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ROYAL AIR FORCE

FLYING INSTRUCTOR'S HANDBOOK

JET PROVOST

T.3 & T.4

AIR MINISTRY
AUGUST, 1962

RESTRICTED

◀**Amendment Procedure**

Temporary Amendment lists (T.A.L.s) to this handbook are issued by Headquarters, Flying Training Command and are to be inserted as appropriate. Subsequently permanent amendments are published in page form and are to be inserted in the appropriate place. New or amended passages are indicated thus ◀............▶ to show the extent of amended text and ▶◀ to show where text has been deleted. ▶

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FLYING INSTRUCTOR'S HANDBOOK

JET PROVOST

INTRODUCTION

1. This publication is an authoritative guide to basic flying instruction. The recommended sequence of the air exercises is the result of experience, but this book cannot be a substitute for individual instructional experience and in no way removes from the instructor the right to use his own initiative. It is, therefore, not essential for each lesson to take the precise form given, so long as the student becomes proficient.

2. The book provides:-

   a. A progressive series of Air Exercises which fulfill the requirements of basic training.

   b. Useful advice to instructors in the form of an Instructional Guide.

   c. The important points of each exercise that should be made clear to the student.

   d. References to those parts of A.P. 129 on which detailed briefings and discussions can be based.

3. a. The information contained in this book can be applied to teaching in the Jet Provost Mks. 3, 4 & 5. Where speeds or settings differ they are written "90/90/95 knots" being speeds for the Marks 3, 4 and 5 respectively.

   b. When presenting an exercise in the Mk 5, consult Annex A for any additional points peculiar to the Mk 5. Unless specifically excluded or changed in Annex A, all the material in the normal sections will apply to the Mk 5.

Instructional Guide

4. The handbook is separated into a series of Air Exercises, each of which has an Introduction (Instructional Guide) which consists of:-

a. General advice on the stage at which the exercise should be taught and on features of the exercise.

b. Considerations applicable to the Air Exercise on which instructors can base their lesson to give the student the necessary background knowledge. These considerations may have been covered in ground school but they should in any case be revised with the student.

c. Advice to the Instructor on the best method of teaching certain sequences of the Air Exercises and, where necessary, amplifying remarks which apply to certain of the observations in the Air Exercises.

d. A list of the more common faults made by students and advice on how to correct them.

Air Exercise

5. The Air Exercise proper is arranged into:-

a. A series of sequences which detail the appropriate demonstrations. The power settings and speeds to be used are given whenever they have a bearing on the success of the demonstration.

b. A list of observations which apply to each sequence. The observations should be made to the student at suitable moments during the demonstration.

6. In the initial demonstration of an exercise it may be unwise to attempt to cover all the observations. The intensity of the instruction given should be tailored to the ability of the student, the aim being eventually to cover all the points in a reasonable time. Note that the order in which the observations are given is not a reflection of their importance - all are equally important - but their order is logical if all the comments are made in a single demonstration.

Preparatory Instruction. Preparatory instruction is a detailed discussion and briefing, and should be given before each new exercise is taught in the air. This briefing should cover the subject thoroughly and may take up to an hour to deliver. The opportunity should be taken to link the instruction given in ground school to the practical aspects of flying. The briefing should be practical and aimed directly at what is to be taught in the air.

8. Pre-Flight Briefing. The pre-flight briefing, which is given just before each flight, should cover such details as the effect of the weather on the course of the flight, any unusual obstacles of restrictions in the circuit and on the airfield, and similar information. A resume of the main points of the lesson about to be taught must be included: these points can be based on the relevant "Observations" in the Air Exercise.

9. Post-Flight Discussion. The post-flight discussion is used to review the exercise and amplify or explain any special point of interest or difficulty that has arisen. This discussion is invaluable for consolidating what the student has just learned.

Notes on Basic Instruction

10. The attitude of the instructor towards his student can have a significant effect on the rate of progress. The instructor should spare no effort to stimulate the student's interest and enthusiasm byteaching in a way that holds the interest. The rate of progress varies between students, but the successful accomplishment of each new exercise serves as a useful spur to further effort. If any feeling of antipathy or incompatibility is sensed in the instructor/student relationship, the student should be put in the hands of another instructor; if this is not done the student's progress may beaffected to the extent of complete failure to progress.

EXERCISE 1

FAMILIARIZATION WITH THE AIRCRAFT

AIM: To familiarize the student with the aircraft, its controls and systems, and to teach the checks, vital actions, procedures, and emergency drills.

INSTRUCTIONAL GUIDE

1. The impressions given at this stage will influence the student's attitude towards instruction and the aircraft. The approach made to this lesson should be such as to instil confidence and promote keenness; and will, if covered thoroughly, save a great deal of time and trouble at later stages.

2. The student should be given an explanation of constructional and technical points without going into too much detail which might confuse and discourage him at this stage. As the training progresses, his knowledge of the aircraft and its systems should be increased to a satisfactory standard by the time he is ready for first solo.

3. As much of this instruction as possible should be given at the aircraft since this is where his main interest lies.

4. **Aircraft.**

(*a*) *Externally*. The student should be taken around the aircraft and given a general survey of the main features. Such items as control surfaces, tabs, intakes, aerials, etc., should be pointed out but without too much detail at this stage.

(*b*) *Internally*. A useful way to explain the cockpit layout once the pupil has had time to become familiar with the position of the major controls is to conform to the order of the internal checks given in Pilot's Notes. The value of systematic cockpit checks should be pointed out. Ensure that the student understands the operation of the canopy and is able to adjust his harness, seat height, and rudder pedals. Particular care must be taken to ensure that he is briefed on, and fully understands, the orders relating to the safety pins fitted to the ejection seats and the hood jettison firing gun.

5. **Aircraft Systems.** Explain the various systems to the student and remind him that information can be found in Pilot's Notes. Technicalities should be avoided at this stage, with the discussion being confined to the practical operation of the system. He should be informed that he will be expected to have a sound working

knowledge of the following systems before he is allowed to fly solo:—

(*a*) Fuel and oil system.

(*b*) Starting system.

(*c*) Hydraulic system.

(*d*) Electrical system.

(*e*) Oxygen system.

(*f*) Radio installation.

(*g*) Centralized warning system.

(*h*) Fire warning and extinguisher system.

(*j*) Flight instrument operation.

(*k*) Hood jettison and ejection seat operation.

(*l*) Cockpit heating, demisting and de-icing systems.

6. **Drills and Checks.** Drills and checks must become instinctive, and the student should become familiar with the cockpit layout so as to be able to locate all controls, switches, indicators and equipment without looking. He should be encouraged to make good use of any spare time at the flights by practising checks and drills in the cockpit with the aid of Pilot's Notes.

7. **Emergency Drills and Equipment.** It must be made quite clear to the student from the outset that Emergency Drills exist and are practised in case an emergency arises, not because they are always expected or are at all commonplace. Emphasize that, if an emergency does occur, seconds are vital, and the position and operation of the equipment and the drills must be so thoroughly known that action is instinctive. The following drills must be thoroughly learned, and frequently practised throughout the course so that no time is lost by indecision or confusion:—

(*a*) Action in the event of fire, in the air and on the ground.

(*b*) Engine failure in flight and relighting procedure.

(*c*) Hydraulic system emergency operation.

(*d*) Canopy jettisoning.

(*e*) Abandoning the aircraft:—

(i) Ejection—automatic and manual separation.

(ii) Free bale-out.

(*f*) Crash landing actions.

Note.—This instruction should be given in the emergencies trainer as far as is possible so that the pupil may carry out the complete actions. Failing this, any instruction given in the aircraft should be made more realistic by his touching the controls he would use.

Instructors must ensure that their students know the drills listed above before the student's first solo, and must continue instruction and revision at frequent intervals thereafter.

8. **Summary.** Although this lesson contains no air instruction it is vitally important and must not be skimped in any way. The operation of the ejection seat, and the abandoning the aircraft drills must be completed before the student flies and the remainder must be completed before he is sent solo. Revision and further instruction should continue throughout the course to increase his knowledge of the aircraft and systems and frequent checks made of the student's competence.

EXERCISE 2

PREPARATION FOR, AND ACTION AFTER FLIGHT

AIM: TO TEACH THOROUGH PREPARATION FOR FLIGHT AND THE ACTION AFTER FLIGHT.

INSTRUCTIONAL GUIDE

1. Thorough and efficient preparation before flight is essential for the safety and overall success of any flight, and particularly for training flights. This preparation entails not only a check of equipment and aircraft but also careful planning and briefing for the flight to be undertaken.

2. Both in this and the previous exercise, a great deal of explanation is required and the student cannot be expected to absorb everything he is told on the first flight. The learning process is gradual and progressive; thus the preparation for flight should be a feature of all lessons and the student must be allowed to play an increasing part until he is proficient. He *must* know the pre-flight procedure and checks by the time he is ready for solo. One of the best ways to ensure this, is to make the student say the checks aloud, touching each item as he is checking it.

3. **Flying Clothing**. The comfort of the student in the air will have considerable bearing on his learning ability; it will be necessary in the early stages to advise him on what to wear. He should be told of the importance of wearing the correct flying clothing, and of maintaining it correctly. A check should be made that his helmet fits correctly, that he can hear clearly, and that his protective helmet is properly fitted and comfortable. Headsets and oxygen masks should be checked before all flights. He should be warned of the dangers associated with loose articles in the cockpit and of the need to check that objects cannot fall from the pockets of his flying overalls. The importance of reporting articles lost in aircraft should be stressed.

4. **Maps.** Ensure that the student always carries the appropriate maps. These should be marked with the local low-flying and prohibited areas, airways, and any other pertinent navigational or air traffic information.

5. **Flight Authorization and Aircraft Acceptance.** The student should be introduced to such points of pre-flight planning as the latest weather information, flying state and air traffic information; avoiding too much detail in the early stages. Reference should be made to the need to check for any recent flying orders. The use of the authorization sheet and Form 700 before flight should be explained.

6. **External Checks.** A general check of the following points should be made:—

(*a*) The aircraft is on a suitable surface, and in a satisfactory position for starting so that the jet efflux will not be directed toward other aircraft or buildings.

(*b*) Fire extinguishers are readily available.

(*c*) The taxi path is unobstructed.

The pilot's responsibility in respect of the external condition of the aircraft, security of panels, etc., should be explained and a detailed check of the points listed in Pilot's Notes carried out.

7. **Internal Checks.** Checks as listed in Pilot's Notes should be carried out before each flight. Student participation will help him to learn these checks and will also familiarize him further with the cockpit layout.

8. **Starting Procedure.** After completing the checks mentioned in para. 7 demonstrate the starting procedure, paying particular attention to the safety precautions and signals to the ground crew. The importance of checking the J.P.T. during the starting cycle should be mentioned together with the action to be taken if the limitations are exceeded. The checks after starting must be conscientiously carried out to ensure the serviceability of engine and systems. The student should be allowed to start the engine at the earliest opportunity as it will give him a sense of achievement and increase his receptiveness to further instruction.

9. **Shutting Down Procedure.** The procedure laid down in Pilot's Notes should be followed. The canopy should be closed when leaving the aircraft in wet weather, and a brief external examination should be made before leaving the aircraft.

10. **Completion of Authorization Sheet and Form 700.** Reference should be made to the recording of flying and instrument times on the authorization sheet and to the method of entering defects or serviceability of the aircraft in Form 700.

11. **Conclusion.** Perfection in checks, drills, etc., will result only from repeated practice, the temptation to hurry through the procedures in order to save time must be resisted. Allow the pupil to do as much as possible from the beginning and insist on him saying the checks aloud. His progress should be unobtrusively supervised, and, when he is competent, show your confidence in him by letting him carry out the full procedure.

EXERCISE 3

AIR EXPERIENCE

AIM: To accustom the student to the sensations of flying and to continue the familiarization with the aircraft.

INSTRUCTIONAL GUIDE

1. The lesson may take the form of an introduction to flying for the pupil who has never flown before, or as familiarization with the aircraft and local area for one who has limited passenger or glider flying experience.

2. Instruction is not normally undertaken on this flight but it can be a very valuable lesson, in that it gives the instructor an opportunity to assess, to some degree, the pupil's temperament and to decide on the manner of approach suitable for subsequent instruction.

3. This flight gives the pupil opportunity to gain knowledge of the aircraft and its operation by watching the instructor, and at the same time becoming accustomed to the new environment and novel sensations associated with flying before having to concentrate on learning.

4. The duration and form of the flight is variable and should be modified to suit individual cases. It should be made in the locality of the airfield so that local landmarks and the appearance of such ground features as airfields, rivers, towns and railways can be pointed out from the air. When the pupil has become accustomed to flying, encourage his interest by getting him to check height and airspeed, and by pointing out the use of the horizon as a reference. His confidence in the aircraft may be increased if it is correctly trimmed to show its stability with hands and feet off the controls. As a general rule treat the pupil and the aircraft gently during this flight, but any reasonable request should not be refused, or the impression may be given that some manœuvres are difficult or dangerous. Aerobatics, if requested, should be limited to manœuvres involving positive loading and the student watched for signs of apprehension or airsickness, the flight being curtailed if necessary. Avoid showing undue concern if he is physically sick.

5. Conscientiously carried out, not as an instructor's pleasure trip, this exercise can be of great value to the student. If his interest is fostered so that he enjoys his first flight, it will provide the foundation on which to build his future instruction.

6. After flight the pupil should be encouraged to ask questions. Try to discover tactfully if he has heard any unfavourable stories about the aircraft or its equipment; if he has, dispel these stories and build up as much enthusiasm as possible.

EXERCISE 4

EFFECTS OF CONTROLS

AIM: To teach the effects of the controls on the aircraft in flight.

INSTRUCTIONAL GUIDE

General

1. Since this is to be the student's first lesson in the air, the instruction should not be hurried. Points which are obvious to the experienced pilot are not so to the student and should not be glossed over or omitted; for example, the direction of movement of the trimmer controls and the rudder bar movement to obtain a required response from the aircraft, may not appear natural and will require special attention. The student must understand the effect of each control before the next is introduced; a clear insight into the principles of this lesson is an essential foundation for later exercises. More than one lesson is usually required to cover the scope of this exercise.

2. The r.p.m. settings and airspeeds given in this exercise are recommended to help the instructor to give satisfactory demonstrations. Unless higher or lower speeds are required for the purpose of the demonstration the general aim should be to fly at the range speed for the altitude.

3. It should be emphasized that displacement of the nose position when demonstrating effect of power, flap, etc., is a change of trim, which, if uncorrected, leads to a change of attitude.

Before Flight

4. **Preparatory Instruction.** The preparatory instruction should be confined to matters of immediate interest, and the following points discussed before the lesson:—

(*a*) Function of the flying controls.

(*b*) Effect of bank.

(*c*) Effect of yaw.

(*d*) Effect of airspeed.

(*e*) Trimming controls.

(*f*) Effect of power.

(*g*) Effect of inertia.

(*h*) Undercarriage.

(*j*) Flaps.

(*k*) Airbrakes.

(*l*) Engine handling.

(*m*) Management of fuel system and fuel state checks.

(*n*) Methods of orientation, use of R/T, REBECCA, and visual pinpoints.

Reference—A.P. 129, Vol. 1, Sect. 1 and Vol. 2, Part 2, Sect. 3, Chap. 1.

During Flight

5. Make certain that the student can hear clearly and is relaxed and comfortable. Check that he holds the controls correctly. Show how the natural horizon is used as a reference for interpretation of the aircraft attitude. Point out that its position relative to the cockpit coaming changes with attitude enabling small changes in pitch to be made or seen.

6. Avoid harsh control movements which may startle or cause discomfort to the student.

7. Allow the student to follow through on all demonstrations and to attempt all the effects demonstrated, giving sufficient time for him to become used to the feel of the controls and to appreciate their effects. Ensure that the aircraft is correctly trimmed before handing over control.

8. **Airmanship.**

(*a*) Since the student cannot be expected to keep a good lookout at this stage, the instructor should explain any actions that he takes for reasons of good airmanship.

(*b*) The correct method of handing over and taking over must be shown and adhered to.

(*c*) The use of the radio, REBECCA, and the map can be demonstrated, and the need to keep a constant check on fuel state and position emphasized.

9. **Flying Controls**. The student should be shown that the aircraft in flight is controlled in three planes relative to the aircraft, irrespective of its attitude.

(*a*) *Primary Effects.*

(i) Show that the response of the aircraft to control movement depends on the magnitude of the movement at any particular airspeed.

(ii) The rolling tendency resulting from the application of rudder should be prevented with aileron during both the demonstration and the student's participation.

(iii) When showing the primary effects of rudder remind the student that the primary function of the rudder is not to control direction but to balance the flight of the aircraft and to prevent yaw.

(iv) The yaw resulting from the application of aileron should be ignored during the primary effects demonstration.

(v) When demonstrating primary effects in banked attitudes, it is not a very convincing demonstration to use top rudder, nor to lower the nose when demonstrating elevator effects.

(*b*) *Further Effects*. It must be quite evident to the student that only the one control is being moved. This can be done by allowing him to rest his hands and feet on the controls.

10. **Effect of Airspeed.** Although the effectiveness of the controls is reduced and the aircraft reponse becomes relatively poor when the speed is reduced, it must be emphasized that positive control is still available.

11. **Effect of Trim.** Remind the student that the purpose of the trimming controls is to relieve the pilot of sustained loads on the flying controls. Emphasize that the adjustment of attitude should be made with the primary controls and the trimmers then adjusted until no force is required on the controls to maintain the attitude or lateral level. During this demonstration ensure that the pupil has his hands and feet resting only lightly on the controls or otherwise he may fail to recognize the no-load trim setting.

12. **Effect of Power and Airspeed Changes on Trim.**

(*a*) Ensure that the tendency of the nose to drop on application of power is shown and allow the demonstration to continue until the nose rises as a result of the increasing airspeed.

(*b*) When reducing power, show that the nose rises initially and then drops as the speed decreases.

13. **Effect of Airbrakes.** Compare the deceleration experienced by throttling back from a high cruising speed with and without airbrakes.

14. **Effect of Undercarriage.** Ensure that the student understands the meaning of the indicator warning lights and the A.S.I. warning flag.

15. **Engine Handling.** Emphasize the need for smooth throttle handling and the importance of checking the J.P.T. frequently. The student should be shown that idling in flight is higher than on the ground, and will increase with height and speed. The time taken to accelerate from flight idling and 60 per cent. r.p.m. should be compared. The method of checking fuel consumption and remaining endurance by reference to the fuel gauge should be mentioned.

EXERCISE 4

EFFECTS OF CONTROLS

AIM: TO TEACH THE EFFECTS OF THE CONTROLS OF THE AIRCRAFT IN FLIGHT.

AIR EXERCISE

1. **Airmanship.**

(*a*) Handing over and taking over control.

(*b*) Lookout.

SEQUENCE	OBSERVATIONS
2. **Effects of Flying Controls.**	
(*a*) Demonstrate primary effects of controls from straight and level flight at cruising speed.	(*a*) Elevators:— (i) Fore and aft movement of the control column. (ii) Nose up and down (pitching). (iii) Airspeed changes. (*b*) Ailerons:— (i) Lateral movement of control column. (ii) Wing up and down (rolling). (*c*) Rudder:— (i) Rudder bar movement. (ii) Nose left and right (yawing). (*d*) Aircraft response continues until control is returned to neutral position. (*e*) Response of aircraft related to amount of control deflection. (*f*) Smooth progressive control movements desired.
(*b*) Demonstrate primary effects in banked attitudes.	Effects are in relation to aircraft axes and not to the horizon.
(*c*) Demonstrate further effects from straight and level flight at cruising speed.	(*a*) Elevators—no further effects. (*b*) Ailerons:— (i) Primary effect (roll). (ii) Further effect is yaw, leading to further roll and spiral descent. (*c*) Rudder:— (i) Primary effect (yaw). (ii) Further effect is roll, leading to spiral descent.

SEQUENCE (*contd.*)	OBSERVATIONS (*contd.*)
3. Effect of Airspeed.	
Demonstrate effect on controls of low (100 knots) and high (220 knots) airspeed.	(*a*) Low airspeed:— (i) Sloppy feel. (ii) Reduced control effectiveness. (iii) Positive control still available. (*b*) High airspeed:— (i) Firm feel. (ii) Increased effectiveness.
◀ **4. Effect of Trimmers.**	
(*a*) Elevator Trimmer. Trim aircraft hands and feet off. Change attitude and show that new attitude creates out of trim condition. Retrim hands off in new attitude.	(*a*) Changed stick force. (*b*) Sense of trimmer operation. (*c*) Adjustment to relieve stick force. (*d*) Trimmers assist in maintaining attitude but are not used to change attitude. (*e*) Aircraft remains in selected attitude when accurately trimmed.
(*b*) Aileron Trimmer. Disturb lateral trim. Select wings level. Retrim hands off.	(*a*) As above.▶
5. Engine Handling.	
Open and close throttle.	(*a*) r.p.m. indications. (*b*) J.P.T. indications and limitations. (*c*) Flight idling. (*d*) Smooth handling desirable.
6. Effect of Throttle and Airspeed Changes on Trim.	
(*a*) *Increasing Power*. Trim to fly hands and feet off at cruising speed, increase to full power.	Increasing power and airspeed:— (*a*) Nose drops initially—power effect. (*b*) Nose rises when speed has increased.
(*b*) *Decreasing Power*. Trim to fly hands and feet off at 200 knots, and throttle fully back.	Decreasing power and airspeed:— (*a*) Nose rises initially—power effect. (*b*) Nose falls as airspeed decreases.

SEQUENCE (*contd.*)	OBSERVATIONS (*contd.*)
7. **Effect of Undercarriage.** Trim hands and feet off before each demonstration.	
(*a*) At 135 knots lower undercarriage.	(*a*) Attitude and airspeed before lowering. (*b*) Limiting speed 140 knots. (*c*) Trim change. (*d*) Undercarriage position indicator. (*e*) Decreased airspeed.
(*b*) At 120 knots raise undercarriage.	(*a*) Attitude and airspeed before raising. (*b*) Limiting speed 125 knots. (*c*) Trim change. (*d*) Undercarriage position indicator. (*e*) Increasing airspeed.
(*c*) Fly at 100 knots, undercarriage up.	(*a*) Point out undercarriage warning flag in A.S.I. (*b*) Flag disappears when undercarriage lowered.
8. **Effect of Flap.** Trim to fly hands and feet off before each demonstration and after initial observations.	
(*a*) Lower flap to take off setting at 145 knots.	(*a*) Attitude and airspeed before lowering. (*b*) Limiting speed 150 knots. (*c*) Nose initially down and then up. (*d*) Increase in lift can be felt. (*e*) Lower airspeed.
(*b*) Lower full flap at 125 knots.	(*a*) Limiting speed 125 knots. (*b*) Nose-down trim change. (*c*) Further reduction in airspeed.
(*c*) Raise flap to take-off setting.	(*a*) Attitude and airspeed before raising. (*b*) Nose-up attitude change. (*c*) Increased airspeed.
(*d*) Raise flap completely.	As above but with sink—need for safe height (200 feet) and speed (110 knots) before raising.
9. **Effect of Airbrakes.** Trim hands and feet off at 220 knots.	
(*a*) Select airbrakes out.	(*a*) Attitude and airspeed before operation.

SEQUENCE (*contd.*)	OBSERVATIONS (*contd.*)
9. **Effect of Airbrakes** (*contd.*)	(*b*) Slight nose-up change of attitude. (*c*) Buffet. (*d*) Decreasing airspeed.
(*b*) Select airbrakes in.	(*a*) Slight nose-down change of attitude. (*b*) Airspeed increases.
(*c*) At 220 knots throttle fully closed, maintain ◀height▶.	Note slow rate of deceleration.
(*d*) At 200 knots select airbrakes out.	Rapid rate of deceleration.
(*e*) At 150 knots select airbrakes in.	
(*f*) At 120 knots select airbrakes out.	At low airspeed airbrakes much less effective.
10. **Effect of Flap and Airbrakes.** Select airbrakes out with flap down, or select flap with airbrakes out.	(*a*) Nose-down change of attitude. (*b*) Loss of height. (*c*) Not normal to select one service until the other is retracted, but there is no inherent danger in doing so.

POST-FLIGHT DISCUSSION

EXERCISE 5

TAXYING

AIM: TO TEACH HOW TO MANŒUVRE THE AIRCRAFT ON THE GROUND.

INSTRUCTIONAL GUIDE

General

1. The elements of taxying should be introduced as early as possible and the student given progressively more responsibility as his proficiency increases. The temptation to take over control in order to save time should be resisted so that he gains the maximum amount of taxying experience under supervision.

2. The sequence in which the items of this exercise are taught depends on variables such as wind velocity, airfield layout, and local regulations, as well as on the student's ability. The lesson should therefore be adapted to the prevailing circumstances. Whenever possible the initial taxying lessons should be done on a runway not in use, where there is plenty of room to manœuvre.

Before the Exercise

3. **Preparatory Instruction.** The following subjects should be discussed with the student:—

(*a*) Effect of inertia and momentum.

(*b*) Use of controls.

(*c*) Use of power.

(*d*) Effect of wind.

(*e*) Use of brakes.

(*f*) Engine handling.

(*g*) Marshalling signals.

Reference—A.P. 129, Vol. 2, Part 2, Sect. 1, Chap. 7, and Sect. 3, Chap. 1.

During the Exercise

4. Emphasize the constant need for a careful lookout and the inherent lack of manœuverability of aircraft on the ground. Mention the following points:—

(*a*) The flying controls have a negligible effect on the steering.

(*b*) The distribution of the keel surface tends to make the aircraft weather-cock into strong winds.

(*c*) There is a time lag between opening the throttle and the aircraft responding.

5. **Airmanship.** The student should be told that the captain is ultimately responsible for the safety of the aircraft and that, although marshallers' signals should normally be obeyed, the captain is at liberty to disregard them if he considers that the safety of his aircraft is endangered by following them. He should also be told of the annoyance and danger caused by directing his jet blast at other aircraft or ground crew, and of the danger of debris being blown into his intakes if he taxies close behind another aircraft.

6. **Lookout.** The great importance of a continuous watch for obstacles and other aircraft must be emphasized.

7. **Brake Failure.** The main considerations affecting the action to be taken if the brakes fail are:—

(*a*) Proximity of obstacles and other aircraft.

(*b*) Wind strength and direction.

(*c*) Nature and gradient of the surface.

(*d*) Lack of control and inherent directional stability of the aircraft.

All these points should be discussed with the student but it should be made clear that usually the safest course of action is to switch off the engine and, if necessary, raise the undercarriage.

8. **Engine Handling.** Throttle movements should be smooth, and checks should be made of the engine instruments while taxying.

9. **Starting and Stopping.** More power is required to accelerate from rest than to maintain taxying speed, so 60 to 70 per cent. r.p.m. should be used initially, and the r.p.m. reduced when taxying speed is attained. To stop the aircraft, close the throttle and apply brake smoothly until the aircraft stops, then apply the parking brake. In dispersal, after the chocks have been placed in position, the brakes should be released.

10. **Control of Speed.** When demonstrating the correct taxying speed, point out that the most accurate assessment is obtained from the rate of movement of the ground close to the aircraft. The throttle should be closed before applying the brakes. Power and brakes are used together, only when turning or checking the brakes on leaving dispersal. The student should be warned that excessive use of brakes will cause overheating, damage, and possible failure. The aim should be to use the minimum r.p.m. to obtain the correct speed. Taxying speed should be reduced over uneven surfaces.

11. **Directional Control and Turning.** Due to the inherent stability resulting from a nose-wheel undercarriage the aircraft will maintain a given direction unless the wind is of sufficient strength to cause a

weather-cock tendency. The brakes provide the only useful means of directional control at taxying speeds since the rudder is virtually ineffective except when taxying into strong winds. The correct turning technique is to use sufficient brake to obtain the required turning rate and enough power to keep the aircraft moving. The direction and amount of brake application required to enter and leave turns must be anticipated and are effected by the wind velocity and whether the turn is made into or downwind.

12. **Turning in a Confined Space.** When turning in a confined space the tail can be made to swing quite sharply through a large angle. The necessity to ensure that there are no obstacles in the path of the tail must be emphasized. The pupil should be told that turning on a locked wheel can cause damage to the tyre and strain on the undercarriage leg, and must be avoided unless the safety of the aircraft is involved.

13. **Leaving Dispersal.** The student should have had sufficient practice at taxying away from the dispersal area to become reasonably competent before this part of the exercise is introduced. When the aircraft has begun to move forward, and before the power is reduced, both brakes should be applied together in order to check their operation without bringing the aircraft to a halt. The aircraft should only be allowed to move slowly prior to the brake check in case they are unserviceable. When turning in dispersal, care must be taken, where necessary, to minimize the danger of the jet efflux.

14. **Use of Controls.** The control column should be held neutral at all times when taxying, firmly so in strong wind conditions to prevent the control surfaces being blown violently against their stops. When turning rudder should be used in conjunction with the required amount of braking.

Common Faults

15. As the student gains experience and confidence he will develop a tendency to taxy too fast—particularly when solo. Although time should not be wasted owing to the high fuel consumption, the dangers and penalties of excessive speeds should be pointed out.

EXERCISE 5

TAXYING

AIM: To teach how to manœuvre the aircraft on the ground.

AIR EXERCISE

1. **Airmanship.**
   (*a*) Brake pressure.
   (*b*) Lookout.
   (*c*) R/T clearance.

Sequence	Observations
2. **Starting and Stopping.** When clear of dispersal, demonstrate starting and stopping in a straight line.	(*a*) Starting:— (i) Foot brakes on. (ii) Parking brake released. (iii) Foot brakes released. (iv) Open throttle to gain momentum. (v) Reduce throttle.
	(*b*) Stopping:— (i) Close throttle. (ii) Nose wheel straight. (iii) Continuous and equal brake application. (iv) Parking brake applied when stationary.
3. **Control of Direction and Turning.**	
(*a*) Demonstrate up or down wind if strong.	(*a*) Controlling direction and turning:— (i) Rudder and brake as required to turn. (ii) Power to maintain speed.
	(*b*) Anticipation.
(*b*) Demonstrate across wind when strong enough to give the desired effect.	(*a*) Weather-cock tendency. (*b*) Turns into wind tend to speed up. (*c*) Turns away from wind sluggish and require more brake.
4. **Control of Speed.**	(*a*) Smooth use of throttle. (*b*) Control of speed with:— (i) Power. (ii) Brake. (*c*) Factors affecting speed:— (i) surface gradient. (ii) Nature of surface. (iii) Wind velocity. (*d*) Judging speed. (*e*) Avoid excessive taxying speeds. (*f*) Avoid use of power against brake.

SEQUENCE (*contd.*)	OBSERVATIONS (*contd.*)
5. **Turning in Confined Spaces.**	(*a*) Low speed. (*b*) Use of brakes and power. (*c*) Importance of keeping aircraft moving with nose wheel turned. (*d*) Avoid turning on locked wheel. (*e*) Check tail is clear of obstacles.
6. **Leaving Dispersal.**	(*a*) Checks. (*b*) Taxy path clear. (*c*) Chocks away. (*d*) Brakes tested as soon as possible. (*e*) Engine efflux dangers. (*f*) Low speed. (*g*) Careful lookout. (*h*) Marshallers' signals—captain's responsibility. (*j*) Dismissing marshaller.

POST-FLIGHT DISCUSSION

EXERCISE 6

STRAIGHT AND LEVEL FLIGHT

AIM: TO TEACH HOW TO FLY THE AIRCRAFT IN A CONSTANT DIRECTION AT CONSTANT ALTITUDE IN BALANCED FLIGHT.

INSTRUCTIONAL GUIDE

General

1. Accurate flying is a measure of professional ability, and is required in straight and level as much as elsewhere.

Before Flight

2. **Preparatory Instruction.** The following points should be discussed with the student:—

(*a*) Forces acting on an aircraft in flight.

(*b*) Control of attitude in all planes.

(*c*) Balanced flight.

(*d*) Trim.

(*e*) Effect of power.

(*f*) Stability.

Reference—A.P. 129, Vol. 1, Part 1, Sect. 1, and Vol. 2, Part 2, Sect. 3.

During Flight

3. **Airmanship.** Stress the importance of a good lookout. Introduce the clock system of reporting aircraft, and ask the student to report the position of other aicraft by using this system.

4. **Orientation.** As in the previous lessons in the air, point out local landmarks and the headings to reach base. Give the student an increasing part to play in the navigation of the aircraft by encouraging him to keep a check on position, by calling for headings by RT, and by use of the Rebecca. The use of the sun as a rough check on direction can also be mentioned. The student should be given progressively more responsibility in this important aspect of navigation in subsequent lessons so that, by the time he is ready for solo, he will be near to competent to leave the circuit area.

Straight and Level Flight at Cruising Power

5. Pay attention to the following points:—

(*a*) The student should be shown how to judge the aircraft attitude by the position of the horizon in relation to the windscreen and how to use that attitude to fly straight and level. He should then concentrate initially on this. In the early stages of the exercise it is sometimes useful to allow the student to make a chinagraph line on the windscreen in the approximate position of the horizon, so that he may more easily detect changes of attitude.

(*b*) When capable of maintaining a constant attitude, the student should be shown how errors in the altitude are corrected by a number of small adjustments to the attitude to avoid the common error of "chasing the needles", caused by allowing insufficient time for the aircraft to settle in its new condition.

(*c*) Later in the exercise the student should be shown how to choose a reference point on which to keep straight and the method of regaining this heading should it alter.

(*d*) The inherent stability of the aircraft in straight and level flight is shown by trimming accurately and then releasing the controls.

(*e*) After the student has become fairly proficient at maintaining straight and level flight the instructor should introduce disturbances by upsetting the attitude, power and trim, and then ask the pupil to restore the aircraft to straight and level.

(*f*) Balanced flight means flight without slip. Slip is not normal in the Jet Provost and is only caused by pressure on the rudder; for example, leaving rudder on when recovering from a ▶◀ slow roll. Marked slip can be readily detected by the sensations experienced and by the yaw present if the wings are level. Slight slip, however, is more difficult to detect and the slip indicator must be used. Demonstrate unbalanced flight by applying considerable rudder, showing the yaw with the wings level and the indication of the slip indicator. Bank the aircraft in the opposite direction to prevent the yaw. ◀Point out that straight and level flight can be maintained, but that the feeling of slipping and loss of air speed (or loss of height if air speed is maintained) indicates inefficient flight. Recover by levelling the wings and correct the yaw with rudder, using outside visual references. Point out that reliance upon external references for yaw correction may result in slight residual unbalance. Show that the slip indicator *must* be used to attain completely balanced flight. The lesson to be learned therefore is that for accurate balanced flight the lateral level is controlled with the ailerons and the rudder *co-ordinated* with this to centralize the slip indicator.▶

6. **Straight and Level at Various Power Settings.**

(*a*) While flying at a constant attitude an increase in power causes the aircraft to accelerate and climb, and a decrease causes it to decelerate and descend. The correct technique, therefore, is to readjust the attitude whilst the speed is changing in order to maintain height. This requires co-ordination between throttle and elevator control.

(*b*) When reducing power, point out that when the speed has fallen below the minimum drag speed (115 knots) the drag is rising, and the aircraft will continue to slow down until it stalls. Before this occurs, demonstrate flying at cruising power in the high drag range (about 90 knots) and point out the inefficient flight conditions. Show then how *height must be lost* to accelerate out of the high drag range if power is not, or cannot, be increased.

(*c*) It is good practice to associate airspeed and height with r.p.m. settings during this exercise and thus provide a basis for interpolation when flying at selected airspeeds.

(*d*) The student should be given plenty of practice at this and the next exercise as they provide good trimming experience.

(*e*) This exercise is best carried out in the lower levels in order to take full advantage of the greater speed range of the aircraft.

7. **Straight and Level at Selected Airspeeds.**

(*a*) It is not necessary to teach this part of the lesson on the first straight and level exercise, but it is a natural follow-on to the preceding sequence, the r.p.m. settings being used to provide a basis on which to interpolate. This exercise should be practised frequently during succeeding flights and may be conveniently carried out when homing to base at the end of a detail. The need for co-ordination of control should again be emphasized.

(*b*) Owing to the reduction of thrust with altitude the r.p.m. setting required to maintain a selected airspeed will increase with height. Furthermore, the setting will vary slightly between aircraft since some engines run "hotter" than others and therefore develop more thrust. The student must be carefully briefed on these points or he may become confused when carrying out practice at different altitudes.

(*c*) The student should aim to carry out his general handling exercises at range speed for the particular height. 83 per cent r.p.m. will give a speed near range speed at any height.

8. **Range and Endurance Flying.** Range and endurance need not be introduced prior to solo, but should be shown before the student leaves the circuit solo. The practical applications should be demonstrated when the conditions arise, *e.g.* flying to the relief landing ground or when standing off for air traffic or meteorological reasons.

9. **Common Faults.**

(*a*) Despite careful instruction and warning to the contrary some students tend to develop the habit of using the trimmers to change attitude. This fault is not always easy to detect and should be watched for very carefully.

(*b*) Some students have difficulty in maintaining direction because they do not realize the importance of accurate lateral level.

(*c*) Inadequate lookout may be the result of over-concentration on accuracy. Encourage the student to strike a sensible balance.

EXERCISE 6 (1)

STRAIGHT & LEVEL FLIGHT

AIM: To teach how to fly the aircraft at constant height in a constant direction, in balance.

AIR EXERCISE

1. Airmanship.

   a. Lookout - clock code.

   b. Fuel, Oxygen, Engine, Instrument Checks.

   c. Location, orientation - visual, UDF, DME.

SEQUENCE	OBSERVATIONS
2. Straight and Level Flight. a. Demonstrate straight and level flight at cruising power.	a. Point out visual picture. b. Constant height, heading, in balance. c. Speed and RPM setting.
b. Demonstrate method of achieving achieving S and L visual picture using aileron and elevator.	a. Level wings and Raise or lower nose to estimated attitude on real horizon. b. Trim.
c. Achieving constant height.	a. Altimeter reading changing. b. Adjust nose attitude. c. Retrim. d. Check altimeter and re-adjust attitude if required.

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d.	Achieving constant direction.	a. Heading changing (visual picture or G 4 F compass).
		b. Check wings level by external references.
		c. Check balance.
		d. Check compass steady.
		e. Trim ailerons if necessary
e.	Maintaining S and L.	a. Need to hold visual attitude accurately.
		b. Method of lookout and need to include cross check of compass and VSI. Small visual attitude adjustments if necessary.
f.	Small corrections to height.	a. Small pitch attitude adjustment in required direction.
		b. Maintain until at correct height.
		c. Resume level flight.
		d. Speed stabilises.
		e. Retrim.
		f. Re-check level flight.
g.	Small corrections to heading.	a. Small amount of bank in required direction.
		b. Anticipate heading, roll wings level.
h.	Demonstrate aircraft stability.	a. If correctly trimmed, aircraft tends to maintain attitude if controls relaxed.

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b. If disturbed in pitch, it tends to return to trimmed attitude.

c. If disturbed in yaw, it tends to return but not fully.

d. If disturbed in bank, there is no righting tendency.

i. Show both exaggerated and slight degrees of slip by applying bank and keeping straight with rudder, maintaining height.

a. Note airspeed in balanced flight.

b. Exaggerated slip.

(1) Physical sensation.

(2) Slip indicator.

(3) Reduced IAS, ineffecient flight.

c. Recovery.

(1) Level wings

(2) Correct slip with rudder

d. Slight slip difficult to feel value of slip indicator.

EXERCISE 6 (2)

STRAIGHT AND LEVEL AT SELECTED AIRSPEEDS

AIM: To teach how to maintain straight and level flight at any required speed.

AIR EXERCISE

SEQUENCE	OBSERVATIONS
1. Maintaining straight and level while changing airspeed.	
a. Deceleration. Demonstrate effect of reducing speed. Close throttle, maintain attitude initially and then S & L. Adjust RPM to hold a low speed.	a. Attitude for level flight at cruising power/speed. b. Inertia, speed decreases slow

c. Loss of lift, aircraft descends.

d. Altimeter or VSI indications.

e. To maintain S & L, nose must be progressively raised, in response to instrument indications, as speed decreases.

f. Maintain direction and lookout.

g. Need to retrim.

h. New aircraft nose high attitude.

i. Note RPM required to maintain IAS.

b. Acceleration. Demonstrate effect of increasing speed by applying full power and maintaining S& L

a. If attitude were maintained, aircraft would climb.

b. Altimeter and VSI indications.

c. To maintain S & L, nose must be progressively lowered, in response to instrument indications, as speed increases.

d. Maintain direction and lookout.

e. Need to retrim.

f. New nose low attitude.

g. Maximum level speed at demonstration height.

2. Achieving selected air speeds whilst maintaining S & L.

(TAL 18, MAY 70)

a. Demonstrate method of reducing speed for large and/or rapid reductions.

a. Throttle closed.

b. Slow deceleration.

c. A/Bs out if large and/ or rapid decelerations required; trim change.

d. Necessary attitude changes.

e. Increases RPM to that required as new speed approaches.

f. A/Bs in as selected speed is reached.

g. Speed settles, adjust RPM if required.

h. Retrim.

b. Demonstrate method of increasing speed rapidly and/ or a large amount.

a. Open throttle fully.

b. Necessary attitude changes.

c. Set required RPM, anticipation depends on rate of acceleration.

d. Speed settles, adjust RPM if necessary.

e. Retrim.

c. Small adjustment to airspeed. (which may be taught at suitable opportunities)

a. To change speed slowly:

(1) Set RPM required.

(2) Speed changes slowly.

(3) Speed settles, adjust RPM if necessary.

(4) Retrim.

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b. To change speed more rapidly.

(1) Set higher/lower RPM than that required.

(2) Speed changes more rapidly.

(3) Just before desired speed reached adjust power if necessary.

(4) Retrim.

c. To reduce speed by small amount, quickly.

(1) A/Bs out.

(2) Adjust RPM if necessary.

(3) A/Bs in at new speed.

3. Flight below minimum drag speed.

Demonstrate S & L flight below the minimum drag speed, using cruising RPM.

a. High nose attitude.

b. Inefficient flight, compare with normal cruising speed/RPM.

c. Aircraft may be accelerated with power if available; if not then height must be sacrificed.

4. Straight and Level with Flap.
Airspeed 120 knots.

a. Note attitude and power at 120 knots without flap.

b. Select T.O. flap.

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c. To maintain straight and level at 120 knots:

(1) Nose must be lowered.

(2) Increased power.

(3) Trim.

d. (1) Improved forward view.

(2) Better response to throttle adjustments.

(3) Higher fuel consumption.

e. Application to bad visibility configuration.

5. Range Flying
Demonstrate range speed for the height.

a. Range speed varies with altitude.

b. Elimination of drag.

c. Range increases with height.

d. Maximum distance - diversion.

6. Endurance Flying
Demonstrate endurance flying.

a. Speed 120/120/130 knots.

b. Elimination of drag.

c. Attitude.

d. Limited manoeuvre.

e. Endurance increases with height.

f. Maximum time in air - standby.

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EXERCISE 7

CLIMBING

AIM: To teach how to climb the aircraft at recommended airspeeds and power settings.

INSTRUCTIONAL GUIDE

General

1. For maximum efficiency an aircraft is climbed at the airspeeds and power settings recommended in Pilot's Notes. Although flaps are not normally used during the climb, the considerations for raising flap during the climb after a mislanding are included under Exercise 13.

Before Flight.

2. **Preparatory Instruction.**

(*a*) Recommended airspeeds.

(*b*) Effect of changing power.

(*c*) Effect of flap and undercarriage.

(*d*) Engine limitations.

(*e*) Effect of altitude.

(*f*) Use of oxygen.

Reference—A.P. 129, Vol. 1, Part 1, Sect. 1, and Vol. 2, Part 2, Sect. 3.

During Flight.

3. **Airmanship.**

(*a*) A good lookout should cover the whole area around the aircraft, but during the climb it is especially important that a good lookout is maintained above and behind, and of the area into which the aircraft is moving.

(*b*) Oxygen Checks should be made in accordance with Air Staff Instructions.

4. **Normal Climb.**

(*a*) The climbing speed should be set by first placing the aircraft in a climbing attitude, referring to the airspeed indicator, and adjusting the attitude as necessary when the airspeed has settled. Unless this method is used the pupil tends to "chase the airspeed".

(*b*) The throttle should be adjusted as necessary to maintain the correct r.p.m. during the climb.

(*c*) If the J.P.T. limitation is reached it should be controlled by reducing the r.p.m.

5. **Levelling-Off.**

(*a*) Initially the student should not be expected to level off from a climb at a specific height, nor should he be expected to maintain an accurate height until the aircraft has settled.

◀(*b*) The normal requirement is to level off at range speed, which in the Mk. 3 approximates to the climbing speed. In the Mk. 4 it will be necessary to teach levelling-off at a speed lower than climbing speed by reducing to cruising power before levelling-off.

(*c*) If speeds higher than range speeds are required, refer back to straight and level at selected airspeeds.▶

Common Faults

6. Students tend to neglect the J.P.T. when concentrating on the flying of the aircraft. The student should be reminded of the vital importance of not exceeding the limitations.

EXERCISE 7

CLIMBING

AIM: To teach how to climb the aircraft at recommended airspeeds and power settings.

AIR EXERCISE

Sequence	Observations
1. **The Normal Climb.**	
Demonstrate climb using climbing power and recommended airspeed.	(*a*) Lookout. (*b*) Assuming the climb:— (i) Full power—J.P.T. (ii) Attitude selected and held constant with wings level. (iii) Trim. *(iv) Aircraft settled—check speed. (v) Adjust attitude. (vi) Retrim hands off. (*c*) In the climb:— (i) Instrument indications. (ii) Lookout. (iii) Control of r.p.m. and J.P.T. (iv) I.A.S. reductions (5 knots per 5,000 feet). (*d*) Rate of climb decreases from ground level. (*e*) Oxygen checks.

[**NOTE.* The Mk. 4 should be climbed at 200 knots I.A.S. until ·4 Mach is reached, thereafter maintaining ·4 Mach.]

Sequence	Observations
2. **Levelling-Off.**	
◀Level-off from a normal climb at a predetermined height and at a speed the same as the climbing speed.	(*a*) Anticipation of height. (*b*) Reduction of power as attitude changes. (*c*) Wings level. (*d*) Trim. (*e*) Check height. (*f*) Adjust attitude. (*g*) Trim hands and feet off.▶

3. In the Mk. 4 it will also be necessary to teach levelling-off at a speed lower than climbing speed by reducing to cruising power before levelling-off.

POST-FLIGHT DISCUSSION

EXERCISE 8

DESCENDING

AIM: To teach how to descend at given speeds and rates of descent.

INSTRUCTIONAL GUIDE

General

1. An accurate descent involves a number of variables which must be correctly controlled and related to obtain the required performance, *i.e.* airspeed and rate of descent. These are:—

(*a*) Attitude.

(*b*) Power.

(*c*) Flap, undercarriage and airbrake settings.

It is particularly important to ensure that the student understands how they apply to the final approach before he is taught circuits and landings.

2. The main factors affecting the descent procedure when power is available are:—

(*a*) Fuel state.

(*b*) Distance from airfield.

(*c*) Weather conditions and visibility.

(*d*) Possibility of cockpit mist or ice.

(*e*) Air traffic regulations affecting local area.

3. It is not intended that all the sequences in the air exercise be introduced prior to solo. The glide and the effect of the variables on the descent should be shown and practised, and applied descents being left until later stages in the course.

Before Flight

4. **Preparatory Instruction**

(*a*) Recommended airspeeds.

(*b*) Effect of power.

(*c*) Effect of flap, undercarriage, and airbrakes.

(*d*) Effect of wind.

(*e*) Physiological effects—ears and sinuses.

Reference—A.P. 129, Vol. 1, Part 1, Sect. 1, and Vol. 2, Part 2, Sect. 3.

During Flight

5. **Airmanship.**

(*a*) During a long visual descent the heading should be changed at intervals so that a lookout can be maintained in the area into which the aircraft is descending.

(*b*) Descents through cloud should not be made unless some form of controlled descent is used or the pilot is sure that there is adequate clearance between cloud base and the highest ground within his circle of uncertainty. The student should be told never to descend below his safety height in cloud.

(*c*) Before descending rapidly from high altitudes full demisting should be selected.

(*d*) The student must be aware of the need to read the altimeter correctly and of the considerable lag present during very rapid descents.

(*e*) The methods and importance of clearing the ears must be explained to the student.

6. **Assuming the Descent.**

(*a*) When entering a 120-knot descent at idling r.p.m., the best method of entry is to throttle back and maintain height until 120 knots is achieved, then assume the gliding attitude. ▶◀ ◀ If necessary ▶ excess speed may be converted to height as in the case of a F.L.W.O.P.

(*b*) When the descending speed is higher than the cruising speed it is achieved more quickly by selecting the attitude first and reducing power when the desired speed is approached.

(*c*) The student may have difficulty in judging the aircraft attitudes required, since the nose may well be below the horizon. It is essential however that he does learn to assume the correct attitudes, quickly and accurately. He should be taught to cross refer to the instruments as soon as possible.

7. **Effect of Airspeed.** The student must understand the reason for gliding at the recommended speeds, and the dangers of trying to "stretch the glide".

8. **Effect of Flap and Undercarriage.**

(*a*) The student should be shown that flap induces a steeper descent path and an increased rate of descent at a constant speed, and, since the stalling speed is lowered, it enables a steep approach at a lower speed to be carried out.

(*b*) The airspeed can be maintained more accurately if the trim and attitude change is anticipated and countered when lowering flap.

(*c*) With the undercarriage lowered, the attitude is steeper and the rate of descent increased because of the greater drag.

◀9. **Effect of Airbrakes.** The airbrakes enable a steeper descent to be made for a given airspeed▶.

10. **Effect of Power.** To ensure that the pupil becomes proficient at descending under defined conditions he should be given frequent practice at varying the rate of descent while maintaining a constant airspeed.

11. **Gliding for Maximum Range.** The speed quoted in Pilot's Notes will give the maximum gliding range in still air conditions. A greater distance will be covered in strong head winds if the airspeed is increased and a slightly greater rate of descent accepted, whereas the best range in a strong tail wind may be obtained at the recommended endurance gliding speed. An increase of approximately 20 per cent in the rate of descent must be allowed for when estimating the range with the engine off.

12. **Side Slipping.** Variations in indicated stalling speed occur with extreme unbalance, particularly in the turn. Students should be made aware of these variations and adequate speed should be maintained. Apply rudder to slip, bank in the opposite sense to control direction, and maintain adequate airspeed.

Common Faults

13. The student will, often, not allow enough time to allow the airspeed to stabilize, and consequently "chases the needle".

EXERCISE 8

DESCENDING

AIM: To teach how to descend at given speeds and rates of descent.

AIR EXERCISE

SEQUENCE	OBSERVATIONS
1. The Glide Demonstrate how to enter and maintain a glide at 120 knots from cruising speed.	a. Lookout. b. Assuming the glide: (1) Close throttle. (2) Reduce speed. (3) Gliding attitude selected and held constant. (4) Wings level. (5) Trim. (6) Aircraft settled - check correct speed and readjust if necessary. c. In the glide, note: (1) Lookout. (2) Instrument indications - rate of descent. (3) Best range speed.
2. Levelling Off From the glide at 120 knots level-off at a predetermined height and cruising speed.	a. Anticipation of height. b. Full power applied. c. Attitude for straight and level flight selected. d. Select cruising power as cruising speed is reached.

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e. Trim.

f. Adjust height and airspeed as necessary.

3. <u>Effect of Undercarriage and Flap.</u> Demonstrate effect of undercarriage and flap on rate of descent while gliding at 120 knots.

a. Note attitude and Rate of Descent in clean glide.

b. Select undercarriage down:

(1) Lower nose position required to maintain 120 knots.

(2) When settled, note increased rate of descent.

c. Select take-off flap: when settled, nose position will be lower and rate of descent higher.

d. Select full flap. When settled, nose position is again lower, rate of descent again increased.

4. <u>Effect of Power.</u> Demonstrate how rate of descent can be varied by use of power. Descend with u/c and full flap selected. Increase and decrease RPM in stages maintaining 120 knots.

a. Note nose attitude and rate of descent.

b. If RPM increased.

(1) Need for higher nose attitude.

(2) Decreased rate of descent.

c. If RPM decreased

(1) Need for lower nose attitude.

(2) Increased rate of descent.

d. Thus changes in power allow the attitude and hence rate of descent to be varied while maintaining constant IAS.

(SAI 18, MAY 70)

5. Controlling Descent Path on Simulated Approach.
With u/c down and full flap selected descend towards a ground/cloud reference point maintaining 115 knots with 65/60/60% set and demonstrate how the descent path may be assessed and then varied by use of power.

a. Note constant aspect of reference point in windscreen on correct approach.

b. Vary power setting to show the changing aspect in the under and overshooting cases.

c. To regain constant aspect at 115 knots power and attitude must be adjusted.

6. Reducing Airspeed on Simulated Approach.
Descend with u/c and full flap selected show how airspeed can be reduced and controlled with power while maintaining the required descent path.

a. Establish correct descent path towards reference point at 115 knots.

b. Reduce power and maintain aspect of reference point by using elevator.

(1) Speed reduces slowly.

(2) Rate of reduction controlled by power.

(3) In making corrections need to anticipate slow response of IAS caused by aircraft inertia.

7. Descent at higher speeds.
Enter descent at 170 knots 65/60/60%, show rate of descent, then with airbrakes.
NOTE: Any speed may be used for descent other than CDTC.

a. Higher rate of descent.

b. Increase rateof descent with A/Bs out.

c. Application to controlled descent through cloud.

8. Sideslipping
From a straight descent at 115 knots, with undercarriage down, full flap and idling RPM sideslip the aircraft while maintaining airspeed.

a. Rate of descent in glide.

b. Sideslip aircraft.

(1) Apply bank and opposite rudder together.

(2) Maintain IAS.

c. Higher Rate of Descent at same IAS.

d. Slight increase in stalling speed.

e. Need to resume balanced flight well before touchdown.

f. Application to forced landings.

EXERCISE 9

MEDIUM TURNS

AIM: To teach how to turn onto specified headings using medium angles of bank.

INSTRUCTIONAL GUIDE

General

1. For the purposes of this exercise the amount of bank used should not exceed about 35 degrees. Turns using higher angles of bank are considered as steep turns.

2. All types of medium turns should be taught before starting circuits.

Before Flight

3. **Preparatory Instruction.**

(*a*) Principles of turning.

(*b*) Use of controls when turning.

(*c*) Use of power.

(*d*) Climbing and descending turns.

Reference—A.P. 129, Vol. 1, Part 1, Sect. 1, Chap. 12.

During Flight

4. The initial emphasis should be placed on the use of the horizon as an external reference for the correct judgement of attitude and angle of bank. As the student becomes more proficient he should be made to cross refer to the instruments to achieve greater accuracy.

5. The student should be able to enter and leave the turns smoothly before progressing to sustained turns through large changes of heading.

6. The direction of turn should be alternated so that the student obtains practice in turning in both directions.

7. **Airmanship.** The student often forgets to maintain a good lookout while concentrating on flying accurately. He should be told that a good lookout is very important before and during a change of direction, particularly on the side towards which he is turning. During the exercise he should be required to orientate himself at intervals so as to develop his sense of direction.

8. **Level Turns.** The following points should be remembered while teaching level turns:—

(*a*) The student should be taught to be systematic and apply the following basic checks to all turns:—

(i) Lookout.

(ii) Angle of bank and balance.

(iii) Attitude and height.

(*b*) In an accurate turn the airspeed settles at a slightly lower figure than that realized in level flight at the same power. When the aircraft is in a steady turn the airspeed should not fluctuate.

(*c*) The side-by-side seating arrangement in the Jet Provost makes it more difficult to judge the nose position. Demonstrate that the nose position appears lower when turning to starboard than when turning to port.

9. **Climbing Turns.** The handling technique is the same as for level turns but the speed is adjusted and maintained by use of the elevators. The angle of bank should be kept comparatively moderate to avoid a substantial fall in the rate of climb. The lower nose position required to maintain the climbing speed in the turn is not readily apparent to the pilot owing to the effect of the offset seating.

10. **Descending Turns.**

(*a*) The handling technique for entry to and recovery from descending turns is the same as for climbing turns.

(*b*) The effects of power, flap, undercarriage and airbrakes are the same as for a straight descent.

(*c*) The amount of power required to maintain a constant rate of descent increases as angle of bank is increased.

Common Faults

11. Most faults stem from the lack of co-ordination of the controls. It should be made clear to the pupil that a correction to any one of the variables involved in the turn will necessitate adjustments of the others. Co-ordination can be improved by getting the pupil to maintain height and balance while banking alternately to port and starboard.

12. Faulty turns often result from inaccurate flying and trimming just before entering the turns.

13. Some students become confused over the function of the controls when the aircraft is banked. It should be made clear that the controls still retain their basic functions when the aircraft is banked, viz:—

(*a*) Ailerons control angle of bank.

(*b*) Elevators control pitch attitude.

(*c*) Rudder controls yawing plane—slip.

EXERCISE 9

MEDIUM TURNS

AIM: To teach how to turn on to specified headings using medium angles of bank.

AIR EXERCISE

SEQUENCE	OBSERVATIONS
1. Level Turns	
a. Turn at 30 degrees angle of bank using cruising power.	a. Airspeed before entry.
	b. Lookout.
	c. Entry:
	(1) Control co-ordination.
	(2) Aileron to bank.
	(3) Pitch attitude controlled with elevator.
	d. In the turn:
	(1) Maintain correct bank with aileron.
	(2) Adjust pitch attitude to maintain height.
	(3) Balance with rudder-slip indicator.
	(4) Instrument indications.
	(5) Reduced IAS.
	(6) Lookout
	e. Rollout.
	(1) Control co-ordination.
	(2) Aileron to level wings.
	(3) Pitch attitude controlled with elevator.
	(4) Check straight and level.

b. Turns in opposite direction. Effect of offset seating.

c. Carry out turns on to pre-selected points and headings — Anticipation of recovery.

d. Turn at 45 degrees angle of bank maintaining 140 knots. (This exercise should be taught before teaching the circuit.)

a. Lookout.

b. Entry as for 30 degrees bank turn but

(1) Progressively increase power as bank increases.

(2) Progressive backward pressure on control column.

c. In turn:

(1) As for 30 degrees bank turns.

(2) Higher rate of turn.

(3) Airspeed same as entry.

(4) Instrument indications.

d. Recovery as for 30 degree bank turns except that power is progressively reduced at the same time as bank.

2. Climbing Turns

a. Demonstrate a climbing turn using 30 degrees of bank and climbing power, starting from a straight climb. (Mk 3 aircraft reduce to 20 degrees of bank above FL 150: Mk 4/5 aircraft reduce to 20 degrees of bank above FL 250).

a. Rate of climb before entry.

b. Lookout.

c. Entry and recovery is similar to level turn but pitch attitude adjusted to maintain airspeed.

d. In the turn:

(1) Maintain a constant angle of bank and speed.

(2) Lower rate of climb.

(3) Instrument indications.

c. Check straight climb after recovery.

b. Increase bank to higher angles.

a. Rate of climb reduces as bank increases.

b. Need for moderate angles of bank.

NOTE: Climbing turns using 45 degrees of bank and 140 knots should be taught before teaching the circuit.

3. Descending Turns

a. Demonstrate a 30 degree banked descending turn at 120 knots.

a. Straight descent at 120 knots

b. Attitude and rate of descent.

c. Lookout.

d. Entry and rollout similar to that for level turn, but pitch attitude adjusted to maintain speed.

e. In the turn:

(1) Maintain constant angle of bank and speed.

(2) Increased rate of descent.

(3) Instrument indications.

b. Demonstrate descending turns with u/c and t/o flap selected, at 115 knots. (Application to final approach should be taught prior to teaching the circuit).

a. Straight and level flight on selected heading.

b. Reduce power to 65/60/60%, adjust attitude to maintain 115 kts, and enter 30 degree banked descending turn.

c. Control rate of descent by use of power to lose 600-700ft in turning through 180 degrees.

EXERCISE 10

STALLING

AIM: TO TEACH HOW TO RECOGNIZE AN APPROACHING STALL AND HOW TO RECOVER FROM A STALL: FINALLY, HOW TO RECOVER WITH THE MINIMUM LOSS OF HEIGHT.

INSTRUCTIONAL GUIDE

General

1. The ultimate aim of this exercise is to teach the pupil how to recover with minimum loss of height; however, this aspect should not be over-emphasized in the early stages of the exercise. The student should first be able to identify the symptoms of a stall and know the correct method of recovery under all circumstances.

2. This exercise cannot be hurried, and should be spread over several trips. The whole exercise must have been taught before the student first flies solo.

3. Frequent dual and solo practice in all types of stall recovery should be given at intervals as training progresses.

Before Flight

3. **Preparatory Instruction.**

(*a*) Lift, stalling angle, and stalling speed.
(*b*) Characteristics of stall.
(*c*) Factors affecting stalling speed.
(*d*) Attitude and stall.
(*e*) Recovery from stall—use of power.

Reference—A.P. 129, Vol. 1, Part 1, Sect. 1, Chap. 5, and Vol. 2, Part 2, Sect. 3, Chap. 3.

During Flight

4. The student may be a little nervous at first; this is understandable, but he will gain confidence as he himself becomes able to identify and recover from the stall. As soon as possible he should be allowed to stall the aircraft and recover, and given plenty of practice until he becomes thoroughly proficient and confident.

5. In the early stages the student should be watched for symptoms of air sickness and the exercise discontinued if necessary.

6. Principal emphasis must be placed on the recognition of the stall warnings and the recovery. Although a practical method of entry must be taught, it is of less importance.

7. Stalling in turns and during aerobatics are considered under the advanced turning and aerobatics exercises.

8. **Airmanship.** The checks listed in the Air Exercise must be carried out before commencing any stalling, spinning or aerobatic exercise. Before the stall the throttle should be closed, the aircraft banked in both directions to clear the space below and if necessary the airbrakes used to reduce the speed so that the stall is carried out in the area that has been cleared. The pupil must appreciate the importance of a similar check before each stall.

9. **First Stall.** The student's first experience of a stall should show him that it is not in any way a frightening experience and should rid him of any false ideas of danger and violent sensations. The first stall is best done at the end of the lesson preceding that in which stalling is to be dealt with in detail. No instruction should be given during the first demonstration but the point of the stall and the commencement of recovery should be indicated. During the subsequent post-flight discussion the stall, as demonstrated, should be discussed and the student's questions answered; in this way he is better prepared for the detailed lesson on stalling.

10. **Symptoms of Stall.**

(*a*) A high nose-up attitude is not always a fundamental of an approaching stall. The nose-up attitude should only be pointed out when it is a valid indication that a stall is imminent.

(*b*) The pupil must be given plenty of practice at approaching the stall and detecting the symptoms for himself in order to become thoroughly familiar with them.

◀(*c*) As the aircraft approaches the stall slight buffeting can be felt on the control column. At the stall there is a slight nose drop; this occurs when the control column is in about the mid-position. Further rearward movement of the control column produces heavy buffeting and the nose of the aircraft will pitch up and down about the attitude assumed after the nose has dropped. At this point any further rearward movement of the control column may induce a wing drop.

Note: Stalling is not a precision exercise and although a student cannot be severely criticised for climbing slightly on entering the stall, instead of maintaining level flight, it should be pointed out that this may mask the slight nose drop. In this case the first indication of the stall will be the onset of the heavy buffet.▶

11. **Effect of Power on Recovery.** The smaller amount of height lost by using power in the recovery should be emphasized, and the student should not be given the impression that it is correct to use the control column only; it is the only method of recovery when power is not available.

12. **Effect of Airbrakes.** Airbrakes will cause the stall to be reached more quickly. The stalling speed is unaffected, but the pre-stall buffet is masked and the aircraft will lose more height in the recovery since the acceleration is reduced and a lower nose attitude is required.

13. **Recovery from Incipient Stage.** An unintentional stall should always be stopped at the incipient stage, therefore the emphasis should be placed on quick recovery action as soon as any stall warning symptoms are recognized. The student should be given ample practice in recovering from the incipient stage of all types of stalls.

14. **Stall under Approach Conditions.** The demonstration should be made as realistic as possible. Show how lack of attention to accurate flying can lead to a stall when concentrating on the approach to land. Although the emphasis is on recovery in the incipient stage the full stall should be shown and practised. Frequent practice must be carried out to ensure that the student learns to recover with the minimum loss of height.

15. **Stall at Higher Speeds.** The student should be under no doubt that the aircraft can be stalled at any speed and power. He should understand that the more extreme cases are not demonstrated because of the danger of overstressing the aircraft in the higher speed range.

16. **Use of Aileron when Stalled.** It must be emphasized that attempts to raise a dropped wing by use of the aileron, when the aircraft is in the fully stalled condition, may aggravate the rolling tendency and possibly cause a spin. If the aircraft is not in a fully stalled condition, the ailerons are effective—Sequence 10 of the Air Exercise illustrates this point. It must be pointed out to the student that the instructor is holding the aircraft at the stall in order to demonstrate certain features, and that normally recovery is initiated earlier.

17. When the student has become proficient at recovery from stalls in level flight he should be given practice at recovering from stalls in exaggerated attitudes, *e.g.* from steep climbs, climbing turns, and steep descending turns. The greater control column movement required to unstall the aircraft from a high nose attitude should be pointed out, as should the ease of recovery when the nose is well below the horizon.

Common Faults

18. Students often have difficulty in estimating the amount of control movement required to recover from the stall. Frequent practice and advice from the instructor is needed until the student

becomes proficient. When the instructor is demonstrating the recovery the student should be allowed to rest his hands and feet on the controls.

19. When a wing drops at the stall the student tends to correct by instinctive use of the ailerons. Only by practice and experience can the proper method be learned.

20. When power is applied during recovery the throttle movement is often hesitant. If this is so, the student should be shown that the amount of height lost and the rapidity with which control is regained both depend on the use of high power.

21. Many students allow the speed to increase during the clearing turns, resulting in a considerable time lag between clearing and the stall. They should be made to carry out the turns at about 120 knots and to throttle back when rolling out, using airbrakes if required.

EXERCISE 10

STALLING

AIM: To teach how to recognize an approaching stall and how to recover from a stall: finally how to recover with the minimum loss of height.

AIR EXERCISE

Airmanship

1. **Checks.**

H—HEIGHT	Sufficient to recover above minimum height laid down in A.S.I.s.
A—AIRFRAME	FLAPS—As required. UNDERCARRIAGE—As required. AIRBRAKES—Test and IN.
S—SECURITY	No loose articles in the cockpit. HARNESS—Locked and tight.
E—ENGINE	J.P.T. and OIL PRESSURE within limits. FUEL—Sufficient for the exercise.
L—LOCATION	Clear of built-up areas, aerodromes and restricted airspaces.
L—LOOKOUT	Well clear of all other aircraft and cloud, vertically and horizontally.

SEQUENCE	OBSERVATION
2. **The Student's First Stall.** Stall and recover from straight and level flight.	(*a*) Not violent or unpleasant. (*b*) Control easily regained.
3. **Symptoms of a Stall.** Demonstrate a stall from straight and level flight.	(*a*) Entry—close throttle, maintain height. (*b*) Symptoms leading up to the stall:— (i) Decreasing airspeed. (ii) Decreasing effectiveness of controls. (iii) High nose attitude. (iv) Buffet. ◀(*c*) Symptoms at the stall:— (i) Slight nose drop. (ii) Heavy buffet. (iii) Sink. *Note.*—During the heavy buffet stage of the stall a wing may drop and the possibility is increased if the control column is moved fully back.▶

SEQUENCE (*contd.*)	OBSERVATIONS (*contd.*)
4. **Recovery from the Stall.**	
(*a*) Demonstrate a stall from straight and level flight, recover without using power.	(*a*) Note stalling height and airspeed. (*b*) Recovery without power:— (i) Control column forward to unstall wings. (ii) Level wings with aileron. (iii) Gain adequate flying speed. (iv) Ease out of dive. (v) Level-off and apply power. (*c*) Note amount of height lost.
(*b*) Demonstrate a stall from straight and level flight, recover using full power.	(*a*) Note stalling height and airspeed. (*b*) Recovery with power:— (i) Simultaneous application of full power and forward movement of control column. Move control column sufficiently far forward to unstall the wings and use aileron, if necessary, to level the wings. (ii) Adequate flying speed regained more quickly. (iii) Ease out of dive and note height loss. (*c*) Compare the height lost during this exercise with the height lost during a recovery without power. (*d*) This is the STANDARD STALL RECOVERY FOR THE JET PROVOST.
5. **Recovery from Incipient Stall.**	
Demonstrate a recovery from initial buffet stage using standard recovery.	(*a*) Note height. (*b*) Standard recovery when buffet felt. (*c*) Small change of nose attitude to regain safe control. (*d*) Little or no height loss.
6. **Effect of Flap on the Stall.**	
Demonstrate stalls with take-off and full flap. During recovery care must be taken not to exceed limiting speeds.	(*a*) Speed falls rapidly. (*b*) Shorter duration of stall warning. (*c*) Lower stalling speed. (*d*) Tendency to drop a wing.

AIR EXERCISE
SEQUENCE (Contd)

OBSERVATIONS (Contd)

e. Standard recovery

f. Slower acceleration - but safe flying speed gained earlier - with flap, better control at low airspeed.

7. Stall under Approach Conditions.

a. Demonstrate and recover from a full stall in the Glide Approach Configuration.

a. Straight descent at 100 kts.

b. Note attitude.

c. Raise nose slowly to reduce IAS to the stall.

(1) High nose attitude

(2) Short duration of stall warning

(3) Tendency for wing drop

d. Recover from stall

(1) Slow increase in thrust

(2) Slower acceleration

(3) Height loss when level

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SEQUENCE (Contd)

OBSERVATIONS (Contd)

e. Stress importance of 600 ft decision in glide approaches.

NOTE Observation e may be omitted during initial stall instruction but must be repeated before beginning glide circuits.

b. Demonstrate a recovery from a full stall in the Approach Configuration using 75/65/65% rpm.

a. Straight descent at 100 knots.

b. Note nose attitude.

c. Raise nose to decrease airspeed to the stall:-

(1) Very high nose attitude.

(2) Short duration of stall warning.

(3) Low stalling speed.

(4) Tendency for wing drop.

d. Standard recovery, noting height loss.

e. Raise undercarriage and flaps as follows:

(1) Undercarriage up when gaining height

(2) When U/C lights out, flap to take off.

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(3) Flap up at safe height with 110 knots or more.

c. Demonstrate a further stall in same configuration recovering at incipient stage.

a. Very little buffet.

b. High nose attitude a good indication of approaching stall.

c. Recover at incipient stage.

d. Small height loss.

d. Demonstrate a recovery from incipient stage in a descending turn in approach configuration.

a. In a descending turn at 115 knots, note nose attitude.

b. Raise nose to decrease airspeed to the stall:

(1) Very high nose attitude

(2) Short stall warning

(3) Importance of recovering at the incipient stage.

8. Effect of Airbrakes on the stall.

Demonstrate a stall using airbrake and leaving airbrakes out during recovery.

a. Pre-stall buffet masked

b. Standard recovery

c. Slightly slower acceleration.

9. Stall in Manoeuvre.	a. Buffetting
Demonstrate stalls at higher speeds in various attitudes and later in aerobatics.	b. Stalling speed higher than in level flight.
	c. Aircraft may be in any attitude.
	d. Relax back pressure to unstall.
	e. Small control column movement to regain control.
	f. Aircraft may 'mush' downwards, even though nose is above horizon.
	g. This stall is the result of harsh use of elevators.
	h. If recovery is delayed aircraft may flick.
10. Use of Aileron when stalled.	
Demonstrate that aileron, used to correct roll whilst the aircraft is stalled, may only aggravate roll.	a. Use of aileron aggravates roll.
	b. Ailerons are effective up to the stall and as soon as the aircraft is unstalled. Only whilst the aircraft is held in a stalled condition are aileron movements likely to produce adverse effects.

POST-FLIGHT DISCUSSION

EXERCISE 11

SPINNING

AIM: TO ACCUSTOM THE STUDENT TO SPINNING AND TO TEACH AND PRACTISE RECOVERIES FROM INCIPIENT AND DEVELOPED SPINS.

INSTRUCTIONAL GUIDE

General

1. Although it is not unusual for the student to be somewhat nervous during the first spins, there may be some doubt as to his suitability for further training if he continues to be apprehensive.

2. Dual practice spins should be carried out at intervals throughout the student's training.

3. Spinning is a frequent cause of air-sickness and the lesson should be discontinued if any signs of illness appear.

4. The student must appreciate that a spin results from a stall (regardless of attitude or loading) which is accompanied by a yaw or roll, and he should ultimately be able to recognize the conditions which may lead to an unintentional spin in time to take preventative action.

Before Flight

5. Preparatory Instruction.

(a) Causes, stages and characteristics of the spin.

(b) Recovery action, including delayed spin recovery actions.

(c) Engine handling.

(d) Inverted spinning (inverted spinning is not demonstrated or practised but the student should be briefed on the recovery action before starting solo aerobatics).

Reference - AP 129, Vol, 1, Part 1, Sect 1, Chap 5, and Vol 2, Part 2, Sect 3, Chap 3. Pilot's Notes.

During Flight

6. The points of difference between a spin and a spiral dive should be made clear. The spiral dive is recognized by a steadily increasing airspeed and, usually, little or no slip.

7. In later stages of training incipient spins should be demonstrated off the more extreme attitudes such as those encountered in poorly executed aerobatics. These spins should have been practised before the student's first solo attempt at aerobatics.

8. The student should follow through on the controls during all spinning demonstrations.

9. Timidity should be discouraged and smooth, positive entries and recoveries demanded.

Airmanship

10. Checks should be carried out during the final stages of the climb to height. The throttle should be closed to reduce speed during steep turns in both directions to clear the airspace below, and the spin entered with the minimum of delay. The importance of a thorough lookout before each spin must be emphasized.

11. To avoid misunderstanding during recovery the words "Recover now" should always be used when telling the student to recover. The student should acknowledge "Recovering now" when he starts the recovery.

Physiological Effects

12. Prolonged spinning can cause disorientation and mental confusion; practices should therefore be carried out only in good visibility. Intentional developed spins should not be practised over the sea, over total cloud cover, or when the horizon or canopy is obscured. Rapid movements of the head during a spin should be avoided as this can lead to disorientation, and it is therefore preferable to look through the windscreen during the spin.

13. The student should be told of the effects of disorientation and of the probability of disorientation if an incorrect spin recovery procedure is used (see para 24). If the disorientation persists after spin recovery he should extend his airbrakes until he is able to level his wings and resume normal flight. He should be told that dizziness is not unusual after a prolonged spin.

Student's First Spin

14. The considerations are the same as those for the student's first stall (Exercise 10) and the first spin should therefore be done at the end of the previous exercise. The spin should consist of not more than two or three turns and the commencement of recovery action should be indicated.

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Spin Recovery Action

15. Normal spin recovery is:-

(a) Close the throttle, if not already closed.

(b) Apply and maintain FULL RUDDER to oppose the direction of yaw as observed visually and indicated by the turn needle.

(c) Observe a two-second pause.

(d) Ease the control column slowly forward until the spin stops (but not further than just forward of the neutral position) ensuring that the ailerons are neutral throughtout.

(e) Centralize the rudder immediately, but not before the spin stops.

(f) Level the wings and ease out of the dive.

Spin Recovery Considerations

16. (a) When spin recovery action is initiated, recovery may be proceded by a speed up in the rate of rotation before the spin stops.

(b) The time taken to recover, and hence the number of turns completed, will depend upon the angular momentum in the yawing and rolling planes, and the anti-spin yawing moment produced by the rudder. If the fuel state or the rate of rotation is high the angular momentum will be high and the maximum anti-spin yawing moment will take longer to reduce the rate of rotation. Movement of the stick forward tends to increase the rate of rotation so that the rudder must be allowed the full 2 seconds to take effect before the stick is moved. If the pause is shorter, or if less than full rudder is applied, recovery will be delayed. Normally the aircraft will recover within 2½ turns. Recovery times are not significantly affected by airbrakes, flaps or undercarriage position, but speed limitations are likely to be exceeded during the recovery.

(c) Releasing the controls will not achieve recovery.

(d) When spins are entered deliberately the direction of spin will be known. Where the spin is entered inadvertently the direction of spin may not be immediately apparent. For this reason the student should always be taught to refer to the turn needle of the Turn and Slip indicator regardless of whether the spin is deliberate or accidental. To recover from a spin the rudder must be applied in the opposite direction to the indicated turn.

(e) The student should understand that failure to centralize the rudder promptly when the spin stops may cause the aircraft to spin in the opposite direction.

(f) The student should become accustomed to the sensation of spinning in a progressive manner, hence prolonged spins should not be carried out until the student has some experience of spins of short duration. He should be warned that higher control forces may be required to recover and that the aircraft may take a little longer to stop spinning. Both hands may be used to hold the control column if necessary.

(g) The horizon should be located and used as a datum for levelling the wings after recovery.

Delayed Spin Recovery

17. If the aircraft has not recovered from the spin after recovery action has been maintained for three turns it is probable that

Continued

(*b*) Apply and maintain FULL RUDDER to oppose the direction of yaw as observed visually and indicated by the turn needle.

(*c*) Observe a two-second pause.

(*d*) Ease the control column *slowly* forward until the spin stops (not further than two-thirds forward), ensuring that the ailerons are neutral throughout.

(*e*) Centralize the rudder immediately, but not before the spin stops.

(*f*) Level the wings and ease out of the dive.

Spin Recovery Considerations

16. (*a*) When spin recovery action is initiated, recovery may be preceded by a speed up in the rate of rotation before the spin stops.

(*b*) The aircraft normally recovers within 2½ turns. Up to 3,000 feet may be lost from the initiation of the recovery to the attainment of straight and level flight. Recovery time from any spin varies with the rate of rotation, fuel state, *etc*. If the undercarriage, flaps and/or airbrakes are extended, recovery times are not significantly affected. However, the speed limitations of the undercarriage and flaps are likely to be exceeded during the recovery.

(*c*) Releasing the controls will not achieve recovery.

(*d*) When spins are entered deliberately the direction of spin will be known. Where the spin is entered inadvertently the direction of spin may not be immediately apparent. For this reason the student should always be taught to refer to the turn needle of the Turn and Slip Indicator regardless of whether the spin is deliberate or accidental. To recover from a spin the rudder must be applied in the opposite direction to the indicated turn.

(*e*) The student should understand that failure to centralize the rudder promptly when the spin stops may cause the aircraft to spin in the opposite direction.

(*f*) Prolonged spins should not be carried out until the student has some experience of spins of short duration. He should be warned that higher control forces may be required to recover and that the aircraft may take a little longer to stop spinning. Both hands may be used to hold the control column if necessary.

(*g*) The horizon should be located and used as a datum for levelling the wings after recovery.

Delayed Spin Recovery

17. If the aircraft has not recovered from the spin after recovery action has been maintained for three turns it is probable that

the controls have been mishandled, resulting in an abnormal spin (*see* para. 23 below). Carry out the following actions:—

(*a*) Recheck the turn needle.

(*b*) Ensure that *full* rudder to oppose the direction of yaw—as indicated by the turn needle—is applied.

(*c*) *Maintain* full recovery rudder until the spin stops.

(*d*) Maintain the control column about two-thirds forward.

(*e*) Centralize the rudder immediately, but not before, the spin stops.

(*f*) Level the wings and ease out of the dive.

Note. If recovery has not been achieved by 5,000 ft. a.g.l. the aircraft must be abandoned.

Recovery at Incipient Stage

18. When the pupil has mastered the recovery from the fully developed spin *the emphasis should be placed on early recognition of the various conditions that can lead to a spin, and to a quick and clean recovery at the incipient stage.* An unintentional spin is usually the result of an uncorrected or undetected stall, but in most cases the warning symptoms are so clear that the impending spin can be recognized and corrected before it reaches an advanced stage.

19. The incipient stage of a spin may be described as the initial roll immediately following a stall before the spin becomes fully developed. The characteristics of the incipient stage will vary according to the airspeed at which the stall occurs; from the basic stalling speed in level flight it may last no more than half a turn, whereas from higher airspeeds and with increased *g* loading the aircraft may complete a few flick rolls before the nose drops and the spin develops.

20. **Recovery.**

(*a*) *Low speed case.* When a spin starts from low airspeed there is no practical difference between a "stall with wingdrop" and an incipient spin. The rate of roll is likely to be comparatively slow, and the standard stall recovery will be the safest and most effective recovery action.

(*b*) *High speed case.* If a spin begins at a higher airspeed and under *g* loading, *i.e.* is encountered during manoeuvre, the rate of roll will be higher; recovery will be almost instantaneous if the controls are centralized as soon as rotation occurs. The throttle should be left where it is unless the aircraft is in a steep diving attitude, when it should be closed.

Spin From Turns and Manoeuvres

21. The direction of a spin from a turn will depend on the degree of misuse of the controls and the pupil should not attempt to anticipate the direction of spin.

22. As the pupil gains experience and before solo aerobatics, he should be given practice at recovering from incipient and full spins from manoeuvre. To avoid overstressing the aircraft full spins may be entered only from the rolling manoeuvre in rolls off the top and from stall turns, with the speed below 110 kts; full pro-spin control is to be used for entry and is to be maintained until recovery is initiated to reduce the likelihood of a high rotational spin. Instruction should be progressive with the student pre-briefed on the direction of spin during the early practices but eventually recovering from spins entered by his instructor without advanced warning.

Effect Of Incorrect Spin Recovery Procedure

23. The importance of following the correct recovery procedure cannot be too highly emphasised.

24. If the control column is moved forward during a normal spin, with only partial pro-spin or anti-spin rudder held on, the attitude will become more nose-down and the rate of rotation will increase to the point where disorientation may be experienced. This type of spin may be entered during recovery from a normal spin when mishandling of the controls causes the aircraft to spin in the opposite direction. Under these conditions the direction of spin may be incorrectly assessed. In order to ensure recovery, the direction of yaw should be noted from the turn needle and full recovery action taken as detailed in para 17.

25. In this type of spin the aircraft is in a near vertical attitude and rotating very rapidly. The rate of descent is higher than in a normal spin and the IAS may rise to 150 knots or more. This type of spin should not be demonstrated to students.

Inverted Spinning

26. Intentional inverted spinning is prohibited.

Spin from Turns and Manoeuvres

21. The direction of a spin from a turn will depend on the degree of misuse of the controls and the pupil should not attempt to anticipate the direction of spin.

22. As the pupil gains experience, and before solo aerobatics, he should be given practice at recovering from incipient spins entered from various attitudes and manoeuvres.

Effect of Incorrect Spin Recovery Procedure

23. The importance of following the correct recovery procedure cannot be too highly emphasized.

24. If the control column is moved forward during a normal spin, with only partial pro-spin or anti-spin rudder held on, the attitude will become more nose-down and the rate of rotation will increase to the point where disorientation may be experienced. This type of spin may be entered during recovery from a normal spin when mishandling of the controls causes the aircraft to spin in the opposite direction. Under these conditions the direction of spin may be incorrectly assessed. In order to ensure recovery, the direction of yaw should be noted from the turn needle and full recovery action taken as detailed in para. 17.

25. In this type of spin the aircraft is in a near vertical attitude and rotating very rapidly. The rate of descent is higher than in a normal spin and the IAS may rise to 150 knots or more. This type of spin should not be demonstrated to students.

Inverted Spinning

26. Intentional inverted spinning is prohibited.

27. The Jet Provost is reluctant to spin inverted and most unintentional spins will be erect ones. With some aircraft inverted spins can be caused by excessive forward movement of the control column when the airspeed is low and the aircraft is at or near the inverted attitude, *e.g.* during a roll-off-the-top or during a stall when the aircraft is allowed to roll in the direction of the turn. The Jet Provost is most unlikely to spin inverted in these circumstances and will usually perform an inverted flick roll.

28. The most likely cause of an inverted spin in a Jet Provost is a grossly mishandled recovery from an erect spin. If the control column is moved harshly and fully forward during recovery from an erect spin the aircraft will go inverted, the direction of yaw will reverse and the aircraft will continue spinning. The inverted spin will continue only as long as the control column is held fully forward and moving it back will effect an immediate recovery

provided full anti-spin rudder is applied. The instructor should emphasize that gross mishandling is necessary to induce an inverted spin and that a considerable push force is required to move the control column fully forward.

29. The direction of a spin is dictated by the direction of yaw, and whilst in an erect spin this is in the same direction as the roll, in an inverted spin the yaw is in the opposite direction to the roll. The instructor should use a model aircraft to demonstrate this fact to the student. He should also explain that the pilot will normally be far more conscious of the direction of rotation or roll than of the direction of yaw and therefore the correct rudder for recovery will prove most unnatural when related to normal spin recovery action.

30. **The Standard Recovery Action for the Inverted Spin is:—**

(*a*) Throttle closed.

(*b*) Full rudder in the opposite direction to the yaw as indicated by the turn needle.

(*c*) Ailerons neutral.

(*d*) Control column progressively moved back until the spin stops.

(*e*) Immediately the spin stops centralize the rudder and recover from the ensuing dive (*see* para. 32).

31. Experienced pilots have wrongly assessed the type of spin. The turn needle of the Turn and Slip Indicator should always be observed before applying rudder and the rudder applied in the opposite direction to the turn needle.

32. Care should be taken when pulling out of the dive as the negative *g* experienced during an inverted spin may seriously reduce the pilot's positive *g* threshold.

Recovery from the Vertical

33. If the aircraft attitude and airspeed is such that the controls are largely ineffective, as in a poorly executed stall turn, the controls should be centralized and held firmly, leaving the throttle setting where it is, until the aircraft is descending and accelerating.

Common Faults

34. Many students forget to throttle back after entering a spin from flight conditions in which power is being used.

35. The student often attempts to identify the behaviour of the aircraft from the position of the controls. It should be impressed

on him that the position of the controls is not a reliable indication of whether a spin has occurred or of the nature of the spin. The spin should be identified from:—

(*a*) Flight conditions obtaining immediately before the suspect spin, *i.e.* proximity of the stall, amount of yaw, nose-down pitching movement or spiral descent. Some or all of these characteristics will be evident.

(*b*) The attitude of the aircraft and the characteristic spinning motion.

(*c*) A high rate of descent with the airspeed remaining at a low figure.

EXERCISE 11

SPINNING

AIM: To accustom the student to spinning and to teach and practise recoveries from incipient and developed spins.

AIR EXERCISE

Airmanship

1. **Pre-Stalling Checks plus:—**
   - (*a*) Not over the sea or 8/8 cloud.
   - (*b*) Clearly defined horizon and canopy not misted over.
   - (*c*) Minimum entry height as laid down in A.S.I.s.
   - (*d*) Fuel limitations.

Sequence	Observations
2. **Student's First Spin.** Demonstrate a 2 or 3 turn spin and recover without detailed instruction.	Ease of recovery.
3. **Spins from Level Flight.** Demonstrate spins in both directions, from level flight, with throttle closed.	(*a*) Checks before spinning. (*b*) Entering the spin:— (i) Note height. (ii) Just before the stall apply FULL rudder and then move control column fully back, ailerons neutral. (*c*) In the spin:— (i) Throttle closed. (ii) Ailerons neutral. (iii) FULL rudder held on. (iv) Control column held FULLY back. (v) No continuous increase in airspeed. (vi) High rate of descent. (vii) Turn needle indication. (viii) Number of turns.

Note. Emphasize that the controls must be kept FULLY deflected whilst in the spin (para. 23 of the Instructional Guide refers).

(*d*) Spin recovery:—

(i) Throttle closed.

(ii) Check direction of yaw-turn needle. Apply and maintain FULL rudder to oppose the yaw.

(iii) Pause for two seconds.

(iv) Ease the control column slowly forward until the spin stops (not further than two-thirds forward) keeping the ailerons neutral throughout.

(v) Centralize the rudder immediately but not before the spin stops.

(vi) Level wings and ease out of dive, applying power as the nose approaches the horizon.

(*e*) Large height loss—associate with number of turns.

4. **Recoveries at Incipient Stage.**

(*a*) Demonstrate the incipient stage of a low speed, low *g* loading spin by holding the aircraft in a fully stalled condition until an appreciable amount of roll develops.

(*a*) Recognition of developing spin:—

(i) Stall, wing drop and yaw.

(ii) Nose down movement.

(iii) Onset of roll.

(*b*) Recovery standard stall recovery (control column forward to unstall wings, full power, ailerons and rudder neutral).

(*b*) Demonstrate the incipient stage of a "relatively high airspeed and high *g* loading" spin by initiating a spin at 100 knots with full rudder and control column fully back; recover as roll develops.

(*a*) High rate of roll at speeds above basic stalling speed.

(*b*) Recovery—centralize controls leaving throttle where it is (unless aircraft is in steep diving attitude when the throttle should be closed).

(*c*) Immediate recovery.

(*d*) Small height loss.

5. **Recovery when Control is Lost in Manoeuvres.**

Mishandle controls in aerobatic manoeuvres, *e.g.* rolls off the top, stall turns, *etc.* Show that aircraft is reluctant to spin. If effective control is lost then centralize the controls, leave the throttle where it is and wait until the nose is below the horizon and speed is increasing.

Incipient spin recovery technique.

POST FLIGHT DISCUSSION

5. Recovery When Control Is Lost In Manoeuvre

a. Mishandle controls during manoeuvres, eg, rolls off the top, stall turns and max rate steep turns. Show that the aircraft is reluctant to spin. If effective control is lost, immediately centralise the controls, leave the throttle where it is, and wait until the nose is below the horizon and the speed is increasing.	a. Incipient recovery technique.
b. Mishandle the controls in rolls off the top and stall turns but fail to take prompt incipient recovery action. NOTE. Full pro-spin control to be applied and maintained until recovery.	a. Entry less predictable than a spin from straight and level flight. b. Turn needle is the only reliable indication of direction of the spin. c. Standard spin recovery is effective. d. Recovery time may be longer than spin from straight and level flight.

EXERCISE 12

TAKE-OFF AND CLIMB

AIM: TO TEACH THE TECHNIQUE OF TAKING OFF, CLIMBING AWAY, AND POSITIONING THE AIRCRAFT ON THE DOWNWIND LEG OF THE CIRCUIT.

INSTRUCTIONAL GUIDE

General

1. Before first solo, the student should be able to take off in both into-wind and crosswind conditions, and should fully understand the action to be taken in the event of an engine failure after take-off.

2. This lesson may be introduced progressively during the many take-offs preceding the intensive circuit sessions. When the student has become reasonably proficient at taxying he can be taught the use of brake and rudder to maintain direction on the take-off run whilst the instructor retains control of the elevators. As his proficiency increases he can be allowed to take over the other controls until he can complete the take-off unassisted.

Before Flight

3. **Preparatory Instruction.**

(*a*) Use of rudder and brake.

(*b*) Use of elevators.

(*c*) Effect of crosswind.

(*d*) Use of power.

(*e*) Factors affecting length of ground run.

(*f*) Vital actions and circuit procedure.

(*g*) Engine failure.

(*h*) Airfield control and R/T procedure.

Reference—A.P. 129, Vol. 2, Part 2, Sect. 3, Chap. 2.

During Flight

4. **Airmanship.**

(*a*) The paramount importance of a good lookout must be stressed and a high standard demanded.

(*b*) The student should be taught to make a thorough check of the vital actions, in the correct sequence; the instructor must insist on accuracy and attention to detail in this matter, and the student must be made fully aware of the importance of these checks.

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c. The student should be completely familiar with the circuit R/T procedure and able to make all the necessary R/T calls before first solo. Few are able to maintain a good listening watch during the early stages of circuit practice because of the high degree of concentration needed.

5. Take-Off into Wind.

a. Whenever possible the first demonstrations and practices should be made into wind.

b. The aircraft should be taxied on to the runway to give the maximum length of take-off run possible without turning sharply, and lined up carefully with the nosewheel straight.

c. When lining up on the runway, the offset seating requires that attention is paid to the importance of sighting directly ahead.

d. The RPM, JPT and oil pressure must be checked as soon as the throttle is fully open. On the Mk 3 this is done with the aircraft stationary; on the Mks 4 and 5 the checks are made on the roll after releasing the brakes at 90%. The student must understand that if the limitations are exceeded, the aircraft is unserviceable.

e. Directional Control. Use of rudder plus gentle differential braking is necessary to keep straight, until, at about 40 knots, the speed is sufficient to provide effective rudder control.

f. Elevator Control. Initially the control column should be held in the neutral position. As the speed increases a gentle back pressure should be applied, sufficient to raise the nose wheel at 75 knots, and the aircraft should be flown off at 85 knots. If the nose is raised too high at a low speed the increased drag in this attitude will seriously retard the aircraft's acceleration and may prevent take-off altogether. This situation is most likely to occur if taking off with the flaps up or executing a flapless roller landing and holding the control column fully aft during the take-off run. The nose will rise sharply at a low speed and the IAS will stabilize at about 80 knots with the aircraft in a semi-stalled condition, unable to leave the ground. Lowering the nose to the normal position will give immediate acceleration, and the take-off may then be continued as normal.

g. Checks after Take-Off. The student should be encouraged to commence the after take-off checks as soon as he is safely airborne and climbing away, but in the early stages control of lateral level and attitude should be the first consideration. The danger of touching down again after applying the brakes or selecting undercarriage up must be mentioned.

h. Attaining Climb Speed. When the undercarriage is locked up and the flap has been raised at a safe height, the correct climbing speed should be attained as soon as possible by allowing the speed to increase in a shallow climb.

6. Crosswind Take-Off.

a. If the crosswind is not strong enough for a convincing demonstration, the lesson should be postponed until conditions are more suitable.

b. Brake may be necessary to counteract the weather-cock tendency in the early stages of the take-off run, and in strong crosswinds, some aileron is needed to prevent the into-wind wing from lifting.

c. The student should be shown that the aircraft is flown off cleanly at a slightly higher airspeed so that there is no danger of touching down again once the aircraft has acquired drift.

d. When safely airborne the student should be required to make a gentle turn into the crosswind in order to make good a track parallel to the take-off heading.

e. When doing oval circuits the angle of bank used on the climbing turn to downwind must be adjusted to achieve the correct distance out downwind.

7. Engine Failure during the Take-Off Run.

a. Although not demonstrated or practised, the student should be fully conversant with the action to be taken should the engine fail during the take-off run or just after the aircraft becomes airborne.

b. In either case the throttle should be closed and kept closed and, if airborne, the aircraft landed as soon as possible, the nosewheel lowered, maximum braking applied, and the HP and LP cocks turned off.

c. Should the aircraft seem likely to overrun the boundary it can be turned to lengthen the available run and the undercarriage raised if necessary.

d. Ensure that the student has been fully briefed on the drill for barrier engagement.

Engine Failure after Take-Off

8. If the engine fails after take-off, and before a landing back on the airfield may be attempted, the best course of action is to eject immediately. Only in exceptionally favourable circumstances should a landing in open country be attempted.

9. Engine Failure in the Circuit. If the engine fails after take-off the student is to be briefed to eject if the aircraft is upwind of the runway in use and below 1,000 ft agl. He should be told that thereafter in the circuit a forced landing on the airfield is feasible and that the speed and direction of the wind and the distance of the aircraft from the airfield will be the deciding factors. If the decision is made to land on the airfield the following actions should be taken:-

a. Glide towards the airfield at 120 knots.

b. Make an emergency R/T call.

c. Land on the airfield with undercarriage down, as near as possible into wind.

Common Faults

10. The high degree of concentration required from the student during his initial attempts at take-offs may cause tenseness on the controls and resulting over-controlling and lack of co-ordination. Progressive introduction of responsibilities, as suggested in para 2 may help to overcome this difficulty.

11. Many students fail to maintain the correct take-off attitude. The dangers of an excessive nose-up attitude and the need for progressive forward movement of the control column should be emphasized.

12. The technique of applying the correct amount of rearward pressure on the control column at the right time, so as to lift the nose sheel just off the runway, requires some elaboration to many students. The bare statement "raise the nose wheel about here" is not sufficient.

EXERCISE 12

TAKE-OFF AND CLIMB

AIM: To teach the technique of taking off, climbing away and positionir the aircraft on the downwind leg of the circuit.

AIR EXERCISE

Airmanship

1. Impress the following points on the student:

   a. Note direction of take-off and circuit.

   b. At marshalling point:

      (1) Position aircraft out of line of the jet efflux of other aircraft.

      (2) Parking brake applied.

      (3) Vital actions.

   c. Check that approach and runway is clear; obtain take-off clearance; check for any signals from caravan and check windsock. Take off with minimum delay.

SEQUENCE	OBSERVATIONS
2. Take-off into Wind.	
a. Lining up and take-off run.	a. Lining up:
	(1) Use of maximum available runway length.
	(2) Reference point at far end of runway.
	(3) Nosewheel straight.
	(4) Open up to max RPM/ 90/90%. Check brakes holding.
	(5) Check RPM, JPT, oil pressure. (Check on roll in Mks 4 and 5.)

	b.	Take-off run:
		(1) Control column neutral
		(2) Brakes off - control direction initially by rudder, and gentle braking (if necessary).
		(3) Increasing effectiveness and firmerfeel of rudder above 40 knots.
		(4) Avoid use of brakes.
		(5) Raise nosewheel at 75/75/80 knots and hold attitude with nosewheel just off runway.
b. Becoming airborne and climbing away.	a.	Becoming airborne:
		(1) Fly aircraft off at 85/85/90 knots.
		(2) Wings level - maintain direction.
		(3) Gain height and speed in shallow climb.
	b.	Climbing away:
		(1) After take-off checks - raise flap gently above 100 ft and 110 knots.
		(2) Lookout.
		(3) Change of attitude as climbing speed is reached.
	c.	Climbing away - circuit:
		(1) Checks.

(2) Reduce RPM (100% - 85% as required) at 140 knots.

(3) Climb at 140 knots.

(4) Trim.

(5) At 500 ft climbing 40-45 degree bank turn, dependent on crosswind.

(6) Level off at circuit height, reducing power to maintain 140 knots (anticipation).

(7) Trim.

(8) Position for entering downwind.

3. Crosswind Take-off

Observations as for take-off into wind except:

a. Prevent weather-cock tendency and use aileron to prevent upwind wing from lifting.

b. Positive fly off at 90/90/95 knots.

c. Allowance for drift when airborne.

4. Flapless Take-off

a. As for normal take-off except:

(1) Danger of raising nose too high - high drag.

(2) Need to fly aircraft off at 95/95/100 knots.

EXERCISE 13

APPROACH AND LANDING

AIM: To teach the correct methods of rejoining the circuit and various types of approaches and landings.

INSTRUCTIONAL GUIDE

General

1. After the introductory upper air work the student will find the intensive circuit sessions a great deal more hurried and demanding. It is imperative that he should know all the vital actions, checks, settings and speeds before serious instruction in the circuit is attempted; for this purpose circuit diagrams should be displayed in crewrooms.

2. As soon as the student is reasonably competent at straight and level, turning, climbing and descending, he may be familiarized with the circuit layout and procedures at the end of the details preceding the circuit lessons.

3. Revision of desdending with flap and undercarriage down at approach speeds and power settings, and the overshoot procedure should be practised at medium altitudes during the detail before concentrated circuit instruction begins.

4. Before the first solo flight the student should be able to make competent engine-assisted approaches and landings and also be able to go round again safely, and the glide approach should be demonstrated.

Before Flight

5. Preparatory Instruction.

a. The circuit, approach and landing.

b. Effect of landing weight.

c. Effect of wind speed.

d. Effect of airbrakes.

e. Aerodynamic braking.

f. Use of brakes.

g. Effect of crosswind.

h. Effect of crosswind.

i. Effect of gusty conditions.

j. Going round again.

k. Airfield control and RT procedure.

l. Lookout.

Reference: AP 129, Vol 2, Section 3, Chapter 2.

6. Pre-Flight Briefing. The pre-flight briefing is most effectively based on the observations listed on the relevant part of the Air Exercise, and with the aid of diagrammatic illustrations and model aircraft.

During Flight

7. Many students have difficulty in mastering the landing and although the instructor's advice is of help, proficency is attained mainly through practice. In the early stages the emphasis should be placed on safe flying rather than on a polished performance.

8. Although some students may have difficulty with the landing it is important to ensure, before the first solo, that they can recognise and correct any errors that may occur.

9. Airmanship.

a. A large number of aircraft may be in the circuit area, and consequently, careful lookout is required. The instructor must demand a high standard from the student.

b. The student must learn and understand the significance of all the visual signals and RT calls that are used by air traffic control for the control of aircraft.

c. Turns in the circuit should be limited to medium angles of bank unless an emergency arises.

10. Joining the Circuit.

a. The Rejoin Overhead. Until thestudent is sufficiently advanced to rejoin at 220 knots, he should be taught to fly overhead the airfield at 1000 ft above circuit height, letting down in a curve on the dead side of the airfield to circuit height at 140 knots and entering the circuit pattern by crossing the upwind end of the runway, tracking at 90 degrees to it. This pattern enables the student to select the power he will require downwind before he reaches the airfield and to use airbrakes to achieve his descent to correct height. This is the method of rejoining the circuit at night.

b. The Rejoin. When a student has sufficient experience, he should be taught to rejoin for a level break onto the downwind leg. The aircraft should be flown to an "initial point", two miles downwind on the dead side of the runway in use, and the call "initial" be made. The run into break should be made at 220 knots at circuit height on the dead side. Power should be adjusted to that required on the downwind leg, the a/b extended at the upwind end of the runway, and a 45 degree banked turn made onto the downwind leg. The angle of bank will need adjustment for crosswind conditions. The airbrakes should be selected in below 140 knots. It is vital to stress the need for a good lookout when joining the circuit and for the need to adjust the position of the break to fit in with other aircraft in the circuit.

11. Downwind Leg. On the downwind leg, the aircraft is at the correct distance from the landing path when the inboard edge of the tip tank is tracking down the farther edge of the runway. The student should appreciate that convergence or divergence of the downwind leg will be shown by the relative movement between the inboard edge of the tip tank and the edge of the runway. The vital actions before landing should be done at the beginning of the downwind leg so that full attention can be devoted to judging the position at which to commence the final turn.

12. Threshold Speeds. Whilst on the downwind leg the student should be taught to calculate his intended threshold speed in relation to the fuel state, aircraft configuration and wind conditions.

13. Engine Assisted Approach.

a. The engine assisted approach from an oval circuit is thebasic technique and all others are variations. This basic circuit should be taught first and other types of approach and landing compared with it.

b. The student must understand that both the position to commence the final turn and the power required for the approach will vary with the strength and direction of the wind. The student should be shown how to choose the point to start his finals turn either by looking back at the runway or by selection of a ground feature on the extended centre line (this second method is essential in right hand circuits).

c. Prior to starting the final turn the student should be told to look for other aircraft on the approach especially for those that are making a long approach or a wider circuit.

d. The turn onto the final approach should, ideally, be made with a constant angle of bank. The student should be shown how to adjust the bank to roll out on the runway extended centre line.

e. The final checks before landing should be completed soon after starting the finals turn and the R/T call made when at 90 degrees to the runway heading.

f. During the finals turn the rate of descent is controlled by adjusting the power and maintaining a constant air speed with attitude. Initially full flap should be selected after rolling out of the turn. Once the student has developed some judgement he may be encouraged to adjust his approach path if necessary by selecting full flap in the later stages of the turn.

g. The final approach should be straight in from 300 ft min with an approach angle of about 3 degrees (VASIs Red/White). The power required will vary with wind conditions but to avoid extremes the approach should be slightly shallower in light or in cross wind conditions and slightly steeper when the wind is strong.

h. Once on the final approach the speed is tapered progressively to the threshold speed and the aircraft attitude is adjusted to maintain a constant angle of approach. The student should be shown that changing aspect indicates under or overshooting and that to make corrections to the approach path he must adjust the power and the attitude until the aspect of the threshold once again remains constant. The student should be made to realise that attitude corrections must be accompanied by the appropriate change of power to prevent undesirable changes in IAS.

i. Corrections to the rate of taper IAS are made with power. The student should understand the lag between the application of power and IAS response caused by aircraft inertia and the need to anticipate this to avoid over corrections. The student should be made to understand the importance of anticipating the need for any increase in power to allow for the slow response of the engine and emphasis should be placed on the need to maintain the safe minimum limit of 57/50/50% until crossing the threshold.

14. Landing. As the runway threshold is crossed at the correct height, the throttle should be closed, and the rate of descent should be reduced so that the aircraft settles gently on to the main wheels in tail down attitude similar to that at take-off. The tendency of the nose to drop at touchdown should be prevented to minimize shock to the nosewheel assembly, and the attitude maintained by a progressive rearward movement of the control column as the speed decreases. The nosewheel should be lowered gently on to the runway at approximately 70 knots, before elevator control is lost. Brake should not be applied until all three wheels are firmly on the ground, the first application being gently and pressure increased as necessary to stop the aircraft before reaching the end of the runway. The aircraft should be kept straight initially with the rudder, and by use of brake as the rudder becomes less effective with decreasing airspeed. The shortest landing run is achieved by lowering the nosewheel immediately afterthe main wheels touch and applying the brakes. The application of this technique to landings on short runways in light wind conditions should be explained to the student. Any tendency to turn off the runway at excessive speeds must be prevented and he should be made aware of the strain that is imposed on the undercarriage by fast cornering. The aircraft should be stopped when well clear of the runway, the parking brake applied and the after landing checks carried out.

15. Going Round Again.

a. Abandoned Approach. When going around from a baulked approach the wings should be levelled and full power applied. When a climb is established the undercarriage should be selected up and flaps raised to the take-off setting. The flaps should be raised fully at a safe speed and height. The aircraft should be held in a shallow climb until the speed has increased so that a normal circuit climb can be carried out. The importance of a good lookout when going round again should be stressed, particularly if overshoot action has been initiated after a collision warning. When settled, and if local regulations permit, a gentle turn should be made towards the dead side of the circuit so the climb is not carried out over the runway but parallel to it. After going round from the approach turn delay the turn on to the downwind leg until reaching the upwind end of the runway.

b. Roller landing. When going round again after touchdown the nosewheel should be held off as full power is applied and the aircraft flown off in the normal manner. The unstick speed will be slightly lower with full flaps down. When airborne, after take-off checks should include the raising of flap to the take-off position, then raising it fully at a safe speed and height and the normal circuit climb carried out.

c. Porpoising. If porpoising occurs during a take-off, roller or full stop landing the corrective action is to hold the control column slightly aft of central, in the take-off position, whilst opening the throttle fully and keeping the wings level. It should be emphasized that attempts at corrective action by elevator and/or throttle movements will only aggravate the porpoising motion of the aircraft and ultimately result in damage to the nosewheel assembly.

16. 1500 ft Glide Circuit. This circuit should be taught as a prelude to the practice forced landing. The downwind leg follows the normal path over the ground but the roundel appears to overlap the runway due to the increased altitude. Initially the aircraft is aimed to touchdown one third of the way up the runway with take-off flap. By 600 ft the pilot must decide whether or not a successful forced landing will result. If he decides not to continue his approach he should in an actual forced landing immediately prepare to eject; during practices he should at once begin to overshoot. Only when it is certain that this initial touchdown point can be reached is full flap lowered to bring the touchdown point back. The actual touchdown should be made between the original aiming point and a point 300-400 yards from the runway threshold (the second VASIs are normally 300-400 yards from the threshold). This allows ample margin for error in the forced landing case. Take-off flap is selected to simulate the drag of a flamed-out engine; this gives rise to two important considerations.

a. Finals IAS should be 115 knots, and this should be maintained until it is certain that the touchdown point will be reached.

b. It is impossible to simulate the full effect of lowering flap on a forced landing. For this reason, and because it is difficult to judge early in the turn whether the initial aiming point can be reached, students should be discouraged from indiscriminate use of flap early on the final approach.

Because of the higher rate of descent and greater attitude change required roundout must be started earlier and at a higher airspeed than for a powered approach. The dangers of rounding out too sharply causing a "g" stall and of allowing the speed to fall too far with the associated high rate of sink should be pointed out.

17. Flapless Approach and Landing. This exercise should be considered as the solution to an emergency situation. Once the introductory stage is passed and the student has shown understanding of the problems of the approach and landing then practices should always be made under conditions as realistic as possible by regoining with a simulated loss of hydraulic pressure or flap damage so that the descent, circuit and approach to land have all to be flown in the low drag configuration. Emphasis

should be placed on the early recognition of a poorly judged approach to land so that the decision to go round again can be made at a safe altitude (approx 200 ft agl). For the approach, the downwind leg should be extended and power reduced for the turn controlling the rate of descent so that the aircraft is lined up with the runway at 300 ft agl. The distance from the threshold will be greater and the approach path flatter; at this point (300 ft), the power should be adjusted to a minimum of 57/50/50%. The importance of maintaining the correct speed and avoiding steep turns to line up (because of the reduced margin above the stall) should be emphasized. The low drag configuration makes even the small airspeed reduction required on the approach more difficult and care is necessary in anticipating power and attitude adjustments if a smooth approach is to result. Special consideration should be given to the possibility of wind gradients or turbulence when deciding on the required threshold speed. A much smaller roundout is required and the aircraft should be put down in the normal touchdown area. Because of the higher landing speed and reduced drag the nosewheel should be lowered immediately after touchdown and smooth progressive braking commenced, balancing the deceleration against the remaining runway length, so as to reach taxying speed a safe distance from the far end. If it is necessary to overshoot from a flapless approach, or landing, the student should be reminded that the undercarriage must be left down and the air speed kept below 140 knots if necessary by throttling back.

NOTE: Instructors must not allow their students to continue poor approaches and must take control if the student's judgement is significantly at fault during the latter stages of a final approach. Instructors must brief solo students not to attempt a landing from a poorly judged approach and that if, at any time below 200 ft they suspect their judgement, they must overshoot.

18. <u>Crosswind Approach and Landing</u>. In the early stage students will have difficulty in the detection and assessment of drift, and therefore the initial demonstration and practice of crosswind technique should be carried out when there is a moderate but not excessive crosswind component on the runway. The student should be told always to check the windsock before take-off and when joining the circuit in order to make the appropriate allowances in good time, but he should appreciate that the wind at circuit height is usually stronger and may vary slightly in direction when compared with that at the surface. An allowance for drift is made to fly the downwind leg parallel to the runway. The student should be told to look for changes in the position of the wing tip relative to the runway and to make the appropriate corrections to maintain

a parallel track. The final turn should be commenced in the same position relative to the runway and the angle of bank adjusted to allow for the strength and direction of the crosswind. Depending upon the direction of the crosswind there will be either more or less time to lose height during the turn and the rate of descent will have to be varied accordingly. When the crosswind is from the circuit side, pupils should be warned of the danger of using excessive bank to line up with the runway in the latter stages of the turn if insufficient bank has been applied in the early stages. On the final approach the drift allowance should be made by heading slightly into wind so that the aircraft tracks along an extension of the landing path. In strong crosswind and gusty conditions the use of flap should be restricted. In the final stages of the approach there is normally less drift because of the wind speed decreases near the ground. This should be allowed for, but the correct drift allowance must be maintained whilst the otherwise normal roundout is completed and as the aircraft is lowered on to the runway, rudder should be smoothly and firmly applied to yaw the aircraft into line with the landing path. Any tendency to weathercock should be prevented with rudder and brake. After touchdown, it may be necessary to use into wind aileron to keep the aircraft level.

19. Circuit Variations. The two variations of the normal circuit are designed to enable the pilot to position his aircraft on the final approach in order to make a normal approach in poor weather;

a. Low Level Circuit. When the cloud base is low, visibility may be adequate for a visual circuit below normal circuit height and clear of cloud. On the downwind leg, at the correct distance, the runway appears further outboard on the roundel, and because of flat perspective it is difficult to parallel the runway without reference to the compass. Height should be maintained during the final turn until the aircraft is at a height and speed from which a normal powered approach and landing may be made. This circuit may be flown in the bad visibility configuration.

b. High Level Circuit. In the hazy weather associated with temperature inversions, vertical visibility is often better than the horizontal. In such cases as increase in the circuit height gives two advantages;

(1) Danger of collision is reduced by flying in clearer air.

(2) Vertical aspect improves view of runway from downwind leg.

At the correct distance downwind the roundel appears to be overlapping the runway, and it may be obstructed owing to the effect of offset seating dependent on circuit direction. In order to remain near the airfield the turn from downwind to finals must be made at a high rate of descent with the engine idling and full flap selected. Power must be increased to 57/50/50% for the last stages of the approach.

Common Faults

20. The usual causes of bad landings are:

a. Failure to roundout sufficiently:

(1) The approach may have been too steep, probably due to turning too early from the downwind leg or throttling back too late causing a tendency to overshoot.

(2) The student may be becoming tense as the runway appears to rush up towards him.

(3) Looking at the runway too near the aircraft and failing to assume the landing attitude.

b. Holding off too high:

(1) This is sometimes caused by a fear of getting too near the ground. This fault, and a tendency to roundout too late, can often be cured by flying the aircraft along the runway at hold-off height and in the appropriate attitude in order to give the student more time to appreciate the appearance of the ground when at the correct height.

(2) Should the student continue to find difficulty in rounding out and holding off, the above demonstration may be repeated and he can be given practice in the same manner whilst the instructor handles the throttle.

c. Bad and erratic judgment of the hold-off height:

(1) Usually causedby looking at the ground too close to the aircraft, or

(2) Becoming tense on the controls.

d. Rounding out with a wing down.

(1) Looking at the ground too close to the aircraft and leaning over for a better view.

(2) Not moving the control column straight back at roundout.

e. General difficulty with all stages of the approach and landing up to the touchdown can often be traced to:

(1) Faulty approaches at too high or too low a speed, or incorrect approach paths.

(2) Slow appreciation of changing path and over correction with the throttle.

f. Poor directional control on the landing run, can be caused by:

(1) Relaxing concentration after touchdown.

(2) Over-controlling with rudder and brake - possibly caused by tenseness on the controls.

(3) Too many consecutive roller landings have been carried out so that the student lacks practice in the use of brakes to slow the aircraft and to maintain direction in the later stages of the landing run.

21. Do not attempt to analyse the student's difficulties until he has had a fair amount of practice at landing because, until he has had this practice, the errors are likely to be of a random nature while he is becoming accustomed to the appearance and feeling of a good approach and landing. After he has grasped the basic requirements, errors will normally form a consistent pattern which can easily be recognised and analysed. During the initial period when the student is feeling his way, the instructor should help by demonstrating when necessary and when guiding and advising the student during his own attempt.

EXERCISE 13

APPROACH AND LANDING

AIM: To teach the correct methods of joining the circuit and various types of approaches and landings.

Airmanship - Lookout

1. a. Checks before joining.
   - a. Fuel contents and balance.
   - b. Instruments erect, synchronised.
   - c. Radio - correct frequency, unmuted. Call "Rejoining" or "Rejoining Overhead".
   - d. Altimeters set to QFE.
   - e. Demist "on" if required.

   b. Whilst joining.
   - a. Recheck correct runway.
   - b. Note position of other aircraft.
   - c. Check windsock.

2. **Circuit Joining**

   a. Rejoin. (Should not be used at night).
   - a. Rejoining checks.
   - b. Call "Initial" at or above 1000ft.
   - c. Enter "dead side"at 220 knots 1000 ft.
   - d. Select planned downwind RPM, good lookout.
   - e. Opposite upwind end of runway, a/b out, break to downwind leg.
   - f. A/bs in below 140 knots.

   b. Rejoin overhead.
   - a. Checks before joining.
   - b. Speed reducing to 140 knots,fly to deadside, crossing threshold of runway at 90 degrees.
   - c. A/Bs as required to descent at 140 knots, curved descent to circuit height, a/b in,level off.
   - d. Cross upwind end of runway at 90 degrees, 1000 ft,140 knots.
   - e. Join downwind leg.

3. Downwind Leg.

a. Distance from runway, note wingtip reference.

b. Trim for straight and level flight.

c. Call "Downwind" opposite upwind end of runway.

d. Downwind VAs.

e. Retrim.

f. Check tracking parallel to runway.

g. Speed not below 115 knots, adjust power if required.

h. Position to commence 180 degree turn, on to finals, depending on type of approach and wind.

4. Normal Powered Approach and Landing

a. Final Turn.

a. Check approach clear.

b. At the correct position for the turn on to finals reduce RPM and enter a descending turn at 115 knots.

c. Check u/c down, three green lights.

d. Call "Finals 3 greens" at the 90 degree point.

e. Assess flight path and adjust bank and rate of descent to give a straight approach at a suitable angle from 300 ft minimum.

f. Select flap if necessary to adjust descent path.

b. Final Approach

a. Commenced from end of final turn 115 kts, not below 300 ft.

b. Full flap if required and not already selected, by 200 ft.

c. Appearance of runway when on a suitable approach path.

d. Maintain approach path and gradually reduce airspeed to threshold speed at threshold. Adjustments to approach path made with power and attitude. Rate of taper of speed controlled with power.

e. Minimum RPM until assured of landing 57/50/50%.

c. Landing.

a. Over runway threshold close throttle and decrease rate of descent so that the aircraft flies gently on to the runway.

b. Nosewheel gently lowered at 70 knots.

c. Decreasing rudder effectiveness.

d. Use of brakes to maintain direction and to slow aircraft, only after nosewheel is on ground.

e. Slow speed for turning off runway.

f. After landing checks.

5. Going Round Again.

a. Overshoot from final approach.

a. Full power.

b. Establish shallow climb straight ahead.

c. Undercarriage up - lights out.

d. Flap to take-off setting.

e. Raise flap fully above 100 ft and 110 kts.

f. Turn on to dead side of runway and climb straight ahead to circuit height using normal circuit settings.

b. From a roller landing.

a. Normal touchdown.

b. Smoothly open throttle fully, holding nosewheel off ground.

c. Fly aircraft off and when safely airborne brake wheels, undercarriage up and flap to take off.

d. Raise flap fully above 100 ft and 110 kts.

e. Normal circuit climb away.

6. Glide Approach and Landing

Demonstrate from 1500 ft.

a. Application to forced landings.

b. Climbing turn from 1000 ft on to downwind leg at 1500 ft.

c. Downwind leg.

(1) Normal VAs with observations on emergency VAs.

(2) Note wingtip reference.

d. At Low Key, ie abeam caravan, with roundel just overlapping the runway, close throttle. Position to commence finals turn dependent upon wind velocity. Finals turn at 115 knots.

e. Initially aim to land ⅓ of the way up the runway. Maintain 115 kts until certain of reaching that point, and then bring the touchdown point back with full flap. Land between initial aiming point and a point 300-400 yds from threshold.

f. Characteristics of glide:

(1) Steeper angle of approach.

(2) Higher rate of descent.

(3) Nose down attitude.

g. Threshold speed as calculated.

h. Because of steeper approach the roundout must be started earlier.

i. Methods of height adjustment on final approach:

(1) Varying radius of turn.

(2) Use of flap.

(3) Diving off excess height.

(4) Sideslipping.

j. Overshoot procedure - safe height.

k. Maintain safe speed during engine acceleration.

6b. Overshooting from a Glide Approach.

Demonstrate an overshoot from a glide approach at threshold speed.

a. Open the throttle smoothly to Max RPM.

b. During engine acceleration maintain threshold speed, rotating the aircraft gently as the thrust takes effect.

c. When in level flight note the height lost.

d. Maintain a shallow climbing angle, accelerate and continue with normal overshooting procedure.

e. Overshoot action should be taken as soon as an undershoot is recognised.
NOTE: Students must be proficient at the overshoot from the glide approach before practicing the exercise solo.

7. Flapless Landing

Demonstrate and compare with normal powered approach.

a. Downwind leg in normal position. Normal VAs with observations on emergency VAs.

b. Extended downwind leg - dependent upon wind strength.

c. At the correct position for the turn on to finals close throttle and commence a descending turn at 115 knots.

d. Bank and rate of descent adjusted to give a straight approach from 300 ft. agl, minimum of 57/50/50% rpm from 300 ft, until assured of landing.

e. Gradual reduction of airspeed to threshold speed at threshold.

f. Characteristics of flapless approach:

(1) Flatter approach path.

(2) Higher nose attitude.

g. Aircraft almost in landing attitude with a low rate of descent when crossing threshold, so little change of attitude required for landing.

h. Place aircraft on to runway as soon after threshold as possible, nosewheel lowered and brake as required.

8. <u>Crosswind Landing</u>

a. Drift allowance downwind.

b. Wind effect on turn to finals - variations of bank required.

c. Use take-off flap in strong or gusty wind conditions.

d. Drift allowance on final approach.

e. Rudder to align aircraft with landing path just before touchdown.

f. Weathercock tendency on landing run.

g. Tendency of into wind wing to lift, use of aileron.

(TAL 19 Dec 71)

9. Low-Level Circuit

a. Downwind leg:

(1) Height 500ft agl for initial practice.

(2) Normal VAs.

(3) Normal downwind position note changed wintip reference.

(4) Position to turn onto final approach.

b. Speed (115 knots) and height maintained until aircraft reaches a position from which a normal approach can be made.

NOTE: If visibility beneath cloud is poor, the downwind leg may be entered in bad visibility configuration, 120 knots and take-off flap, and the final turn at 115 knots.

10. High Level Circuit (Assumes that the runway has approach lighting).

a. This type of circuit is intended for use when horizontal visibility is poor, but slant visibility is adequate.

b. Downwind leg.

(1) 1500 ft or as required.

(2) Normal VAs.

(3) Normal downwind position note changed wingtip reference.

c. Approach.

(1) Turn in point as for normal circuit.

(2) Close throttle, full flap descending turn at 120 knots.

d. Power increased to 57/50/50% for last stages of approach.
(TAL 19 Dec 71)

EXERCISE 14

FIRST SOLO

INSTRUCTIONAL GUIDE

1. A successful first solo flight, free from incident, gives the student added confidence which is often apparent as an improvement in his flying ability. The first solo flight is an important occasion for the student, and the instructor must do all he can to ensure that the student starts the flight with the knowledge that he is fully competent to do so.

2. The flying instructor makes his most important decision in the training of a student when he decides to send him solo for the first time. One of the main problems of basic instruction is the recognition or selection of the right time to send the student on his first solo flight. On the one extreme, if he is sent solo before he is sufficiently competent and confident the result may be a poor flight and a loss of confidence; on the other, if the first solo is delayed until after the appropriate moment, the result is often a deterioration in his flying skill, a loss of interest and, again, a loss of confidence.

3. The minimum requirements for pre-solo instruction are to be found in the appropriate orders and instructions. The student must have had sufficient practice to be able to recognize and recover from stalls especially under approach conditions.

4. The main requirements to send a student solo are not for polished flying but general competence and safety, and most important, the ability to recognize and to correct faults. The instructor must be reasonably sure that he can take the appropriate measures promptly in an emergency; to this end his reactions should have been watched at the times when anything in the nature of an emergency has occurred in training flights.

5. A guide to what constitutes an acceptable standard of flying for the first solo flight is given in the following sub-paras:—

(*a*) *Airmanship*. The student should maintain a good lookout without reminders from the instructor. He should be able to maintain a listening watch and to make the appropriate RT calls. All vital actions, checks and drills should be faultless. There should be no doubt as to his ability to avoid other aircraft and to overshoot in good time should his approach and landing be baulked.

(*b*) *Take-Off and Climb*. The student should be able to line up and maintain direction on the take-off run and should fly the aircraft off at a safe speed and not hold it on the ground until an excessive speed is reached or try to haul it off in an exaggerated nose-up attitude. The initial climb should be at a safe angle and a good lookout maintained whilst completing the after take-off checks.

(*c*) *Circuit.* Although his circuit need not be precise in all respects, the student should be consistent in maintaining satisfactory headings and in judging the positions at which to turn. Angles of bank should be reasonably accurate, and he should not be in the habit of overbanking. Variations in altitude are acceptable provided that he is aware of, and corrects for, them; however, the variations should not be large enough to cause marked difficulty on the approach.

(*d*) *Approach.* The student should have good control of the speed, particularly during the final turn and on the last stages of the approach. He should be able to recognize changes in the approach path and thus anticipate the need for corrections to the power settings and must appreciate when it is necessary to go round again. It is important that these decisions are not left until the last moment and that he is aware of the slow response of the engine at low r.p.m.

(*e*) *Landing.* The main consideration is whether the student's landings are safe. There should be no consistent fault such as holding off high, or flying on without rounding out. A series of good landings is not necessarily proof of readiness for solo; the student must have demonstrated that he can go round safely from ground level, and know that he must do so when in trouble.

(*f*) *Emergencies.* He should have a thorough knowledge of the actions to be taken in the event of fire in the air and on the ground, and emergency undercarriage lowering. ◀He should have been briefed on the action to be taken in the event of engine failure in the circuit and have had a glide landing demonstrated to him.▶

(*g*) *Confidence.* The instructor will have noted and taken steps to correct any tendency towards under- or over-confidence during pre-solo instruction. True confidence is the ability to meet difficulties with assurance and the student should display the ability to keep calm and react sensibly to unusual situations. The pilot who is unaware of his limitations is no more reliable than the one who allows himself to be overwhelmed by them and both invite trouble through either ignorance or panic. When the student is ready for solo he should be able to make safe and reasonable corrections on his own initiative and generally handle the aircraft in a manner which inspires trust.

Before Flight

6. The instructor must ensure that he is qualified to authorize a first solo flight in accordance with the relevant orders.

7. The pre-flight briefing should be short and simple. The student may be somewhat excited and unable to absorb detailed instructions. It is sufficient to brief him to take-off, complete the circuit, and land, with a reminder that it is better to abandon an unsatisfactory approach rather than risk a poor landing. Mention should be made of any special air traffic instructions and crosswind conditions. Last minute briefings on emergency drills and procedures are a complete waste of time. Weather conditions must obviously be suitable. If possible, traffic density should be low and A.T.C. warned that the flight is a first solo.

After Flight

8. The instructor should watch early solo flights in order to note progress and any signs of over-confidence or excessive timidity.

9. After his first solo the student may have a strong sense of achievement; any comments on his performance should be carefully measured against his temperament and it should be made clear that the first solo is merely a step to more serious training and not regarded as an end in itself.

10. During the subsequent circuit consolidation period the student should be given practice at glide and flapless landings in his dual checks before solo, and when competent, authorized to carry them out solo providing that conditions are suitable.

EXERCISE 15

ADVANCED TURNING

AIM: To teach turning at high angles of bank, and how to obtain the maximum turning performance.

INSTRUCTIONAL GUIDE

General

1. Since the steep turn, particularly at the maximum rate, has important operational use, the student should be given enough practice to reach a high standard. Steep turns give valuable practice in co-ordination of control movements and when done at maximum rate, give the student confidence in handling the aircraft at its limits.

2. The basic principles of steep level turns should be introduced shortly after the student's first solo; he will have already had some experience of high angles of bank during clearing turns when accuracy will have been ignored for the sake of a good lookout. Before he is permitted to practice steep turns solo, the stalling in turns sequence should be covered in full and he must be competent in recovering at the buffet and when the aircraft flicks.

3. The remaining sequence should be introduced at later stages of the course as required, when the student can carry out a steep turn with reasonable accuracy.

Before Flight

4. **Preparatory Instruction.**

(*a*) Forces in the turn.

(*b*) Effect of loading on the stall.

(*c*) Use of power.

(*d*) Considerations for maximum rate and minimum radius turns.

(*e*) Use of controls.

(*f*) Aircraft limitations.

(*g*) Physiological effects.

Reference—A.P. 129, Vol. 1, Part 1, Sect. 1, Chap. 12; Vol. 2, Part 2, Sect. 3, Chap. 1, and Sect. 4, Chap. 1.

During Flight

5. **Airmanship.**

(*a*) Emphasize the importance of a good lookout before and during a rapid change of direction, particularly on the inside of the turn.

(A.L. 3, Oct. 61)

(*b*) Students may become disorientated during a number of steep turns and should therefore be reminded of the importance of making a periodical check of their positions.

(*c*) The Jet Provost limit of 6 *g* should not be exceeded for structural reasons. At speeds above 220 knots the *g* limitation may be reached before any airframe buffet is felt and it is therefore important to check the accelerometer reading frequently when turning at high speed to avoid overstressing of the aircraft.

6. **Steep Level Turns.**

(*a*) Steep turns should first be taught at an angle of bank of about 50 degrees; as the student becomes proficient, the bank should be increased to about 60 degrees.

(*b*) During steep turns in each direction, the side-by-side seating has a greater effect on the apparent nose position than in medium turns.

(*c*) Good practice in co-ordination can be obtained by turning from one direction to another in a smooth continuous movement.

7. **Stalling in the Turn.**

(*a*) This lesson should be thoroughly learnt before the student does a solo practice involving steep turns.

(*b*) When recovering from a stall in a turn, power must be applied unless the nose is well below the horizon.

(*c*) Avoid large control movements when recovering from the stall particularly if the aircraft is inverted, for at low speed these may precipitate a spin. It is sufficient to centralize the controls, apply full power if required, and return to S & L as soon as safe control is regained.

(*d*) The student should be shown that the aircraft may spin if recovery is delayed.

8. **Steep Gliding Turns.** The steep nose-down attitude makes estimation of the gliding attitude difficult; cross reference to the instruments is required to ensure accuracy.

9. **Maximum Rate Turns.** The student may well benefit from revision of turning theory before this exercise is covered in the air. He should appreciate that the maximum rate and minimum radius of turns are achieved by a combination of:—

(*a*) Maximum angle of attack (*i.e.* at the verge of the buffet).

(*b*) Maximum angle of bank.

(*c*) Maximum power.

(*d*) Maximum airspeed attainable.

(A.L. 3, Oct. 61)

In a sustained level turn under these conditions the airspeed is limited by the power available and will stabilize at a constant figure (dependent on height). At this speed the aircraft will be turning at its maximum sustained rate and minimum radius for level flight. In a dive when the thrust is supplemented by gravity the higher speed will permit a greater angle of bank and thus an improvement in the turning performance but care must be taken not to exceed the *g* limitation of the aircraft.

10. When comparing turns in successive demonstrations they should be carried out in the same direction.

11. Demonstrations of the effect of power on the rate of turn should be carried out at low altitude. The fall off of power with height results in insufficient difference between the effect of full and partial power to make a convincing demonstration.

12. When entering a steep turn at speeds in excess of 220 knots the maximum *g* limitations should be maintained until the decreasing speed permits the verge of the buffet to be achieved.

13. Sustained maximum rate turns should be practised at 98 per cent. r.p.m. to prevent unnecessary engine wear, the emphasis being placed on rapid entry and attainment of the maximum rate.

14. When the pupil has had some practice at sustained maximum rate turns the emergency break should be taught and during subsequent dual details his speed of reaction should be noted when he is told to "Break Port/Starboard".

15. **Effect of Altitude on Turning Performance.**

(*a*) The effect of altitude on manoeuvrability is discussed in Exercise 23 and should be demonstrated during a high-level familiarization detail.

(*b*) It has already been recommended that the introductory sequence to maximum rate turns is carried out at lower altitudes (*e.g.* 5,000 feet). This will ensure that the student understands the significant effect that the power available has on turning performance. As the student's training progresses he should be given practice at maximum rate level turns at increasing altitude, and the reducing performance as indicated by the reduced angle of bank, lower airspeed and decreased rate of turn pointed out as it becomes apparent.

(*c*) At a later stage of the course the student should be shown that a good turning performance can be maintained at altitude by diving the aircraft in the turn; the limit is then the blackout threshold of the pilot or the maximum *g* of the aircraft.

Common Faults

16. Many of the inaccuracies in steep turns stem from the student's failure to appreciate that if the bank is allowed to vary, then the amount of back pressure on the control column required to maintain height will also change. The importance of maintaining a constant angle of bank should be pointed out.

17. A consistent loss of height is usually due to overbanking, allowing the nose todrop, and then attempting to make height corrections without first reducing bank, leading to a spiral descent. To avoid this and a possible cause of unintentional stalling, the student should be told to reduce the amount of bank before correcting with the elevators.

18. When entering steep turns at high speeds, maintenance of height is more difficult and for this reason the bank should be applied slowly until experience is gained.

19. Students often have difficulty initially in holding the aircraft on the buffet in the max rate turn and controlling the height with ailerons. Practice at lower speeds with less than full power may help them master the technique.

EXERCISE 15

ADVANCED TURNING

AIM: To teach turning at high angles of bank, and how to obtain the maximum turning performance.

AIR EXERCISE

Airmanship

1. a. Lookout. Look around before and during all changes of direction, particularly on inside of turn.

   b. Limitation. Structural limitation of 6g must not be exceeded. And for practice purposes 5½g should be regarded as the maximum.

   c. Orientation. Check position frequently.

SEQUENCE	OBSERVATIONS
2. Steep Level Turns.	
a. Demonstrate steep turns in each direction from normal cruising speed, at about 50-degree bank, increasing power to maintain entry speed. Note - When student becomes proficient 60-degree bank should be used.	a. Lookout. b. Entry as for medium turn but:- (1) Progressively increase power as bank increases. (2) Progressive backward pressure on control column. c. In turn:- (1) As for medium turns. (2) High rate of turn. (3) Airspeed same as on entry. (4) Instrument indications.

d. Recovery as for medium turns except that power is progressively reduced at same time as bank.

b. Demonstrate entry to a spiral dive by overbanking allowing nose to drop and using elevators in an attempt to raise nose.

a. Use of elevators to raise nose has effect of increasing rate of turn and loading.

b. Possibility of unintentional stall.

c. Importance of reducing bank first and then raising nose.

3. Stalling in the turn.

From a steep turn at cruising power:-

a. Tighten turn to buffet and demonstrate recovery.

a. Normal pre-stalling checks.

b. At buffet, note airspeed.

c. Recover by relaxing back pressure slightly and applying power as necessary. Turn can be continued.

b. Tighten turn further

a. Heavy buffet and airframe shaking.

b. Airspeed decreasing.

c. Use standard stall recovery and level wings.

d. If recovery delayed, at approximately 110 knots a roll will develop which will be aggravated by the use of opposite aileron.

e. If recovery delayed further aircraft will readily spin.

4. Emergency Break.

Demonstrate how to change direction as quickly as possible. Turn through approximately 180 degrees using full power. Practise from both low and high airspeeds.

a. As rapidly as possible co-ordinate the following:

(1) Maximum power.

(2) High angle of bank and rudder to balance.

(3) Maximum back pressure within loading or stall limitation.

b. Back pressure more important than accurate bank.

c. Use in emergency.

5. Steep Descending Turns.

Compare gliding turns at 100 knots with turns at a higher airspeed.

a. At 100 knots buffet occurs at about 45-degree bank.

b. At 120 knots:-

(1) Buffet occurs at about 65-degree bank.

(2) Rate of turn increased.

(3) Higher rate of descent.

c. Need for increased airspeed when a steep descending turn is required.

6. Turning limitations in Level Flight.

a. Demonstrate a turn at low IAS (About 120 knots) and medium power. Tighten the turn to the threshold of the stall.

a. Note.

(1) Airspeed when buffet occurs.
(2) Rate of turn and angle of bank.

b. If turn is tightened beyond buffet, rate of turn decreases.

c. Maximum rate of turn therefore justat buffet.

b. Demonstrate a maximum rate level turn with full power from 150 knots. Compare with low speed turn.

a. Buffet IAS increases.

b. Increased back pressure needed.

c. Higher angle of bank.

d. Higher rate of turn.

e. Amount of power determines IAS obtainable which governs:

(1) Maximum angle of bank.

(2) Maximum rate of turn.

f. Higher "g" loading.

7. Maximum Rate Level Turns.

a. Teach maximum rate level turns, entering at 150 knots.

a. Lookout.

b. Entry:-

(1) Initially as for steep turns.
(2) Increase to full power
(3) Increase bank and back pressure until buffet occurs then relax slightly.

c. In the turn:-

(1) Maintain full power.

(2) Note stabilization IAS.

(3) Maintain back pressure to keep aircraft just free of buffet.

(4) Use bank to adjust nose attitude to maintain height.

d. Recovery as for steep turn except that aircraft is allowed to accelerate to cruising speed before power is reduced.

b. Teach maximum rate level turns entering at range speed.

a. Bank must be reduced as IAS decreases.

b. IAS will eventually stabilize as in sequence 7a.

8. Turning at Maximum Possible Rate.

Establish a maximum rate level turn and then dive aircraft, holding it on verge of buffet. Allow speed to increase until studentreaches his blackout threshold or 5½g limitation is reached.

a. Bank, rate of turn and loading increase with airspeed.

b. Attention to accelerometer.

c. Maximum possible rate of turn achievedwhen verge of buffet coincides with 5½g or blackout threshold has been reached.

d. This rate of turn can only be sustained in a dive.

e. Large loss of height.

9. Entry into Maximum Rate Level. Turns from High Air-speeds.

Entry from 250 knots.

a. Lookout.

b. Entry as before but:-

(1) Pull to and maintain 5½g or blackout threshold until buffet is reached, and then keep aircraft on verge of buffet.

(2) Attention to accelerometer.

c. Initially very high angle of bank and rate of turn, but these decrease as airspeed falls, until eventually maximum rate sustained level turn is reached as before.

d. Importance of adjusting nose attitude and altitude with bank.

10. Rejoin.

Demonstrate procedure for level break from 220 knots onto downwind leg. (Application to advanced circuit flying, should be taught when required).

a. Straight and level flight at 220 knots

b. Reduce RPM to approx 80/70/70%

c. Lookout.

d. A/Bs out.

e. Level, 45 degree banked turn through 180 degrees.

f. Progressive change of pitch attitude to maintain level flight with decreasing airspeed.

g. A/Bs in below 140 knots.

h. Roll out on reciprocal heading.

POST-FLIGHT DISCUSSION

EXERCISE 16

LOW FLYING

AIM: TO TEACH HOW TO FLY THE AIRCRAFT NEAR THE GROUND WITH CONFIDENCE AND SAFETY.

INSTRUCTIONAL GUIDE

General

1. Although the student should fly confidently and with the requisite amount of dash, the instructor should immediately curb any tendency towards over-confidence or disregard of regulations. Low flying requires a high standard of both flying ability and self-discipline. The student should be taught to approach this exercise with these points in mind.

Before Flight

2. **Preparatory Instruction.**

(*a*) Regulations governing low flying and circumstances when it is necessary.

(*b*) Effect of wind.

(*c*) Effect of turbulence.

(*d*) Effect of aircraft momentum.

(*e*) Flying over contours.

(*f*) Navigational problems.

References—A.P. 129, Vol. 2, Sect. 4, Chap. 6, and A.M.F.O. No. 406.

During Flight

3. **Airmanship.**

(*a*) The student should have marked the low flying area and obstacles, cables, etc., on his map before starting the first lesson.

(*b*) Although accurate flying is important near the ground, this must not be to the detriment of a good lookout. The student should be warned that the low-flying area is not large and that there may be other aircraft using it at the same height.

4. **Familiarization at Low Level.**

(*a*) The first flight should be simple and the student should be allowed to handle the controls as much as possible.

(*b*) The danger of relying on the altimeter (Q.N.H. setting) when close to the ground should be pointed out. The correct height should be demonstrated and the student told to pay particular attention to the appearance of the ground at that height.

(*c*) Point out the importance of anticipating the power changes required when flying over marked changes of contour, particularly when flying downwind.

(*d*) The student should be advised to fly with a hand on the throttle at all times when at low level thus reducing the time to obtain further power in an emergency.

(*e*) The position in the low-flying area should be frequently checked to avoid leaving the area unintentionally. This practice also serves as introduction to low-level navigation.

5. **Effect of Wind.** To enable the student to more readily appreciate the effect of wind these demonstrations are best carried out in the bad visibility low-flying configuration at 120 knots. The reason for this should be explained and he should understand that the same effects are present at higher speeds but to a lesser extent.

6. **Low Flying in Bad Visibility.**

(*a*) The first demonstration and practice should be done in good visibility. Later practice can be given in poor visibility.

(*b*) The instructor should ensure that the student adopts the correct technique when suitable conditions arise at any time during his flying.

(*c*) Flying at low speed with flap down greatly increases the fuel consumption, which is already high at low level. The range and endurance in these circumstances is therefore considerably reduced.

(*d*) The reduced turning radius resulting from the lower speed can be convincingly demonstrated by comparing 180-degree turns at high and low speeds with the same angle of bank, both turns from the same feature.

EXERCISE 16

LOW FLYING

AIM: TO TEACH HOW TO FLY THE AIRCRAFT NEAR THE GROUND WITH CONFIDENCE AND SAFETY.

AIR EXERCISE

Airmanship

1. Before descending into the low-flying area:—
   - (*a*) Identify the low-flying area and its boundaries.
   - (*b*) Check fuel state—increased consumption at low altitudes.
   - (*c*) Harness tight and locked—more turbulence near ground.
   - (*d*) Note wind direction.
   - (*e*) Check that regional Q.N.H. is set on altimeters.

SEQUENCE	OBSERVATIONS
2. **Descending into the Low-Flying Area.**	
Descend into area and level off at about 200 feet A.G.L.	(*a*) Cruising speed. (*b*) Moderate rate of descent. (*c*) Gentle turns to clear blind spot —lookout. (*d*) Increasing impression of speed. (*e*) Changing aspect of ground features.
3. **Familiarization at Low Level.**	
Fly at about 200 feet A.G.L.	(*a*) Importance of lookout. (*b*) Trim for level flight. (*c*) Cruising power. (*d*) Increased turbulence. (*e*) Visual assessment of height, altimeter of little use. (*f*) Maintain height above ground level over contours. (*g*) To maintain height over large contours:— (i) Use power as necessary. (ii) Anticipation of power requirements—danger of delaying climb when approaching steeply rising ground. (*h*) Landmarks, obstacles, and hazards—power cables, etc. (*j*) Boundaries of low-flying area. (*k*) Importance of frequent position checks.

SEQUENCE (*contd.*)	OBSERVATIONS (*contd.*)
4. **Bad Visibility Low Flying.**	
Demonstrate at 120 knots, first without flap and then with take-off flap.	(*a*) Need to fly slowly. (*b*) Note pitch attitude and low power at 120 knots with no flap. (*c*) With take-off flap:— (i) Lower nose attitude—better forward view. (ii) Lower safe speed—lower stalling speed. (iii) Smaller turning radius. (iv) High power more quickly available. (v) Reduced range and endurance.
5. **Effect of Wind.**	
Demonstrate at 120 knots and with take-off flap in moderate winds. (*a*) Fly at right angles to wind along a line feature.	(*a*) Wind direction. (*b*) Drift more apparent than at altitude. (*c*) Drift allowance to maintain track and avoid obstacles. (*d*) Reduced effect at higher speeds.
(*b*) Fly into wind and turn accurately through 180 degrees. Fly downwind and then turn through 180 degrees. Maintain a constant airspeed and height above ground level.	(*a*) Into wind:— (i) Airspeed. (ii) Note low groundspeed. (iii) Not necessary to increase power. (*b*) While turning downwind note drift towards inside of turn. (*c*) Downwind:— (i) Airspeed the same. (ii) Note increased groundspeed. (iii) Danger of decreasing power (*d*) When turning into wind, note drift toward outside of turn. (*e*) Danger of drifting into obstacles during turn.
6. **Low-Level Steep Turns.**	
(*a*) Demonstrate increasing power to maintain entry speed from:— (i) Normal cruise. (ii) Bad visibility configuration.	(*a*) Importance of look out for other aircraft, changing contours and obstacles. (*b*) Need for accuracy—constant height A.G.L. (*c*) Drift during turns. (*d*) Importance of reducing bank to gain height quickly.
(*b*) Low-flying patterns.	As above, with adjustment of bank to compensate for drift.

SEQUENCE (*contd.*) | OBSERVATIONS (*contd.*)

7. High-Speed Low Flying.

◀Demonstrate at 98% r.p.m.▶

(*a*) Good visibility essential.

(*b*) High closing speed—avoiding action taken earlier.

(*c*) Large turning radius.

(*d*) High fuel consumption.

(*e*) Navigational problems—limited time to identify features—high groundspeed.

POST-FLIGHT DISCUSSION

EXERCISE 17

FORCED LANDINGS

AIM: To teach how to make an approach and landing after partial or complete engine failure.

INSTRUCTIONAL GUIDE

General

1. Any landing not pre-planned before take-off is considered a forced landing. Such landings may vary from a Grade 2 Administrative Diversion in good weather conditions to a landing resulting from complete engine failure. The major part of the Instructional Guide and the whole of the Air Exercise will be concerned with forced landings after complete or partial engine failure.

2. It should be impressed upon the student that, despite the reliability of modern engines and equipment, failures can and do occur, and may well lead to the necessity of forced landing. Such landings must therefore be taught, and practised frequently, to develop the necessary skill, judgement and confidence. In particular, the success of a forced landing without power depends to a great extent on the pilot's ability to carry out a well judged glide approach. The student should therefore be given every opportunity to practise glide approaches from the beginning of his training, so that he can gain confidence in his ability to land without power.

3. The student must have attempted the forced landing without power exercise before being authorized to leave the circuit on solo flights. He must be given further dual and solo practice at frequent intervals throughout his course.

4. The teaching of the forced landing sequences must be a progressive process—as the student's flying skill and his ability to absorb instruction increase, further aspects of the exercises can be introduced. However, to enable him to appreciate the requirements resulting from varying circumstances and to assist him in understanding the need for specific actions, the Preparatory Instruction should give a broad background knowledge of all types of forced landings, and the circumstances leading up to them. As well as presenting a more balanced picture to the student, this may prevent him taking totally incorrect and potentially dangerous action during early solo flying if faced with an emergency not yet covered by detailed instruction.

5. Once the student has become reasonably competent at judging glide approaches the instructor should demonstrate planning from various heights so as to intercept the glide approach path, starting at low level and progressing to higher altitudes.

6. The student should be told that, under some circumstances, as for example at night or over unsuitable terrain, a forced landing should not be attempted, and he should eject.

7. To simulate the rate of descent of an actual engine failure flap should be lowered as recommended in Pilot's Notes when in sight of the airfield and intending to remain at less than 150 knots.

8. **Forced Landing without Power.** Forced landings without power can be broadly classified under the following headings:—

◀(*a*) Engine failure in the circuit when not upwind of the runway in use (Exercise 12, Para. 10 refers)▶.

(*b*) Engine failure at low altitude.

(i) At low speed, or when the cloud base is too low for the aircraft speed to be converted to height.

(ii) At high speed.

(*c*) Engine failure at medium or high altitude followed by a forced landing on an airfield by:—

(i) Visual letdown.

(ii) Controlled descent through cloud.

9. **Forced Landing with Power.** The circumstances associated with a forced landing with power can vary considerably. For training purposes, two main classifications are offered:—

(*a*) Landings on an in-use airfield, which can result from a diversion or from the pilot becoming lost, short of fuel, *etc.* The use of RT or the signals square to obtain the necessary landing information should be part of normal airmanship instruction.

(*b*) Landings at a disused airfield for any of a variety of reasons, as for example lost and short of fuel. The normal landing technique should be used, after inspecting the landing area from low altitude.

During Flight

10. Each type of forced landing should first be demonstrated by the instructor. The subsequent instruction is best given in two stages:—

(*a*) The instructor assists with the various cockpit checks so that the student can concentrate on the planning and judgement required for the descent and approach.

(*b*) The student carries out the full procedure.

11. Drills which cannot be realistically simulated in the air, *e.g.* action in the event of engine failure or fire, should be indicated verbally and by the student pointing to the controls he would use.

He should be thoroughly drilled in the Emergencies Trainer in the use of the relevant controls, and by these two training methods, it should be possible to make his actions nearly automatic in the event of an actual emergency.

12. **Airmanship.**

(*a*) Forced landings away from the airfield are practised only in the low-flying area or on special airfields detailed in Unit Flying Orders. Since several aircraft may be engaged in practice at the same time, a good lookout is essential. This must be impressed on the student, whose lookout will probably suffer because he is concentrating on planning and checks.

(*b*) Prior permission must be obtained from air traffic control for practice forced landings on an active airfield.

13. **Position of Undercarriage.** After considering the factors involved, the aircraft captain must decide whether or not the undercarriage is to be lowered for a forced landing. In the majority of cases a wheels-down landing is made when landing on an airfield, and experience has shown that, in many cases, it is also advantageous to lower the wheels if landing in open country. The undercarriage cushions the initial impact and holds the fuselage clear of smaller obstructions. A longer landing run will result with wheels down, and although brakes can be used to the maximum, and the aircraft steered, the undercarriage may have to be raised to decelerate more quickly.

14. **Choice of Field for a Forced Landing.** When a landing cannot be made on an active airfield, the next best choice is a disused airfield, if the runways are known, or appear to be clear. Only in exceptional circumstances is a forced landing to be attempted in open country, and the following requirements must then be met:—

(*a*) A long landing run, into wind where possible.

(*b*) A firm, level surface.

(*c*) An approach path clear of obstacles (and a clear overshoot area for the practice case).

(*d*) Close to communications and assistance when possible.

The appearance of suitable surfaces, and seasonal variations, should be pointed out to the student from various altitudes. Further, he should be encouraged to be aware of the area over which he is flying, so that, in the event of a forced landing becoming necessary, he can select the landing area with a minimum of delay.

15. A Jet Provost aircraft can be expected to spend a large proportion of its airborne time at medium and high altitudes. Thus

initial dual instruction should be devoted to forced landings without power from these altitudes, both on airfields and in open country. Other types of forced landing can be introduced progressively as soon as possible after solo.

16. **Immediate Action.** When practising forced landings without power, the throttle should be closed, speed reduced and height gained, and the appropriate emergency drill simulated. As the student becomes proficient, practices should be made more realistic by closing the throttle without warning, at various altitudes and under various conditions of flight.

17. **Initial Descent.**

(*a*) As the immediate actions are being completed, the aircraft should be trimmed to glide for range, the most suitable landing area selected, and the descent planned. To enable the instructor to assess planning and judgment, the student should nominate his selected landing area as soon as he has chosen it.

(*b*) The altitude at the time of engine failure will greatly influence the plan of action. Many factors affect this course of action, and the instructor should have discussed fully with the student the effects of the following:—

(i) Height above ground and gliding range.

(ii) Position of airfields or suitable landing areas.

(iii) Time available, and drills and checks that can be carried out in this time.

(iv) Wind velocity.

(v) Weather conditions.

(vi) Whether engine failure is complete or partial.

(vii) Experience of pilot.

(*c*) The importance of careful planning cannot be overstressed. Point out that the descent should be planned to arrive in a position from which a normal glide approach can be made.

(*d*) In the event of an actual engine failure, the pilot should make an immediate distress call on the R/T frequency in use. During practice, the student should simulate such a call, and then indicate his actions to send out the necessary distress message (if time is available) on the distress frequency.

(*e*) The following points should be considered during the descent:—

(i) If engine failure has been due to fire or an obvious mechanical fault, no attempt should be made to relight. In other cases, the full relight drills, as laid down in Pilot's Notes and Flying Wing Orders, should be carried out, at least two attempts to relight being made if time permits.

(2) The aircraft batteries, if well charged, should operate the radio, instruments and pitot head heater for a considerable period. However they should be conserved by reducing the load as much as possible.

(3) The pressure in the main hydraulic accumulator is sufficient to retract the airbrakes, lower the flaps and partially lower the undercarriage. Thus, the available power must be conserved as far as possible, and used only for essential purposes. Indiscriminate use of airbrakes may result in the pressure becoming exhausted with the brakes "out" and they cannot then be retracted. The undercarriage should be lowered using the emergency system, but it must be remembered that, should the hydraulic accumulator be completely exhausted of pressure, the undercarriage cannot then be retracted on the ground.

(4) Hot air will not be available for demisting if the engine has failed. A glycol rag should therefore be used early in the descent to prevent misting.

(5) In the event of an actual failure, with a seized engine, the gliding range would be reduced by approximately 20 per cent.

18. Circuit and Landing. The final part of the initial descent should be regulated to position the aircraft just on the dead side at 2500 ft abeam the caravan, parallel to the runway, into wind, at 120/120/130 knots (with take-off flap selected for the practice). This is High Key. A turn should be entered, to join the downwind leg, and should be adjusted to finish opposite the caravan at 1500 ft with the roundel overlapping the runway. This is Low Key. The methods of height control are:

a. If high, delay the start of the turn.

b. Adjust the radius of the turn.

c. Advance or delay lowering the undercarriage.

19. Final Approach. The final turn should be entered at 115 knots aiming to touchdown one third of the way along the landing run without flap. The following methods can be used to control the descent path during the final turn and approach.

a. Varying radius of turn.

b. Lowering flap by stages.

c. Diving to lose excess height.

d. Side slipping.

20. **Landing.** The accuracy of a practice forced landing can be judged without descending to ground level and except when approaching a runway in use, the pilot should overshoot at not below 200 feet A.G.L. However, a number of practices should be carried out on the runway in use, and a touchdown made. Thus the student will gain experience and confidence in touching down from forced landing approaches. The extra distance covered by round-out and hold-off after a fast approach can be demonstrated and allied to discussion with the student of the technique of using airbrakes and flying on the ground when approaching fast from an actual forced landing. The student should understand too that, in an emergency, insufficient height may well dictate a landing out of wind or even downwind.

21. **Forced Landing through Cloud.**

(*a*) In the event of engine failure in, or above cloud it is imperative that the position of the aircraft be fixed as soon as possible after the immediate actions are complete, to enable air traffic control to direct the aircraft to the most suitable diversion airfield within gliding range. The fix is best obtained by the use of the Emergency Fixer Service.

(*b*) The final decision as to whether he should attempt to make a forced landing through cloud must rest with the captain of aircraft. It is therefore essential that the pilot is informed of the prevailing weather conditions as soon as possible.

(*c*) The initial demonstration should be started from a position and height to give sufficient time to show the need for orientation during the spiral descent. The value of the procedure in an emergency should be pointed out—not only after complete engine failure but also when insufficient fuel remains at overhead to carry out a full C.D.T.C.

22. **Forced Landing without Power from Low Altitudes.** There can be no hard and fast definition of "low altitude" in the event of engine failure, or for that matter, hard and fast procedure to be followed. The student must understand that the immediate actions are applicable to all cases, but actions from there on will depend entirely upon height and availability of a suitable landing area, it should also be stressed that if no good landing area is available then he should eject.

Forced Landings with Power.

23. When demonstrating forced landings with power, realism should be introduced by imposing limits on time available, fuel amounts to be used or any other limiting factors which can be simulated. The points should always be stressed however that good airmanship will normally make this type of landing unnecessary.

24. The factors affecting the detailed procedure to be adopted are listed in the following sub-paras.—they should have been discussed with the student before the flight:—

(*a*) The landing must be made before the fuel is exhausted. Thus, when a forced landing is decided on, the remaining endurance must be calculated, and from this, after substracting a reserve for inspection of the field, circuit and landing, the search endurance decided.

(*b*) The choice of height to fly during the search may be restricted by weather. If this is not the case, the advantages of decreased fuel consumption and increased field of vision and radio range at higher altitude must be weighed against the easier assessment of possible landing areas possible at lower altitudes. In good weather the remaining endurance will obviously influence the choice.

(*c*) The speed at which to fly will depend on weather conditions. Poor visibility may force the pilot to adopt the bad visibility low-flying configuration, with resulting increase in fuel consumption. If it is possible, flying at the relevant range of endurance speeds offers obvious advantages.

(*d*) Flying downwind will give the greatest ground coverage.

(*e*) If they are available, maximum use should be made of radio and navigational aids. There should be no hestitation in using the emergency frequencies.

(*f*) The landing area chosen should conform to the requirements set out in para. 12. An airfield is the obvious first choice for a forced landing but, if it is disused, the surface should be checked for suitability since many have obstructed runways.

(*g*) Conditions permitting, a normal circuit should be flown on the selected field. In poor visibility, when it is difficult to keep the selected field in sight, the bad weather circuit technique applicable should be used.

25. In the event of an actual landing, the final approach should be under power, and at the safe minimum approach speed. The aircraft should be flown onto the ground as early as possible, airbrakes being used if necessary to reduce float, and the nose wheel should be lowered immediately and maximum braking used.

Common Faults

26. Students often find difficulty in allocating their time and thoughts between flying and planning, and covering the checks and drills. This can only be put right by practice and by ensuring that the checks and drills are performed instinctively.

EXERCISE 17

FORCED LANDINGS

AIM: To teach how to make an approach and landing after partial or complete engine failure.

AIR EXERCISE

SEQUENCE	OBSERVATIONS
1. Visual Forced Landing.	
a. Simulate engine failure by closing throttle	a. Immediate actions: (1) Fire-fire in air drill. (2) Mechanical failure - close throttle, HP and LP cocks. Do not attempt relight. (3) Otherwise attempt to relight as laid down in Pilot's Notes. (4) Convert excess speed into height. (5) Establish glide at 120/120/130 knots - trim (6) If engine has not relit, close throttle, HP cock and turn off non-essential electrics.
	b. Select landing area and turn towards it.
	c. RT distress call.
	d. Set QNH or QFE as required.
b. While gliding for maximum range. Once there is no possibility of increasing speed above 150 knots, then take-off flap should be	a. Plan descent and circuit taking into account:- (1) Wind strength and direction.

	selected to simulate the case of the dead engine).		(2) Height to lose.
			(3) Circuit pattern and key positions.
			(4) Position aircraft so that a landing area is always visible.
			(5) Carry out relight drill.
			(6) Continuous review of descent pattern-conservation of electrical and hydraulic services.
c.	Circuit pattern - High Key to Low Key.	a.	Position on deadside, 2500 ft, abeam caravan (High Key).
		b.	Call "High Key".
		c.	Adjust turn to downwind, depending on wind.
		d.	Normal vital actions with observations on emergency VAs.
		e.	Methods of height control.
			(1) Delaying start of turn if high.
			(2) Adjusting turn to downwind.
			(3) Advance or delay u/c lowering.
		f.	Low Key - ideally 1500 ft, abeam caravan.
		g.	Call "Low Key".
d.	Low Key to touchdown.	a.	As 1500 ft glide approach.

b. Ejection decision by 600 ft. agl.

c. Use of airbrakes and undercarriage override in emergency.

2. Forced Landing through Cloud.

a. Simulate engine failure within gliding range of airfield. (Minimum cloud base for practice 3,000 ft agl.)

a. Immediate actions same as visual forced landing.

b. RT distress call.

c. Homing to airfield within gliding range at 120/120/130 knots.

d. Relight drills.

b. Spiral descent from overhead.

a. Commence Rate 1 turn and increase airspeed to 170 knots.

b. State height and heading in all transmissions.

c. Simulate breaking cloud at 3,000 ftagl.

a. When ground is visible, make call "visual", a steer to airfield will then be given.

b. Use of excess speed to position for a visual forced landing.

c. When airfield sighted, make call "contact".

d. Select best available runway and carry out a visual forced landing.

3. Forced Landings from Low Level.

Simulate engine failure at heights between 1,000 and 1,500 ft agl at low and high airspeeds.

a. Immediate actions as for normal forced landing.

b. Rapid assessment of wind direction and selection of landing area.

SEQUENCE (*contd.*) OBSERVATIONS (*contd.*)

(*c*) R/T distress call.

(*d*) Vital actions.

(*e*) Considerations for height adjustment as for normal forced landing.

Note.—It should be emphasized that if no good landing area is available, then ejection is recommended.

POST-FLIGHT DISCUSSION

EXERCISE 18

AEROBATICS

AIM: To teach accurate and confident control in all attitudes, and the ability to fly the aircraft to its limits.

INSTRUCTIONAL GUIDE

1. Aerobatics are an essential part of a service pilot's training, for although their operational value is limited, they improve confidence, judgment and co-ordination, and accustom the student to extremes of speed and attitude. Furthermore, they will increase his *g* tolerance and thus prepare him for more advanced types.

2. Before attempting to teach aerobatics the instructor should accustom the student to the sensations involved by demonstrating loops and rolls. Should he show any signs of airsickness, aerobatic practice should be discontinued; eventually he will become conditioned and able to complete a lengthy period of aerobatics without feeling ill.

3. Regular practice is important; frequent brief lessons achieve better results than lengthy concentrated periods at irregular intervals. Most instructional flights provide opportunity for a short aerobatic interlude before landing and this often presents a pleasant way of relieving the tension after any exercise which has required such concentration by the student, although the instructor should not relax the standard of accuracy required.

Before Flight

4. **Preparatory Instruction.**

(*a*) Effect of loading on aircraft and pilot.

(*b*) Effect of airspeed on control forces and effectiveness.

(*c*) Effect of height and inertia.

(*d*) Engine and airframe limitations.

(*e*) Loop.

(*f*) Barrel roll.

(*g*) Inverted flight.

(*h*) Slow roll.

(*j*) Stall turn.

(*k*) Roll off the top of a loop.

(*l*) Half roll.

(*m*) Recovery from stalls, including *g* stalls, spins from manœuvres, and vertical attitudes.

(*n*) Advanced aerobatics.

(*o*) Regulations and restrictions.

References—A.P. 129, Vol. 2, Part 2, Sect. 4, Chaps. 1 and 5, and A.M.F.Os. Nos. 401 to 405.

During Flight

5. Initial instruction in aerobatics should be confined to the basic manœuvres, *i.e.* the loop and barrel roll, and further aerobatics introduced as the student becomes proficient and familiar with the sensations and attitudes involved.

6. The stall most commonly encountered during aerobatics is the *g* stall, and recovery is effected by relaxing the back pressure on the control column. Should the stall occur at a very low speed and with the aircraft in an extreme nose-up attitude the recovery should be as for recovery from the vertical at low speed (Exercise 11). Demonstration of stalls and recoveries from various attitudes should be made during instruction on the loop.

7. The student should be taught to fly the aircraft through aerobatics and so become aware of the control movement required and the response available at each stage of the manœuvre. Automatic and drill-like control movements indicate that he lacks co-ordination and the sense of being part of the aircraft.

8. Aerobatics involve large variations in speed and result in changes of control forces and control effectiveness. The aircraft should not be trimmed through aerobatics manœuvres, the changing stick force must be held by the pilot, and the varying effectiveness of the controls calls for care in avoiding excessive *g* through large control movements at high airspeeds.

9. Students often have difficulty in continuing a control movement when negative *g* is imposed. It is essential that the harness, in particular the lap strap, is well tightened.

10. Flick manœuvres and aerobatics involving marked or prolonged negative *g* are prohibited. The safe period for inverted flight depends on the r.p.m. setting and is given in Pilot's Notes. Sudden applications of negative *g* and harsh control handling generally are undesirable and indicative of poor flying.

11. The entry airspeeds and power settings used for aerobatics should be as required for the particular manœuvre, but until the student is sufficiently competent a power setting of 90 to 98 per cent. r.p.m.

and the entry speeds quoted in the relevant air exercise should be used at medium levels. As his skill increases he should be encouraged to vary the speeds, *e.g.* he can gradually reduce the entry speed for a loop until he arrives at a minimum speed to carry out the manœuvre satisfactorily.

12. The student's attitude towards aerobatics will be greatly influenced by that of his instructor and he will be readily affected by any signs of apathy. It is very important, therefore, that the aerobatic exercises are carried out enthusiastically as well as conscientiously.

13. Within the bounds of safety, the pupil should be allowed to correct his own mistakes. Many who normally carry out good stall and spin recoveries fail to recognize these conditions when they occur unexpectedly during manœuvres. In such cases the instructor should carefully point out the symptoms which went unheeded and the action that should have been taken.

14. **Airmanship.**

(*a*) The checks before aerobatics are the same as those before stalling and spinning, and should be carried out before any aerobatic exercise is commenced.

(*b*) The airspace around the aircraft must be thoroughly inspected before each manœuvre to ensure adequate clearance from all other aircraft and clouds. Most aerobatics involve marked and rapid changes of height, heading and position, and the lookout must be continued during the manœuvre.

(*c*) Whenever possible, aerobatics should be carried out with the sun on the beam otherwise the blinding effect will hamper accurate flying and may seriously impair lookout.

(*d*) As the student increases in proficiency he should be encouraged to enter the dive from the clearing turn or by a wing-over.

15. **Spin from Manœuvres.** Before the pupil is permitted to carry out solo aerobatics he must have been shown and have practised the recovery from [redacted] incipient spins caused by AL15. mishandling of the controls during aerobatics.

16. **Loop.** In the loop the aim should be to maintain a constant rate of movement in the looping plane, and positive loading throughout. The stick forces vary as the airspeed changes, being greatest at the bottom and least at the top of the loop where the speed is lowest.

17. **Barrel Roll.** Positive loading should be applied throughout the barrel roll. The size of the helix described by the aircraft is

dictated by the distance the nose is from the reference point along the horizon at the commencement of the roll. This in turn will depend on the distance the nose is below the horizon in the dive, ideally therefore the dive should be steeper for rolls of large radius. The circle described by the nose should be centered on, and at constant distance from, the selected reference point. Thus half the circle will appear to be above the horizon and half below it. The control deflection required to maintain a constant rate of roll will vary as the airspeed changes. A higher entry speed should be used for rolls of large radius.

18. **Inverted Flight.** The inverted flight should be practised before slow rolls so that the student becomes accustomed to the appearance and sensations of inverted flight. The entry to, and the recovery from, the inverted flight is similar to that for the slow roll. Care must be taken that the permitted inverted flight period is not exceeded or the engine may flame out.

19. **Slow Roll.** Particular care should be taken to ensure that the student fully understands the co-ordination of rudder and elevator control required to maintain the nose position and attitude during the slow roll. He should appreciate that when rolling out, the effect of dihedral and top rudder is to increase the rate of roll unless the aileron deflection is progressively reduced. Little advantage is gained by increasing the entry speed to any extent above that recommended as the increased foot load makes rudder difficult to apply. It may prove advantageous however, to teach and accept a higher rate of roll until he has gained experience, when he should attempt to progressively reduce the rolling rate.

20. **Recovery from Vertical Attitudes.** Before authorizing solo aerobatic practice the student's technique in recovering from near vertical attitudes should be checked. The use of the angle that the wing tip makes with the horizon to judge the exact attitude should be pointed out. Revision of this exercise is particularly important before the student is permitted to carry out solo stall turns.

21. **Stall Turn.** The use of a higher entry speed for initial practice of the stall turn may assist the pupil by allowing him more time. The use of elevators to prevent pitch movements and of aileron to prevent the rolling tendency should be pointed out. Stall turns to the right may be found easier if the throttle is closed earlier than normal. Application of rudder before the control column is central could lead to a spin. During an accurate stall turn the aircraft should yaw through a reference point on the horizon. This reference point should be selected on the wing tip when the aircraft is vertical.

22. **Roll-off-the-Top.** The roll-off-the-top is a combination of the loop and the roll and the entry speed should be slightly higher

than for a loop in order to provide sufficient speed for the roll. Two methods of rolling out are given in the Air Exercise, the first is easier and can be taught initially, but ultimately the student should be capable of using both methods.

23. **Advanced Aerobatics.** When the student is competent at the basic manœuvres, combination or variations of the aerobatics can be introduced, and he should reach a standard where he is able to complete an aerobatic sequence. The instructor must ensure that the high standard of lookout required does not deteriorate when consecutive aerobatics are practised. By the end of the course the student should be able to carry out reasonably accurate vertical roll, aileron turns, four- and eight-point rolls, Derry turns, "spectacles", horizontal figures-of-eight, and clover leaf patterns. The more apt student should also master the vertical eight.

24. **Vertical Roll.**

(*a*) The pullout from the dive that is required to achieve the high entry speed for a vertical roll should be made at a moderate loading (about 3 to 4 *g*). Use of high *g* will cause a rapid loss of speed owing to the high drag and also involves the risk of overstressing.

(*b*) Aileron should not be used to start the roll until the vertical is reached and the loading is reduced.

(*c*) The student should not be asked to roll through a specific number of degrees until he is capable of a reasonably accurate roll and can complete the recovery at a safe speed. The speed at which to recover is best judged by feel; looking into the cockpit at this stage of the manœuvre is undesirable.

(*d*) The recovery can be effected by looping to the horizon and then rolling out or continuing to pull through, or by a stall turn. Whichever method is used, the speed when recovery action is taken should be sufficient to provide a positive measure of control. The student should realize that if control effectiveness is lost the action for recovery from the vertical should be taken, *i.e.* controls centralized and held firmly until the nose is below the horizon and the aircraft is accelerating.

(*e*) The vertical roll is not easy to perform accurately, and many students have difficulty in maintaining the vertical. The position and angle of the wing tip relative to the horizon when truly vertical should be pointed out. Alternatively, he can be shown that by looking up through the canopy the horizon remains visible directly overhead during an accurate roll. If the horizon is not seen, the roll should be continued until it appears, before pulling towards it if looping out.

25. **Aileron Turn.** The aileron turn can be commenced from a half roll, a stall turn or the second half of a loop when the aircraft is pointing vertically downwards. In all cases the entry speed should be as low as possible as the airspeed increases rapidly; for this reason the throttle should be closed and the airbrakes extended as necessary if the roll is to be prolonged. The recovery should be started well before the aircraft limitations are reached and rolling pullouts at high *g* loadings should not be allowed.

26. **Aerobatics at High Level.** When the student is proficient at medium levels he should be introduced to aerobatics at heights in excess of 20,000 feet. The effects of height on manœuvrability will already have been discussed and demonstrated during the high-level familiarization details. Subsequent student practice should be devoted mainly to aerobatics in the looping plane in order to develop the necessary smooth and delicate control. To partially compensate for the reduced thrust, a setting of up to 98 per cent. r.p.m. may be used providing that the limitations are observed.

Common Faults

27. Many students tend to become disorientated during aerobatics and should, therefore, be encouraged to check their position between manœuvres. They should also to told to carry out aerobatics into wind when it is strong, and when it does not conflict with the need to avoid heading into sun.

28. Most faults in handling can be traced to over controlling at high speeds, and under controlling at low airspeeds through failure to appreciate the effects of airspeed on control effectiveness and trim. Some students also fail to realize the need for gentle handling when the speed is low, for example during a roll-off, when harsh aileron and rudder will cause wallowing and possibly an incipient spin.

29. Students tend to practice their rolls in the one direction which comes more easily to them. The instructor should ensure that rolls are practised in both directions.

30. The co-ordination required to execute an accurate slow roll may be improved by getting the student to roll to the inverted, pause, and then roll back in the opposite direction.

EXERCISE 18

AEROBATICS

AIM: To teach accurate and confident control in all attitudes, and the ability to fly the aircraft to its limits.

AIR EXERCISE

Airmanship

1. (*a*) Checks—as before stalling and spinning.

(*b*) Limitations—the aircraft's speed and loading limitations must not be exceeded.

(*c*) Orientation—frequent position checks.

(*d*) Visibility—sufficient and with a clearly defined horizon.

(*e*) Instruments— resynchronize G4F after aerobatics.

Sequence	Observations
2. **Loop.**	(*a*) Lookout. (*b*) Use of line feature. (*c*) Straight dive. (*d*) Pull up started at 220 knots. (*e*) Accelerometer reading. (*f*) Check wing level as nose cuts horizon and when vertical. (*g*) Progressive rearward control column movement. (*h*) Decreasing stick force. (*j*) Gentle control movements at low speed. (*k*) Second horizon—check wing level. (*l*) Relaxation of back pressure in the dive. (*m*) Pull out—accelerometer. (*n*) Check direction—line feature. (*o*) Climb away.
3. **Barrel Roll.**	(*a*) Lookout. (*b*) Reference point on horizon. (*c*) Straight dive below reference point. (*d*) Apply 45-degree bank in opposite direction to roll as 180 knots is approached. (*e*) Pull up to horizon to one side of reference point with elevator.

SEQUENCE (*contd.*)	OBSERVATIONS (*contd.*)
3. **Barrel Roll**—(*contd.*)	(*f*) Apply aileron to ensure wings level as nose cuts horizon—maintain balance with rudder throughout. (*g*) Co-ordination of elevator and aileron to circle reference point at a constant distance. (*h*) Wings vertical when nose above reference point. (*j*) Wings level as nose nears horizon on downward path. (*k*) Control deflection increased at lower speeds to maintain constant rate of roll. (*l*) Wings vertical when nose below reference point. (*m*) Roll completed when nose back on horizon wings level, as at start of roll. (*n*) Positive loading maintained throughout roll. (*o*) Higher entry speed for rolls of large radius—greater looping and reduced rolling movement.
4. **Spin from Manœuvres.** Demonstrate before authorizing solo aerobatics.	See Exercise 11, Air Exercise para. ◀5▶.
5. **Recovery from Vertical Attitudes.** Revise before authorizing solo aerobatics.	See Exercise 11, Instructional Guide, para. ◀33▶.
6. **Inverted Flight.** (*a*) Invert aircraft by a half roll at about 180 knots and maintain level inverted flight.	(*a*) Attitude in level inverted flight. (*b*) Forward position and load on control column. (*c*) Time limitation. (*d*) Application to slow roll.
(*b*) Invert aircraft and bank aircraft in each direction.	Control effect is in normal sense relative to pilot.
7. **Slow Roll.**	(*a*) Lookout. (*b*) Reference point on horizon. (*c*) Straight dive, if necessary, below reference point to obtain 180 knots. (*d*) Shallow climbing attitude, nose-up movement checked before rolling. (*e*) Rolling in (up to 90 degrees):— (i) Aileron.

SEQUENCE (*contd.*) — OBSERVATIONS (*contd*,)

7. **Slow Roll**—(*contd.*).

(ii) Progressive slight top rudder.

(iii) Elevator movement to maintain direction and nose position.

(*f*) 90 degrees to inverted:—

(i) Control column progressively forward to maintain nose position.

(ii) Co-ordination of rudder to maintain direction.

(iii) Attitude for inverted level flight.

(iv) Continued application of aileron to maintain roll.

(*g*) Rolling out:—

(i) Co-ordination of rudder and elevator to maintain direction and nose position.

(ii) Large amount of top rudder required to prevent nose dropping.

(iii) Tendency for rate of roll to increase prevented by opposite aileron.

(iv) Roll stopped when wings level.

(v) Slightly higher nose position to maintain height at lower speed.

(*h*) Residual skid removed smoothly.

(*j*) Aim to achieve constant rate of roll and eventually to reduce height changes to a minimum.

8. **Stall Turn.**

(*a*) Lookout.

(*b*) Line feature reference.

(*c*) Straight dive along line feature to obtain 200 knots.

(*d*) Pull up to vertical.

(*e*) Check wing level when pulling up.

(*f*) Wing tip angle to horizon used as reference for vertical—select reference point on horizon.

(*g*) Forward control column movement to maintain vertical.

(*h*) Smooth and progressive application of rudder.

(*j*) Rolling tendency prevented with aileron.

SEQUENCE (*contd.*) | OBSERVATIONS (*contd.*)

(*k*) Pitch attitude controlled with elevators to ensure nose cuts horizon following path of wing tip.

(*l*) Throttle closed as nose drops towards horizon.

(*m*) Anticipation of rudder to stop yaw.

(*n*) Vertical dive—check line feature.

(*o*) Ailerons neutral to prevent roll.

9. Roll off the Top of a Loop.

(*a*) Lookout.

(*b*) Line feature.

(*c*) Begin as for loop at 250 knots.

(*d*) Rolling out (first method):—

(i) Roll started before reaching inverted level flight attitude.

(ii) Reference point on horizon.

(iii) Co-ordinated rudder and elevator to bring nose onto reference point with wings level.

(*e*) Rolling out (second method):—

(i) Loop checked in inverted level flight attitude—forward control column movement.

(ii) Roll completed as for slow roll.

(*f*) Large control deflections at low speed require gentle handling.

(*g*) Check accuracy of 180-degree heading change.

10. Half Roll.

(*a*) Lookout.

(*b*) Line feature.

(*c*) Entry as for slow roll—airspeed not excessive.

(*d*) Roll checked when inverted.

(*e*) Close throttle.

(*f*) Pull through second half of loop.

(*g*) Airbrakes to limit speed build-up, if necessary.

(*h*) Height loss increases at higher entry speeds.

(*j*) May be started from steep climbing attitudes.

SEQUENCE (*contd.*) — OBSERVATIONS (*contd.*)

11. Vertical Roll.

(*a*) Lookout.

(*b*) Steep dive to obtain 300 to 320 knots.

(*c*) Pull up to vertical-accelerometer reading.

(*d*) Use of wing tip angle with horizon to judge vertical.

(*e*) Forward control column movement to maintain vertical.

(*f*) Roll started when loading removed.

(*g*) Check maintenance of vertical.

(*h*) Roll stopped before control lost.

(*j*) Recovery:—
- (i) Stall turn.
- (ii) Half loop.
- (iii) Pull over towards horizon followed by roll out.

12. Aileron Turn.

(*a*) Lookout.

(*b*) Entry from stall turn, half roll or loop.

(*c*) Throttle closed.

(*d*) Airbrakes extended if necessary.

(*e*) Vertical dive—angle of wing tips to horizon.

(*f*) Aileron to roll—balance with rudder.

(*g*) Speed increases rapidly.

(*h*) Roll stopped and pullout commenced well before limiting speed.

(*j*) Large height loss.

SEQUENCE (*contd.*)	OBSERVATIONS (*contd.*)
13. **High-Level Aerobatics.**	
Practice above 20,000 feet using up to 98 per cent. r.p.m.	(*a*) Rolling manœuvres:— (i) Negligible effect on rolling manœuvres at low loading. (ii) Possibility of inducing *g* stall—in barrel rolls of large radius. (*b*) Looping manœuvres:— (i) Proneness to stalling under loading, especially at top of loop. (ii) Need for smooth and gentle handling. (iii) Rapid deceleration in the climbs as a result of low thrust. (iv) Increased airspace involved. (v) Height lost in manœuvres. (*c*) Advanced aerobatics:— (i) Restricted by low power. (ii) High indicated airspeeds require steep dives.
14. **Further Aerobatics.**	
(*a*) Four- and eight-point rolls.	
(*b*) Derry turn.	
(*c*) Horizontal figures of eight.	
(*d*) Vertical figure of eight.	See A.P. 129, Vol. 2.
(*e*) Continuous half rolls.	Part 2, Sect. 4, Chap. 5.
(*f*) Clover leaf pattern.	

POST-FLIGHT DISCUSSION

EXERCISE 19

INSTRUMENT FLYING

INSTRUCTIONAL GUIDE

NOTE: The terms and doctrine used in this chapter are fully explained in the SSG Chap 19 paras 1-9. It is necessary, therefore, to read those paragraphs first.

Introduction

1. So far the student has been taught to fly using visual references. Now, instead of making corrections against a natural background he should be taught to use the artificial horizon. This chapter contains advice on giving instrument flying instruction and also details the sequence of instruction for the basic and applied manoeuvres and instrument weather procedures. It also details a sequence of instruction for flying with an unserviceable artificial horizon (AH). Each manoeuvre and procedure has been broken down into logical parts to achieve specific intermediate objectives. In addition to acting as a guide towards a logical presentation of the lessons it will also ease your task of isolating and identifying any fault in the student's work.

Preparatory Instruction

2. a. Student Study guide - JP Chap 19.

b. Instruments - indications, limitations and errors.

c. Physiological considerations.

d. Weather procedures.

3. Pre-flight Briefings. Although no new techniques or manoeuvres are taught during instrument flying the mental disciplines and the procedures are new. Moreover, the training is likely to be spread over a long period. Consequently, a series of briefings will be required. Break the sequences down into their natural parts either to fill a whole detail or just a part and give briefings accordingly. Include advice on the control technique, the instruments which should comprise the scan for the particular lesson and, any likely pitfalls.

General

4. The air exercise has been so arranged that the student deals with a small number of instruments at first; then, as progress is made, the number is gradually increased. By the end of the instrument phase he should be competent to fly the aircraft and operate all its aids without visual assistance and your lessons must be planned accordingly. The normal cockpit duties have not been detailed in the sequences because the time when they should beadded to the students' responsibilities will vary

However, the correct time in each case is during the consolidation period of a sequence before proceeding with the next. Also during these consolidation periods string together small sections of the sequences to form scan exercises. The aim should be to extend the student but not to saturate or discourage him.

5. Beware of attempting short cuts in training. Since there are specific tests at various stagesof the instrument phase the temptation is to tailor the instruction exclusively to the tests. Faster progress will be made in the long term if the student receives thorough instruction in each aspect. This is of particular importance when the procedureal stage is reached. The instrument flying techniques required for a CDTC or GCA should be taught at medium level on a quiet frequency. There is little time for patter on an actual approach on busy R/T channels.

6. The Student Study Guide should serve as a useful aid to your instruction. Be aware of its contents and give your student specific reading tasks before each lesson. Sometime, before pre-flight briefing, interrogate him to see how much he has retained.

7. The decision when to use an instrument visor requires careful consideration since it can have a claustrophobic effect and delay progress. Generally, it is better introduced late rather than early. The best time is probably when the student is flying any one manoeuvre or procedure smoothly and confidently. Therefore, although he may be ready for the visor on medium level turns it does not necessarily mean he should use it during steep turns; each stage should be considered separately.

Selective Radial Scan

8. The selective radial scan outlined in the "observations" section and fully explained in the Student Study Guide should equip the student with a type of scan suitable for use throughout his Service career. It is essential, therefore, that he receives a thorough grounding in it. Avoid introducing tricks of the trade and short cuts peculiar to the JP which may achieve immediate gains but prove to be bad investments in the long term.

9. A particular advantage of the radial scan is the facility to group together instruments of immediate value. By emphasising the two or three instruments necessary for each manoeuvre, in addition to the AH, the task for the student and yourself will be greatly eased. Furthermore, the importance of restricting the scan to those instruments strictly essential to achieving the manoeuvre cannot be over emphasised.

10. Give, as far as possible, precise information on the AH indications for each manoeuvre. For example, during the entry to the instrument descent, the following patter would be appropriate:

> "Adopt the descending attitude on the AH and reduce to 65% RPM. As the speed reaches 170 kts extend airbrakes. Trim to hold the attitude. If the speed settles high, reduce the nose down attitude by one bar width and re-trim. If the airspeed settles low, lower the nose furtherby one bar width and re-trim. Re-check the ASI".

Do not, either directly, or by implication, teach the student to try and select his attitude primarily on the ASI by saying:

> "Lower the nose to achieve 170 kts".

The student should be convinced that any flight path can be achieved by using certain attitude indications on theAH combined with the necessary power settings. However, the final accuracy can only be obtained by using information gleaned from the performance instruments. Therefore, teach the technique of reliance on the AH as the primary instrument and the correct selective scan of the performance instruments to support it.

11. When a student returns to full panel work after a period on limited panel he will tend to continue to rely on the performance instruments and exclude the AH from his scan. Be prepared for this and if necessary adopt the method of calling out the scan mentioned below until he has regained the correct pattern.

12. During the early part of each exercise and whenever a student experiences scan difficulties get him to call out each instrument as he includes it into his scan. Abbreviate the titles so that it flows easily off the tongue. The ASI thus becomes "Climb" or "Descent", the Airspeed Indicator "ASI" or "Speed". By this means the student has his attention drawn to the correct instrument and you are able to check his progress or pinpoint an error. Furthermore, if the student calls out "Compass" where there is a 5 degree error and no corrective bank is applied, you know he is just reciting the scan and not correlating the information.

Trimming

13. Although trimming is mentioned only occasionally in the "Sequence Observations" the importance of correct trimming should be emphasised throughout and a constant watch kept for bad technique. The student should realise that bad trimming makes tasks such as radio frequency changes and DME selection more difficult and can lead to early fatigue.

Limited Panel

14. Instruction on limited panel should be kept separate from full panel instruction and taught as an emergency or standby system of operation. Undoubtedly, experience of limited panel flying leads to a better appreciation of the performance instruments but when deliberately used as an instructional aid to full panel flying it tends to disrupt the development of a full selective scan.

15. The most difficult problem the student must overcome is that of changing attitude. Without a direct indication he should be taught to assess the attitude change by interpreting the instrument indications with due allowance for lag and aircraft momentum. Emphasise the need for small unhurried smooth control movements. If he becomes tense, overcontrols, and gives no indication of improving, demonstrate and let him practise similar attitude changes cross-referring with the visual references.

16. Maintaining an attitude is more easily taught. Point out that now only two instruments are required to maintain accurately any of the basic manoeuvres, provided occasional glances are made at the altimeter when climbing or descending and the compass when turning.

17. Remember that when limited panel turns are taught it is the first time that the turn needle has been included in the scan. Make sure he understands that any variation of the "G" forces in a turn will cause a change of reading and this does not necessarily mean that the bank has changed.

18. The low rate of instrument unserviceabilities leads to the possibility of such failures being overlooked. Discuss with your student the actions to be taken should any instrument become unuseable during flight. Also discuss the possible effects of icing, AC power failure and so on. Find time during some of the later sorties to put him into some of these situations. Aim to make him aware of what he could be faced with at any time during his career.

Spatial Disorientation

19. The student must appreciate that the physiological effects of flight can give rise to false impressions of attitude and performance. The senses used for maintaining equilibrium and orientation are: sight, the vestibular sense and muscle sense. These senses work well on earth but their limitations may be exceeded in flight leading to a number of illusions or even disorientation.

20. The student should be givensome simple demonstration of sensory illusions to illustrate the need to rely on his instruments regardless

of his physiological sensations. These should be limited to false attitude sensations and false feelings of turning. It is important that the student's confidence should not be undermined by over enthusiastic demonstrations at an early stage of his training. Some suggested sequences are included with the Air Exercise which will be more convincing if not carried out in direct sunlight; this prevents moving shadows on the instrument panel. Include them at relevant times. The more advanced Coriolis effects for example should be covered during the introduction of unusual attitudes. These demonstrations do not embrace all the sensory illusions that may be encountered: visual phenomena and high altitude effects both at day and night are not easily produced to order.

21. The student should understand that the chances of disorientation can be reduced by avoiding large or rapid movements of the head, by making all changes or corrections to aircraft attitude slowly and smoothly, and by restricting activities when on instruments to one at a time. Lack of flying practice increases the risk of disorientation.

22. The student must learn to control his aircraft by relying on the sense of sight and the flight instruments. He must learn to ignore or control the urge to believe any false sensations perceived from the supporting senses. Should he become disorientated or begin to disbelieve his instruments he should be briefed to recover to straight and level flight using the standard UP (Limited Panel) recovery. Since students have found themselves in this predicament when flying both dual and solo, it is necessary to ensure that he is able to execute the procedure safely before authorizing solo flight. Moreover, he should be made to realise that, even if he suspects instrument malfunction or disorientation he should immediately initiate the UP recovery and not delay the recovery hoping to analyse the trouble.

23. You should ensure the student is given every opportunity to practise transition from visual flight to flight on instruments. This may be done during controlled descents on practise IF sorties as well asat other times. The student should also be allowed to practise the loss of contact in cloud procedure during the formation phase.

Common Faults

24. On full panel the common fault is failure to carry out the correct selective scan:

a. Insufficient Reference to the Control Instruments. If the control instruments are not included in the scan, there could be an incorrect attitude on the AH, or an incorrect RPM setting

b. Too Much Attention to AH. If the performance instruments are not used to support the AH a small erection error or a small error in the attitude adopted can cause a large error to develop slowly in one or more of the performance instruments. For example if there were a small bank error of just a few degrees and the student adopts the wings level indication the G4F could turn through a large angle before he notices.

c. Becoming Engrossed in One Instrument. Probably the most common error is a student becoming engrossed in one instrument. It can be identified in one of two ways. Firstly, it can show as an error in one of the other planes; if he becomes attached to the ASI, he may turn or if he choses the VSI he may overshoot a level off height. Secondly, it may show in the form of needle chasing when an Instrument is made to hunt around but never settle on a reading.

d. Scanning Too Slow. If other than small attitude adjustments are made the scan is too slow.

e. Superficial Scan. If the scan is too fast, correct information cannot be obtained from the instruments. Thus haphazard changes in attitude or control movements can be expected.

f. Failure to Compare Altimeters. During a controlled descent there is a high student work-load. Often this causes the altimeter check to ascertain the lowest reading to be overlooked.

g. Mis-reading the Altimeter. On marks of altimeter earlier than the Mk 22, the presentation is easily mis-read.

25. Control Technique.

a. Trimming. Trim-chasing is another common error. It is caused usually by students guessing the amount rather than relieving the pressure.

b. Excessive Control Movements. There are two ways in which excessive control movements can be made. Firstly, if the control is deflected for too long it usually results in the aircraft hunting about on attitude. Secondly, if too much control is deflected corrections are rapid and finish with a jerk.

c. Throttle. Throttle errors can be caused either by not knowing the required setting (interrogate student to confirm) or omitting the RPM gauge from the scan.

26. Airmanship. During the procedural stage some of the more common faults are:

a. Failure to think and plan ahead.

b. A haphazard use of aids.

c. Omission of part of or a whole check.

EXERCISE 19

INSTRUMENT FLYING

Aim: To teach the student to fly instrument weather procedures by sole reference to instruments.

AIR EXERCISE

Artificial Horizon

1. Objective: To familiarise the student with the Artificial Horizon (AH).

SEQUENCE		OBSERVATIONS
Adopt positive climbing and descending attitudes some including bank. Compare the AH with the true horizon. Return to the S and L attitude after each one using the AH.	a.	AH gives a miniaturised presentation which can be used in the same manner as the real horizon in visual flight.
Allow the student to practise similar manoeuvres and disturb the trim before handing over control.	b.	No change of technique is required.
	c.	Use smooth co-ordinated movements.
	d.	Direct reading of attitude in pitch and bank.
	e.	Pitch angle measured in horizon bar widths.
	f.	Angle of bank easily read.
	g.	During a turn pitch attitude made easy to assess by centre white dot.
	h.	Unlike real horizon, turn cannot be observed on AH when aircraft is banked.

i. When aircraft is properly trimmed the AH presentation remains steady "hands-off".

j. For accurate flight, information must be supported by performance instruments.

Straight and Level Flight

2. Objective: To achieve S and L Flight.

Demonstrate selection of level flight from various pitch attitudes using cruising power.

a. Adopt level flight on AH.

b. Check altimeter.

c. Adjust AH using half bar widths to stop altimeter moving.

d. Hold attitude constant on AH and trim to relieve stick load.

Demonstrate selection of straight flight from various banked attitudes.

a. Level wings on AH.

b. Check G4F.

c. Check ball in middle.

d. Possible for AH to be wrongly erected to show slight bank when wings are level.

3. Objective: To maintain S and L Flight.

Demonstrate how to maintain straight and level flight.

a. Deviations from level flight of less than 200 ft/min are not easily seen during a normal scan of the altimeter, therefore, scan VSI.

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b. Any application of bank in normal speed range will cause a turn, therefore, monitor G4F.

c. Thus, the selective scan for S and L is AH, monitored with the VSI and compass with less frequent checks on the altimeter.

d. All corrections are made by appropriate attitude changes on the AH.

4. Objective: To regain a specified flight level.

Fly 200ft above then below a specified flight level and demonstrate correcting procedure.

a. Lower (raise) nose bar width.

b. Altimeter moves slowly; VSI confirms trend.

c. Fractionally before the flight level is reached, raise (lower) the nose to the level attitude.

d. VSI slowly settles - then use in conjunction with the AH.

5. Objective: To regain a specified heading.

Fly 20 degrees either side of a heading and regain. Use bank equal to half the error initially. Increase the bank to equal the error as student progresses.

a. Apply bank on AH.

b. Monitor VSI for level flight.

c. As heading is reached level wings.

d. Check G4F for accuracy of heading.

Medium Level Turning

6. Objective: to achieve a level entry to a 30 degree banked turn.

From S and L at cruising speed enter a 30 degreebanked turn.

a. Apply 30 degree bank on AH and introduce sufficient back pressure to keep the centre white dot of AH on horizon bar during a turn right and just below the bar to the left.

b. VSI is main support instrument but also monitor altimeter.

7. Objective: To maintain a 30 degree banked level turn.

Instructor demonstrates maintaining the turn.

a. Angle of bank maintained on AH.

b. Pitch attitude maintained on AH but turning errors make it necessary to cross-check with VSI and less frequently with the altimeter.

c. Despite turning errors, pitch changes can still be made on AH.

d. Corrections to flight level are made as for S and L.

8. Objective: To achieve a level roll-out on a specific heading.

Instructor demonstrates rolling out on a specified heading.

a. Desired heading progressively included in scan as roll-out heading is approached.

b. 10 degrees before heading, begin roll out on AH applying forward pressure to maintain the white dot on the horizon bar.

c. Monitor VSI.

d. As wings are levelled revert to normal S and L scan ie AH, VSI, AH, Compass.

e. Correct for heading and flight level as necessary.

Climbing

9. Objective: To enter a climb.

From S and L at cruising speed enter a full-power climb.

a. Apply full power.

b. Adopt climbing attitude on AH and make a coarse trim.

c. Whilst airspeed is settling monitor compass and correct to heading if necessary.

d. Airspeed corrections made by adjusting AH up or down as appropriate by approximately half bar width/5kts.

e. Ensure correct trim technique is used.

10. Objective: To maintain a climb.

Instructor demonstrates maintaining a climb. During a 5,000ft interval between airspeed reductions, select QNH on altimeter. Student re-selects 1013 mbs during his practise.

a. Selective scan is now AH, ASI, AH, Compass.

b. Speed reductions, achieved by adjustments to AH.

c. Importance of accurate trimming before carrying out cockpit tasks.

d. Progressive inclusion of altimeter into scan as desired flight level approaches.

11. Objective: To level off at range speed.

Instructor demonstrates a level off at range speed.

a. Anticipate flight level begin lowering the nose.

b. Adopt the S and L attitude on the AH and reduce to cruise power together.

c. Resume selective scan for S and L.

d. Intermix quick single glances at the RPM and ASI with the scan and adjust the power to achieve accurate range speed.

12. Objective: To turn onto a specified heading during a climb.

During a normal climb demonstrate a climbing turn and roll out on a stated heading.

a. Apply 30 degree bank and slightly lower the nose on the AH.

b. Speed corrections made by pitch adjustments on AH.

c. Progressive inclusion of roll-out heading into scan as it approaches.

d. 10 degrees before heading commence roll out and resume the normal climbing attitude.

e. As wings are levelled revert to straight climbing scan ie AH, ASI, AH, Compass AH, Altimeter.

Descending

13. Objective: To enter and maintain a descent at range speed.

From S and L at range speed enter a descent at range speed with throttle closed.

a. Simultaneously close throttle and select descending attitude on AH.

b. Adjustments to airspeed made using AH.

c. Selective scan for the descent is AH, ASI, AH, Compass, AH, altimeter Note the increased importance of the altimeter during a descent in cloud.

14. Objective: To turn onto a specified heading.

During a slow descent demonstrate a descending turn and roll out on a stated heading.

a. Apply 30 degree bank and slightly lower the nose on the AH.

b. Speed corrections made by pitch adjustments on AH.

c. Progressive inclusion of roll-out heading into scan as it approaches.

d. 10 degrees before heading commence roll out and resume the normal descending attitude.

e. As wings are levelled revert to straight descent scan ie AH, ASI, AH Compass, AH, Altimeter.

15. Objective: To level off at range speed.

From a descent at range speed level off at range speed.

a. Anticipate height or flight level.

b. Simultaneously, re-apply cruising power and slowly adopt the level flight attitude on the AH to achieve the specified height.

c. Resume selective scan for S and L .

d. Intermix quick single glances at the RPM and ASI with the scan and adjust the power to achieve accurate range speed.

16. Objective: To achieve a controlled high rate of descent.

Demonstrate the entry and how to maintain a descent using 65/60/60% at 170 kts, airbrakes out.

a. Select de-mist.

b. Adopt the descending attitude on the AH reducing to 65/60/60%.

c. At 170 kts select airbrakes out.

d. Selective scan for the descent is AH, ASI, AH, Compass, AH, Altimeter.

e. If airspeed settles high or low adjust by attitude change on AH.

f. During any high rate descent the altimeter should be kept to the forefront of the pilot's mind.

17. Objective: To level off clean from a high rate descent.

Descend using 65/60/60% RPM, A/Bs extended 170 kts; level-off to maintain 140 kts clean.

a. Anticipate height and change the attitude on the AH to achieve level flight at the designated height.

b. As the level-off is begun use the basic 'Achieving' S & L scan but include the ASI.

c. Increase RPM to 75/70/70%.

d. At 140 kts retract A/Bs.

e. Maintain 140 kts.

18. Objective: To enter and maintain a slow rate descent.

From S & L clean at 140 kts enter a descent using A/Bs maintaining 140 kts and the level flight RPM.

a. Extend A/Bs and change attitude on AH.

b. Implement 'Descending' scan.

c. Maintain 140 kts and RPM.

d. Note rate of descent is low.

19. Objective: To change from a high to a low rate descent.

From a high rate descent at 170 kts, A/Bs extended, 65/60/60% RPM, demonstrate a change to the slow rate descent at 140 kts, A/Bs extended, 75/70/70% RPM.

a. Continue 'Descent' scan.

b. Adopt the slow rate descent attitude on the AH.

c. Increase RPM to 75/70/70%.

d. Maintain 140 kts.

e. Note decreased rate of descent.

20. Objective: To level off from a slow rate descent.

From a 140 kts descent, using 75/70/70% RPM A/Bs extended, level off and maintain 140 kts clean.

a. Anticipate the height, retract A/Bs and select the level attitude on the AH.

b. As the level off is begun use an 'Achieving S & L' scan but include the ASI.

c. Adjust power if necessary to sustain 140 kts.

Straight and Level at Various Airspeeds

21. Objective: To experience aircraft control on instruments in the high speed range.

Demonstrate an increase of speed from cruise up to 220 kts.

a. Apply full power.

b. Use normal S and L selective scan.

c. As speed and control effectiveness increase, speed of scan and interpretation of information from the performance instruments should also increase.

d. Risk of hurried trimming with heavier stick forces.

e. Approaching 220 kts reduce power to 93% and adjust.

Student should practise increasing speed to 220 kts then carry out 30 degrees banked turns.

f. At higher speeds, even small pitch errors result in positive changes showing on the VSI and altimeter yet bank errors have little if any effect.

g. Importance of relaxed flying on AH.

22. Objective: To experience the change of control effectiveness over a wide speed range.

Demonstrate a reduction of airspeed from 220 kts to 120 kts using airbrakes.

a. Whilst maintaining S and L scan close throttle.

b. Select airbrakes noting pressure error effect on altimeter and VSI AH suitable for attitude control.

c. As speed decreases slowly correct to flight level.

d. At 125 kts retract airbrakes.

e. Adjust RPM to 120 kts using selective scan for S and L at a selected airspeed.

APPLIED INSTRUMENT FLYING

23. TO and Entry to Climb

a. Checks during taxying and VAs.

b. Set G4F pointer on runway heading.

c. Normal TO until nose is raised.

d. When nose is raised transfer to instruments and maintain attitude on AH. Keep straight on compass.

e. Ease the aircraft off at 85 kts and adopt climbing attitude.

f. Obtain rate of climb between 500 and 1,000 ft/min.

g. Safely airborne indicated by increasing altimeter reading - carry out "After TO Checks".

h. As airspeed increases assume normal climb.

24. Steep Turns

Demonstrate 45 degree bank turn maintaining airspeed. As student becomes proficient in maintaining level flight and airspeed, increase with proficiency to 55 degrees bank and .4 (.5)M.

a. Instrument scan during entry same as med level turn.

b. Apply approximate power (4%) initially by feel. Once established in turn single quick glances at RPM gauge to assess necessary adjustments.

c. AH errors more noticeable. Nevertheless still easy to make adjustments in pitch and bank.

d. Greater rate of turn demands closer monitoring of the G4F

e. Possible to encounter gimballing.

25. Sim App Stall

Demonstrate the stall using simulated GCA approach conditions.	a. 'Forget' to re-introduce power after descent. b. Totally absorbed by instruments and/or ground controller. Omit ASI from scan. c. Proximity of ground makes recovery at incipient stage imperative.
Recovery.	a. Simultaneously lower nose one bar width and apply full power. b. Maintain attitude on AH until aircraft is unstalled. c. Gently change attitude to climb on AH monitoring ASI. d. When altimeter begins to increase select undercarriage and flap up to TO whilst scan is continued.

PROCEDURES TRAINING

26. Homing and CDTC

a. Demonstrate a H and CDTC when convenient. b. Make R/T calls during student's first attempts. c. Only introduce the visor when student is confident on instruments and radio.	a. Approaching overhead do FIRAD checks. b. R/T call. Request homing and CD while flying above FL 120. State quadrantal/semi-circular FL and met conditions. c. Fly at range speed. d. Fast rate letdown.

(1) Used down to Interim Descent Height (IDH).

(2) 170 knots airbrakes out 65/60/60% rpm.

(3) Importance of memorising and obeying instructions.

(4) Rate 1 turns only.

(5) Mandatory comparison of altimeters.

(6) Patterns vary between stations according to local airspace conditions.

(7) Normally aircraft are instructed to level off at IDH before commencing slow-rate descend. However, during a straight CDTC aircraft may be instructed to advise approaching the height and cleared straight through.

e. Slow Rate Descent (1,000 ft/min).

(1) Invariably used below Interim Descent Height.

(2) Descend at 140 kts using 75/70/70% RPM A/Bs extended.

(3) Continue descent under control until below cloud, airfield in sight or minimum break off height is reached.

(4) Importance of levelling at Min BOH.

(5) Action if cloud base is below Min BOH.

(6) If visibility is bad below cloud adopt Bad Visibility Configuration.

27. GCA

a. Demonstrate a GCA on an opportunity basis before giving instruction.

b. Initial instruction should be given aloft away from the circuit tasking him with various rates of descent.

c. Feed in radio to students procedure as confidence is gained.

d. Introduce visor only when student is confident on instruments and radio

a. Can be obtained from:

(1) CDTC.

(2) Overhead the airfield.

(3) Missed approach procedure.

b. Two types of radar approach:

(1) Precision approach radar (PAR)

(2) Surveillance Radar Approach (SRA) which has azimuth information only.

c. Initiate flying directions immediately - acknowledge as convenient.

d. All turns Rate 1.

e. When instructed to 'Reduce to circuit speed, carry out checks and advise', reduce speed to 105/105/115 kts and do the normal downwind VAs.

f. Final approach:

(1) When instructed to "Begin your descent etc" select full flap and adopt a gentle descending attitude on the AH.

(2) Maintain 105/105/115 kts by attitude adjustment.

(3) Required rate of descent varies with wind - usually 400-500 ft/min. RPM used to control rate.

(4) Inclusion of view ahead into scan as BOH is approached.

(5) Importance of BOH.

(6) If runway threshold, two bars of a standard T-bar or VASIs sighted an average pilot has 95% chance of making a successful landing.

(7) If no contact make normal overshoot by BOH:

(a) Full power gradually adopting gentle climb.

(b) At 500 ft/min climb raise u/c and flap to TO.

(c) At 140 kts, climb as visually 100/90/90% RPM.

(d) Carry out missed approach procedure.

(e) Decide whether to divert or make another attempt.

Airmanship

Unusual attitudes and disorientation exercises must be practised in VMC conditions with sufficient clearance from cloud to prevent going IMC inadvertently.

Limited Panel

Straight and Level

28. Objective: To achieve S and L flight.

SEQUENCE	OBSERVATIONS
a. Demonstrate selection of level flight from various pitch attitudes using cruise power.	a. Apply elevator to oppose altimeter movement.
	b. Altimeter slows, stops, then reverses.
	c. Apply sufficient elevator movement to hold steady altimeter reading.
	d. VSI magnifies altimeter trends but also lags behind.
	e. Fine trim adjustment possible on VSI.
b. Demonstrate selection of straight flight from various banked attitudes.	a. Turn needle and G4F give indications of bank.
	b. Centralise needle with aileron.
	c. Confirm wings level with G4F.

29. Objective: To maintain S and L Flight.

Demonstrate how to monitor S andL flight.	a. Scan VSI and G4F. Less frequently monitor altimeter.

b. Small early corrections.

c. Value of accurate trim.

30. Objective: To regain a specified flight level.

Fly 200' above then below a specified level and demonstrate correcting procedure.

a. Lower (Raise) nose to obtain correction rate of double the error ie 200' error = 400 ft/min correction.

b. Altimeter moves slowly giving time to continue scan of VSI and G4F.

c. Anticipate height start attitude change.

d. Stop altimeter - confirm on VSI.

31. Objective: To regain a specified heading.

Fly 20 degrees either side of a heading and regain. Use Rate ½ corrections.

a. Apply bank on Turn needle (TN).

b. Monitor VSI for level flight.

c. As heading is reached centralize TN.

d. Confirm heading and wings level on G4F.

Rate One Level Turns

32. Objective: To familiarise the student with the TN.

Demonstrate the sluggish behaviour of TN when entering and rolling out.

a. TN central in straight flight.

b. If turbulent take a mean reading.

c. TN lag - anticipate.

During a turn make the TN re-act to elevator pressures using constant bank.

a. TN re-acts to increases and decreases of elevator thus bank can be constant despite TN movements

33. Objective: To achieve a level entry to a Rate 1 turn.

From S and L at cruising speed enter a Rate 1 turn.

a. Apply bank on turn needle to rate ¾ and centralise ailerons.

b. Maintain VSI on zero.

34. Objective: To maintain a Rate 1 level turn.

Demonstrate maintaining the turn.

a. Angle of bank maintained by maintaining TN on Rate 1.

b. VSI for pitch with less frequent inclusion of altimeter.

c. Corrections to flight level are made as for S and L.

35. Objective: To achieve a level roll-out on a specified heading.

Demonstrate a roll-out

a. Desired heading progressively included in scan as roll-out heading is approached.

b. 10 degree before heading begin roll-out on TN applying forward pressure to maintain VSI on zero.

c. When TN registers. Rate ½ revert to S and L scan.

d. Correct for S and L as necessary.

Climbing

36. Objective: To enter a climb.

From S and L at cruising power enter a full power climb.

a. Apply full power maintaining S and L scan.

b. Raise nose to maintain climbing speed. A slow attitude change will keep attitude and performance

c. Speed and VSI settle - trim.

d. Airspeed corrections made using VSI and ASI.

37. Objective: To maintain a climb.

Demonstrate maintaining a climb.

a. Scan is now ASI, G4F.

b. Speed reductions made using VSI and ASI.

e. Progressive inclusion of altimeter into scan as desired flight level approaches.

38. Objective: To level off at range speed.

Demonstrate a level off at range speed.

a. Anticipate FL - begin lowering the nose and reducing power.

b. Stop altimeter at FL.

c. Implement S and L scan ie VSI G4F.

d. Adjust ASI with power.

Descending

39. Objective: To enter and maintain a descent at range speed.

From S and L at range speed enter a descent at range speed with throttle closed.

a. Simultaneously, close throttle and lower nose to maintain airspeed.

b. Scan: ASI, G4F, ASI, G4F, Alt.

e. Pitch corrections made using ASI, VSI.

40. Objective: To level off at range speed.

From a descent at range speed.

a. Anticipate FL.

b. Simultaneously, re-apply cruise power and raise nose to stop altimeter at desired FL.

c. Implement S and L scan and include ASI for speed corrections.

41. Objective: To achieve a controlled high rate of descent.

Demonstrate the entry and how to maintain a descent using 65/60/60% at 170 kts airbrakes out.

a. Lower the nose to increase speed to 170 kts reducing to 65/60/60%

b. At 170 kts extend airbrakes.

c. VSI increases to 3,000 ft/min.

d. Scan: ASI, G4F, Altimeter, VSI.

42. Objective: To turn onto a specified heading.

Demonstrate a turn onto a specified heading.

a. Apply bank to achieve Rate 1.

b. Speed corrections same as when straight.

c. Scan: ASI, TN, ALT.

d. Progressive inclusion of roll-out heading into scan as it approaches.

e. 10 degree before heading commence centering TN.

f. Level wings finally on G4F.

g. Revert to scan of ASI, G4F, ALT, VSI.

43. Objective: To level-off clean from a high rate descent.

From a high rate descent level-off and fly at 140 kts clean.

a. Anticipate level-off height begin raising the nose.

b. Monitor G4F during pitch change.

c. Regulate pitch change to stop altimeter at designated height.

d. As altimeter stops, scan G4F and VSI.

e. Increase RPM to 75/70/70%

f. Retract A/Bs at 140 kts.

g. As speed decreases small bank errors will cause aircraft to turn. TN useful support of G4F.

h. Implement full S & L scan including ASI to maintain 140 kts.

44. Objective: To enter and maintain a slow rate descent.

From S & L clean at 140 kts enter a descent using A/Bs maintaining 140 kts and the level flight RPM.

a. Simultaneously extend A/Bs and lower nose.

b. Scan ASI, G4F, altimeter and ahead.

c. Maintain 140 kts and RPM.

d. Check rate of descent is approx 1000 ft/min.

45. Objective: To change from a high to a low rate of descent.

From the High Rate descent, demonstrate a change to the Slow Rate Descent.

a. Continue to scan ASI, G4F altimeter and VSI.

b. Slowly raise the nose to move the VSI and make an exploratory check movement at approx 1500 ft/min.

(TAL 18, MAY 70)

c. Increase RPM to 75/70/70%.

d. Correlate ASI and VSI to achieve 140 kts.

46. Objective: To level-off from a slow rate descent.

Demonstrate a level-off from a Slow Rate Descent.

a. Anticipate the height, retract A/Bs and raise the nose to stop the altimeter at the designated height.

b. Commence S & L scan including ASI for 140 kts.

Unusual Positions

Airmanship. If the speed increases past 250 kts during a spiral dive the development of "G" is rapid and surreptitious. Therefore any student practise likely to exceed 250 kts must be terminated immediately by the instructor.

47. Objective: To familiarise the student fully with the TN.

a. Demonstrate rate one turns at 120 kts and 200 kts.

a. Rate one at 120 kts achieved with 15 degree bank.

b. Rate one at 200 kts approx 30 degree bank.

c. Response of TN is less at higher TAS therefore it is less responsive to bank.

b. Demonstrate fast and slow entries to turns at 200 kts.

a. Lag increases with rate of roll.

c. During a descent demonstrate increased lag when levelling wings with positive "G" applied.

a. Lag increased with "G"

b. Thus, when selecting bank or wings level, anticipate the turn needle by an amount appropriate to the "G" loading and rate of roll applied.

48. Objective: To familiarise the student with the use of the altimeter when recovering from unusual attitudes.

Adopt various pitch attitudes and return to level flight comparing visual horizon and altimeter.	a.	Apply appropriate positive elevator control.
	b.	As altimeter stops before reversing direction nose moves through level attitude.
	c.	Crisp control movement required to check the rate of pitch. Allow for the out of trim force.

49. Objective: To achieve straight and level flight.

Recover to S and L flight from various attitudes involving pitch and bank using cruise power.	a.	Bank invariably before pitch.
	b.	Anticipation of TN and check movement.
	c.	Pitch correction on altimeter - ignore TN.
If the student attempts to correct in pitch with bank still applied demonstrate how a "G" force can hold the TN in the wrong direction.	d.	As altimeter stops - check movement.
	e.	Re-check TN and start a S and L scan.

50. Objective: To achieve S and L from a fully developed UP.

Demonstrate recovery from various UPs. Increase complexity of recovery as student progresses.	a.	Airspeed low or decreasing - full power. Airspeed high or increasing - close throttle. airspeed very high or rapidly increasing throttle closed and extend airbrakes.
	b.	Remove any excess "G" loading.
	c.	Level wings on TN.
	d.	Confirm wings level on G4F if AC power is available (check "OFF" flag on AH).

e. Select level attitude on altimeter with ailerons neutral - ignore TN.

f. Co-ordinate for S and L. Adjust power and retract airbrakes if used.

g. Recovery is made using three separate distinct actions in the correct order ie Power, Bank then Pitch.

h. Whenever confused or uncertain of the aircraft's attitude whether on full or limited panel, use this procedure and fly S and L.

51. Max Rate Descent

Enter descent at FL 250 increase speed to .5M throttle off and extend A/B. Maintain .5M until 250 kts. Maintain 250 kts down to FL 120.

a. For use in cases of hypoxia etc.

b. Select steep dive attitude on AH.

c. At .5M close throttle and extend airbrakes.

d. Select de-mist.

e. Scan: AH, Mach, AH, ASI, AH, G4F.

f. To maintain .5M continuously lower nose.

g. To maintain 250 kts attitude is raised.

h. SCAN: AH, ASI, AH, ALT, AH, G4F.

i. Small amounts of bank have little, if any effect on heading at high TAS.

(TAL 18, MAY 70)

j. Increased importance of accurate altimeter reading.

k. Start level-off 1,000 ft before desired FL.

Spatial Disorientation

52. Objective: To demonstrate the need for instruments and the unreliability of any "seat of pants" sensations.

With the student's eyes open do a small, fast barrel roll, then immediately ask the student to fly S and L with his eyes closed. The aircraft will usually end up in a spiral.

a. The natural senses are of little use in cloud.

53. Objective: To demonstrate that natural senses cannot detect low value angular accelerations.

With student's eyes closed instructor slowly applies 20 degrees bank (take 20 secs). Ask student for aircraft attitude then let him open his eyes.

a. Student normally thinks he is S and L.

b. The natural senses cannot detect low value angular accelerations.

c. Need for good scan rate.

54. Objective: To demonstrate that a violent correction of an unsensed inadvertant application of bank may produce strong sensations of the leans.

The student should wear a visor and close his eyes.

Slowly enter a 30 degree bank turn. Tell him to look at the AH then sharply roll the wings level.

a. After wings are levelled student will normally feel the aircraft is banked in the opposite direction to the original turn.

b. Avoid making a violent correction, if an unsensed inadvertant application of bank is suddenly discovered.

55. Objective: To teach the student to believe the instruments when disorientated.

During practice unusual attitudes tell student to close his eyes. Perform two rapid aileron rolls and hand over control in a climbing or descending turn attitude.

a. Student will rightly feel a sense of disorientation.

b. Believe the performance instruments and follow the correct procedure.

EXERCISE 20

NIGHT FLYING

AIM: TO TEACH CONTROL OF THE AIRCRAFT AT NIGHT, ON THE GROUND AND IN THE AIR.

INSTRUCTIONAL GUIDE

General

1. Before commencing night flying the student must have attained his Advanced Instrument grading or an instrument rating.

2. The instructor should not give the impression that night flying is any more difficult than flying by day. It is, in fact, far simpler in some respects since flying conditions are usually smoother, the number of aircraft in the circuit is limited, and judgement on the approach is assisted by approach lighting.

Before Flight

3. Preparatory Instruction.

(a) Airfield lighting.

(b) Procedure for taxying, take-off, circuit, landing, and going round again.

(c) Marshalling signals.

(d) R/T procedure, lamp signals, and pyrotechnic signals.

(e) Emergency procedure.

(f) Aircraft lighting.

References - AP 129, Vol 2, Part 2, Sect 2, Chap 2, Sect 4, Chap 3, Sect 1, Chap 7 and JSP 318-1-1-0106, 1-1-0503, 1-2-0310-0312.

4. Pre-Flight Briefing. The mass briefing held before night flying, given by the meteorological forecaster, air traffic controller, and the officer in charge of night flying, deals only with procedures and not with techniques. Thus it does not absolve the instructor from an individual briefing on night flying which should cover all aspects of the lesson about to be taught.

(a) The layout of the airfield lighting and the use of runway lights should be explained with the aid of models and diagrams.

(b) The student should be checked by day to ensure that he is fully conversant with the aircraft lighting and the position of relevant lamps and switches.

(c) Night adaptation should be explaned to the student and he should be encouraged to remain in subdued lighting for the 30 minutes preceding take-off. Subsequent use of the torch should be discreet, and cockpit lighting kept to an acceptable minimum.

During Flight

5. Airmanship.

(a) The need for the utmost caution when taxying must be emphasized. The student should be told to stop the aircraft or to use the taxi-lamps if he is ever in any doubt about the taxi-path or the distance from obstacles.

(b) Checks of instrument serviceability are of even greater importance than before most day flights and must be made conscientiously.

(c) All R/T calls must be made at the standard positions in the circuit so that air traffic control and other pilots have a reliable indication of the aircraft's position. Local regulations with regard to calls stating the pilot's intention (eg flarepath demo, overshoot, landing or roller) should be insisted on.

(d) During night flying a serviceable torch should always be carried, and be readily accessible, to assist with external checks and in case of emergency.

6. Familiarization

(a) The familiarization lessen should be used to give the student confidence as well as to familiarize him with night flying.

(b) It should be pointed out that night flying is a sensible combination of visual and instrument flying. The degree of instrument flying required is dependent on the clarity of the natural horizon, but whatever the extent of the concentration on instruments necessary, visual reference is made for orientation and an adequate lookout must be maintained at all times.

(c) The instructor should climb away from the circuit and point out the airfield lighting, local landmarks, and the appearance of other aircraft.

(d) The student should be allowed to fly the aircraft for a period before rejoining the circuit for the flarepath demonstration.

7. <u>Flarepath Demonstration.</u>

(a) The downwind leg must be extended considerably further downwind than usual in order to make the flarepath demonstration convincing without descending to very low level. This extension of the approach also gives plenty of time to point out the appearance of the flarepath and ◄ visual approach slope indicators (VASIs).►

(b) The student must be taught to judge the approach path primarily by the pattern of the runway lights. The ◄ VASIs ► should be used as a guide only, and disregarded completely below about 200 feet agl.

8. <u>Take-Off.</u>

(a) At night, Vital Actions before take-off must always be carried out with the aircraft stationary at the marshalling point.

(b) With the aircraft correctly aligned on the runway for take-off the lights appear to converge ahead of the nose. The appearance and perspective of the runway lights should be carefully noted by the student as a guide for landing.

(c) The pilot's attention must be transferred fully to instruments before reaching the end of the runway, and a straight climb maintained until a safe height is reached.

(d) A safe rate of climb must be established from the moment of becoming airborne: 500/1000 feet per minute should be maintained until the airspeed has increased to 140 knots when power should be reduced and the aircraft climbed ahead to 1000 feet.

(e) The after take-off checks must be carried out only after a positive gain of height is indicated by the altimeter.

9. Circuit.

(a) The night circuit pattern and procedure is similar to that flown by day except that to ensure adequate spacing between aircraft in the circuit a straight climb to 1000 feet is made before turning downwind.

(b) The position of all other aircraft in the circuit should be determined by a good lookout and by their R/T calls.

10. Approach.

(a) If approach lights are not available, the positions at which to turn should be judged by the appearance and relative position of the flarepath after making the usual allowances for wind conditions.

(b) The final turn should be completed to permit a straight approach from 300 feet agl and on the correct approach path judged by the flarepath and ◀VASIs▶

(c) Any alterations made to power and attitude in order to regain the correct approach path will necessitate readjustment as the correct angle of approach is gained, otherwise an error in the opposite sense will result.

11. Landing.

(a) During the final stages of the approach the ◀VASIs▶ should be ignored and full attention given to the perspective of the runway lighting in order to judge the roundout height.

(b) The emphasis should be on consistently safe landings at first although a high standard should be aimed for. The student must understand the dangers of holding off high or at low speed; the power response is too slow to correct the high rate of sink that will result.

(c) Speed is particularly difficult to judge when about to turn off the runway at night. The student must be warned that it is essential to ensure that the speed has been reduced sufficiently to permit a safe turn.

12. Going Round Again.

(a) Before the student flies solo he must be competent at going round again from the approach and from ground level.

(b) The climb away should be carried out on instruments, using full power until the circuit climbing speed has been gained.

(c) When overshooting from the approach the aircraft should be turned slightly towards the dead side of the runway as soon as the climb has been initiated, to ensure that aircraft taking off are given sufficient clearance.

13. Low-Level Circuit. When proficient at normal circuits the student should be given dual practice at low-level night circuits. The attention to accurate height keeping, particularly in the turns must be emphasized. Their application to the emergency procedures should be pointed out.

Common Faults.

14. Most faults are due either to over-concentration on the instruments to the detriment of the circuit procedure, or to insufficient attention to the instruments leading to inaccurate flying. The student must learn to strike the correct balance between the two.

15. Many students have difficulty in maintaining a downwind leg parallel to the flarepath. Attention should be drawn to the importance of maintaining lateral level, accurate trimming, and the use of the G4F compass.

16. A common tendency amongst students is to make the circuit wider than usual, probably owing to over-cautiousness in judging the spacing. The night circuit should be the same as that flown by

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day, and spacing preserved by extending the into-wind leg after take-off.

17. Some pupils place too much reliance on the ◀V.A.S.I.s▶ often resulting in over correction on the approach. Emphasize that these indicators are an aid only and should be used in conjunction with the flarepath perspective. If these faults persist the ◀V.A.S.I.s▶ should be switched off where possible, and in any case some practice using the flarepath indications alone is always desirable.

18. Many students have difficulty in judging the roundout height. The correct height should be demonstrated clearly and the flarepath indications pointed out. The student should be encouraged to use the appearance of the flarepath as a whole, rather than to look or feel for the ground.

19. Students nearly always tend to line up for take-off, and approach to land near the left-hand side of the flarepath. The fact that the flares are some distance off the runway, and the need to use the centre of the flarepath, should be pointed out.

EXERCISE 20
NIGHT FLYING

AIM: To teach control of the aircraft at night, in the air and on the ground.

AIR EXERCISE

Airmanship

1. (*a*) Especially good lookout, both in the air and on the ground.

   (*b*) Checks normal, with the addition of external and cockpit lighting.

   (*c*) Signals to ground crew.

   (*d*) Night flying emergency procedures.

Sequence	Observations
2. **Starting Up.**	(*a*) Careful examination of aircraft, using torch. (*b*) Check of external lights. (*c*) Light signals to ground crew.
3. **Taxying.**	(*a*) Good lookout. (*b*) Signals to marshaller. (*c*) Taxiway and airfield lighting. (*d*) Speed difficult to judge—taxi slowly. (*e*) At marshalling point:— (i) Taxi-lights off.
4. **Take-Off.**	(*a*) R/T and visual clearance. (*b*) Line up in centre of runway. (*c*) Note appearance of runway lighting to assist judgement when landing. (*d*) Minimum delay. (*e*) Maintain direction by use of runway lights. (*f*) Progressive transference of attention to instruments—complete before end of flarepath. (*g*) Immediate check of safe climb 500 to 1,000 f.p.m. (*h*) R/T call airborne. (*j*) Checks at safe height.
5. **Local Familiarization.** Fly around the local area at about 2,000 feet a.g.l.	(*a*) Airfield lighting layout. (*b*) Local landmarks. (*c*) Other aircraft. (*d*) Combination of visual and instrument reference for flight. (*e*) Cockpit lights minimum.

SEQUENCE (*contd.*) — OBSERVATIONS (*contd.*)

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6. Rejoining the Circuit.

OVERHEAD REJOIN

(*a*) Same procedure as for day, at 140 kts.

(*b*) Good lookout essential. Placing other aircraft by listening to R/T.

7. Flarepath Demonstration.

Fly further downwind than normal and reduce height to 400 feet a.g.l. during the final turn. Fly level on finals to show flarepath and A.A.I. or ◀V.A.S.I.▶ indications.

(*a*) Undershooting:—

(i) Pattern of runway lights or close spacing of lights.

(ii) Reds on A.A.I.s or ◀V.A.S.I.s.▶

(*b*) Correct approach paths:—

(i) Note appearance or spacing of runway lights.

(ii) Greens on A.A.I.s or Red/White and 'square' aspect of ◀V.A.S.I.s.▶

(*c*) Overshooting:—

(i) 'Plan' view of runway lighting or wide spacing of individual lights.

(ii) Ambers on A.A.I.s or whites on ◀V.A.S.I.s.▶

(*d*) Flarepath pattern and light spacing are primary indications of approach path.

8. Going Round Again.

(*a*) Full Power. R/T call.

(*b*) Turn out of take-off path.

(*c*) Using instruments, climb straight ahead to circuit height.

(*d*) Lookout-spacing with other aircraft.

(*e*) Position for turn downwind.

9. Downwind Leg.

(*a*) Position for starting downwind leg.

(*b*) Lookout.

(*c*) Track parallel to flarepath—distance out.

(*d*) R/T call opposite upwind end of flarepath.

(*e*) Position for turning relative to flarepath.

SEQUENCE (*contd.*)	OBSERVATIONS (*contd.*)
10. **Approach and Landing.**	(*a*) Control technique as for normal daytime approach. (*b*) Use of approach lighting. (*c*) R/T call. (*d*) Adjust approach by reference to pattern of flarepath and A.A.I.s or ◀V.A.S.I.s.▶ (*e*) Ignore A.A.I.s or ◀V.A.S.I.s▶ in final stages of approach—concentrate on flarepath perspective. (*f*) Judgement of roundout by flarepath—remember take-off. (*g*) Last point of touchdown indication. (*h*) Keep straight using flares. (*j*) Speed low before turning off runway. (*k*) R/T call clear of runway. (*l*) Stop. Checks. Taxi-lights.
11. **Roller Landing.**	(*a*) Power on as soon as aircraft touches down. (*b*) R/T call airborne. (*c*) Climb as for take-off.
12. **Re-Entering Dispersal.**	(*a*) Speed low. (*b*) Identify marshaller. (*c*) Taxi-lights off, navigation lights steady.
13. **Low-Level Circuits.**	(*a*) Procedure as for day. (*b*) Level out at 600 feet a.g.l. before turning downwind. (*c*) Maintain height, particularly in turns. (*d*) Different perspective of lights from lower downwind position. (*e*) Maintain height and correct approach speed during first part of final turn use power if necessary. (*f*) Power reduced as normal approach path is reached.

POST-FLIGHT DISCUSSION

EXERCISE 21

PILOT NAVIGATION

AIM: To teach pilot navigation techniques under all conditions of flight.

INSTRUCTIONAL GUIDE

General

1. The student should understand that the ability to navigate an aircraft is part of the general art of flying and not additional to the pilot's normal duties. For this reason the techniques used are simple, and navigational activity in the air is kept to a minimum by sound flight planning.

2. The following aspects of navigation should have already been introduced during previous flying:—

(*a*) Use of local features for orientation.

(*b*) Map orientation.

(*c*) Simple map reading.

(*d*) Estimation of headings and distances to reach base or chosen points.

(*e*) Use of G4F and maintenance of headings.

(*f*) Use of radio for steers and bearings.

(*g*) Use of Rebecca for ranges and homings.

3. Although the student should ultimately be able to navigate by using a combination of the most suitable aids and methods, it is necessary to introduce the various considerations progressively to ensure that he obtains a firm grasp of the fundamental principles. (Navigational exercises should start with simple map reading and track crawling cross countries at 3 to 5,000 feet in V.M.C. and the further aspects of pilot navigation introduced by stages during succeeding sorties to increase the student's ability and confidence.) All should be planned to introduce or revise some particular aspect or consideration. The instructor should refer to the relevant paragraphs of the Instructional Guide and the Air Exercise, and to the syllabus.

4. The varying techniques of pilot navigation are broadly classified in the following sub-paragraphs: although the basic principles remain the same, the relative importance of some aspects change with height and conditions:—

(*a*) Navigation at medium level in visual contact with the ground.

(*b*) Navigation at medium level out of sight of the ground.

(*c*) High-level navigation.

(*d*) Low-level navigation.

(*e*) Navigation at night.

Before Flight

5. **Preparatory Instruction.**

(*a*) Meteorological forecasts.

(*b*) Map preparation.

(*c*) Estimation and computation of headings, groundspeeds, E.T.A., and safety heights.

(*d*) Pilot navigation techniques.

(*e*) Uses and limitations of radio aids.

(*f*) Air traffic regulations in V.M.C. and I.M.C.

(*g*) Distress and lost procedures.

(*h*) Diversions.

(*j*) Range and endurance flying.

(*k*) Use of flight planning tables and fuel required calculations.

References—A.P. 129, Vol. 2, Part 2, Sect. 4, Chap. 14; Sect. 2, Chap. 1; Part 3, Sect. 1, Chaps. 1 and 2; and A.M.F.Os. Nos. 141 and 165.

6. **Pre-Flight Briefing.** The student should be helped with the preparation of flight plans for his early navigational exercises and his working of the computor checked. He should also be assisted in the preparation of his map and advised on the choice of check points and positions for obtaining bearings. Any other aids available for the exercise or particular techniques to be used should be discussed before flight. The instructor should insist on meticulous planning and route study before dual and solo exercises.

During Flight

7. **Airmanship.**

(*a*) Lookout must not be neglected while the pilot is engrossed in navigational matters: any laxity by the student should be checked at once.

(*b*) The importance of frequent fuel checks, and comparison with planned consumption should be stressed. Checks of temperatures, pressures, oxygen, etc., must be carried out at normal frequency.

(*c*) If it is necessary to descend below safety height to retain sight of the ground, it must be regained immediately should the aircraft enter cloud.

8. **Setting Heading.**

(*a*) During the early exercises each leg should start overhead base or the turning point. Climbing on track is more economical and should be used on the high-level cross-countries.

(*b*) The student should be taught to make a common-sense check of his heading by use of his knowledge of local features, or by a true bearing soon after setting heading. This obviates the possibility of gross errors, such as flying a reciprocal or setting the airspeed as a heading.

9. **In Transit.**

(*a*) The attention devoted to flight plan computations is pointless if the flying is not sufficiently accurate. In particular, headings and airspeeds must be correct. Small height variations will have little effect on navigation but air traffic regulations call for accurate height keeping to provide quadrantal separation.

(*b*) The value of D.R., supported by careful planning and accurate flying, as the basic method of pilot navigation should be demonstrated whenever possible, *e.g.* when the ground is obscured by cloud. The student should be asked to work out D.R. positions by consulting his watch and time marks on the map.

(*c*) The vital importance of flying according to the flight plan when pin-points or other fixing aids are not available must be emphasized in the air and during briefings.

(*d*) The more important times, *i.e.* times of setting and altering heading, and E.T.As. should be entered on the log card (Form 4255) or on the map.

10. **Map Reading.**

(*a*) The value of map orientation will already have been shown to the student, and should be re-emphasized en route.

(*b*) The very great importance of the clock or watch, used in conjunction with the time marks on the map to anticipate features, should be pointed out.

(*c*) The value and reliability of a pinpoint depends on its uniqueness, size, and contrast in relation to the surrounding area. The value of certain types of pinpoint may change with the angle of observation and with seasonal or weather variations, *e.g.* higher ground is not so readily apparent from high altitude, small rivers may have dried up in summer, deciduous woods are less distinguishable in winter.

(*d*) Attempting to correlate an excessive amount of detail will often lead to confusion. The student should be told to use only the major features in conjunction with planned check points and D.R. calculations, avoiding continuous map reading and the identification of numerous minor pinpoints.

(*e*) When in continuous visual contact with the ground the correct technique is to read from map to ground, using the watch and time marks to anticipate the selected features. At other times, when the ground is visible only periodically or when uncertain of position, a circle of uncertainty should be estimated and the ground features identified on the map. Under such conditions and when definite pinpoints are not available the area summary method should be used.

(*f*) The area summary method enables the pilot to establish the general locality over which he is flying by the type of terrain he has identified. Although this does not give a definite pinpoint it reduces the area of uncertainty, and should lead to a pinpoint or will confirm the D.R.

11. **Navigational Technique.** The two basic considerations affecting pilot navigation are revisions of headings and E.T.As. To these must be added the more advanced requirement of the estimation of heading and time to reach a diversion airfield or alternative target. It is important, particularly at high speeds, that the methods used be as simple as possible to reduce the mental effort and be capable of quick application. Lengthy and complicated calculations are valueless if by the time they are worked out the aircraft has travelled so far that the correction is no longer applicable.

12. **Revision of Heading.** Although the experienced pilot is capable of accurate visual estimations, these are beyond the powers of the student pilot and it is therefore necessary to provide him with guidance. Of the two methods in common use, the 5- and 10-degree drift line method is simplest and should be introduced first, followed later by the 1 in 60 rule. The applications of track errors and closing angles to regain track or to alter heading for the destination should be demonstrated when suitable circumstances arise.

13. **Revision of E.T.A.** The two principal methods, proportional distance scales and time scales, rely on E.T.A. revision by fractional proportion. The time-scale method is the most useful since D.R. positions can be easily interpolated whilst the proportional-distance method relies on fixes being available at specific distances. When radio cross bearings are to be used as E.T.A. checks, the rate of change of bearing should be precomputed.

14. **Fixing Position.** The principal methods of fixing position are:—

(*a*) *Visually:—*

(i) Pinpoint.

(ii) Visual cross bearings from line features, transit bearings and relative bearings.

(iii) Visual bearing and estimated distance.

(*b*) Radio cross bearings or radio fix.

(*c*) Radio bearing and Rebecca range.

(*d*) Rebecca ranges.

(*e*) "Hayrake".

In many cases a single bearing or range, used in conjunction with a D.R. position, gives sufficient information to enable a revision of heading or E.T.A. to be made.

15. **Use of Radio Aids.** Some cross-country exercises should be flown in conditions necessitating navigation entirely by radio aids. Ideal conditions exist when the exercise can be flown in the clear at 10 to 12,000 feet above continuous cloud cover. Attention to the instruments under actual conditions would limit the student's ability to absorb instruction during the early exercises. The technique used is similar to that already taught except that positions are fixed by means of radio aids. The uses and limitations of the available aids should be fully discussed before flight, and radio bearings to be obtained should be carefully planned before flight so that each is useful. Selected bearings and ranges should be plotted on the map and the frequencies and call-signs or identification of the aids noted. Bearings and positions obtained, together with the times, should be noted on the map as a precaution against forgetfulness. All bearings obtained should be checked for their validity, especially when they indicate a marked variance from the flight plan.

Low-Level Navigation

16. The main difficulties associated with low-level pilot navigation are:—

(*a*) Restricted field of view.

(*b*) Identification of ground features complicated by the low perspective and their limited time in sight.

(*c*) Range and accuracy of radio aids seriously reduced.

(*d*) Concentration required to fly the aircraft.

Careful flight planning and thorough map study are essential in order to reduce these difficulties and to minimize mental effort. Check features should be chosen for their uniqueness and ease of recognition from low level.

17. Low-level navigation depends entirely on map reading and the technique calls for a sensible combination of D.R. and feature tracking. Anticipation of features is essential. The E.T.As. at selected check points should be marked on the map and any revisions calculated by converting the punctuality error to a simple proportion of the flight plan time and applying it to subsequent check point E.T.As.

18. If a check point is missed the flight should be continued according to flight plan and the next anticipated, but if a series of features is missed or it is apparent that the aircraft is off track, the student must gain height (on flight plan heading) to find his position and let down again only when track is regained.

19. Although the log card should be prepared and carried, the essential information (headings, groundspeeds, and times) should be marked on the map so that it is clearly legible when the map is correctly orientated. Log keeping must not be attempted, except that it is advisable to note the time of setting heading. This, and fuel checks, must be carried out at a safe height.

20. During the first low-level cross country flight the instructor should fly the aircraft for the early part of the exercise so that the student may devote his entire attention to navigational matters. General aspects such as lookout, trim, wind effect, anticipation of obstacles and especially the increased fuel consumption should not be neglected.

High-Level Navigation

21. High-level navigation is of particular importance in jet aircraft since engine characteristics result in a marked improvement in range and endurance with increasing height. The service pilot must, therefore, be able to navigate accurately and confidently at high altitude and at the associated high true airspeeds.

22. The following additional factors must be considered when navigating at high level:—

(*a*) Difficulty in the accurate prediction of high-level winds.

(*b*) Navigation in prolonged climbs.

(*c*) Map reading often restricted by cloud.

(*d*) Altered perspective for map reading and difficulty in obtaining accurate pinpoints.

(*e*) Increased errors resulting from inaccuracies in heading and timing at the higher true airspeeds.

(*f*) Increased range of radio aids.

23. Although the basic principles of navigation remain unaltered, radio aids replace map reading as the main means of fixing position, and the need to climb on track in order to increase range requires additional flight planning and air activity. Pre-flight planning should be thorough to reduce calculations in the air:—

(*a*) Heights to fly should be selected, as far as possible, to take advantage of favourable winds and weather.

(*b*) Bearings, ranges and positions at the top of climb should be precomputed and marked on the map.

(*c*) Turning radius must be taken into consideration in order to teach the student high-speed techniques and to keep the sortie time as near to flight plan time as possible. On a 1:500,000 map the turning circle at 180 knots T.A.S., Rate 1 turn, can be represented by drawing round the end of a normal lead pencil placed so that it is against track at the turning point and the new track drawn tangential to the arc produced. This will show the actual track to be followed. The distance covered in the turn should be added to the next leg and can be easily calculated from the fact that one nautical mile is covered for every 60 degrees of turn.

24. The climb should be commenced immediately after take off, turning onto track as required by air traffic control regulations, and the correct heading checked by reference to local landmarks. The position at the top of climb should be fixed and subsequent heading revisions based on the track made good from this point.

25. As for navigation at other levels, the aim is to obtain reliable checks on track and E.T.A. at five- to ten-minute intervals as planned. Owing to the difficulty in obtaining accurate pinpoints the accent should be placed on full use of radio aids.

26. The standard recovery from a high-level sortie, *i.e.* C.D.T.C., should be initiated when within ten minutes of E.T.A. base.

Night Navigation

27. Owing to the difficulty of map reading at night, greater emphasis should be placed on thorough flight planning and the use of radio aids. Under favourable conditions map reading is possible, but only prominent features are identifiable, *e.g.* coastlines, large towns and rivers, and identification beacons. Visibility and identification of some features, particularly water, is usually considerably better up-moon. Distances are particularly difficult to judge at night.

28. In addition to the precomputed bearings, identification beacons and their morse characteristics should be marked on the map. Colours used for map marking should be carefully selected since some are difficult to see in cockpit lighting. The procedure at night resembles that already taught for day navigation—use of radio aids supplemented by map reading where possible.

Lost Procedure

29. Full use of the emergency organization should be made when a pilot becomes lost, and prompt action is essential. Delay will reduce the time available for the ground organization to fix and home the aircraft to a suitable airfield and may result in the aircraft running out of fuel before a landing is made. The procedure should already have been demonstrated during a general handling detail

by simulating shortage of fuel and uncertainty of position, and making a practice emergency call on the distress frequency. It is imperative that the student's knowledge is revised before each solo navigational exercise. The importance of making a "securité" call as soon as it is apparent that the pilot is lost cannot be overstressed.

30. In the unlikely event of experiencing complete failure of both main and standby radio sets, the action to be taken will depend on numerous factors, including weather, terrain, and endurance. No hard and fast rules can be laid down. It is vital however to adhere to flight plan until a definite plan of action has been formulated. The first actions should be to check safety height and calculate endurance. A check should then be made on the heading, time, airspeed and, when possible, wind velocity since the last reliable pinpoint or fix to discover any reason for becoming lost and to work out a D.R. position. The subsequent actions will depend on circumstances and the following considerations should be fully discussed with the student:—

(*a*) Remain in visual contact with the ground if possible, establish a general position by the area summary method, adhere to flight plan until a definite position is obtained, and then take appropriate action. The procedure outlined in Exercise 17B should be followed if position cannot be established and an active airfield is not sighted. The student should be reminded that in such circumstances it is far preferable to be able to use power to inspect and ensure an accurate approach into a selected area, rather than to wait until the engine stops as a result of fuel shortage and then to be faced with an immediate forced landing and a limited choice of fields.

(*b*) When visual contact cannot be established without descending below safety height, the pilot should head towards areas of known better weather, to the coast in order to letdown over the sea, or to low-lying areas with their lower safety heights. If visual contact has not been established before the fuel is exhausted the aircraft should be abandoned. Any emergency procedure likely to be of use, *e.g.* the present triangular pattern, should be discussed with the student before he is permitted to fly solo above cloud.

31. **Diversions.** It may be necessary to divert to another airfield at any time during a cross-country flight; the student should be asked occasionally to select suitable alternatives and to calculate the heading, time and fuel required.

32. **Range and Endurance.** The general principles will already have been taught during general handling details but the considerations should be revised. All cross-countries should be flown

at the correct range speed for the altitude. The student should have a thorough understanding of turbo-jet range flying and be fully competent in using flight planning charts and tables.

Common Faults

33. Most faults are of a random nature and do not form a consistent pattern. Their origin usually lies in overhasty D.R. calculations and carelessness in applying corrections, or jumping to conclusions over pinpoints. Remind the student of the importance of adhering to flight plan until a reliable fix shows that the aircraft is off track.

34. Some pupils attempt too much air activity—continuous map reading and calling for unnecessary bearings are examples—with the result that flying accuracy suffers.

35. It is desirable that the student be left, within the bounds of safety, to discover and rectify any mistakes he may make. He will often learn more from such errors than from a flight which proceeds exactly as planned and requires little in the way of heading or E.T.A. revision.

36. Over-concentration on navigational matters often results in neglect of lookout, fuel and temperature checks, etc. The instructor should insist on a high standard of airmanship.

EXERCISE 21

PILOT NAVIGATION

AIM: To teach pilot navigation techniques under all conditions of flight.

AIR EXERCISE

Airmanship

1. (*a*) Before starting—check equipment:—
   (i) Map.
   (ii) Log card.
   (iii) Pencils.
   (iv) Watch.
   (v) En route document.

   (*b*) After starting:—
   (i) Check of radio on frequencies to be used.
   (ii) Check Rebecca.

   (*c*) Before take-off—set first heading on G4F pointer.

Sequence	Observations
2. **Setting Heading.**	(*a*) After take-off, plan the climb to arrive overhead the airfield on the first heading and at the correct height and airspeed, unless a climb away from base on the correct heading is required for fuel or other considerations. (*b*) Log the time of setting heading. (*c*) Calculate E.T.A. (*d*) Check on correct heading by reference to local features. (*e*) Concentrate on accurate flying until first check point. (*f*) Check synchronization of G4F and cross check with E2B.
3. **In Transit.**	(*a*) Lookout and normal checks. (*b*) Heading revisions made only after reliable fix. (*c*) E.T.A. revisions. (*d*) Log keeping. (*e*) Fixes. (*f*) D.R. positions. (*g*) Airways crossing—intermediate flight levels—radar clearance by A.T.R.C.U.

SEQUENCE (*contd.*)	OBSERVATIONS (*contd.*)
4. **Heading Revision.**	
(*a*) Calculation of track error and closing angle.	(*a*) Five- and ten-degree drift lines:— (i) Direct indication of error. (ii) Suitable for short distances only. (*b*) The 1 in 60 method:— (i) Error calculated from distance off track and distance run or to go. (ii) Practicable over any distance.
(*b*) Use of track error and closing angle.	(*a*) Alter heading by track error to parallel track. (*b*) Alter heading by twice track error to regain track after same time interval, then maintain track by altering back by track error. (*c*) Double track error method not possible after half-way point. (*d*) Alter heading by sum of track error and closing angle to fly direct to destination. Practicable at any stage of leg. (*e*) Common-sense check on direction of heading change to avoid alterations in wrong direction.
5. **E.T.A. Revisions.**	(*a*) Use of time marks. (*b*) Use of proportional distance scale. (*c*) E.T.A. revisions made by fractional proportion.
6. **Location of Destination.**	(*a*) Large heading changes may be necessary. (*b*) Use of funnel features. (*c*) At the turning point:— (i) Set new heading on G4F. (ii) Manoeuvre to carry out setting heading procedure. (iii) Attain new height. (iv) R/T call to base. (v) Log keeping—time and fuel states.
7. **Use of Radio Aids.**	(*a*) Setting heading—use of radio aids to set heading overhead. (*b*) Back bearings to obtain track error—not too soon after setting heading. (*c*) Bearings from destination to obtain closing angle. (*d*) E.T.A. checks from bearings with good cut across track.

SEQUENCE (*contd.*)	OBSERVATIONS (*contd.*)
7. **Use of Radio Aids** (*contd.*)	(*e*) Position fixed by:— (i) Two or more bearings. (ii) Bearing and Rebecca Range. (iii) Two Rebecca ranges. (iv) "Hayrake". (*f*) Bearings and times noted on map. (*g*) Use of precomputed rate of change of bearing. (*h*) Fixes obtained as planned. (*j*) Revisions of heading and E.T.A. as necessary. (*k*) Turn on E.T.A. if positive fix not possible. (*l*) Homing:— (i) Headings to steer. (ii) Rebecca.
8. **Procedure when Lost.**	(*a*) Change to distress frequency and transmit "securité" call. (*b*) If radio fails—select standby and transmit "securité" call.
9. **Low Level Navigation.**	(*a*) Limited field of view. (*b*) Different aspect results in changed relative importance of features. (*c*) Concentration on flying limits navigational activity—importance of flight planning and pre-flight map study. (*d*) Features in view for limited time—need for:— (i) Anticipation. (ii) Accurate timing. (iii) Quick recognition. (iv) Thorough pre-flight map study. (*e*) Importance of lookout for other aircraft and natural hazards.
10. **High-Level Navigation.**	(*a*) Climb on track. (*b*) Back bearings to establish track error on the climb. Ignore small errors. (*c*) Fix or D.R. position at top of climb. (*d*) Heading and E.T.A. revisions calculated from fix at top of climb. (*e*) Difficulty in visual pinpointing, even when possible, owing to increased blind spot. (*f*) Estimation of distance deceptive. (*g*) Reliance on radio aids for position lines and fixes. (*h*) Normal navigational procedures. (*j*) Airways crossing—intermediate flight levels—radar clearance by A.T.R.C.U.

SEQUENCE (*contd.*)	OBSERVATIONS (*contd.*)
10. **High-Level Navigation** (*contd.*)	(*k*) Turning points:— (i) Allowance for turning radius. (ii) Turn on E.T.A. if definite fix not possible. (iii) Attain new height. (iv) Next heading on G4F. (v) R/T call. (vi) Log keeping. (vii) Compare fuel state with planned consumption. (*l*) C.D.T.C. to be carried out at base on return.
11. **Night Navigation.**	(*a*) Lookout. (*b*) Limited map reading. (*c*) Distances deceptive. (*d*) Prominent ground features:— (i) Identification beacons. (ii) Large towns. (iii) Coast lines, rivers, etc., under suitable conditions. (*e*) Better visibility up-moon. (*f*) Reliance on radio aids supplemented by map reading when possible. (*g*) Normal navigational procedures.
12. **Range and Endurance.**	See EXERCISE 6

POST-FLIGHT DISCUSSION

EXERCISE 22

FORMATION FLYING

AIM: To teach the student to fly accurately and confidently in formation.

INSTRUCTIONAL GUIDE

General

1. Some types of operational flying, and the shepherding of partially unserviceable aircraft, require aircraft to be operated in formation. To be effective, a formation must operate as a single unit, requiring not only a high standard of ability, but also excellent discipline and complete understanding between all members. This will only be attained by thorough briefings and sound instruction. The potential service pilot must show that he is capable of absorbing instruction in formation flying and his progress should be such that there is no doubt that he will be able to reach a high standard in later stages of training.

2. The high degree of concentration required during formation exercises is extremely tiring. The earlier lessons should be of short duration and the instructor should take over periodically in order to allow the student time to relax. If found necessary, the spacing between aircraft can be increased to provide respite.

3. Before being authorized to fly solo in formation the student must be competent in joining, breaking formation in emergency, station keeping, formation changing, and performing stream take-offs and landings.

4. For a variety of reasons, it is often necessary for instructors to fly with students (or lead formations containing students) whose ability is unknown to them. It is therefore of vital importance that instructors ascertain the student's ability before the flight to ensure that all manoeuvres to be carried out are within the student's capabilities. It is of equal importance that their progress be carefully and fully recorded on their Form 5060. This will ensure that:—

(*a*) A student does not fly solo in any exercise until he is competent to do so.

(*b*) All instructors can readily check the student's ability and plan the exercise accordingly.

(*c*) The correct standard is reached by all students.

5. The student will learn mainly by practice, with verbal assistance, and he must be allowed to handle the controls as much as possible without becoming overtired in the early stages. As general pro-

ficiency increases, the practices should be made more difficult by steepening the bank in turns, increasing the speed range, and eventually progressing to the more advanced exercises.

Before Flight

6. **Preparatory Instruction.**

(*a*) Basic formations and positions.

(*b*) Station keeping.

(*c*) Joining and breaking formation.

(*d*) Formation changing.

(*e*) Formation leading.

(*f*) Taking-off and landing in formation.

(*g*) Hand and R/T signals.

(*h*) Tailchasing.

(*j*) Emergencies.

References—A.P. 129, Vol. 2, Part 2, Sect. 4, Chap. 10, and A.M.F.O. No. 407.

7. **Pre-Flight Briefing.** Individual briefings should be given to cover the particular aspect of the lesson about to be taught. Full use should be made of diagrams, models, and when possible, aircraft on the ground, to demonstrate stations and correct spacing. A formation briefing, attended by all pilots involved, must be given before each flight and should cover the following points as applicable:—

(*a*) Identification:—

(i) Formation call sign.

(ii) Positions, numbers and aircraft identification.

(iii) Deputy leader.

(*b*) R/T procedure:—

(i) Frequencies to be checked and used.

(ii) Changing frequency.

(*c*) Signals to be used:—

(i) R/T.

(ii) Hand signals (as in A.P. 129).

(*d*) Starting procedure—synchronized starting by signal or time.

(*e*) Taxying:—

(i) Order and distance.

(ii) Route.

(*f*) Marshalling point—signals when V.As. complete.

(*g*) Take-off:—

(i) Positions on runway.

(ii) Stream take-off—intervals and type of climb.

(iii) Formation take-off.

(*h*) Climbing procedure—leader's power and speed.

(*j*) Plan of flight:—

(i) Signals.

(ii) Frequency changes.

(iii) Formation changes.

(iv) Changing leader—position.

(v) Fuel checks.

(vi) Manoeuvres.

(vii) Descent.

(*k*) Circuit:—

(i) Joining height and speed.

(ii) Formation break—intervals.

(iii) R/T calls.

(iv) Runway position.

(v) Formation landing.

(*l*) Emergencies:—

(i) Radio failure—signals and actions.

(ii) Losing leader—in the clear and in the cloud.

(iii) Cockpit misting.

8. A student should be told that he may become disorientated when the horizon is obscured. To combat this he must trust his leader, maintain an accurate formation position, and make a conscious effort to relax mentally and physically.

9. One effect of the side-by-side seating in the Jet Provost is that the student often has difficulty in flying formation in the No. 3 position. It is desirable, therefore, that he flies in the No. 2 position during the initial demonstrations and practice.

10. Any tendency towards overconfidence, especially by a solo student flying too close in order to impress, must be checked immediately.

11. Early dual and solo formation exercises should be flown at medium altitudes. High-level formation should follow when the student is capable of accurate station keeping in all positions.

12. The instructor must insist on the correct handing-over procedure in order to avoid misunderstandings.

13. **Starting Procedure.** All aircraft in the formation should start together to avoid wasting fuel. This can be done on a signal from the leader, or if this is impracticable, at a prearranged time. Before taxying, the leader should check R/T communication with the formation on all frequencies to be used during the detail.

14. **Taxying.** The aircraft should taxy together as a formation, in the correct order and close enough to prevent others cutting in, but far enough behind to avoid stones thrown up by the jet efflux of preceding aircraft. The parking brake must be applied whilst carrying out the Vital Actions. A "thumbs up" signal should be passed up the formation when the checks are complete.

15. **Stream Take-Off.** It is customary to line up with odd numbers on the left, and even numbers on the right of the runway, but it may be advisable to reserve this order in conditions of crosswind from the left of the runway. The take-off run should commence 10 seconds after the aircraft ahead rolls. The leader should climb straight ahead to 1,000 feet and then carry out a climbing turn at about Rate 1 through 90 degrees and at 97 per cent. r.p.m. to allow the formation to join up quickly. The technique of turning inside the leader should be practised where possible; when the leading aircraft remains stationary relative to the wind-screen the bank is correct. If the leader appears to move ahead the rate of turn is too low, and vice versa. Bank must be reduced progressively to maintain the relative position of the leader as the closing distance is reduced.

16. **Joining Formation.**

(*a*) A knowledge of the leader's speed and power setting is a great advantage in judging closing speed and in settling down quickly.

(*b*) The large throttle and control movements sometimes necessary when joining should be anticipated to avoid over controlling. Airbrakes may be used when the closing speed is high.

(*c*) The procedure when joining should be to take up the correct vertical and longitudinal positions at about two spans distance, and, when settled, move into the correct lateral position by careful use of aileron.

(*d*) The student must realize that use of aileron causes a change of heading and so alters the lateral spacing. When closing in, the opposite bank that is necessary to restore the correct heading must be anticipated.

17. **Station Keeping.**

(*a*) Before starting any detailed air instruction in formation, the instructor should fly the aircraft in formation for a period to accustom the student to the novelty and the appearance of the leading aircraft.

(*b*) Whilst the initial instruction is being given, the leader should maintain straight and level flight for relatively long periods in order to give the student time to settle down.

(*c*) Any reference points which give early indications of displacement from the correct position should be pointed out, as should the relative size of the next aircraft which, when kept constant, will ensure a steady spacing.

(*d*) Accurate station keeping requires anticipation of control movements; these must be small and prompt. The importance of accurate trimming and thus making full use of the aircraft's natural stability should be stressed. Smooth formation flying will only be achieved if the pilot remains mentally alert and physically relaxed.

(*e*) To avoid confusion in the air, the instructions that are given to correct errors in position must be completely standardized. Longitudinal corrections should be given as "forward" or "back", vertical as "up" or "down" and lateral spacing corrections as "in" or "out".

(*f*) The main control of lateral spacing is by use of ailerons. The student must realize the importance of gentle control movements when close to other aircraft and that, when aileron is used to reduce the distance, corrective bank must be applied in good time to avoid harsh last-minute corrections which may result in losing sight of the leader.

(*g*) Rudder can be used to make fine adjustments to lateral spacing when close in, any tendency to bank being prevented with aileron so that the wings remain parallel to those of the leader.

(*h*) Changes in the longitudinal position must be corrected immediately. The greater the rate of change of position, the greater will be the throttle movements required to correct, and vice versa. As the correct position is being regained the further throttle movement necessary to maintain it must be anticipated. Any delay in the correction of errors will usually result in over-controlling and the student will have difficulty in holding a steady position.

(*j*) During early formation practice, the student should increase his lateral separation before checks of oxygen, temperatures, etc., are made. As the student becomes proficient however, these checks may be carried out in station but the student must check each instrument singly as it takes several seconds to locate and read an indicator correctly. Attention must be diverted from the leader for the shortest possible time.

18. **Breaking and Rejoining Formation.**

(*a*) When sight of the leader is lost, a positive upward and outward break must be made immediately, and the formation rejoined from a safe distance and at the same height. The danger of attempting to rejoin from above should be pointed out. If the formation is overtaken, the same procedure must be followed as it is equally dangerous to attempt to fall back into position, especially on, or just after, take-off.

(*b*) If contact is lost in cloud, the aircraft must be immediately turned 30 degrees away from the formation and the leader informed by R/T. The original heading may be resumed after 30 seconds and the leader's airspeed maintained. Rejoining must not be attempted until clear of cloud.

(*c*) The rejoining procedure follows the same pattern as joining the formation after take-off, (see para. 15) except that air-brakes will not be necessary when the closing speed is low. The student should be given rejoining practice in straight flight and turns.

19. **Formation Changes.**

(*a*) The procedure and order of position changes must be settled before flight.

(*b*) All formation changes should usually be made by the aircraft moving behind and below the formation to take up its new position.

(*c*) When moving into line astern the aileron movement required to position the aircraft correctly must be anticipated or an overshoot will result.

(*d*) When a three-aircraft formation changes into line astern, No. 3 may descend and drop back but should not move across until No. 2 is in position.

(*e*) When changing from line astern to Vic or echelon, No. 2 should delay slightly to give time for No. 3 to clear.

(*f*) During all formation changes an aircraft should not be closed to the correct lateral or longitudinal position until the preceding aircraft appears to be settled in position. The student should appreciate, however, that prompt formation changes are essential operationally and a high standard must be achieved.

(*g*) Rapid and efficient formation changes require smooth control handling and considerable anticipation of power to avoid lagging.

(*h*) Care must be taken to keep the other aircraft in view as much as possible during position changes.

20. **Formation Leading.** The student must realise that good leadership is vitally important and can considerably ease the task

of the formating pilots. The leader is responsible for the formation briefing before flight, and in the air for the overall safety and airmanship of the formation. Particular attention should be paid to the following points:—

(*a*) *Control and Manoeuvre*. All manoeuvres should be carried out smoothly and accurately and within the capabilities of all the formating pilots. Aircraft farthest from the leader in large formations, particularly in echelon, must make relatively large changes in height and airspeed during turns. Entries and recoveries should be made gently and bank restricted to moderate angles. Maximum and minimum power settings must never be used by the leader as formating pilots must be allowed a wider throttle range than the leader to maintain position. Similarly, very low speeds must be avoided or aircraft on the inside of turns may lose control.

(*b*) *Airmanship*. The importance of a high standard of airmanship and in-flight planning must be impressed upon the student.

(i) *Lookout*. In close formation, the attention of formating pilots is concentrated on the leader who must assume the responsibility of lookout for the entire formation, bearing in mind the greater airspace taken up and the reduced manoeuvrability of a formation.

(ii) *Navigation*. The leader is responsible for the navigation and use of radio aids. Fuel states must be obtained periodically, and it should be appreciated that the following aircraft will have a higher fuel consumption than the leader.

(iii)*Position of the Sun*. The leader should avoid, whenever possible, flying so that he is directly up-sun of any member of the formation.

21. **Circuit Rejoining and Stream Landing.**

(*a*) The straight approach on the dead side of the duty runway should be of sufficient length to allow the formation to settle down in echelon.

◀(*b*) During the earlier exercises the final run-in should be made at circuit height and cruising speed, the throttle being closed and airbrakes extended during the break as bank is applied. When the student becomes more proficient, the run-in speed should be increased to 220 knots, and the time interval between individual aircraft breaks reduced in accordance with A.S.I.s. It is imperative that the exact break procedure be clearly stated during the pre-flight briefing. The accuracy of the level break will be ensured if the aircraft ahead is kept in sight and on the horizon during the turn downwind.▶

(*c*) The correct spacing should be attained downwind so that normal approach speeds may be used.

(*d*) The effects of crosswind on the slipstream of the aircraft ahead should be anticipated and a slightly steeper approach carried out. Long flat approaches which necessitate high power during the final stages should be avoided.

(*e*) In marginal weather conditions the final run-in should be at a low safe cruising speed, and a gentle turn made downwind at about 10-second intervals to allow adequate spacing.

22. **Tail Chasing.** When the student has reached a satisfactory standard in general formation flying he should be introduced to tail chasing. This should not be regarded merely as a period of relaxation at the end of a detail but as a most important aspect of a student's flying training. The ability to hold position throughout a period of tail chasing is one indication of his potential as a fighter pilot. A high standard will be attained eventually by starting with gentle rolling manoeuvres maintaining slight positive loading and gradually building up to more advanced looping manoeuvres involving higher loading as the student becomes competent. Before a detail involving tail chasing takes place, the instructor leading must check on the proficiency of the solo students and plan the exercise accordingly. Prolonged negative *g* loadings must be avoided. Particular attention must be paid to the following points:—

(*a*) *Airmanship*. Tail chasing should be carried out only in suitable weather conditions. The leader must not fly so that any member of the formation is likely to descend below FL 100 or within 5,000 feet of cloud tops, nor must he fly at an I.A.S. or loading which may result in a follower losing control or exceeding the aircraft limitations. The leader must ensure that the airspace is completely free of other aircraft.

(*b*) *Spacing*. The distance between aircraft in extended line astern should be 100 yards. The appearance of a Jet Provost at this distance should be pointed out on the ground as a guide. No. 3 must fly on No. 2 and not the leader.

(*c*) *Briefing*. The briefing before flight should include the sequence of manoeuvres to be carried out and the action to be taken if position is lost. Manoeuvres not included in the briefing should not be attempted.

23. **Snake Climb and Descent.** During early solo details, before the student is fully competent to formate in actual conditions, it may be necessary to climb and descend singly through cloud. The snake technique can be used and should be demonstrated during a dual detail when suitable conditions arise.

(*a*) *Snake Climb*. The formation should take off in the correct order at 30-second intervals. The normal instrument climb should be carried out, and particular emphasis made to the importance of accurate power settings, climbing speeds, and headings. When above the cloud, the leader should reduce to 97 per cent r.p.m. continue climb to 1,000 feet above cloud tops, level out and orbit at a low rate of turn until the formation has joined up. He should watch for the other aircraft breaking cloud and pass his relative bearing in clock code. The climb should not be resumed until the formation is settled in position.

(*b*) *Snake Descent*. The formation should home to overhead for the C.D.T.C. in the normal manner and one aircraft should be detached outbound on each orbit, thus providing a two-minute separation. Any aircraft with a low fuel state should be given priority, but under normal conditions the instructor leading should detach solo students in turn for the letdown and bring up the rear himself. The controlled descents, circuits and landings are carried out individually. The importance of accurate power settings, speeds and headings to maintain the separation should again be stressed.

24. **Formation at High Altitude.** As the student gains proficiency, the operating altitude should be increased to ◀FL 200▶ or higher. At these heights the control response is changed only slightly and should not present any difficulty. If the aircraft is allowed to lag, however, the reduced thrust results in poor acceleration and it is often difficult to catch up: it may be necessary to dive slightly to gain speed more quickly. When overhauling the leader, the increased inertia at the higher T.A.S. calls for greater anticipation in use of throttle and airbrakes. Greater care should be taken to avoid harsh throttle movements at altitude. ◀Above FL 200 a spacing of two spans between aircraft in V.I.C. formation and two lengths in line astern should be used. These spacings can be reduced as the student gains more experience in high altitude formation flying.▶

25. **Formation Take-Off.** During late dual details, the student's experience can be broadened by introducing formation take-offs. As with other formation exercises, the programme should be arranged so that each pupil has the opportunity to practice both leading and formating. The aircraft should be positioned on the runway in the correct stations, care being taken to ensure accuracy in lining up with the nosewheel straight. Full power should be checked and power reduced to 95 per cent r.p.m., the leader increasing to 97 per cent during the take-off run, leaving the runway at a speed slightly higher than normal. The formating aircraft must concentrate on maintaining station relative to the leader and will become airborne at the same time. The call to raise the undercarriage should not be made until well clear of the ground.

26. **Formation Landing.** When the student has reached a high standard of proficiency in general formation flying, he can be shown the technique used when landing pairs of fighters or when shepherding an aircraft with an unserviceable airspeed indicator. For this exercise the formation should be limited to two aircraft in order to allow one span lateral separation: landing should be made on each side of the runway centre line. Few students will have acquired the ability to make safe landings in larger formations at this stage of training. If three-aircraft formations are being flown and it is desired to give formation landing practice, one aircraft should be detached when joining the circuit for an individual landing. The programme must be carefully planned to ensure that each student has at least one demonstration in each position. Under operational conditions formation landings are normally made from straight-in approaches, but a circuit with a long final approach may be used during practice.

Common Faults

27. Some students fail to make allowance for dihedral with the result that they fly with crossed controls. The flat cross made by the two adjacent wings should be pointed out, and when more proficient the student should make periodic checks of the slip indicator.

28. Harsh control movements and overcontrolling in general are often due to physical and mental tension; the student should be encouraged to make a conscious effort to relax. When these symp toms appear the instructor should take over control for shor periods whilst the student rests.

29. Unsteady vertical positioning is often due to poor trimming.

30. If a student is having difficulty especially in maintaining longitudinal position, he may make faster progress if control is split during an early lesson, the student handling the throttle with the instructor on the flying controls until experience is gained.

31. In line astern, failure to anticipate the levelling of the wings as the correct position is approached results in overcontrolling and swinging from side to side. A definite effort must be made to match the wing level of the aircraft ahead, and corrections made by very small alterations in bank.

EXERCISE 22

FORMATION FLYING

AIM: TO TEACH THE STUDENT TO FLY ACCURATELY AND CONFIDENTLY IN FORMATION.

AIR EXERCISE

SEQUENCE	OBSERVATIONS
1. Starting and Taxying.	(*a*) Start on leaders signal either by hand or radio, or at a preselected time. (*b*) Leader:— (i) R/T checks with formation. (ii) R/T call for taxy clearance. (iii) Taxy with consideration for formation. (iv) Marshalling point—parking brake on—vital actions. (v) R/T call for take-off clearance when formation ready. (*c*) Formation:— (i) R/T checks in numerical order. (ii) Taxy in numerical order. (iii) Taxy with care and at correct distance—checks of brake pressure. (iv) Marshalling point—line up at safe distance—parking brake on—vital actions. (v) Signal when checks complete.
2. Stream Take-Off.	(*a*) Leader:— (i) Line up and held on left side of runway. (ii) Check formation in position and ready. (iii) Normal take-off. (iv) Accurate climb at 97 per cent. r.p.m. (v) Climb turn, Rate 1 through 90 degrees at 1,000 feet. (vi) Call for frequency change as required. (*b*) Formation:— (i) Line up on alternate side of the runway. (ii) Signal when ready. (iii) Take-off at 10-second intervals. (iv) When leader turns, Nos. 2 and 3 out the corner. (v) Change frequency when instructed. (vi) Maintenance of relative position of leader. (vii) Progressive reduction of bank.

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SEQUENCE (*contd.*)	OBSERVATIONS (*contd.*)
3. **Station Keeping.**	
(*a*) Fly vic formation at normal spacing.	(*a*) Appearance of other aircraft. (*b*) Correct position:— (i) Longitudinal—opposite tail-plane. (ii) Vertical—same height, upper and lower aileron surfaces visible. (iii) Lateral—half span between wing tips. (*c*) Attention fixed on leader. (*d*) Importance of relaxing physically. (*e*) Difference in No. 3 position due to offset seating.
(*b*) Demonstrate the use of controls for station keeping.	(*a*) Vertical position ("up" or "down"):— (i) Controlled by elevators. (ii) Small, gentle control movements essential. (iii) Illusion of leader moving. (iv) Importance of trim. (*b*) Lateral position ("in" or "out"):— (i) Ailerons primary control. (ii) Small gentle movements. (iii) Wings parallel to leaders—illusion caused by dihedral. (iv) Anticipation of levelling wings or corrective bank when closing. (v) Check no slip or skid. (*c*) Longitudinal position ("forward" or "back"):— (i) Controlled by throttle. (ii) Small prompt adjustments. (iii) Anticipation required—due to slow engine response and aircraft inertia. (iv) Constant throttle setting aimed for—avoidance of over-controlling. (*d*) The effects of all controls are inter-related — control movements must be co-ordinated. (*e*) Importance of corrections immediately a change in relative position is noted.
(*c*) Turns in formation.	(*a*) Attention concentrated on maintaining position relative to leader. (*b*) Station keeping as for level flight. (*c*) Same bank as leader. (*d*) Anticipation of power changes on entry and recovery. (*e*) Need for climb or descent on entry and recovery to maintain plane of formation.

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SEQUENCE (*contd.*) — OBSERVATIONS (*contd.*)

4. Breaking and Joining Formation:—

(*a*) Climb to lose sight of the leader, break away and demonstrate rejoining.

(*a*) Positive upward and outward break.
(*b*) Danger of attempting to rejoin from above.
(*c*) Locate the leader.

(*b*) Joining in level flight.

(*a*) Knowledge of leader's speed, an advantage in judging closing speed.
(*b*) Apply full power.
(*c*) Attain correct vertical position.
(*d*) Aim for correct longitudinal position two spans out from lead aircraft.
(*e*) Anticipate joining up and decelerate by reducing power and using airbrakes as necessary.
(*f*) Gentle control movements to obtain correct position.

5. Changing Formation.

(*a*) Change in correct order.
(*b*) No violent movements.
(*c*) Half-wing span or aircraft length between aircraft at all times.
(*d*) Position of other aircraft.
(*e*) From vic to line astern:—
(i) Reduce power slightly to drop back one length clear of leader's tail—power to maintain position.
(ii) Reduce height to clear jet wash.
(iii) Bank to move into position.
(iv) Anticipation of levelling wings.
(v) No. 3 drops back to correct position and descends to correct height but waits for No. 2 to take up position before moving across.

(*f*) From vic to echelon, or vice versa:—
(i) All movements through the line astern position.
(ii) Next aircraft in echelon settled before moving in.

6. Line Astern.

(*a*) Vertical position:—
(i) Angle of sight through wind-screen.
(ii) Avoidance of jet wash of aircraft ahead.
(iii) Gentle elevator movements.

SEQUENCE (*contd.*)	OBSERVATIONS (*contd.*)
6. **Line Astern** (*contd.*)	(*b*) Lateral position:— (i) Directly astern of aircraft ahead. (ii) Effect of offset seating. (iii) Wings parallel to aircraft ahead. (iv) Position adjusted by small, prompt aileron movements. (v) Small changes of bank produce large lateral movements. (*c*) Longitudinal position:— (i) One length astern of aircraft ahead. (ii) Small displacements, difficult to detect. (iii) Prompt corrections essential.
7. **Formation Leading.**	(*a*) Responsible for safety of the formation:— (i) Lookout. (ii) Fuel checks. (iii) Oxygen checks. (iv) Navigation. (v) R/T procedure. (*b*) Power changes kept to a minimum and made smoothly and slowly. (*c*) Distinct commands and signals—complete before manoeuvre commenced. (*d*) Avoid sun dazzle of formating pilots. (*e*) Climbing—97 per cent. r.p.m. (*f*) Descending—minimum 70 per cent. r.p.m. (*g*) Handing over lead—over definite pinpoint.
8. **Circuit Rejoining and Stream Landing.**	(*a*) Leader:— (i) Circuit joining instructions obtained early. (ii) Final descent planned to line up with runway in use. (iii) Echelon formation—away from circuit direction. (iv) Run-in made into wind on the dead side of the runway at circuit height. (v) R/T call for break at upwind end of runway. (vi) R/T call downwind. (*b*) Level break at briefed intervals. (*c*) Use of throttle and airbrakes as briefed. (*d*) Normal circuit—spacing 500 yards. (*e*) Individual R/T call on finals. (*f*) Land on alternate sides of the runway. (*g*) Last aircraft calls "clear".

SEQUENCE (*contd.*)	OBSERVATIONS (*contd.*)
9. Tail Chasing.	
(*a*) Leader.	(*a*) Constant r.p.m. setting.
	(*b*) Manoeuvres as briefed.
	(*c*) Clearance from ground and cloud.
	(*d*) Speed and loading limitations.
(*b*) Formation.	(*a*) Spacing—100 yards.
	(*b*) Appearance of aircraft ahead.
	▶◀ (*c*) Last aircraft calls when in position.
	(*d*) Perspective of aircraft ahead changes as loading varies.

POST-FLIGHT DISCUSSION

EXERCISE 23

HIGH-LEVEL FAMILIARIZATION

AIM: (*a*) To familiarize the student with flying at high altitude.

(*b*) To teach the effect of high altitude on performance and manœuvre, and the control of the aircraft at high speeds and mach numbers.

INSTRUCTIONAL GUIDE

1. For reasons of operational necessity and for efficient functioning of the gas turbine engine, a great proportion of the airborne time of modern aircraft is spent at high altitudes. Service pilots must, therefore, be fully conversant with the effects of altitude on the handling and control of their aircraft and be confident in their ability to fly the aircraft to its limits.

2. This exercise introduces an important aspect of pilot training and the instructor should take every opportunity of discussing it with his student. A thorough pre-flight briefing is essential, especially when authorizing solo practice. Care must be taken not to give the impression that high-level operation is a particularly dangerous or completely different type of flying: it should be regarded as a further aspect of flying training. On the other hand the student should be warned of the dangers of unauthorized high-level climbs before he is considered competent to undertake them. To guard against unfortunate incidents arising from possible solo attempts at the "height record" by students, it is advisable to carry out a familiarization detail soon after the solo consolidation period. The height available at the end of the demonstration presents an ideal opportunity to demonstrate and practice prolonged spinning. Only the general aspects of high altitude flight should be taught at this stage, ensuring that the student appreciates the importance of correct engine handling, the possibility of strong upper winds, and the physiological effects of height. Particular reference should be made to the need for frequent checks of oxygen and the actions to be taken in the event of oxygen failure or suspected anoxia. The further aspects should be dealt with later in the course when the student is proficient at low and medium level flying.

3. The sequences fulfil the aims of the exercise by giving a series of demonstrations that are designed to acquaint the student with the various aspects of flight at high level. The exercise, which can be covered in two dual details, serves as an introduction only and should precede the applied exercises of aerobatics, navigation and formation flying at high altitude.

Before Flight

4. Preparatory Instruction.

(*a*) Effect of altitude on engine thrust and efficiency.

(*b*) Effect of altitude on aircraft control and performance.

(*c*) Effect of altitude on manœuvrability.

(*d*) Relationship between IAS, TAS and Mach number.

(*e*) Engine handling.

(*f*) High altitude meteorology.

(*g*) High altitude navigation.

(*h*) Physiological effects of altitude.

References:—A.P. 129, Vol. 1, Part 1, Sect. 1, Chaps. 2 and 12; and Vol. 2, Part 1, Sect. 1, Chap. 2.

5. **Pre-Flight Instruction.** The briefing will of necessity take longer than usual since a number of varied aspects are covered in one flight.

During Flight

6. When possible, the first detail should be carried out on a day with good visibility, little cloud and average winds enabling such points as the increasing visual range, difficulty of pinpointing and distance covered in the climb to be made.

7. The student should be permitted to fly the aircraft during the climb but thereafter the instructor should carry out the main demonstrations before handing over control. Care must be taken during demonstrations to avoid causing apprehension of high altitude, high speeds or high rates of descent in the mind of the student, but the instructor should discourage any lack of determination in these respects.

8. Climbing.

(*a*) The aircraft should be climbed at maximum power, within the limitations, to reduce the time to height. However, should the use of full power be required at a later stage of the flight, *e.g.* for high speed runs etc., the period spent climbing at maximum r.p.m. should be reduced to remain within the limitation of twenty minutes at 100 per cent. r.p.m. ~~in each hour~~.

AL.15.

(*b*) The importance of maintaining the recommended climbing speeds, especially at altitude, should be stressed.

(*c*) The appropriate observations should be made at intervals during the climb. The vital importance of correct engine handling should be stressed and the student must be fully conversant with the rpm, jpt, and time limitations, and the need for frequent checks, careful throttle handling and the prevention of rpm creep. It may be necessary to reduce rpm, to maintain the jpt within limits.

d. Use of the zoom climb technique from FL 300 to FL 350 enables more time to be spent at maximum altitude within the limits laid down in ASIs.

NB: It is vital that, during the zoom climb, the Mach No is not allowed to reduce below .4M.

9. Navigation. The exercise involves flight at altitudes where the wind may be very strong. The sortie should be planned with due regard to the forecast winds, bearing in mind that exceptional ground speeds can be attained in jet streams and that a careful check must be kept on the aircraft's position during flight. Full use of radio bearings and Rebecca should be made to assist the mental DR. The normal procedure is to climb into the mean wind and to carry out high speed runs on the heading for base.

10. Physiological Effects.

a. The importance of oxygen cannot be over emphasized: the frequent checks of contents, connections and flow must become a habit. The symptoms of, and precautions against, anoxia and hyperventilation should be explained before flight, but care should be taken not to alarm the student.

b. The physiological discomforts resulting from high altitude flight in an unpressurized cockpit should also be explained before flight. Particular reference must be made to the importance and methods of clearing the ears, and periodic reminders should be given during rapid descents.

11. Effect of altitude on Control and Performance.

a. Although the effect of altitude on the control and stability of the Jet Provost is less marked than on more advanced aircraft which operate at greater heights, a high degree of concentration is required to fly to the same limits of accuracy as at lower levels.

b. For a constant IAS, the control forces and changes in attitude for a given control deflection vary only slightly with altitude. However, because of the higher TAS the inertia is increased and the aircraft takes more time to change its flight path.

c. The most marked effect of increasing altitude is the reduction of the thrust developed by the engine, resulting in a progressive decrease in the speed range as seen on the ASI. The student should realize that although the maximum IAS is decreasing the TAS is increasing.

d. The student should be shown that at high level the Mach meter begins to register at a relatively low IAS and reference should be made to that instrument as much as possible.

12. Effect of Altitude on Manoeuvrability.

a. Manoeuvrability is reduced as height is gained. This is due to the increasing disparity between IAS and TAS, and to the decreasing thrust available. The reduced lift at the lower IAS and the increased inertia at the associated high TAS limit the amount of "g" that can be applied before stalling. Since all changes in the flight path involve "g", any restriction on the loading that can be applied will result in reduced manoeuvrability.

b. For any given IAS and angle of bank, the radius of turn is increased and the rate of turn is decreased with an increase in altitude. The decreased thrust available further reduces the turning performance at height, since the maximum sustainable airspeed and angle of bank are limited.

c. Although the demonstration of manoeuvres in the looping plane is a useful introduction to high-level aerobatics, the object is merely to demonstrate the effect of altitude on control and manoeuvrability. Accurate aerobatics at altitude will be taught in later exercises.

13. High Speed Run. High speed effects at normal loading should present little difficulty to the student provided that he has been fully briefed and is given a firm and convincing demonstration.

14. Maximum Rate Descent. The demonstration of a maximum rate descent should be related to itsuse in emergency, eg oxygen failure, or as a means of reducing height with a minimum consumption of fuel and as quickly as possible.

EXERCISE 23

HIGH LEVEL FAMILIARIZATION

AIM: To show the effects of high altitude and compressibility on aircraft performance and handling.

AIR EXERCISE

Airmanship

1. Navigation.

Accurate flight planning use of Fixers and DF aids in addition to mental DR. Hi Lvl Training.

2. Oxygen.

Check mask and tube connection, flow and contents at 10,000 ft and at least every 5,000 ft thereafter. Select high flow from commencement of exercise.

3. Engine Handling

Particular care should be taken to avoid exceeding the rpm and JPT limitations during the climb and at altitude.

4. Security.

Test the airbrakes in addition to the normal security checks before compressibility run.

5. Lookout.

The high TAS and limited manoeuvreability demands a very thorough lookout. Use of canopy demisting devices is especially important from this aspect.

SEQUENCE	OBSERVATIONS
1. Climb to FL 350	
After take-off, when height is sufficient, demonstrate a roll at 170 knots using full aileron deflection; noting the rate of roll as a basis for comparison in Sequence 3. Climb at 100% RPM until JPT reaches 735 degrees; thereafter limit JPT by reducing RPM as required. Level off at FL 300 and accelerate to maximum speed straight and level (approx .55M). Zoom climb by gently adopting a climbing attitude to give 2000 ft/min on the VSI then maintain that attitude until the speed decays to .4M. Climb at .4M to FL 350.	a. After rate of roll demonstration, climb at 200 knots until .4M is reached, thereafter maintain .4M until FL 300. Zoom climb allows greater time at FL 350. b. Climbing attitude becomes shallower as height is gained. c. Decreasing rate of climb. d. Increasing sensitivity of machmeter in comparison with ASI. e. Physiological effects. f. Oxygen checks. g. Frequent rpm/JPT check necessary. h. Improved visibility but difficulty in estimating ranges and distances.
2. Levelling Off	
Level off and fix position visually or by use of radio.	a. Little height required to level off, small change of attitude. b. Distance covered in the climb. c. Fuel used in the climb.

3. Manoeuvrability and Control at Altitude

a. Checks, as before aerobatics. Height FL 300-350 .	
b. At 170 knots, roll the aircraft in a similar manner to Sequence 1.	Compare rate of roll with earlier demonstration. Feasibility of aerobatics in the rolling plane.
c. Allow student to familiarize himself with handling at altitude, carry out max rate level turns.	Less warning of stall. Marked reduction in turning performance.

4. High Speed Run.

a. Estimate a heading for base. Confirm with a steer.	Good RT contact even at long range.
b. From FL 300 fly towards base at full power until max. level speed (approx .55M) is obtained.	Aircraft is slow to accelerate.
c. Commence a dive at 30 degrees to 40 degrees and hold until .72M is achieved.	Progressive change of trim. Controls "Heavying Up". No compressibility effects in straight dive.
d. Recovery.	
(1) Air brakes out. (2) Throttle closed	Simultaneously.
(3) Ease out of dive whenbelow .7M and retract airbrakes if intending to regain height.	

5. High Level Looping Manoeuvres

Demonstrate loops at FL 250 ft at approx .6M.	a. High M.No for given IAS on entry, need for care in pulling up.

b. Rapid decrease in M No when nose is above horizon, aircraft less sensitive to g at this stage.

c. Rapid increase of M No and IAS when diving out of loop.

EXERCISE 23A

HIGH LEVEL FAMILIARISATION (MK 5 ONLY)

AIM: To show the effects of high altitude on aircraft performance and handling.

AIR EXERCISE

1. **Navigation.** Knowledge of Upper Air Space radar control and training areas. Accurate flight planning, use of Fixer service and DF aids to supplement mental DR. High level winds normally strong.

2. **Oxygen.** Check flow indicators and contents at least every 5000 ft on the climb and at regular intervals when at altitude. Pressurisation also to be checked at regular intervals.

3. **Engine Handling.** Increased chance of compressor stall and surge due to poor throttle handling or high N/T values. Symptoms of and recovery from, stall and surge must be fully known. RPM and JPT limitations must be carefully observed.

4. **Security.** Test the airbrakes in addition to the normal security checks before the compressibility run.

5. **Lookout.** The high TAS, limited manoeuvrability and empty visual field myopia demands special attention to lookout. Canopy demist should be used from medium level in the climb.

SEQUENCE		OBSERVATIONS
1. Climb to FL 350. After a take off at full power, climb at 98% and 200 knots/.4M until FL 200 is reached, then use full power. Ensure that the JPT and RPM are maintained within limits either automatically or manually.	a.	Direction of climb in relation to wind and/or Training Area.
	b.	Climbing attitude becomes shallower as height is gained.
	c.	Decreasing rate of climb.
	d.	Increasing sensitivity of machmeter in comparison with ASI.
	e.	Oxygen and cabin pressure differential checks.
	f.	Frequent RPM/JPT checks necessary.
2. Levelling off. Level off and maintain .45M. Fix position by use of radio.	a.	Little height required to level off, small change of attitude.
	b.	Distance covered in climb.
	c.	Fuel used in climb.
	d.	Improved visibility but difficulty in estimating distances and visually fixing position.
	e.	Greater range of radio aids.
	f.	Greater concentration necessary to fly accurately.

3. Manoeuvrability and Control at Altitude

Demonstrate general handling including steep turns and maintaining .45M; maximum rate level turns, but do not prolong these.

a. Use of machmeter instead of ASI.

b. Smooth and gentle handling needed.

c. Frequent reference to instruments necessary for accurate turns.

d. Necessity to reduce bank in order to maintain speed.

e. Angle of bank when maximum rate reached is low.

4. Descending Maximum Rate Turns. (To be demonstrated after the initial High Level sortie). Commence a maximum rate turn from .45M overbanking and allowing the speed to increase to .5M. Maintain this IMN.

a. Initial overbanking.

b. When optimum IMN reached speed is controlled by use of bank.

c. High rate of turn.

d. Large loss of height, increasing "g".

5. High Speed Run and Compressibility Effects. (To be commenced above FL 330).

a. Estimate a heading for base and confirm with a steer. Accelerate to .5M in level flight.

b. Commence a steep dive and hold until .7M is achieved.

a. Progressive change of trim and controls become firmer and more sensitive. No compressibility effects in straight dive.

b. Trim to .7M

c. At .7M apply sufficient bank and firm back pressure to induce compressibility effects.

High frequency buffet and loss of elevator effectiveness.

d. Recovery.

(1) Relax back pressure and level wings.

(2) A/Bs out.) Simult-

(3) Throttle closed.) aneously

(4) Ease out of dive.

a. Compressibility effects stop as wings are levelled and back pressure removed.

b. Forward stick pressure necessary to check trim change caused by use of A/Bs.

e. Retract air brakes as nose approaches horizon, apply full power and zoom climb until .4M reached when aircraft is levelled off.

6. High Level Manoeuvres.

Demonstrate manoeuvres.

a. Feasibility of aerobatics.

b. High IMN for given IAS.

c. More delicate handling required to avoid "g" stalling.

d. Rapid decrease in IMN when nose is above horizon.

e. Larger height change than at lower altitude.

f. Rapid increase of IMN and IAS when nose below the horizon.

7. Maximum Rate Descent.

Enter a steep dive by lowering the nose, closing throttle,

a. Entry technique depends on circumstances.

selecting A/Bs out at .6M. Maintain until 250 knots IAS is reached and then hold this speed.

b. To maintain constant IMN nose attitude becomes steeper as height is lost.

c. Attitude on artificial horizon.

d. High rate of descent.

e. Constant check of altimeter.

f. Large anticipation required for levelling off.

ANNEX A TO
AP 3225D

NOTES FOR THE GUIDANCE OF INSTRUCTORS WHEN PRESENTING EXERCISES IN THE JET PROVOST T MK 5

1. These notes should be read in conjunction with the Aircrew Manual which details the handling techniques, characteristics and limitations.

EXERCISE 1. FAMILIARISATION WITH THE AIRCRAFT

2. The student should have a working knowledge of the pressurisation and oxygen demand systems and the emergency drills pertinent to these systems.

EXERCISE 4. EFFECT OF CONTROLS

3. Effect of Power. The nose down trim change when increasing power is more positive and makes a convincing demonstration.

4. Effect of Flap. The trim changes with flap are in the same sense but are less marked.

EXERCISE 6. STRAIGHT AND LEVEL

5. Attitudes. The judgement of visual attitudes is relatively simple.

6. Power Settings. Because the aircraft is aerodynamically cleaner the power settings for particular airspeeds are 1 - 2% down on those required for the Mk 4.

7. Minimum Drag Speed. The minimum drag speed is some 5 knots higher.

EXERCISE 10. STALLING

8. Recovery from the stall. As a teaching guide on the Mk 3 and 4 a figure of about 100 knots is often quoted in the early stages as "adequate flying speed" to ease out of the dive. On this aircraft a better speed would be "about 110 knots".

9. Effect of Full Flap on the Stall. The use of full flap causes very mild airframe buffet and the difference between this and the pre-stall buffet should be made clear to the student.

EXERCISE 11. SPINNING

10. Incorrect Control Technique. It is essential that the controls

are maintained fully pro-spin during the spin. There is pronounced rudder buffet during the spin and it is easy to allow the amount of pro-spin rudder to reduce. This will induce an oscillatory spin with an increasing airspeed.

11. Normal Spin. The airspeed stabilises normally between 125-150 knots and the spin may be oscillatory particularly to the right and at lower fuel weights. The recovery is prompt, often requiring only one turn.

EXERCISE 13. APPROACH AND LANDING

12. Downwind. The aircraft is correctly spaced downwind on a normal circuit when the wing tip just overlaps the runway. For all other circuits the normal spacing indications are valid.

13. Approach and Threshold Speeds. As the speed is reduced towards the threshold speed there is a considerable rise in drag. This is seen as a tendency for the speed to reduce rapidly through the last ten knots. Students should be made aware of this tendency and the need to counteract this drag rise promptly with power if necessary. In strong wind conditions add 5-10 knots to the threshold speed.

EXERCISE 15. ADVANCED TURNING

14. Maximum Rate Level Turns. There is ample pre-stall buffet and this makes it very much easier to fly these turns. The aircraft must be held a little further into the buffet than on the Mk 3, a good indication is the IAS, if this is steadily decreasing towards the stabilisation IAS of approx 130 knots then the back pressure is sufficient.

EXERCISE 18. AEROBATICS

15. Initially the absence of tip tanks may cause a little difficulty with aerobatics in the vertical plane. This difficulty should soon disappear as experience is gained, particularly if more attention is given to achieving a straight pull up.

EXERCISE 22 - FORMATION

16. The normal positions are easily flown. The visual reference in echelon are:

a. Front of wing tip and nose of leader's aircraft in line.

b. Abreast leaders elevator hinge line...

EXERCISE 23A. HIGH LEVEL FAMILIARISATION

17. Since there is no restriction on the time spent at altitude the new sequence, 23A has been arranged to make the maximum use of the aircraft at height to demonstrate the effects of altitude on control and manoeuvreability.

18. Physiological Effects.

a. Although the cabin is pressurised it is still vital to check oxygen.

b. The necessity to monitor the cabin pressure differential and the action to take should cabin pressure fail should be fully appreciated by the student.

c. He should also still be made aware of the physiological discomforts which may be mildly experienced and be prepared for the high rates of descent which will affect his ears.

19. Lookout. The problem of empty visual field myopia which decreases the sighting range of other aircraft and also makes judgement of their size and range difficult, should be mentioned.

20. Engine.

a. The Viper engine is normally stall/surge free but at altitude the possibility of this happening does exist. The symptoms and subsequent actions should be fully explained. Many pilots are surprised at the audible indications - a rapid loud metallic hammering. To help reduce the possibility of surge/stall throttle movements must be made smoothly. Students should also be aware that in certain circumstances surge/stall may occur with a constant throttle setting when temperature and IAS are low $(N/\sqrt{\theta})$.

b. In order to conserve the time available at full power the first part of the climb is carried out at the maximum intermediate power setting. Nevertheless care must be taken to keep the use of full power within limits.

21. Navigation. The provision and use of the high level training areas and Upper Air radar services should be discussed.

22. High Level Handling.

a. Steep Turns. The gentle handling required and the necessity for frequent cross reference to instruments should be clearly demonstrated. The need to limit bank in order to maintain IMN will be readily apparent.

The maximum angle of bank which can be sustained is about 45 degrees at .45 Mach.

b. Level Maximum Rate Turns. Because speed is lost so quickly these turns should be entered gently and not prolonged or the speed allowed to reduce below .4M. These turns are flown to demonstrate the poor turning performance at altitude in level flight.

c. High Speed Run and Compressibility Effects. Compressibility effects can be simply demonstrated by attempting to turn the aircraft at .7 Mach. Shock stalling is felt as a high frequency buffet and inability to increase the rate of turn by pulling back on the stick. Recovery from the high speed run by use of the throttle and airbrakes must be done with the wings level to avoid the possibility of overstressing due to the pitch up when the airbrakes are extended. Commence the run above FL 330 to avoid high IAS in the dive with the consequent possibility of inadvertently pulling high 'g'.

d. Descending Maximum Rate Turns. Once the student has seen the 'poor rate' of turn in level flight it should be pointed out that a better rate of turn is produced by increasing speed and sacrificing height. The optimum speed is .5M: at higher IMNS compressibility effects are experienced. Student should realise that the turn can be continued with increasing 'g' and IAS until the aircraft is in the max possible rate turn. It is unnecessary to demonstrate this because of the height loss involved.

e. High Level Aerobatics. Looping and rolling manoeuvres are possible above FL 300 but to reduce the chances of $N/\sqrt{\theta}$ compressor stalling the maximum pull up height for loops should not be higher than FL 250. If done above FL 250 there is the chance of flame-out.

f. Maximum Rate Descent. With the cleaner aircraft the maximum rate descent speed has been increased to .6M until 250 knots. Should cloud penetration be necessary in emergency the attitude on the artificial horizon is steep but adequate.

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