A.P. 2062A—P.N. (3rd Edition)
A.P. 2062C—P.N. (2nd Edition)
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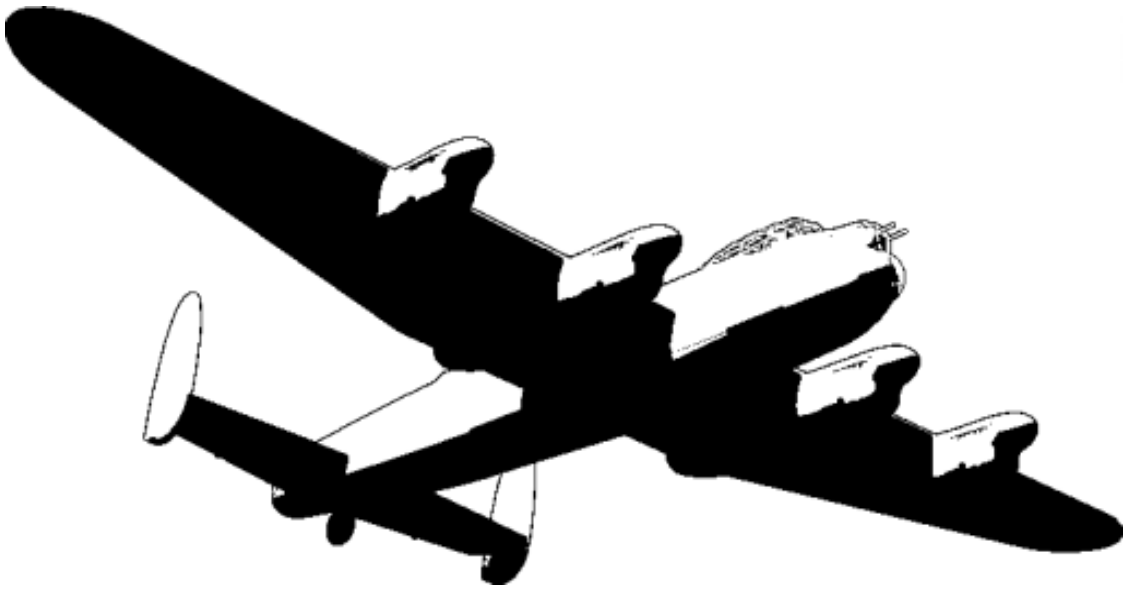
PILOT'S

AND

FLIGHT ENGINEER'S

N O T E S



LANCASTER

MARK I—FOUR MERLIN XX, 22 or 24 ENGINES
MARK II—FOUR HERCULES VI or XVI ENGINES
MARK III & X—FOUR MERLIN 28 or 38 ENGINES

PROMULGATED BY ORDER OF THE AIR COUNCIL

CONTENTS

INTRODUCTION

We present the next product from **Plane Design** - the **Avro Lancaster**. This model includes a fully clickable Virtual Cockpit with fully working controls and instruments with the added realism of animated precipitation effects. Due to the positioning of the radio in the real life cockpit, it has been added as a popup display. The different variants include individual custom xml gauges to reflect the changes in the design.

The external model is highly detailed with reflective skins and is fully animated.

Authentic **Rolls Royce Merlin** engine sounds are included, allowing you to experience the mighty Lancaster to the fullest.

All major components were created using copies of the original **Avro** drawings, and with the assistance of the **Canadian Warplane Heritage Museum**, Hamilton, Ontario, allowing us to produce a truly accurate model.

CREDITS

Visual Models, Gauge Programming	Ed Walters
Sounds, Manual	
Aircraft Textures	Ken Scott & Ed Walters
Flight Dynamics, Testing	Ken Scott
Bubble Sextant	Mark Beaumont & Dave Bitzer
Supercharger gauge	Bill Leaming

SPECIAL THANKS TO:

Martin Mclean at the Canadian Warplane Heritage Museum, for his assistance with photographs and liaison with the museum.
Mark Beaumont and Dave Bitzer for generously allowing the inclusion of their Bubble Sextant.

NOTE REGARDING BUBBLE SEXTANT

The bubble sextant has been included by kind permission of Dave Bitzer and Mark Beaumont. For instructions on how to use the sextant, please consult their Sextant Manual in the "Flight Simulator 9\Plane Design\Sextant Manual" folder. This explains all the procedures required to operate the sextant correctly.

The sextant manual and the celestial almanac are accessible in Flight Simulator through the checklist on the kneeboard.

L A N C A S T E R H I S T O R Y

In 1936, with war clouds gathering, the British Air Ministry issued Specification P13/36, which called for a twin engined medium bomber, capable of carrying a 3,000lb bomb load for 2,000 miles, cruising at 275mph at 15,000 feet. The maximum bomb load was to be 8,000lb. It was also to be capable of dive-bombing, dropping torpedoes, and troop carrying.

A V Roe & Co, Manchester, Handley Page and Hawker submitted designs to meet the criteria. The Avro 679 design for a bomber fitted with two 1,700hp Rolls Royce Vulture engines was selected to be built (although the HP.56 design submitted by Handley Page was developed into the HP.57 Halifax).

The Avro 679, by then named "Manchester" prototype L7426 first flew on July 25th 1939. By then it was clear the Vulture engines were having development difficulties, and they had been de-rated from the original 1,700hp to 1,500hp. It was immediately obvious that the aircraft had directional stability problems, and that it was underpowered.

Avro Manchester prototype, L7426, around the time of its first flight

The design was progressively modified, and entered service with 207 Sqn in November 1940. By that time, Avro's designer, Roy Chadwick, had already decided that the Manchester did not have sufficient development potential, and had decided to replace the two Vultures with four Rolls Royce Merlin XXs.

In the summer of 1940, the Manchester's 90' wing was stretched to 100' (later changed to 102' with a wingtip modification), and the four fuel tanks were replaced by six. Bristol Beaufighter Mk.II's Merlin XX installation was the basis for that used on the Lancaster. The mid upper turret was changed from an FN7a to an FN50, and the rear turret from an FN4 to an FN20. BT308, the first prototype of the Manchester III flew on January 9th 1941, and the design was renamed "Lancaster".

Lancaster prototype BT308

44 (Rhodesia) Sqn received their first Lancasters on 24th November 1941, and first flew operationally on March 3rd 1942, on a mine-laying sortie to Heligoland Bight. The Lancaster leapt into the public eye with the Augsburg raid on Germany. On 17th April 1942, six Lancasters from 44 Sqn and six from 97 Sqn were sent to attack the MAN diesel engine factory at low level in broad daylight. Seven of the aircraft were shot down, and Squadron Leader J Nettleton, the leader of the formation, was awarded the Victoria Cross.

Lancaster B.II in flight

As a precaution against interruptions in the supply of Merlin engines, an alternative of Bristol Hercules engines was used on 300 aircraft. Lancasters so fitted were known as B.IIs. These aircraft had a better

take off and low altitude performance, at the expense of high altitude performance and range. These aircraft entered service from around March 1943.

Lancaster B.III LM446 of 619 Sqn

Packard in America had agreed to produce Merlin engines for Britain and the US, and in 1942, production had been properly established. By late 1942, Lancasters were being produced with Packard Merlin 28s in place of the Rolls Royce built XXs. These aircraft were known as B.IIIs.

Lancasters were incredibly successful as main force bombers due to their good performance and heavy bomb load. The Lancaster had a consistently lower loss rate than its contemporaries - the Halifax and Stirling.

Perhaps the most famous use of Lancasters was on the night of May 16th -17th 1943. Wg Cdr Guy Gibson led 19 Lancasters of 617 Sqn on a daring attack on the Ruhr dams. The B.III Lancasters were modified with cutaway bomb doors to allow the bomb to be mounted under the fuselage. A hydraulic motor was fitted to rotate the bomb at 500rpm and spotlights were fitted under the belly to allow the crews to judge when they were 60' above the water. To offset the increased weight, the mid upper turret was removed.

The Lancasters successfully destroyed two dams, creating a large amount of flooding and some industrial disruption in the Ruhr area. Much manpower was diverted to repair the dams, and defences were placed on the dams to protect them for the rest of the war. Eight Lancasters were lost, with 53 men killed and 3 taken prisoner. For his bravery in action, Gibson was awarded the VC.

In 1944, 617 Sqn and 9 Sqn Lancasters using the "Tallboy" earthquake bomb attacked the German Battleship Tirpitz on several occasions. One strike on 15th September damaged the ship beyond repair, but it was moved to be used as a floating fortress. It was attacked again on 12th November, and hit by two Tallboys, which capsized the ship.

617 Squadron later used the enormous 22,000lb "Grand Slam" bomb to attack bridges and fortifications.

The Lancasters modified for this initially had their mid upper turret removed, two guns removed from their tail turret and one from the nose turret. The bomb bay doors were completely removed and the bomb carried externally. Subsequently, the nose turret was removed and the rear turret returned to its four-gun armament. These Lancasters were designated B.I (Special)

Nine Lancaster B.VIs were produced in 1943 - these were B.III Lancasters fitted with four bladed propellers and two stage Merlins with annular radiators. They saw limited service with 7 Sqn and 635 Sqn.

Lancasters were also produced in Canada under the designation B.X. A pattern aircraft, serial no. R5727 was sent from Britain to Victory Aircraft at Malton, near Toronto, Canada. This aircraft was copied, and on August 1st 1943, the first Canadian Lancaster, KB700, was rolled out. These aircraft had their instrumentation replaced with American components, and they used Packard Merlins, but were essentially the same as British built aircraft - so much so that major assemblies were interchangeable between them. After 155 aircraft had been produced in Canada, the FN50 mid upper turret was replaced with an American built Martin 250CE turret.

After the end of the war in Europe, a force of Lancasters was being built up in preparation for Operation Downfall, the invasion of Japan. The Lancasters for this force, known as the "Tiger Force" were fitted with American radio equipment and were tropicalised for operations from Okinawa. With the dropping of the atomic bomb, the war ended before the deployment of the "Tiger Force" could go ahead.

Some of the "Tiger Force" Lancasters were built to a modified B.I standard, which was renamed the B.VII. These Lancasters had the Martin 250CE mid upper turrets and had the FN20 tail turret replaced with an FN82, with 2 x .50 cal machine guns.

Post war, with the end of lend-lease, many of the allied air forces found themselves without long-range aircraft for maritime patrol, photo mapping and air/sea rescue. Lancasters were pressed into these roles for the French Aeronavale, the Royal Canadian Air Force, and the Royal Air Force. British Lancasters were finally withdrawn in 1956, the French scrapped their fleet in 1962, and the Canadians in 1963.

In total 7,377 were Lancasters built, of which 17 complete airframes exist. Two Lancasters are now airworthy - B.I PA474 with the RAF's Battle of Britain Memorial Flight, and B.X FM213, now registered C-GVRA, operated by the Canadian Warplane Heritage Museum.

AVRO TYPE 683 LANCASTER B.I SPECIFICATION

DIMENSIONS:
Span: 102 ft
Length: 69 ft 5½ in
Height: 17 ft 7 in
Wing Area: 1300 sq ft

POWER PLANT:
Four 1280 hp Rolls Royce Merlin XX/22/24 twelve cylinder vee liquid cooled engines.
Fuel capacity 2,154 Imperial Gallons in 6 wing tanks.

WEIGHTS:
Tare Weight: 37,000 lb
Weight Loaded: 65,000 lb
Wing Loading: 50.10 lb/sq ft
Power Loading: 12.7 lb/hp

PERFORMANCE:
Maximum speed (at 65,000lb): 275 mph at 15,000 ft
Cruising speed (weak mixture): 210 mph at 20,000ft
Service ceiling: 23,000 ft

RANGE (under still conditions at 15,000 ft with no allowance for climb):
With minimum bomb load: 2700 miles

ARMAMENT:
8 Browning .303 machine guns (2 in nose turret, 2 in mid upper turret, 4 in rear turret)
Up to 14,000lb bombs.

CREW:
Pilot, flight engineer, navigator, bomb aimer, wireless operator, two gunners.

HANDLING - MERLIN LANCASTERS

Preliminaries

(i) Switch on undercarriage indicator and flaps indicator switches (if fitted) and check indicators.
Switch on fuel contents gauge switch (if fitted) and leave it on, and check fuel contents.
Check master engine cocks OFF

Starting engines and warming up

(i) Set engine controls as follows:

Master engine cocks	OFF
Throttles	½ in. open
Propeller controls	Fully up
Slow-running cut-out switches	IDLE CUT-OFF
Supercharger control	M ratio (Warning light not showing)
Air intake heat control	COLD
Radiator shutters	Over-ride switches at AUTOMATIC

(ii) Turn tank selector cock to No. 2 tank and turn on the master engine cock of the engine to be started. On Lancasters III and X aircraft the master engine cocks of all other engines which are not running must be OFF.
(iii) Switch on the booster pump in the No. 2 tank to be used.
(iv) Switch on the ignition and booster coil, and press the starter button. Turning periods must not exceed 20 seconds with 30 second wait between each.
(v) When all engines are running satisfactorily, switch off the booster-coil switch.
(vi) Open each engine up slowly to 1,200 r.p.m. and warm up at this speed.

Testing engines and installations

While warming up:

(i) Check temperatures and pressures, and test operation of hydraulic system by lowering and raising flaps and bomb doors-but do not test bomb doors if a bomb load is on board.
(ii) Switch off electric fuel booster pump so as to test engine driven pumps.

After warming up:

NOTE. - The following comprehensive checks should be carried out after repair, inspection other than daily, or otherwise at pilot's discretion. Normally they may be reduced in accordance with local instructions

(iii) Switch radiator shutters over-ride switches to OPEN.
(iv) At 1,500 r.p.m. test each magneto in turn to ensure that no magnetos are unserviceable.
(v) Open up to +4 lb./sq.in. boost and check operation of two-speed supercharger. The red warning light should come on. Return to M ratio.
(vi) At the same boost, check operation of constant speed propeller. R.p.m. should fall to 1,800 with the control fully down.
(vii) Open throttle to take-off position and check take-off boost and r.p.m.
(viii) Throttle back to +9 lb./sq.in. boost; check that r.p.m. fall below 3,000 and if not throttle back until a drop is shown, to ensure that the propeller is non constant speeding. Then test each magneto in turn. The drop should not exceed 100 r.p.m.

Check list before taxying

Navigation lights	On if required
Altimeter	Set
Instrument flying panel	Check vacuum on each pump - 4½ lb./sq.in.
Radiator shutter switches	OPEN
Brake pressure	Supply 250-300 lb./sq.in.

Check list before take-off

Auto controls-	Clutch	IN
	Cock	SPIN
Pitot head heater switch		ON
T - Trimming tabs		Elevator slightly forward
		Rudder neutral
		Aileron neutral
P - Propeller controls		Fully up
F - Fuel		Check contents of tanks
		Master engine cocks ON
		Tank selector cocks to No. 2 tanks
		Crossfeed cock OFF
		Booster pumps in Nos. 1 and 2 tanks ON
Superchargers		MOD
Air intake		COLD
Radiator shutters switches		AUTOMATIC
F - Flaps		15°-20° down

Taking off

(i) Open the throttles to about zero boost against the brakes to see that the engines are responding evenly. Throttle back, release brakes, and open throttles gently checking the tendency to switch to port by advancing port throttles slightly ahead. This will give as good a take off as taking off against the brakes, and renders it easier to correct swing.

(ii) The tail should be raised as quickly as possible after the throttles are fully open and the aircraft eased off the ground at not less than 95 m.p.h. I.A.S. if loaded to 50,000 lb., or 105 m.p.h. if loaded to 60,000 lb.

(iii) Safety speed is 130 m.p.h. I.A.S.

(iv) Raise the flaps at a safe height , not below 500 feet when heavily loaded, and return selector to neutral. Raising flaps causes a nose-down change of trim.

(v) Switch off electric fuel booster pumps of Nos. 1 and 2 tanks after initial climb, but if a warning light comes on or fuel pressure drops below 10 lb./sq.in., switch on No. 2 pumps immediately.

Climbing

(i) The recommended speed for a quick climb is 160 m.p.h. I.A.S. The most comfortable climbing speed is about 175 m.p.h. I.A.S.

(ii) Switch on electric fuel pumps of tanks in use, at any signs of fuel starvation (at approximately 17,000 feet in temperate climates).

General flying

(i) *Stability.*-At normal loadings and speeds, stability is satisfactory.

(ii) *Controls.*-The elevators are relatively light and effective, but tend to become heavy in turns. The ailerons are light and effective, but become heavy at speeds over 260 m.p.h. I.A.S.
The rudders also become heavy at high speeds.

(iii) *Change of trim:*

Undercarriage UP	Slightly nose up
Undercarriage DOWN	Slightly nose down
Flaps up from 25° from fully DOWN	Slightly nose down
Flaps up from 25°	Strongly nose down
Flaps down to 25°	Strongly nose up
Flaps fully DOWN from 25°	Slightly nose up
Bomb doors open	Slightly nose up

(iv) *Flying at low airspeeds.*-Flaps may be lowered about 15°-20°, r.p.m. set to 2,650, and the speed reduced to about 130 m.p.h. I.A.S.

Stalling

(i) Just before the stall, slight tail buffeting occurs.

(ii) There is no tendency for a wing to drop.

(iii) The stalling speeds in m.p.h. I.A.S. at 50,000 lb are:

Undercarriage and flaps up	110
Undercarriage and flaps down	92

Diving

(i) The aircraft becomes increasingly nose heavy in a high-speed dive. The elevator tab control should not be used to help the entry into the dive, but it should be used to trim out the pull necessary in the later stages of the dive.

(ii) The flight engineer should be ready to assist the pilot as required.

Check list before landing

Auto-pilot control cock	SPIN
Superchargers	M (low) ratio
Air intake	COLD
Brake pressure	Supply pressure 250-300 lb./sq.in.
Reduce speed to below 200 m.p.h. and carry out the following drill:	
Flaps	20° down on circuit
U - Undercarriage	DOWN (check by indicator, visually and horn)
P - Propeller	Controls up to at least 2,850 r.p.m.
F - Flaps	DOWN on final approach (handle neutral)
F - Fuel	Booster pumps ON in tanks in use

Approach speeds

Recommended speeds for the approach in m.p.h. I.A.S.:

	45,000lb	55,000lb
Engine-assisted	110	120
Glide	120	130

Mislanding

(i) The aircraft will climb satisfactorily with the undercarriage and flaps down.

(ii) Climb at about 140 m.p.h. I.A.S. and, after raising the undercarriage, start raising the flaps a little at a time, retrimming as necessary.

After landing

(i) Before taxying, raise the flaps and open the radiator shutters.

(ii) The outer engines may be stopped and taxying done on the inners. This is preferable to stopping the inner engines, as the brakes compressor is on the inner engine, and the outer engines are more liable to overheat.

(iii) Before stopping the engines, open the bomb doors for bombing up (if required).

(iv) Switch off all booster pumps before stopping engines.

(v) *Stopping engines, Merlin XX, 22, 24.* With the engines running at 800 r.p.m., turn OFF the master engine cocks and switch OFF the ignition after the engines have stopped.

(vi) *Stopping engines, Merlin 28 or 38.*-To stop an engine check that the air pressure gauge reads at least 130 lb./sq.in. and move the slow-running cut-out switch to the IDLE CUT-OFF (down) position with the engine running at about 800 r.p.m. Then switch off the ignition and leave the slow-running cut-out switch in the IDLE CUT-OFF (down) position.

When all engines have been stopped, turn off master engine cocks, check again that all booster pumps are OFF, and then return the slow-running cut-outs to the ENGINE RUNNING position.

(vii) Switch off all electrical switches.

O P E R A T I N G D A T A - M E R L I N

Engine data-Merlin 24

Engine limitations with 100 octane fuel:

		R.p.m.	Boost lb.sq./in	Temp. °C. Cyldr.	Oil
MAX. TAKE-OFF TO 1,000 FEET	. . M	3,000	+18		
MAX. CLIMBING	. . M	2,850	+9	125	90
1 HOUR LIMIT	. . S				
MAX.	. . M	2,650	+7	105	90
CONTINUOUS	. . S				
COMBAT	. . M	3000	+18	135	105
5 MINS. LIMIT	. . S				

Engine data-Merlin 38

Engine limitations with 100 octane fuel:

		R.p.m.	Boost lb.sq./in	Temp. °C. Cyldr.	Oil
MAX. TAKE-OFF TO 1,000 FEET	. . M	3,000	+14		
MAX. CLIMBING	. . M	2,850	+9	125	90
1 HOUR LIMIT	. . S				
MAX.	. . M	2,650	+7	105	90
CONTINUOUS	. . S				
COMBAT	. . M	3000	+14	135	105
5 MINS. LIMIT	. . S	3000	+16	135	105

Flying limitations

(i) The aircraft is designed for manœuvres appropriate to a heavy bomber and care must be taken to avoid imposing excessive loads in a recovery from dives and turns at high speed. Spinning and aerobatics are not permitted.
Violent use of the rudder should be avoided at high speeds.

(ii) *Maximum speeds in m.p.h. I.A.S.*
Diving: 360
Bomb doors open: as for diving
Undercarriage down: 200
Flaps down: 200

(iii) *Maximum weights:*

Take-off and straight flying 65,000 lb.
Landing and all forms of flying 55,000 lb.
Flying should be restricted to straight and level until weight is reduced to 63,000 lb.

(iv) *Bomb clearance angles:*

Dive	30°
Climb	20°
Bank	10° (with S.B.C. 25°)

Maximum performance

Climbing: 160 m.p.h. I.A.S. to 12,000 ft.
155 m.p.h. I.A.S. from 12,000 to 18,000 ft.
150 m.p.h. I.A.S. from 18,000 to 22,000 ft.
145 m.p.h. I.A.S. above 22,000 ft.

Maximum range

(i) *Climbing*.-160 m.p.h. I.A.S. at +7 lb./sq.in. boost, and 2,650 r.p.m.

(ii) *Cruising.* (including descent).

(a) Fly in M ratio at maximum obtainable boost not exceeding +4 lb./sq.in. obtaining the recommended airspeed by reducing r.p.m., which may be as low as 1,800 if this will give the recommended airspeed. Higher speeds than those recommended may be used if obtainable in M ratio at the lowest possible r.p.m.

(b) The recommended speeds are

Fully loaded (outward journey)

Up to 15,000 ft.,	170 m.p.h. I.A.S.
At 20,000 ft.	160 m.p.h.

Lightly loaded (homeward journey):
160 m.p.h. I.A.S.

(c) Engage S ratio when the recommended speed cannot be maintained at 2,500 r.p.m. in M ratio.

(iii) The use of warm intakes will reduce air miles per gallon considerably. On this installation there is no need to use warm air unless intake icing is indicated by a drop of boost.

Fuel capacity and consumptions

(i) *Capacity.*- Two No. 1 tanks .. 1,160 gallons
Two No. 2 tanks .. 766 gallons
Two No. 3 tanks .. 228 gallons
Total .. 2,154 gallons

(ii) *Weak mixture consumptions, Merlin 24:*

The following figures are the approximate total gallons per hour and apply in M ratio between 8,000 and 17,000 feet, and in S ratio between 14,000 and 25,000 feet.

Boost lb./sq.in.	R.P.M.				
	2,650	2,400	2,200	2,000	1,800
+7	240	235	217	200	-
4	216	204	196	180	-
2	196	184	176	164	-
0	172	164	156	144	128
-2	148	140	128	124	112
-4	124	120	108	104	96

(iii) *Weak mixture consumptions, Merlin 38:*

The following figures are the approximate total gallons per hour and apply in M ratio between 8,000 and 17,000 feet, and in S ratio between 14,000 and 25,000 feet.

Boost lb./sq.in.	R.P.M.				
	2,650	2,400	2,200	2,000	1,800
+7	240	235	217	200	-
4	216	204	196	180	-
2	196	184	176	164	-
0	172	164	156	144	128
-2	148	140	128	124	112
-4	124	120	108	104	96

(iv) *Rich mixture consumption, Merlin 24:*

Boost lb./sq.in.	R.p.m.	Total gallons per hour
+14	3,000	500
+12	3,000	460
+9	2,850	380

(v) *Rich mixture consumption, Merlin 38:*

Boost lb./sq.in.	R.p.m.	Total gallons per hour
+9	2,850	420

HANDLING - HERCULES LANCASTERS

Preliminaries

(i) Switch on fuel contents gauge switch and leave it on, and check fuel contents.
(ii) Switch on undercarriage indicator and flaps indicator switches and check indicators.

Starting engines and warming up

(i) Turn on the engine master cocks and test the performance of the fuel booster pumps with the fuel pressure warning lights, thus priming the carburettors.
(ii) Set engine controls as follows:

Throttles	½ in. open
Mixture control (if fitted)	NORMAL
Propeller controls	Fully up
Supercharger control	M ratio (warning light not showing)
Air intake heat control	COLD
Cowling gills	OPEN

(iii) Have each engine turned slowly by hand for at least two revolutions of the propeller, to avoid the danger of hydraulicing.
(iv) Switch on the electric booster pump in the No. 2 tank to be used.
(v) Switch on the ignition and booster coil, and press the starter button. Turning periods must not exceed 20 seconds with 30 second wait between each.
(vi) When all engines are running satisfactorily, switch off the booster-coil switch.
(vii) Open each engine up slowly to 1,000 r.p.m. and warm up at this speed.

Testing engines and installations

While warming up:

(i) Check temperatures and pressures, and test operation of hydraulic system by lowering and raising flaps.
(ii) Switch off electric fuel booster pump so as to test engine driven pumps.

After warming up:

NOTE. - The following comprehensive checks should be carried out after repair, inspection other than daily, or otherwise at pilot's discretion. Normally they may be reduced in accordance with local instructions

(iii) Open up to 1,500 r.p.m. with propeller switch at AUTO and check that no magneto is completely unserviceable.
(iv) At 1,500 r.p.m. exercise and check operation of two-speed superchargers. Warning light should come on when S ratio is engaged.
(v) At +2 lb./sq.in. boost, check response of the propeller to movement of the lever.
(vi) Open throttle, and check take-off boost and static r.p.m., which should be 2,800.
(vii) Throttle back to +6 lb./sq.in. boost and test each magneto in turn. The momentary drop should not exceed 50 r.p.m. (The r.p.m. will be restored to 2,800 by the C.S.U.)

Check list before taxying

Entrance door	Fastened
Pressure head	Cover removed and heater switch ON

Auto controls- Clutches	IN
Control Cock	SPIN
Instrument flying panel	Check vacuum on each pump.
Brake pressure	Supply 250-300 lb./sq.in.

Check list before take-off

T - Trimming tabs	Elevator slightly forward
	Rudder and aileron neutral
M - Mixture control	NORMAL
Air intake	COLD
P - Propeller controls	Fully up
F - Fuel	Master engine cocks ON
	Tank selector cocks to No. 2 tanks
	Crossfeed cock OFF
	Fuel Booster pumps:
	No. 2 pumps only ON
F - Flaps	15°-20° down
Superchargers	M (low) ratio
Gills	Closed or 1/3rd open

Taking off

(i) Open the throttles to about 2,000 r.p.m. against the brakes, then release the brakes and open throttles fully with the starboard slightly ahead. There is a slight tendency to swing to starboard, but this can be checked initially on the throttles and, as speed increases, by the rudders.

(ii) The aircraft should be eased off the ground at not less than 95 m.p.h. I.A.S. if loaded to 50,000 lb., or 105 m.p.h. if loaded to 60,000 lb.

(iii) Safety speed is 130 m.p.h. I.A.S.

(iv) Raise the flaps at not below 800 feet when heavily loaded, and return selector to neutral. Raising flaps causes a nose-down change of trim.

(v) Switch off electric fuel booster pumps of No. 2 tanks after initial climb, but if a warning light comes on, switch on the pumps immediately.

Climbing

(i) The recommended speed for a quick climb is 155 m.p.h. I.A.S but this should be increased if cylinder temperatures become excessive. The most comfortable climbing speed is about 175 m.p.h. I.A.S.

(ii) Switch on electric fuel pumps of tanks in use, at any signs of fuel starvation (at approximately 17,000 feet in temperate climates).

General flying

(i) *Stability*.-At normal loadings and speeds, stability is satisfactory.

(ii) *Controls*.-The elevators are relatively light and effective, but tend to become heavy in turns. The ailerons are light and effective, but become heavy at speeds over 260 m.p.h. The rudders also become heavy at high speeds.

(iii) *Change of trim:*

Undercarriage UP (20 seconds): slightly nose up

" DOWN (40 seconds)	slightly nose down
Flaps up from 25° from fully DOWN:	slightly nose down
" up from 25°:	strongly nose down
" down to 25°:	strongly nose up
" fully DOWN from 25°:	Slightly nose up
Bomb doors open:	Slightly nose up

(iv) *Flying at low airspeeds*.-Flaps may be lowered about 15°-20°, r.p.m. set to 2,650, and the speed reduced to about 130 m.p.h. I.A.S.

Stalling

(i) There is no tendency for a wing to drop.

(ii) The stalling speeds in m.p.h. I.A.S. at 50,000 lb are:

Undercarriage and flaps up	110
Undercarriage and flaps down	92

Diving

The aircraft becomes increasingly nose heavy in a high-speed dive. The elevator tab control should not be used to help the entry into the dive, but it should be used to trim out the pull necessary in the later stages of the dive.

Check list before landing

Auto controls: control cock	SPIN
Superchargers	M (low) ratio
Air intake	COLD
Gills	One third open.
Brake pressure	Supply pressure 250-300 lb./sq.in.
Reduce speed to below 200 m.p.h. I.A.S.	
U - Undercarriage	DOWN (check by indicator and horn)
M - Mixture control	NORMAL
P - Propeller	Controls fully up.
F - Flaps	20° down on circuit
	DOWN on final approach (handle neutral)
F - Fuel	Booster pumps ON in tanks in use

Approach speeds

Recommended speeds for the approach in m.p.h. I.A.S.:

	45,000lb	55,000lb
Engine-assisted	110	120
Glide	120	130

Mislanding

(i) The aircraft will climb satisfactorily with the undercarriage and flaps down.

(ii) Climb at about 140 m.p.h. I.A.S. and, after raising the undercarriage, start raising the flaps a little at a time, retrimming as necessary.

After landing

(i) Before taxying, raise the flaps and open the gills.

(ii) The outer engines may be stopped and taxying done on the inners. This is preferable to stopping the inner engines, as the brakes compressor is on the starboard inner engine.

(iii) Open the bomb doors for bombing up (if required).

(iv) *Shutting down procedure:*

(a) Open up gradually and evenly, and run the engine for about 5 seconds at -2 lb./sq.in. boost.

(b) Close the throttle slowly and evenly taking about 5 seconds until speed is reduced to 800-1000 r.p.m.

(c) Run at this speed for a further two minutes.

(d) Operate the slow-running cut-outs by turning OFF the master engine cocks and, when the engine has stopped, switch OFF ignition. Should a backfire occur at any stage the above procedure should be repeated.

(v) Switch off

Pressure head heater switch
Undercarriage indicator switch
Flaps indicator switch
Fuel contents gauge switch

O P E R A T I N G D A T A - H E R C U L E S

Engine data-Hercules VI and XVI

Engine limitations with 100 octane fuel:

		R.p.m.	Boost lb.sq./in	Temp. °C. Cyldr.	Oil
MAX. TAKE-OFF TO 1,000 FEET	. . M	2,800	+8¼		
MAX. CLIMBING	. . M	2,400	+6	270	90
1 HOUR LIMIT	. . S	2,500			
MAX. RICH	. . M	2,400	+6	270	80
CONTINUOUS	. . S				
MAX. WEAK	. . M	2,400	+2	270	80
CONTINUOUS	. . S				
COMBAT	. . M	2,800	+8¼	280	100
5 MINS. LIMIT	. . S				

Flying limitations

(i) The aircraft is designed for manœuvres appropriate to a heavy bomber and care must be taken to avoid imposing excessive loads in a recovery from dives and turns at high speed. Spinning and aerobatics are not permitted.
Violent use of the rudder should be avoided at high speeds.

(ii) *Maximum speeds in m.p.h. I.A.S.*
Diving: 360.
Bomb doors open: 360.
Undercarriage down: 200.
Flaps down: 200.

(iii) *Maximum weights:*

Take-off and straight flying	63,000 lb.
All forms of flying	55,000 lb.
Landing	56,000 lb.

(iv) *Bomb clearance angles:*

Dive	30°
Climb	20°
Bank	10° (with S.B.C. 25°)

Maximum performance

Climbing: 155 m.p.h. I.A.S. to 12,000 ft.
150 m.p.h. I.A.S. from 12,000 to 17,000 ft.
145 m.p.h. I.A.S. above 17,000 ft.

Maximum range

(i) *Climbing*.-Use same conditions as for maximum performance.

(ii) *Cruising.* (including descent).

(a) Fly in M ratio at maximum obtainable boost not exceeding +2 lb./sq.in. obtaining the recommended airspeed by reducing r.p.m., which may be as low as 1,600 if this will give the recommended airspeed, but if rough running is experienced increase r.p.m. as necessary to about 1,900 and do not alter the throttle setting. In these circumstances an airspeed above the recommended will give practically no reduction in range. *Higher speeds than those recommended may be used if obtainable in M ratio at the lowest possible r.p.m.*

(b) The recommended speeds are

Fully loaded, outward journey (over 18,000 ft. reduce as necessary to a minimum of 150 m.p.h. I.A.S.)	165 m.p.h. I.A.S.
Lightly loaded, homeward journey	160 m.p.h. I.A.S.

(c) Engage S ratio when the recommended speed cannot be maintained at 2,300 r.p.m. In M ratio.

Fuel capacity and consumptions

(i) *Capacity*.- Two No. 1 tanks 1,160 gallons
Two No. 2 tanks 766 "
Two No. 3 tanks 228 "
Total = 2,154 "

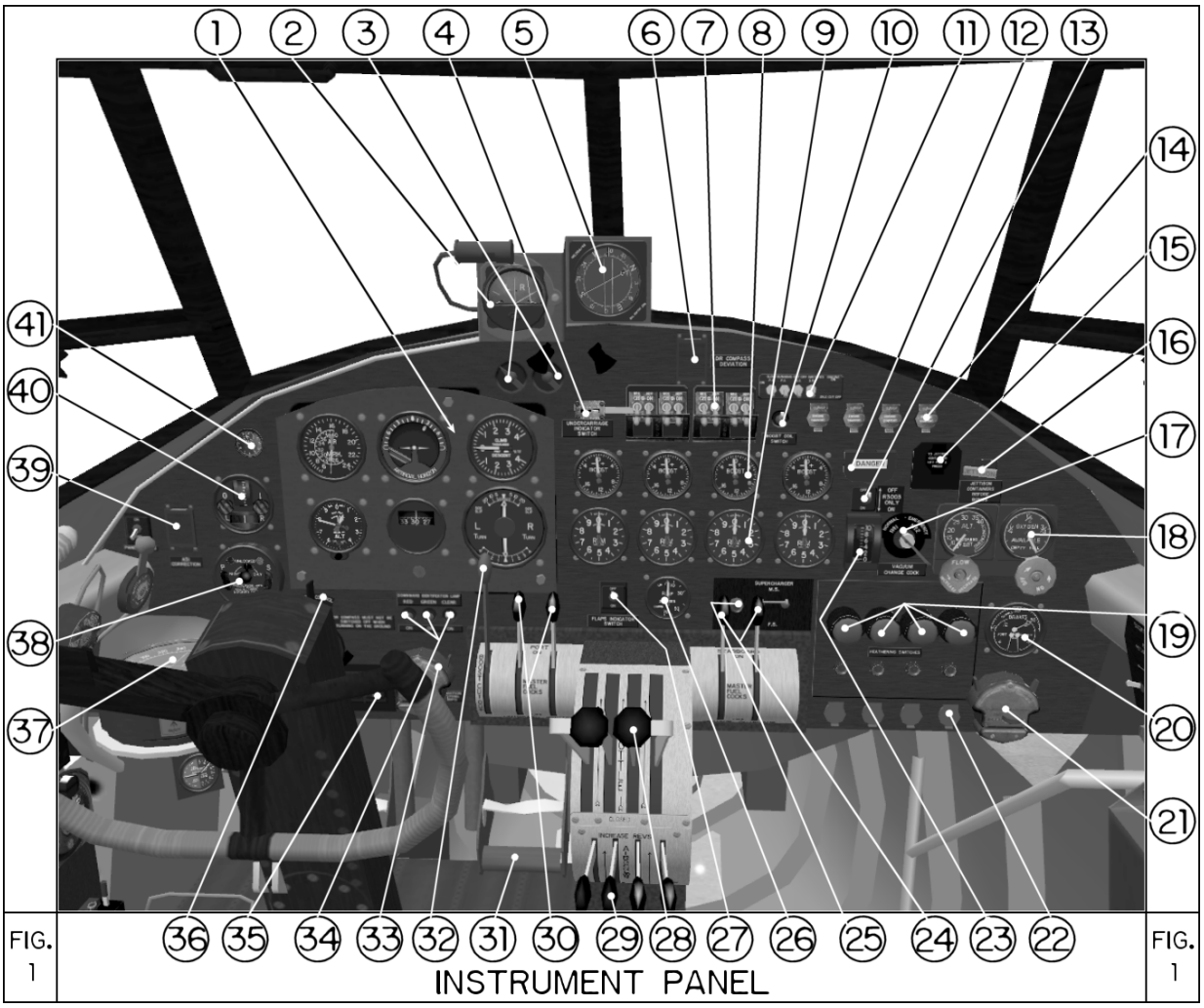
(ii) *Rich mixture consumptions (approximate).*-M ratio at 5,000 ft.

R.p.m.	Boost lb./sq.in.	Approx. total consumption gals./hr.
2,800	+8¼	640
2,400	+6	478

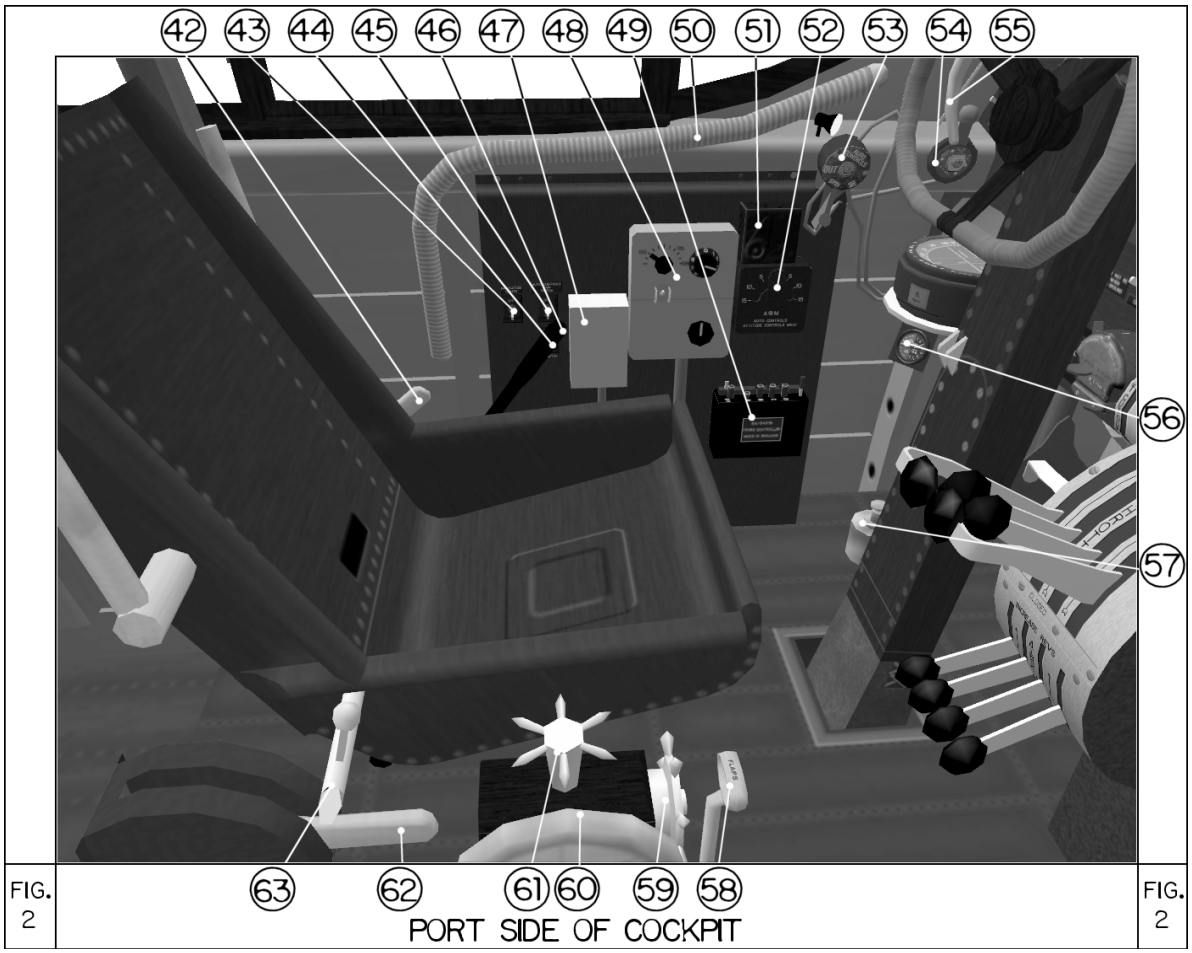
(iii) *Weak mixture consumptions (approximate)* in gals./hr.

Boost lb./sq.in.	*M ratio at 5,000 ft.* R.p.m.				*S ratio at 15,000 ft.* R.p.m.			
	2,400	2,200	2,000	1,800	2,400	2,200	2,000	1,800
+2	236	220	204	188	232	220	212	192
0	212	196	184	160	208	200	192	176
-2	188	176	164	148	188	180	172	160
-4	168	160	148	136	172	164	156	-

LOCATION OF CONTROLS



1. Instrument flying panel.
2. D.F. Indicator.
3. Landing light switches
4. Undercarriage indicator switch.
5. D.R. compass repeater.
6. D.R. compass deviation card holder.
7. Ignition switches.
8. Boost gauges
9. R.p.m. indicators.
10. Booster coil switch.
11. Slow-running cut-out switches (Mk. III and X only)
12. I.F.F. detonator buttons.
13. I.F.F. switch.
14. Engine starter switches.
15. Bomb containers jettison button.
16. Bomb jettison control.
17. Vacuum change-over cock.
18. Oxygen regulator.
19. Feathering buttons.
20. Triple pressure gauge.
21. Signalling switchbox (non functioning).
22. Fire-extinguisher push buttons (non functioning)
23. Suction gauge.
24. Starboard master engine cocks.
25. Supercharger gear change control panel.
26. Flaps position indicator.
27. Flaps position indicator switch.
28. Throttle levers.
29. Propeller speed control levers.
30. Port master engine cocks.
31. Rudder pedal.
32. Boost control cut-out (non functioning)
33. Signalling switchbox (recognition lights)
34. Identification lights switches.
35. D.R. compass switches (non functioning)
36. Auto controls steering lever.
37. P.4 compass.
38. Undercarriage position indicator.
39. A.S.I. correction card holder.
40. Beam approach indicator.
41. Watch holder.



42. Bomb doors control.
43. Navigation lights switch.
44. D switch.
45. Auto controls main switch.
46. Seat raising lever.
47. Mixer box.
48. Beam approach control unit.
49. Pushbutton unit for T.R.1196 (non functioning)
50. Oxygen connection.
51. Pilot's call light.
52. Auto controls attitude control unit.
53. Auto controls cock.
54. Auto controls clutch.
55. Brake lever.
56. Auto controls pressure gauge.
57. Windscreen de-icing pump.
58. Flaps selector.
59. Aileron trimming tab control.
60. Elevator trimming tab control.
61. Rudder trimming tab control.
62. Undercarriage control lever.
63. Undercarriage control safety bolt

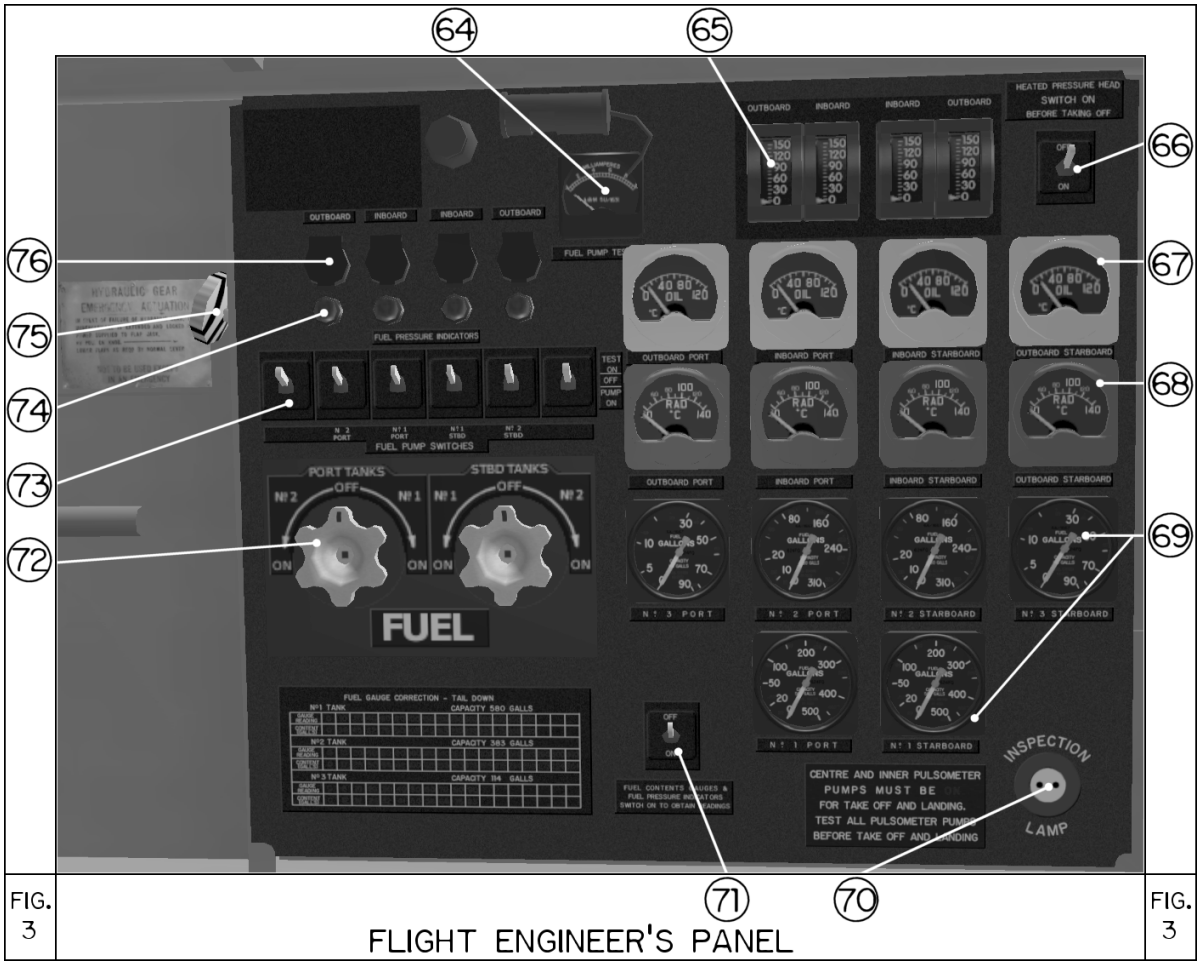


FIG. 3 — FLIGHT ENGINEER'S PANEL — FIG. 3

64. Ammeter
65. Oil pressure gauges
66. Pressure-head heater switch
67. Oil temperature gauges
68. Coolant temperature gauges
69. Fuel contents gauges
70. Inspection lamp socket
71. Fuel contents gauge switch
72. Fuel tank selector cocks
73. Fuel transfer switches
74. Fuel pressure warning lights
75. Emergency air control
76. Oil dilution buttons (non functioning)

CONTROLS NOT SHOWN:

Cross feed cock — Front spar cover, under step
Carburettor Heat — On floor at left of pilot's seat
Radiator shutter switches — On starboard cockpit wall

F U E L S Y S T E M E X P L A I N E D

The fuel system in the real **Lancaster** had 3 tanks in each wing.
The engines only drew fuel from the no.1 and no.2 wing tanks; fuel could only be transferred from the no.3 into the no. 2 tanks.

Due to the limitations in FS2004's fuel systems modelling, we have been forced to compromise. The main fuel selector taps allow the selection of the no. 1 and no. 2 tanks (as per the real aircraft), however, when the fuel transfer switches are selected, the engines feed no. 3 tanks, as outlined by the table below.

Fuel tap position	Fuel transfer switch	Tank in use
1	Off	1
2	Off	2
2	On	3

When no.3 tanks are exhausted, the system will automatically switch back to the no.2 tanks.

C O N T R O L S & I N S T R U M E N T S D E S C R I B E D

As the Lancastrian instrumentation is unlike most modern instrumentation, a short description of some of the instruments and controls follows.

1. The "**Automatic Pilot Mk. IV"** is represented in this model with the clutch permanently engaged, and the control cock can be selected in either the **IN** or **SPIN** positions. When the control is put in the "**IN**" position, the autopilot is engaged. The autopilot will keep the wings level and maintain attitude. To adjust the attitude, the hand control on the left panel can be used. To make turns, switch on the Autopilot main switch, and then use the autopilot steering control to turn left or right. When the turn is completed, switch the Autopilot main switch off.

2. The "**STANDARD BEAM APPROACH**" system was similar to the ILS system in modern aircraft, and we have modelled it to use the ILS signals in FS2004. The light on the left marked "**O**" is the Outer Beacon marker, and the one marked "**I**" is the Inner Beacon marker. The vertical needle at the bottom shows the lateral offset from the runway centreline and the horizontal needle shows the vertical offset from the glideslope. These needles operate in the same sense as in a conventional ILS gauge, i.e. the needle shows the direction to fly to get onto the glideslope and runway centreline.

The two knobs on the grey SBA control box to the left of the pilot's seat set the ILS frequency. The knob on the left selects the integers of the frequency, and the knob on the right sets the fractions.
E.g. 112.250Mhz - the 112 is set with the left knob, and the .250 is set with the right hand knob.

3. The "**DF INDICATOR**". This gauge will allow you to home on an ADF beacon. To home on a beacon, tune the main radio (Shift+5) to the frequency of the beacon. Unless you are pointing directly at the beacon, the needles will flick over to one side, with one needle almost horizontal, and the other needle vertical. Turn towards the vertical needle, i.e. if the right needle is vertical, turn to starboard. Eventually the needles should settle down so they are crossed over the yellow centre line.

4. The "**BRAKE TRIPLE PRESSURE GAUGE"** shows the air pressure to each wheel brake, and the large needle shows the system air pressure.

5. The "**SUPERCHARGER CONTROL PANEL"** controls the two speed superchargers for the Merlin engines. When the engine boost drops off due to an increase in altitude, the FS supercharger gear can be engaged to increase the boost again. This should not be used until the boost has fallen by 3 lb./sq.in. on Merlin Lancasters and 4¼ lb./sq.in. on Hercules Lancasters.
The warning light will be lit if the undercarriage is down and the supercharger is in FS gear.

SPECIAL MODEL FEATURES

A few special animations on this model that you may not otherwise notice.

1. The arm-rests on the pilots seat will flip up if you click them.

2. If you click the sliding windows on the cockpit, they will open

3. The engineer's seat and seat back will fold if clicked.

4. The bomb doors are operated using the spoilers key (by default "/"). On the Dam buster this makes the bomb revolve.

5. The sun-screen on the top of the cockpit slides if clicked and dragged.

6. On the Dam Buster, turn on the taxi lights (shift + L) to see the height setting spotlights.

C O P Y R I G H T