

Washington Roundup

NASA Biomed Plans

National Aeronautics and Space Administration is assuring Congress that it will not duplicate the military services' work or facilities in space medicine. Dr. Clark Randt, chief of NASA's Office of Life Sciences, says he plans to build a small headquarters staff of 16-18 highly qualified professionals this year.

Randt says NASA will stick to basic research and won't duplicate the services' applied research in the bio-technology field. Space agency plans a small life sciences research center to permit the headquarters staff to keep current on research.

NASA plans to hold meetings of 30-35 experts in space bioscience within the next month or so to discuss improvement of bioscience experiments in space. Group will try to find better ways to use payloads available in space vehicles. It also will plan payloads aimed primarily at biological experiments.

Human factors expert Alfred M. Mayo will join NASA this month as assistant director for bio-engineering in the Office of Life Science Programs. Mayo currently is chief, equipment and safety research, for Douglas Aircraft Co.

Dr. Cornelius A. Tobias will join the space agency life sciences staff about Sept. 1. Dr. Tobias has studied the effects of radiation on humans. He will be on leave from the University of California.

Public Relations Policy

National public relations policy on key space shots is being set by the White House, not NASA, with Brig. Gen. Andrew J. Goodpaster, staff secretary, playing a key role. Latest Goodpaster idea is to bounce a tape-recorded message from President Eisenhower off the Project Echo communications relay satellite. Original tape stressed peaceful use of space, but plans have changed since the U-2 incident.

USAF's Operation Cherrytree, originally scheduled last month at Maxwell AFB, will now be held May 18-20 at Andrews AFB. Purpose of the meeting is to give top Air Force commanders a chance to take a hard look at weapon system development and production programs over the next decade (AW Apr. 4, p. 25). Conference is to determine the hard core of the USAF weapon structure over that period.

Soviet air force commander Chief Air Marshal K. A. Vershinin and nine top aides are scheduled to tour key USAF installations in a cross-country tour of the U. S. Soviet group will attend the Armed Forces Day show at Andrews AFB, then leave on a tour that will include Tactical Air Command headquarters at Langley AFB, Air Force Missile Test Center at Cape Canaveral and Strategic Air Command base at Ft. Worth, Tex.

USAF Missile Concern

Air Force is concerned over its lack of ballistic missile assembly, test and launch capability. USAF has relied on contractors to handle these functions in research and development launches. Contractors are still used as an important supplement to test and training activities at operational bases.

Major Air Force effort to increase its capabilities may come in the Dyna-Soar program. USAF may try to assume the assembly, test and launch roles in the boost-glider program.

Special House group is evaluating the aircraft nuclear propulsion program. Subcommittee of the House Appropriations Committee was established after that group questioned ANP progress when it approved the \$75 million Fiscal 1961 request for USAF's share in the program. Members of the special subcommittee now holding closed hearings on ANP are: Reps. George Mahon (D.-Tex.), Harry R. Sheppard (D.-Calif.), Louis C. Rabaut (D.-Mich.), Ben F. Jensen (R.-Iowa) and John R. Pillion (R.-N. Y.).

Russians apparently recovered the capsule ejected from Discoverer II last year which landed on Spitsbergen. Re-entering capsule and parachute were seen and located by three Norwegians. An intense search of the landing area produced no capsule, but there were signs that it had been found and carried to a nearby Russian colony.

Descending capsule should have been easy to see from the Soviet colony, but the Russians denied any knowledge of it when asked. Discoverer II was supposed to eject the capsule south of Kodiak, Alaska, for recovery near Hawaii. A minor malfunction and a programing error fired the retro-rocket prematurely.

Wrapup

Senate Defense Appropriations Subcommittee is scheduled to complete hearings on the defense budget this week, then move into closed meetings to make its final decisions. Senate version of the budget is expected by June 15 . . . General Accounting Office report on Air Force management of its ballistic missile programs is scheduled to go to Congress this week . . . Aviation subcommittee of the Senate Commerce Committee will begin hearings this week on proposed authority for the CAB to limit the type and extent of service in air carrier certificates.

—Washington Staff

U. S. to Continue U-2 Flights Over Soviet

**'Rocket' boast of Russians largely discounted;
loss of plane attributed to flameout of engine.**

Washington—United States will continue manned reconnaissance flights over the heart of the Soviet Union despite Russian retaliation threats until an effective surveillance satellite system becomes operational and/or an arms inspection agreement is reached.

The decision to continue such flights, which have been under way since 1956 at least, followed in the wake of the May 1 crash of a Lockheed U-2 high-altitude reconnaissance aircraft 1,400 mi. inside Russia near Sverdlovsk in the Ural Mountain region.

It also was a public indication of U.S. official disbelief in Soviet Nikita Khrushchev's boast that the U-2 had been downed by a single anti-aircraft "rocket" while flying at an altitude of 65,000 ft. and his boasts that similar "rockets" could destroy Strategic Air Command's bomber force.

The U-2, piloted by Francis Gary Powers, a civilian under contract to Lockheed Aircraft Corp., actually experienced a flameout of its Pratt & Whitney J75-P-13 turbojet engine near its maximum altitude of about 90,000 ft.

The aircraft had descended to about 37,000 ft. attempting an engine restart when last contact with the pilot was made. Efforts by Powers to restart the U-2 engine had not been successful down to this altitude.

At this relatively-low altitude, or lower, the plane may have been intercepted by either Soviet interceptors or ground-to-air missiles.

Several Versions

The U-2, whose design was begun in 1954, is not the only U.S. high-altitude aircraft available for reconnaissance missions over the Soviet Union.

Other, more advanced manned reconnaissance systems will go above 100,000 ft. using exotic fuels developed during the past five years and a lightweight supersonic airframe. These light metal, boron and hydrogen-based fuels have proved practical for specialized missions, particularly those where the turbojet engines can be overhauled after a few hours of running time.

Cost and handling problems have generally prevented the adoption of these fuels for wide operational use within the Air Force.

There also are several versions of the U-2, whose subsonic airframe is limited by Mach number effects to an altitude of approximately 100,000 ft.

While the U-2 downed over the Soviet Union was powered by a J75 engine, earlier versions were powered by a version of the lower-powered Pratt & Whitney J57. Range and altitude performance also probably have been substantially boosted since the initial

design through structural changes and internal improvements.

Gross weight of early versions of the U-2 with slipper tanks on the wings is 17,270 lb., including 995 gal. of fuel. Without the tanks, weight is 15,850 lb., with 785 gal. carried internally.

Lockheed also lists the cruising speed of this version as 460 mph. true airspeed at altitude, top speed as 500 mph. true airspeed. Wing span, as given by the company, is 80 ft.; length, 49 ft., 7 in. Lockheed reports the range at approximately 2,200 stat. mi. without slipper tanks and about 2,600 mi. with them. Range figures are based on having a 100 gal. reserve on letdown.

The Soviets apparently were alerted to the proposed U-2 flight and tracked it by radar from its initial penetration of the Afghan border on a course that took it over Stalinabad west of Tashkent, over Tyura Tam, past Aralsk and on to the Chelyabinsk area where engine trouble apparently developed.

The U-2 downed near Sverdlovsk, which according to Soviet sources, was equipped with extra fuel tanks, was flying a route from Peshwar, Pakistan, to Bodo, Norway, that would have covered more than 3,000 mi.

Main Checkpoints

Main checkpoints on the flight were to have been:

- **Large rocket launching complex** at Tyura Tam just east of the Aral Sea to monitor any space launchings which might be made to coincide with the Soviet May Day celebration.
- **Industrial complex at Sverdlovsk** to report on the status of the new missile defense installation there which has hemispherical, domed launch points rather than the herringbone pattern of the older Russian ground-to-air missile sites that resemble U.S. Nike installa-

tions. Vice President Richard M. Nixon reported seeing these domed sites, dubbed "House of David" by the U.S., at Sverdlovsk during his 1959 visit.

• **Archangel and Murmansk**, both of which house large bases for the Soviet navy and air force. Soviet submarine, air defense and long-range bombing forces all have numerous installations in the vicinity of these two cities.

First pictures released by the Soviets in their propaganda barrage over the incident and purporting to show the U-2 wreckage (see p. 30) were quickly discredited by Clarence L. "Kelly" Johnson, Lockheed vice president who had been charged with the aircraft's design. After a thorough study of available photographs, which showed a heavily damaged aircraft, Johnson said not one part could be identified as belonging to the lightweight U-2 and that the small pieces of heavy structure that could be studied closely were definitely not from a U-2. He said the wreckage most probably was that of an obsolescing Soviet Il-28 Beagle light bomber.

Johnson's skepticism, which was voiced in other quarters, including the White House, prompted the Soviets to display the remains of a relatively lightly damaged aircraft at a public exhibition in Moscow's Gorki park and to release new pictures. Lockheed officials, after a study of these photographs, said there was no doubt that the aircraft on display was the U-2.

Mission Responsibility

Aircraft and pilots employed on strategic reconnaissance missions around the periphery of the Communist territory also serve NASA by gathering gust and meteorological data at altitudes of up to 55,000 ft. as part of a four-year-old high-altitude weather research program.

Three reports by NASA and its predecessor agency, the National Advisory Committee for Aeronautics, presenting data gathered by U-2 aircraft have been issued during this time. This data has shown primarily that turbulence at 55,000 ft. is, on the average, half as frequent and half as severe as that at 20,000 ft.

Under procedures established in 1956, the aircraft used in this program are paid for by the Air Force and put out on bailment to NASA for specific periods of time. This practice has been used for many years by both Air Force and Navy to support NACA programs.

The Air Force originally purchased the U-2 for a joint USAF-Atomic Energy Commission high altitude radiation detection research program. The

project, however, was conducted on a sporadic basis, and some of the aircraft were baled to NASA for its weather research program during slack periods.

The Air Force Weather Service acts as administrator for the portion of the NASA program investigating high-altitude weather conditions outside the continental U. S. There are no personnel directly employed by NASA in these overseas activities.

These units apparently take their orders primarily from the Central Intelligence Agency, with NASA receiving only raw weather data from these units.

Cover Plane

On May 1, as Powers' plane flew into the Soviet Union from Pakistan, another U-2 was flying as a cover in the Lake Van region near the eastern border of Turkey. The aircraft over Turkey was following the pattern of a normal weather reconnaissance flight such as those made for NASA.

First reports that a U-2 was missing came on May 3 from the Incirlik Air Base in Adana, Turkey, the aircraft's home base. These reports placed the aircraft in the Lake Van region and said the pilot had reported difficulty with his oxygen system.

Two days later, when Soviet Premier Nikita Khrushchev told a session of the Supreme Soviet that a U. S. reconnaissance aircraft had been downed over the Soviet Union, the U. S. still clung to the Lake Van U-2.

A NASA release, made at State Department insistence, and apparently based upon reports received from Turkey, reiterated the statement that the Lake Van U-2 was missing and that the pilot had experienced trouble with his oxygen equipment.

It added that the aircraft was on a northeasterly course when last heard from and that, if the pilot had lost consciousness it could have strayed across the Soviet border.

The State Department release stated that "there was no deliberate attempt to violate Soviet airspace and there never has been."

These statements stood for two days—until Khrushchev announced to the Supreme Soviet that the aircraft had been downed near Sverdlovsk deep in Russian territory, that Powers had safely parachuted from his crippled

SAC U-2 Fleet

Strategic Air Command has a fleet of 15 U-2 aircraft which are used for training purposes, high altitude weather research and nuclear radiation detection missions. Other USAF U-2 aircraft have been assigned to Air Research and Development Command.

Wreckage Displayed

Moscow—Underside damage predominated in the sections of wreckage of a blue-black unmarked Lockheed U-2 the Russians put on display here last week. Greatest degree of damage appeared to be in the center section and to the Pratt & Whitney J75-P-13 turbojet engine.

Vertical tail surfaces were less damaged than the underside of the tail section. Trailing edges of both wings were torn and there were holes from one to ten inches in diameter in the right wing. Underside of the left wing showed very little damage. Slipper tanks on the wings were bent upward and the left one was flattened on the bottom.

Unofficial Soviet sources maintained the airplane was hit by a rocket in the engine section. Equipment described by the Soviets as radio and ground radar reconnaissance systems was displayed along with dome antennas carrying designations of MP 11719 and MP 12570. Seven glass ports for cameras were noted by observers and a 9x18 in. film size camera designated 73B and an astro-tracker for calibrating pictures taken in flight by reference to the sun also were included.

Airspeed indicator needle was stuck on 340 kt. Altimeter needle was gone. None of the pilot's survival equipment displayed appeared soiled or damaged.

Lettering on the wing "Fuel only with MIL-P-25524A" correspond with markings on U-2s photographed in the U. S. (see p. 29, lower left photo).

plane and that he had admitted flying a reconnaissance mission on orders from his "chiefs."

State Department then issued a statement acknowledging that the aircraft had been sent on a reconnaissance mission over the Soviet Union and officially expressing surprise at the belligerence of the Russian leaders' attack on the U. S. since, it said, they had known of these flights for several years.

In a later statement, Secretary of State Christian Herter said the U. S. intends to continue such flights, terming them necessary to assure the West that it will not be taken by surprise attack. A day later, President Eisenhower gave his tacit approval to the flights and outlined the reasons the U. S. believes they are necessary (see p. 32).

Initial Design

In the initial design of the aircraft in 1954, existing state-of-the-art information was used in the development of the airframe, and no elaborate research program was conducted before work on actual hardware was begun.

Construction of the aircraft is ex-

remely light, a necessity for high-altitude planes. The wings flap noticeably during flight near the ground, and the main landing gear has been reduced to one strut with dual wheels to conserve weight. This strut is located just forward of the center of gravity so that the pilot can balance on it during his landing ground roll.

Wing-tip skids are provided to prevent damage to the wing when the aircraft slows down and the pilot loses lateral control with his ailerons. During takeoff, two small wheels under each wing keep them level. These wheels are held firmly on the ground by a flexible strut inserted in a wing socket so that, on takeoffs, the struts come out of the sockets and the whole assembly remains on the runway.

Small wheel supports the tail section when the pilot lowers it near the end of his landing roll and during takeoff.

U-2 Surface

Surface of the U-2 is exceptionally clean, with flush riveting over much of the aircraft. Careful attention is paid to joints and junctures during manufacture, since a very smooth surface is required to keep friction drag low at high altitudes.

High aspect ratio, sailplane-type wing was used on the aircraft to permit it to operate at high lift coefficients during cruise with a small penalty in drag due to lift. The turned-down wing tips that form the skids for landing increase the effective aspect ratio of the wing and make it more efficient for the U-2 mission.

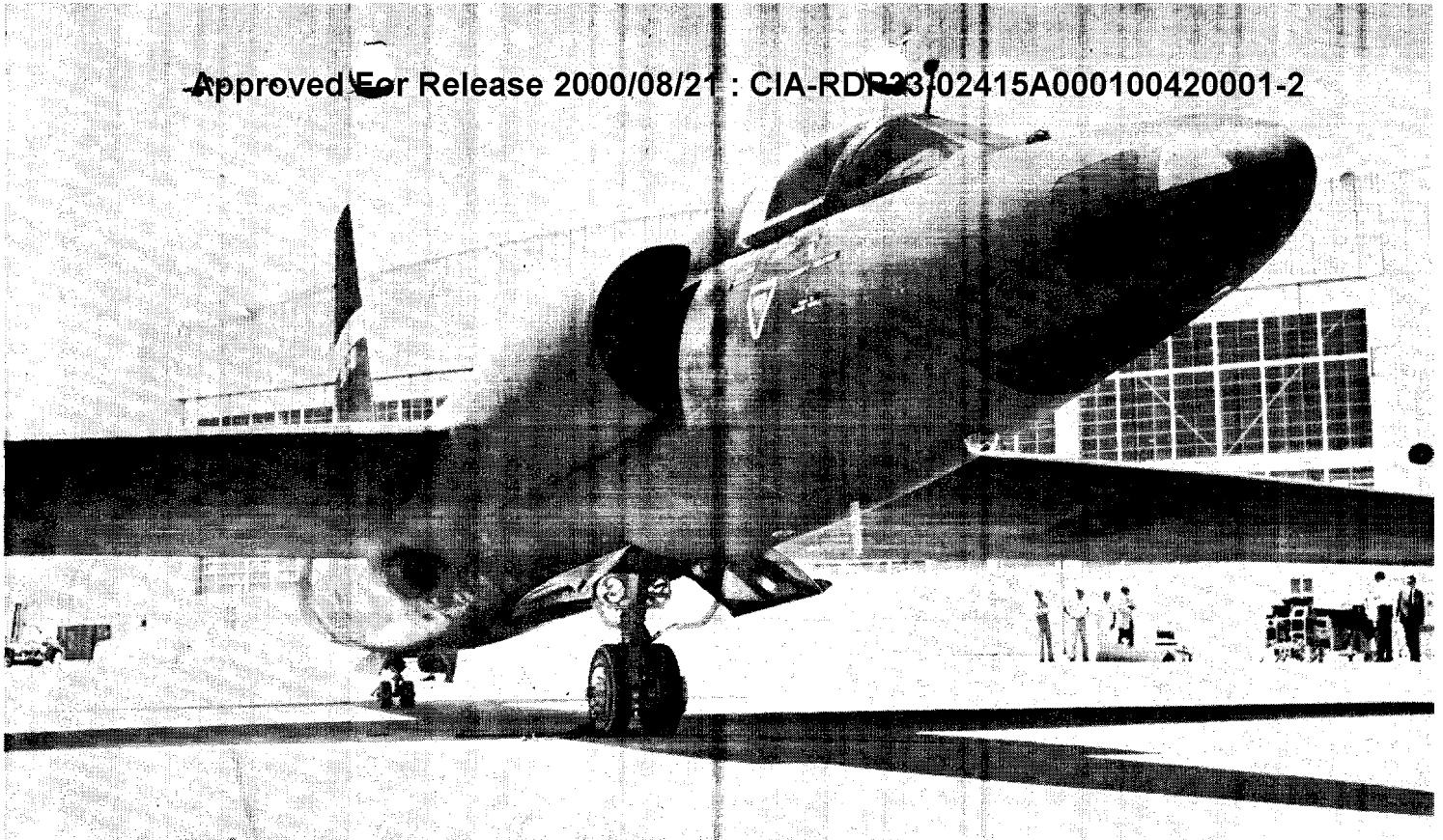
Primary mechanical modification to the J57 powerplant in initial installations was the use of larger, wide chord compressor blades to pump thin, low-density air more efficiently than those on normal turbojet installations which must function effectively through a wide altitude range.

Soviet Missile Command

Moscow—Soviet Union has established a separate missile command, apparently on a level equal to that of its air force, army and navy.

New service is under the command of Marshal Mitrofan Ivanovich Nedelin, who has headed the Soviet army artillery and served as chief of the principal artillery administration in the Ministry of Defense for the past 10 years.

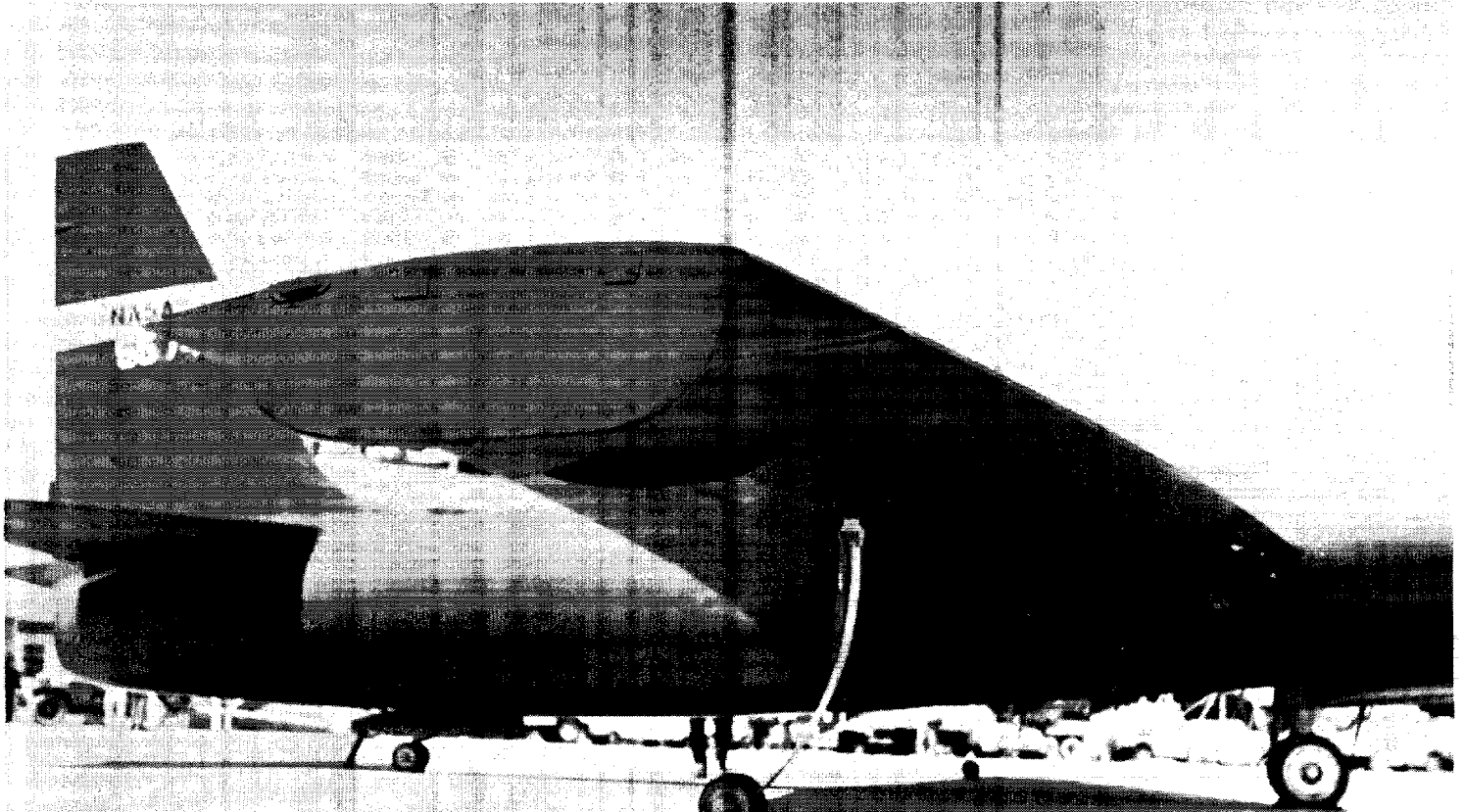
First indication of the separate command came shortly after Soviet Premier Nikita Khrushchev's initial announcement that a Lockheed U-2 aircraft had been downed over Russian territory. At a formal reception, Khrushchev introduced Nedelin as "Marshal of Rocketry Nedelin."



Extremely clean wing-fuselage juncture and engine air inlet design are shown in these photographs of a Lockheed U-2 with National Aeronautics and Space Administration markings taken at Edwards AFB, Calif., five days after a U-2 was lost near Sverdlovsk, Russia. Slight droop of the wings indicates their light construction.

Extreme Cleanness, Manufacturing Care Mark U-2

Unusual landing gear on the Lockheed U-2 provides considerable savings in structural weight; an important factor for high altitude aircraft. Small wheels on flexible strut are held firmly on ground by wing weight and drop off at takeoff. Near the end of the landing ground roll, the pilot normally turns onto the grass and heels over on one wing tip skid.





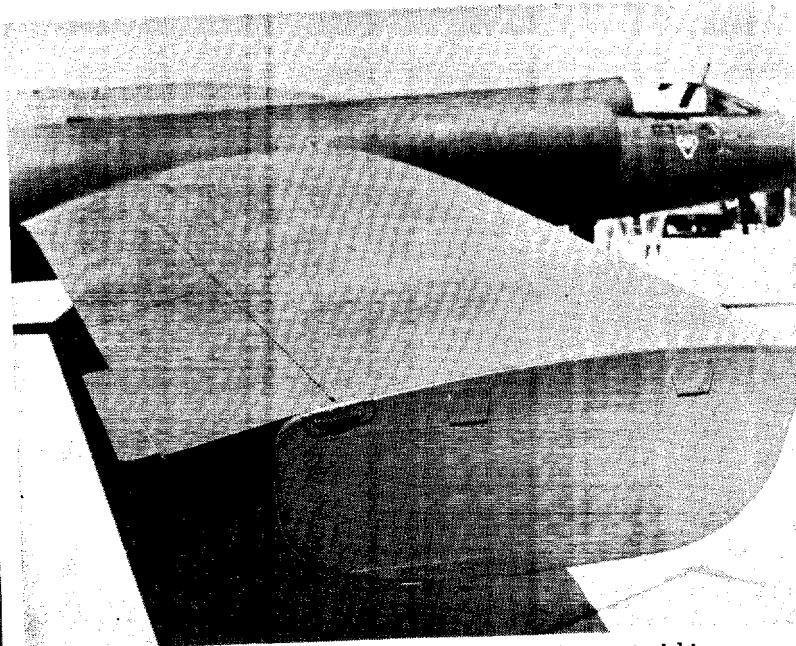
Sole identification marks on the U-2 shown at Edwards are the NASA letters in a small stripe on the tail and a serial number (left). Manufacturing excellence in the U-2 is evidenced on its tail areas which have flush riveting and essentially no mismatch of adjoining skin panels perpendicular to the airflow over the aircraft. The manufacturing tolerances held on the after sections of the U-2 are better than those on the nose of many operational high-speed aircraft. The aerodynamically balanced rudder and elevator installations with almost no gap at the hinge again show extreme manufacturing care. The hand-built U-2s were originally constructed in the Experimental Department of the



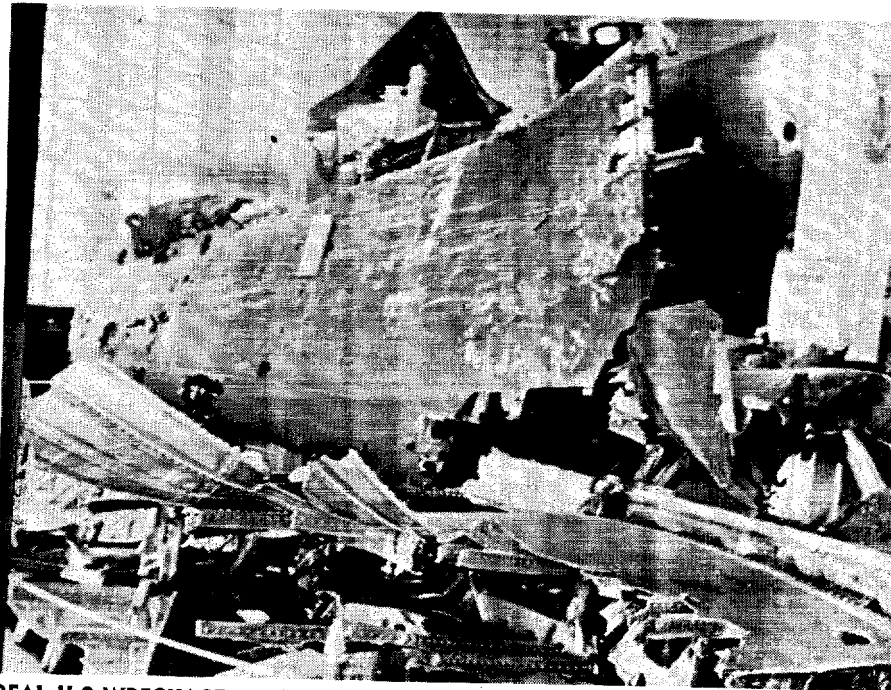
California Division of Lockheed Aircraft Corp. Nose view of the U-2 (right) shows double truck main gear and its brake system. Large open areas are provided on bottom and both sides of the U-2 nose structure to permit the mounting of a variety of cameras and other reconnaissance equipment. Radar can be mounted in the nose of the aircraft. Main engine air inlets are large for a single engine aircraft and are needed for high-altitude operation. The inlet lips are fairly sharp because of the compressibility problems the aircraft experiences near its maximum altitude. Auxiliary air scoop on the right side of the fuselage is located back under the wing.



Stenciling on the fuselage under the canopy states types of fuel to be used in the aircraft, gives canopy operating and rescue instructions and includes the conventional ejection seat warning sign. Bullet-shaped body on strut at the top of the windshield houses a rearview mirror for the pilot. Details of the aileron and



tab installation and the wing tip skid design are shown at right. The tip skid also serves as a partial end plate for the wing and reduces the strength of the wing tip vortex and improves the efficiency of the wing when it is operating at high lift coefficients as it would do during cruise at high altitude.



REAL U-2 WRECKAGE was finally displayed later by Soviets in Moscow Gorki Park exhibit after earlier faked wreckage picture had been exposed by Lockheed's Johnson and President Eisenhower. Wreckage shows major portion of U-2 wing panel. Soviets claim to have recovered most of the U-2 reconnaissance equipment intact and description of cockpit equipment indicates they may have recovered this plane relatively undamaged, again casting suspicion on their earlier claim of rocket hits at 65,000 ft. Pratt & Whitney J75 engine from U-2 exhibited in Moscow showed evidence of impact damage. Tail section was intact except for missing rudder tab. U-2 wreckage was painted blue-black and no insignia was visible on wings, fuselage or tail.



FAKED U-2 WRECKAGE is shown in this photo originally released by the Soviets labeled as the wreckage of the U-2 as it was shot down near Sverdlovsk. Wreckage is actually the remains of an Aeroflot Tu-104 jet transport that crashed near Sverdlovsk last February killing an official Chinese delegation to Moscow. C. L. "Kelly" Johnson, Lockheed designer of the U-2, analyzed the structural members showing in this photo and said they bore no resemblance to the lightweight U-2 structure and were probably of a bomber type aircraft. Aeroflot Tu-104 crash near Sverdlovsk was one of few publicly announced in USSR because of large foreign delegation aboard. Faked U-2 wreckage was apparently released to create impression of heavy damage from Soviet anti-aircraft missile whereas genuine U-2 wreckage displayed later in Moscow showed major damage sustained along aircraft belly similar to that from a forced landing. Khrushchev awarded medals to Red Army missile crew who allegedly fired the rocket that supposedly hit the U-2. New type anti-aircraft missiles have been observed in the Sverdlovsk area since last summer.

Moscow—Soviet Union last week exploited the May 1 downing of a Lockheed U-2 reconnaissance plane well inside Russia with boasts of its own defensive strength and warnings to U. S. and its allies that further flights might be met by "more drastic action."

At a press conference called shortly after U. S. Secretary of State Christian Herter said the U. S. plans to continue such flights, Soviet Foreign Minister Andrei Gromyko warned:

"Once again, the violation of the sovereignty and integrity of foreign frontiers, spying and subversion, are pronounced as the U. S. official policy.

"We shall meet, as the Soviet people have always met aggressors, and aircraft which dare to make a sortie into our borders will be smashed to smithereens."

Gromyko warned that those "who lend bases on their territory for aircraft violating our frontier . . . should know that in the event of a repetition of such provocations, the Soviet Union will be able to render these bases harmless."

Earlier, a Radio Moscow broadcast beamed to the U. S. threatened that, "if these American flights over our territory do not cease, the Soviet Union will be compelled to take more drastic action and the security of the United States will hardly benefit."

The furor over the U-2 crash—and the debate over the actual facts behind it—near Sverdlovsk 1,400 mi. inside the Soviet border was dramatically touched off by Premier Nikita Khrushchev four days after the incident.

In a speech before the Supreme Soviet, in which he failed to mention that U-2 pilot Francis Powers had been captured alive, Khrushchev said:

"That day (May 1) . . . an American plane flew over our frontier and continued its flight into the interior of the Soviet land. A report on this aggressive act was immediately given to the government by the Minister of Defense.

"The government has stated this: Since he realizes what he comes up against when intruding into a foreign territory, if he gets away with it, he will attempt fresh provocations. Therefore, the plane must be shot down.

"This task was fulfilled, and the plane was shot down."

Khrushchev said that, upon being told of the invasion, he personally ordered that the U-2 be shot down.

He saved his greatest propaganda coup until May 7 after U. S. spokesmen had issued a statement that a U-2 flying a high-altitude weather mission in the vicinity of Lake Van near the eastern border of Turkey had been missing since May 1.

The Soviet Premier, after a wait of two days, then retorted in a speech highlighted by a statement that U-2 pilot Powers was in Soviet hands. Khrushchev told the Supreme Soviet:

"The flier testified he had no dizziness nor had his oxygen apparatus failed (as U. S. officials had speculated). He was flying along an assigned course, accurately executing his chiefs' order, switching on and off equipment over preselected targets for gleaning intelligence data on the Soviet Union's military and industrial establishments, and flew on until the very moment his piratical flight into this country's interior was cut short."

He told the Supreme Soviet that the U-2 was hit at an altitude of approximately 65,000 ft. by a "rocket" and boasted that, "if they fly higher, we will also hit them."

A "competent commission of experts" which examined the wreckage of the U-2, Khrushchev said, had established "that this American plane was a specially prepared reconnaissance aircraft" with the mission of crossing "the entire territory of the Soviet Union" from Pakistan to Norway. He added:

"Besides aerial cameras, the plane carried other reconnaissance equipment for spotting radar networks, identifying the location and frequencies of operations stations and other special radio engineering equipment."

Khrushchev also brandished pictures 2 x 2 ft. in size and tapes which he said came from the U-2 and showed, among other things:

- "Airfields and planes on it."
- "Petrol stores."
- "Industrial enterprises."
- "Signals of a number of our ground radar stations," Khrushchev said, were recorded on one of the tapes.

Terming Washington's version of the flight "baloney," Khrushchev gave what he termed the "truth" of U-2 mission.

The plane's base was, as Washington said, in Adana, Turkey, Khrushchev said. It was attached to a military intelligence unit headed by Col. William Weston, numbered 10-10. The 10-10

Khrushchev charged, was using the National Aeronautics and Space Administration, to which the aircraft was attached as a "cover" while probing radar installations.

Khrushchev quoted Powers as saying May 1 he left Peshwar, Pakistan, over the Aral Sea and then toward Sverdlovsk where his plane was downed.

Khrushchev also quoted Powers as saying that the plane flew into Soviet territory "with instructions to fly along a course indicated on a map over the Aral Sea, Sverdlovsk radar points and reach Archangel Gorskoye before landing at Bodo in Norway." He said Powers told Soviet authorities:

Khrushchev Scores Twining

Moscow—Soviet Premier Nikita Khrushchev, in rising anger over the U-2 incident, last week described Gen. Nathan F. Twining, chairman of the Joint Chiefs of Staff, as a man to be compared with "an animal that may do its dirty doings where it eats."

Recalling the 1956 visit of Gen. Twining, then USAF chief of staff, to Russia, Khrushchev said the American general was "welcomed as a guest" and added:

"He left our country by air and next day sent a plane flying at great altitude to our country. This plane flew as far as Kiev (approximately 200 mi. inside the Soviet Union).

"The question arose—should we protest? I proposed no protest should be lodged. All Twining might be compared to is to an animal that may do its dirty doings where it eats. From such behavior, we drew a conclusion: To improve rockets, to improve fighters.

"Our fighters can fly as high as 28,000 meters (92,000 ft.), but the difficulties of a fighter are, though it can rise high, it is not so easy and simple to find a target in the air; a plane in the air is like a needle in the ocean.

"But a rocket finds its target itself. This is the advantage of a rocket, and we make use of it. We have both fighters and rockets. That is why I say: If there are still politicians who would like to rely on bombers, they are doomed to failure.

"With up-to-date military techniques, bombers will be shot down even before they approach a target."

Earlier, Khrushchev repeated his charge that a U. S. reconnaissance plane flew over the Soviet Union on Apr. 9, adding:

"We should have shot down the reconnaissance plane. . . . However, our military men slipped up, to put it mildly, and we put them on the carpet."

"I believe my flight over Soviet territory was meant for collecting information on Soviet guided missiles and radar stations."

Khrushchev said that, after the U-2 was struck by a "rocket," Powers "bailed out by parachute; note he was not ejected by catapult but left through the upper canopy. . . . He did this possibly because there was an explosive charge in the aircraft which was to blow the plane as soon as the pilot catapulted. The pilot knew this and possibly was afraid he would be killed in the explosion."

Later, Red Star, the Soviet army magazine, reported that the U-2 "catapult" appeared faulty "and probably would not have worked" had Powers used it.

The Red Star article written by Col. F. Luchnikov and Maj. V. Zhukov said Powers would have destroyed himself if he had attempted to use the ejection system. The article said investigation of the wreckage showed that it contained a cache of TNT designed to go off after the pilot had ejected but that the escape system bore a stamp saying it had last been checked in 1956 and would have failed if used. The explosive mechanism, it added, was in perfect order "and would have spared neither the plane nor the flyer." It added:

"Powers apparently knew his boss's habits very well. Probably this is why he did not make use of the catapult, realizing what the end would be."

Red Star reported that the U-2 was equipped with extra tanks providing sufficient fuel to carry him the approximately 3,000 mi. needed to cross the Soviet Union.

The article said that, in an interview, Powers had never heard of U. S. aviation magazines mentioned to him and concluded:

"So we are dealing with a stupid, corrupt, greedy adventurer in military form. He has no pricks of conscience that he is a spy."

The article also reported that Powers attributed the crash of his aircraft to an "explosion" in the U-2 engine rather than to a Soviet missile.

Other Soviet publications, however, carried lengthy reports on the actions of the missile crew which supposedly downed the aircraft. Pravda carried this account of the action:

"Interference made search difficult and operators strained their eyes and ears to the utmost. The target was maneuvering and, with each minute, their job was becoming ever more difficult." Noting that U-2's radar blips on the screen were "barely visible," Pravda continued:

"The pirate plane was flying with almost sonic speed at very great altitude. A private," it said, "manipulated the instruments until the target mark was fixed on the plane's course.

"Corp. Kharbargin faultlessly plotted the target flight on a map. Maj. Mikhail Voronov at the command post was given precise parameters of the target, then gave the order to fire.

"The rocket shot through the air, shaking all things around and leaving a fiery trace. Then there was an explosion in the sky meaning destruction of the American plane.

"Our Army has many units like the one which has downed the pirate plane."

U-2 Missions Approved by Eisenhower

Washington—President Eisenhower last week gave his tacit approval to U. S. reconnaissance flights over the Soviet Union. At the same time, he documented the formal U. S. position on such flights and, more specifically, on the Lockheed U-2 lost near Sverdlovsk on May 1. In a prepared statement presented at his weekly press conference, the President said: "The first point is this: The need for intelligence-gathering activities.

"No one wants another Pearl Harbor. This means that we must have knowledge of military forces and preparations around the world, especially those capable of massive surprise attacks. Secrecy in the Soviet Union makes this essential. In most of the world, no large-scale attack could be prepared in secret, but in the Soviet Union there is a fetish of secrecy and concealment. This is a major cause of international tension and uneasiness today. Our deterrent must never be placed in jeopardy. The safety of the whole free world demands this.

"As the Secretary of State pointed out in his recent statement, ever since the beginning of my Administration, I have issued directives to gather, in every feasible way, the information required to protect the United States and the free world against surprise attack and to enable them to make effective preparations for defense.

"My second point: The nature of intelligence-gathering activities.

"These have a special and secret character. They are, so to speak, 'below the surface' activities.

"They are secret because they must circumvent measures designed by other countries to protect secrecy of military preparations.

"They are divorced from the regular visible agencies of government which stay clear of operational involvement in specific detailed activities.

"These elements operate under broad directives to seek and gather intelligence short of the use of force—with operations supervised by responsible officials within this area of secret activities.

"We do not use our Army, Navy or Air Force for this purpose, first to avoid any possibility of the use of force in connection with these activities and, second, because our military forces, for obvious reasons, cannot be given latitude under broad directives but must be kept under strict control in every detail.

"These activities have their own rules and methods of concealment which seek to mislead and obscure—just as in the Soviet allegations there are many discrepancies. For example, there is some reason to believe that the plane in question was not shot down at high altitude. The normal agencies of our government are unaware of these specific activities or of the special efforts to conceal them.

"Third point: How should we view all of this activity? It is a distasteful but vital necessity.

"We prefer and work for a different kind of world—and a different way of obtaining the information essential to confidence and effective deterrents: Open societies in the day of present weapons are the only answer.

"This was the reason for my 'open skies' proposal in 1955, which I was ready instantly to put into effect—to permit aerial observation over the United States and the Soviet Union which would assure that no surprise

attack was being prepared against anyone. I shall bring up the 'open skies' proposal again at Paris—since it is a means of ending concealment and suspicion.

"My final point is that we must not be distracted from the real issues of the day by what is an incident or a symptom of the world situation today.

"This incident has been given great propaganda exploitation. The emphasis given to a flight of an unarmed non-military plane can only reflect a fetish of secrecy.

"The real issues are the ones we will be working on at the summit—disarmament, search for solutions affecting Germany and Berlin, and the whole range of East-West relations, including the reduction of secrecy and suspicion.

"Frankly, I am hopeful that we may make progress on these great issues. This is what we mean when we speak of 'working for peace.'"

Asked if there have been Soviet reconnaissance flights "over the western part of the world," the President replied:

"Well, I could just say this: As far as I know, there has never been any over the United States."

Earlier, in reply to a query as to whether he saw any chance of success at this week's Summit Conference in Paris in view of the strong denunciations of the U. S. emanating from Moscow, the President pointed out that the Soviets have been, and presently are, actively engaged in espionage in the U. S. Referring specifically to the trial of Soviet Col. Rudolph Abel, he said: "Well, I say yes. I have some hope, because these things have been said for many years, ever since World War II, and there is no real change in this matter.

"Now, if you—I wonder how many of you people have read the full of the Abel trial, the record of the of Mr. Abel. Well, I think he sentenced to 30 years. Now, the mess of saying that you're doing that are provocative, why, the better look at their own record I'll tell you this:

"The United States and no allies that I know of has anything that would be considered as provocative. We are to our own security and our and we have no idea of provoking kind of conflict or war. This is absolutely ridiculous, and that is."

The President was also as planned to order accelerated development programs for Force Midas and Samos recon

President's Visit in Doubt

Moscow—Soviet Premier Nikita Khrushchev indicated last week that he may be considering the withdrawal of his invitation for President Eisenhower to visit the Soviet Union in June.

Reversing earlier statements in which he had taken pains to disassociate the President from responsibility for U. S. reconnaissance missions over the Soviet Union, Khrushchev told newsmen that his opinion of the President has now changed "of course."

Khrushchev, during a tour of an exhibit in Moscow's Gorki Park allegedly showing the wreckage of the Lockheed U-2 downed near Sverdlovsk on May 1, was asked if he still wants President Eisenhower to visit the Soviet Union. He replied:

"What would you like me to say? Get up here in my place and reply.

"The difficulty is—and I say it frankly—that my hopes in him have not been justified.

"After all, I am responsible for the Soviet government. The Russian people are open-hearted. Can I expect them to welcome him as a dear guest?

"I would be mad to say to the Russian people to welcome as a host a man who sends espionage planes here."

satellite systems. Eisenhower replied: "Well, I know of nothing—now, I keep in touch with my scientific advisory committee and operators, and I know of nothing we could do to speed these up. They are research items and, as such, no one can predict exactly what would be their degree of efficiency. So I couldn't make a real prediction of

what is going on—how useful they are going to be."

In reply to another question as to whether the satellite systems "will ease our worries on the question of secrecy," the President said:

"Well, I say, I just can't predict what the final results will be. Now, we do know this, right now. I believe

it's better than that is sending back constantly pictures on the cloud cover all around the earth, and that is admittedly a rather rough example of what might be done in photography. But that is being done constantly, and I don't know how many thousands of photographs have been taken, and they send them back on command."

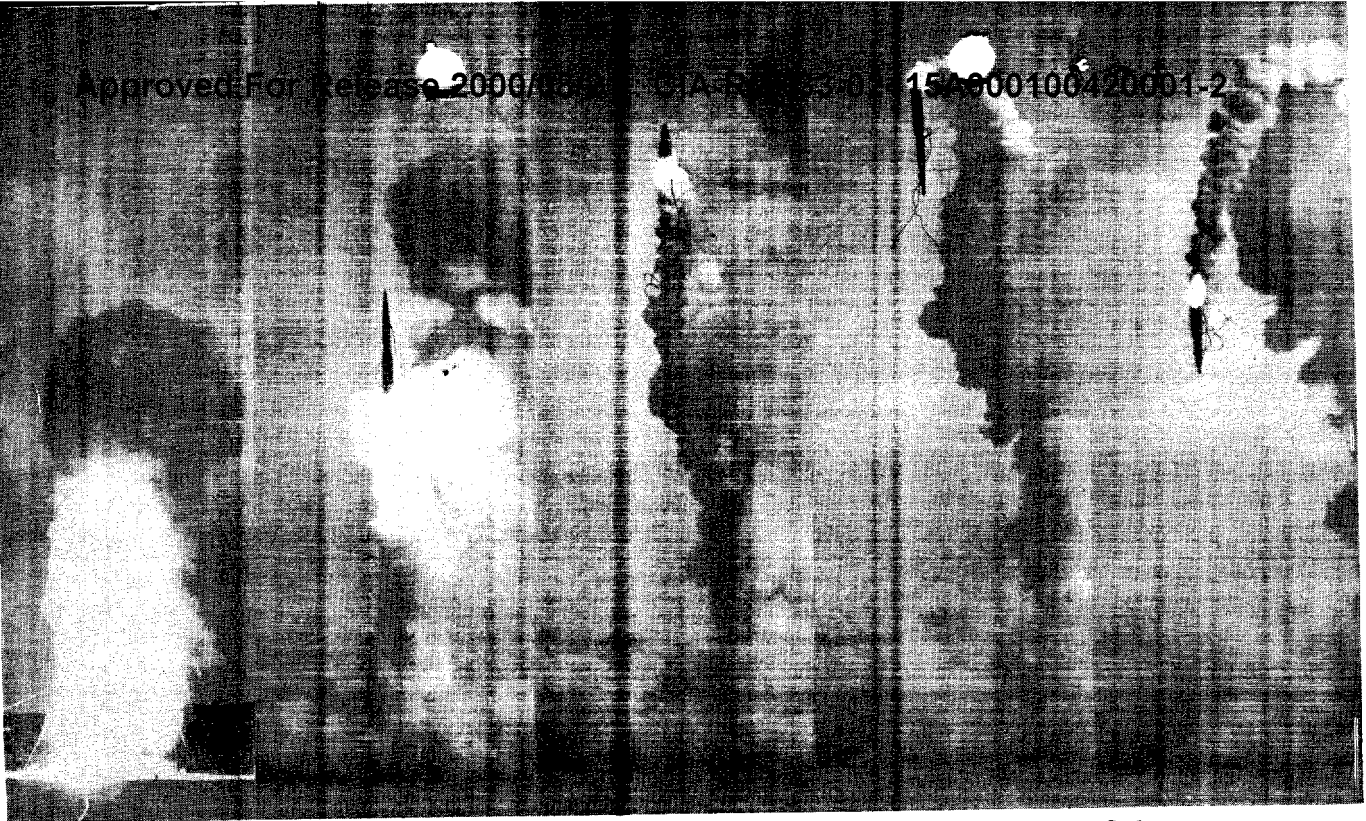
U-2 Developmental and Operational Chronology

Following is a chronology of the developmental and operational cycles of the Lockheed U-2:

- Mid-1954—Lockheed began the design of the U-2.
- Late 1955—After flight tests had proven the capabilities of the U-2, the Air Force purchased several of the aircraft for a joint USAF-Atomic Energy Commission high-altitude research program.
- Early 1956—National Advisory Committee for Aeronautics, which had assisted Lockheed in the original design, began planning a high altitude meteorological research program around the U-2 and other aircraft. U-2s operated by NACA were owned by the Air Force and bailed to the civil agency under the arrangement used for the majority of its research aircraft.
- Early 1956—Air Force formed its first U-2 squadron, the Weather Reconnaissance Squadron, Provisional (1st). It first operated from Watertown Strip, Nev., and assisted the USAF-AEC and NACA research programs which occupied the same airfield but were separate.
- Feb. 16, 1956—U-2 crashed in Arizona after fire started in cockpit. Pilot Robert J. Everett bailed out at about 30,000 ft. Everett was a Lockheed employe flying for NACA with NACA pilot number 357.
- May 7, 1956—NACA announces start of its high altitude gust-meteorological research program.
- May 22, 1956—NACA announces it is making preparations to begin the portion of its research program covering the European area. First U-2 operations in Europe were to be from USAF bases in England with the Air Force Air Weather Service providing logistical support. All planes were civilian with civilian contract pilots.
- July 9, 1956—NACA reported that the initial high-altitude weather data gathered by the U-2 had been processed and that it had proved the value of the aircraft as a research tool.
- Sept. 17, 1956—U-2 crashed near Kaiserlautern, West Germany. Pilot was Howard Carey, a Lockheed employe.
- February, 1957—NACA released first U-2 pictures.
- Mar. 27, 1957—NACA published Research Memorandum RM L57A11 entitled "Preliminary Measurements of Atmospheric Turbulence at High Altitude as Determined From Acceleration Measurements on a Lockheed U-2 Airplane." This report was unclassified, as are all other reports concerning the high-altitude weather program.
- April, 1957—U-2 crashed in isolated region of northwest Nevada killing Lockheed engineering test pilot Robert L. Sieker.
- July 2, 1957—NACA report RM L57G02 was written entitled "Airplane Measurements of Atmospheric Turbulence at Altitudes from 20,000 to 55,000 ft. over the Western Part of the United States," which contained more data taken by a U-2.
- May, 1958—Articles published in the Soviet air force newspaper Soviet Aviation indicated that Red Air Force intelligence was concerned over U. S. operations with the U-2. One article complained that the U-2 "lacks all identification marks indicating its mission." The Soviet writer then suggested that strategic reconnaissance was included among the high-altitude research activities of U-2s based at Wiesbaden, West Germany.
- March, 1958—Japanese magazine Air Review ran pictures of

U-2s landing in Japan reportedly taken by a 16-year-old boy standing at the end of the runway.

- Apr. 17, 1959—NASA personnel finished third report on U-2 weather research data. This paper, NASA Memo 41759L, was entitled "Airplane Measurement of Atmospheric Turbulence at Altitudes From 20,000 to 55,000 ft. for Four Geographic Areas." These areas were Western Europe and England, Turkey, U. S. and Japan.
- Sept. 24, 1959—U-2 made an emergency belly-landing with slight damage at Fugisawa airfield while it was attempting to land at its base at Atsugi Airport near Tokyo. Six U-2s were based in Japan at the time, and it was reported that at least some of them flew almost every day.
- Nov. 28, 1959—New York Journal-American published an article by George Carroll on U. S. reconnaissance over Russia which suggested that U-2 flights were used for this purpose.
- Dec. 12, 1959—Article in Soviet Aviation discussed U. S. strategic reconnaissance activity with the U-2 and gave some of the design details of the aircraft. The Soviet newspaper quoted Carroll's article and other material which had appeared in Model Airplane News in March, 1958.
- May 3, 1960—U-2 based at Adana, Turkey, reported missing since May 1 on weather mission in Lake Van region near the eastern border of Turkey by U. S. officials in Adana. Report says the civilian, Lockheed-employed pilot had radioed he was experiencing trouble with his oxygen equipment. Missing plane was officially assigned to NASA.
- May 5, 1960—Soviet Premier Nikita Khrushchev tells the Supreme Soviet that a U. S. aircraft has been shot down over Russia. NASA's Washington headquarters reports that it had been told the U-2 missing in the Lake Van region may have strayed over the Soviet border while the pilot was unconscious because of lack of oxygen.
- May 6, 1960—State Department said, "There was no deliberate attempt to violate Soviet airspace and there has never been."
- May 7, 1960—Khrushchev retorts that the aircraft was downed near Sverdlovsk well inside the Soviet Union, that the pilot had been captured alive and admitted attempting a photo-reconnaissance mission across the Soviet Union from Pakistan to Norway. U. S. State Department then issued a statement acknowledging that "an unarmed civilian" aircraft probably had made an information-gathering flight over Soviet territory. It denied that authorization came from Washington.
- May 9, 1960—Secretary of State Christian Herter admits that U. S. reconnaissance planes have collected information on the Soviet Union by flying along its borders and "on occasion by penetration." Herter indicates the U. S. will continue such flights, which, he says, are conducted under broad directives from President Eisenhower.
- May 10, 1960—Soviet Foreign Minister Andrei Gromyko issues a formal note of protest over the U-2 incident to the U. S. Embassy in Moscow.
- May 11, 1960—President Eisenhower at his weekly press conference gives tacit approval to reconnaissance flights over the Soviet Union and the reasons the U. S. believes they are necessary.



Minuteman ICBM Tethered Test Vehicle Fired From Silo

Minuteman ICBM test vehicle is fired from a silo at Edwards AFB, Calif., in one of seven successful silo launchings (AW May 9, p. 28). Improvised nose cone is for ballast. The vehicle is restrained by a nylon tether which interrupts the flight after a few seconds.

Space Technology

Pioneer Switched to 150-Watt Unit

Washington—Pioneer V began broadcasting space data through its 150-watt transmitter last week, but battery troubles have dimmed prospects of getting useful data from the space probe at distances as great as the hoped for 50 million mi. (AW May 9, p. 32).

National Aeronautics and Space Administration turned on the 150-watt transmitter after data broadcast from the five-watt transmitter became almost useless and when it became apparent that the probe's batteries are degenerating. Pioneer V was 8,001,000 mi. from earth when the 250-ft. Jodrell Bank radio telescope at Manchester, England, commanded the first transmission from the 150-watt unit.

Since the larger transmitter draws a great deal more power than the five-watt unit, ground stations can interrogate the probe for only a few minutes every six to eight hours. Broadcasts begin when battery power is at 18 volts, and the system has an automatic cutoff that terminates transmission when power drops below 15 volts. This was cutting off transmissions from the five-watt transmitter just before the shift was made to the larger unit, and last week it was limiting transmissions to about a minute and a half.

NASA deduces from this relatively-rapid power drop that the 28 battery

cells are leaking. One theory is that the ambient gas in the batteries is leaking after two months in space.

Following the switch, Manchester could receive data at the rate of either 8 or 64 bits per sec. Both Manchester and the station at South Point, Hawaii, were taking data at one bit per second before the switch. The data received at Hawaii had been unusable for two weeks, and the data at Manchester had become very poor.

The station in Hawaii will continue to receive data at one bit per second. At this rate, it takes 44 min. to get a complete readout of data on the seven channels stored by the Pioneer V telemetry system. A complete readout can be obtained in 1.5 min. at 8 bits per sec. and in 12 sec. at the 64-bit rate. As distance increases, Hawaii will be out of range and Manchester will be reduced to receiving one bit per second. Diminishing power will make it difficult to obtain data at that rate.

The five-watt transmitter had broadcast 109 hr. of data before the change was made to the 150-watt unit. At its highest rate, the smaller unit broadcast 2.5 hr. of data in a single day; it was down to about 68 min. just before the change. NASA can get only about four minutes of data a day from the larger transmitter because of its greater power

demands and weakening power supply

Manchester station commanded the 150-watt transmitter on and received the first transmission about 1.5 min. later, the time it took for the command signal to reach the probe and for the responding broadcast to reach earth. This initial transmission followed a sequence of command signals which prepared the 150-watt system for use.

The day before the first transmission, Manchester commanded power into the tubes through a resistor, warming the filaments for about a minute. Six hours later, this step was repeated without the resistor, supplying full filament heating for several minutes. First transmission command was sent from Manchester early the following day, May 8.

Transmitter and its converter operated after remaining idle in space for two months. Packaged in the probe by Space Technology Laboratories, the transmitter was constructed by Spectrolabs, Inc. It uses Radio Corp. of America tubes and is served by a converter built by Engineered Magnetics, Inc., a division of Gulton Industries, Inc.

Earlier, a malfunction had been detected in the Pioneer V system, and a means was devised of compensating for it in analyzing the data. Bad component was a diode in a temperature-sensing system which produced a battery temperature reading too low for an operating battery. Since the batteries were operating, the trouble was traced to the temperature-monitoring system.

China Post

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SUNDAY, SEPTEMBER 13, 1959

U-2 Of USAF Said Reconnoitering Red China At Unreachable Altitude

Honolulu, Sept. 11 (CNA-UPI) The *Honolulu Star Bulletin* reported today a top secret Air Force experimental jet plane, the U-2, may be flying from Hawaii on "reconnaissance at unreachable altitudes over Red China and Soviet Russia."

The story, written by *Star Bulletin* military reporter, Mark Waters, drew a flat, "no comment" from Pacific Air Force headquarters at Hickam Air Force

Base where the plane has been stationed for "operational tests" since last April.

Waters described the U-2 as one of 25 now being used by the Air Force and said it could fly "above 70,000 feet" in rarefied atmosphere at the fringes of space. "He reported the plane could 'cruise for hours beyond the reach of any known aircraft and perhaps has 'anti-radar' to ward off detection by unfriendly radar."

Waters speculated that it was U-2 "a pilot on Formosa" referred to last spring when Waters visited there and was told by the pilot that "the Communist Chinese army can't move an artillery piece without it being seen and reported by our high flying reconnaissance planes."

Waters said other reports of the plane indicates:

It has taken overhead photographs of hurricanes while flying more than 15 miles high.

It has been used as a "nuclear sample" catchers over Siberia.

The results of its work are being utilized by all branches of the armed services.

Waters said "the true mission of the mystery plane, now highly classified, may be more fantastic than the wildest suppositions."

Waters said the U-2 carries only a pilot and is powered by a single Pratt and Whitney J-57 jet engine. He said its wingspan was so great that outrigger wheels must support it on the ground. When taking off, Waters said, ground crewmen ride on each wing holding a wheeled dolly in place until the plane gains enough speed to support its long wings without scraping the ground.

No Secret

Washington, Sept. 11 (CNA-UPI) Air Force officials declined to comment today on a report in the *Honolulu Star Bulletin* about reconnaissance flights by a new U-2 jet plane.

But an Air Force spokesman said the existence of the plane is "no secret."

He laughed at the report that crewmen of the plane ride the wings on takeoff.

GRD RESEARCH NOTES

No. 4

SOME CHARACTERISTICS OF TURBULENCE
AT HIGH ALTITUDES

Mariano A. Estoque

December 1958



GRD

GEOPHYSICS RESEARCH DIRECTORATE
AIR FORCE CAMBRIDGE RESEARCH CENTER
AIR RESEARCH AND DEVELOPMENT COMMAND
UNITED STATES AIR FORCE
BEDFORD, MASSACHUSETTS

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UNITED STATES AIR FORCE
Bedford, Mass.

A B S T R A C T

Turbulence data obtained at altitudes of 23,000 to 60,000 feet by the GRD Project Jet Stream and the NACA-AWS groups using instrumented aircraft are analyzed as an initial attempt to construct a synoptic climatology of high-altitude turbulence. Statistical characteristics of turbulence in and outside of the jet stream region are presented. The parameters examined are the horizontal extent of turbulent areas and of the intervening non-turbulent areas, the maximum gust velocity in a turbulent area, and the percentage of flight time in turbulent air.

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SOME CHARACTERISTICS OF TURBULENCE
AT HIGH ALTITUDES

1. INTRODUCTION

Free-air turbulence is a phenomenon of sub-synoptic scale. In the upper troposphere, turbulent areas which average about 15 miles in horizontal extent are interspersed between relatively smooth regions several times larger. Successive airplane flights traversing along the same lines show that these turbulent areas persist only for brief periods of time. The scale of disturbances associated with high-altitude turbulence appears to be of the same order of magnitude as those of thunderstorms and similar local convective phenomena. A short-range categorical forecast of the occurrence, intensity, and extent of an individual turbulent area is therefore extremely difficult to make on the basis of physical considerations. The only practical approach to the prediction problem seems to be in terms of probability forecasts using statistical relationships between turbulence and synoptic scale parameters. It is therefore necessary to collect data under various synoptic situations so that a detailed synoptic climatology of high-altitude turbulence may be constructed.

This paper summarizes the results of an analysis of a limited amount of high-altitude turbulence data and presents statistical characteristics of turbulence in and outside of the jet stream region.

2. OBSERVATIONAL DATA

Two sources of information were available for study. These are the GRD Project Jet Stream (B-47) and the NACA-Air Weather Service (Lockheed U-2) flights.

Note: This Research Note was originally produced as a Technical Memorandum to the Director, Geophysics Research Directorate, AFCRC, August 1958.

The Jet Stream data consists of about fifty flights made mostly in jet streams over the eastern half of the United States from 1953-57. Flight altitudes ranged from 23,000 to 42,000 feet. In the 1953-54 phase of the observational program, a NACA VGH accelerometer was used to make the measurements. For the rest of the flights, a highly sensitive airspeed cell was installed to measure the fluctuations in the indicated airspeed. These fluctuations provided a measure of the turbulence encountered. Turbulent areas are defined by portions of the records where the VGH accelerometer and the airspeed traces were continuously disturbed or where horizontal gust components of at least 5 fps were recorded. However, this does not mean that in a given area of turbulence all the gust velocities were in excess of 5 fps. Large portions of the areas designated as turbulent contained numerous velocities smaller than 5 fps; these were probably imperceptible to the flight crew.

The U-2 research flights were made over Western Europe, Turkey, United States, and Japan at altitudes mainly from 40,000 to 60,000 feet. During these flights no special efforts were made to fly in the jet stream. Examination of the flight records indicated that about 80 percent were located at more than 10° of latitude from the jet stream core or above 40,000 feet. Therefore, it may be assumed that the U-2 data is approximately representative of conditions outside (laterally or vertically) the jet stream. The turbulence probes used during the U-2 flights were VGH accelerometers.

In the analysis of the U-2 records, turbulent areas are defined as those where the accelerometer trace was continuously disturbed and contained vertical gust velocities greater than 2 fps. It will be noted that this definition is somewhat different from that used in the analysis of the B-47 data. Therefore, the two results are not strictly comparable.

3. RESULTS

The data available may be classified into two broad synoptic types: jet stream and non-jet stream as represented by the B-47 and U-2 data, respectively. The parameters treated are the horizontal extent of a turbulent area (L_t), the horizontal extent of a "smooth" area separating two successive turbulent areas (L_s), the maximum gust velocity (V_m) in a turbulent area, and the percentage of flight time in turbulent air. These quantities are shown schematically in Fig. 1. These parameters may be important in planning mid-air refueling operations.

Figure 2 shows the cumulative frequency distribution of the horizontal extent of turbulent areas both inside and outside of jet streams. It may be seen that the turbulent areas are much longer inside the jet stream than they are outside. No data on the extent of smooth areas is available for non-jet stream regions; only the corresponding distribution for jet stream regions is presented. On the average, the lengths of smooth areas are about five times those of the adjacent turbulent areas.

The cumulative frequency distribution of maximum gust velocities (Fig. 3) indicates that gust velocities within the jet stream are much greater than in areas outside the jet stream. Thus, while some gust velocities of 36 fps were recorded in the former, the largest observed in the latter is only 12 fps in about twice as many cases.

Figure 4 represents the percentage of flight time in turbulent air as a function of height. For convenience in interpretation, the average vertical distribution of the wind speed through the jet stream region is included. It may be seen that above the 150-mb level the percentage of rough air for either synoptic type is smaller, being equal to about 2 percent. Below this level, however, turbulence becomes more frequent. In jet stream regions the percentage gradually increases to a maximum of 22 percent near 300 mb. Outside the jet stream, a similar but smaller maximum occurs at a slightly higher level. This maximum may in part be due to the fact that a few of the U-2 flights in the vicinity of the jet stream were made.

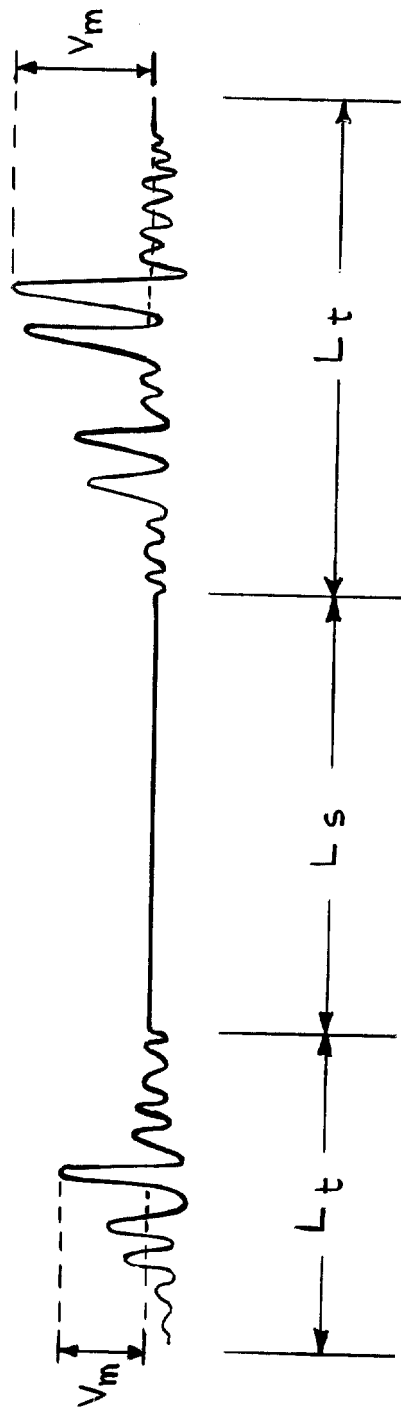


Fig. 1. Diagram of gust velocity plotted against distance showing maximum gust velocity and lengths of turbulent area and smooth area.

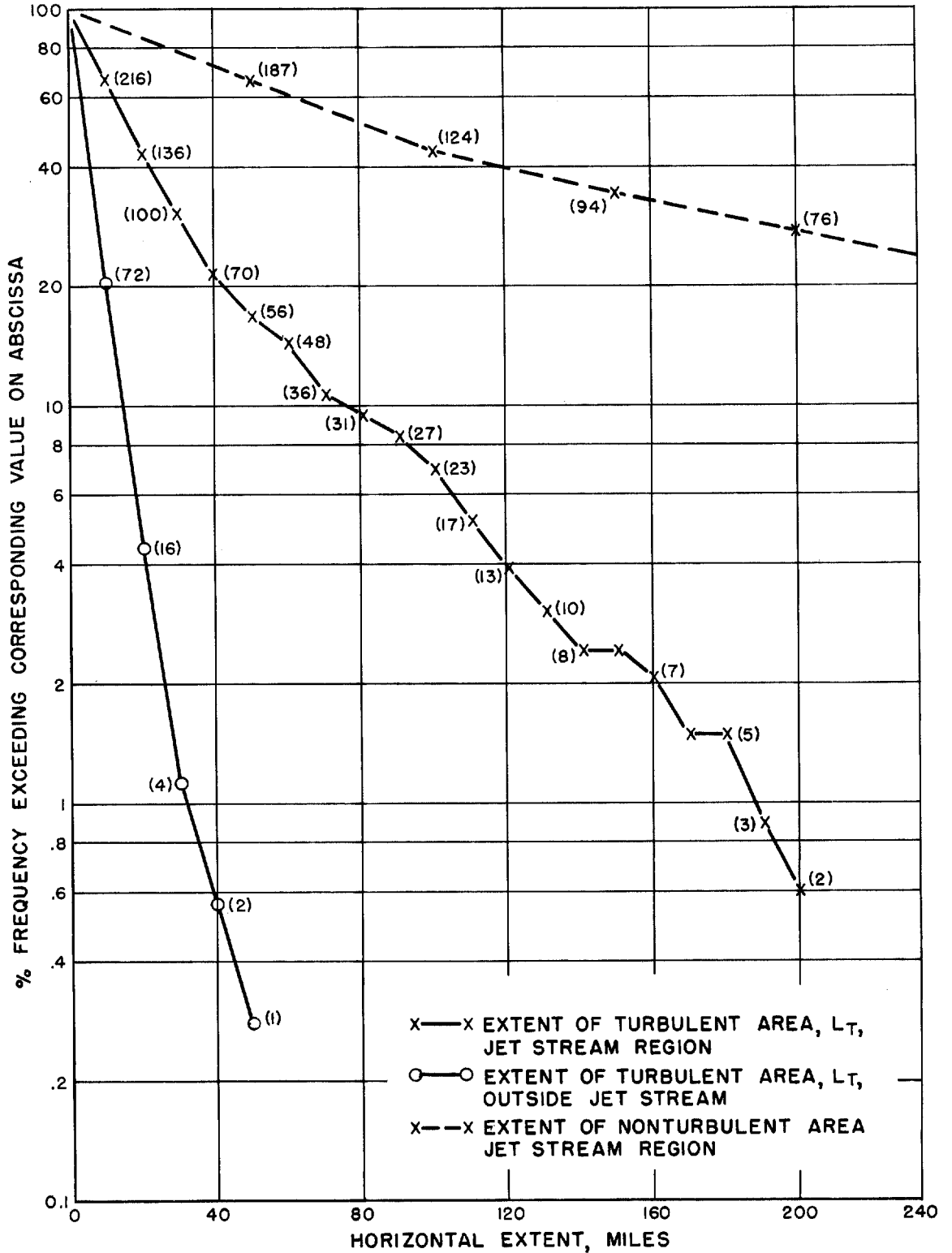


Fig. 2. Cumulative frequency distribution of the extent of turbulent and non-turbulent areas. Inside parenthesis is number of cases.

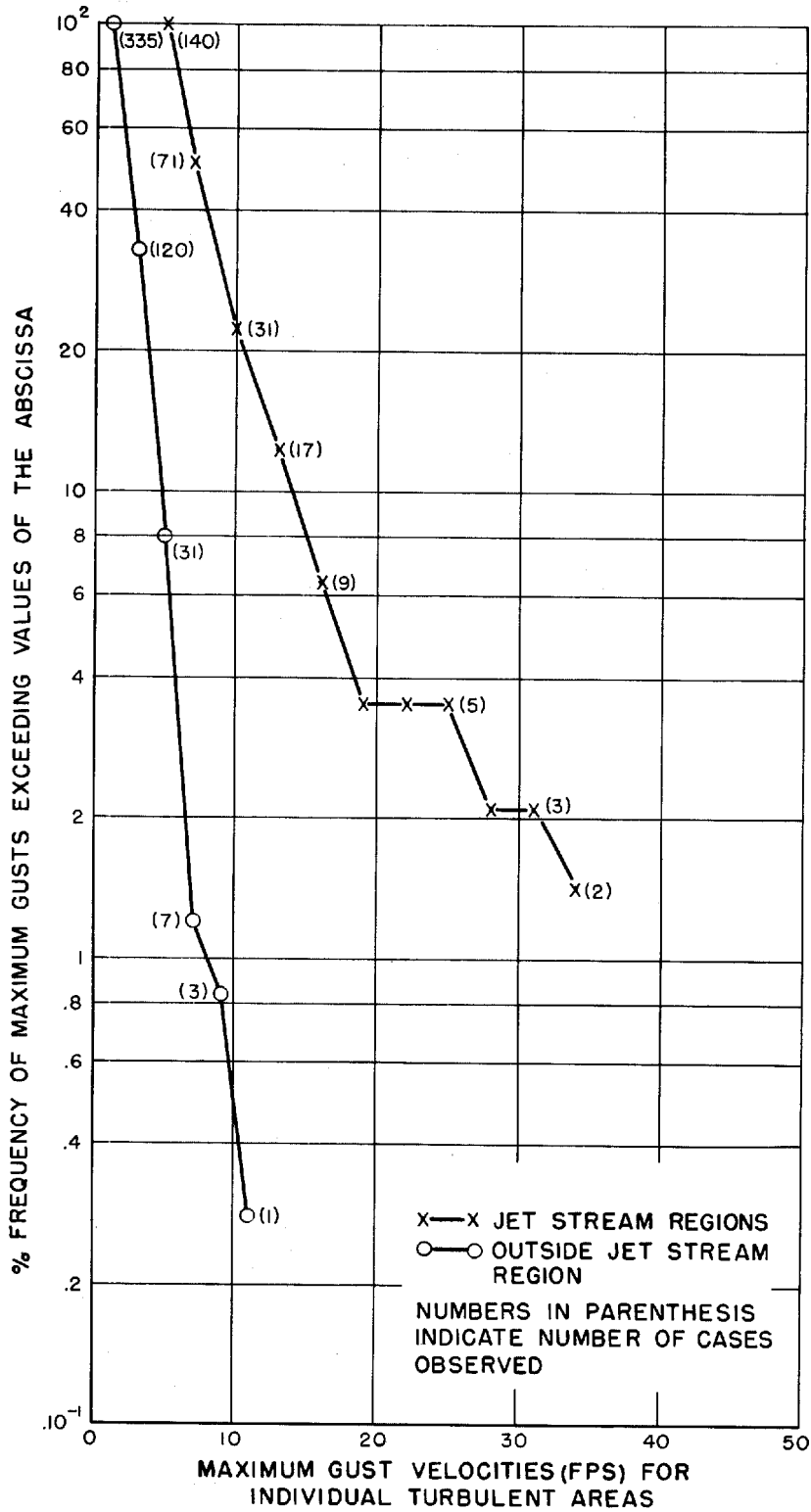


Fig. 3. Cumulative frequency distribution of maximum gust velocities of individual turbulent areas.

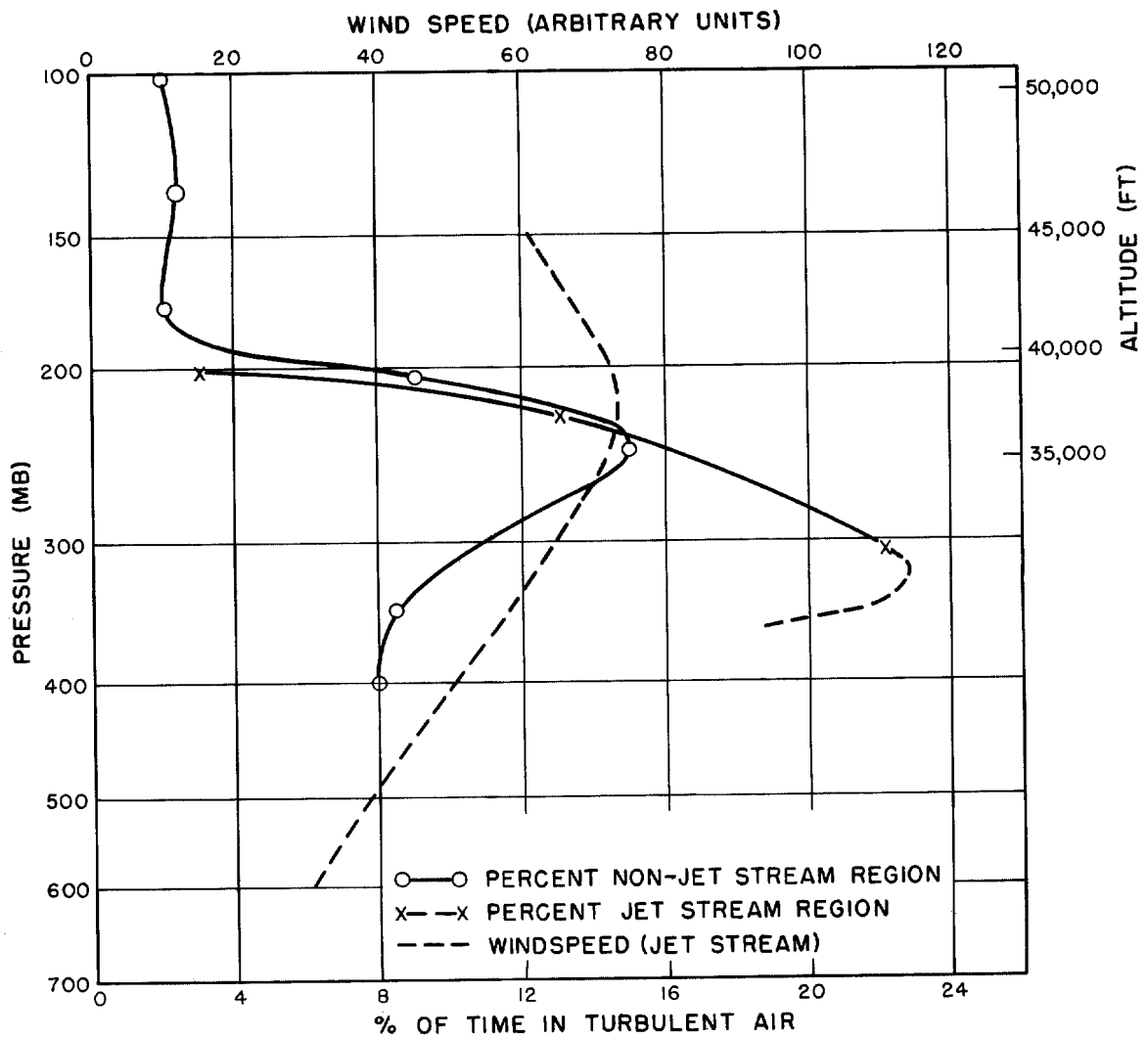


Fig. 4. Vertical distribution of percentage of time in turbulent air.

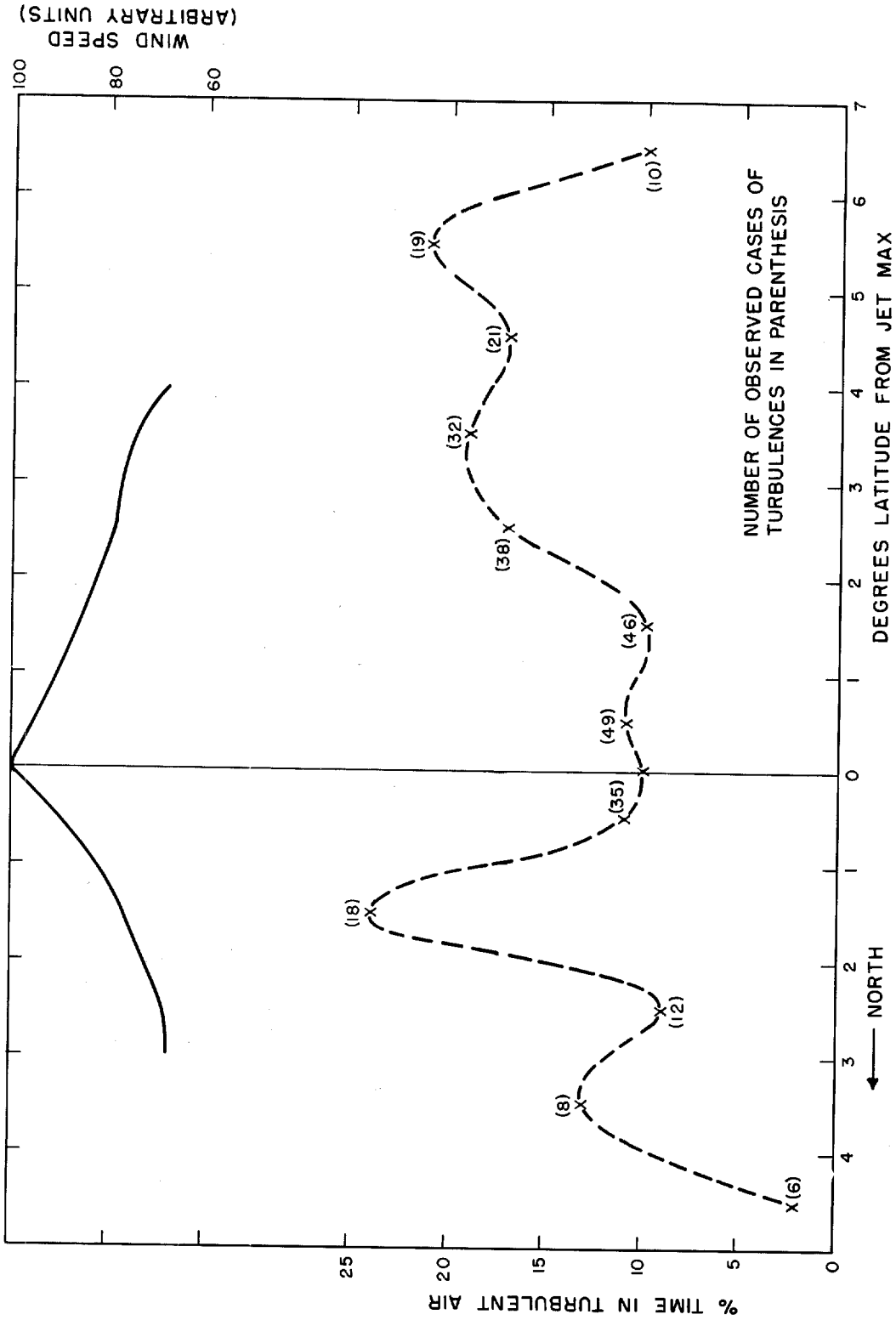


Fig. 5. Horizontal distribution of percentage of time in turbulent air across the jet stream.

The horizontal distribution of the percentage of turbulent air across the jet stream core is shown in Fig. 5. The percentages represent average values for the layer from 400 to 200 mb. The diagram indicates a relatively less turbulent core (10 percent) flanked by more turbulent portions (20 percent) at a distance of 3° to 5° latitude from the core on both sides. The rather irregular distribution is probably due to the small number of cases considered. It is expected that the percentages would decrease beyond the two maxima.

Table 1 is presented as a possible application of the data obtained to the problem of mid-air refueling operations. In the table, the percentage probability of failure in refueling is given for different altitudes and for different critical gust velocities (defined as velocities above which refueling operations are impossible because of turbulence).

Table 1. Percentage probability of failure in refueling as a function of critical gust velocity, altitude, and synoptic type. Percentages refer to operations outside and inside (in parenthesis) the jet stream.

		CRITICAL GUST VELOCITY (feet per second)		
		10	5	2
ALTITUDE (mb)	150	.02% (.44%)	.16% (2%)	2%
	200	.09% (.66%)	.72% (3%)	9%
	250	.15% (3.74%)	1.20% (16%)	15%
	300	.11% (4.62%)	.88% (22%)	11%
	350	.08% (4.18%)	.72% (19%)	9%

The percentages are estimates based on Figs. 3 and 4 and the multiplication rule of probability. It will be seen that the risk of refueling failure within the jet stream is about an order of magnitude greater when compared to the data for areas outside of it. However, refueling is not a serious problem at the 150-mb level (45,000 ft). A small increase in the gust velocities which can be tolerated during refueling operations would result in a large decrease of the probability of failure.

4. CONCLUSIONS

The results of an analysis of turbulence characteristics at upper levels in the jet streams and outside are presented. The statistics confirm previous findings of more frequent and more intense turbulence in the former. From this study it is shown that turbulence as a problem in mid-air refueling operations is not an important problem outside and above jet streams. However, in the vicinity of jet stream cores, the risks of failure are relatively high; it is therefore recommended that refueling operations be avoided in these regions.

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2. A Bibliography of the Electrically Exploded Wire Phenomenon, by W. G. Chace, November 1958.
3. Venting of Hot Gases Through Temperature Inversions, by M. A. Estoque, December 1958.

<p>AD 160757</p> <p>Air Force Cambridge Research Center Geophysics Research Directorate Bedford, Mass.</p> <p>SOME CHARACTERISTICS OF TURBULENCE AT HIGH ALTITUDES, by M. A. Estoque, December 1958. 10 p. incl tables, illus. (GRD Research Notes No. 4; AFCRC-TN-58-624). Unclassified Report</p> <p>Turbulence data obtained at altitudes of 23,000 to 60,000 feet by the GRD Project Jet Stream and the NACA-AWS groups using instrumented aircraft are analyzed as an initial attempt to construct a synoptic climatology of high-altitude turbulence. Statistical characteristics of turbulence in and outside of the jet stream region are presented. The parameters examined are the horizontal extent of turbulent areas and of the intervening non-turbulent areas, the maximum gust velocity in a turbulent area, and the percentage of flight time in turbulent air.</p>	<p>UNCLASSIFIED</p> <p>1. Turbulence- statistical analysis 2. Jet Stream - turbulence</p> <p>I. Estoque, M. A.</p>	<p>AD 160757</p> <p>Air Force Cambridge Research Center Geophysics Research Directorate Bedford, Mass.</p> <p>SOME CHARACTERISTICS OF TURBULENCE AT HIGH ALTITUDES, by M. A. Estoque, December 1958. 10 p. incl tables, illus. (GRD Research Notes No. 4; AFCRC-TN-58-624). Unclassified Report</p> <p>Turbulence data obtained at altitudes of 23,000 to 60,000 feet by the GRD Project Jet Stream and the NACA-AWS groups using instrumented aircraft are analyzed as an initial attempt to construct a synoptic climatology of high-altitude turbulence. Statistical characteristics of turbulence in and outside of the jet stream region are presented. The parameters examined are the horizontal extent of turbulent areas and of the intervening non-turbulent areas, the maximum gust velocity in a turbulent area, and the percentage of flight time in turbulent air.</p>	<p>UNCLASSIFIED</p> <p>1. Turbulence - statistical analysis 2. Jet Stream - turbulence</p> <p>I. Estoque, M. A.</p>
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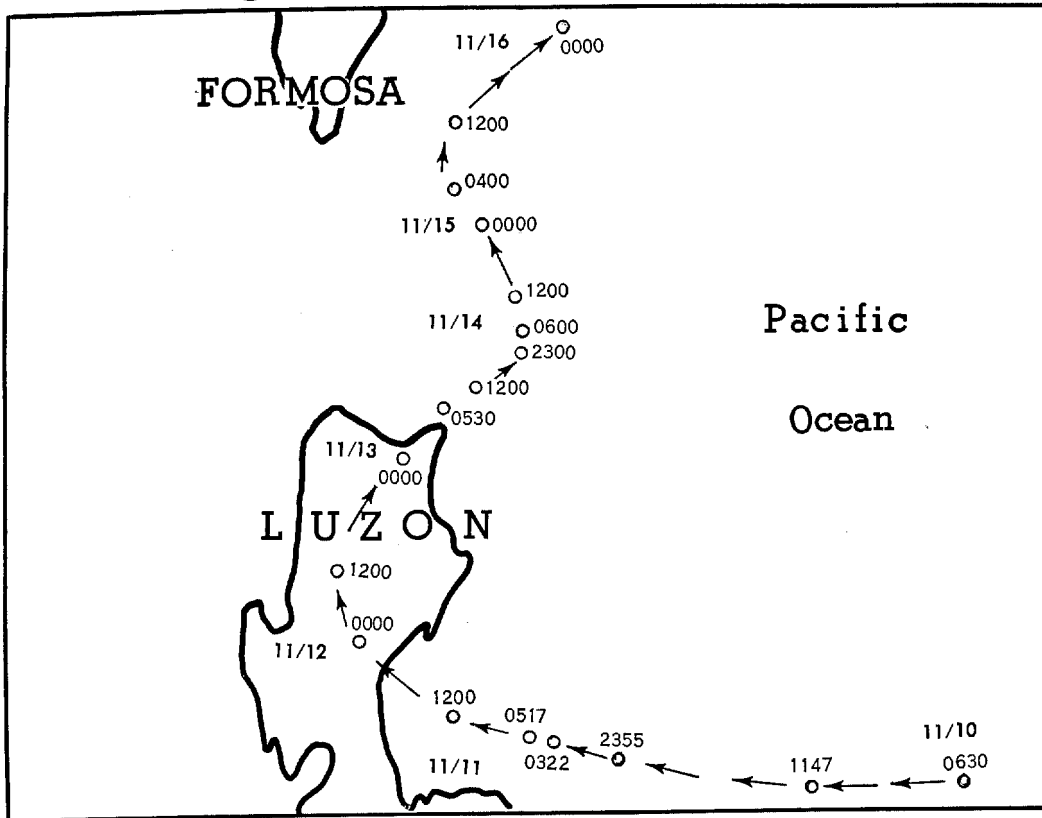
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Upper Air Studies Made Over Argentina

Buenos Aires—Tests of Argentina's upper air were started recently by U. S. Strategic Air Command team to gain precise information about jet streams, clear air turbulence and cosmic radiation in the next 18 months.

Test equipment includes Lockheed U-2 weather research jet, capable of sustained flight above 55,000 ft. U-2 used for sampling atomic radiation is fitted with test gear by National Advisory Committee for Aeronautics and Wright Air Development Center.

AVIATION WEEK, July 21, 1958



The path of Typhoon Kit through Luzon in the Philippines. Location of reconnaissance fixes are indicated; times are Greenwich Mean Time on 10-16 November 1957.

The First Flyover of a Tropical Cyclone

With Compliments,
 LT. COL. ROBERT C. BUNDGAARD, USAF,
Hqs, 10th Weather Group

FOR the flying weatherman of the Third Weather Reconnaissance Squadron, Provisional, the mission was a new one, never previously tried. It was their task to conduct a reconnaissance of Typhoon Kit from *above* and inside the eye of the storm and to produce a film record of her violence through means of a Perkin-Elmer Model-501 tracking camera. This horizon-to-horizon aerial camera would wipe Kit's image onto 70 mm film with a continuously-rotating scanning-prism. The Model-501 is small and light enough to be carried aloft by the U-2 jet aircraft, which are operated by the Air Weather Service in

support of the National Advisory Committee for Aeronautics' upper-air research program.

To Americans back home, last year's Typhoon Kit in the Pacific is probably not cloaked with as much ill-repute as was her eldest sister Agnes which earlier brought havoc and destruction to our military installations in Okinawa. But Kit is well remembered in the Republic of Philippines. Striking on the day of the recent presidential election, Kit behaved very much unlike our Lady of Liberty, and suspended the exercise of their constitutional right to vote for upwards of a million citizens of the Republic.

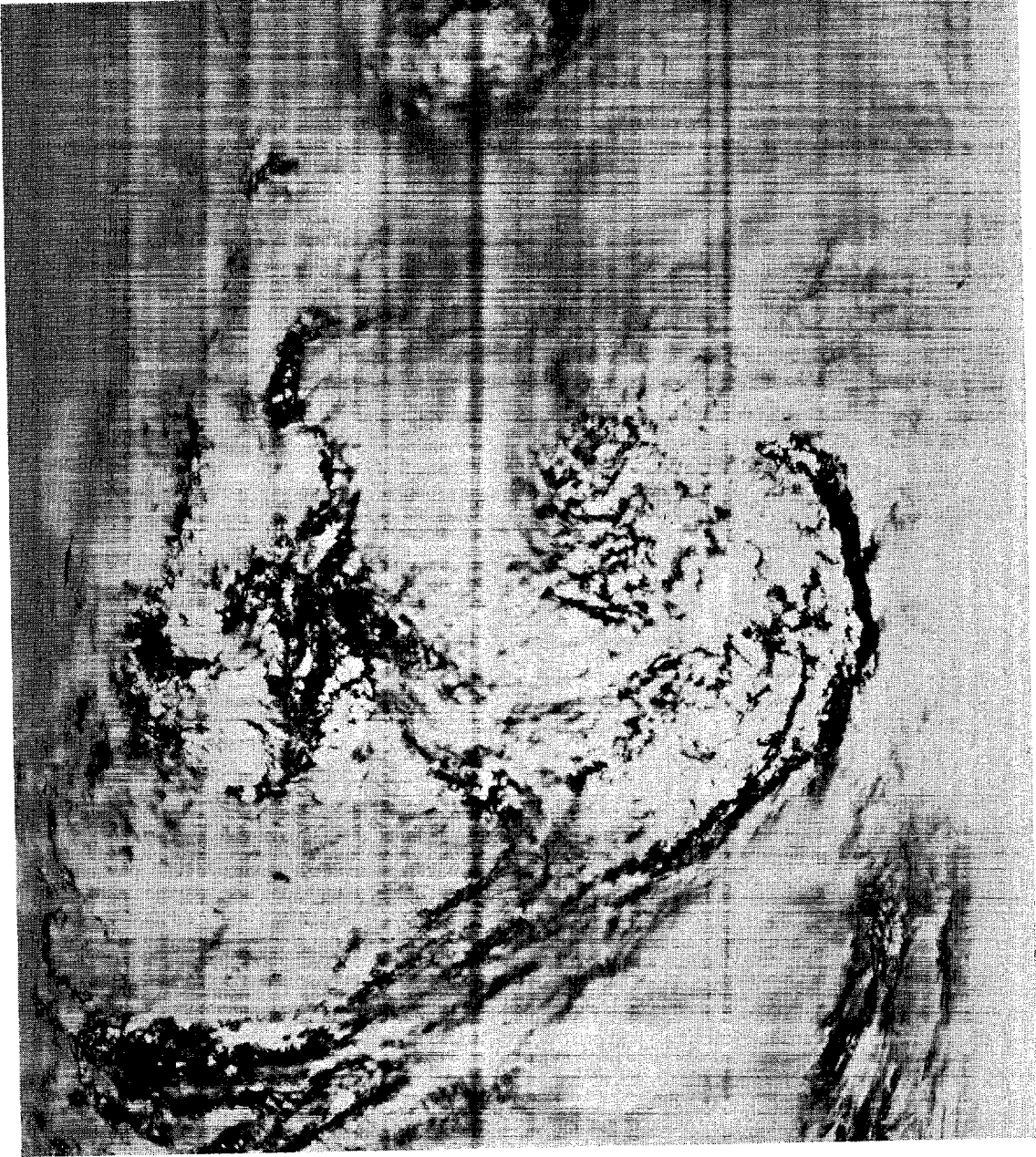
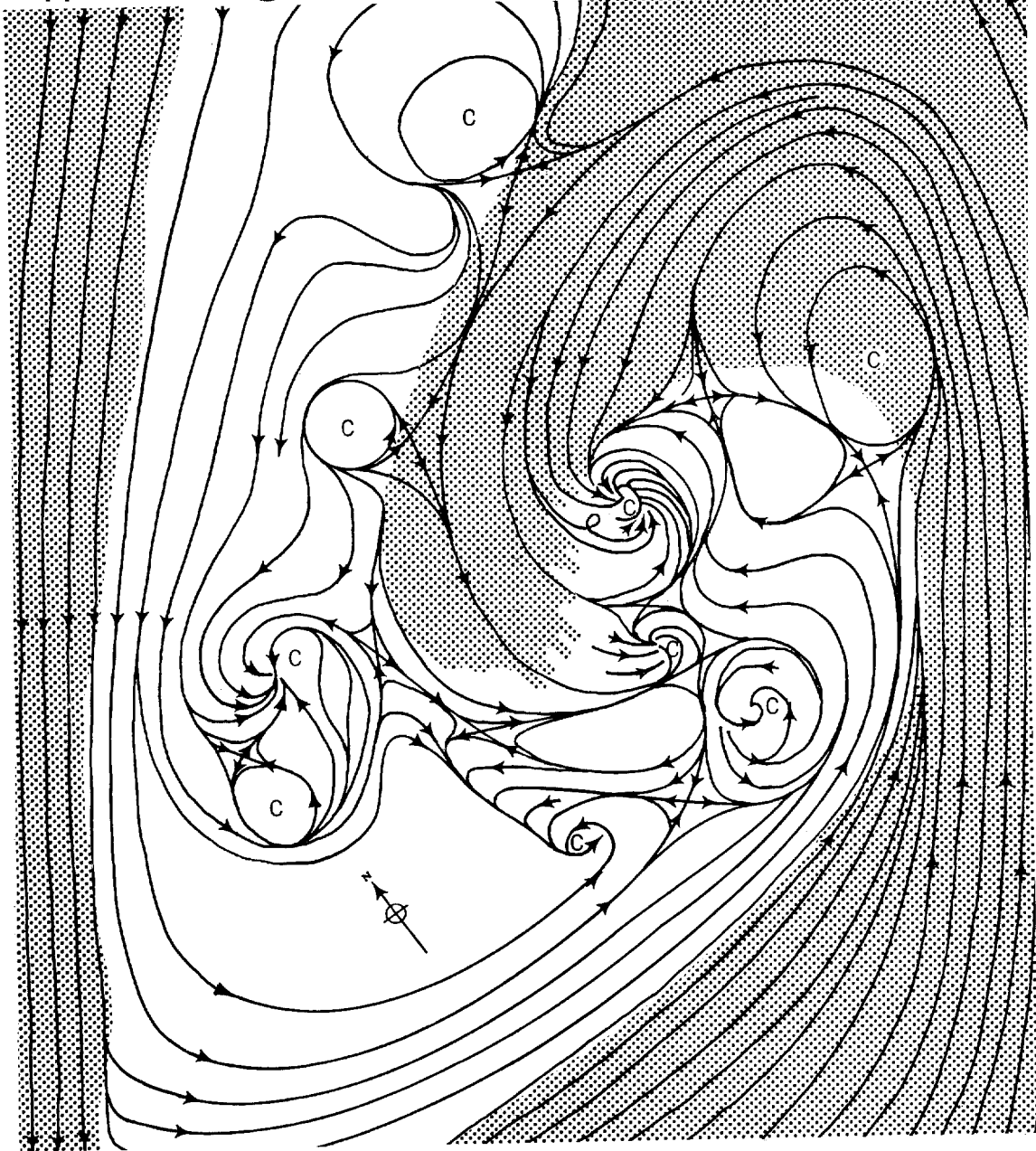


FIG. 2. Vertically above the eye of Typhoon Kit. The storm center is located at $19^{\circ}30'N$ and $123^{\circ}35'E$. This picture was taken at approximately 0422 GMT on 14 November 1957. It is an unconstituted mosaic of aerial photographs taken from the WRSP/3, U-2 aircraft. The U-2 traversed the center of the eye on a 235° heading. This traverse is the mid-vertical of this picture from top to bottom. Along this mid-vertical appears a 39 nautical-mile length of cloudscape. From top to bottom of this picture, the middle-third continuously depicts a nearly correct vertically downward view toward the sea and clouds below. From side to side, however, the picture falls gradually off toward the horizons. The left side of the picture is toward the west-northwestern horizon. At the time of this picture, which is approximately one hour and a half after local noon, Kit is headed northward, which is toward the top of the picture and slightly to the left (N. B. the compass directly in this figure). The large bowl-shaped appearance of Kit's eye is approximately 30 miles in diameter. Kidney-shaped, the darkened strips are portions of the sea surface visible



through cloud-free moats. A fetch of transverse sea waves may be seen in the fleur-de-lis shaped moat just to the left of the picture's center. The tops of the cloud turrets at the upper middle of the picture are at 48,000 feet. Along the right of the picture and curving counterclockwise in from the upper left corner is a sheet of high cloud. As this cloud spirals cyclonically into the eye's center, it appears to sink and dissipate, as part of an upper indraft ventilating the typhoon center. This high cloud is also represented by the dotted shading in figure 3. Congruent with this picture in figure 2 and having the same orientation and coverage, figure 3 shows also for the storm center the horizontal streamlines indicated by the apparent motion and structure of the clouds, as shown in this picture, figure 2.

FIG. 3. A horizontal streamline analysis made of the cloud picture in figure 2 for the eye of Typhoon Kit. This figure has exactly the same areal extent and orientation as figure 2. This figure shows that within Kit's eye there are nine small cyclonic swirls, marked by the "C's."

Surveyed in her aftermath, Kit wrought over \$5 million damage to public works, private property, the maturing rice and palay crops. She rendered some 58,900 persons homeless, probably many more. Miraculously, despite her viciousness, she claimed the lives of only 39 persons. Yet, for all her waste, suffering, and lives lost, Typhoon Kit could well have led to a far greater catastrophe, were it not for the typhoon warnings promptly and amply provided days in advance by the dependable WB-50 aircraft of Lt. Colonel Howard Berg's 54th Weather Reconnaissance Squadron, based at Andersen Air Base on Guam.

Meandering westward over the Eastern Caroline Islands during the early days of November 1957, the South Pacific tradewinds, it might be presumed, momentarily wobbled and recurved northward, spanking rotation and life into a small depression there. The mothering trades then nursed this slowly-spinning depression with her moisture-enriched hot breath. Doddering westward attached to the trades' apron strings, the whirl progressively strengthened and grew to gain full storm intensity. On the morning of November 8th, Colonel Berg's vigilant typhoon-chasers first spotted the storm practically in their own backyard, just 170 miles south-southwest of Guam. It was already spewing 50-mile-per-hour winds. By that same afternoon, the storm had intensified into a full-blown typhoon, and the watching of Kit by the 54th began.

Typhoon Kit plowed west-northwest at 20 mph. toward the Philippines, 930 miles away. Riding herd on Kit during the next three days of fatiguing and teeth-chattering flights, the 54th weather crews twelve times boxed the typhoon and penetrated into its very eye. Little did these flying weathermen suspect that fate had destined that a crew was soon to be lost in these very same waters; for just two months later a WB-50 from the 54th disappeared into Typhoon Ophelia, following Kit's same path, and was never heard from again.

On November 11th, the eve of the Philippines national elections, Kit packed 200 mph. surface winds, only a day out of Luzon. Despite the fury of these howling winds, the 54th continued to look three times more into Kit's bewitching eye, as she skirted north past

Catanduanes Island, passed within 60 miles to the north of the Bicol Peninsula, and until at last she poised to stab into east central Luzon at Baler Bay.

As Kit travelled inland, the rugged mountain terrain of Luzon took a lot of wind out of her, at least in the lower part of the typhoon. Steered under the influence of the upper southerlies, Kit now curved abruptly northward into a parabolic swing, barely side-swiping Clark Air Base. Apparently with the prophetic power that would be the envy of even the greatest of soothsayers, USAF typhoon forecasters had gathered at Clark Air Base from all over the Far East and were midway through a two-week Typhoon Workshop, led by Professor C. S. Ramage and Major James Sadler of the University of Hawaii. The workshopers followed Kit closely, predicting her movement by various techniques. Only one technique successfully called for Kit's sudden swing northward through Luzon after her four-day trek westward. This technique is an empirical method recently developed by Keith Veigas and Robert Miller at the Travelers Weather Research Center under the leadership of Dr. Thomas Malone.

Noon the next day, after exhausting her strength in battering the Luzon land cap, Kit bid her *pallam*, or adieu, and slipped out of the Ilocos coast, at a point 30 miles east of the coastal city of Aparri, at the Cagayan delta. Now subdued, erratic Kit turned back to the Pacific, zigzagging sluggishly northward and skirting east of the Batanes Islands.

But now, as Typhoon Kit threatened to recurve to the northeast in the direction of Okinawa, the responsibility for watching her passed to the 56th Weather Reconnaissance Squadron and the 3rd Weather Reconnaissance Squadron, Provisional, both units based in Japan. Again the WB-50 was dispatched to keep a watchful eye on Kit. The suspense of such flights was now beginning to appear among the personnel of the 3rd Squadron.

By noon on the 14th, Typhoon Kit had reached a critically interesting, degenerative stage. Few opportunities had thus far been afforded scientists for studying the manner in which typhoons dissipate into tropical storms, thence into tropical depressions, or sometimes into fast-moving, sub-tropical cyclones. Occasionally, typhoons temporarily weaken

into separate storms, such as Kit did, only to be reborn again as typhoons. Scientists had long hoped for an opportunity of examining a typhoon from above with the hope that it might shed some light upon which of these dissipating atmospheric processes future man might alter in order to control typhoons.

So, as Kit mauled indecisively at 20°N and 123°E, Dr. Robert D. Fletcher, past president of the American Meteorological Society and currently visiting the 3rd Squadron, suggested that now was the time to dispatch one of the U-2 research aircraft to peer down at Kit. Approaching the storm area the recon-pilot was guided by giant cloud "streets" spiraling in toward a coliseum-like wall of nimbostratus surrounding Kit's eye. In the wide converging sectors between these towering squall bands, a floor of soft flat clouds hid the ocean from the pilot's view. Climbing into the storm center, the U-2 hedge-hopped over the towering 48,000-foot cloud wall around the eye. Once within this wall at 10 miles above the ocean's surface, the pilot saw the angered ocean far below him and waves were clearly visible through long moat-like arcs, clear of cloud. Downdrafts of hot air had gouged out these moats at the eye-wall's very edge. Looking much like the froth on a boiling caldron, a large island of low-lying and hard, cauliflowery clouds bleared Kit's eye. Around an island-like hub-cloud, the eye cloud churned in smaller, cat-eyed swirls. The pilot

counted nine such cat eyes within the center area of Kit. These false-eyes, like parasites, were consuming the dying typhoon, much in the manner so aptly described in 1922 by L. F. Richardson, on page 66 in his famous book, *Weather Prediction by Numerical Process*.

Big whirls have little whirls that feed on their velocity,
And little whirls have lesser whirls and so on to viscosity.

Thus, the primary motion of Kit formed by the instability of large-scale vertical and horizontal motions, when subjected to destabilizing processes through loss of moisture supply in passing over Luzon, now led to the creation of secondary smaller whirls. These false-eyes were partly of a dynamic nature, caused by the disorganization of Kit's kinetic energy, and partly of the thermal type.

Here, then, was the eye of Kit, the first ever seen in its entirety. The mission had been accomplished. The furor of Kit was now recorded on film. Kit was dying a normal death, but in her last gasping breaths she had provided scientists with a new area of interest. The 3rd Squadron had also found an entirely new mission to perform. Through the willingness of NACA to utilize the U-2 in flights over typhoons, the way had been opened for a better understanding of Nature's most disastrous storms.

TABLE I

CONCISE WEATHER REPORT FROM THE PHILIPPINES IN CONNECTION WITH THE PASSAGE OF KIT

1. Barometric Minimum at MSL 937.0 mb at 0000Z, November 11 and
921.0 mb at 0600Z, November 11
2. Maximum sustained winds:
 - a. Over land 80 miles per hour at Virac, Catanduanes, and Casiguran, Quezon, at 2200Z, November 10, and 1600Z, November 12, respectively; 100 miles per hour at San Vicente Quezon, at 1900Z, November 11
 - b. Over water 200 miles per hour at 0600Z on November 11
3. Maximum 24-hour rainfall 16.66 inches at Baler, Quezon, on November 12

DEFENSE

U.S. Planes Over Russia?

The Strategic Air Command's 2,000-odd B-47 medium-jet bombers and hundreds of heavy B-52 intercontinental jet bombers hold an overwhelming power margin over the U.S.S.R., reported the monthly *Missiles and Rockets* magazine last week. The proof, said *M. and R.*, is that SAC aircraft are conducting "numer-

TIME, JANUARY 20, 1958

ous and continuing" reconnaissance missions over the U.S.S.R., and the Russians have not been able to stop them. "It is true that modern Russian fighters attack our bombers with major advantages of altitude, speed and maneuverability. It is also true that they score hits. But so far no attacks have been made by the Russians with missiles, either because they don't have antiaircraft missiles that are operational or because the Reds don't want to tip their hand. In any case, U.S. radar and photographic mapping missions over the Russian land mass continue with a fair degree of success and immunity. This indicates that in the event of an all-out situation, SAC bombers would get through in high enough proportion to result in a major catastrophe to the Soviet Union. The Kremlin knows this."

M. and R.'s report, reprinted by such European newspapers as Rome's *La Stampa*, and in the U.S. by the *Christian Science Monitor*, brought a denial from the Air Force.

Approved For Release 2000/08/21 : CIA-RDP33-02415A000100420001-2

SAC Bombers Map Soviet, Paper Says; U.S. Denies It

Washington, Jan. 7 (AP)—A trade magazine said today United States planes are flying mapping missions over Russia despite attacks by Soviet fighters, but the Pentagon denied it.

"The Air Force denies that it is engaged in photographing Soviet Russia," the Defense Department said. There was no further comment.

The brief statement was issued in response to queries about an article in the magazine *Missiles and Rockets* which said such missions are being flown by bombers of the Strategic Air Command.

Article By Editor

An article by Seabrook Hull, associate editor of the privately owned trade publication, said such flights demonstrate that this country retains "an overwhelming retaliatory ability" as compared with Russia.

"The clincher that demonstrates the United States capability through its SAC bombers is the fact that these aircraft continue to fly over the Soviet Union with a relative degree of

immunity," the magazine said.

"It is true that modern Russian fighters attack our bombers with major advantages of altitude, speed and maneuverability. It is true that they score some hits.

"But so far no attacks have been made by the Russians with missiles, either because they don't have anti-aircraft missiles that are operational or because the Reds don't want to tip their hand.

"Fair Degree Of Success"

"In any case, United States radar and photographic mapping missions over the Russian land mass continue with a fair degree of success and immunity.

"This indicates that in the event of an all-out situation SAC bombers would get through in high enough proportion to result in a major catastrophe to the Soviet Union. The Kremlin knows this."

The article said it is safe to assume that within two years the Russians will have inter-

(Continued, Page 10, Column 5)

(Continued from Page 1)

continental ballistic missiles trained on American cities and air bases, seriously diminishing United States retaliatory capacity.

"Already," the article said, "pilots and crewmen of the Strategic Air Command assume that theirs would be a suicide mission, if the countdown were called."

Hull said: "The big problem that faces the West is not now today — but 12 to 24 months from now," adding:

"There is strong evidence that the United States is lagging behind the Russians in missile and space-flight development. This . . . points toward a very dangerous situation two years from now, unless the West takes unprecedented steps."

Is Widely Read

The magazine *Missiles and Rockets* is widely read in industry and Government circles and is given a generally high accuracy rating.

There have been a number of incidents involving United States and Soviet aircraft, but Russia's last official protest was made nearly a year and a half ago.

On July 12, 1956, Russia complained to the United Nations Security Council that United States aircraft had violated Soviet air space on four occasions that month. A United States note to Russia one week later dismissed the charges as "in error."

The most recent shooting incident involving the United States and Russia occurred June 22, 1955. Soviet fighters attacked a Navy patrol bomber over the Bering Strait, causing it to crash-land and injure five crewmen.

Approved For Release 2000/08/21 : CIA-RDP33-02415A000100420001-2

U.S. Planes Photographing Russia Says Russia; Pentagon Denies It

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HARTFORD COURANT - 8 January 1958