The Sukhoi Su-27 has plenty of "pooke," excellent maneuvering capability and truly impressive slow-speed handling characteristics.

This was the comment of Air Chief Marshal Sir Peter Harding, chief of the Air Staff of the Royal Air Force after flying a Su-27 from the Farnborough Airshow with Sukhoi chief test pilot Viktor Pougachev at Farnborough on Sept. 7.

The flight by Harding in the late afternoon following the air show was the 100th different type of aircraft, including helicopters, flown by the head of the RAF. Harding is current in the RAF Tornado versions and regularly flies the British Aerospace 250, which is used for military support missions. The air chief marshal also has flown the USAF Rockwell International B-1B, the McDonnell Douglas F/A-18 and the General Dynamics F-16.

"I was impressed with the fact that you could hit the engine start buttons before pressing in and by the time you were fully plugged in, you could taxi-
power was reached. The acceleration was rapid, and at 115 kt. I rotated the nose of the aircraft to a 10-deg. climb attitude. The aircraft lifted off at 135 kt. after a takeoff roll of 1,100 ft. and approximately a 10-sec. roll.

The landing gear lever was pulled out and up to raise the flap, and the flap button was pushed to raise the flaps. There is only an up and down button on the flaps, with no intermediate settings. As I attempted to pull the throttles back to climb power, I momentarily forgot that the latches in front of the throttles that must be depressed to enter the afterburner regime also have to be depressed to come out of afterburner power. At first I thought that Pougachev wanted me to stay in afterburner, but a call from the back seat—"Dave, afterburner"—prompted me to lift the latches and reduce power. By this time, I had exceeded the 5,000-ft. altitude given to me by air traffic control and had to perform a sharp inverted roll to acquire the correct attitude. Not helping was the fact that the altitude instrumentation in the Su-27 is in meters and the speed in km./hr., requiring me to make quick mental calculations.

About this time, I was struck by the realization that I was an American flying an unfamiliar Soviet fighter over the English countryside with a Soviet pilot who did not speak English. However, knowing that Viktor Pougachev is one of the top Soviet pilots and that British air traffic control is extremely professional calmed me. I had been switched to London military AC for the flight to Boscombe Down. The military control cleared us to operate from 4,000 ft. to flight level 150 (35,000 ft.) and kept us under radar surveillence so we would not stray outside the control area.

During the 5-10-min. flight to the control area, I had time to get a better look at the cockpit instrumentation. During the flight in the MiG-29, and now the Su-27, there had been no question of turning on the radar, the infrared sensors or the head-up display. Earlier requests had been turned down by both the Mikoyan and Sukhoi pilots, so I made no request this time to operate the systems.

The front cockpit of the Su-27 is spacious compared with many Western fighters. The size of the cockpit is more on the scale of the F-15 than other aircraft. Visi-
bility is excellent in all directions, and there did not seem to be any distortion in the teardrop shape canopy. The hand-up display and its mounting did restrict forward vision more than was expected.

IDENTICAL FLIGHT INSTRUMENTS

Cockpit instrumentation of the Su-27 is very similar to that of the MiG-29. The attitude gyro, horizon, attitude indicator, airspeed and altitude indicators, and rate of climb appear to be identical in both Soviet fighters. The weapon control panel was raised from this Su-27, but would normally have been located in the upper left side of the instrument panel.

The engine instruments in both aircraft are different, as is the fuel quantity gauge. Pougachev said the Su-27 does not have a fuel flow meter, or gauge, and one could not be seen.

The Sirena II passive radar warning on the lower right side of the instrument panel appears to be the same as the one mounted in the MiG-29. The aircraft test equipment panel installed in the Su-27 also looks identical to that of the MiG-29.

While the aerodynamic performance of the Su-27 is excellent and is comparable to or better than Western fighters, the cock-
pit is where some shortcomings are evi-
dent. The Soviets believe in designing aircraft that are reliable and simple to op-
erate. But the lack of computer and system integration technology places the Soviet pi-
lot at a disadvantage in terms of situation awareness. The Soviets are flying Su-27s and MiG-29s with cathode ray tubes in the
cockpit, but when these are unveiled in the coming months, they will still be behind current Western cockpit technology.

Once in the Boscombe Down area, I commenced three successive aileron rolls to the left. The stick was displaced only half the available distance, but the roll rate was still impressive and was approximately 150 deg/sec. Pougachev said the maximum roll rate of the Su-27 is close to 270 deg/sec. The roll rate is higher than that of the F-15C, but it is in the same roll rate regime as the F/A-18. The stick pressure to achieve this roll rate was very light. Pougachev said that this aircraft belonged to another test pilot who was a former Su-26 aerobatic pilot and preferred lighter stick forces. The single-seat Su-27 flown by Pougachev is programmed with a 50% higher stick force, more in line with military aircraft, he said.

ANALOG FLY-BY-WIRE SYSTEM

The Su-27, unlike the standard MiG-29, is equipped with a four-channel analog fly-by-wire flight control system. Each control system has its own computer and air data source mounted on the fuselage. There are four control lights on the left console and Pougachev said earlier that if any of the lights came on, to depress the appropriate switch.

I flew several split-S maneuvers to obtain a feel for the aircraft. The first two were flown at different airspeeds, and by using military power (maximum power without afterburner) and pulling 4 g I was able to resume level flight in less than 3,000 ft.

The final split-S was started at 220 kt. at maximum power. Attempting to keep a constant 24-deg. angle of attack results in a loss of 2,300 ft. and an ending speed of close to 220 kt. During the maneuvers, there was no wing fall-off and no buffet. A half Cuban eight was started at 375 kt. with a 6.5 g pull-up in maximum power. The starting altitude was 8,200 ft. and the ending altitude was 12,000 ft. with an airspeed of 185 kt. Again, there was no buffet and aircraft control was positive throughout the maneuvers.

Afterburner power was used sparingly during the flight, although when it was used, there was only a short lag before the acceleration could be felt. The maximum power of the AL-31F engines in afterburner is close to 27,500 lb. of thrust each, giving the Su-27 better than a 1.0 thrust to weight ratio at mid-gross-weight takeoffs. Military power is close to 18,000 lb. of thrust each for the engines. The afterburner in the Lyulka engine is a single stage with metered fuel, giving a steady power increase from the minimum afterburner setting to maximum power. This is unlike the Pratt & Whitney F100 engine in the F-16 and F-15, which incorporates multiple stages in the afterburner range.

The next maneuver I performed, as briefed earlier by Pougachev, was a low-speed loop. Entry was at 270 kt. and 6,500 ft. Military power was used as I started the loop pulling 4 g. The angle of attack was around 15 deg as the Su-27 topped out at 9,800 ft. and at 118 kt. The downside of the loop ended at a speed of 192 kt. while pulling close to 24-deg. angle of attack on the bottom of the loop.

I had intended to enter a tight 360-deg. turn at 7 g in afterburner, but Pougachev indicated that I should stay in military power because of the 426-kt. entering speed. Following the flight, Pougachev said that at 426 kt., we would have exceeded Mach 1 during the turn in afterburner power. General air show limitation restricted us to airspeeds below Mach 1. In military power, the 7 g maneuver was performed with the speed the same coming out of the full circle. Below a speed of 370 kt. and entering the turn prior to the application of power, the turn could have been completed without exceeding Mach 1, Pougachev said.

Slow-speed flight was entered at close to 10,000 ft. by first pulling the nose of the aircraft up to a 25-deg. pitch attitude and then using close to maximum power to maintain a 26-deg. angle of attack. There was positive pitch and roll control throughout the slow-speed routine. The speed was 97 kt. and we were descending slightly because of the altitude and the fuel load. Pougachev performs this maneuver during his aerobatic routine and maintains altitude at close to sea level. The 26-deg. angle of attack is a Soviet
military limitation, and the aircraft is capable of maintaining a much higher angle of attack.

A similar routine in the Navy F/A-18 flown earlier yielded a 35-deg. angle of attack and a 90-knot speed with the same amount of controllability. The slow-speed flight in the F/A-18 was at 15,000 ft., and we also had a rate of descent of 2,000 fpm. established at military power.

Pougeachov then performed the next two maneuvers while I followed him on the stick. At 7,000 ft. and with an entering speed of 320 kt., he pulled the nose up to a 75-deg. pitch angle. The power was set at 85% and at 10,000 ft. the airspeed indicator read zero. The angle-of-attack indicator was pegged at its mechanical limit of 38-deg. The Su-27 then slid back for about 3 sec. before the nose fell slowly through the horizontal to a nose-low attitude and Pougeachov added power. The altitude at recovery was 8,200 ft.

The Pougeachov Cobra was the next maneuver performed by the Soviet pilot. Pougeachov had not instructed me how to turn off the angle-of-attack limiter in the front cockpit, so he had to pull an additional 34 lb. of back pressure to go past the 26-deg. angle-of-attack limit. The Cobra maneuver was entered at 220 kt. at 10,000 ft. Pougeachov pulled very quickly on the stick and achieved close to a 90-deg. pitch attitude with an 85% engine power setting. The one speed that registered as I followed the maneuver was 83 kt. after the maximum pitch and before power was added to resume horizontal flight. The forward center of gravity of the two-seat Su-27 precludes pitching beyond 90 deg., Pougeachov said. During one Cobra routine at the Farnborough air show, Pougeachov achieved a 130-deg. pitch attitude. The low-speed maneuvering capability of the aircraft was impressive and the ability to point the nose of the aircraft throughout the slow-speed regime was equally impressive. The large differential horizontal stabilizers provided positive control in slow flight.

During the tail slide and the Cobra maneuver, the two Lyulka engines did not stall or give any indication of a problem. The engine temperature appeared to be stable during the maneuvers and remained at approximately the temperature corresponding to the 85% power setting. Although we did not perform any acceleration checks in the Su-27, Pougeachov estimated that the time to accelerate from 330 kt. to 540 kt. in maximum afterburner would be less than 10 sec. I found during the flight that power response was quick and positive.

Commenting later on the Su-27, Patrick Henry, McDonnell Douglas vice president of flight operations, said that the overall performance figures and airspeeds of the Su-27 were similar to those of a comparably equipped F-15. For many years, Henry was the F-15 air show demonstration pilot. The agility and low-speed maneuverability of the Su-27 represented by the Cobra and other maneuvers were truly impressive, he said.

The speedbrake in the Su-27 was not tried in flight, but Pougeachov said that the extension limit for the large speedbrake mounted on the top of the fuselage was Mach 0.9. There is no such limit for the F-15, but the F-15's speedbrake will not fully extend until airspeed decreases below Mach 1.3 because of the air loads, Henry said.

Another system not used during the flight was the panic system. The Su-27—as is the MiG-29—is equipped with a button on the control stick that, once depressed, brings the aircraft to wings level, right side up no matter what the attitude of the aircraft was when the button was pushed. The panic feature is tied into the autopilot system.

The incorporation of this system prompted me to ask Pougeachov after the flight about the spin characteristics of the Su-27. At first, Pougeachov said that the angle-of-attack limiter prevented operational pilots from departing from controlled flight and putting the Su-27 into a spin. He later added that during flight testing, the Su-27 was put into steep and flat spins, but that the spins had a slow rotation rate and were easy to control.

Following the Cobra maneuver, I once again took control of the Su-27 and asked London military control for a steer back to the Farnborough airport. The clear weather in the area allowed me to see the
Su-27’s Lyulka Engines Designed For 3,000-Hr. Service Life

Aviation Motors, told AVIATION WEEK & SPACE TECHNOLOGY, "His staff has done an excellent job since his death." The AL-31F engine is inspected every 100 hr. by the use of borescope, oil analysis, engine vibration monitoring and other parameters. Victor M. Chepkin, president and chief executive officer of the Lyulka engine design bureau, said.

TWO 1,000-HR. OVERHAULS

At the 1,000-flight-hr. mark, each engine is removed from the aircraft and dismantled and overhauled at the factory. All of the parts are inspected, and new engine parts are installed where needed. "The new parts that are put into the engine at the 1,000-hr. overhaul represent 10% of the cost of a new engine," Chepkin said. "The new parts are primarily in the high-pressure turbine and combustor chamber, although there are some from the fan section and afterburner."

Another overhaul is performed at 2,000 flight hr., and the new parts installed during this engine breakdown reflect 15-18% of the cost of a new engine, he said. The replacement parts are the same as identified during the 1,000-hr. overhaul. The AL-31F has been run for up to 12,000 hr. on a test stand, but Chepkin was reluctant to state the maximum flight hours accumulated by any one engine in service.

Lyulka is working to increase the efficiency and cycle life of the AL-31F engine by modifying the compressor and the combustion chamber. Increasing the temperature of the engine also has been evaluated.

Chepkin said that there have been no bearing problems in the engines. He also said that there are no engine cycle limitations and that the reliability of the AL-31F has been very high, especially measured against engines installed in earlier Sukhoi and Mikoyan fighters.

Approach speed for the Su-27UB is 140 kt. at a 10-deg. angle of attack. Touchdown was at 125 kt. Automatic braking system allows a stopping distance of 1,600 ft. for a normal landing gross weight.