

MICROSOFT FLIGHT SIMULATOR 2004

Tupolev Tu-124



SCS and Samdim Design

December 2006

1 TUPOLEV TU-124 ADD-ON FOR FS2004

Soviet Classics Simulation and Samdim Design are proud to present Tupolev Tu-124 for Microsoft Flight Simulator 2004. This is a complete package, independent from any other add-on.

1.1.1 Team

Mikhail Mitin (Wishmaster) - panel design, gauge programming, textures, Russian documentation;
 Dimitri Samborski (Samdim) - visual model, textures, sounds, English documentation, packaging;
 Oleg Tchernikov (Aleck) - flight dynamics, documentation;
 Igor Borodin (Arhangel), Vasili X (RVA84), Dmitry Shevtsov (SheV), Nikolai Samsonov (INS) - textures;
 Nick Sharmanzhinov (except), Alexei Litvinov (lial) - gauge programming, cabin soundset;
 Igor Borozdin (Bor) - RSB system programming;
 Pavel Usachev - sound recording;
 Nick Efimov (Frankie B) - English translation.

1.1.2 Visual model

There is no virtual cockpit in the model, though dynamic wing views are available.
 The model contains all the standard animations plus a number of custom ones:

- all the control surfaces are animated
- gears animations
- the main gear undercarriage stays parallel to the ground independently from the plane pitch
- spoilers (inoperant in flight)
- passenger and cargo doors (half-close when the plane is moving)
- landing lights deployment (use the dedicated switch)
- braking shield (deploys after the flaps are full out)
- braking parachute (use the dedicated button)
- window curtains close on the sunny side of the plane (only when the sun is not too high)

1.1.3 Textures

Any repaints are welcome. If you decide to make your own repaint, you don't need to ask a special permission from us - just paint and share.

1.1.4 Support

Check regularly the SCS homepage <http://tu-124.argo-khabarovsk.ru> for updates, repaints, new utilities etc.

2 DESCRIPTION

The short-range passenger aircraft Tupolev Tu-124 was a further development of the first soviet passenger jet Tu-104. The passenger capacity is 44-56, the range : 2100 km (1134 nm) and the cruise speed about 750-850 km/h (405-460 kts). It was built at Kharkiv aircraft factory N° 135, Ukraine. In total 165 aircraft were built from May 1961 to March 1968. Aeroflot used the Tu-124 from October 1962 to December 1979.

The engines are double-flow turbofans Soloviev D-20P with the thrust 5500 kgs (54 kN – 12140 lb) each. When needed, the emergency power boost system can increase the thrust to 5800 kgs (56.9 kN – 12790 lb).

2.1 HISTORY

2.1.1 Birth

In July 1958, Tupolev Design Bureau began developing a new regional airliner that would replace aging piston aircraft Lisunov Li-2 and Ilyushin Il-14. In order to simplify development of the new aircraft, Tupolev decided to use the same scheme as used on the Tu-104, the first Soviet jet airliner. Essentially, most of the aircraft's elements were simply reduced in size by 25%. However, that also meant that the new aircraft would inherit the aerodynamic flaws of the Tu-104.

However, the Tu-124 was not just a down-scaled Tu-104. For the first time in the USSR, the plane was powered by turbofans. Other novelties were spoilers, double-slot flaps, a braking shield and exhaust gas silencers. According to the decision of Council of Ministers on 18 July, 1958, the development of this aircraft was started. A possibility of re-equipment Tu-124 under the airport conditions for the transportation of injured, soldiers and servicemen was also prescript. The plane thought to be less noisy with the use of new turbofans D-20P with lower exhaust temperature. More rigid wing design was supposed to reduce turbulence shudder.

2.1.2 First flights

The first prototype was built in January 1960. The registration number was CCCP-45000. On March 24, 1960 captain A.Kalina and his crew made the maiden flight on the Tu-124. The tests and certification flights lasted two and a half years, 20 aircraft were built during this period by Kharkiv aircraft factory. Finally, the Aeroflot CCCP-45013 was the first to enter regular service on October 22, 1962 on the route Moscow (Vnukovo) – Tallinn. A special terminal was built in Vnukovo airport to receive Tu-124s, later it was rearranged to receive only governmental flights.

On November 10 1962, the second route from Moscow to Ulianovsk was introduced. New routes to Gorki (December 1962) and to Stavropol (January 1963) were opened thereafter. In the end of 1963, the Tu-124s were flying between eleven soviet cities.

2.1.3 Modifications

Tu-124Sh

The first modification of the Tu-124 was Tu-124Sh designed as a navigator training aircraft. 70 aircraft were built between 1962 and 1967. The navigation equipment was changed, several navigator's places were installed in the passenger cabin. After 1963, the Tu-124Sh were adapted to carry bombs under the wings – up to 1000 kg.

Tu-124B

The second modification – 1963. Three experimental aircraft were built. New engines D-20P-125 were installed. They had 8% more thrust and a better economy. On the other hand, they were larger and thus required some modifications in the engine nacelles. Eventually, the engine was abandoned – most likely because of the cost of new nacelles, the higher weight and drag.

Tu-124V

In the middle of the 1960-ies a higher capacity version was developed. It could carry 56 passengers instead of 44. The place gain was achieved by removing a galley in the middle of the cabin, removing some tables between the seats and joining three passenger cabins in one. The galley was placed in the front of the plane, behind the cockpit.

This modification did not affect the plane's geometry, its characteristics or the engines. The existing Tu-124 were gradually upgraded to this modification. At the end of 1968, all the aircraft were converted into Tu-124V. Finally, this version was again called Tu-124 (without suffix).

Tu-124K

After the Tu-124V, a mixed passenger-cargo version was developed. It was capable of carrying 36 passengers and 3 tons of cargo load. The passenger cabin could be transformed into a cargo compartment. This transformation was usually made directly by the operators in few hours. Seven such planes were built, they were all used by the army – both Soviet and foreign.

Tu-124K-2

VIP variant Tu-124K-2 with only 22 seats was built for the DDR Air Force in January 1965. Five aircraft of this type were built from 1965 to 1967, they were all exported.

Tu-124A

An in-depth modification Tu-124A brought new main landing gears, new wing, new tail and moved the engines from the wing root to the tail – after two prototypes it was assigned a new name Tu-134 and quickly became the main soviet medium range jet, still in service. But it is another story...

2.1.4 Tu-124 in Aeroflot

In the Soviet Union, the Tu-124 was in service in 13 civil aviation divisions: Moscow (Vnukovo and Sheremetievo), Vilnius, Volgograd, Kazan, Kuibyshev, Mineralnye Vody, Minsk, Leningrad (Pulkovo), Rostov-on-Don, Tallinn, Tbilisi and Oufa. The Tu-124 served most of the Soviet airports. From Moscow and Leningrad, it also flew regularly abroad to Amsterdam, Belgrade, Berlin, Bucharest, Warszawa, Vienna, Copenhagen, Oslo, Prague, Stockholm, Helsinki and Zurich. From September 1962 to February 21, 1966 Aeroflot received 85 Tu-124s.

Thanks to the Tu-124, the jet aviation came to small Soviet province cities. Passengers appreciated this reliable and fast airliner. The "golden age" of the Tu-124 was between 1969 and 1974. Starting from 1975 they were progressively and rather quickly retired from service, leaving place to the more capable and comfortable Tu-134. At the beginning of 1979, only 26 Tu-124s remained in regular civil service, and the last flight was made to Kazan on December 20, 1979. The reason for such a quick retirement was that the new Tu-134 was better in all aspects both for operators and for passengers. The engines situated in the wing base and integrated into the body of the Tu-124 provoked terrible vibrations and unbearable noise in the passenger cabin. The newer Tu-134 was a world apart in terms of the comfort.

2.1.5 Military service

The Soviet Air Force used the Tu-124 for transport of their high army and navy officers, and also for training purposes. As usual, military Tupolevs stayed much longer in service than their civil sisters – the passenger variants flew until April 14, 1982 when the service was ended by the order of Minister of Defence. The last flight of a Tu-124Sh took place at "Chkalovski" aerodrome near Moscow on February 19, 1986. This date is considered the official end of Tu-124 service. Some observers however reported a flying Tu-124 owned by the Ministry of Aircraft Industry until 1988-1989.

2.1.6 Foreign service

The only foreign company that bought the Tu-124 for civil service was Czechoslovakian CSA. They used three Tu-124, delivered in November 1964 and in July 1965. After 8 years in service one was retired, one – sold back to the USSR and one – to Iraqi Airways.

The DDR government bought three Tu-124 in 1965 – all of them in the K-2 modification. They were returned to the USSR in August 1975.

In April 1965, two Tu-124K were delivered to Iraqi Air Force. Both of them stayed a long time in service and were destroyed during the first Gulf War, in February 1991.

Two Tu-124V were sold to China in January 1965. Chinese Tu-124 stayed the longest time in service – on of them until October 1988, the other – until October 1993.

In February 1967 three Tu-124K were sold to Indian Air Force. Two of them were used as personal jets by the Prime Ministers at that time – Indira Ghandi and later Morarji Desai. One of them (reg V643) crashed in 1977 with the Prime Minister Morarji Desai on board, the crew were killed but all the passengers survived. The other plane stayed in service until the end of the 1980-ies.

Three Tu-124K-2 were acquired by the Hungarian government in January 1967. For some unknown reasons these aircraft returned very quickly to the USSR and the Hungarian government bought some Antonov An-24 instead.

2.1.7 Epilogue

165 Tu-124s were built from January 1960 to 1967. Not a very big number, but after nearly 30 years of service, the Tu-124 leaved an important track in the Soviet aviation history. It had a reputation of being reliable and safe, although uncomfortable. It was involved in 11 fatal accidents. Some of the planes are currently exposed in museums or as monuments in the following cities: Irkutsk, Kimry, Monino, Naberezhnye Chelny, Nalchik, Ulianovsk.

2.2 TECHNICAL CHARACTERISTICS

2.2.1 Dimensions

Length, m	30,57
Wingspan, m	25,55
Height, m	8,08
Diameter of the fuselage, m	2,80

2.2.2 Performance

Ceiling, m (ft)	11600 (38000)
Maximum range ceiling, m (ft)	10100 (33100)
Maximum economy ceiling, m (ft)	9100 (29900)
Maximum range, km (nm)	2100 (1134)
Maximum range with maximum payload, km (nm)	1500 (810)
Cruise speed for maximum range, km/h (kts)	710-750 (383-404)
Economy cruise speed, km/h (kts)	700 (378)
Maximum speed, km/h (kts)	850 (460)
Passenger load for maximum range	44
Maximum passenger load	56
Takeoff distance, m (ft)	2300 (7550)

2.2.3 Limitations

Maximum takeoff weight, kg (lbs)	38000 (84260)
Maximum landing weight, kg (lbs)	35000 (77600)
Maximum IAS, km/h (kts)	600 (324)
Maximum Mach number	0,86
Maximum speeds for, km/h (kts)	
- Gear deployment	400 (215)
- Flaps 10°	400 (215)
- Flaps 30°	380 (205)
- Flaps 40° and the braking shield	340 (183)
Minimum IAS, km/h (kts)	
- Flaps clear	300 (162)
- Flaps 10°	270 (146)
- Flaps 30°	250 (135)
Maximum angle of attack	16°
Maximum banking angle at speeds less than 500 km/h (270 kts)	30°
Maximum banking angle at speeds greater than 500 km/h (270 kts)	45°

2.2.4 Panels

In addition to the main panel (MAIN), there are several other panels that can be called by pressing the keys "1" to "5":

- "1" : Autopilot (AP)
- "2" : Navigator (NAV)
- "3" : Radio (RAD)
- "4" : Overhead (OVH)
- "5" : Throttles (THR)

Below, when referring to an instrument, we mention the panel name and the instrument's number as shown on the panel layout screenshots. For example, OVH-12 means the button 12 on the overhead panel (press "Shift+4" to show it up).

Pressing "W" will hide the main panel and bring up the navigator's view (the glass nose).

3 PROCEDURES

3.1.1 Before the flight

Engines start up

- Batteries	ON	NAV-13
- Starter-generators switches	OFF	NAV-7,8
- Fire extinguishers switches	ON	OVH-20
- Fire warning system	ON	OVH-21
- Fire warning check	CHECK	OVH-8,9
- Fuel pumps	ON	OVH-16,17
- Automatic fuel flow system	CHECK	OVH-6
- Throttles	IDLE	THR-3
- "Main" switch	ON	THR-10
- "Ground/Air" switch	"ground" (земля)	THR-12
- "Start/Crank" switch	"start" (запуск)	THR-11
- "Start" button	PRESS	THR-13,15

After the engines started

- "Main" switch	OFF	THR-10
- "Ground/Air" switch	"air" (воздух)	THR-12
- Starter-generators switches	ON	NAV-7,8
- PO-3000 transformer switch	ON (left)	NAV-17
- PT-500Ts transformer switch	ON (up)	NAV-2
- Supplies switches	ON	RAD-2-7
- Navigation systems gyroscopes (refer to the section 4.1.5)	SYNCHRONIZE	NAV-20
- Attitude indicators (press the buttons on the left edge of MAIN-22 and MAIN-37 until the attitude indicators return to the neutral position)	RESET	MAIN-22,37

Taxiing

- "Headlights" switch	"out" (выпуск)	OVH-5
- "Beacons" and "Nav.lights" switches	ON	OVH-3,4
- "Taxi/Landing lights" switch	"taxi" (малый)	OVH-15
- Before Taxiing Checklist	READOUT	
- Throttles (set 70% thrust to start moving, then decrease to 65% for constant speed taxiing)	INCREASE slightly	THR-3
- Steering switch (switch on immediately after the plane starts moving)	ON	THR-6

- brakes CHECK MAIN-3
(check the indicators MAIN- while braking. Apply brakes and warm the engines by setting briefly 80% thrust)
- Gyro instruments CHECK NAV and MAIN
(check gyro instruments are OK while turning during the taxi)

3.1.2 Takeoff

Before the takeoff

Roll 10-30m on the runway to make sure the aircraft is well aligned with the runway.

- "Taxi/Landing lights" switch "landing" (большой) OVH-15
- Steering switch OFF THR-6
- Pitot heating ON OVH-13,14
- Autopilot heating ON OVH-12

Acceleration

- Flaps SET TO 10° THR-7
- Elevator trimmer SET TO 0.5°-1° THR-16
- Brakes SET
- Throttles SET TO TAKEOFF THR-3
(check both engines are working synchronously)
- Brakes RELEASE

Control the heading by applying differential brakes for the speeds below 150 km/h (80kts). For higher speeds control the heading with the rudder. Keep the yaw in neutral position.

Takeoff

Begin rotating at VR=210-230 km/h (113-124 kts). Continue raising the nose to achieve 6-7 degree nose-high attitude by V2 (230-240 km/h - 124-130 kts)

Maintain 9-10° nose-up attitude at Vt-20km/h (Vt-11kts). Continue the acceleration with this speed until the plane gets airborne. The takeoff speed Vt can be found in the following table, depending on the takeoff weight:

Table 1

TOW tons	38	37	36	35	34	33	32	30
Vt km/h	260	255	250	245	245	240	235	230
TOW lbs x1000	84.2	82	79.8	77.6	75.4	73.2	70.9	66.5
Vt kts	140	138	135	132	132	130	127	124

After the takeoff

After the takeoff continues accelerating. At 5-10 m altitude apply brakes to the wheels. At 25m (82 ft) retract the landing gear. The speed should be about 350 km/h (189 kts). Set the landing lights switch OVH-15 to the neutral middle position. Retract the landing lights (set the switch OVH-5 to the upper position "уборка").

Retract the flaps at minimum altitude of 100 m (330 ft). The speed during flaps and gears retraction should not exceed 400 km/h (216 kts)

Short field / high air temperature / low atm. pressure takeoffs

In these conditions, the runway length can appear insufficient. Setting flaps to 20° decreases the necessary runway length by 12% and the takeoff speed by 10km/h (5.4 kts).

3.1.3 Climb

Once the flaps retracted set the throttles to the climb power at minimum 100 m (330 ft) and less than 400 km/h (216 kts).

At 200-300 m radio altitude (350-1000 ft) reduce vertical speed to 2-3 m/s (400-600 ft/min) and accelerate to the indicated airspeed 520-600 km/h (280-324 kts). Keep this speed until the plane reaches 6000m (19700 ft). Then, keep the speed indicated in the following tables 3.1 and 3.2 (calculated for TOW=38 t)

Table 2

Climb with maximum vertical speed

Alt, km	IAS, km/h	T, min	Dist, km	Fuel, kg
takeoff	0-560	2,4	0	260
2	520	5,9	30	610
4	520	9,7	70	940
6	520	13,7	115	1260
8	480	18,3	170	1560
10	440	23,4	230	1860
11	420	28,3	300	2150

For example, to reach 8000m (FL 262) you will need 18,3 minutes, the covered distance will be 170 km (91 nm) and 1560 kg (3440 lbs) of fuel will be used.

Table 3

Climb with maximum ground speed (use for flights shorter than 1400 km – 755 nm)

Alt, km	IAS, km/h	T, min	Dist, km	Fuel, kg
takeoff	0-560	2,4	0	260
2	600	6,8	45	720
4	600	11,4	100	1130
6	600	16,6	165	1530
8	590	22,9	255	1980
10	520	32,9	390	2550

3.1.4 Cruise

Cruise flight parameters are represented in the table 4.

Table 4.

Weight, tons	Altitude, km	Maximum flight duration				Maximum range			
		IAS, km/h	TAS, km/h	N, %	Q, kg/h	IAS, km/h	TAS, km/h	N, %	Q, kg/h
36	11	-	-	-	-	-	-	-	-
	10	360	590	87.6	2260	462	750	88.4	2460
	9	359	555	85.8	2200	173	728	87.3	2480
	8	358	523	85	2150	487	710	56.6	2530
	7	357	493	84.3	2150	495	688	86	2580
	6	356	481	83.6	2220	504	667	85.6	2670
35	11	357	620	89.3	2290	447	765	89.4	2405
	10	356	583	86.9	2180	460	743	88.1	2395
	9	355	548	85.3	2120	471	723	87	2410
	8	354	518	84.5	2085	483	702	86.3	2460
	7	352	487	83.8	2090	491	683	85.7	2530
	6	351	461	83.4	2160	500	661	85.4	2610
34	11	353	612	88.4	2200	441	756	89.1	2330
	10	351	577	86.3	2110	453	734	87.5	2315
	9	350	542	84.8	2050	465	714	86.6	2335
	8	349	510	84	2020	477	695	85.9	2375
	7	348	481	83.4	2030	486	674	85.3	2450
	6	346	453	83	2100	494	653	85	2540

For example, a cruise flight of 800 km at 10 km altitude for a 35 tons configuration, maximum range mode: Keep the indicated air speed of 460 km/h, maintain the engine thrust 88.1%. The true air speed is 743 km/h, so the time to make 800km is $800/743=1.07$ hours, and the quantity of necessary fuel is $1.07*2395=2579$ kg

3.1.5 Descent

Procedures

The second officer must calculate the point to begin the descent. He also calculates the landing weight and reports to the captain.

Normally, the landing weight shouldn't exceed 32 tons (70500 lbs). Maximum landing weight for the Tu-124 is 33 tons (72750 lbs).

Use the table 5 to calculate the descent distance, the time and the fuel burn

Table 5

Altitude, m	Vy, m/s	IAS, km/h	Time of descent, min	Distance, km	Fuel, kg
12000	8,5	430	33	250	725
11000	8	440	31	225	700
10000	7,5	450	28,8	200	670
9000	7	455	26,4	170	630
8000	6,5	460	23,8	145	590
7000	6	460	21,1	120	540
6000	5,5	465	18,2	90	480
5000	5-10	470	15,1	60	410
4000	5-10	475	13,4	45	380
3000	5-10	480	11,8	30	350
2000	5-10	490	10,2	20	310
1000	5-10	500	8	10	270
hold	-	-	6	0	250

After descending below 10000 ft (3000m) reduce the speed to 400 km/h (216 kts) and keep the vertical speed of 7 m/s (1370 ft/min) until the airport hold altitude.

Emergency descent

Proceed to an emergency descent in case of pressure loss, fire etc.

Procedures:

1. Set idle thrust
2. Start descending by pushing the yaw with force to reach 15-17 m/s (2900-3300 ft/min) vertical speed in 5 sec. The G-force will attain 0.5-0.6 at this moment
3. Pull slightly the yaw and keep increasing the vertical speed until it reaches 35-40 m/s (6900-7800 ft/min)
4. Continue descending with this vertical speed until the IAS reaches 700 km/h (378 kts)
5. Reduce the vertical speed to keep the indicated airspeed at 700 km/h
6. Descent to a safe altitude (5000 m – 16400 ft), then reduce the speed and proceed as during a normal descent.

3.1.6 Approach and Landing

Approach and landing in normal conditions

Extend the landing gear at 400m altitude and the speed of 380-400 km/h. The banking angle during the approach procedures shouldn't exceed 30° in visual flight conditions and 15-20° otherwise.

On the crosswind leg, set the flaps 15°, reduce the speed to 300 km/h.

On the final, set the flaps 30°. Trim to keep the vertical speed constant, equal to 260 km/h (140 kts) for 32 t landing weight or 270 km/h (146 kts) for 32-35 t. Deploy the landing lights (OVH-5 down) and switch them to the position "landing" (OVH-15 down). Deploy the braking shield.

Keep 260-270 km/h (140-146 kts) until the flare. This can require a high throttle setting, as the braking shield is very effective. Never descend below 250 km/h (135 kts) – increase the thrust to reduce the vertical speed instead of using the elevator.

The flare distance (from H=15m to the landing) is about 110 m (360 ft). Reduce the thrust at 8-10 m altitude. Land with angle of attack of about 6°. The exact landing speed can be found in the following table, depending on the landing weight:

Table 6

Landing weight, t	Less than 30	32	33	35
Landing speed, km/h	220	225	230	235
Landing weight, lbs	Less than 66100	70500	72700	77100
Landing speed, kts	118	121	124	127

Deploy the spoilers and apply brakes (but at least 3 seconds after landing). Retract the flaps, the spoilers and the braking shield as you turn to a taxiway. Set the light switch to "taxi" (OVH-15 up)

Using the braking parachute

The braking parachute can be used in the following conditions:

- When landing with the maximum landing weight
- When landing on a short runway
- When the wind direction is collinear to that of the plane
- When landing on an inclined runway
- When landing on a icy runway
- At rejected takeoff
- In other emergency cases

To use the braking parachute, press the button MAIN-41. The green lamp indicates it has been deployed. The braking effectiveness decreases as the plane slows down. The parachute rests deployed even when the aircraft is stopped – due to the gas flow coming from the engines. Press the button MAIN-42 to release the parachute. NB: after the braking parachute has been used and released, it is impossible to use it again. You need to reload the plane to get the braking parachute work again.

4 USE OF THE INSTRUMENTS

4.1.1 Blind landing system SP-50 (СП-50)

The system is analogous to ILS. The SP-50 panel is situated in the navigator's cabin, it can be popped up by Shift+3 (ELEC-1). The indications are shown on the KPP-M (MAIN-20) gauge.

- switch on the channels 1 and 2 before the flight
- set the KPP-M mode switch (MAIN-47) to the "Ground" position (up)
- set the frequency 110.1 MHz, then press three control buttons under the scale and observe beam indicators moving on the MAIN-20 gauge.
- in case 100.1 MHz is the airport ILS frequency, set the frequency 110.3 MHz for control
- before landing, set the ILS frequency on the SP-50 and the heading on the KPP-M (MAIN-20)
- KPP-M should indicate the beam position, exactly like the ILS gauge does.

NB : VOR navigation is not possible – this type of radio devices didn't exist at that time.

4.1.2 Automatic radio compass ARK-11 (АРК-11)

Automatic radio compass is intended for the navigation on the driving stations, and also for constructing the prelanding manoeuvres with the aircraft landing approach. The ARK determines the relative bearings of a radio station.

- switch on both ARK-11 (RAD-4,5) ;
- set the desired NDB frequency on any ARK-11 set (NAV-37, RAD-10). To do that, select the appropriated range with the range button (Диапазон), then fine tune the frequency with the button "настройка грубая". For example, to set 320 KHz, select the range "240" and tune to the value of "80". $240+80=320$;
- control the radio signal intensity with NAV-34 ;
- the resulted frequency is reported to a post-it NAV-19 ;
- the direction to the station is indicated by MAIN-16, MAIN-27 and NAV-23.

4.1.3 Short-range Navigation Radio System RSBN (РСБН-2С)

RSBN is intended for determination of the azimuth and the distance from the ground-based radio beacon to the aircraft. It is analogous to the VOR system together with the DME and has a slightly wider range (up to 400km)

- switch on the RSBN (RAD-2) ;
- set the channel using two leftmost selectors – the upper one sets the tens, the lower one – the units. Report to the appendix A for the correspondence between channels and airports in the USSR.
- set the KPP-M mode switch (MAIN-47) to the lower position (РСБН)
- the measuring of the azimuth and the distance is monitored on the gauges MAIN-12 and NAV-25. The thick needle indicates the azimuth FROM the station TO the aircraft. If you fly towards the station, the opposite direction is pointed by the needle. The NAV-25 gauge has an additional small needle that shows the units of degrees (for instance, the thick arrow between 140 and 150 and the thin arrow on 8 means the azimuth is 148°)
- in case of a failure or a signal loss, the leds MAIN-11 and NAV-29 come up
- to fly towards a RSBN station, set the mode selector on NAV-36 to the position «азимут НА», set the azimuth with the knob «Азимут».
- the vertical bar on the KPP-M (MAIN-11) indicates the deviation from the track – turn towards the bar to bring it to the centre. Then keep the cap in order the vertical bars stays in the centre.

- in flight along an arbitrary route, on the NAV-36 set the mode selector to the «СПП» position; on the NAV-35 set the distance to the station with the «Расстояние до цели» knob, use the knob «Угол цели» to set the bearing to the station and set the desired cap with the knob «ЗПУ». The further flight is analogous to the flight to or from a RSBN station ;
- the lamps MAIN-14 and MAIN-15 indicate the flight over the control points whose azimuth and distance were set previously

4.1.4 Autopilot AP-6E (АП-6Е)

The autopilot AP-6E controls the pitch and the bank of the plane. It can also keep the barometric altitude.

- the autopilot needs DC, single- and tri-phase AC to work;
- to engage the autopilot, switch the power on (AP-7), switch on bank- and pitch channels (AP-8, AP-9). Press the button AP-6;
- the green lamps AP-1, AP-3 come up, indicating both channels are engaged. The plane will conserve the pitch it had at the moment the autopilot was engaged. The bank will automatically return to zero;
- use the turn button AP-2 to change the bank. It can vary $\pm 22^\circ$. Click in the middle of the button to quickly return to zero;
- use the wheel AP-5 to change the pitch. It can vary $\pm 10^\circ$ from the initially set position. Use mouse wheel to smoothly adjust the pitch.
- press the level button AP-4 to keep the current altitude. The vertical speed should not exceed 5 m/s at this moment and the pitch channel should be on.
- to turn the autopilot off, use the switch AP-7

4.1.5 Navigation system KS-6 (КС-6)

KS-6 (NAV-20) is intended for determination and maintaining the magnetic, true and orthodromic course, the angle of turn, and also for monitoring course signals. The system can work in modes gyrocompass (GPK), magnetic correction (MK) and celestial correction (AK).

Synchronization :

- make sure DC and AC circuits are on ;
- set the mode to "МК", set the latitude (round knob) and the hemisphere of the departure airport (left switch "северн" – North, "южн" – South)
- press and hold the synchro button (Согласование). Observe the internal scale moving on the navigation gauge USh-1 (NAV-23) and the needle "G" ("Г") on UGA-1U (NAV-21), wait until they point at the same direction and stop moving;
- for orthodromic course navigation, set the mode switch to "GPK" (ГПК) and synchronize the systems with the same button.
- during the flight, adjust the latitude if necessary

4.1.6 Astrocompass DAK-DB (ДАК-ДБ)

navigation with the astrocompass is yet not fully implemented. The corresponding needle "A" on the UGA-1U gauge (NAV-21) points always to the true cap of the aircraft

4.1.7 Navigation system NI-50BM (НИ-50БМ)

this system is intended to monitor continuously the aircraft position.

- make sure DC and AC circuits are on;
- set the wind speed and direction on the knob NAV-30 (they can be read from the post-it NAV-19);
- set the map angle from the current position to the next waypoint on the knob NAV-31;
- reset the counter NAV-32 by clicking on it;
- the needle "C" indicates the distance covered in the leg's direction. The needle "B" – the lateral deviation from the leg.

5 PANELS LAYOUT

1. MAIN – the captain's panel



1. « Spoilers deployed » lamps
2. « Doors open » lamp
3. « Braking » lamp
4. « Low fuel » lamp
5. « Stall » warning
6. N1 indicator ITE-2T (ИТЭ-2Т)
7. Left engine fuel flow indicator
8. Right engine fuel flow indicator
9. Hydro-compass UGPK (УГПК)
10. « Marker » lamp
11. « RSBN signal loss » lamp
12. RSBN azimuth and distance indicator
13. Main communication panel RSIU (РСИУ)
14. « approaching RSBN zone » lamp
15. "leaving RSBN zone" lamp
16. ARK-1 indicator
17. EGT indicator
18. Left engine oil pressure and temperature
19. Right engine oil pressure and temperature
20. Combined navigation gauge KPP-M (КПП-М)
21. Altimeter VD-20 (ВД-20) - the long needle shows hundreds of meters on the external scale. The short needle shows kilometers on the internal scale
22. Horizon AGB-2 (АГБ-2)
23. Radio altitude indicator RV-UM (РВ-УМ)
24. Indicated air speed gauge KUS-1200 (KYC-1200)
25. Vertical speed indicator VAR-30 (BAP-30)
26. "Flight attendant calling" lamp
27. ARK-2 indicator
28. "Low oil pressure" lamps
29. Flaps position indicator
30. Braking shield position indicator
31. Hydraulic system pressure indicators
32. Altitude alert lamp
33. Altitude alert selector
34. Machmeter MS-1 (MC-1)
35. "Overspeed" lamp
36. Outboard temperature indicator
37. Standby horizon AGI-1 (АГИ-1)
38. Landing gear control lamps
39. Slide and turn indicator EUP-53 (ЭУП-53)
40. Clock (АЧС-1)
41. braking parachute deploy button
42. braking parachute lamp and release button
43. RV-UM power switch;
44. AGB-2 power switch;
45. EUP-53 power switch;
46. AGI-1 power switch
47. KPP-M mode selector



1. Bank channel lamp
2. Controlled turn selector
3. Pitch channel lamp
4. Level button
5. Pitch controller
6. Engage A/P button
7. Power switch
8. Bank channel switch
9. Pitch channel switch

2. Autopilot AP-6E (Shift+1)

3. NAV - Navigator's panel (Shift+2)



1. voltmeter of three-phase AC network
2. three-phase converter PT-500 switch and its lamp
3. ammeter of the right engine's generator
4. ammeter of the left engine's generator
5. DC network ammeter
6. DC network voltmeter
7. left engine's generator switch and lamp
8. right engine's generator switch and lamp
9. batteries and ground power connect to the network switch
10. ground power switch
11. DC network voltmeter selector
12. "powered by batteries" lamp
13. batteries switch
14. single-phase AC converter PO-3000 lamp
15. single-phase AC network voltmeter
16. auxiliary bus tension control button
17. single phase AC converter PO-3000 power switch
18. auxiliary bus switch
19. a post-it with the wind direction and speed and NDB tuned frequencies (from ARK-1 and ARK-2)
20. control panel of the navigation system KS-6 (KC-6)
21. gyrocompass and astrocompass indicator UGA-1U (УГА-1У)
22. astrocompass track corrector DAK-DB (ДАК-ДБ)
23. navigator's main indicator USh-1 (УШ-1)
24. outboard temperature indicator
25. RSBN azimuth and distance indicator
26. indicated air speed gauge KUS-1200 (КУС-1200)
27. altimeter VD-20 (ВД-20)
28. clock (AЧ-1)
29. « RSBN signal loss » lamp
30. wind selector from the NI-50BM set (НИ-50БМ)
31. course automate from the NI-50BM set
32. odometer from the NI-50BM set
33. vertical speed indicator VAR-30 (BAP-30)
34. NDB signal intensity indicator
35. RSBN SRP control panel
36. RSBN control panel
37. ARK-1 control panel

4. RAD - Additional navigator's (radio) panel (Shift+3)



1. Blind landing system SP-50 control panel
2. RSNB power switch
3. KS-6 power switch
4. ARK-1 power switch
5. ARK-2 power switch
6. NI-50BM set power switch
7. astrocompass DAK-DB power switch
8. squawk box
9. standby communication panel
10. ARK-2 control panel.

5. OVH - Overhead (Shift+4)



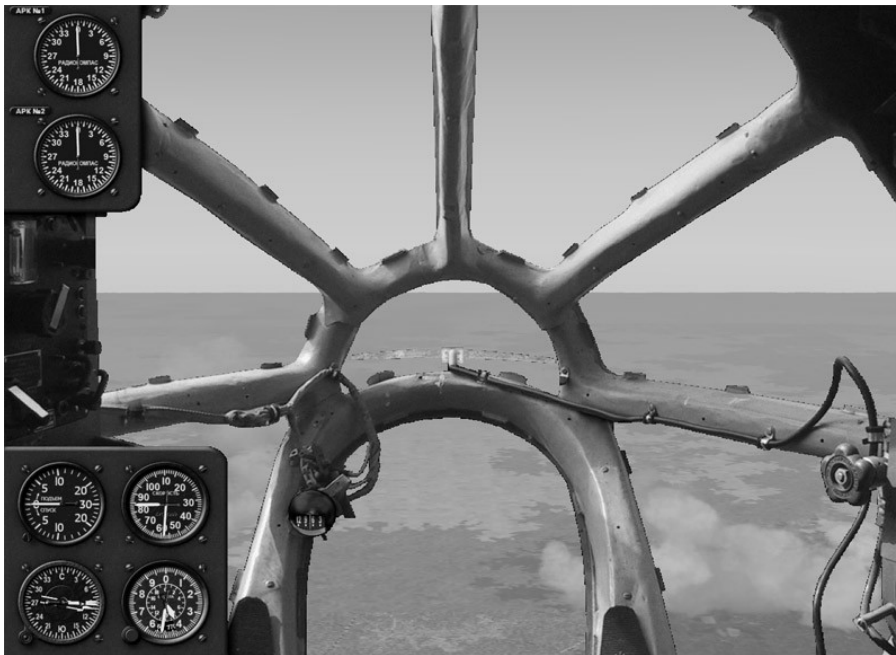
1. Elevator trimmer power switch
2. Cabin lights switch
3. Nav lights switch
4. Beacons switch
5. Landing lights extension/retraction switch
6. Fuel pump lamps
7. braking shield extension handle (inop)
8. Fire system control lamps
9. Fire system warning lights
10. Captain's window heat switch
11. FO's window heat switch
12. A/P heating switch
13. Left Pitot heating switch
14. Right Pitot heating switch
15. Landing/Taxi lights switch
16. Left fuel pumps switches
17. Right fuel pumps switches
18. Gears handle
19. Ring fire extinguisher switch
20. Fire extinguishers switches
21. Fire warning system switch
22. Fire extinguishers control lamps
23. Fire extinguishers power buttons
24. Left pitot heat control lamp and button
25. Engine starter lamp
26. Right pitot heat control lamp and button

6. THR – Throttles panel (Shift+5)



1. braking parachute control lamp
2. Critical regime signal lamp control button
3. Throttle levers
4. braking parachute control button
5. Critical regime signal lamp switch
6. Steering blocker switch and control lamp
7. Flaps handle
8. Engine stop buttons
9. SPU control panel
10. Engine starter "Main" switch
11. Engine starter mode switch
12. "Ground/Air" switch
13. Right engine starter button
14. Abort engine start button
15. Left engine starter button
16. Elevator trimmer indicator

7. Navigator's view (press "W")



6 APPENDIX

RSBN database

CH	NAME	ID	FREQ		LAT			LON	
24	ANADYR	UX	117,15	N	64	44,1	E	177	43,9
30	ANDIZHAN	AN	117,45	N	40	43,5	E	72	17,5
20	ARKHANGELSK	AZ	116,95	N	64	36,1	E	40	43,2
01	ARMAVIR	TG	116	N	44	58,2	E	41	6,9
02	ASTRAKHAN	GV	116,05	N	46	16,6	E	48	0,2
11	BAKU Nasosnaya	GU	116,5	N	40	36,1	E	49	33,7
39	BARNAUL	00	117,9	N	53	22,4	E	83	34,7
06	BELAYA	GW	116,25	N	52	55	E	103	34,7
38	BODAYBO	IA	117,85	N	57	52,4	E	114	13,7
17	CHELYABINSK Shagol	MZ	116,8	N	55	15,1	E	61	18,2
14	CHERSKY	CE	116,65	N	68	45,2	E	161	20,6
10	CHKALOVSKY	OF	116,45	N	55	52,8	E	38	3
02	CHOKURDAKH	QG	116,05	N	70	37,7	E	147	54,4
23	DIKSON	QK	117,1	N	73	31	E	80	24,8
16	DONETSK	DN1	116,75	N	48	4,6	E	37	44,7
12	DOROKHOVO	AL0	116,55	N	57	43,4	E	36	39
02	DUSHANBE	FN	116,05	N	38	32,5	E	68	48,8
14	DZHANKOY	DN0	116,65	N	45	41,8	E	34	24,6
29	FERGANA	ZU	117,4	N	40	21,4	E	71	44,9
30	GROZNY	00	117,45	N	43	23,6	E	45	42,3
20	IVANO-FRANKOVSK	IF	116,95	N	48	53,2	E	24	41,1
22	IVANOVO	AL1	117,05	N	56	57,2	E	40	53,9
05	KAKAYDY	TD	116,2	N	37	37,4	E	67	31
04	KALININGRAD	KR	116,15	N	54	53,5	E	20	35,1
27	KARSHI	WF	117,3	N	38	49,4	E	65	55,2
14	KEMEROVO	NC	116,65	N	55	16,3	E	86	7,2
15	KHABAROVSK	BD	116,7	N	48	31,8	E	135	11,8
34	KHANSKAYA	01	117,65	N	44	40,7	E	40	1,9
29	KHARKOV	HR	117,4	N	49	55,7	E	36	17,9
15	KHERSON	HE	116,7	N	46	40	E	32	30,3
36	KHUDZHAND	HD	117,75	N	40	12,8	E	69	42,1
40	KIYEV	KB	117,95	N	50	20,2	E	30	52,7
38	KOLPASHEVO	FB	117,85	N	58	19,7	E	82	55,6
18	KOMSOMOLSK N A Dzemgi	UI	116,85	N	50	36,8	E	137	5,1
26	KOMSOMOLSK N A Hurba	UL	117,25	N	50	24,6	E	136	56,3
13	KOSTANAY	KT	116,6	N	53	12,4	E	63	32,5
28	KOTLAS	BR	117,35	N	60	59,8	E	46	51,9
32	KURSK	WA	117,55	N	51	45,3	E	36	17,5
14	LEBYAZHYE	MA	116,65	N	50	12,1	E	45	12,9
39	LIMANSKOYE	KE	117,9	N	46	39,9	E	30	1
30	LUGANSK	LU	117,45	N	48	24,8	E	39	23,4
28	LUKHOVITSY	GW	117,35	N	54	54,5	E	39	2,3
23	LVOV	LO	117,1	N	49	48,8	E	23	56,9
05	MAGDAGACHI	GU	116,2	N	53	28,2	E	125	48,7
27	MAKHACHKALA	SM	117,3	N	42	49	E	47	38,5
33	MINERALNYYE VODY	MW	117,6	N	44	13,5	E	43	5,6
39	MINSK	WN	117,9	N	53	46	E	27	34,7
03	MIRNY	SG	116,1	N	62	33	E	114	5,4
23	MOGOCHA	KU	117,1	N	53	43,4	E	119	45,5
04	MOSKOW Vnukovo	OB	116,15	N	55	35,9	E	37	16,7
25	MURMANSK Kilpyavr	VA	117,2	N	69	6,3	E	32	25,6
37	NADYM	PZ	117,8	N	65	28,5	E	72	42,3

36	NAKHICHEVAN	TP	117,75	N	39	11,5	E	45	27,5
18	NERYUNGRI	RQ	116,85	N	56	54,6	E	124	52,9
26	NIZHNY NOVGOROD	UV	117,25	N	56	15,6	E	43	46,6
35	NORILSK	BF	117,7	N	69	19,1	E	87	21,2
35	NOVOKUZNETSK	UF	117,7	N	53	48,9	E	86	52,5
24	NOVOSIBIRSK	KT	117,15	N	55	0,9	E	82	40,1
27	NOVOSIBIRSK Yeltsovka	KP	117,3	N	55	6,2	E	83	1,1
23	OKHA	TQ	117,1	N	53	30,9	E	142	53,3
02	OLEKMINSK	ON	116,05	N	60	24,8	E	120	26,6
22	OLENYA	PL	117,05	N	68	9,2	E	33	29,3
07	OMSK Severny	LD	116,3	N	54	58,6	E	73	33,6
31	OMSK Tsentralny	RM	117,5	N	54	57,6	E	73	17,9
35	OSH	OU	117,7	N	40	36,5	E	72	47,9
23	PAVLODAR	PW	117,1	N	52	11,3	E	77	4,5
33	PECHORA	PM	117,6	N	65	6,8	E	57	7,6
08	PENZA	RN	116,35	N	53	6,5	E	45	0,7
20	PERM	PX	116,95	N	57	55	E	56	2
33	PEVEK	BM	117,6	N	69	47,6	E	170	34,9
37	PSKOV	NP	117,8	N	57	47,1	E	28	24,4
06	RAMENSKOYE	00	116,25	N	55	31,9	E	38	11,1
35	ROSTOV-NA-DONU	RN	117,7	N	47	16,3	E	39	50
21	SAMARA Bezymyanka	NA	117	N	53	13,7	E	50	20,1
05	SAMARA Kurumoch	FK	116,2	N	53	30,1	E	50	8,4
11	SEMIPALATINSK	SP	116,5	N	50	20,8	E	80	15,1
19	SEVASTOPOL	BP0	116,9	N	44	41,3	E	33	34,2
05	SEVEROMORSK-3	JN	116,2	N	68	52,3	E	33	42,6
18	SHYMKENT	EN	116,85	N	42	21,7	E	69	28,5
18	SIMFEROPOL	SI	116,85	N	45	1,2	E	33	59,1
28	SOLTSY	FB	117,35	N	58	8,9	E	30	19
34	SOVETSKAYA GAVAN	RO	117,65	N	49	14,2	E	140	10,6
02	St PETERSBURG Pulkovo	PO	116,05	N	59	48,7	E	30	16,3
40	St PETERSBURG Siversky	RS	117,95	N	59	21,5	E	30	2,7
13	STARAYA RUSSA	00	116,6	N	57	57,4	E	31	23,1
11	STRY	BP1	116,5	N	49	14,8	E	23	47,2
25	TAGANROG	UF	117,2	N	47	11,6	E	38	51,5
39	TARAZ	MB	117,9	N	42	52	E	71	17,1
31	TASHKENT Vostochny	IS	117,5	N	41	18,9	E	69	23,4
23	TIKSI	KF	117,1	N	71	41,7	E	128	54,9
09	TVER	KU	116,4	N	56	49,5	E	35	44,5
35	UFA	RG	117,7	N	54	33,3	E	55	53,6
02	ULYANOVSK	LS	116,05	N	54	15,6	E	48	13,7
30	ULYANOVSK Vostochny	DR	117,45	N	54	24,2	E	48	48,9
13	UST-BOLSHERETSK	UB	116,6	N	52	49,3	E	156	16,7
36	UST-KAMENOGORSK	US	117,75	N	50	2	E	82	30,4
36	UZIN	LV	117,75	N	49	47,5	E	30	26,3
26	VLADIVOSTOK	JL	117,25	N	43	24,2	E	132	9,2
36	VOLGOGRAD	WG	117,75	N	48	46,8	E	44	20,7
19	VORKUTA	DW	116,9	N	67	29,4	E	63	59,3
07	VOZDVIZHENKA	ZL	116,3	N	43	54,7	E	131	55,2
13	YAKUTSK	UD	116,6	N	62	5,4	E	129	46,9
03	YEKATERINBURG	ED	116,1	N	56	44,3	E	60	49,8
13	YUZHNO-SAKHALINSK	SL	116,6	N	46	53,1	E	142	42,6
11	ZAPOROZHYE	ZP	116,5	N	47	51,8	E	35	18,3
30	ZAVITINSK	GT	117,45	N	50	11,4	E	129	30
29	ZHEKAZGAN	GN	117,4	N	47	42	E	67	43,8
28	ZHITOMIR	DO	117,35	N	50	9,4	E	28	44,3