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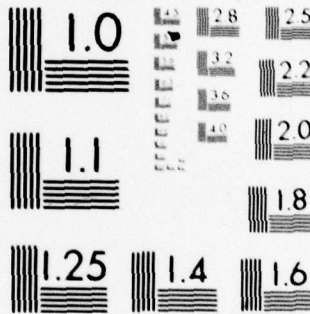
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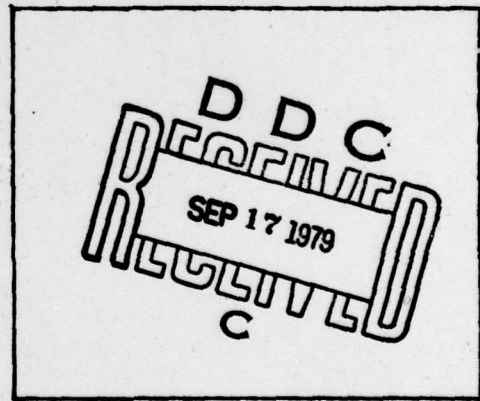
The Latest Soviet...
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THE LATEST SOVIET TRANSPORTATION AIRCRAFT

By

J. Grzegorzewski



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The Latest Soviet Transportation Aircraft

by

Jerzy Grzegorzewski

Jet aircraft, introduced to the airlines in the Soviet Union in 1956, caused, due to their higher speed and capacity as compared with the prop aircraft, a rapid growth in passenger traffic. By use of the jet aircraft, airline travel became one of the main means of transportation in the USSR. The regularly scheduled flights connect over 3500 cities and towns, with several or more flights a day.

This is how the passenger (in million persons) and cargo (in thousand tons) traffic grew in the USSR from 1956 to 1971:

1956 : 3.1 and 220.5;

1961: 21.8 and 842.9;

1966: 47.2 and 1335.4;

1971: 70.1 and 1960.1.

The further dynamic increase of passenger and cargo traffic and also the agricultural services will take place in the current five year period. The Table 1 shows the projected growth of "Aeroflot."

To accomplish these goals one needs not only to increase but to modernize the aircraft fleet. The Soviet airline is introducing or will introduce shortly new types of aircraft.

Transcontinental IL - 62

The greatest achievement of the Ilyushin design team is the transcontinental passenger IL - 62 aircraft, test flown on January 12, 1963 by

*

V.K. Kokkinak. The aircraft, with the starting weight of 157500 kg, and good aerodynamic properties, takes off and lands on the existing airports without necessity of extending the runways. It is the largest of the "Aeroflot" aircraft.

The IL - 62 is built in four versions: economy - for 186 passengers, tourist - for 168 passengers, first class - for 114 passengers and combination (first class and deluxe) for 85 to 100 passengers. The cruising altitude is 10,000 - 11,000 m. In the crew cabin there are two seats for pilot and copilot, and one each for flight engineer, navigator and radio operator.

The aircraft is equipped with the complex system for control and navigation. It allows for automatic flight in the entire flight route starting from 200 - 400 m after start and down to 60 m. at landing. The pilots and navigator do not have to perform complicated calculations.

The novelty in this aircraft design is the use of fourth support point, in the form of tail wheel, while standing on the ground. The use of the fourth wheel allows the loading of the aircraft in any order, without danger of tipping over.

The power is supplied in most of IL -62's in the form three phase current 200/115V, generated by four generators with the total power of 160 kW.

The ventilation and airconditioning system is very well designed. The compressor delivers to the cabin up to 7600 kg of air per hour; this allows for 30 fold exchange. Up to 7000 m altitude the cabin pressure is constant and equal to the atmospheric pressure at the sea level, above that the pressure slowly drops. At the 13,000 m altitude it corresponds to the pressure at 2100 m.

The cabin temperature is maintained at 20° C. regardless of the altitude and the external temperature.

*Read-take-off

The power plant consists of four NK 8-4 turbofan engines with the 10,500 kg thrust each, mounted in pairs at the rear. The titanium firewalls are installed between the engines and the fuselage, and also across the pods. The servicing of the engines is convenient and doesn't require much time. In the case of fire, the engine pods contain six eight-litre fire extinguishers, and the engines, in the case of fire, are fueled with the extinguishing mixture from three two-litre extinguishers.

The fuel system is simple, reliable and it functions automatically. The total fuel capacity in the aircraft is 100,000 liters. Each engine has its own independent fuel system. The emergency fuel dumping is done using seven electric pumps. The automatic control of the fuel system can be replaced by the manual control.

During landing with the landing gear closed, or after receiving the fire alarm, four 6-litre CO₂ fire extinguishers are turned on in the main landing gear compartment. The gas fills the empty space in the fuel tank under the fuselage. At the touchdown, the entire fire extinguishing system is automatically turned on.

The jet, designated as IL - 62 M - 200, carries 198 passengers in the economy class, or 186 in the tourist class. The powerplant consists of four D-30KN engines, with 11,500 kg of thrust each, thus larger than in the IL -62. However, the fuel consumption is smaller.

The more efficient engines and the additional fuel tank with the 5,000 l capacity, increases the range of IL - 62 - M -200 to 10,300 km. New navigational and communication systems and also a new automatic pilot, allows for the landing according to Class II of ICAO.

The improvements introduced in the IL-62-M-200 aircraft considerably increased the technical and economical characteristics of the IL-62 jet. Depending on the distance, the IL-62-M is capable of transporting 43 to 61% more cargo than the IL-62. For example, between Moscow and Tokyo, it

can carry 16 tons of cargo, as compared with 13 tons for IL - 62. The cruising speed also increased from 830 to 870 km/h.

Wide-body IL -86 jet

The high intensity of passenger traffic in the airports, caused the airlines to introduce new high capacity aircraft, capable of carrying 300 to 500 passengers. The main advantage of these aircraft is that they lower the unit cost per passenger - kilometer and simplify the service. The high-capacity planes, so called wide-body jets, can carry a similar number of passengers as two or three smaller planes. The number of take-offs and landings decreases and so does the number of gates in the airports.

As a result of extensive studies, the Ilyushin Design Bureau developed the new wide-body jet IL-86, which satisfies the modern needs.

IL - 86 is the large aircraft which can carry up to 350 passengers. It has conventional low wing configuration, and is equipped with four jet engines suspended under the wings and moved forward to the front edges.

The wide-body IL -86 jet has the shell construction wings with slant angle of 35 degrees. The slots distributed over the entire wing's length, three-gap flaps and the aerodynamic brakes provide the excellent aerodynamic properties, especially during landing. *

The fuselage has a large diameter, this permitted dividing the interior into two decks: the upper one for passengers and the lower one for cargo and luggage. On the left side of the fuselage there are three entries with stairs, the passengers are able to enter or leave the lower deck without using the airport ramps. The passengers walk up the stairs onto the lower deck where they leave their luggage, and then using the internal stairway walk up to the passenger cabin. In this aircraft then, the idea is realized of travelling with luggage, the passenger leaving the aircraft

*Read-sweep

can take it with him without waiting for general unloading.

The landing gear consists of three four-wheel assemblies: the main landing gear and the two wheel front landing gear.

The IL-86 has the automatic pilot and the auxiliary systems assisting the steering in all three planes; these systems are driven by four independent hydraulic systems.

The fuel, 70 - 80 thousand liters, is stored in the wing tanks (in each wing there is one main tank and two supply tanks). The air conditioning system provides the cabin pressure equal to the pressure at the airport, up to 6600 m altitude, and during the flight at 12,000 altitude the pressure equivalent to the pressure at 2400 m altitude. The pressure regulation system provides the air exchange rate of 35 kg per passenger during the flight. The aircraft is equipped with an electric system for de-icing of wings, engine inlets and pilots windshields.

The power plant of the IL - 86 consists of four turbofan D-30 KP engines, with 12,000 KG thrust each and with relatively low fuel consumption. The noise suppression devices lower the noise levels to conform with the latest international regulations. The engines are equipped with the thrust reverses and the fire warning systems.

The modern radionavigational system coupled with the autopilot and the on-board computer, allows for completely automated flight from take-off to landing. The crew cabin, normally for three persons (captain, copilot and flight engineer) can be adapted for four persons (navigator).

The passengers cabin has three compartments with separate entrances and, depending on the class, can accommodate up to 350 passengers in the tourist class.

The wide-body jet IL - 86 was test flown on Dec. 22, 1976 and at the present time undergoes extensive testing on the ground and in the air.

The Polish aircraft industry, mainly the Transportation Works PZL - Mielec, joined the production effort. They will manufacture the main steering mechanisms and other structural elements. One should not be surprised by the designation "main steering mechanism", since one has to realize that the width of the steering system is 19.0 m and several meters high.

Another member of "Yak" family

The Alexander Yakovlev design bureau developed a new type of transportation aircraft - Yak-42. In the next few years a considerable number of this aircraft will enter the "Aeroflot" lines, since it is expected that they will use the regular airports, presently accepting the Yak-40 and An - 24 aircraft.

The Yak - 42 is designed for passengers and cargo transportation on the routes from 400 to 2700 km, with the cruising speed of 800 km/h. The aircraft design conforms to the rules of FAR. There are two independent electrical power systems. One of them provides three phase 220/115V power (three generators with 20 kVA power each), the other provides 27 V d.c. power, from three brushless generators, with 9 kW power each. The emergency ac power supply are the dc - ac converters.

The steering system does not have the hydraulic amplifiers, this simplified the hydraulic system and its maintenance.

The extensive autopilot and navigational equivalent and automation of many procedures allows for piloting the aircraft by the two men crew. The landing can take place at bad weather equivalent to the IIIA class of ICAO. Ruggedized landing gear and wide tires allow for landing on the gravel strips, especially in the North and Far East of USSR.

The aircraft is designed in two versions. One version utilizes the

principle of carry-on luggage, this version has 100 seats and is intended for the local traffic. The other version, for 120 passengers, holds the luggage in containers in the lower deck. The stairway for passengers, built into the aircraft, are located in the rear of the aircraft (similar as in the Yak-40) and in the front on the left side.

The wing design is of the continuous type, this lowers the weight and the production cost.

The powerplant consists of three D-36 turbofan engines, designed by V. Lotaryev, with 6500 kG of thrust each. The outside engines are equipped with the thrust reversers, in order to shorten the landing distance and to ease the maneuvering in the airport. The unit fuel consumption is 0.65 kg/kG.h, which is very economical. During the test flights on the Moscow-Leningrad route, the Yak-42 uses 25% less fuel per passenger as compared with the currently used Tu-134 aircraft. The engine operating time is estimated for 18,000 hours, and the aircraft itself can fly without general overhaul for 30,000 hours. Since one expects that the average flying time on the local routes will be one hour, it is expected that the aircraft will make 30,000 take-offs and landings.

The Yak-42 will be the main aircraft of the "Aeroflot" airlines.

The starting weight of the aircraft is 50,000 kG, the maximum loading is 14,000 kG, the normal loading is 10,500 kG. The range at the normal loading is 1850 km, and the speed at this loading - 820 km/h.

The IL - 76 transport aircraft

The newest transport aircraft in the "Aeroflot" is the IL - 76, developed by S.V. Ilyushin design bureau. The aircraft was test flown in spring of 1971. The four-engine IL - 76 is intended for cargo transportation on medium and long distance routes. It is powered by four D-30 KN

turbofan engines, designed by P. Solovyov, with 12,000 kg of thrust each, suspended on pods under the wings. The engines are equipped with thrust reversers.

The slanted wing, of all metal construction and 28° slant angle, is equipped with hydraulic driver, triple flaps and slots. Well-developed wing mechanism and low pressure front and main landing gear allow for landing on gravel airstrips. The electric wing deicing allows for flights in difficult winter conditions.

The large pressurized cargo space allows for transporting a large-size load. The loading mechanism in the form of two cranes, each with a lift capacity of 2500 kg, allow for shortening of loading and unloading the aircraft.

fuselage length is 46.59m, height is 14.76 m
The wing span of IL-76 aircraft is 50.50m, maximum take-off weight 157,000 kg, maximum load is 40,000 kg. The cruising speed is 850 km/h, maximum range is 5000 km and the ceiling is 12,000m.

Supersonic TU-144

The first attempts to develop supersonic passenger plane in the USSR were started at the end of the 50's, but their realization encountered severe technical difficulties. Although there were the military aircraft with similar capabilities but the adaptation was not economical. The development continued on a completely new design, typically civilian. Many problems had to be solved which would assure the economy of exploitation. Careful aerodynamical design allowed for the decrease of the aerodynamical friction coefficient and to achieve good aerodynamical properties.

The Tu-144 aircraft is powered by four NK-144 turbofan engines, with 13,000 kg of thrust each, and with the afterburn of 17,500 kg each. The engines are placed next to each other, under the fuselage. During the start, the so-called stand-by afterburn is turned on, and only if any of

the engines malfunctions, the afterburners are turned on. The afterburners are normally turned on while crossing the sound barrier. Two outside engines are equipped with the thrust reversers, which shorten the landing distance down to 1800 m.

The nose of the aircraft tilts during the take-off and landing by 12° , in order to improve the pilot's visibility.

The designers had to solve many very difficult problems, for example, one can mention the problem of acoustical stress and the aerodynamic heating.

The air conditioning presented considerable difficulties. The air, obtained from the engine compressor, has the temperature of 500°C and had to be cooled to the ambient temperature. Among others, the fuel tank was used for that purpose. The passenger cabin has triple walls between which the air is circulated. The inside wall is porous, and sucks out the used air.

The exploitation life time of the aircraft is expected to be 30,000 hours. To increase the safety, the monolithic panels were used in the construction, since the rivets just pop out due to the stress differences. This also prolonged the life time of the aircraft. The entire wing is built from panels, the rear part is welded. The panels are fastened with screws. The elements are either chemically etched or machined. A special aluminum alloy was used in the construction, and also, the titanium sheets in the high temperature areas. For example, the titanium sheets are used for engine walls and for cover of the rear end fuselages, behind the engines. For safety reasons, all major systems in the aircraft are quadrupled, independent and automatic.

The aircraft reaches the cruising altitude of 20,000 m in 20 minutes. The sound barrier is crossed at 11,000 m, in order to avoid the sonic boom on the earth surface.

The Tu-144 has two passenger cabins, the first class for 18 passengers, and the tourist class for 80 passengers. The first class cabin can be

easily converted to 40 seats tourist class. The starting weight of the aircraft is 180,000 kg.

The Tu-144 has thin delta-shaped wing. The landing gear is normal three point type. The front gear, with two-wheels, can be steered. The main landing gears have 6 wheels each. The aircraft can take-off on normal airports, and it does not require special runways or devices.

The production of the Tu-144 aircraft has started, and the number of seats increased to 140. Other changes were also made. The main landing gear stores into the engine pods, while in the prototype it was stored in the wing. In the front of the fuselage little additional wings were added to improve the steering control. The cruising speed of Tu-144 is 2500 km/h.

Since the end of 1975 this aircraft has operated on the "Aeroflot" routes for the transport of mail and cargo.

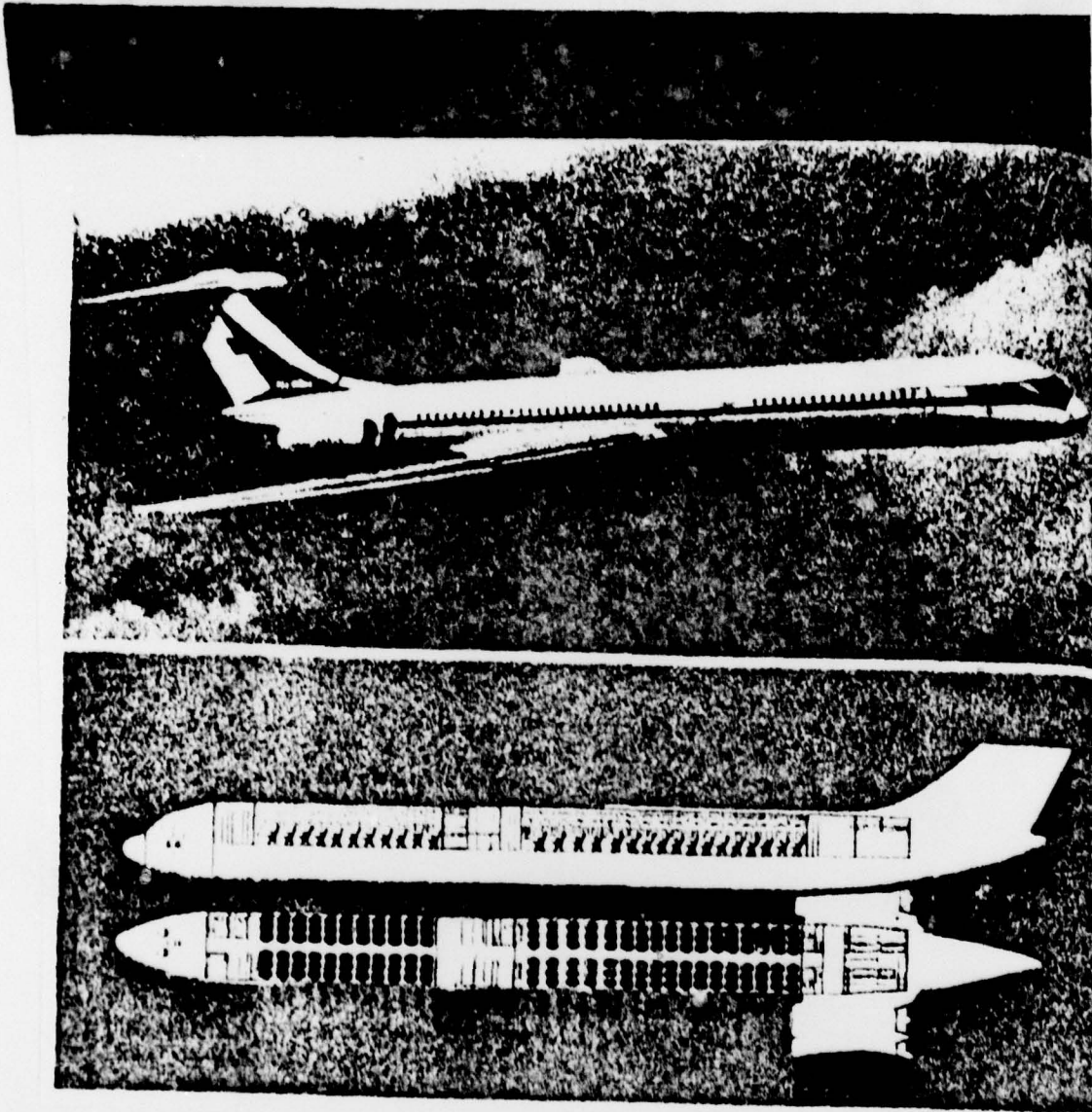
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Table 1. "Aeroflot" in the five year period 1976 - 1978

1 - year, 2 - number of passengers (millions) 3 - cargo (million tons),
4 - agricultural services (millions of hectares).

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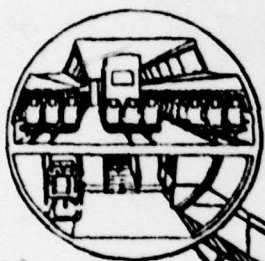
Rok	1976	1977	1978	1979	1980	1976-80
② Przewozy pasażerów (mln)	101	105	111	116	122	555,8
③ Przewozy towarów (mln ton)	2,15	2,28	2,38	2,48	2,58	11,79
④ Usługi agrolotnicze (mln ha)	89,0	92,0	94,0	97,0	100,0	472,0



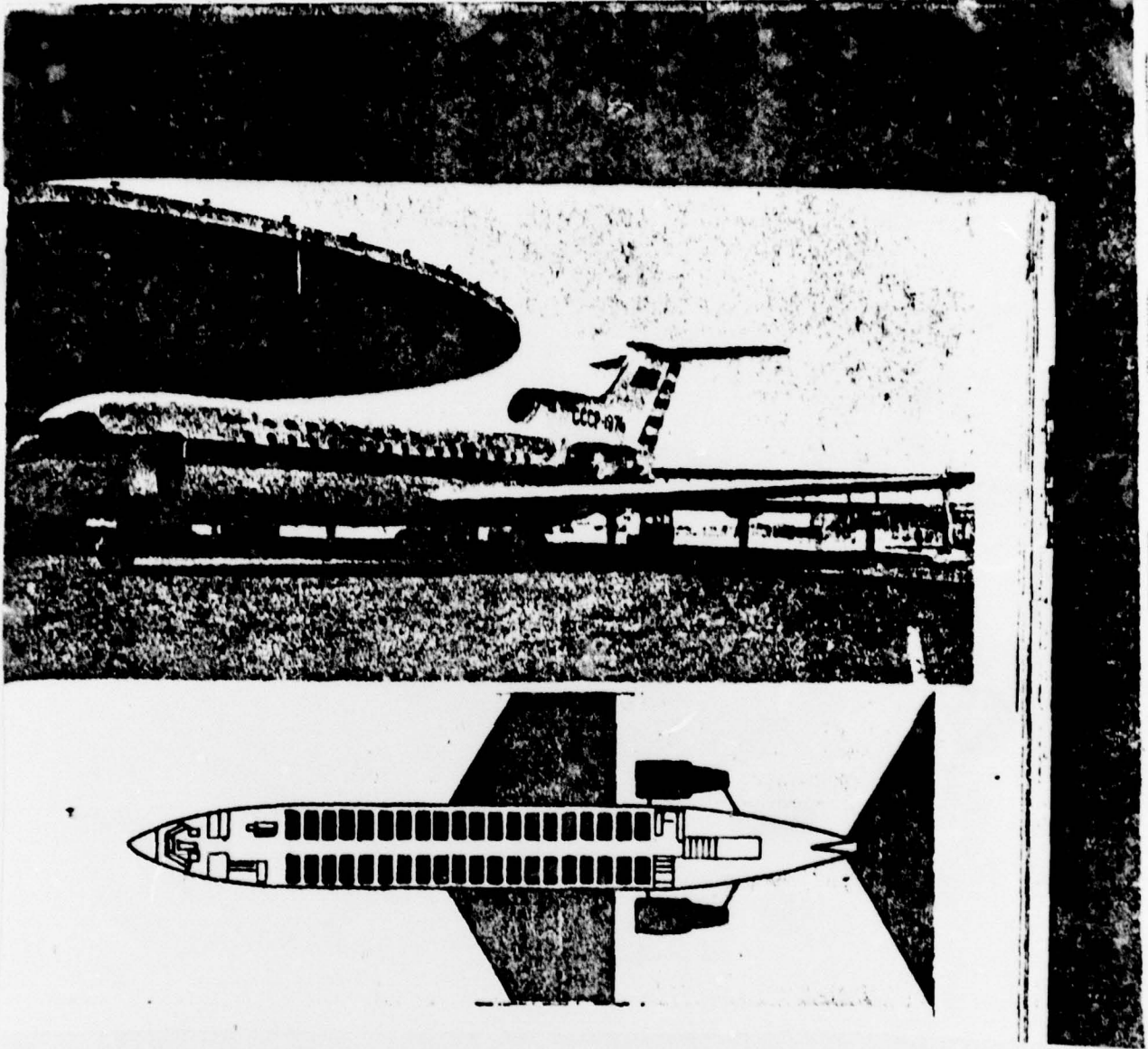
The IL - 62M passenger aircraft for transcontinental flight.
The cross section shows the tourist version with 160 seats.



Aerobus Il-86 - największy pasażerski samolot radziecki. Wersja pokazana w przekroju mieści 350 pasażerów



Wide-body IL - 86 - the largest Soviet passenger aircraft. The version shown in cross section seats 350 passengers.



"Small" passenger plane Yak-42. The cross section shows the tourist version for 120 passengers.

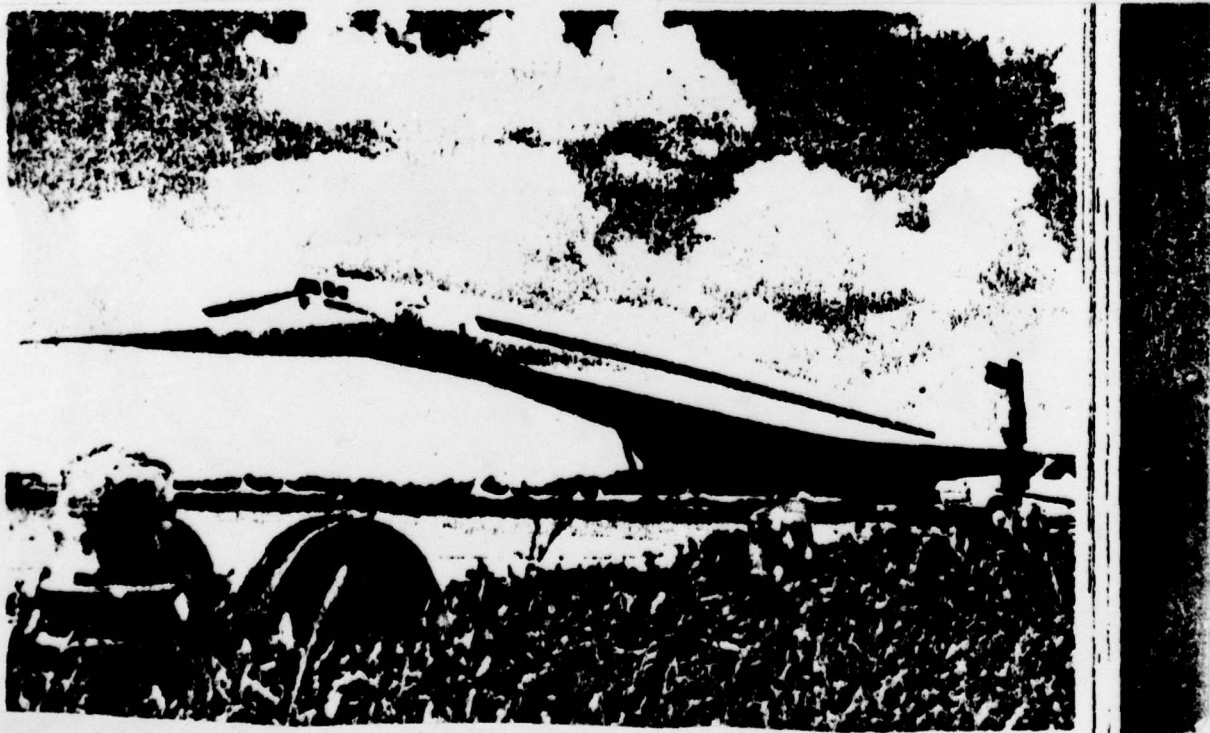


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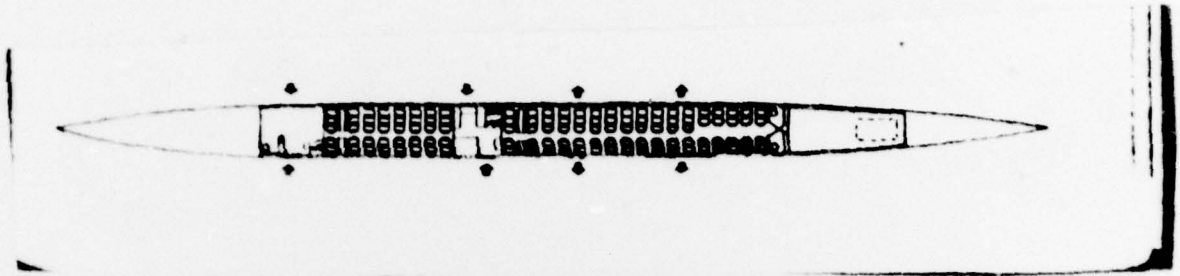
IL - 76 transport plane can carry 40 tons of cargo.



Front view of Tu - 144



The fastest Soviet passenger plane Tu-144 on the runway.



Seat location on Tu-144 (tourist version for 120 passengers)



The Tu-144 landing gear.

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