factors related to spins.

2. Flight situations where unintentional spins may occur.

3. Procedures for recovery from unintentional spins.

IX. BASIC INSTRUMENT MANEUVERS

A. Straight-and-Level Flight
1. Exhibits knowledge of the elements related to attitude instrument flying during straight-and-level flight. 177, 181, 175?

2. Maintains straight-and-level flight solely by reference to instruments using proper instrument cross-check and interpretation, and coordinated control application. 184, 175?

3. Maintains altitude, ±200 feet (60 meters); heading, ±20°; and airspeed, ±10 knots. 184

**B. Constant Airspeed Climbs**

1. Exhibits knowledge of the elements related to attitude instrument flying during constant airspeed climbs. 177, 181

2. Establishes the climb configuration specified by the examiner. 184

3. Transitions to the climb pitch attitude and power setting on an assigned heading using proper instrument cross-check and interpretation, and coordinated control application. 184

4. Demonstrates climbs solely by reference to instruments at a constant airspeed to specific altitudes in straight flight and turns. 184

5. Levels off at the assigned altitude and maintains that altitude, ±200 feet (60 meters); maintains heading, ±20°; maintains airspeed, ±10 knots. 184

**C. Constant Airspeed Descents**

1. Exhibits knowledge of the elements related to attitude instrument flying during constant airspeed descents. 177, 181

2. Establishes the descent configuration specified by the examiner. 184

3. Transitions to the descent pitch attitude and power setting on an assigned heading using proper instrument cross-check and interpretation, and coordinated control application. 184

4. Demonstrates descents solely by reference to instruments at a constant airspeed to specific altitudes in straight flight and turns. 184

5. Levels off at the assigned altitude and maintains that altitude, ±200 feet (60 meters); maintains heading, ±20°; maintains airspeed, ±10 knots. 184

**D. Turns to Headings**

1. Exhibits knowledge of the elements related to attitude instrument flying during turns to headings. 177, 181

2. Transitions to the level-turn attitude using proper instrument cross-check and interpretation, and coordinated control 184
application.

3. Demonstrates turns to headings solely by reference to instruments; maintains altitude, ±200 feet (60 meters); maintains a standard rate turn and rolls out on the assigned heading, ±10°; maintains airspeed, ±10 knots.

**E. Recovery from Unusual Flight Attitudes**

1. Exhibits knowledge of the elements related to attitude instrument flying during unusual attitudes.

2. Recognizes unusual flight attitudes solely by reference to instruments; recovers promptly to a stabilized level flight attitude using proper instrument cross-check and interpretation and smooth, coordinated control application in the correct sequence.

**F. Radio Communications, Navigation Systems/Facilities, and Radar Services**

1. Exhibits knowledge of the elements related to radio communications, navigation systems/facilities, and radar services available for use during flight solely by reference to instruments.

2. Selects the proper frequency and identifies the appropriate facility.

3. Follows verbal instructions and/or navigation systems/facilities for guidance.

4. Determines the minimum safe altitude.

5. Maintains altitude, ±200 feet (60 meters); maintains heading, ±20°; maintains airspeed, ±10 knots.

**X. EMERGENCY OPERATIONS (ASEL)**

**A. Emergency Approach and Landing (Simulated)**

1. Exhibits knowledge of the elements related to emergency approach and landing procedures.

2. Analyzes the situation and selects an appropriate course of action.

3. Establishes and maintains the recommended best-glide airspeed, ±10 knots.

4. Selects a suitable landing area.

5. Plans and follows a flight pattern to the selected landing area considering altitude, wind, terrain, and obstructions.

6. Prepares for landing, or go-around, as specified by the examiner.

7. Follows the appropriate checklist.
B. Systems and Equipment Malfunctions

1. Exhibits knowledge of the elements related to system and equipment malfunctions appropriate to the airplane provided for the practical test.

2. Analyzes the situation and takes appropriate action for simulated emergencies appropriate to the airplane provided for the practical test for at least three (3) of the following—
   a. partial or complete power loss.
   b. engine roughness or overheat.
   c. carburetor or induction icing.
   d. loss of oil pressure.
   e. fuel starvation.
   f. electrical malfunction.
   g. vacuum/pressure, and associated flight instruments malfunction.
   h. pitot/static.
   i. landing gear or flap malfunction.
   j. inoperative trim.
   k. inadvertent door or window opening.
   l. structural icing.
   m. smoke/fire/engine compartment fire.
   n. any other emergency appropriate to the airplane.

3. Follows the appropriate checklist or procedure.

C. Emergency Equipment and Survival Gear

Exhibits knowledge of the elements related to emergency equipment and survival gear appropriate to the airplane and environment encountered during flight. Identifies appropriate equipment that should be aboard the airplane.

XI. NIGHT OPERATION

Night Preparation

1. Physiological aspects of night flying as it relates to vision.
2. Lighting systems identifying airports, runways, taxiways and obstructions, and pilot controlled lighting.
3. Airplane lighting systems.
4. Personal equipment essential for night flight.
5. Night orientation, navigation, and chart reading techniques.
6. Safety precautions and emergencies unique to night flying.

XII. POSTFLIGHT PROCEDURES

A. After Landing, Parking, and Securing

1. Exhibits knowledge of the elements related to after landing, parking and securing procedures.
2. Maintains directional control after touchdown while decelerating to an appropriate speed. 322, 323, 325
3. Observes runway hold lines and other surface control markings and lighting. 322, 323, 325, 330
4. Parks in an appropriate area, considering the safety of nearby persons and property. 323, 325, 330, 332, 333, 336
5. Follows the appropriate procedure for engine shutdown. 326, 335
6. Completes the appropriate checklist. 324
7. Conducts an appropriate postflight inspection and secures the aircraft. 334, 336

X. EMERGENCY OPERATIONS (AMEL)

A. Emergency Descent (AMEL)
1. Exhibits knowledge of the elements related to an emergency descent.
2. Recognizes situations, such as depressurization, cockpit smoke and/or fire that require an emergency descent.
3. Establishes the appropriate airspeed and configuration for the emergency descent.
4. Exhibits orientation, division of attention, and proper planning.
5. Maintains positive load factors during the descent.
6. Completes appropriate checklists.

B. Engine Failure During Takeoff Before VMC (Simulated) (AMEL)
1. Exhibits knowledge of the elements related to the procedure used for engine failure during takeoff prior to reaching VMC.
2. Closes the throttles smoothly and promptly when simulated engine failure occurs.
3. Maintains directional control and applies brakes (AMEL) or flight controls (AMES), as necessary.

C. Engine Failure After Lift-Off (Simulated) (AMEL)
1. Exhibits knowledge of the elements related to the procedure used for engine failure after lift-off.
2. Recognizes a simulated engine failure promptly, maintains control, and utilizes appropriate emergency procedures.
3. Reduces drag, identifies and verifies the inoperative engine after simulated engine failure.
4. Simulates feathering the propeller on the inoperative engine. Examiner shall then establish zero-thrust on the inoperative engine.
5. Establishes VYSE; If obstructions are present, establishes VXSE or VMC +5 knots, whichever is greater, until obstructions are cleared. Then transitions to VYSE.
6. Banks toward the operating engine as required for best performance.
7. Monitors operating engine and makes adjustments as necessary.
8. Recognizes the airplane's performance capabilities. If a climb is not possible at VYSE, maintain VYSE and return to the departure airport for landing, or initiates an approach to the most suitable landing area available.
9. Secures the (simulated) inoperative engine.
10. Maintains heading, ±10°, and airspeed, ±5 knots.
11. Completes appropriate emergency checklist.

D. Approach and Landing with an Inoperative Engine (Simulated) (AMEL)

1. Exhibits knowledge of the elements related to an approach and landing with an engine inoperative to include engine failure on final approach.
2. Recognizes engine failure and takes appropriate action, maintains control, and utilizes recommended emergency procedures.
3. Banks toward the operating engine, as required, for best performance.
4. Monitors the operating engine and makes adjustments as necessary.
5. Maintains the recommended approach airspeed +10/-5, and landing configuration with a stabilized approach, until landing is assured.
6. Makes smooth, timely and correct control applications during roundout and touchdown.
7. Touches down on the first one-third of available runway, with no drift and the airplane's longitudinal axis aligned with and over the runway center/landing path.
8. Maintains crosswind correction and directional control throughout the approach and landing sequence.
9. Completes appropriate checklists.

E. Systems and Equipment Malfunctions (AMEL)

1. Exhibits knowledge of the elements related to system and equipment malfunctions appropriate to the airplane provided for the practical test.
2. Analyzes the situation and takes the appropriate action for simulated emergencies appropriate to the airplane provided for the practical test for at least three (3) of the following:
   a. partial or complete power loss.
   b. engine roughness or overheat.
   c. carburetor or induction icing.
   d. loss of oil pressure.
   e. fuel starvation.
   f. electrical malfunction.
g. vacuum/pressure, and associated flight instruments malfunction.

h. pitot/static.
i. landing gear or flap malfunction.
j. inoperative trim.
k. inadvertent door or window opening.
l. structural icing.
m. smoke/fire/engine compartment fire.
n. any other emergency appropriate to the airplane.

3. Follows the appropriate checklist or procedure.

I. Emergency Equipment and Survival Gear (AMEL)

Exhibits knowledge of the elements related to emergency equipment and survival gear appropriate to the airplane and environment encountered during flight. Identifies appropriate equipment that should be aboard the airplane.

XI. Multiengine Operations

Multiengine Operations will not be specifically addressed

A. Maneuvering with One Engine Inoperative (AMEL)

1. Exhibits knowledge of the elements related to maneuvering with one engine inoperative.

2. Recognizes engine failure and maintains control.

3. Sets the engine controls, reduces drag, identifies and verifies the inoperative engine, and feathers appropriate propeller.

4. Establishes and maintains a bank toward the operating engine as required for best performance in straight and level flight.

5. Follows the prescribed checklists to verify procedures for securing the inoperative engine.

6. Monitors the operating engine and makes necessary adjustments.

7. Demonstrates coordinated flight with one engine inoperative (propeller feathered).

8. Restarts the inoperative engine using appropriate restart procedures.

9. Maintains altitude ±100 feet (30 meters) or minimum sink as appropriate and heading ±10°.

10. Completes the appropriate checklists.

B. VMC Demonstration (AMEL)

1. Exhibits knowledge of the elements related to VMC by explaining the causes of loss of directional controls at airspeeds less than VMC, the factors affecting VMC and the safe recovery procedures.

2. Configures the airplane at VSSE/VYSE, as appropriate—

   b. Flaps set for takeoff.
   c. Cowl flaps set for takeoff.
d. Trim set for takeoff.

e. Propellers set for high RPM.

f. Power on critical engine reduced to idle.

g. Power on operating engine set to takeoff or maximum available power.

3. Establishes a single-engine climb attitude with the airspeed at approximately 10 knots above VSSE.

4. Establishes a bank toward the operating engine, as required for best performance and controllability.

5. Increases the pitch attitude slowly to reduce the airspeed at approximately 1 knot per second while applying rudder pressure to maintain directional control until full rudder is applied.

6. Recognizes indications of loss of directional control, stall warning or buffet.

7. Recovers promptly by simultaneously reducing power sufficiently on the operating engine while decreasing the angle of attack as necessary to regain airspeed and directional control. Recovery SHOULD NOT be attempted by increasing the power on the simulated failed engine.

8. Recovers within 20° of the entry heading.

9. Advances power smoothly on operating engine and accelerates to $V_{XSE}/V_{YSE}$, as appropriate, +10/–5 knots, during the recovery.

C. Engine Failure During Flight (by Reference to Instruments) (AMEL)

1. Exhibits knowledge of the elements by explaining the procedures used during instrument flight with one engine inoperative.

2. Recognizes engine failure, sets the engine controls, reduces drag, identifies, and verifies the inoperative engine and feathers appropriate engine propeller.

3. Establishes and maintains a bank toward the operating engine as required for best performance in straight and level.

4. Follows the prescribed checklists to verify procedures for securing the inoperative engine.

5. Monitors the operating engine and makes necessary adjustments.

6. Demonstrates coordinated flight with one engine inoperative.

7. Maintains altitude ±100 feet (30 meters), or minimum sink as appropriate and heading ±10°, bank ±5°, and levels off from climbs and descents within ±100 feet (30 meters).

D. Instrument Approach—One Engine Inoperative (by Reference to Instruments) (AMEL)

1. Exhibits knowledge of the elements by explaining the procedures used during a published instrument approach with one engine inoperative.
2. Recognizes engine failure, sets the engine controls, reduces drag, identifies and verifies the inoperative engine, and feathers appropriate engine propeller.

3. Establishes and maintains a bank toward the operating engine, as required, for best performance in straight and level flight.

4. Follows the prescribed checklists to verify procedures for securing the inoperative engine.

5. Monitors the operating engine and makes necessary adjustments.

6. Requests and receives an actual or a simulated ATC clearance for an instrument approach.

7. Follows the actual or a simulated ATC clearance for an instrument approach.

8. Maintains altitude within 100 feet (30 meters), the airspeed within ±10 knots if within the aircraft's capability, and heading ±10.

9. Establishes a rate of descent that will ensure arrival at the MDA or DH/DA, with the airplane in a position from which a descent to a landing, on the intended runway can be made, either straight in or circling as appropriate.

10. On final approach segment, no more than three-quarter-scale deflection of the CDI/glide slope indicator. For RMI or ADF indicators, within 10° of the course.

11. Avoids loss of aircraft control, or attempted flight contrary to the engine-inoperative operating limitations of the aircraft.

12. Complies with the published criteria for the aircraft approach category when circling.

13. Completes landing and appropriate checklists.

Practical Test Standards - Instrument Rating

I. PREFLIGHT PREPARATION

A. Weather Information

1. Exhibits adequate knowledge of the elements related to aviation weather information by obtaining, reading, and analyzing the applicable items, such as—

   a. weather reports and forecasts.  

   b. pilot and radar reports.  

   c. surface analysis charts.  

   d. radar summary charts.  

   e. significant weather prognostics.  

   f. winds and temperatures aloft.  

   g. freezing level charts.  

   h. stability charts.  

   182, 185, 193, 197, 198

251, 253, 292, 31

31

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31

31

33

195, 31

31
i. severe weather outlook charts.
j. SIGMETs and AIRMETs.
k. ATIS reports.

2. Correctly analyzes the assembled weather information pertaining to the proposed route of flight and destination airport, and determines whether an alternate airport is required, and, if required, whether the selected alternate airport meets the regulatory requirement.

B. Cross-Country Flight Planning

1. Exhibits adequate knowledge of the elements by presenting and explaining a preplanned cross-country flight, as previously assigned by the examiner (preplanning is at examiner’s discretion). It should be planned using real time weather and conform to the regulatory requirements for instrument flight rules within the airspace in which the flight will be conducted.

2. Exhibits adequate knowledge of the aircraft’s performance capabilities by calculating the estimated time en route and total fuel requirement based upon factors, such as—

a. power settings.
b. operating altitude or flight level.
c. wind.
d. fuel reserve requirements.


4. Obtains and correctly interprets applicable NOTAM information.

5. Determines the calculated performance is within the aircraft's capability and operating limitations.

6. Completes and files a flight plan in a manner that accurately reflects the conditions of the proposed flight. (Does not have to be filed with ATC.)

7. Demonstrates adequate knowledge of GPS and RAIM capability, when aircraft is so equipped.

II. PREFLIGHT PROCEDURES

A. Aircraft Systems Related to IFR Operations
Exhibits adequate knowledge of the elements related to applicable aircraft anti-icing/deicing system(s) and their operating methods to include:

1. Airframe.
2. Propeller.
3. Intake.
5. Pitot-static.

B. Aircraft Flight Instruments and Navigation Equipment

1. Exhibits adequate knowledge of the elements related to applicable aircraft flight instrument system(s) and their operating characteristics to include—
   a. pitot-static.
   b. altimeter.
   c. airspeed indicator.
   d. vertical speed indicator.
   e. attitude indicator.
   f. horizontal situation indicator.
   g. magnetic compass.
   h. turn-and-slip indicator/turn coordinator.
   i. heading indicator.
   j. electrical systems.
   k. vacuum systems.
   l. electronic flight instrument display.

2. Exhibits adequate knowledge of the applicable aircraft navigation system(s) and their operating characteristics to include—
   a. VOR.
   b. DME.
   c. ILS.
   d. marker beacon receiver/indicators.
   e. transponder/altitude encoding.
   f. ADF.
   g. GPS.
   h. FMS.

C. Instrument Cockpit Check

1. Exhibits adequate knowledge of the elements related to preflighting instruments, avionics, and navigation equipment cockpit check by explaining the reasons for the check and how to detect possible defects.
2. Performs the preflight on instruments, avionics, and navigation equipment cockpit check by following the checklist appropriate to the aircraft flown.

3. Determines that the aircraft is in condition for safe instrument flight including—
   a. communications equipment.
   b. navigation equipment, as appropriate to the aircraft flown.
   c. magnetic compass.
   d. heading indicator.
   e. attitude indicator.
   f. altimeter.
   g. turn-and-slip indicator/turn coordinator.
   h. vertical speed indicator.
   i. airspeed indicator.
   j. clock.
   k. power source for gyro-instruments.
   l. pitot heat.
   m. electronic flight instrument display
   n. traffic awareness/warning/avoidance system.
   o. terrain awareness/warning/alert system.
   p. FMS.
   q. auto pilot.

4. Notes any discrepancies and determines whether the aircraft is safe for instrument flight or requires maintenance.

III. AIR TRAFFIC CONTROL CLEARANCES AND PROCEDURES
   A. Air Traffic Control Clearances

1. Exhibits adequate knowledge of the elements related to ATC clearances and pilot/controller responsibilities to include tower en route control and clearance void times.

2. Copies correctly, in a timely manner, the ATC clearance as issued.

3. Determines that it is possible to comply with ATC clearance.

4. Interprets correctly the ATC clearance received and, when necessary, requests clarification, verification, or change.

5. Reads back correctly, in a timely manner, the ATC clearance in the sequence received.

6. Uses standard phraseology when reading back clearance.

7. Sets the appropriate communication and navigation systems and transponder codes in compliance with the ATC
clearance.

B. Compliance with Departure, En Route, and Arrival Procedures and Clearances

583 1. Exhibits adequate knowledge of the elements related to ATS routes, and related pilot/controller responsibilities. 193, 202

584 2. Uses the current and appropriate navigation publications for the proposed flight. 26

585 3. Selects and uses the appropriate communication facilities; selects and identifies the navigation aids associated with the proposed flight. 189, 26

586 4. Performs the appropriate aircraft checklist items relative to the phase of flight. 140, 177

587 5. Establishes two-way communications with the proper controlling agency, using proper phraseology. 137, 187, 189, 190

588 6. Complies, in a timely manner, with all ATC instructions and airspace restrictions. 137, 188

589 7. Exhibits adequate knowledge of communication failure procedures. 178

590 8. Intercepts, in a timely manner, all courses, radials, and bearings appropriate to the procedure, route, or clearance. 200

591 9. Maintains the applicable airspeed within +/-10 knots; headings within +/-10°; altitude within +/-100 feet; and tracks a course, radial or bearing within ⅜ scale deflection of the CDI. 144

C. Holding Procedures

592 1. Exhibits adequate knowledge of the elements related to holding procedures. 257

593 2. Changes to the holding airspeed appropriate for the altitude or aircraft when 3 minutes or less from, but prior to arriving at, the holding fix. 264

594 3. Explains and uses an entry procedure that ensures the aircraft remains within the holding pattern airspace for a standard, nonstandard, published, or nonpublished holding pattern. 262

595 4. Recognizes arrival at the holding fix and initiates prompt entry into the holding pattern. 262

596 5. Complies with ATC reporting requirements. 137, 188, 189

597 6. Uses the proper timing criteria, where applicable, as required by altitude or ATC instructions. 137

598 7. Complies with pattern leg lengths when a DME distance is specified. 264
8. Uses proper wind correction procedures to maintain the desired pattern and to arrive over the fix as close as possible to a specified time.

9. Maintains the airspeed within +/-10 knots; altitude within +/-100 feet; headings within +/-10°; and tracks a selected course, radial or bearing within ¼ scale deflection of the CDI.

IV. FLIGHT BY REFERENCE TO INSTRUMENTS
A. Basic Instrument Flight Maneuvers
1. Exhibits adequate knowledge of the elements related to attitude instrument flying during straight-and-level, climbs, turns, and descents while conducting various instrument flight procedures.

2. Maintains altitude within +/- 100 feet during level flight, headings within +/- 10°, airspeed within +/- 10 knots, and bank angles within +/- 5° during turns.

3. Uses proper instrument crosscheck and interpretation, and apply the appropriate pitch, bank, power, and trim corrections when applicable.

B. Recovery from Unusual Flight Attitudes
1. Exhibits adequate knowledge of the elements relating to attitude instrument flying during recovery from unusual flight attitudes (both nose-high and nose-low).

2. Uses proper instrument cross-check and interpretation, and applies the appropriate pitch, bank, and power corrections in the correct sequence to return the aircraft to a stabilized level flight attitude.

V. NAVIGATION SYSTEMS
A. Intercepting and Tracking Navigational Systems and DME Arcs
1. Exhibits adequate knowledge of the elements related to intercepting and tracking navigational systems and DME arcs.

2. Tunes and correctly identifies the navigation facility.

3. Sets and correctly orients the course to be intercepted into the course selector or correctly identifies the course on the RMI.

4. Intercepts the specified course at a predetermined angle, inbound or outbound from a navigational facility.

5. Maintains the airspeed within +/-10 knots, altitude within +/-100 feet, and selected headings within +/-5°.
6. Applies proper correction to maintain a course, allowing no more than three-quarter-scale NC deflection of the CDI or within +/-10° in case of an RMI.

7. Determines the aircraft position relative to the navigational facility or from a waypoint in the case of GPS.

8. Intercepts a DME arc and maintain that arc within +/-1 nautical mile.

9. Recognizes navigational receiver or facility failure, and when required, reports the failure to ATC.

VI. INSTRUMENT APPROACH PROCEDURES

A. Nonprecision Approach (NPA)

NOTE: The applicant must accomplish at least two nonprecision approaches (one of which must include a procedure turn or, in the case of an RNAV approach, a Terminal Arrival Area (TAA) procedure) in simulated or actual weather conditions. At least one nonprecision approach must be flown without the use of autopilot and without the assistance of radar vectors.

1. Exhibits adequate knowledge of the elements related to an instrument approach procedure.

2. Selects and complies with the appropriate instrument approach procedure to be performed.

3. Establishes two-way communications with ATC, as appropriate, to the phase of flight or approach segment, and uses proper communication phraseology and technique.

4. Selects, tunes, identifies, and confirms the operational status of navigation equipment to be used for the approach procedure.

5. Complies with all clearances issued by ATC or the examiner.

6. Recognizes if any flight instrumentation is inaccurate or inoperative, and takes appropriate action.

7. Advises ATC or examiner anytime that the aircraft is unable to comply with a clearance.

8. Establishes the appropriate aircraft configuration and airspeed considering turbulence and wind shear, and completes the aircraft checklist items appropriate to the phase of the flight.

9. Maintains, prior to beginning the final approach segment, altitude within +/-100 feet, heading within +/-10° and allows less than ¾ scale deflection of the CDI or within +/-10° in the case of an RMI, and maintains airspeed within +/-10 knots.
10. Applies the necessary adjustments to the published MDA and visibility criteria for the aircraft approach category when required, such as—

a. NOTAMs.
b. Inoperative aircraft and ground navigation equipment.
c. Inoperative visual aids associated with the landing environment.
d. NWS reporting factors and criteria.

11. Establishes a rate of descent and track that will ensure arrival at the MDA prior to reaching the MAP with the aircraft continuously in a position from which descent to a landing on the intended runway can be made at a normal rate using normal maneuvers.

12. Allows, while on the final approach segment, no more than a three-quarter-scale deflection of the CDI or within 10° in case of an RMI, and maintains airspeed within +/- 10 knots of that desired.

13. Maintains the MDA, when reached, within +100 feet, -0 feet to the MAP.

14. Executes the missed approach procedure when the required visual references for the intended runway are not distinctly visible and identifiable at the MAP.

15. Executes a normal landing from a straight-in or circling approach when instructed by the examiner.

B. Precision Approach (PA)

NOTE: A precision approach, utilizing aircraft NAVAID equipment for centerline and vertical guidance, must be accomplished in simulated or actual instrument conditions to DA/DH.

1. Exhibits adequate knowledge of the precision instrument approach procedures.

2. Accomplishes the appropriate precision instrument approaches as selected by the examiner.

3. Establishes two-way communications with ATC using the proper communications phraseology and techniques, as required for the phase of flight or approach segment.

4. Complies, in a timely manner, with all clearances, instructions, and procedures.

5. Establishes the appropriate airplane configuration and airspeed/V-speed considering turbulence, wind shear, microburst conditions, or other meteorological and operating conditions.
7. Completes the aircraft checklist items appropriate to the phase of flight or approach segment, including engine out approach and landing checklists, if appropriate.

8. Prior to beginning the final approach segment, maintains the desired altitude +/-100 feet, the desired airspeed within +/-10 knots, the desired heading within +/-10°; and accurately tracks radials, courses, and bearings.

9. Selects, tunes, identifies, and monitors the operational status of ground and airplane navigation equipment used for the approach.

10. Applies the necessary adjustments to the published DA/DH and visibility criteria for the airplane approach category as required, such as—
   a. NOTAMs
   b. inoperative visual aids associated with the landing environment.
   c. NWS reporting factors and criteria.

11. Establishes a predetermined rate of descent at the point where the electronic glide slope begins, which approximates that required for the aircraft to follow the glide slope.

12. Maintains a stabilized final approach, from the Final Approach Fix to DA/DH allowing no more than threequarter scale deflection of either the glide slope or localizer indications and maintains the desired airspeed within +/-10 knots.

13. A missed approach or transition to a landing shall be initiated at Decision Height.

14. Initiates immediately the missed approach when at the DA/DH, and the required visual references for the runway are not unmistakably visible and identifiable.

15. Transitions to a normal landing approach (missed approach for seaplanes) only when the aircraft is in a position from which a descent to a landing on the runway can be made at a normal rate of descent using normal maneuvering.

16. Maintains localizer and glide slope within three-quarters scale deflection of the indicators during the visual descent from DA/DH to a point over the runway where glide slope must be abandoned to accomplish a normal landing.

C. Missed Approach
1. Exhibits adequate knowledge of the elements related to missed approach procedures associated with standard instrument approaches.

2. Initiates the missed approach promptly by applying power, establishing a climb attitude, and reducing drag in accordance with the aircraft manufacturer's recommendations.

3. Reports to ATC beginning the missed approach procedure.

4. Complies with the published or alternate missed approach procedure.

5. Advises ATC or examiner anytime that the aircraft is unable to comply with a clearance, restriction, or climb gradient.

6. Follows the recommended checklist items appropriate to the go-around procedure.

7. Requests, if appropriate, ATC clearance to the alternate airport, clearance limit, or as directed by the examiner.

8. Maintains the recommended airspeed within +/-10 knots; heading, course, or bearing within +/-10°; and altitude(s) within +/-100 feet during the missed approach procedure.

**D. Circling Approach**

1. Exhibits adequate knowledge of the elements related to a circling approach procedure.

2. Selects and complies with the appropriate circling approach procedure considering turbulence and wind shear and considering the maneuvering capabilities of the aircraft.

3. Confirms the direction of traffic and adheres to all restrictions and instructions issued by ATC and the examiner.

4. Does not exceed the visibility criteria or descend below the appropriate circling altitude until in a position from which a descent to a normal landing can be made.

5. Maneuvers the aircraft, after reaching the authorized MDA and maintains that altitude within +100 feet, -0 feet and a flight path that permits a normal landing on a runway. The runway selected must be such that it requires at least a 90° change of direction, from the final approach course, to align the aircraft for landing.

**E. Landing from a Straight-in or Circling Approach**

1. Exhibits adequate knowledge of the elements related to the pilot's responsibilities, and the environmental, operational, and meteorological factors, which affect a landing from a straight-in or a circling, approach.
2. Transitions at the DA/DH, MDA, or VDP to a visual flight condition, allowing for safe visual maneuvering and a normal landing.

3. Adheres to all ATC (or examiner) advisories, such as NOTAMs, wind shear, wake turbulence, runway surface, braking conditions, and other operational considerations.

4. Completes appropriate checklist items for the pre-landing and landing phase.

5. Maintains positive aircraft control throughout the complete landing maneuver.

**VII. EMERGENCY OPERATIONS**

**A. Loss of Communications**

1. Recognizing loss of communication.

2. Continuing to destination according to the flight plan.

3. When to deviate from the flight plan.

4. Timing for beginning an approach at destination.

**B. One Engine Inoperative During Straight-and-Level Flight and Turns (Multiengine Airplane)**

1. Exhibits adequate knowledge of the procedures used if engine failure occurs during straight-and-level flight and turns while on instruments.

2. Recognizes engine failure simulated by the examiner during straight-and-level flight and turns.

3. Sets all engine controls, reduces drag, and identifies and verifies the inoperative engine.

4. Establishes the best engine-inoperative airspeed and trims the aircraft.

5. Verifies the accomplishment of prescribed checklist procedures for securing the inoperative engine.

6. Establishes and maintains the recommended flight attitude, as necessary, for best performance during straight-and-level and turning flight.

7. Attempts to determine the reason for the engine failure.

8. Monitors all engine control functions and makes necessary adjustments.

9. Maintains the specified altitude within +/-100 feet, (if within the aircraft's capability), airspeed within +/-10 knots, and the specified heading within +/-10°.

10. Assesses the aircraft's performance capability and decides an appropriate action to ensure a safe landing.

11. Avoids loss of aircraft control, or attempted flight contrary to the engine-inoperative operating limitations of the aircraft.
C. One Engine Inoperative—Instrument Approach (Multiengine Airplane)

1. Exhibits adequate knowledge of the elements by explaining the procedures used during an instrument approach in a multiengine aircraft with one engine inoperative.

2. Recognizes promptly, engine failure simulated by the examiner.

3. Sets all engine controls, reduces drag, and identifies and verifies the inoperative engine.

4. Establishes the best engine-inoperative airspeed and trims the aircraft.

5. Verifies the accomplishment of prescribed checklist procedures for securing the inoperative engine.

6. Establishes and maintains the recommended flight attitude and configuration for the best performance for all maneuvering necessary for the instrument approach procedures.

7. Attempts to determine the reason for the engine failure.

8. Monitors all engine control functions and makes necessary adjustments.

9. Requests and receives an actual or a simulated ATC clearance for an instrument approach.

10. Follows the actual or a simulated ATC clearance for an instrument approach.

11. Establishes a rate of descent that will ensure arrival at the MDA/DH prior to reaching the MAP with the aircraft continuously in a position from which descent to a landing on the intended runway can be made straight-in or circling.

12. Maintains, where applicable, the specified altitude within +/-100 feet, the airspeed within +/-10 knots if within the aircraft’s capability, and the heading within +/-10°.

13. Sets the navigation and communication equipment used during the approach and uses the proper communications technique.

14. Avoids loss of aircraft control, or attempted flight contrary to the engine-inoperative operating limitations of the aircraft.

15. Complies with the published criteria for the aircraft approach category when circling.

16. Allows, while on final approach segment, no more than three-quarter-scale deflection of either the localizer or glide slope or GPS indications, or within +/-10° or ¾ scale deflection of the nonprecision final approach course.

17. Completes a safe landing.
D. Loss of Primary Flight Instrument Indicators

1. Exhibits adequate knowledge of the elements relating to recognizing if primary flight instruments are inaccurate or inoperative, and advise ATC or the examiner.

2. Advises ATC or examiner anytime that the aircraft is unable to comply with a clearance.

3. Demonstrates a nonprecision instrument approach without the use of the primary flight instrument using the objectives of the nonprecision approach TASK (AREA OF OPERATION VI, TASK A).

VIII. POSTFLIGHT PROCEDURES

A. Checking Instruments and Equipment

1. Exhibits adequate knowledge of the elements relating to all instrument and navigation equipment for proper operation.

2. Notes all flight equipment for proper operation.

3. Notes all equipment and/or aircraft malfunctions and makes appropriate documentation of improper operation or failure of such equipment.
## Appendix B – HALE UAS KSAs

### HALE UAS Pilot KSA

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Recognize poor performance/abnormal indications and perform abort/emergency procedures as dictated by the situation

System operation

ATC clearances and pilot/controller responsibilities

Limitations of aircraft in terms of the ability of the UA to comply with ATC messages

Procedures for requesting clarification, verification and changes

Frequency Management

Standard Phraseology for reading back clearances

Appropriate communications and navigation system transponder codes in compliance with the ATC clearance

Copy and correctly interpret ATC messages

Ability to operate radio and navigation equipment

Standard Instrument Departure procedures

Aircraft best climb profile

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Basic UA instrument flight control

Skill in using AVCS interfaces to access required information

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Stall characteristics and stall recovery procedures

Instrument crosscheck and interpretation procedures

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