APPENDIX 1

FEEL UNIT TESTING

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

General

1. Prior to installation in the aircraft system, each feel unit is accurately adjusted to provide the control characteristics appropriate to its particular system. To ensure that the required characteristics are maintained after bench servicing, it is necessary for the feel unit to be subjected to the function and calibration checks contained in the Schedule of Tests. These checks are made on the complete feel unit assembly, i.e. consisting of the mechanical and electrical component units. It must be understood that after testing, the feel unit must be retained and subsequently installed in the aircraft as a complete tested assembly.

2. To service and test the feel unit, the operator must be fully conversant with the mechanical and electrical operation of the system. This information is contained in Sect.3, Chap.4 and Sect.5, Chap.1, Group 6 of this publication. The feel unit is shown diagramatically in fig.1.

Feel unit adjustments

3. Due to the mechanical and electrical tolerances in the feel unit, adjustments are provided so that each feel unit can be set to give the correct requirements. The cam can be moved in the slotted mounting holes in the fulcrum lever, and two trimmers identified HIGH SPEED and LOW SPEED respectively, can be used to reset the balance of the wheatstone bridge. The positions of the cam and trimmers are initially determined by first setting the trimmers to their mid positions and then applying a suitable load to the feel unit at each airspeed indicated on the appropriate calibration sheet. The resultant input shaft movement for the load is plotted and must be within the limit lines appropriate to the airspeed. By altering the position of the cam and re-setting the trimmers, the required setting can be obtained. Movement of the cam towards the pivot will normally stiffen the feel. Care must be taken to ensure that the cam does not foul any other part of the unit. The

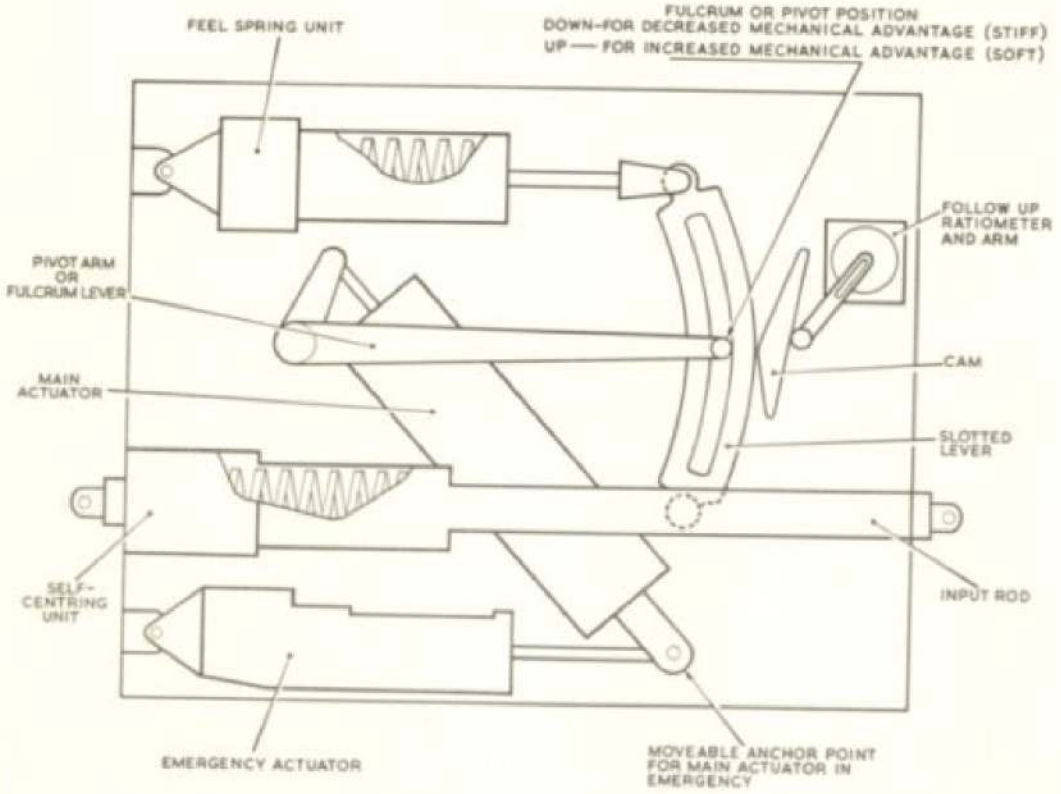


Fig.1. Simplified diagram of feel unit

low speed trimmer will have most effect at low speeds, but it should be understood that any adjustment will alter the feel at all speeds. The sensitivity trimmer should always be set to maximum increase.

4. The stroke of the main actuator is set by the component manufacturer to provide the operating range of the feel unit. The fork end of the actuator is adjustable, the correct setting being generally obtained when the fork end is screwed 2½ turns out. This adjustment is used to ensure that:

(a) Fouling does not occur. With the actuator in the fully extended or retracted positions, the fulcrum pivot must not touch the end of the slot in the slotted lever. With the cam set and the actuator fully retracted, the cam should not force the follow-up ratiometer arm against its stops or against the side of the feel unit.

(b) Maximum and minimum stiffness can be obtained for the elevator and rudder feel units, and maximum and minimum movement between stops for the aileron feel unit.

(c) When fully retracted, the actuator should give a pivot setting which is slightly nearer to the input shaft end of the slotted lever than that obtained when maximum airspeed is applied. The reason for this is that as the input shaft is moved, the fulcrum lever is strained so that the pivot setting deflects upwards toward a position of softer feel. When this occurs, the wheatstone bridge is unbalanced and the actuator further retracts to return the pivot to its original setting. There must therefore be sufficient actuator movement available to enable this resetting to occur at the maximum speed position.

5. No defined procedures can be specified for setting a feel unit, it is only by experience that the operator will learn how to make the desired correction.

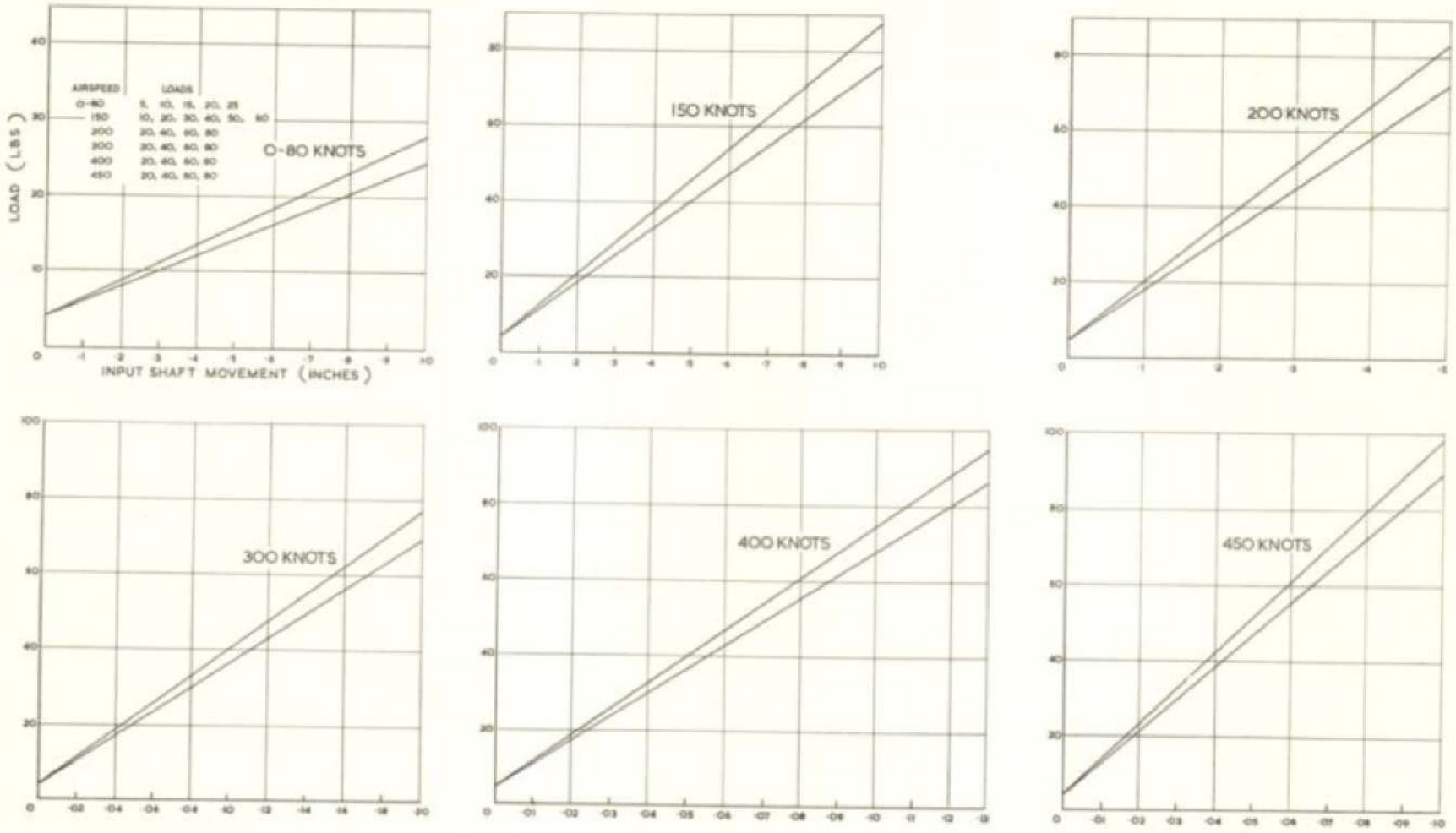


Fig.2. Elevator A.F.U.-Load input/shaft movement limits

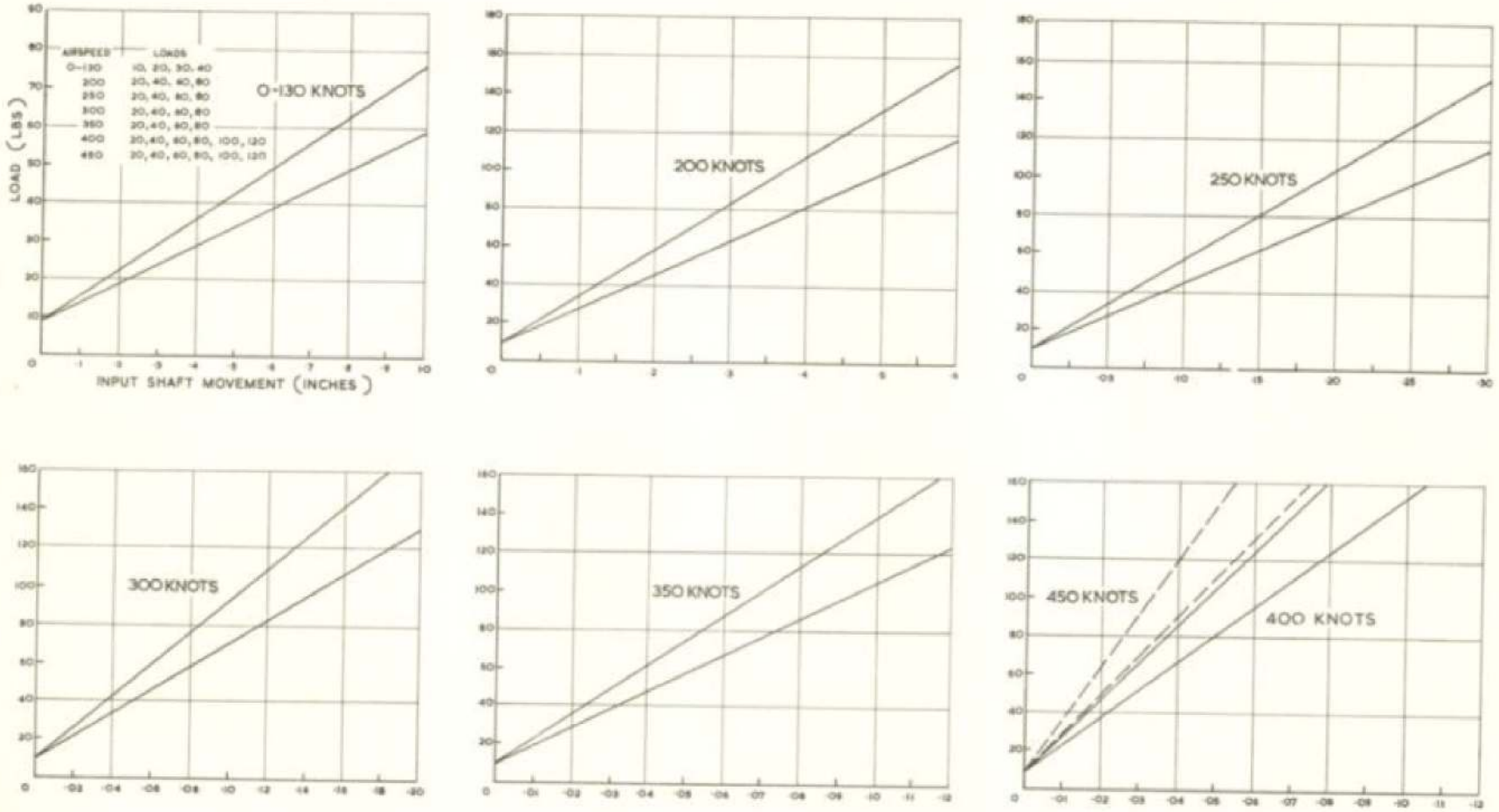


Fig. 3 Rudder A.F.U. Load/input shaft movement limits

SCHEDULE OF TESTS

ELEVATOR AND RUDDER FEEL UNITS

6. Elevator and rudder feel units operate on the same basic principles and are tested in a similar manner. The following paragraphs outline the checks necessary and specify the requirements for both pre. and post Mod.1498 units.

Preparation for test

(1) With the feel unit installed in the calibrator as detailed in Group 8, para.25, proceed as follows:-

(a) Connect a 28 volt supply to the console terminals.

(b) Set the master switch SW.1 to ON.

(c) Set switch SW.2 to FEEL and check that the GREEN indicator lamp lights.

(d) Set switch SW.3 to the RUDDER, ELEVATOR and MK.1 AILERON position.

(e) Set switches SW.4 and SW.5 to OFF.

(f) Set switch SW.6 to NORMAL.

(g) Ensure that the three airspeed control valves are closed.

Cut-in and cut-out speeds

(2) To check the cut-in and cut-out speeds:-

(a) Open the airspeed INCREASE valve slowly until the main actuator commences to operate, and note the indicated airspeed. This is the cut-in speed.

NOTE...
Operation of the main actuator can be heard as a medium pitched hum quite distinct from the high pitched operating noise of the relief actuator.

(b) Continue to increase airspeed slowly until the main actuator stops operating, and note the airspeed. This is the cut-out speed.

(c) Check that the cut-in and cut-out speeds are within the following limits.

	Cut-in	Cut-out
Elevator	80-85	450-465
Rudder	130-137	450-465

Symmetrical loading

(3) Check for symmetrical loading by selecting an airspeed and applying a suitable load to the feel unit, using first the R.H. and then the L.H. weight carrier. Movement of the input shaft in each direction should be the same.

Break out force

(4) To check break out force:

(a) Select zero airspeed.

(b) Load the weight carrier in small increments until the input shaft moves. Check that the applied weight is within the following limits:-

Elevator	4 - 5½ lbs.
Rudder	9 - 11 lbs.

Feel relief check

(5) To check function of the unit under feel relief conditions:-

(a) Select zero airspeed.

(b) Set switch SW.2 to RELIEF. Check that the RED indicator lamp lights, and the relief actuator retracts to a slightly softer feel position, i.e., nearer to the spring unit, before tripping the limit switch.

(c) Set switch SW.2 to FEEL. Check that the GREEN indicator lamp lights, and the relief actuator extends to the normal low speed position.

(d) Set airspeed to 460 knots. Set switch SW.2 to RELIEF. Check that the RED indicator lamp lights and the relief actuator retracts to the feel relief position.

(e) Select switch SW.2 to FEEL and reduce airspeed to zero.

Calibration check

(6) The object of the calibration check is to determine the load/input shaft movement characteristics of the feel unit. The calibration sheets fig.2 elevator, and fig.3 rudder, show the upper and lower limits for input shaft movement at the various airspeed settings. To check calibration:-

(a) Set the dial gauge to zero.

(b) Select the lowest airspeed appropriate to the unit being tested.

(c) Apply PULL loads to the feel unit by loading the appropriate weight carrier in the stages specified on the calibration sheet. Plot input shaft movement for each load. When maximum load is reached remove the load in the same increments as for loading and plot results. Repeat this procedure at each airspeed setting.

(d) Check that the graphs plotted for increasing and decreasing loads at each airspeed setting are within the limit lines shown on the calibration sheet.

(e) Repeat operations (c) and (d) using the opposite hand weight carrier to apply PUSH loads to the feel unit.

Friction check

(7) Friction of the feel unit is checked at the low (pre-cut-in), and high (after cut-out) airspeed setting. A typical plot to determine friction of a rudder unit is shown in fig.6. To check friction:-

(a) Set switch SW.2 to FEEL.

(b) Open the air increase valve to obtain the low speed setting, i.e. 0-80 knots for elevator units, 0-130 knots for rudder units.

(c) Apply PULL loads to the feel unit by loading the appropriate weight carrier in increments of 2 lbs. up to 28 lbs. An initial load of 10 lbs. will be required for rudder units to overcome the break-out force. Unload in the same increments as for loading, and plot load/input shaft movement for each increasing and decreasing load.

(d) Increase airspeed to the high speed setting of 460 knots.

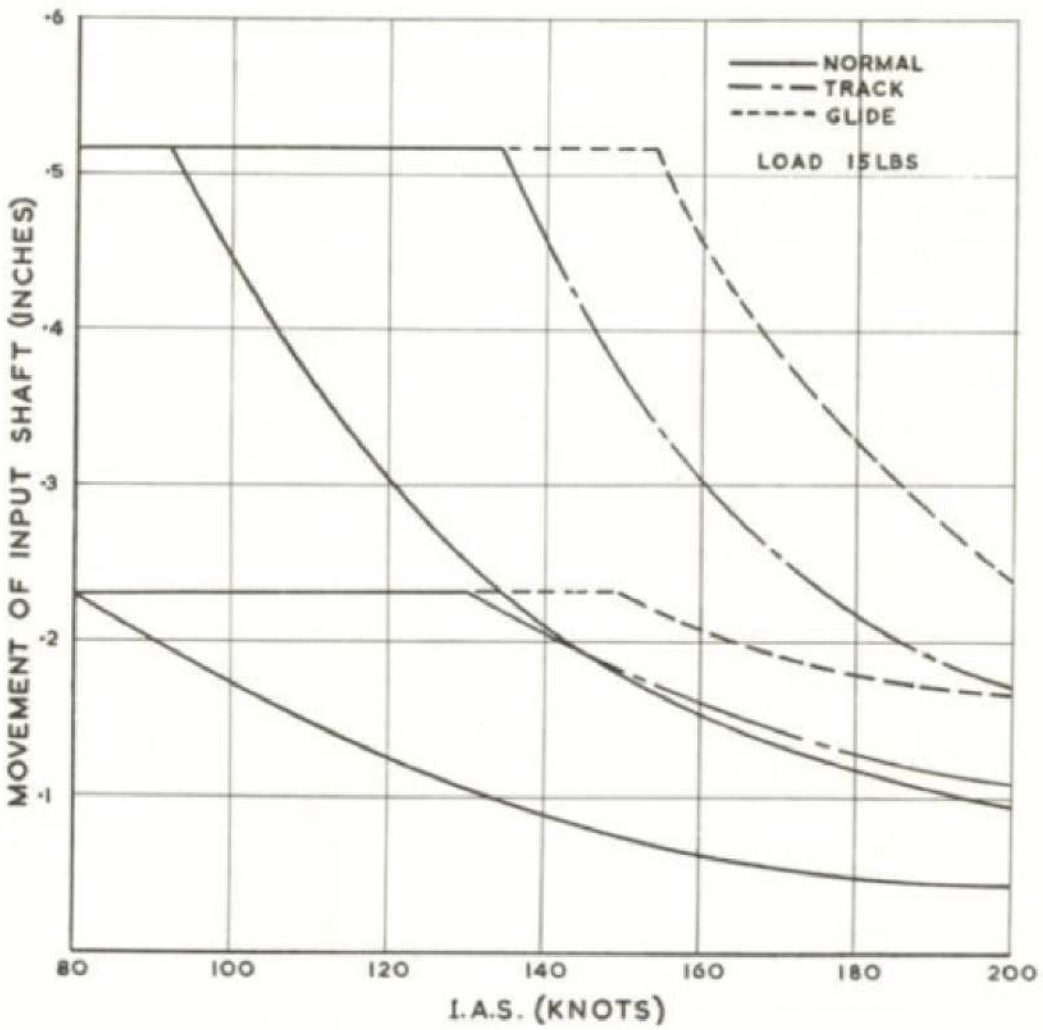


Fig.4 Elevator A.F.U. Track and glide calibration limits

(e) Apply PULL loads to the feel units in 2 lb. increments up to 40 lb., unload by the same amounts and plot results.

(f) Repeat operations (a) to (e) using the opposite hand weight carrier to apply PUSH loads. Friction of the feel unit is equal to half the vertical distance between the increasing and decreasing load curves, and at the 0.1 in. (low speed) and .01 in. (high speed) input shaft movement positions must not exceed: ▶

	Elevator	Rudder
Low speed	½ lb.	1 lb.
High speed	1 lb.	1¼ lb.

Track and glide calibration (elevator only)

(8) During auto-pilot control on an I.L.S. approach, the elevator feel unit is given a degree of relief when TRACK is selected, and is further relieved when GLIDE is selected. To check track and glide calibration:-

◀ (a) Set the controls as in sub-para. 6(1).

(b) Apply a load of 15 lb. to the input shaft.

(c) Increase airspeed from 80 to 200 knots in 10 knot increments, and plot input shaft movement at each speed using calibration sheet, fig.4.

(d) Reduce airspeed to zero, apply the load in the opposite direction and repeat the procedure.

(e) Set switch SW.4 to ON and repeat operations (c) and (d).

(f) Set switch SW.5 to ON, and with switch SW.4 still ON, repeat operations (c) and (d). Check that the graphs plotted are within the limit lines on the calibration sheet.

AILERON FEEL UNITS

7. To check aileron feel units to both pre. and post Mod.1498 standard:- ▶

Preparation for test

(1) With the feel unit installed in the calibrator as detailed in Group 8, para.25, proceed as follows:-

(a) Connect a 28 volt supply to the console terminals.

(b) Set the master switch SW.1 to ON.

(c) Set switch SW.2 to FEEL and check that the GREEN indicator lamp lights.

(d) Set switch SW.3 to the RUDDER ELEVATOR and Mk.1 AILERON position.

(e) Set switches SW.4 and SW.5 to OFF.

(f) Set switch SW.6 to NORMAL.

(g) Ensure that the three airspeed control valves are closed.

Cut-in and cut-out speeds

(2) To check cut-in and cut-out speeds:-

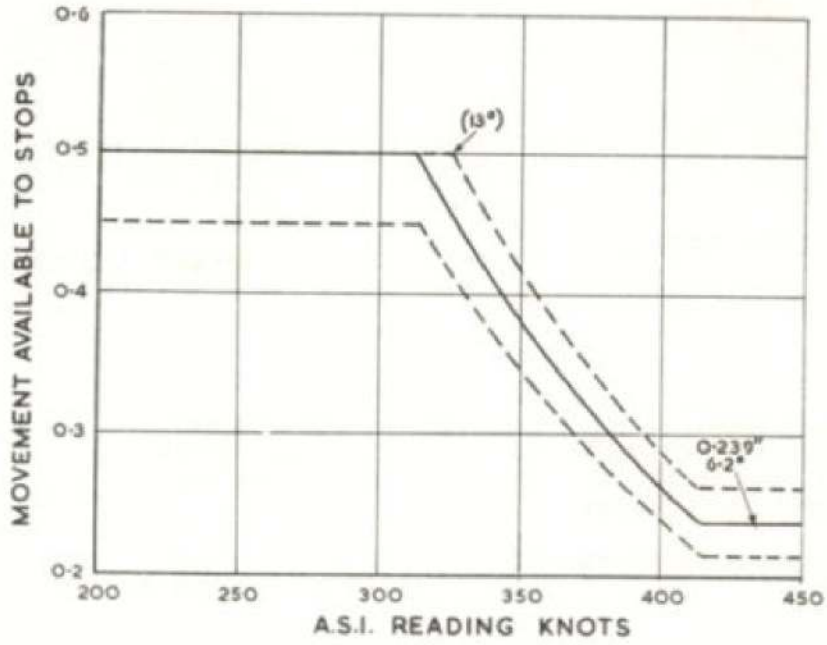
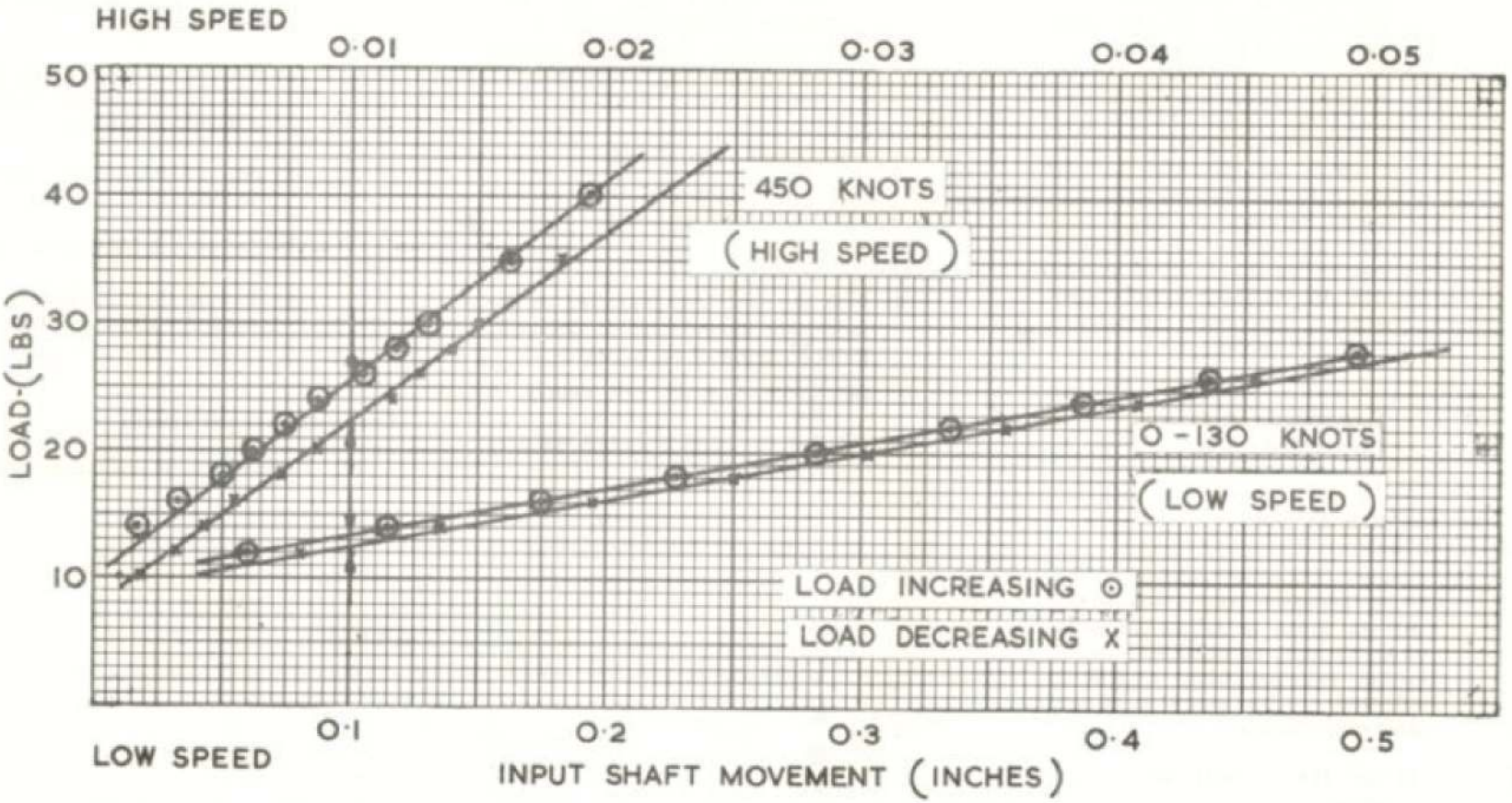


Fig.5 Aileron A.F.U. Airspeed/stop movement limits



◀ FRICTION IS EQUAL TO HALF THE VERTICAL DISTANCE BETWEEN THE LOAD INCREASING AND LOAD DECREASING CURVES MEASURED AT THE 0.10 IN. (LOW SPEED), AND 0.01 IN. (HIGH SPEED) INPUT SHAFT MOVEMENT POSITIONS.

IN THE EXAMPLE SHOWN, FRICTION AT LOW SPEED - ½ lb.
AT HIGH SPEED - 1½ lb. ▶

NOTE . . .
FRICTION OF ELEVATOR AND AILERON A.F.U.'s IS DETERMINED IN A SIMILAR MANNER AT THE APPROPRIATE LOW AND HIGH AIRSPEED SETTINGS.

Fig.6. Typical friction calibration - rudder A.F.U.

(a) Open the air INCREASE valve slowly until the main actuator commences to operate, and note the indicated airspeed. This speed is the cut-in speed and should be between 310-315 knots.

(b) Continue to increase airspeed slowly until the main actuator stops operating, and note the airspeed. This is the cut-out speed and should be between 410-415 knots.

Break out force

(3) To check break out force:-

(a) Select zero airspeed.

(b) Load the weight carrier in small increments and check that the load required to move the input shaft is not more than 3 lb.

Feel relief check

(4) To check function of the unit under feel relief conditions:-

(a) Select zero airspeed.

(b) Set switch SW.2 to RELIEF. Check that the RED indicator lamp lights, and the relief actuator retracts slightly before tripping the limit switch.

(c) Set switch SW.2 to FEEL. Check that the GREEN indicator lamp lights and the relief actuator extends to the normal zero position.

(d) Increase airspeed to 420 knots. Set switch SW.2 to RELIEF and check that the relief actuator retracts to provide unrestricted movement between the stops.

(e) Select switch SW.2 to FEEL and reduce airspeed to zero.

Calibration check

(5) The calibration check is to determine the airspeed/available movement characteristics of the feel unit. The upper and lower limits of movement are shown on the calibration sheet, fig.5. To check calibration:-

(a) Set the dial gauge to zero.

(b) Set airspeed to 325 knots. Depress the balance arm by hand to take up movement between the stops, and record input shaft movement on calibration sheet, fig.5. Repeat at 25 knot intervals throughout the normal speed range.

(c) Repeat operation (b), depressing the balance arm in the opposite direction, and record on a second calibration sheet. Check that the graphs plotted in both directions are within the limit lines.

NOTE...

Movement of the aileron input shaft at low speed is shown as 0·5 in. in each direction and the aileron stops in the aircraft are set to this movement. Any slight excess in the aileron unit will therefore be annulled by the aircraft stops, and this is acceptable providing more satisfactory readings can be obtained.

Friction check

(6) Friction of the aileron unit is determined in a similar manner to that used for elevator and rudder units. To check friction:-

(a) Set airspeed to 300 knots.

(b) Using the appropriate weight carrier for PULL loading, apply loads in 2 lb. increments up to 14 lb. and then unload by the same amounts. Plot load/input shaft movement for each increasing and decreasing load.

(c) Set airspeed to 420 knots.

(d) Apply loads in 1 lb. increments up to 9 lb., unload by the same amounts and plot results.

(e) Repeat operations (a) to (d) using the opposite hand weight carrier to apply PUSH loads. Friction of the feel unit is equal to half the vertical distance between the increasing and decreasing load curves, and at the 0·1 in. input shaft movement positions should not exceed:

½ lb. at 300 knots

¾ lb. at 420 knots