Pressing on at Paris

Much trepidation preceded the Paris air show this year. Terrorist threats and two assassinations of defense or aerospace industry figures produced the tightest security measures at the show in two decades. Guards at social functions at the show were so careful they kept out wanted guests as well as the uninvited.

Despite the complications, hardly anyone at the show was complaining about the security problems entailed in just moving around the show. What the rest of the show was doing this year was simply catching up to what measures the Israelis had adopted over a decade ago with their buildings at the Le Bourget site and their carefully controlled access and precautions about orphan packages or its recesses.

Most alarms were false. One afternoon at Aerospatiale's big static display stand in Hall 1, spectators watching the flying display were startled by the arrival of a French police car with siren blaring. Police with automatic rifles debouched from it and dashed into various entrances at the buildings. Motorcycles followed. Guards with walkie-talkies shouted in French. After a few minutes the scene quieted and the police van and motorcycles sped away. All the excitement stemmed from a package at the Aerospatiale stand with no identified owner. As instructed, the staff at the stand called security the minute it was spotted. It was a purely innocuous package, but no one complained about the unnecessary fuss.

This scene was repeated at various times during the show. Sniffer dogs were much in evidence. At one reception at the show site, a French security team with dogs checked the hall before the guests arrived. When the sweep was finished the French team walked up to the head security guard of the American host and the leader said in a solemn voice: "We have found something." The American looked suitably aghast and asked in a low tone what. "Zoe, waitess," the French leader answered with much ho-ho-hoing from the group. Because of the intense precautions, these kinds of incidents through the bulk of the show could be treated this lightly. British cars were vandalized in Paris, but primarily because of a riot involving a soccer team from that country in Belgium rather than because of the Paris air show. A small group of demonstrators demanding there be no arms sales at Le Bourget appeared in front of a French military pavilion one day but were hustled off by the French authorities.

Intensified security precautions will undoubtedly become a part of future Paris air shows but not simply because of possible terrorist or anti-military activity. Many chalet receptionists were taking badges of guests from them when they departed so that they could not be used again for automatic reentry. A few chalets had computer terminals installed. As guests were checked in, their names and affiliations were entered into a permanent database. The unexpected fallout from this procedure was that it gave chalet managers an excellent and ready record of repeat requesters for hospitality and what their business had been before. It became an excellent filter for potential free-riders.

Another security feature did not sit so well for exhibitors at the show. This was the closing of the entire exposition for the opening day visit of French President Francois Mitterrand. Visitors were admitted if they arrived early in the morning. Once at a chalet or exhibit stand, they were frozen there until Mitterrand departed, which amounted to an entire morning. The result was that many customers skipped the show entirely that day and little was accomplished by those who were there.

In turn, the closure of the show led to frequent comments by exhibitors during the initial days that the show was a slow one. What has happened over the past few shows is that visitors are tending to arrive later and stay fewer days. Attendance also was trimmed by the alarm over security. Some companies cut back their marketing forces to lessen their exposure to terrorist attack—or for economic reasons in the process. A few advised staffs not to bring their wives. Overreaction ensued to the point that at least one company refused to let its executives or any wives even stay in Paris, let alone attend the show. The biggest danger to participants early in the show turned out not to be terrorists, but the VIP car convoys roving through the chalet lines, speeding to give attackers a shorter time on target, but scattering pedestrians right and left who had the misfortune to be in the way.

By the start of the second week of the show, it looked like vintage Paris air show again. Chalets were crowded, the exhibit halls were bordering on impassable, and the weather was hot enough to overwhelm European air-conditioning, but for an air show, superb. Veterans at the show with memories of pouring rain or the kind of raw damp days that caused the French to invent cognac called the weather this year the best sustained clear spell they could recall. It was not until Thursday that thunderstorms and hail moved in.

Reaction was mixed to how successful the show was from the standpoint of individual company marketing objectives, but the rolls of top government and industry visitors looked as robust as ever. U.S. companies that defected at the last show or two were back, though not clearly decided on whether they would stay back. They found that dropping out can well make for problems at future shows in getting preferred chalet sites. As one smaller company exhibitor put it: "I don't really sell anything at the Paris air show. But our European customers expect us to be here." In other words, the Paris air show is another essential part of product support and customer service in Europe.

Like the last Paris air show, there were no brand-new high-performance fighters, but the revival and evolution of the air transport market was reflected in a bevy of new commuter-class transports making first or second appearances at Le Bourget. Besides, there was the new Soviet An-124 heavy cargo transport in the USAF/Lockheed C-5 mode that was the star of the flight line. There was no question that the show still had its old zing, and the cornucopia of subsystems and materials as well as new concepts for everything from advanced fighters to second-generation space shuttles spread out in the exhibit halls at Le Bourget were a sample of the new technology waiting in the wings for 1987.

—William H. Gregory
New Powerplant, European Fighter Program Spark Debate at Le Bourget

Paris—Debate among the West's large jet engine manufacturers over the best technical solution and development pace for the next generation of commercial transport engines and the probable restructur- ing of the European Fighter Aircraft (EFA) program as a four-nation concor- datus without France were the central is- sues of the 1995 Paris air show. The 36th in the series of expositions at Le Bourget was held here May 31-June 9 amid the heightened security precautions over security measures were in evidence throughout the show, but caused minimal disruptions for participants and visitors. The exception was May 31, when French President Francois Mitterrand visited Le Bourget. Exhibitors were told to arrive at their chalets and display areas early and to expect restrictions on their movements around the show grounds during Mitter- rand's visit.

Many company representatives said the show effectively was closed by the French president's visit at least 1 p.m. Some top aerospace company officials who ar- rived after the security restrictions were put in place said they were locked out of their chalets. Others were locked inside for the entire morning. Visitors were simi- larly restricted and the final result was that many participants said they lost the better part of a day's business activities.

The engine debate that raged up and down the chalet line at Le Bourget was sparked early in the show when General Electric's Aircraft Engine Business Group confirmed that it had signed a memorandum of understanding with France's Sncema, assigning the French engine company a 35% share in General Electric's Unducted Fan (UDF) development pro- gram (Avionics May 27, p. 20).

General Electric officials said Sncema's participation in the development program did not mean a commitment had been made to full-scale development and produc- tion effort for the UDF, but that it did constitute a first step in that company's "revenue-sharing participation in future phases of the program.

By midweek, Pratt & Whitney, Rolls- Royce and the Allison Gas Turbine Div. of General Motors had responded by assert- ing that the gearless design being de- veloped by General Electric for the UDF—recently designated GE36—was the wrong technical approach. They also contended that the company's plans to cer- tify the engine in December, 1990, for its advanced design teams were pursu- ing development of propfan options, but added that they thought the best technical approach was to use a gear-driven fan. They also agreed that the first application should be on a military aircraft, such as the Future International Military/Civil Airliner (FIMA).

For its part, General Electric said that acoustic testing of powered scale models of the GE36 have demonstrated that it will meet the U.S. Federal Aviation Admin- istration's latest noise regulations. This means the program's schedule of cer- tifying the engine by December, 1990, can be maintained, one General Electric official said.

In addition to Sncema, General Electric is discussing participation in the GE36 program by Sweden's Volvo Flygmotor AB, Alfa Romeo and Fiat Aviazione in Italy and companies with jet engine capable- inities in the People's Republic of China. Some engine company officials dis- missed the GE36 project as an attempt by General Electric and the Boeing Commer- cial Airplane Co. to derail the Airbus In- dustria A320-190-passenger transport program and the candidate V2500 engine the five-nation International Aero Engines (IAE) consortium is developing for it.

Boeing recently opted out of the compe- tition to develop a 150-seat transport in the A320 class using current technology in favor of pursuing an advanced technol- ogy New Airplane Program (Avionics Feb. 4, p. 28).

Boeing officials reiterated their belief that the technology advantages to be gained support the company's decision to delay development of an all-new transport until 1992 and to use a propfan type en- gine as the baseline engine for the aircraft. In addition to the GE36, Boeing is consid- ering a geared propfan design being off- ered by Allison.

McDonnell Douglas officials said they cannot afford to ignore the efficiency gains being projected by General Electric for the GE36, and therefore are pressing the company to build a second demonstra- tor UDF engine based on a F404 engine core. General Electric presently is com- mitted to building a single demonstrator engine that will be test-flown first on a Boeing 727-100 and later on a McDonnell Douglas MD-80 series transport.

On the static display line, the center of interest was the Soviet Union's Antonov An-124 wide-body cargo aircraft, which made its first appearance in the West and participated in the flying demonstrations (Avionics June 3, p. 57).

The Soviets also displayed and flew the Kamov Ka-32 and the Mi-26. It was the first appearance in the West for the Ka-32, a utility helicopter with a coaxial, counter-rotating dual main rotor system and a maximum gross takeoff weight of 12,600 kg/27,720 lb. The Mi-26, one of Russia's largest helicopters with a maxi- mum gross weight of 125,200 lb., made its first appearance at the Paris show in 1981 (Avionics June 8, 1981, p. 49).

The flying displays featured several new aircraft this year, including the Soviet An-124 transport and Ka-32 helicopter; the Aeritalia/Aermacchi/Embracer AMX fighter bomber, the Yagnatov/Romania's Zlin-142 regional transport; Israel Aerospace Industries' Westwind Astra business jet; Italy's Agusta A129 attack helicopter; and Clau- dius Dornier's Seastar amphibious.

Interest in the flight demonstration pro- gram was dampened by the absence of Northrop Corp.'s F-20 Tiger- star. The second prototype crashed late last month at Goose Bay, Labrador, as Northrop test pilot David Barnes was practicing its Paris flight demonstration route. The crash brought the flying display to a halt May 20, p. 22).

A record number of more than 1,000 exhibitors from 33 countries participated in the 36th Paris air show (Avionics May 27, p. 28, Apr. 29, p. 34).

A majority of the large aerospace firms reported excellent attendance at their cha- lets and product stands despite early concerns about terrorist attacks at the show and the precautions taken to guard against that threat. Hot, sunny weather prevailed throughout the first week of the show, and was broken only by...
brief thundershowers near the end of the show.

Some exhibitors said attendance was so low the first two days of the show that it was not worthwhile for senior executives to arrive then. They suggested starting future shows a day later, making press day on the first Friday. That would allow most executives to avoid Paris completely during the crowded weekend public days and arrive fresh for Monday, when the real business of the air show began.

Entrances to the show grounds were more tightly controlled than in previous years, although it was evident that it was impossible to seal completely the exhibition area to penetration by an organized terrorist attack. Armed French police/troops guarded the grounds during the day and special security teams patrolled the outdoor static display areas and the indoor exhibition hall stands by night.

Visitors to exhibitors' chalets were closely monitored, especially early in the show. Invitations were checked at entrances and briefcases and handbags were examined prior to entry. In many chalets, visitors also were required to leave their briefcases in checkrooms outside the main chalet rooms.

Several companies reported difficulties during the first two days with chalet services such as telephones, electrical power and water supplies, but these problems generally had been solved by the first weekend of the show.

The U.S. pavilion introduced some of the strictest security measures for display halls and stands at the show. The measures were enforced even before the show's opening to prevent the planting of time-delayed explosive devices.

Armed French police/military sharpshooters were in evidence on rooftops at a number of key locations at Le Bourget.

Squadrons of bomb and munitions specialists were positioned around the Le Bourget exhibition area and early in the show responded to several bomb scare calls from chalet employees who found stray briefcases or packages. By midweek the number of alarms had dropped off signifi-
cantly as visitors either began to watch their briefcases and handbags more carefully or chalet and exhibit stands employees got over their show opening jitters.

Three primary U.S. aerospace companies that did not participate in the 1983 Paris air show—General Dynamics, Lockheed and McDonnell Douglas—returned to the show this year.

Lockheed and McDonnell Douglas had cited increasing costs as their reason for declining to participate in 1983. Costs were significant for all participants in the 1983 show, but were particularly heavy for U.S. exhibitors because of the dollar/franc exchange rate at the time. The dollar was worth 4.5-5 francs two years ago.

This year, the dollar is worth almost twice that rate—from 9-10 francs on most exchanges. This meant that, except for effects of inflation over the past two years, U.S. exhibitors were paying only half as much for the goods and services they were buying here in conjunction with participation in the air show.

This was not the primary factor cited by either Lockheed or McDonnell Douglas, however, for their return to Paris. Lockheed executives said the company had polled its marketing and public relations organizations last year and decided to participate in this year’s show as a result of that poll.

The firm had no brand-new programs to introduce, but did bring its C-130 High Technology Test Bed (HTTB) aircraft and airborne early warning (AEW) derivative of its P-3 Orion anti-submarine patrol aircraft to exhibit. The latter was flown in daily demonstrations at the show.

McDonnell Douglas’ decision to return to the Paris show was oriented primarily around the AH-64 Apache attack helicopter produced by the company’s Hughes Helicopters subsidiary for the U.S. Army. A large potential export market is forecast for the aircraft because of the growing requirements in many countries for this type of antitank/antitank system.

Ironically, the U.S. Army decided several weeks before the show to cancel plans to allow several types of Army helicopters, including an AH-64, to self-deploy from the U.S. to Europe along a North Atlantic route. McDonnell Douglas was unable to make other arrangements to wash an Apache from the Army and have it airlifted to Europe in time for the Paris exposition.

Most Hughes Helicopters executives canceled their plans to attend the show. The McDonnell Aircraft Co. division had already decided against heavy participation by its St. Louis-based executives, and the company was represented instead by few members of its European-based staff.

Most of the corporate representation at the show was left to the Douglas Aircraft Co., which had a small display of scale models of its present and future commercial aircraft line in a booth in the aircraft static display area. LTV did not take chalet space this year, but maintained headquarters in a Paris hotel, as they did in 1983. The company had a sizable static display area on the Le Bourget ramp that featured the company’s Army Hummer multipurpose land vehicle. Company officials said here they are going to meet after this year’s show and evaluate how they will participate in the 1987 exposition.

General Dynamics took a large chalet space this year, but was unable to get a location on the outer “B” line facing the flying display over the main Le Bourget runway. The company had two USAF F-16s—an F-16A and an F-16C—at the show, and both were parked in the static display area behind the chalet between flight performances. One company official said concerns that the chalet location might reduce the number of visitors was borne out, and that attendance had been very good.

China was represented for the first time at the Paris air show this year by the China Precision Machinery Import/Export Corp. (CPIEMC).

Final approval for CPIEMC’s participation was received from the Chinese government only 40 days before the show opened, according to one official in the delegation. But the group decided to attend anyway, because the gathering at Le Bourget afforded an excellent opportunity to market its small line of antiship and air-to-air missiles and to offer launch services on China’s CZ-1, CZ-2 and CZ-3 expendable launch vehicles (AWST Oct. 8, 1984, p. 48).
Four European Nations Expect To Proceed With EFA Definition

Paris—Aerospace industrial partners in four European nations—Britain, West Germany, Italy and Spain—expect to begin work this summer on an 8-10-month project definition study for a European Fighter Aircraft (EFA).

The four will issue a standing invitation to other nations in Europe to join the program. Dutch government officials at the Paris air show expressed interest in joining a European fighter development consortium, although their requirement for a new aircraft will be timed later than the other nations now in the EFA program.

The government of the Netherlands will complete a series of studies by the end of August on participation in a program such as EFA, according to Jan van Houwelingen, Dutch secretary of state for defense.

The governments currently in agreement on European Fighter Aircraft development requirements are believed ready to approve the formation of the four-nation consortium immediately after the forthcoming meeting of the defense ministers of the four nations and France in London June 17-18, unless they can agree on a common design.

The move will effectively remove France from the EFA program and will permit work to start, possibly in time to meet the 1995 in-service date set for the EFA aircraft (AWST June 3, pp. 61 and 119).

Last-Minute Shift

Industry leaders at the Paris air show held out little hope that a last-minute shift in the French position on the type of aircraft needed would save the original five-member EFA development consortium.

Fausto Cereti, president of Aeritalia, the Italian member of the EFA airframe development consortium, said “at least four” of the five EFA group nations would begin formal definition studies on the aircraft by September.

“If one nation stays out, we will hope that within a month or two they will decide it is in their best interest to come in,” Cereti said. “If they don’t, we will go on without them.”

This view was shared by senior British and West German aerospace industry leaders. “From the German side, we cannot wait any longer,” one senior official of Messerschmitt-Boelkow-Blohm said. “It appears that the four nations agreeing on the fighter requirement will have to go ahead but leave the door open to others to join later.”

A senior British Aerospace official said the company “hoped to move into a project definition phase in July or August, which would last eight or ten months and would permit us to launch the development program in the spring or summer of 1986.”

French officials earlier in the week had reiterated their demand for effective control of the development program as the only terms under which they could participate.

B. C. Valtiers, president of Dassault-Breguet, the French airframe member of the original EFA group, said his company’s experience in developing agile delta-wing combat aircraft should qualify it for leadership in the design and development phase of the EFA project.

Officials in some of the EFA countries expressed bitterness at the French attitude, but others sympathized and acknowledged that the French faced some unusual problems.

“Germany initiated the present five-nation project, and we still want a cooperative development program, starting with agreement on a common configuration,” one West German aerospace official said.

He said the Tornado was developed jointly by three nations because the three governments ordered their respective industries to complete the work by a specified time.

“Then we had an agreement,” he said. “Now we have an understanding—you can hardly call it an agreement.”

French Demands

Several officials said France’s problem was not that the country wanted design leadership on the EFA program but that “they want everything—design leadership, engine leadership, location of the development and assembly work and flight test.”

A senior British official noted that the French faced difficult problems in seeking to gain consensus on development of a new common fighter aircraft.

“Dassault has an outstanding export record, which caused them to expect too

Full-scale model of the British concept of a European Fighter Aircraft was displayed at the Paris air show last week. Model is based on the earlier Agile Combat Aircraft displayed in 1982 (AWST Sept. 6, 1982, p. 80). Single fin has replaced the twin vertical fins, and the wing is more of a pronounced cranked delta than the earlier version. Air intakes also have been modified.
much from a partnership arrangement as payment for their past achievements," he said.

Dassault also had no partnership experience in a program such as the Tornado, for example. "Finally you have to ask whether the French political establishment is ready to join a Panavia-type partnership," he said.

At the same time the industry officials were discussing a realigned EFA development program, they were discounting the possibility of the program's becoming a transatlantic development effort involving U.S. companies.

**Strike Eagle Decision**

"The possibility of a transatlantic project was killed practically when the U.S. decided on the [McDonnell Douglas F-15E] Strike Eagle," Cereti said. He said that Italy and others in Europe had anticipated a buy of the Panavia Tornado to fulfill the ground attack role at least in Europe.

"That [the failure to purchase Tornado] showed there was no possibility of a two-way street with the U.S.," he said.

The Dutch also were skeptical of the possibility of U.S. involvement in the program. Van Houwelingen said the Netherlands would push for European cooperation, based at least partly on the Dutch experience in the General Dynamics F-16 program, among others.

"When we go to the U.S. government to talk about offsets, we are told that they are the responsibility of industry. When we go to industry, they say the offsets are the responsibility of the government. So we support European cooperation," he said.

And, he added, "research and development costs are too much for any one nation to do it alone. We must keep stimulating cooperation."

The EFA program drew attention early in the Paris air show when West German Defense Minister Manfred Woerner said that Germany "will not participate in the French or British fighter aircraft that are being developed. If we participate... it will be in an entirely new program."

Neither of the aircraft now being developed—Britain's Experimental Aircraft Program (EAP) technology demonstrator and France's Rafale aircraft—met Germany's specifications, he said.

The statement was interpreted as meaning that West Germany wanted a third design, different from either of the existing aircraft.

"That's correct," a senior West German industry official said, "but it's not a new position. It has been stated several times that Germany wants a jointly developed and jointly produced new aircraft and does not want to be merely a subcontractor on someone else's design."

Germany, he said, wants a twin-engine aircraft that would be a "genuine fighter" in the Central European area beyond the year 2000.

"It's time to get started on this program," he said. "We have a very small window in which to develop the aircraft, and it is closing some each day. If it closes on EFA, we will have to find some other window."

**Operational Needs**

British officials said the lighter aircraft proposed by the French would have difficulty in achieving the operational capability that is required by the four other nations.

Point performance could be met by such an aircraft, one official said, "but that's like the aircraft being demonstrated here at the Paris show with no weapons and little fuel. It's not what's required for military operations."

The British believe the French requirement for 50-100 naval versions of the EFA to equip the French navy's two aircraft carriers also is causing the French government to fight to keep the weight down. □

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**Yugoslavia Displays Orao Aircraft With Uprated Viper Engines**

Yugoslav Orao light attack/close air support aircraft was one of those appearing for the first time at Paris, in both static and flying displays. The aircraft exhibited was one of the first in the Orao series to fly with upgraded Rolls-Royce 633-41 Viper engines.
Boeing Vertol, Sikorsky Team For LHX Design Competition

Paris—Boeing Co.'s Vertol Div. and the Sikorsky Aircraft Div. of United Technologies Corp. signed a memorandum of understanding here at the Paris air show to team for the U.S. Army's upcoming light scout/attack/utility helicopter (LHX) competition.

The Army plans to purchase up to 4,500 light twin-engine helicopters in the LHX program in two basic configurations—a single-pilot machine for the scout/attack missions and a two-pilot version with a larger fuselage for the utility missions (AW&T Apr. 15, p. 24). The engine for the LHX will be bought in a separate procurement and provided to the winner of the airframe/systems contract as government-furnished equipment.

Boeing and Sikorsky started serious discussions on forming a joint team for LHX about three months ago, according to Joseph Mallen, president of Boeing Vertol. Earlier, Boeing also talked with Bell Helicopter Textron and McDonnell Douglas Corp.'s Hughes Helicopter Div.—the other helicopter companies considered to be prime contenders for the LHX contract, Mallen said.

“We had three columns on a sheet of paper at that time and when we added them up, we felt Sikorsky was the best option,” he said. “What tipped the balance in favor of teaming with Sikorsky was the fact that several of their major strengths matched ours in such a way that adding one and one from each side equaled more than two.”

Composite technology, which will be a critical element in achieving the lightweight high-strength structure the Army is expected to specify for LHX, is one of those strengths, Mallen said. During the next 90 days, Boeing Vertol and Sikorsky will negotiate the final details of the teaming arrangement on LHX and establish a joint preliminary design team. This team will be colocated at either the Boeing Vertol facility near Philadelphia or the Sikorsky facility in Stratford, Conn.

The program manager for the combined LHX will be selected from Sikorsky, according to William F. Paul, president of Sikorsky. Other details of the teaming arrangement and the composition of the joint design team will be established in the next 90 days. Another issue to be resolved during this period will be the selection of the subcontractor and system suppliers for the joint LHX team.

“That’s the next step to be taken, but it is certain that Martin Marietta will be a central figure in our LHX team,” Paul said. “They are key to our sensor fusion approach to the LHX weapons management system because they have the best grasp of the Army’s battlefield requirements.”

Paul added that Sikorsky has demonstrated large-scale systems integration skills, which are expected to be important to a successful LHX program, and that this, matched with Boeing Vertol’s extensive production experience, gives Boeing/Sikorsky a strong basis from which to compete in the LHX program.

De Havilland of Canada Developing Stretched Version of DHC-8 Transport

De Havilland of Canada will deliver 26 DHC-8 transports this year and is considering increasing its production rate in 1986. The aircraft is shown above at the Paris air show. The company has completed a full-scale mockup of the stretched DHC-8 Series 300, which could be ready as early as 1988. The Series 300 will compete directly with the DHC-7. De Havilland expects the Series 300 to replace the DHC-7 in the standard 50-seat commuter role, and that the DHC-7 will mainly be bought for short takeoff and landing (STOL) applications.
France’s Aerospatiale and Dassault-Breguet exhibited scale models of their proposed designs for the Hermes manned space shuttle vehicle at the Paris air show. The two companies are competing for the Hermes prime contract, and the French CNES space agency is expected to select the winning prime contractor this September. Dassault-Breguet’s Hermes model (above) included astronauts working on a satellite in the open payload bay. Dassault-Breguet has used its experience from the Mirage fighter aircraft family in developing its Hermes proposal. Aerospatiale’s Hermes model (below) includes a raised upper fuselage profile, which begins behind the cockpit, where a docking port is located. Cockpit layout for Aerospatiale’s Hermes was derived from the company’s Airbus A320 cockpit concept.
British Aerospace Hotol space launcher model, displayed at the Paris air show, has three propulsion engines located at the rear of the spacecraft's long fuselage (top). Three smaller engine bells are visible and there also are maneuvering engines on the vehicle. The spacecraft would be 62 meters from nose to engine bells, slightly longer than the present Concorde supersonic transport (A\&WAST June 3, p. 356). Underslung engine air intake is a semi-circular, two-cone external compression design (photo directly above). Location under the wing permits the intake to take advantage of the undersurface compression effect. Note curvature of wing undersurface. The wings were developed from the Concorde design, but have been refined for increased lift. Wings are located aft to provide stability with the heavy, aft-mounted rocket motors. The cargo bay, approximately 24.6 ft. long, is located immediately forward of the engines and liquid oxygen tanks, and the vehicle's liquid hydrogen tanks are ahead of the cargo bay. View from under the forward portion of the Hotol fuselage (right) shows wing curvature and landing gear arrangement. This view makes the fuselage appear slightly longer in relation to the wingspan than it really is.
Soviet Design and Large Aircraft

Without much doubt, the Soviet Antonov An-124 large cargo aircraft dominated the Paris air show this year, simply in terms of sheer size. Most of the show days it spent parked at the far end of the ramp at Le Bourget Airport, where curious visitors from the West stood around its protective fences negotiating for a chance to go on board. Many did so, for the team from the Antonov design bureau brought in with the aircraft were proud of the new airplane and were in a properly affable mode that fit with the bubbly atmosphere that traditionally marks the Paris air show.

The An-124 flew a qualifying hop early in the air show for its later flight demonstration planned to coincide with its departure for home. It flew a couple of turns around the field with relative agility for an airplane of its size. It landed on the 8,700-ft. show runway—empty—in less than half the available distance, demonstrating one of the requirements laid down for the transport. In that respect and in its configuration, it is in the same class as the USAF/Lockheed C-5 but slightly heavier at about 900,000 lb. maximum gross weight. Although the fuselage cross-section and wing-engine layout are similar to the C-5’s, the Soviet airplane has a low instead of a T-tail and the nose and radome have the characteristic notch of the Antonov forward fuselage in the An-76, An-22 and An-12 cargo airplanes. Like the C-5, it has room for passengers on the upper deck behind the cockpit.

A tour of the airplane led by Petr V. Balabouev provided a rare opportunity for a close look not only at a new Soviet aircraft not yet in service but also at the new generation of Soviet design bureau leaders coming onto the scene. Balabouev has spent his career at the Antonov design bureau and was deputy to O. K. Antonov for 13 years before succeeding him after his death.

Relative agility in flight of the An-124 was not imagination. The airplane has a fly-by-wire control system, quadrupled for redundancy and backed up by an independent hydraulic system. Fly-by-wire is an intriguing technical jump for Soviet transport aircraft, which were slow to move into power controls. There are also other technical features, interesting from the standpoint of simplicity or operational usefulness:

- Last two bogies on each six-bogie side of the main landing gear are steerable. Balabouev said the airplane can be turned around 180 deg. on the ground in the width of a 150-ft. runway. Ground turning requirements for the C-5 were a reason cited for U.S. development of the smaller USAF C-17.
- Carbon composites are used on landing gear doors in other areas of the aircraft but strictly in secondary structure. Glass fiber also is used in similar ways.
- Nose section of the aircraft opens upward for front access to the cargo compartment but excludes the cockpit area to avoid breaking electrical or hydraulic lines at a hinge joint.
- Floor of the cargo compartment is studded with what look like round-head rivets about a quarter of an inch in diameter, part of the Soviet system for cargo restraint. Tie-down lugs were not in evidence but there were bolts in the floor that the crew told visitors were used for this purpose.
- Two separate struts, each with two-wheel bogies, make up the nose gear. This layout was lighter, according to design studies, Balabouev said. There were shimmy problems to begin with, but they were overcome, he said.
- Deicing system uses an electrical pulse to break off buildups, as well as a hot air system for keeping surfaces clear.
- Hatches in the upper deck provide maintenance access to the wing and tail, a Soviet design detail for operation in remote areas where work stands are not available.

Most significant about the aircraft is the appearance of a Soviet high-bypass-ratio turbofan engine. Its development, after Western refusal to sell commercial high-bypass engines to the Soviets in the 1970s, has come about a decade later. The engine, from the Lotarev design bureau and designated the D18T, has a thrust of 51,400 lb., a bypass ratio of about 6:1 and a cruise specific fuel consumption, the Soviets said, of 0.057. For maximum efficiency in cruise, the airplane is trimmed out with a slightly aft center of gravity so that it flies with 2-3 deg. nose up, as some wide-body commercial transports do. Thrust reversers reduce the aircraft’s landing roll 25-30%. In flight at Le Bourget, the four engines were in the same general noise ballpark as Western high-bypass engines.

A distinctly Soviet design feature for the An-124 is that, in effect, it is designed as a system with the 20-metric ton (44,000-lb.) payload Mil Mi-26 heavy-lift helicopter. The An-124 with its 150-metric ton (330,000-lb.) payload is the wholesale delivery system to remote areas in such missions as oil field support. Its load is prepalettized in 15 sections of 10 metric tons each, which can then be loaded one or two at a time into the Mi-26 as the retail deliverer to the user in the field, civil or military. Other Soviet cargo transports and helicopters are similarly matched as load carrying systems.

When the An-124 enters service—the aircraft at Paris was the first production version—it will do its heaviest load carrying in the nine coldest months of the year. It is designed to land on frozen lakes, swamps or rivers where it links up with the Mi-26, all done without any special airfield construction work. For oilfield support in areas where no surface transport exists, the An-124 will be able to carry about 80% of Soviet heavy petroleum equipment.

While the An-124 owes something to U.S. design, it also has its own Soviet concepts—particularly in load matching with the Mi-26. Another point of interest to the U.S., which takes over 10 years to develop an aircraft now, is that the An-124 basic design was done six and a half years ago, the design frozen about four and a half years ago, and the first flight was Dec. 27, 1982. Once the Soviets overcame the high-bypass engine problem, the development of the An-124 moved along with dispatch.

—WILLIAM H. GREGORY
Soviet An-124 Nose Section Swings Up to Aid Cargo Loading

Soviet Antonov An-124 wide-body cargo aircraft, which was displayed for the first time in the West at this year’s Paris air show (above, this page), is equipped with a hinged, upward opening nose section that permits loading to the full vertical and horizontal cross-section of the cargo bay. Separation line between hinged nose section and remainder of fuselage can be seen in side view of the aircraft (top left on facing page) just behind the number 8 and forward of crew access door and steps. Integral forward loading ramp is stowed in folded position in forward cargo bay (top right, facing page) and can be extended and retracted using on-board hydraulic power. Cargo compartment (lower right, facing page) is 119.8 ft. long, 21.1 ft. wide and 14.5 ft. high, and it is capable of accommodating a 330,000 lb. (150,000 kg.) payload. Titanium floor plates are used to control weight and numerous tie-down points are available to restrain cargo. When extended, integral loading ramp (lower left, this page) allows vehicles to be driven in and out of the cargo bay without the need for any external support equipment. Ladder visible in forward cargo bay (bottom right photo, facing page) provides crew access to flight deck, which does not fold upward with the rest of the nose section. Integral jacks in the nose of the aircraft extend and dual-strut nose landing gearfold forward (lower left photo, facing page), permitting aircraft to kneel for loading/unloading. Nose gear for this maneuver appears to be electro-mechanically actuated. Procedure is reversed when loading/unloading operations are completed.
Cockpit of the Antonov An-124 cargo transport is relatively uncluttered compared with earlier Soviet transports and reflects the incorporation of recent flight control and avionics technology. Automatic flight control system control panel at top of glareshield (photo above) is similar to arrangement on many Western transports. Vertical tape engine instruments are installed in center instrument panel, just above weather and ground mapping radar displays (square screen and round screen, respectively, at center). Both pilot and copilot positions have conventional attitude indicator/flight director and horizontal situation indicators, and numerous caution and warning lights are mounted around basic flight instrument and in glareshield on each side of the automatic flight control system panel. Separate throttles are provided for the pilot and copilot, and a single set of thrust reverser handles are located between the two sets of throttles on the center console. A quadruple-redundant fly-by-wire control system is used in the An-124, and the control columns are attached to the floor in a ball and socket type arrangement. Dynamometers for gathering test data are mounted on each control yoke. In addition to the pilot and copilot, the cockpit has positions for two flight engineers, a radio operator and a navigator. Flight engineer's panel in the An-124 cockpit (photo above) appears relatively well-organized, with switches arranged to show the schematic flow of electrical, fuel and hydraulic systems. Backlighted, push-button on/off switches are used extensively on the panel, as they are on the most recent Western transport aircraft. Engine vertical tape instruments are at lower left in the photo. Not visible here, but located behind the engineer seated in foreground is a cathode ray tube maintenance diagnostics display similar to that installed in the Lockheed C-5A military airlift aircraft. Graphics on the panel depict the position of primary and secondary flight control surfaces and the status of such systems as landing gear and brakes. A crew rest area behind the flight deck has accommodations for a relief crew for long-distance or long-endurance operations.
Soviets Tailor Cargo Transport For Remote-Site Operations

By Donald E. Fink

Paris—Antonov An-124 large cargo transport is a USAF/Lockheed C-5A size aircraft which its designers say is tailored to support oil, gas and mineral exploration in the Siberian and northern arctic regions of the Soviet Union where it must be capable of operating from austere runways laid on frozen lakes and tundra.

The An-124 made its first public appearance in the West at the recent Paris air show (AWST June 3, p. 58). It is the No. 1 series production version, according to Anatolely Bounalenko, one of the Antonov design engineers who accompanied the aircraft to Paris.

While the aircraft has several design features that adapt it for operations from unimproved runways at remote oil exploration and geological survey sites, its suitability for heavy military airlift operations was evident to many observers at the Le Bourget exhibition.

It is powered by four Lotarev D-18T high-bypass-ratio turbfans that are rated at 51,840 lb. of thrust each. The engines, which are slung under the wings on aerodynamically clean pylons, are fitted with thrust reversers. Separate thrust reverser control levers are mounted on the cockpit central console between the pilot’s and copilot’s throttles.

The aircraft has a hinged nose section that swings up over the cockpit and upper fuselage, a foldout front-loading ramp that doubles as part of the forward cargo compartment pressure bulkhead and a combined rear door/loading ramp.

Opening both ends of the cargo compartment permits straight-through loading and unloading of large wheeled or tracked vehicles and oversized cargo pallets. The rear door/ramp also can be opened in flight for paratroops.

The deck height of the forward end of the cargo compartment is lowered to facilitate loading by pivoting the nosewheel units about the midpoint on each strut. The rear portion of the cargo deck is lowered by compressing the hydraulic struts on the main gear units.

Rows of hydraulic pumps, each of which controls one of the five main landing gear struts in each main gear unit, are mounted on both inner walls of the cargo compartment.

Design features that suit the An-124 for operations from remote austere sites include:

- Dual radar systems—a circular antenna mounted in a nose cap radome for collision avoidance and weather scanning and an elliptical antenna mounted in a

Large truck emerges from cargo deck of Antonov An-124 transport during recent loading tests. Nose section pivots open over cockpit, and self-contained loading ramp folds out. Dual nose wheels pivot forward to lower deck height. (Tass photo)

Petr V. Balabouev, left, who succeeded the late Oleg K. Antonov as head of the Antonov design bureau, accompanied the An-124 cargo transport to the 1985 Paris air show and conducted guided tours of the aircraft for special guests. Balabouev was Antonov’s deputy for 13 years (AWST June 17, p. 13).
The An-124 has no inflight refueling system because its unrefueled range is sufficient to reach all potential operating sites in the Soviet Union, Boulanenko said.

The An-124 operating environment is quite different from that of USAF C-5s, which need aerial refueling because they have to operate non-stop over much longer stage lengths, he said.

The four-channel fly-by-wire flight control system in the An-124 has a fifth mechanical backup link, and it has performed well in flight tests, he said. The aircraft ultimately will be certified to International Civil Aircraft Organization (ICAO) Category 3A approach standards, including the 60-meter (200-ft.) decision height.

Category 1 Operations

"We are operating the aircraft only to Category 1 standards now, but will soon start tests to qualify it for Category 2," he said. "Then we will move to Category 3A operations."

The An-124 is scheduled to start civil operations in November, 1986, Boulanenko said. The first Aeroflot flight crews have been selected to fly the aircraft and have completed their ground school and simulator training, he said, and they were scheduled to begin flight training in the No. 1 aircraft when it returned to Kiev from Le Bourget.

Initial production rate on the An-124 will be relatively slow to insure that design modifications identified in the continuing flight test and certification phases of the program can be included in subsequent aircraft, he said.

Interior and exterior workmanship on the An-124 is superior to previous Soviet aircraft displayed at the Paris air show, in the opinion of several observers. The exterior of the aircraft is aerodynamically clean and from a manufacturing point of view showed more emphasis on such details as smooth production joints, rivets and seals.

This is especially evident in the areas where conventional aluminum sections of the An-124 airframe are joined with composite sections, according to one observer.

Composite Parts

The design uses 5,500 kg. (12,000 lb.) of composite material in a variety of non-load bearing portions of the airframe. A total of 2,500 kg. (5,500 lb.) of this is carbon epoxy material and the remainder is glass fiber.

Composite elements on the aircraft include sections of the nose and the radomes, the landing gear sponeons and doors, the engine cowlings portions of the nacelles, elements of the flap system, the fairings covering the wing roots and horizontal stabilizer/fuselage joint, the wing and horizontal stabilizer tips and the tail cone.