AEROSPACE

SAFETY

UNITED STATES AIR FORCE

January 1964

THE SAFEST YEAR

A year of substantial improvement and record low accident rates! This is the outlook for the 1963 USAF aircraft safety picture. At press time (early in December) the major accident rate—accidents per 100,000 flying hours—stood at 4.4, a rate significantly lower than the 5.7 rate recorded in 1962.

Indications, based on press-time figures, are that by the end of the year the 1963 rate will be less than 4.4. To record any dramatic increase will require a rash of accidents exceeding any recent experience. Further, this adverse condition would have to occur in a month of decreased flying. There is no indication of such a trend.

The aircraft fatality rate (total number of persons killed in aircraft) of 3.4 is another indicator of improvement in accident prevention. Previously, the lowest fatality rate ever recorded was 3.7 in 1960. The 1963 rate also reverses an unfavorable three year trend that saw the USAF fatality rate climb to 5.6 in 1962.

The fatality rate, however, can be affected by fortuitous events and caution should be exercised in accepting all of the improvement shown as indisputable proof of an improved level of accident experience.

More indicative of the level of success attained is the fatal accident rate (aircraft accidents in which there were one or more fatalities) which is expected to be down to 1.8 as comparred to 2.0 in 1962. However, the lowest fatal accident rate on record was the 1.5 achieved in 1960.

The aircraft destroyed rate, another valid indicator of improvement, shares the record low rate of 3.8 established in 1960 and shows a substantial improvement over the 1962 rate of 4.5.

The table below compares some annual rates beginning with 1946.

Due to the time requirement for detailed investigation and final evaluation, 1963 aircraft accident cause factors are still preliminary. As of press time there is no indication that accident causes will differ substantially from those of recent years. Pilot and materiel cause factors continue to predominate and will continue as areas to receive considerable prevention attention. Another area, "undetermined," is also being looked at more and more closely ("What Happened," page 2, this issue).

Despite a general leveling off of the major aircraft rate for three years, 1963 tends to support the contention that many aircraft accidents are still preventable. Continued diligence in reporting of all hazards is emphasized as a means of achieving the safety goal—eliminating preventable aircraft accidents. ☆

	Major Acft Accident Rate	Fatal Accident Rate	Destroyed Aircraft Rate
1946	61	7.6	20.9
1951	33	5.5	12.9
1956	15	3.1	7.5
1961	6.3	1.8	4.7
1962	5.7	2.0	4.5
1963 (Year end estimate)	4.4	1.8	3.8

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IN THIS ISSUE

FALLOUT

RUNWAY STOP LIGHTS

Dear Editor—

Standing in the local snack bar recently, I was approached by an airman who asked me if I worked in the control tower. I replied that I did, and the following conversation ensued:

"Why did you people have the Air Police stop me after I crossed the runway?"

(At that time our runway had just been reopened after being closed for almost five months for repairs. The tower was having trouble getting the vehicles to stop for a light now that it was a "hot" runway. For protective measures we were having the Air Police stop vehicles that were crossing without a green light.)

I replied to the airman, "The only thing I can think of was that you crossed the runway without a light."

"But I did get a light," he said.

"Are you sure you got a green light?"

"Yes, I got a green and white light. That's the light for using extreme caution, isn't it?"

I wondered what controller would give him a green and white light when I remembered that the field was IFR on the day the airman was stopped. I asked him from where he got the light signal and sure enough he said he got it from the large tower located behind the control tower. I explained to him that he was receiving his light from the rotating beacon.

This incident may sound funny but I started checking with some of the other controllers and many recalled this same thing happening to them at some time or another.

One controller told me of an airman who crossed the runway when a red light was flashed at his vehicle. Later when questioned the airman replied that his supervisor had instructed him to watch for a light but didn't specify what type of light, so when given a red light he thought he was cleared to cross. This type of situation could get very serious, especially if an aircraft were touching down on the runway at the time.

I feel that all supervisors should take a look at their orientation programs and re-brief on light gun signals. They should also point out to the airmen just where to look for a light gun signal. Remember, the only signal that gives you clearance to cross a runway is a solid green or an alternating green and red which means use extreme caution. This signal will come from the control tower. The proper way to obtain either of these signals is to face your vehicle towards the tower and blink your headlights. This lets the controller know that you want to cross the runway. Then and only then you will be cleared to cross if you get the proper light. Permission to go on the airdome, including the ramp and all taxiways, must be obtained from base operations.

A2C Lanny G. Heater
1952 Comm Sq AFCS

PLEASE

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Volume Twenty Number One — USAF Recurring Publication 62-1

Every day of our lives, we in the Directorate of Aerospace Safety are faced with the accident investigator's perpetual question . . .

WHAT HAPPENED?

Lt Col Donald E. Miller, Directorate of Aerospace Safety

Let's set the stage for all that follows by briefly reviewing a recent accident wherein the investigative procedures and techniques left, to say the least, considerable to be desired.

Two Century Series fighters were returning from a gunnery mission when at 3000 feet the flight leader signaled for spread formation. The wing man smartly executed a 90-degree break from which he never recovered. Scratch one bird and chalk up another nylon letdown.

Now for some complications that resulted.

The destroyed aircraft belonged to one command, was being flown under the training jurisdiction of another command, and the accident was investigated by a third command owning the base nearest to the scene.

A "limited board" was convened consisting of four company grade officers, one a medical member, and one a recorder. Thus, the entire investigative effort was reduced to two people.

The investigating officer had no experience at all in the type aircraft involved and the pilot member very limited experience. The presence of a maintenance member would have added much to the quality of the investigation and the assignment of a senior, highly experienced officer as president of the board should have been a basic consideration.

The investigation consisted primarly of two interviews (one by phone) with the pilot involved and the findings based for the most part on the board's confidence in the pilot.

After the findings of the board were reviewed and suspected (and rightfully so, due to the perfunctory investigation conducted), no attempt was made to reconvene a board or reconsider further attempts to recover the aircraft.

Speaking of attempts to recover the aircraft, this was abandoned in the early stages, based on a decision by a base employee in the reclamation unit that attempts to secure the wreckage would be too expensive! Remember now, we're speaking of possibly saving a few million dollars worth of aircraft if we find the real cause of this accident versus the expenditure of a few hundred or possibly a few thousand dollars to recover the wreckage.

No apparent attempts were made to secure witnesses; maintenance on the aircraft was considered *professional* because the forms were up-to-date; over 50 per cent of the report consisted of reproductions of AFTO Form 781 Part II and AFTO Form 781A, the contents of which had no bearing on the accident other than to add to the weight—literally—of the folder; no apparent attempt was made to review similar accidents or request technical assistance or data from the prime AMA or the Directorate of Aerospace Safety.

The findings and subsequent recommendations were based on *ifs*. This led all concerned to start charging off in several directions for remedial action until the prime AMA and the command having accident investigation review authority threw some cold logic on the whole issue and put the trolley back on the track.

There was no indication that some of the more outstanding possible cause factors were reviewed, even though rudder lock was a prime cause factor suspect. Rudder lock on this particular aircraft can be caused by several things, some purely mechanical such as the rudder pedal hanging up on the side of the center pedestal. Large adverse yaw angles can be developed at low to medium speeds by abrupt application of aileron and/or rudder; failure of the yaw/pitch damper in this aircraft can also produce a hard over signal, full extension or retraction of the rudder actuator, failure of utility hydraulic system return line quick disconnect

. . . there are others. Discussion on these subjects was either omitted or not clearly presented in the analysis.

Anyhow, without the wreckage to begin with, how do you conclusively prove your findings? Now we are back to the *ifs* again and at best—in this writer's humble opinion—an accident with an undetermined cause.

Nothing is more fundamental to accident prevention than a thorough investigation of an aircraft accident. Every effort must be expended to determine the real cause.

It is imperative that new procedures be developed within the accident prevention field to preserve our combat capability. In this regard, a proposal has been made that commands form centralized/specialized investigation teams. Obviously, the use of command-wide resources to form such teams has a great deal of merit. The importance of having the most *highly qualified* individuals available to conduct investigations of accidents, particularly those with strong materiel failure or malfunction implications, will do much to decrease the "undetermined cause factor" rate. To insure success in such an endeavor, however, would require the formation of a workable pre-accident plan in which the selected individuals would be identified by name. From 1 January 1956 through 31 December 1962 there were 1624 major accidents involving jet bombers and Century Series fighters. Of these, the cause factors for 206, or 12.7 per cent, were never determined. Many times TDRs were inconclusive, vital parts were never located, wreckage was not recovered, accident boards relied primarily on the investigating officer (often not qualified) to lead the way.

Another investigative technique which should be emphasized is the use of flight simulators to duplicate the flight maneuvers that could have been a factor in the sequence of events culminating in the accident. The

Recovery of wreckage is vital in finding cause of accident.

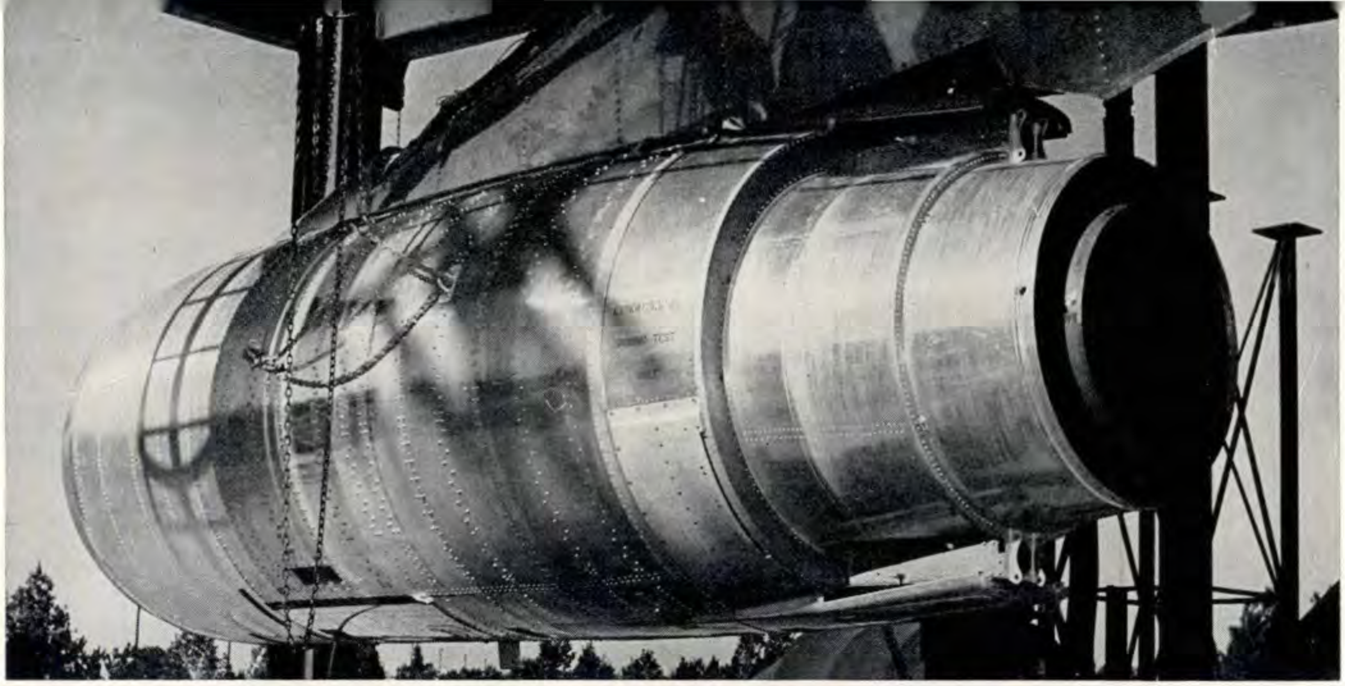
use of this technique materially assists the investigator in proving or disproving certain assumptions that must be made in order to determine the courses of action the board must explore.

Another area, and one that can be controlled by the local commander to a great extent, is the careful selection of personnel assigned to standing accident investigating boards. Usually the accident investigating officer is a novice, not having had any formal training in the highly technical field of accident investigation. The Aircraft Accident Investigating Officer (AAIO) is the key man on an accident board. *The proper conduct of the investigation and the validity of the board findings and recommendations are directly related to the qualifications of the AAIO.* There is a serious shortage Air Force-wide of officers qualified to serve as AAIOs. Officers possessing AFSC 1925 who are graduates of the Flight Safety Officers Course and/or the Jet Engine Accident Investigation Course are normally the only trained personnel available for accident investigation. Several commands are requiring these prerequisites for accident investigation officers. Currently we are losing 30 per cent of all USC graduates per year to career progression, retirement, and change of primary duty. Air Force-wide, 161 out of 533 UMD authorized FSO positions are not filled by officers possessing AFSC 1925. The AAIO must be trained, identified and utilized in this highly specialized task if the quality of accident investigations is to be improved and a significant reduction made in the number of undetermined accident cause factors. Increasing the number of USC graduates would materially aid in solving this problem. *Use of all USC graduates in the Flying Safety Career Field is a partial immediate solution to the problem.* A method of identifying qualified AAIOs must be devised if maximum use of these experienced personnel is to improve. An ATC Short Course in aircraft accident investigation would aid in providing qualified officers.

As you have probably deduced by now, the foregoing discussions undoubtedly should result in some recommendations. They have—as a result of the 4th Annual Safety Congress Seminar. If recommendations of this group are acted upon, the percentage of "undetermineds" should decrease. For the sake of brevity, detailed discussion on these recommendations will not be undertaken in this article.

Remember: a better accident prevention program is a natural by-product of better accident investigations. We're not advocating that you conjure up cause factors, but when you reach an impassé and the recorder is about to use that word "undetermined" to close the board proceedings, take one more hard look at what you have, explore one more possible cause factor, check and recheck the accident scene, make another attempt to secure the wreckage, and talk to one more witness before the board members sign that Form 711.

Comparing the 1957 major accident rate of 13.6 with the projected rate of 4.4 for 1963 (destroyed aircraft rate: 1957, 7.5; 1963, 3.8 — projected), one can say that we have made improvements resulting in an excellent accident prevention program. However, now is no time for complacency. Let's explode this myth that we have reached the *irreducible minimum* by taking a healthy cut at the undetermined cause rate by improving our investigation techniques and procedures NOW] ☆



BIG PUSH

Jack G. Gilley, Aviation Safety Engineer, Lockheed-Georgia Co.

One morning early in June of this year a freight car full of thrust arrived at the receiving dock of the Lockheed-Georgia Company. This prodigious shipment of power was packaged in four containers, each slightly larger than a compact car. Stenciled markings identified each as being one Pratt and Whitney TF-33-P-7 engine destined for installation on the first C-141A Star-Lifter.

The combined power of the four turbofan engines is 84,000 pounds in the static condition, with a total reverse thrust up to 53,000 pounds.

The TF-33-P-7 engine officially passed the Military Qualification requirement and received the FAA Type Certificate on March 26, 1963. The first production engine was accepted on March 28, 1963.

The predecessor of the TF-33, the JT3D turbofan, had accumulated over one million hours of commercial airline service and the experience gained in this worldwide usage was applied to the advanced design. Changes and improvements were evaluated and tested prior to incorporation. To obtain full qualification of the production engine, Pratt and Whitney compiled a total of 7623 hours of test on 11 development engines. Eight endurance runs of 150 hours each and extensive operation in the environmental laboratory at Eglin Air Force Base at temperatures ranging from minus 65 degrees to plus 165 degrees Fahrenheit were accomplished. A comprehensive flight test program with the TF33 installed in a special wing pod on a B-66 rounded out the initial test and development phase.

Since September 1962, a prototype pylon and nacelle have been undergoing development testing at the Lockheed-Georgia Company plant. The engine test stand accommodates a C-141A wing section with provisions for a landing flap attachment and pylon and nacelle installation. A specially designed "wind machine" powered by a P & W R2800 reciprocating engine generates a blast of 143 miles per hour velocity to create the effects of flight air flow, gusts, and cross wind conditions.

Three pre-production engines were delivered in mid 1962 for operation on the engine test stand. These engines were used for development testing of the prototype engine inlet, the fan exhaust hardware, and for evaluating power plant systems and accessories. Components developed on the test stand were sent to PWA for further testing with production engines to insure compatibility between nacelle and engine components.

The test stand is presently being used to obtain Air Force and FAA approval of the C-141A engine thrust reverser system. In the near future Lockheed will install a production engine and nacelle and will continue extensive testing of engine /nacelle compatibility including cooling, sonic fatigue, fire detection, vibration and noise and inlet anti-icing. A 150 hour nacelle endurance test simulating operating conditions is programmed for completion prior to airplane first flight.

In the meantime, the installation of the first four production pylons and nacelles has been completed on the first C-141A which has been rolled from the manufacturing plant and is getting into flight testing. Design of the power-plant attachment to the aircraft and details of engine cowling, including the inlet and ex-

Four big engines providing 84,000 lbs. of thrust will push Air Force's new C-141A Starlifter.

haust areas, were selected to meet or exceed the requirements of Pratt and Whitney. Engine isolation for fire protection, inlet and exhaust air flow, cooling provisions for the engine and associated equipment, and anti-icing provisions are some of the factors that influenced the configuration.

The TF33-P-7 is suspended from the under surface of the C-141A wing by a pylon made up of a box section faired by leading and trailing edge assemblies. A horizontal firewall forms the bottom of the pylon and extends over the top 90-degree included angle of the nacelle.

Each nacelle is divided by vertical firewalls into three compartments: the aft exhaust nozzle assembly, the combustor-turbine section (Zone X), and the accessory-compressor section (Zone II). Cowl doors provide easy access to equipment for inspection and maintenance.

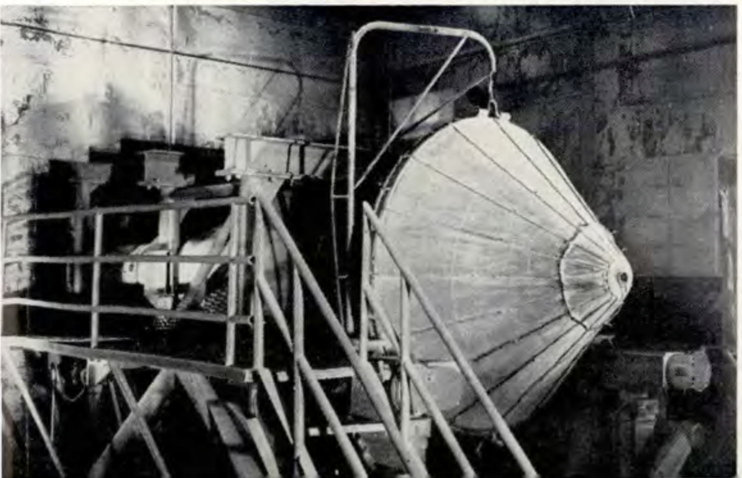
The Lockheed designed "zero length inlet duct" locates the fan inlet guide vanes almost flush with the front of the nacelle and allows air flow into the fan and primary compressor with minimum drag and maximum efficiency. Primary compressor air discharges into the engine combustor section and exhausts through the turbine and primary exhaust nozzle. Fan discharge air is carried through two long kidney-shaped ducts extending along the sides of the engine merging into an annular fan discharge duct surrounding the primary nozzle assembly.

This long fan discharge duct arrangement was an important factor in the selection of the thrust reverser configuration. A target-type reverser consisting of two doors and actuating mechanism completely external to the primary and fan discharge ducts was the optimum choice. Advantages over alternate configurations were simplicity of design, minimum drag when stowed, and a significant savings in weight. The two doors are attached to each nacelle through a series of linkages and hinges and are extended during reversing to deflect both the primary and secondary exhaust gas streams. The thrust reverser hydraulic system is pressurized by a pump mounted on and driven by each engine and shares fluid with the Constant Speed Drive unit. Each engine thrust reverser system is totally independent of those for the other engines.

The thrust reverser system is designed for ground operation only and the reverse thrust developed combines with the engine inlet ram drag and the drag of the extended reverser door to give valuable improvement in stopping capability during landing roll or during a rejected takeoff.

Operational safety or "Design with the Pilot in Mind" was the

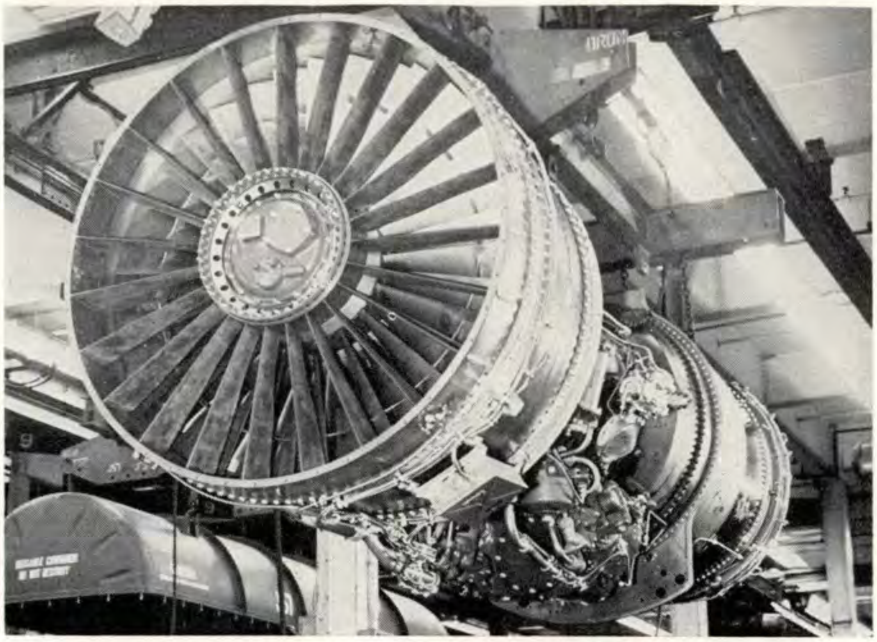
Pratt and Whitney TF33-P-7 engine during cold weather tests at Eglin, in flight on B-66 test bed.



watchword for the engineers responsible for the engine throttle control system. A mechanical control system made up of levers, control rods, bellcranks, cables, cable drums and pulleys was selected on the basis that past experience has proved this to be the most accurate, reliable and troublefree approach.

The throttles have a total travel of approximately 80 degrees from full forward thrust to full reverse. At a position approximately 51 degrees from the full forward thrust position a ramp in the quadrant stops throttle movement at a "start idle" position. A separate and distinct action by the operator, lifting the throttle 1-1/8 inches, permits movement into the reverse range, actuating the electrical-mechanical control system applying hydraulic pressure to the reversers and extending the reverser doors in less than two seconds. Increased reverse thrust is applied by continued aft movement of the throttles once the doors are extended and the interlock releases. Engine power in reverse is limited to a maximum value by an adjustable stop provided in the throttle quadrant which will be set before each takeoff and landing to compensate for ambient. The thrust reverser doors are retracted by moving the throttles forward into the forward thrust regime. The doors retract within five seconds with the engine at idle speed.

The spacious arrangement of the C-141 flight station dictated dual throttles for ease of operation from either pilot's seat and full engine control is attainable from either position. The throttle cable system is designed to protect against slipping or creeping from a selected power and against unwanted rapid throttle movement in the event of a control cable separation.



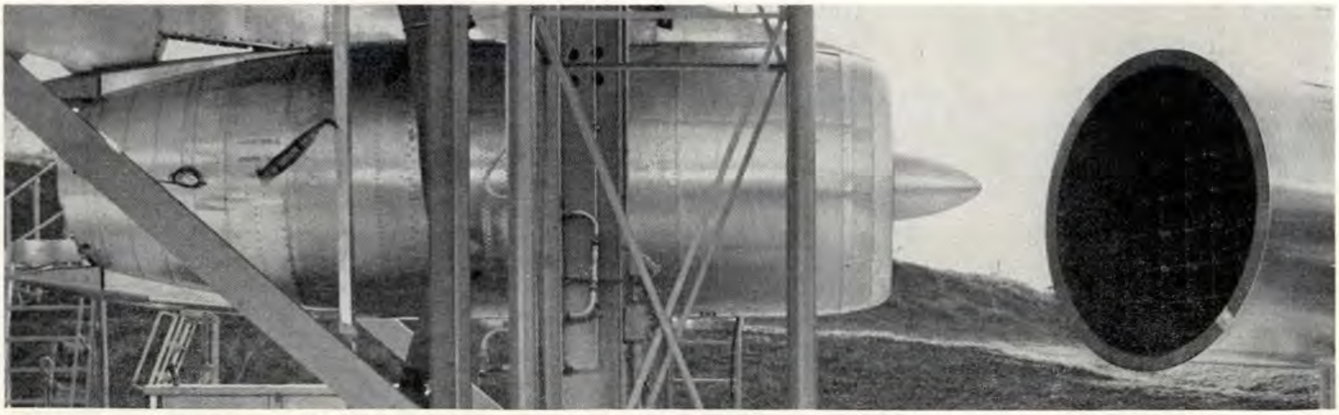
Powerful turbofan engine being readied for installation in new transport.

Protection against inadvertent reverser actuation in flight is provided by the fixed quadrant ramp, by incorporation of two valves, one mechanically actuated and one electrically controlled. Both of these valves must be operated before "extend" pressure is applied to the door actuators. In addition a mechanical stop is positioned by the throttle linkage to block "extend" pressure when the throttles are in the forward thrust range. The reverser door actuating mechanism locks over center when the doors are retracted.

The possibility of serious assymetric power in reverse if one set of doors should fail to extend is prevented by an engine control system interlock that limits power application in reverse until the doors are properly extended.

Safety considerations for both flight and ground operation are evident in other propulsion sub-systems.

The engine pneumatic starting system, providing completely self



Wind machine subjects C-141 engine to crosswind conditions, gusts and effects of flight air flow.

contained starting capability, is a prime example of simplicity in control. A guarded push-pull type switch energizes the system and applies pneumatic power to the starter from the Auxiliary Power Unit air source, from bleed from another engine or from an external power source. The starter control system includes automatic cut-out action, a light that illuminates whenever the button is depressed, and a separate independent indication that the starter air valve is open. The starter has been demonstrated to safely contain the metal fragments resulting from a starter turbine blade disintegration at speeds which simulate the maximum probable failure condition.

In order to provide engine isolation in the event of equipment malfunction or failure, the propulsion sub-systems are completely separate as to function on each engine. Fuel, lubrication, instrumentation, control, thrust reversing, and other functions are independent so that failure of any sub-system will affect only the one engine with which it is associated.

Fire prevention and protection features include the prevention of the spread of fire by firewalls, the separation of combustibles from ignition sources by baffles, the drainage of spilled combustibles from compartments, and structure to contain the fire within the nacelle long enough to allow detection and extinguishment. Fire emergency shut-down is accomplished by pulling a single fire emergency handle for each engine.

Test and development of the C-141A StarLifter power package will continue both on the test stand and in the air as the flight test program gets underway. Every aspect of engine operation will be recorded for analysis by special instrumentation in the test aircraft. Flight in inclement weather, turbulence, and ice is on the program. All grades of approved fuel will be used to assure suitability under all conditions. Flight test pilots and engineers from Lockheed, the Air Force, and the Federal Aviation Agency will all have an opportunity to evaluate and report on engine performance and control, and they will all contribute to the final recommended operating procedures which you will use to safely service, maintain and operate the StarLifter. ☆

TWX's

ACCIDENTS, INCIDENTS AND ALMOST . . .

▶ WHO'S MINDING THE STORE? The jet transport was at flight level 350, Mach 0.82, IAS 278 knots. The copilot was busy filling out forms. The panel engineer called the pilot's attention to an indication of generator difficulty. No one noticed that the generator OFF light had illuminated simultaneously with the onset of the generator problem. In the next two minutes:

> Over 1000 feet of altitude was lost, Mach increased to 0.86, heading changed 40 degrees and bank angle reached 20—30 degrees.

During recovery much buffeting was experienced and 2.9 G were recorded.

▶ A MATTER OF INTERPRETATION. A mechanic on the interphone signaled to the ramp coordinator that he had no communication with the crew. The ramp coordinator misinterpreted this to mean "Clear to start Nr 2 engine." He signaled the pilot accordingly. The pilot misinterpreted the signal and started Nr 3 engine instead. Luckily, the traffic specialist standing near the rear belly compartment door escaped burns from the jet blast as the engine started.

▶ "IDLE" RAIN REMOVAL SYSTEM. On GCA final the '135 broke out at 500 feet, in a heavy rain shower. Visibility good with rain removal on and RPM approximately 80 per cent. After crossing the end of the runway, throttles were retarded to idle and flare for landing was initiated. At that time forward visibility was reduced to zero due to inefficiency of the rain removal system with engines at idle RPM. The only reference for keeping the aircraft aligned with the runway was the runway edge which was visible through the lower left corner of the Nr 1 and Nr 2 pilot's windows. The runway centerline was not visible for approximately five seconds after touchdown. When engine RPM increased during thrust reversal the rain removal system again became effective.

AERO CLUBS

▶ Reference A Hard Look At Aero Clubs (page 20, December issue). Following is a message from Hq USAF to all major commands: QUOTE Five members of the Air Force have been killed during an 8-day period in Aero Club aircraft accidents as a result of questionable pilot proficiency, marginal weather conditions or inadequate clearance procedures. Effectively immediately, the following controls will be imposed: Members of Air Force Aero Clubs will file DD Form 1080 for all local flights and DD Form 175 for all cross-country flights with base operations when departing from a military base. A rated pilot designated by the base commander will clear all flights of local Aero Club aircraft to insure currency of pilot in the aircraft to be flown. Major commanders will insure that comparable clearance procedures are established and implemented for Aero Club aircraft operated on military bases. AFR 34-14 will be revised earliest to reflect these controls. UNQUOTE ☆

When it comes to driving, flying or running, Captain C. Z. Chumley learns that . . .

ICE is for HIGHBALLS

Archie D. Caldwell, Directorate of Aerospace Safety

Are you sure that he's out there? I mean, that he just walked in and sat down?" The "World's Greatest Aviator," Captain Chauncey Z. Chumley, looked apprehensive as he asked the question. It wasn't every day that the commanding general would visit the base and decide to make an impromptu visit to the monthly safety meeting—especially the one meeting being conducted by C.Z.

"No doubt about it," Major Pasentino replied. "You can see the stars from here. He's sitting with the Commander in the first row. Here's your chance to make a lasting impression. It's thirteen hundred—you're on!"

Chaunce fumbled his notes together and, with the practiced ease of one who has had to bluster his way through many times, entered the stage right and moved quickly to the lectern. He decided against the joke about the bikini and the grandmother and plunged right in.

"General Twister, Colonel Martin, Gentlemen. As you know, this month's theme for the base accident prevention program and the topic of my discussion at this safety meeting is, The Winter Months. Now that ol' Jack Frost is upon us for sure, it's time we mention a few of the known hazards associated with the winter season."

A blast of sub-freezing air hit the old base theatre and the sound of sleet on the metal fire doors added a timely emphasis to C.Z.'s remarks. A cold draft fluttered lose pages of notes. A "second balloon" in the rear sneezed four times in rapid succession. C.Z. waited for the laughter to quiet down, and continued.

"Now I have made up a little 'Cold Weather Safety' checklist which will be on the stand in the lobby. As you go out, pick up one and consider each of the items. You may want to add some of your own. The whole point is to be aware that things are different when there's snow up to your—to a tall Indian's earlobes, and the temp's down to nothing."

Chaunce paused, drank from a glass on the lectern, grimaced at the taste of pure water, shuffled his notes, dropped one, bumped his head as he reached for it, tripped over the mike cord and finally staggered back into position. His thinking keeping pace with his footwork, he commented, "You can just imagine how much more dangerous that would have been had the stage been icy.

"I'll just run through some of the items now for you. We'll start in the home and, since almost all of you are involved in flying, end up with your profession. May I have the slide, please?" The lights dimmed and the slide projector clicked to life. Chumley read from the card he had retrieved.

"First, adequate food intake. You use more fuel in the winter; good physical condition keeps you alert, and you're less susceptible to germs, flu and colds. Adequate clothing for work and play; when you're cold, you don't perform as efficiently and tend to be more susceptible to injury. Gas heaters that are unvented still take their toll of Air Force personnel and families. Fires from overheated furnaces or blocked chimneys are yet another hazard. Make a safety survey of your own home front—see how many hazards you can uncover and correct. That done, you climb into the family bus and head for the office.

"Winter driving requires extra care and a car in top-notch condition. Lights, tires and skid chains, if needed, should be in A-number-one shape. Speed on icy roads should be cut considerably, and the money you put out for extra care, can save your life. Mufflers should be in good working order. We lost quite a few troops last year from carbon monoxide poisoning—while driving or stopping with the windows closed tight, and a leaky muffler.

"O.K., so you make it to the office or flight line; preflighting the coffee urn is only the beginning, especially for you maintenance officers. You have all sorts of directives on the winter care and feeding of airplanes, deicing, snow protection, and so on, but what about your crews? Do they have adequate shelters and work areas? Are they expected to load aircraft or make critical adjustments with hands that feel like they've been in a deep freeze for the last four hours? Are they alert to the dangers of working around aircraft when their parkas give them a furlined, tunnel-shaped vision field? How well briefed are your drivers? Is all snow removal equipment in good shape? How about GCA and navaid units? The list can be endless if you think about it for awhile."

Chumley looked at his watch. He had run overtime and had a similar presentation at the base gym for the NCOs and enlisted supervisors.

"Well, it seems I'm a little late so I'll conclude my presentation by introducing Major Strum, who will speak briefly on the base fund drive."

C.Z. left the stage at a half-trot and headed for the exit.

At the conclusion of the program, the General and Commander were slowly walking toward the rear exit. "Good presentation, Harry. You say that was Captain Chumley, the one who has been a problem? Seems like he may have shaped up."

"Well, General, maybe it's just my own feelings about him but . . ."

The sound of an approaching siren cut the Commander's words. The wail came closer and appeared to stop at the rear of the theater. The two quickened their steps to the exit while getting on overcoats, gloves and scarves. The flashing red light of an ambulance cast an eerie glow onto the snow and the figures in white, lifting a groaning shape onto the litter.

"What happened here, Sergeant?" The Colonel approached one of the ambulance attendants.

"Nasty break, right leg. Looks like a compound. The fella who called us said this guy came flying out of that exit, hit the ice on the steps and did a half gainer before he piled into the telephone pole and sidewalk. Gosh, you'd think a guy would know better than to try and run on ice like we've had around here."

The ambulance had pulled away headed for the hospital. The staff car with the General and Commander pulled away from the curb before the General spoke.

"I didn't get a look at the chap who fell. An officer?"

"Yes, General."

"A captain?"

"Yes, General."

"Don't tell me it was—"

"Yes, General." ☆

Fording The Jet Stream

Considerable attention continues to be devoted to turbulence associated with jet streams. Since there are often no indicators such as cloud formations to denote its presence, careful attention to available weather information and liberal use of seat belts in jet stream areas can best assure a comfortable ride. It is most timely as, in the winter season, the jet stream moves farther south, drops to a lower altitude and is generally stronger at normal jet flight levels. The following review of the subject includes suggestions on anticipating and avoiding jet stream turbulence.

A jet stream is a belt of strong winds embedded in the upper atmosphere and meandering in a wavelike pattern around the globe. While the strongest winds are in the core, most turbulence occurs in areas away from the core where the wind velocity changes most rapidly in either the vertical or horizontal plane. Since wind shear is usually accompanied by rapid changes in temperature, we can often associate areas of turbulence with those areas on the weather chart where the temperature gradient is largest.

We have long known that significant turbulence can occur where wind velocity varies five knots or more per thousand feet, and that this condition usually occurs when the temperature changes roughly five degrees or more per two degrees of latitude (120 nautical miles). Also, studies have indicated that turbulence often occurs when wind velocity changes more than about 50 knots in 150 miles horizontally. These rules are used by the meteorologist in defining turbulence areas in his analyses and forecasts. The pilot does not often have access to such detail while in flight, however, the winds analysis forecasts describe the location of jet streams and associated areas of turbulence.

Since the turbulence areas are localized and are carried by the wind, the roughness experienced by successive flights on identical paths only a few minutes apart may vary considerably. The following general rules may be of assistance to the pilot, however, in alleviating jet stream turbulence effects:

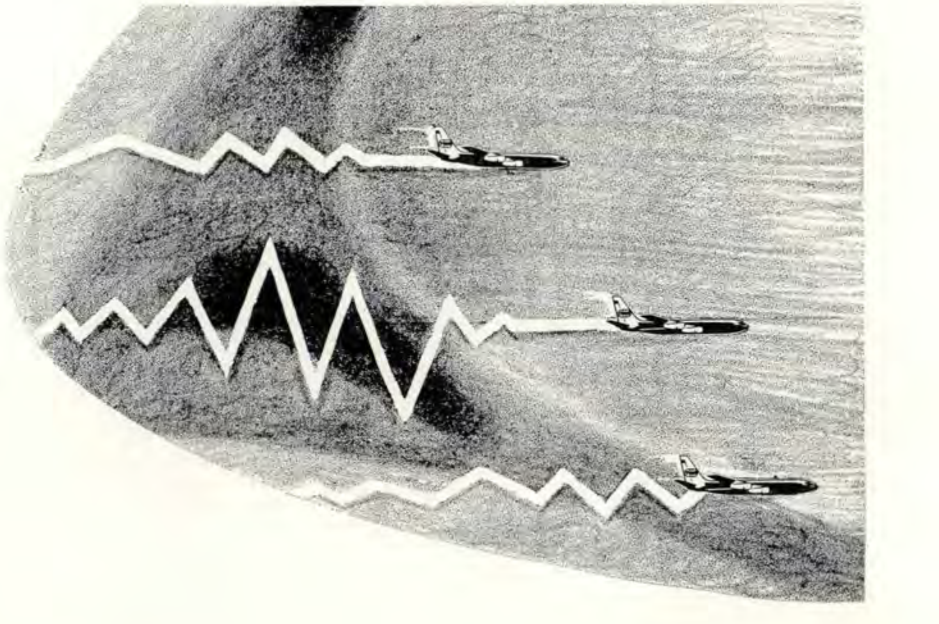
• If the flight path must "ford" a jet stream, it is best to select an altitude either below or above the altitudes of maximum wind shear, which are also the altitudes of maximum turbulence. If little or no altitude choice is available or the jet stream is entered sooner than expected, try to cross it as near to a right angle as possible. Other than to slow down, there is really nothing else that can be done. Generally, it won't take too long to cut through it.

• If the wind parallels the flight path, a turn to either right or left should help, but a right turn is toward a more favorable wind component. Since zones are normally less than 4000 feet in vertical thickness, a climb or descent to the next flight level should place the aircraft in smoother air.

• If the temperature along the flight path is changing, climb if the temperature is rising, or descend if the temperature is falling. This will prevent flying up or down a sloping front or tropopause surface.

As the illustration shows, there are two areas of pronounced turbulence usually associated with a jet stream. One is along the tropopause just above the core of the jet stream, and the other is in the jet stream front which extends below the jet stream. Turbulence in these areas often extends along the tropopause and jet stream front.

TWA Flite Facts



If you must ford a jet stream, select an altitude above or below altitudes of maximum wind shear, which are also the altitudes of maximum turbulence.

A FEW GET BY

He was apprehensive, because of the weather and darkness, but did feel more at home than he had right after takeoff. Then he had had difficulty finding the ADF controls when departure control had asked that he maintain four thousand until past the Papa Whiskey Beacon. He had allowed himself to concentrate attention too long on one item, neglecting his cross-check and outside scan until those had come up, airspeed had dropped 30 knots, and the right wing was down. His instinctive reaction was a sudden over-correction, and he had criticized himself under his breath for it. Perhaps it had been a good lesson though; he had subsequently disciplined himself to think out each thing he did.

It had been dark for two hours now. For the past half-hour flight had been in clouds. The metallic scraping sound, varying in intensity, was due to sleet striking the aircraft. The autopilot was working and the CDI was almost in the center. He managed a wry smile as an old cliche came to mind—win a few, lose a few.

"Air Force 12345, Atlanta Center."

"Uh, Atlanta Center, Air Force 12345, over."

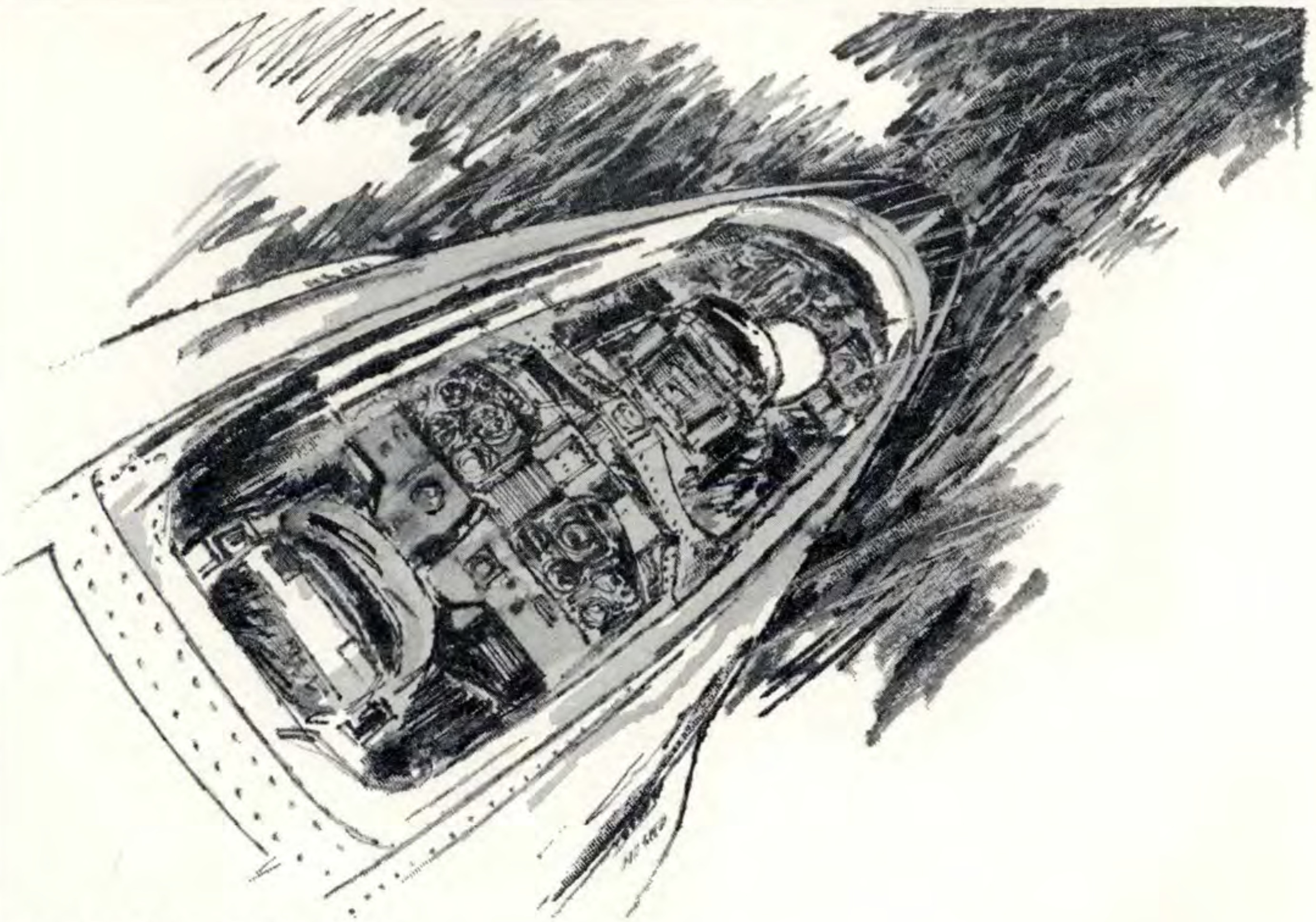
"Air Force 12345, would you like a radar enroute descent?"

"Uh, that will be O.K, Roger."

"Roger, Air Force 12345, continue heading one two zero, descend to one two thousand."

"Uh, Rog, Center, descend to twelve thousand."

He pulled back the throttle, pushed forward on the stick and rolled in nose down trim. He did these things automatically mostly. His brain was struggling with some-



A FEW GET BY continued

thing he had heard about these radar enroute descents . . . couldn't remember what it was.

He held his heading, pulled back slightly on the throttle as he noticed indicated airspeed had increased 20 knots. Things were settling down now. They had just caught him unawares—wasn't expecting descent for several minutes yet. Probably should have asked them to stand by—give himself a chance to get squared away—but he had pride.

"Air Force 12345, Atlanta Center. Have you started descent?"

"Rog, Center, descending now. Air Force 12345." He wondered why the call, then remembered that reporting leaving assigned altitudes is a mandatory report.

"Air Force 12345, Atlanta Center, say type of approach desired."

"Uh, Center, how about radar vector until below the clouds? Then I'll cancel and go in VFR."

"Air Force 12345, Atlanta Center. Be advised, weather is reported below VFR minimums; would you like a radar vector with a handoff to GCA?"

"Uh, Roger, that would be fine."

"Air Force 12345, contact Atlanta Approach Control on 381.6."

"Uh, Rog, going 381, uh, say again frequency."

"Air Force 12345, switch to 381.6, over."

"Uh, Rog, 381.6." He turned the rheostat up in order to see the numbers on the UHF control head. He fumbled a little, but set in 381.6.

"Air Force 12345, Atlanta Approach Control, turn left to one two zero, continue descent to one zero thousand, acknowledge."

"Uh, Roger, Cent . . . uh, Approach. Air Force 12345, I am heading . . ." How had he wandered over to 165 like that? "Turning to one twenty, descending to ten thousand."

"Roger, Air Force 12345. Say altitude."

"Uh, Cent . . . Approach, say again."

"Air Force 12345, Atlanta Approach, say altitude."

"Uh, fourteen point seven—fourteen thousand seven hundred."

At this point lost communications procedures were issued.

Descent was continued and the handoff made to GCA. GCA reported the weather, 800 overcast 2½ miles, wind 090 12 knots.

Descent was continued and, approaching 3000, another frequency change was issued. He had to ask for a repeat on this frequency as Approach's transmission was blocked by Guard. He switched from T/R & G to T/R.

No contact with GCA. He tried calling them. Still no contact. He wanted to go back to Approach. Couldn't remember the frequency. Should have jotted it down. It's in the book. Let's see . . . Atlanta, Atlanta . . . no, that's not right; it's under Dobbins. Funny, they should be calling on Guard. Oh, oh, turned that off. Back to T/R & G.

"If you read, proceed to Lost Mountain radio beacon and execute a standard ADF approach. Air Force 12345, proceed to Lost Mountain radio beacon and execute a standard ADF approach. Acknowledge."

"Atlanta App . . ." They're on Guard; they can't read. Gotta look up that approach control frequency. Oh, oh, two thousand feet. He added power and began to climb, checking the attitude indicator and leveling the wings. He brought the Enroute Supplement into his cross-check and, between glances at flight instruments, leafed through the pages until he found Dobbins. That was it, 381.6. He went to it.

"Uh, Atlanta Approach, Air Force 12345. Do you read? Over."

"Air Force 12345, Roger, read you loud and clear. Home on the Lost Mountain radio beacon and execute a standard ADF approach. Acknowledge."

"Uh, Rog, Atlanta. Understand you want me to home the uh, what mountain was that?"

"Lost Mountain. Air Force 12345. Home on the Lost Mountain radio beacon."

"Uh, Rog, Lost Mountain . . . uh, Cent . . . Approach, I'm having some radio trouble. Could you vector me to Lost Mountain?"

"Air Force 12345, Atlanta Approach Control. Reply code zero four, mode three, squawk emergency for radar identification."

Oh, Lord, where's that IFF control thing?

Finally he found it. No positive ID; finally though—after they asked him to verify normal power and he made a two detent change on the setting.

He was 28 miles east of Atlanta, 3700 feet. Approach turned him around. He pushed the stick forward and rogered when they asked if he were still at 3000. Then, as he got his dive established they instructed him to climb to 4000. He muttered something and pulled back on the stick. Trouble enough without Approach not knowing whether they wanted him to go up or down.

All at once he remembered something and, dexterously holding his pen-lite in his mouth while he flew with his left hand and rummaged through the FLIP packet with his right hand he came up with the Atlanta Terminal Chart. Sure enough, there was a Lost Mountain radio beacon. He tuned it in. It worked fine. The needle was on the nose.

He had a moment of inactivity and used it to salve his feelings with a little self pity at his misfortune. If all this had come up a month later he would have been much better prepared. His birthday was six weeks away and he always made it a habit to get in a couple hours of Link just before he took his instrument check. Always ran through one each of all the approaches too. And "good ole' Joe" had always passed him with the justification, "a little rusty in spots, but . . ."

Some of the pent-up tension had eased a little, and the bird was holding heading better. He lit a cigarette and let out a big sigh. For a moment he wondered if maybe he *really* should be in Category III. The value of a lot more study and practice never entered his mind. The way he figured it, the few times he would face an emergency in an aircraft didn't make a lot of study and practice worth the effort.

"Air Force 12345, Atlanta Approach. We have you two miles west of Lost Mountain radio beacon. Are you proceeding outbound for ADF Approach?"

Sure enough, Nr 1 needle has swung around on the tail—didn't remember when.

"Uh, Rog, I'm outbound. Uh, I'll call procedure turn."

"Roger, Air Force 12345."

Ground controllers were to blame really. If they hadn't offered him that Radar Vector-GCA thing he'd of had his approach plates ready. Let's see. Atlanta, Atlanta, Atlanta . . . no, it's under Dobbins. Ah, there it is. Oops, how'd the bird ever get in a bank like that. Oh, well, might just as well go on around . . . just home in on the Nr 1 needle.

"Uh, Atlanta Approach, Air Force 12345, procedure turn."

"Roger, Air Force 12345, call low station."

"Uh, Rog."

Oh, oh, looka there. Lights. Breaking out. Thank goodness. Man, there's not much terrain clearance out here. Gad, those are trees. Hope they don't have any TV towers out here. Let's see, 1550 indicated. Little low. Not at low station yet, but I'm not going to go back up into those clouds.

"Air Force 12345, Atlanta Approach Control. Radar contact lost. Say position."

"Uh, Approach, this is 45. Approaching low station. Starting to break out."

"Roger, Air Force 12345. Report station passage and field in sight."

"Uh," with their reminder he looked down and saw the needle swing. "Low station, now."

Holy mackeral, they sure don't give a guy much clearance out here.

A whisp of cloud blotted out lights below and he eased the stick foward. He looked at the approach plate and checked the heading to the field. He looked at his RMI and corrected back 20 degrees—the 15 he was off, plus five to account for the unknown distance he had flown off heading. Ought to average out—'bout due for a *good* break pretty soon.

Was that? It was!

"Field in sight, Atlanta, uh, this is Air Force 12345."

"Air Force 12345, Atlanta Approach, Roger. Change to Dobbins Tower, 236.6 for landing instructions."

"Rog. Uh, Goodnight!"

He made the change to Channel 1. Sure was a lot easier to maintain attitude visually.

"Uh, Dobbins Tower, Air Force 12345. Landing instructions, please."

"Air Force 12345, Dobbins Tower. Wind zero niner zero, 14 knots. You are cleared to land, straight in, runway one zero. Call gear down and locked."

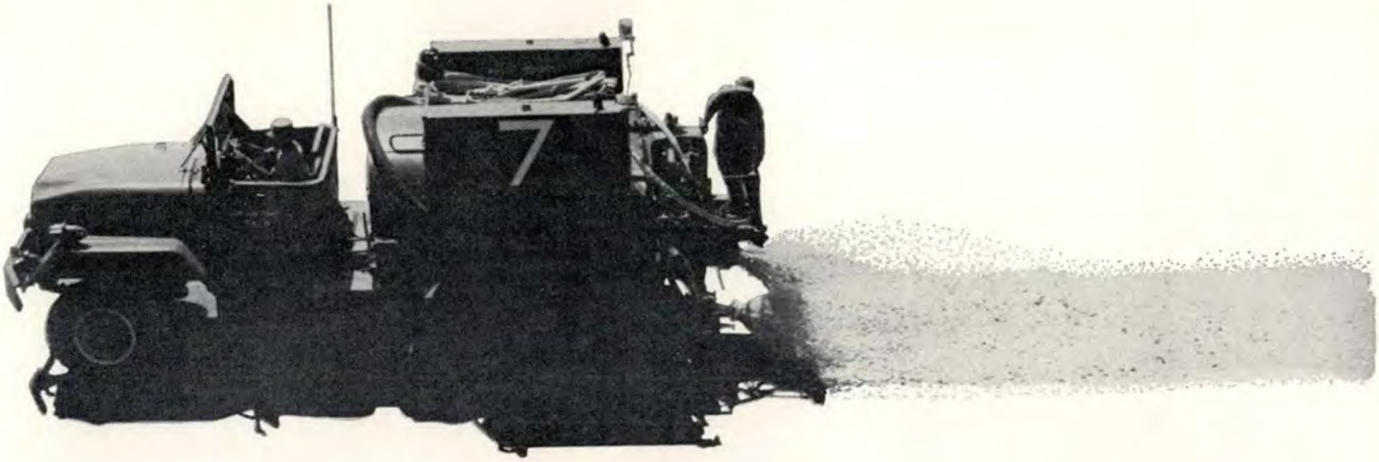
He shoved the gear handle down. That's right. Mustn't forget the gear. Would be terrible to forget the gear after all he had been through. He pulled back on the throttle and lined up with the left side of the runway. "Uh, gear down and locked. On final."

With the tower's help he got it parked.

It was quiet when the engine stopped. The fellow who put the chocks in called up. "Pretty nasty out there tonight, isn't it, sir?"

"Naw," he said. "After 20 years, a few clouds and a little rain don't mean much anymore."

. . . what're you gonna do? How do you ever motivate such pilots with the need for more study and practice? ☆



BLANKET OF SAFETY

T-37B At 1408 hours, Crash Control was alerted that a T-37B's left main gear would not come down. Crash trucks and crews responded to standby positions. The Flying Safety Officer requested that the runway be foamed. This was done.

The aircraft landed successfully with its left wing in the foam strip, sliding approximately a thousand feet.

An HH-43B Helicopter received the alarm the same time that Crash Control was alerted and responded in two minutes. The helicopter followed the aircraft down the runway, taking the pictures shown on these pages. The foam was then removed with a Wayne Sweeper.

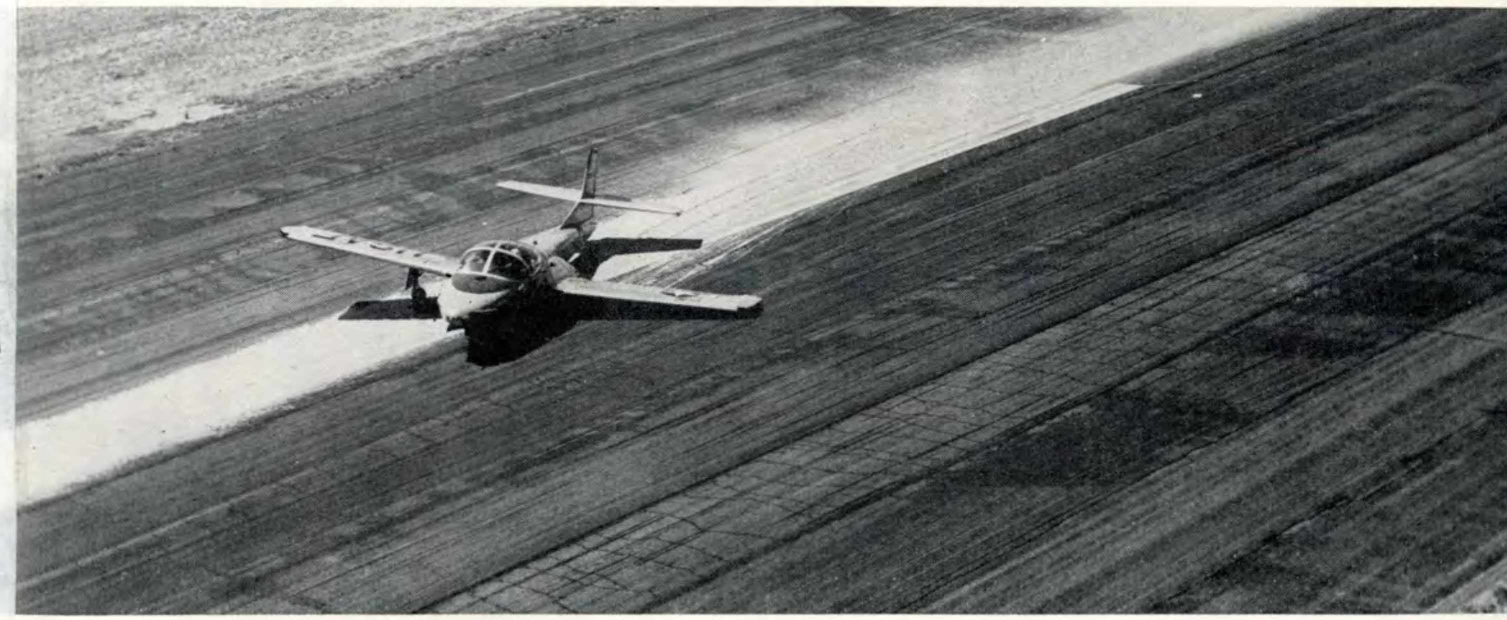
Here are some of the particulars of this incident:

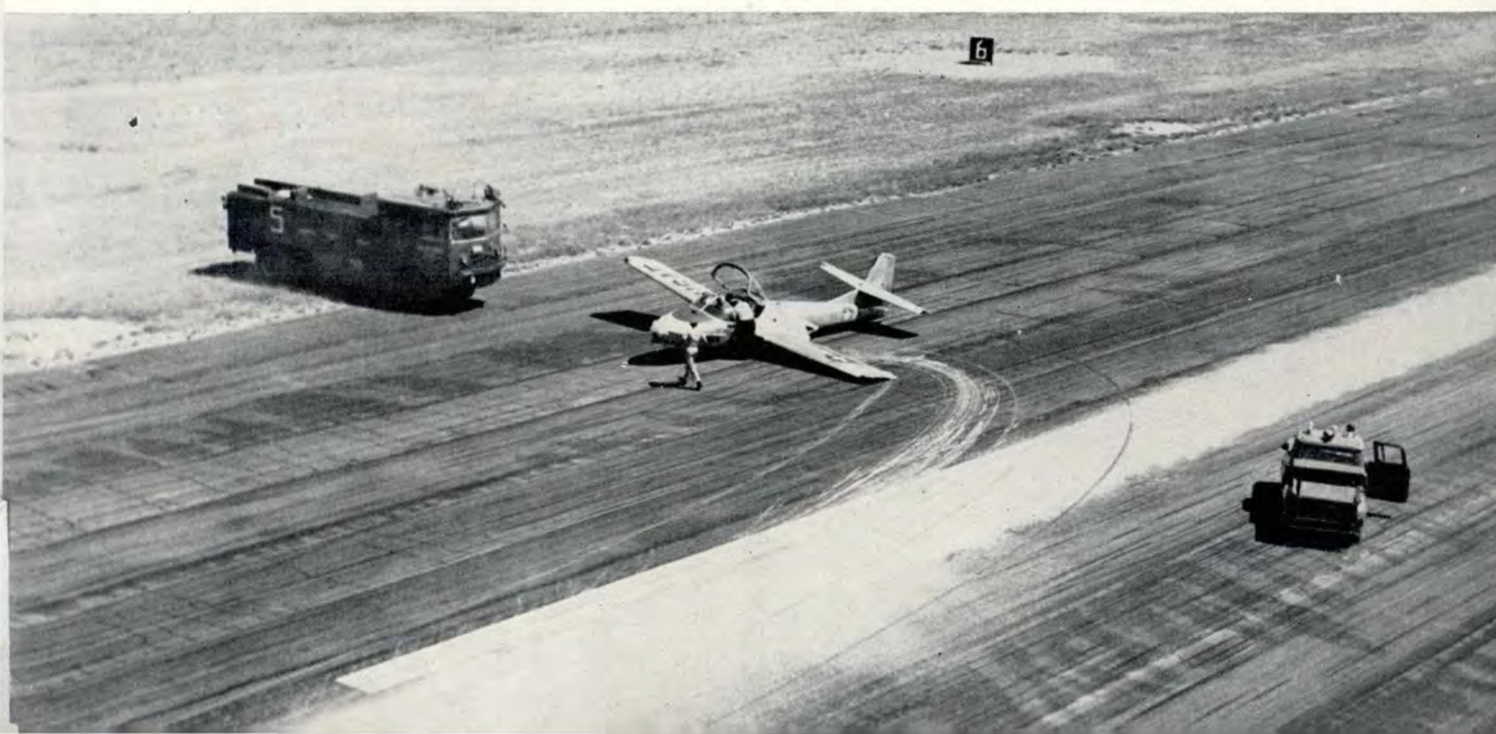
- Nature of the emergency: A T-37B with main left gear in the UP position.
- Foam strip was 2500 feet long, 12 feet wide and two inches deep. This length was determined adequate to stop the aircraft, and the 12-foot width was ample for keeping the left wing and fuselage on the wet macadam surface for better skidding action.
- Method of application: A 1000-gallon water tanker with two 2½-inch Rockwood nozzles attached to pump piping. Both nozzles were used as shown in the picture of the tanker in operation.
- Quantity: 150 gallons of foam and 900 gallons of water were used for a total of 1050 gallons of liquid. Ratio of water/foam solution: 16 per cent.
- Pump pressure was 80 pounds, and nozzle pressure approximately 60.
- Foam blanket was applied in five minutes at a rate of 200 gallons per minute.
- The 94° temperature had little or no effect on the foam solution since the plane landed immediately after the runway was foamed.
- Had there been any trailing fuel the foam blanket would have minimized the fire hazard created by sparks from the metal contacting the runway. ☆

T-28

Another base, another time, another airplane—but again a foamed runway, helicopter and alert firemen make for a safe landing with minimum damage to Air Force equipment and limited risk to personnel.


27
USAF

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THE BARRIER STORY

Mr. Veryl V. Vary, Chief, Launching and Runway Equipment Br., ASD

This is a report on USAF aircraft arresting barriers, where we've been, where we are and where we are going with discussion of investment and profits.

In Figure 1 you see the Granddaddy of all USAF barriers. This is the first successful adaptation of the Navy's low net idea to the USAF overrun problem on land bases. This picture was taken in Japan during the Korean war. Pilots argued about her flying qualities but barrier people loved the F-84 because she was the best barrier engager the Air Force ever had.

The Aeronautical Systems Division developed a better net and a better chain distribution which yielded higher speed performance, polished up a few functional problems and called it the MA-1A shown in Figure 2. We bought and installed some 500 odd of these at a cost of around $6,000,000. In other words, they cost us about $10,000 per copy plus spares, new nets and so forth. Add to this whatever we had to pay for the roughly 50,000,000 pounds of chain we scrounged from the navies of the world. Each barrier used 91,000 pounds of chain to yield 12,000,000-foot pounds capacity. This is adequate for the T-33 but you'd need four to five times this much to give full protection for today's big fighters. On the other hand, if you hung that much chain on a T-Bird, you'd strip off the gear in the first hundred feet. We added the hook pendant at the start of the hook program. This gives about 96 per cent reliability with the century fighters.

Since we started keeping track in 1954, we've had a total of 2076 aircraft hit the MA-1A. The F-100 has been our favorite guest with the T-Bird holding a strong second place. The rest of the Air Force and some Navy fighters too have been good customers. It hasn't been all gravy but the barrier has caught 1289 of these birds, roughly 60 per cent. That 1099 that took minor damage contains the big profit. We can't put a dollar figure on it because, for one thing, we don't know how many would have been destroyed. I feel that 200 is a very conservative guess. Most of the 98 that took major damage would have been destroyed. The loss of the eight that were destroyed was caused by fire or obstructions such as drainage ditches. It is amazing what a pilot can live through so your guess is as good as mine on pilots saved. I think you will agree that our little plant has yielded a fair quantity of this premium by-product. The injuries shown are mostly face lacerations and back injuries due to those same drainage ditches. Most of the overruns are cleaned up now so we don't get many of these anymore.

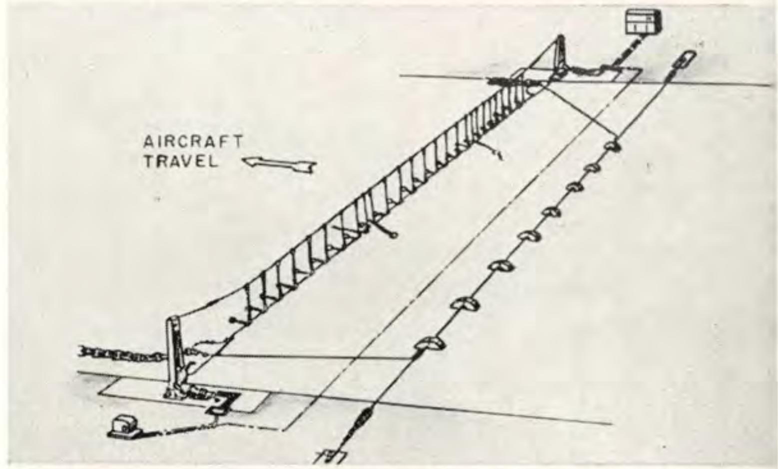
Roughly 40 per cent went through. Half of these didn't need help because they rolled to a stop without damage. Another 239 got their pants torn by the barrier. They didn't need help either because they also stopped in the overrun. The 80 that took major damage and the 34 that were destroyed are our big losses. Mostly high speed heavy weight, many of them just plain busted through and hit the ditches, fences, railroads and so forth. The amazing responses of pilots have kept the injury and death rate down. Not all have been lucky. A double death in a T-39 brought our grim total to 11. So even though our modest investment in the MA-1A has and will continue to yield a handsome profit, it falls far short of the total potential product.

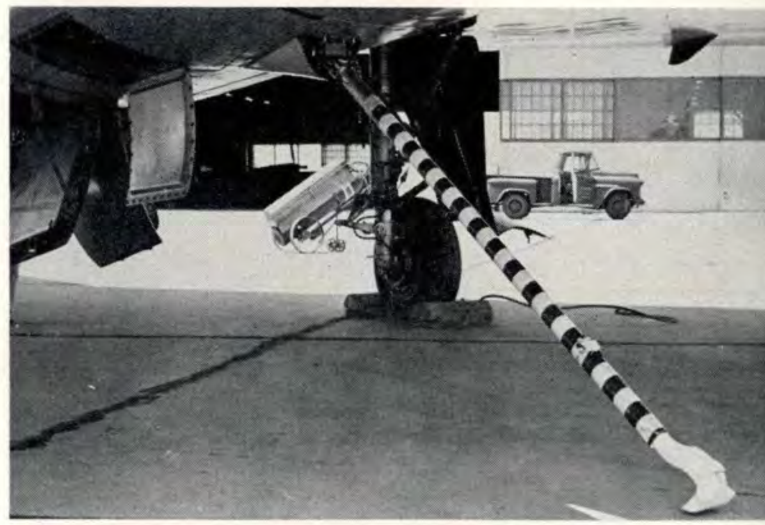
In 1959, Air Force Headquarters followed our oft repeated recommendation to buy hooks. It turned out that only the century fighters got hooks, leaving the T-33, T-38 and T-39 still depending solely on the MA-1A for protection.

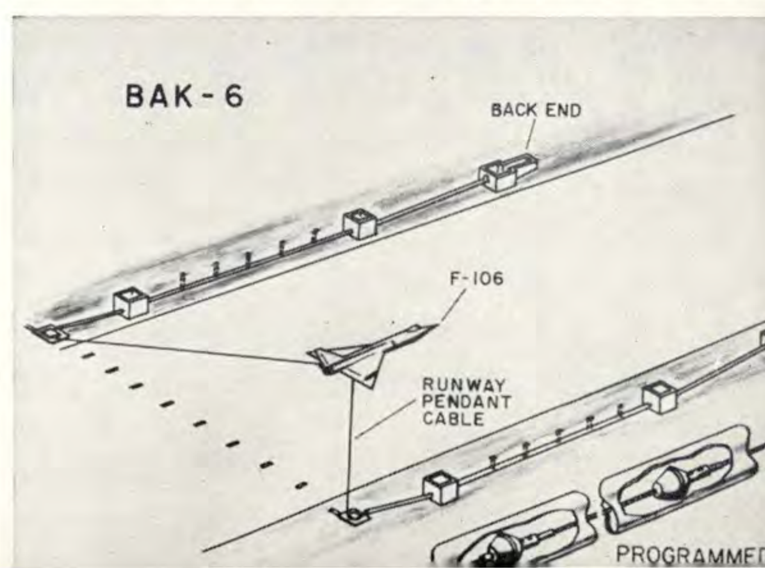
Air Force hooks are intended and designed for emergency arrestment only. The pilot cannot retract the hook as is done on Navy fighters. Since we have more room in which to work, we do not require the strength that is built into a Navy hook and the weight can be held down accordingly. Air Force hooks are of two general types. First is the conventional, stiff shanked hook with air oil dampers which we commonly call the Navy type hook shown in Figure 3. This is used on the F-102, F-104 and F-105. The second is the patented Shaefer spring hook developed by the All American Engineering Company. This consists of a long flat spring attached at the fuselage by a vertical pivot bolt. At the free end of the spring is a Navy hook shoe. A picture of a spring hook is presented in Figure 4. We use the spring hook on the F-100, F-101 and F-106. Both hook types work equally well and we have had no serious problems with either in our widespread use.

At the start of the hook program, we ordered from All American Engineering Company, 50 of the water

Figures 1 through 5, top to bottom: USAF's first barrier was used in Korea; improved, it became the MA-1A; shanked hook with air oil dampers used on F-102, F-104, F-105. F-106 with spring hook after engaging BAK-6; diagram illustrates water squeezer principle.







squeezer energy absorbers shown in Figure 5. We call it the BAK-6. These were installed at 25 Air Defense Command Bases to protect the F-106. It was an outgrowth of one of our development programs and was the best available at that time. With 50,000,000 foot pounds capacity, it does a good job on the heavy fighters while handling the light ones gently enough to avoid bending. These units cost us $70,000 a copy installed. A total of $3,500,000. While the cost of arrestment went up, the value of the product has been going up. So far we have had 50 engagements with 23 being F-106s. If we assume that the average saving per engagement was $70,000, then the plant is paid for and all saves for the next ten years or so are almost pure profit.

This is rugged equipment which will give many years of good service. However, it has some serious disadvantages when compared with later equipment. Once you plant this thing it is there to stay because it costs more to dig it up than to build a new one. It has a limit engaging speed of 160 knots which isn't fast enough and we will probably lose at least one heavy hot bird because of this. It is slow to retrieve and if you break a retrieve rope, you've got an all day job. The arresting pendant is on the active runway because the BAK-6 must have 1500 feet to do the job. This causes trouble on the approach end as attested by two very surprised F-106 pilots. Imagine setting down nicely in that tail down semi-pogostick landing attitude of the F-106 then suddenly you are hanging on your shoulder straps with your eyes bugging out in a two G arrestment. Convair ginned up a guard to keep the cable out of the stowed hook. A couple of C-133s have had their low hanging pants torn by the pendant. Air Defense Command complains about this. The excellent all weather pneumatic retractable cable support system we call the BAK-10 would solve their problem. It would cost about $10,000 per site or about $500,000 for all 50.

The machine we call the BAK-9 was developed by the E. W. Bliss Company and thoroughly tested by the Navy and the Air Force jointly. The BAK-9 costs less than the BAK-6. It does the job in 1000 feet. The upper speed limit is 190 knots and it is actually gentler on the light birds. An electric motor retrieves the system after arrestment in five minutes. The machine is easy to trouble shoot and maintain. It comes in a neat package you can stick in a pit at the runway edge. The pits are built so you can lift the lid and add a second machine to double the capacity if needed. Because the lid must be able to take 100,000 pound wheel loads, that pit is a real blast shelter. In fiscal '61, we ordered 110 of these at $25,000 per copy. In fiscal '62 we ordered 76 more. So far we have about 70 installed, mostly in our NATO bases. Installations are averaging about

Fig 6 is schematic of new BAK-12, rotary friction system; Fig 7 shows Van Zelm metal bender, novel approach to arrestment; Fig 8 nylon tape on Navy water twister; Fig 9 illustrates BAK-9 and BAK-11 teamed up to catch all type aircraft including bombers.

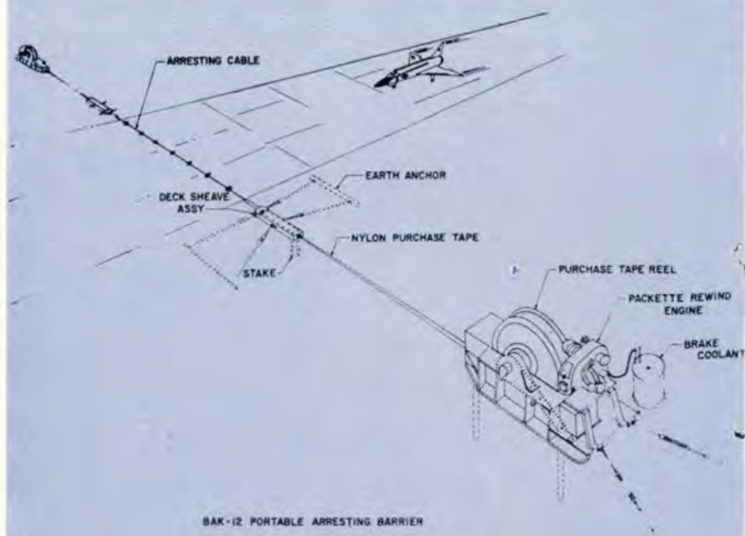


Fig 6

continued

THE BARRIER STORY

$37,000 each. This includes bringing three phase power to the site. So far we have had 65 recoveries. Again the F-100 is our favorite guest at 30 and the F-102 holding second place at 24. If we again assume an average saving of $70,000 per engagement, then these 70 BAK-9s have paid for themselves and are now working on the bill for those we have on order.

Before I leave the subject of energy absorbers, there are several energy absorbers which have been developed and tested which deserve mention.

The E. W. Bliss Company has developed a rotary friction system similar to the BAK-9 except that two separate identical units are placed symmetrically, one on each side of the runway. The Navy has tested this thoroughly as the M-20. It is a very sound approach. The Air Force has ordered four pairs with performance equal to the BAK-9. The equipment is to be expeditionary with installation to be on top of the ground like the M-20. A schematic drawing of this equipment which the Air Force will call the BAK-12 is presented in Figure 6.

A very novel approach to the arresting energy absorber is the Van Zelm metal bender shown in Figure 7. This equipment stores a long strip of mild steel strap in a unique low inertia reel. The strap feeds out of the reel through a series of rollers which bend it beyond the yield point several times thus absorbing the energy. The Navy and Air Force jointly tested the metal bender and found it to be a sound approach. It has excellent high speed capacity and the retarding load is very smooth and predictable.

The metal bender is a constant force machine. The retarding force can be preselected by use of an adjustable stop on the torture chamber jaws, thus accommodating aircraft of various weights and strengths. The straps are discarded after an arrestment and resetting is slow. The initial cost is attractively low compared to that of other systems. The Air Force anticipates use of the metal bender at locations where the above limitations are not a problem and frequent use is not expected.

The All American Engineering Company has developed a new approach which they call the water twister. Nylon tape is reeled on a drum in a manner similar to that of the BAK-12 except that the reel is horizontal. The reel shaft drives a paddle wheel in a tub of water, very simple and effective. Because of the decreasing effective drum diameter as the tape pays out, the paddle wheel is driven at essentially constant speed as the aircraft decelerates. The Navy has reported that their M-24, which is a water twister, has yielded very satisfactory performance. This equipment in expeditionary form is shown in Figure 8.

Vortec, a subsidiary of Douglas Aircraft Company, also offers a rotary hydraulic energy absorber with nylon tape reels. The hydraulic energy absorber is somewhat more sophisticated in concept than the paddle wheel and tub approach. To date, insufficient test data exist to allow an evaluation to be made.

In 1958 when it was decided that hooks would not be placed on bombers and tankers, we scraped up some funds and contracted with Research Incorporated to develop a cable thrower to get ahold of the main landing gear. The effort has been completely successful resulting in the BAK-11 engaging device. We commonly call it "The Pop-Up." Switch mats connected to a simple electronic timing system sense the position and speed of the aircraft. The cable lies in a slot across the runway. At the correct time, high pressure air is admitted to the slot under the cable and the cable is thrown vertically to intercept the main landing gear struts. The system can also be set to fire behind the main wheels and engage a hook.

With two BAK-9s and a BAK-11 teamed in the manner shown in Figure 9, we can catch and safely arrest all fighters and jet trainers and all bombers and tankers at energies up to 100,000,000-foot pounds. We can do the same for the commercial jet fleet and most of the propeller driven commercial fleet and will guarantee that the propellers will not be touched. We have yet to prove this with bombers, tankers and cargo craft. So far we haven't been able to get an airplane. We are now ready and standing in line for a B-58. It is a matter of waiting for a test bird to get tired enough to be grounded. We consider this phase of tests to be important, not because we don't know what the system will do, but because we must demonstrate this to the potential users so that they will buy with complete confidence.

The Aeronautical Systems Division considers the ar-

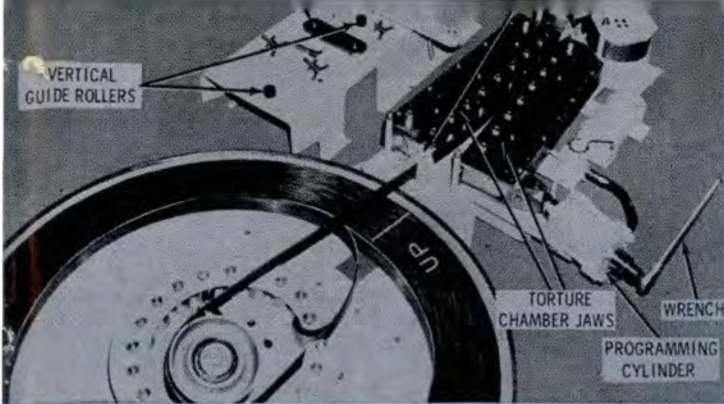


Fig 7 top

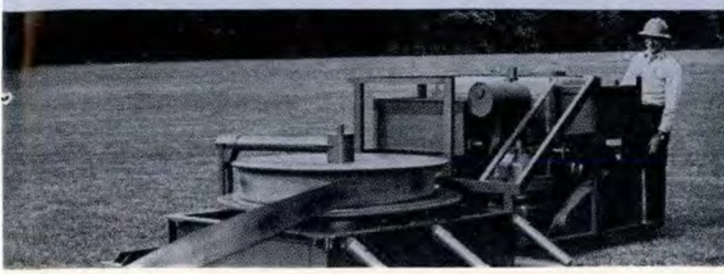


Fig 8 bottom

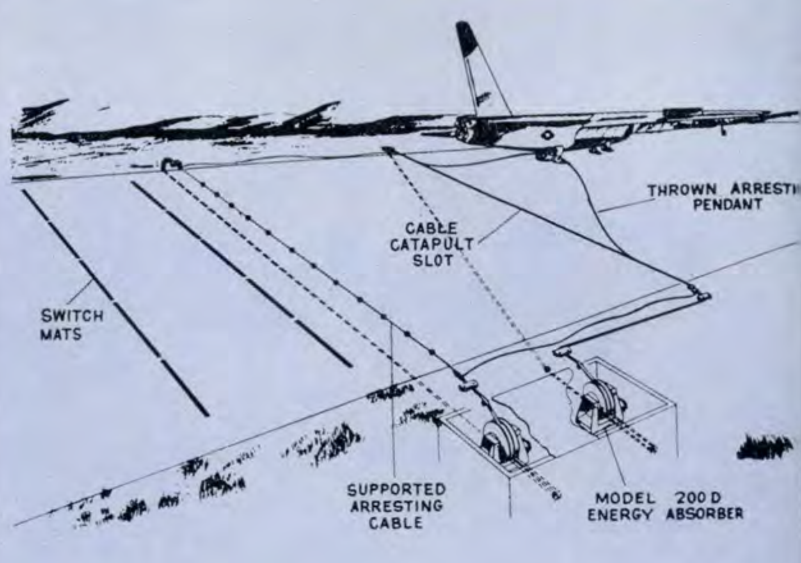


Fig 9

resting barrier technology to be well developed. If, for example, USAF wanted an arresting barrier that would take the B-52 at takeoff speed at maximum weight and arrest it without exceeding any reasonable arbitrary maximum retarding load, this would require an energy absorber of 500,000,000-foot pounds capacity which is ten times that of the BAK-9. We would have the procurement data ready within two months. We would expect to get firm fixed price proposals with guaranteed performance from at least two of the five well qualified competitors. We would confidently expect completely acceptable equipment to be installed at the site ready for acceptance tests within 12 months of the contract date. We would use some reasonable selection of existing airplanes to verify the performance curves. Incidentally, we would also expect the machine just described to do a good job on other airplanes ranging in weight from 50,000 pounds upward.

We don't care how heavy, fast or fragile the bird is. The state of the art is now at the point where you can give the knowledgeable competitors the numbers and a reasonable amount of room to work in and they can give you equipment that will stop your bird without bending it. It is the official position of the Aeronautical Systems Division that development of fixed base aircraft arresting barrier technology is essentially complete. All future efforts in this area will be toward reduction of cost and upgrading the hardware we have in hand.

The resounding success of the Air Force fighter barrier program demonstrates that modest investments in such equipment are highly profitable. It is conceded that equipment for heavier birds will naturally cost more but the value of the airplanes is also greater, to say nothing of the value of that very premium by-product, human lives. What is needed now is action on the part of the board spectrum of potential users, both military and civil, to implement positive programs to procure the equipment which can now be obtained so that we may soon begin to approach 100 per cent of the potential product of aircraft arresting barriers. ☆

Hit 'Em Anywhere

Safety publications have repeatedly been guilty of advocating a very dangerous maneuver which is absolutely unnecessary. The exhortation "Steer toward the center of the runway if possible" is typical. Several variations and elaborations on this theme have been published in the past. There are several well documented cases in the files of barrier contract reports in which pilots, believing this maneuver necessary, attempted it and lost directional control and completely missed the barrier or caused an engagement failure by an angling approach. Several of these airplanes were destroyed and pilots injured all because of this reasonable appearing but completely false notion. The simple brutal truth is that within the speed range of anything short of a "fly on" engagement, the BAK-9 couldn't care less whether you are on center or clear over next to the deck sheave.

Even with the older MA-1A and BAK-6, barriers, if you have time to even think about "steer toward the center of the runway if possible," your speed at contact will be within easy off center tolerance of these barriers.

Airplanes are not built for ground maneuvering. Anyone who ever rode a tricycle at any speed knows it is unstable when you go around a corner. So why try to steer this high speed, very awkward tricycle around corners when such maneuvering serves not the least useful purpose?

An approach end engagement is a different matter. In this case you need the full speed capability of the barrier. You should line up on center as you roll out on final and stay on center as you descend to touchdown and engagement. In this case there is plenty of time and the airplane maneuvers in its natural environment. If you drift off at the last minute, you can go around the same as on a bad landing approach. But for safety's sake don't try to maneuver after you are on the deck because this can be deadly.

Last year 236 Air Force aircraft, headed for trouble off the end of a runway, were saved by barriers, proving the value of equipment that can . . .

CATCH'EM-SAVE'EM

The headline above testifies to the value of barriers to the Air Force accident prevention program. Possible, and in many cases certain damage was prevented thanks to these bands of nylon webbing stretched across Air Force runways. The 1962 engagements represent an 84 per cent success rate, a notable increase in the reliability rate of 66 per cent during the previous year.

One modification must be credited—tail hook equipped aircraft. Tail hook engagements were 98 per cent successful; in fact, the six tail hook engagements made inadvertently on the approach end were successful insofar as stopping the aircraft. All were stopped, but in two cases the nose gear failed. This is most likely to occur when engagement is made in a nose high attitude. Installation of the tail hook light is expected to minimize such inadvertent engagements. (However, as one pilot proved, it's possible to engage the cable with the hook stowed—provided you land with the nose high enough.)

All told there were 287 arresting barrier contacts. In the case of non tail hook equipped aircraft going into MA-1A barriers the success rate remained at between 60 and 70 per cent.

Of the 45 unsuccessful engagements, 30 were due to too slow a speed—again pointing up the design deficiency of the MA-1A barrier which requires a minimum airspeed for engagement of the main landing gear.

Optimum success was achieved with BAK-6 and BAK-9 installations and tail hook equipped aircraft. (A BAK-12 barrier, offering even greater reliability potential, has been tested at Edwards AFB.)

Materiel failure accounted for over 60 per cent of all barrier contacts. Of these, the predominant cause was drag chute failures—failure to deploy, inadvertent jettisoning and failure of the chute to open properly.

Although barrier contact reports do not require explanation of drag chute failure causes, it has been suggested that more adequate packing procedures and better inspection of drag chute installations would improve the situation. Weak brakes and hydraulic system failures were reported numerous times as the cause for barrier contact. The combination of drag chute-brake malfunctions were involved in 132 of the cases.

In 58 of the cases, pilots brought on the engagements themselves through poor technique—landing too fast, or too far down the runway and errors in aircraft systems operation.

Two of the unsuccessful engagements were attributed to pilots failing to raise speed brakes prior to contact with the MA-1A barrier. ☆

CAUSES OF UNSUCCESSFUL ENGAGEMENTS

Aircraft Speed Too Slow	30
Speed Brakes Deflected Cable	2
Landing Gear Retracted	2
Barrier Maintenance	2
Arresting Cable Failed (MA-1A)	2
Reverse Engagement	2
External Stores Deflected Cable	1
Other (1 BAK-9 improperly serviced)	4
	45

TYPE BARRIER

	Successful	Unsuccessful	Per cent
MA-1 (Unmodified)	87	43	66.9
MA-1 (Modified, hook used)	27	0	100.0
BAK-6	57	1	98.2
BAK-9	71	1	98.6

CENTURY SERIES FIGHTERS VS OTHER AIRCRAFT

	Successful	Unsuccessful	Total
Century Series	199	19	218
Other Aircraft	43	26	69
	242	45	287

CAUSES OF BARRIER CONTACTS

MATERIEL	
Drag Chute System Failures	72
Brake System Failures	43
Brakes and Drag Chutes (Failed Jointly)	17
Engine Failures (Inducing Aborts)	29
Tire and Gear Malfunctions	9
Flight Control Failures	6
Other Materiel Failures	9
	185
PERSONNEL	
Pilot—Poor Landing Technique	58
Intentional Engagements (To prevent tire damage)	7
Jettisoned Drag Chute in X-Wind Landing	8
	73
AIRFIELD CONDITIONS	
Wet and Slippery Runways	29
TOTAL:	287

MISSILANEA

CALIBRATION PROGRAM. A Calibration Program Information Letter of interest to AMA and base Precision Measurement Equipment Laboratories (PMEL) personnel is being published by the 2802d Inertial Guidance and Calibration Group (MAAMA). Several articles appearing in this letter would be of interest to quality control personnel assigned to missile organizations. Recommend a copy of this letter be obtained from the local base PMEL. For further information contact the 2802d Inertial Guidance and Calibration Group (MAAMA), Newark Air Force Station, Newark, Ohio (MAHL).

HEAVY HANDED SUPERVISION. When you as a supervisor feel that your instructions, safety briefings, and tech data are adequate for every eventuality —BEWARE—something new may rear its ugly head. Result: Personnel injury or equipment damage.

A film was being made for use in the audio-visual training program and photographs of a vernier engine were required. A photographer and airman helper went to a complex, checked in with the combat crew commander, received a safety briefing and permission to go into the silo. The photographer and airman helper went down to Level 6, opened the door, lowered the work platforms, and set up their camera equipment. The airman accompanying the photographer felt that some people viewing the film might not know a vernier engine if they saw one and that possibly his presence in the picture might improve it. So, he leaned against the LOX tank pressurization duct and pointed to the Nr 1 vernier engine as the picture was taken. Later, it was discovered that "old heavy hands" had put dents in the duct that were beyond allowable limits. The bird had to come off ALERT to be repaired.

Supervision cannot become routine. Supervisors must always be on the alert. Many things that are not covered in the tech data or in the standard safety briefings occur frequently. If the supervisor isn't on his toes, someone will get hurt or equipment will be damaged.

Maj Curtis N. Mozley, Directorate of Aerospace Safety

TITAN TOPICS. *"Oops"—it could be a long first step!*

Recently, an individual working in a Titan II silo almost took that proverbial *long first step*. He opened the elevator door and started to step in. Fortunately for him, he looked inside where the elevator should have been and noticed an odd looking vacant space with *no* floor! When he peeked over the side into the elevator shaft, he noted that the elevator was in fact many floors below.

We know that an interlock mechanism is incorporated in the system that should prevent this type of malfunction. But—inspection of this interlock mechanism revealed that it was out of adjustment. Apparently a gradual maladjustment resulted from continual slamming of the door.

A check was made of all elevator doors on the complexes and several were found almost out of tolerance. Simple adjustments were made where needed, which corrected the situation.

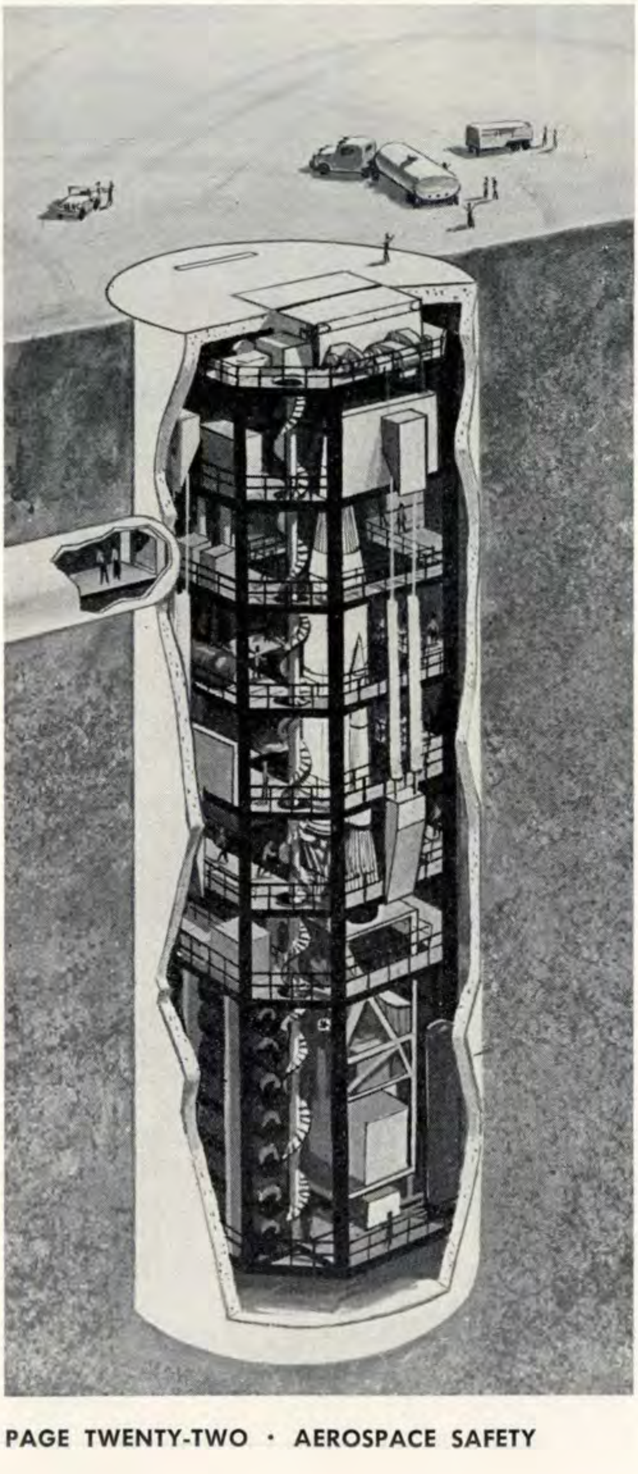
The unit recommended that signs be posted on all elevator doors to "CAUTION" against rough handling. Signs may be posted warning personnel to "LOOK" before entering. But, the fellow who almost took the "long" step won't be needing a sign to remind him that it's a long way down to the bottom of a silo.

Suggest Missile Safety Officer of units with elevators in their silos investigate to see if a similar hazard exists in their own backyard. ☆

Lt Col Driskill B. Horton
Directorate of Aerospace Safety

Needle in a SILO

CONCLUSION



LAST MONTH: In part one of* Needle In A Silo *the Aerospace Safety Accident Investigation Board (ASAIB) for the Atlas convened at the request of the major command to investigate an explosion that wrecked a missile and turned its silo into a chamber of horrors reminiscent of a Hollywood set for a science fiction movie. Quickly the Board assembled at the site and began the long, tedious investigation that eventually found the needle in the silo that was suspected as being responsible for the catastrophe. In the concluding half of this article the author completes his description of the investigation.

ALL PHASES OF INVESTIGATIVE ACTIVITY except for the hardware and systems examinations within the silo continued vigorously. A group of investigators who had been working within the silo were sent to examine an operational site for possible fire sources and to verify locations of explosive components. By this time review of standardization board records was completed and it was verified that the crewmembers were qualified in accordance with major air command requirements.

On the sixth day additional personnel from the Directorate of Aerospace Safety joined the ASAIB to assist in hardware failure analysis. The RP-1/LOX explosive expert arrived for evaluation of the explosive forces. The development agency sent two engineers from contractor sources to advise the board on LOX gel behavior characteristics. A telephone call was received from the major air command safety and maintenance personnel stating that immediate action was being taken on recommendations of the board concerning GOX detectors, personnel escape and emergency equipment, and housecleaning requirements of the silo area. The rest of the recommendations were being considered. Based on observations at the accident site and other sites the board recommended to the development agency that an evaluation be made of the location of fire detector units in the diesel engine generator areas on levels 5 and 6.

On the seventh day an evaluation of the immediate hazards involved in site re-entry for investigative purposes was conducted by board members and cryogenic materials advisors. Examination of condition changes by the hazard team indicated increased LOX flow from the damaged LOX storage tank line and an increased flow of ground water through the spalled concrete silo wall area. Air sampling showed 25 per cent oxygen content at level 5, 21 per cent at level 6 and approximately 16 per cent at level 8. Continued integrity of the crib structure was questioned.

To complete the evaluation of hazards involved in silo re-entry, for continuation of that phase of the investigation, the development agency was requested to provide for a silo structure examination by qualified engineers. This action was taken to determine whether continued controlled investigation activity would cause collapse of the crib structure.

The board president briefed the major air command vice commander-in-chief on progress of the investigation and recommendations. A tape library with footage logs was established to facilitate review of witness testimony and special reports. Maintenance records pertinent to the investigation were indexed for use while the evaluation and analysis effort was still in progress. Excessive time was required by the maintenance, inspection and records group to locate missing maintenance forms and to correlate squadron and "Long Reach" team records. The group leader compared the effort to that of a Chinese bank audit.

A file of EURs, AF Forms 1395, and missile hazard reports was provided to the board by the major air command safety office.

On the eighth day, two engineers arrived from the architectural engineering corporation that had designed the site to advise the board on the structural condition of the silo. Evaluation of the hazards to continuation of investigative activities was accomplished by the board and advisors. Cryogenics specialists' evaluation of hazard team observations indicated that liquid oxygen was still present in the silo and liquid nitrogen was also present in at least one storage vessel. Content of the high pressure gas storage bottles was unknown. There was a dangerously low oxygen level in the lower portion of the silo. Considerable quantitites of material that was thought to be both impact sensitive and combustible were still in the silo. Water seepage into the silo was continuing at an increasing rate. I-Beam fractures in the vicinity of the L-15 filter had resulted from cryogenic temperature embrittlement. Gaseous oxygen detectors were inoperative.

A major fire apparently existed in the silo outside the missile enclosure area prior to the major explosion. The fire did not penetrate the missile enclosure area until just prior to the major explosion. Because of the serious risk to the lives of the persons making the entry the advisors recommended that no further entry be permitted into the silo. Their advice was based on the following hazards: crib structure integrity was questionable. Silo structural integrity was questionable. An oxygen deficiency existed at the lower levels of the silo, even though liquid oxygen was present in the facility and generating gaseous oxygen. There was a danger of combustible and impact sensitive material in the silo. The high pressure gas bottles may not have been vented. There was considerable falling debris from the various levels.

The observations, conclusions, and recommendations of the advisors from the architectural engineering corporation were: there was severe spalling of the concrete, particularly on the underside of the silo cap and the walls on the south side around the southerly shock hangar wall bracket and the southeast quadrant down

to level 7. The structural members of the crib were not damaged except that columns C and D were severely distorted at levels 3 and 2, the penthouse beams on the north and south sides were severely distorted, the counterweight hand guide rail was distorted and torn loose from its support, the principal member on level 3 between the launch platform area and the counterweight area was distorted and torn loose from its connection on the south end, counterweight cables were broken and the counterweight had fallen to the bottom of the silo, secondary members supporting heavy equipment on various levels were extremely deflected, shock struts were fully extended and the springs had bottomed on the south and west sides. The silo walls had failed due to spalling caused by prolonged exposure to fire and high temperature rather than blast forces. No further collapse of the walls or cap was anticipated since ring beam supports carry earth loading.

From a structural standpoint only, it was determined that there was no undue hazard under controlled conditions for limited personnel access to the silo. The water level should not be permitted to rise above the floor of level 8. Heavy equipment should not be permitted on the cap. Should shifting of the crib occur, the silo should be evacuated.

By the tenth day the advisors had completed their hazard evaluations and submitted their reports to the board. Cryogenics personnel felt that by this time the LOX gel hazard no longer existed. The remaining unacceptable hazard to resuming the investigation was the unvented high pressure gas vessels. Board members and advisors concentrated their efforts on determining whether the high pressure gas vessels actually contained gases under pressure. The hazard team and the chemical engineer advising the board re-entered the silo to determine whether the vessels were still charged and whether valves in the system could be operated to release such pressure. Their evaluation confirmed that as much as 6000 psi gas pressure could still be in the system and that there was no practical way of operating any valves in the systems to relieve those pressures.

The EOD specialist from the local munitions maintenance squadron briefed the board on the merits of thermite grenades for cutting the heavy duty stainless steel lines and shaped charges for piercing the lines. He conducted tests on sample pieces of the lines involved and discovered that a MARK II shaped charge with two ounces of composition C4 would drill a 1/4 inch hole completely through the diameter of even the 1/2 inch wall thickness line. Air munitions personnel supplied the board with empirical formulas for determining the overpressures that could be expected from two ounces of composition C4. There were five lines that required piercing. Overpressures were calculated and checked with the explosives expert advising the board.

It was decided that two setups would be used, one group of two charges and another for the three remaining lines. The EOD specialist volunteered to set the charges and the line piercing operation was completely successful with the first grouping. In the second grouping, however, one of the charges slipped slightly gouging out the side of the line without piercing the wall. The board recessed for two days to allow adequate venting of the helium and gaseous nitrogen vessels.

LOX transfer control prefab received careful scrutiny.

Upon re-examination it was discovered that the line which had not been pierced had been weakened sufficiently to rupture and exhaust the vessel during the waiting period.

Full scale controlled activity was resumed on the investigation of the systems and hardware remaining in the silo. Analysis groups were established and detailed questions were presented to the missile structure and subsystems group to insure complete coverage of questionable components and systems. The explosives expert had completed his explosive forces analysis and presented a preliminary report to the board. Structures above ground exhibited no evidence of overpressure damage. Lack of evidence of lateral deformation of the cooling tower structure and the undamaged glass windows in the utility building showed that overpressures as close as 110 feet from the center of the silo cap were below 1/2 psi. The silo cap doors, however, were blown off and were lying 100-110 feet from their original position. Structural deformations within the silo were generally downward from level 5 and below, while from level 4 and above they were upward in nature. The approximate location of the main explosion was in the area of the intermediate bulkhead.

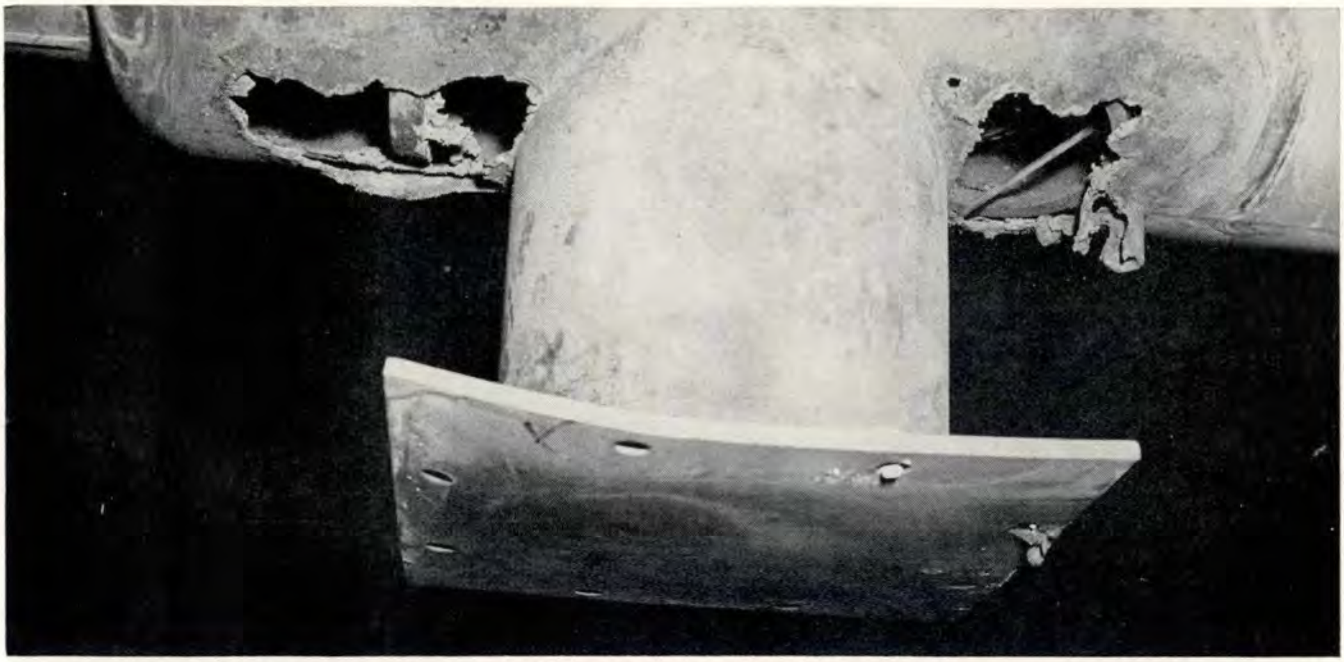
The sequence of events within the silo from a blast point of view were:

1. A GOX rich atmosphere probably existed within the silo for some time during the drain sequence.

2. During the abort mode, after approximately 20 minutes of LOX downloading, fire was observed on TV monitors and indicated by the fire alarm system. Not more than 1500-2000 gallons of LOX remained on board the missile.

3. Shortly thereafter, the LOX tank pressure went to zero and the major explosion occurred, blowing the silo cap doors off and venting the explosion to the atmosphere.

4. The explosion was followed by a fuel fire lasting for approximately 19½ hours.

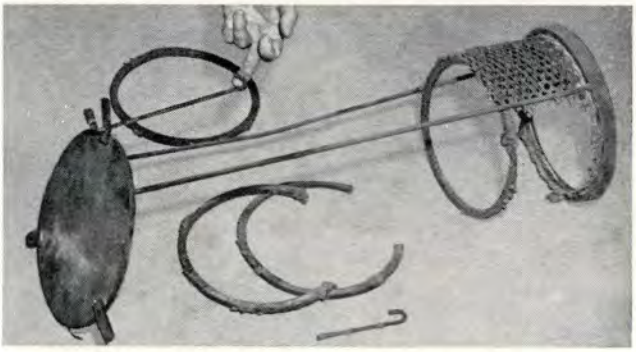


Large holes in LOX filter housing resulted from an internal oxygen-steel fire during missile downloading cycle.

The explosives expert stated that lower yield detonations occur both above ground and in-silo if mixing is minimized before ignition and if a positive ignition source is present at the time of mixing of the fuel and oxidizer. In this accident both of these conditions were present. The mixing interface occurred through a rupture in the intermediate bulkhead. A mass spill of fuel and oxidizer did not occur. The early ignition source was present in the form of a fire in the GOX rich atmosphere. It was concluded that a massive oxygen rich deflagration occurred within the silo.

The search was painstaking and time consuming. The rubble was sifted and pawed and scraped away from components and whole systems. Gradually components then subsystems were exonerated as possible cause factors. The pod air conditioner, a prime suspect from the start of the investigation, was given a clean bill of health. The electrical power production system was finally exonerated. The LOX transfer system was receiving careful scrutiny when one of the investigators started pawing the spall away from the L-15 filter on the LOX prefab. Feeling around underneath the filter housing, he found a large hole adjacent to the mounting pedestal. Careful removal and examination of the L-15 filter revealed three large burned-through areas, one on either side of the mounting pedestal and one into the pedestal area which did not penetrate the butt plate. The unit was removed from the silo for failure analysis.

The holes in the filter housing were the result of an internal oxygen/steel fire originating in the filter mesh and burning through the filter housing during the downloading cycle. There was evidence of LOX flow during the fire both through the L-16 valve and through the burned hole areas. LOX flow through the holes in the filter housing caused the cryogenic failures of the steel beams observed in the vicinity of the L-15 filter. Examination of the filter element J-bolts revealed a cold bend in one of the bolts at the end plate. Evaluation of this failure indicated that sufficient force had been exerted on this J-bolt to bend it approximately 90 degrees prior to the occurrence of the fire within the housing.



Filter J-bolts failed from unknown force prior to fire.

The specific cause for the ignition of the oxygen/steel fire within the filter housing could not be determined. Additional advisors with experience concerning oxygen/steel fires examined the evidence available; however, it could not be positively established whether an impact sensitive contaminant or mechanical action of the filter element provided the heat source to start the fire.

After sifting the mass of evidence gathered during the investigation, the board spent many long hours putting it all together in logical sequence in order to read the story it told. The board's report contained 26 conclusions, seven findings and 16 recommendations. Valuable lessors learned from this accident are being passed on to each F series squadron in presentations and cleanliness inspection procedures briefings. ☆

Aerobits

CALL TWO LUCKY—Mission was a functional test flight in the T-Bird after periodic. The pilot assigned to fly the mission received clearance from the tower, taxied into takeoff position and advanced power. As the RPM increased he noticed a red light come on —generator warning light. He chopped the power, reported his difficulty and taxied back to the line.

Repairs were made, the airplane checked out by maintenance, and again scheduled for a functional test flight. Another pilot was assigned to fly the mission. He too received clearance for takeoff, lined up, shoved the throttle forward and checked power. O.K. He released brakes and the T-Bird was rolling. After start of takeoff roll he noticed the tailpipe temperature fluctuating. He aborted, taxied back in and wrote up the discrepancy on the '781.

Again repairs were made. Maintenance ran up the engine. Tailpipe temperature steady, in limits. For the third time it was scheduled for a functional test flight.

A third pilot was assigned the mission. He picked up his gear, filed and went out to the bird. He went through the normal preflight checks and, as was his custom, checked controls for free movement and proper direction of travel of control surfaces.

The ailerons were hooked up in reverse!

We don't know the names of the first two pilots, but "Lucky" will do.

AN ACCIDENT WAS CREATED—Two highly qualified B-47 crews planned and briefed a mission that was to include refueling with a KC-135, day celestial navigation and low level activity. The crews were briefed to fly a loose visual formation during the day celestial navigation leg en route to the refueling area. MARSA was entered on the Form 175 at base operations, indicating that the pilots were aware of the hazard associated with being at the same altitude, going the same direction, to the same termination point, at the same airspeed. This would also mean that their navigators' and copilots' attention would be directed to accomplishing the celestial navigation, while the pilots' primary attention was to keep their aircraft clear of each other for collision avoidance.

Not long after the start of the celestial leg, the aircraft appeared to be converging—with the number two aircraft overtaking the leader. (At this point the writer must surmise that both crews were so engrossed in their crew duties that they were not aware of their close proximity or that they did not consider it "too close for comfort.")

Just before the collision, the copilot of one aircraft called out that they were converging. The pilot disconnected the autopilot and attempted evasive action but to no avail. The aerodynamic disturbance of the higher aircraft had already been induced on the lower aircraft and the accident was assured. The warning on page 6-14 of the B-47 Flight Manual again proved valid—an accident was created.

Since both copilots were using their sextants for celestial observations, they had removed their parachutes and their survival gear. Both were killed. The body of one copilot was finally located a considerable distance from the aircraft wreckage. One navigator was apparently unfamiliar with his ejection system and manually bailed out through a gaping hole in the fuselage. One aircraft commander apparently waited too long and was killed during a low altitude ejection.

When two bombers are scheduled to fly the same route at the same altitude and airspeed at the same time with multitudinous crew requirements, there is a strong likelihood that sooner or later they will collide unless extreme care is exercised to prevent the collision.

Every individual assigned to a combat crew should devote his full duty time to learning every "trick of his trade." An intimate knowledge of his flight manual will enable him to perform his job with ease and at the same time adequately prepare him to react to any emergency, as would be expected of a professional crew member.

Lt Col David J. Schmidt, Directorate of Aerospace Safety

PILOT MASHER—T-BIRD STYLE. The bug with skull and crossbones on the cover of the September issue of AEROSPACE SAFETY is indeed a grim reminder of the many pilots presently residing in the aviator's Valhalla; and of the many shattered flying machines trundled to the bone yard because of foreign objects.

A recent T-Bird incident points up a real hairy one. When the IP lowered his seat the seat belt and man-seat separator fired. He was thrown up against the canopy and forward in the cockpit. His body exerted pressure against the stick until he unsheathed his knife and cut the snapper.

Post landing investigation disclosed a locally manufactured let-down book holder under the seat. The book holder bent when the seat was lowered on it and pushed against the cable assembly (P/N NAS 324C22-0123). The force exerted against the cable assembly caused the M-32 initiator to fire.

Fortunately for the pilots the "snapper" functioned at 3000 feet; had it occurred at 30 or 300 feet it is very likely the formidable oaken gates would have swung open and Odin would have had two more of our experienced pilots.

The system worked, as designed, but was unable to differentiate between a real ejection emergency and a foreign object impulse. Moral—Keep those cockpits clean!

Lt Col K. I. Bass (USAF) Ret.

APPROACH END BARRIER ENGAGEMENTS—A pair of F-102s recently made intentional approach end engagements of BAK-9 barriers. Both engagements were successful and probably averted major aircraft accidents. Circumstances involved in the two cases were:

During takeoff the left main tire blew just prior to lift-off. The aircraft became airborne and the tire failure was confirmed by the pilot of another aircraft. After considering aspects of the emergency, a decision was made to perform an approach end engagement of the BAK-9 barrier. This decision stemmed largely from the probability of loss of directional control during landing roll. First, the MA1-1A barrier on the approach end of the runway was removed to prevent an inadvertent engagement in the event the aircraft touched down short. After reducing fuel load to 1800 pounds, the pilot set up a five mile straight in approach, gear down, speed brakes and tail hook extended. The aircraft touched down on the right side of the runway at 140 knots, 1200 feet from the BAK-9 barrier. The pilot deployed the drag chute and lowered the nose wheel to utilize nose wheel steering for directional control. Immediately after touchdown severe vibrations were experienced from the left wheel. These vibrations were so severe the UHF radio was re-channeled and the pilot was unable to determine whether the nose wheel steering was operating. Marginal directional control was maintained with right brake, however the severe vibration from the left wheel caused a break in the high pressure pneumatic lines. Loss of the high pressure pneumatic system caused the drag chute to jettison. Effective directional control was lost and the aircraft began an uncontrollable swerve to the left. At this point the tail hook engaged the BAK-9 barrier near the center of the runway. The aircraft stopped 724 feet after

engagement. The pilot reported deceleration forces to be very mild, comparable to those experienced during drag chute deployment. The pilot escaped injury and aircraft damage was limited to incident classification. Cause of the blown tire was not determined.

The other planned approach end engagement occurred at the end of a routine training mission when the pilots of a TF-102 were unable to extend the right main landing gear. Normal and emergency gear extension procedures were tried, but the right gear remained in the wheel well. The canopy was jettisoned on final approach and the arresting hook was extended approximately one foot in the air as the aircraft crossed the approach end of the runway at 150 knots. Engagement was successful and the aircraft was brought to a stop 735 feet from the engagement point. The right wing dropped to the runway after 150 feet of roll and the nose gear failed shortly thereafter. The pilots were not injured and total damage fell in the minor accident classification. Runway barrier configuration in this instance included an MA-1 barrier installed on the overrun, 55 feet from the BAK-9 barrier. The MA-1 was in the retracted position during this approach and landing. The tail hook struck the runway 12 feet prior to engaging the BAK-9 barrier. Failure of the right main gear to extend was due to the right tire being caught on top of a locally fabricated metal box. This box had been installed in the wheel well as a container in which to store landing gear pins.

Although there are numerous variables involved in a decision to attempt an approach end engagement of a BAK-6 or BAK-9 barrier, these two instances point out a capability which should be considered when landing the F-102 under certain emergency conditions.

Capt Vernon G. Knourek, Directorate of Aerospace Safety

Aerobits

EJECTION SEAT AND RESCUE HELICOPTER—There has been some discussion of whether or not the possibility exists of a static surface or subsurface ejection from a floating crashed aircraft into the rotor blades of the rescue helicopter. The Naval Air Engineering Center has released the following information concerning the trajectory of ejection seats from aircraft that have crashed in the water:

- If the pilot should eject with the aircraft floating on the surface, the seat will travel in an aft direction, 11 to 23 degrees from the aircraft vertical, and will attain a height of approximately 60 feet (although rocket-assisted ejection seats attain a greater height, the trajectory of the seat approximates that of the standard seat). The aircraft will remain afloat from zero seconds up to a maximum time of about one minute depending upon the weight of the aircraft and the integrity of the airframe following contact with the water. Usually they will stay afloat for less than 30 seconds.

- As a general rule, if the canopy and cockpit are intact, the aircraft will sink in a tail down attitude, throwing the ejection angle farther aft. If the cockpit is flooded, the aircraft will sink in a level or slightly nose down attitude. Sinking rates of aircraft will vary from about two feet per second to 12 feet per second, depending upon the destiny and the integrity of the aircraft, particularly the cockpit area.

- Once the aircraft has reached a depth of eight feet, which will occur in from 3/4 of a second to four seconds, the seat if ejected will just about break the surface of the water, but will not attain any height in the air.

Based on this information, it is reasonable to assume that the safest position for the helicopter to hover for the rescue operation is forward and slightly to one side of the cockpit. Once the plane starts sinking there is practically no danger to the hovering helicopter if the pilot should eject from underwater.

NASC Personal/Survival Equipment Crossfeed

DANGEROUS DRY ICE—Less than five minutes after departing blocks, passengers aboard a combined cargo-passenger-loaded transport complained of breathing difficulties, and some went on oxygen. The loadmaster, observing this, reported to the aircraft commander who immediately put both aircraft air conditioning packs on, taxied back to the ramp and off-loaded his passengers.

Cargo consisted of 41 boxes, each containing 84 frozen meals and 50 pounds of dry ice. Dry ice is solid carbon dioxide (CO_2) that gives off carbon dioxide gas at temperatures above minus 78°C. CO_2 displaces oxygen in the air, has physiological effects on the body (increased breathing rate) and, in concentration, can cause suffocation.

AFM 71-4 lists the following formula for computing the maximum amount of dry ice to be placed aboard pressurized transport aircraft:

$$\frac{\textit{Vol of acft x Nr of air changes per hour x .47}}{32.2}$$

For this particular aircraft, volume is 5313 cubic feet. Air changes per hour: 19.2, but this is airborne in normal cruise condition with both airpacks operating.

Air changes per hour on the ground with all engines at idle is only 2.5. With air packs off, as checklists stipulate, it's even less.

This aircraft carried 2050 pounds of dry ice. According to AFM 146-2, Section C: "A conservative guide is to use one pound of ice for each 10 meals for each 24 hours." Using this guide, 343.2 pounds of dry ice would be required. There was six times this much on board. According to the formula above, 193.87 pounds is the maximum amount of dry ice that could safely be carried in this aircraft on the ground, with both air packs operating. The aircraft was loaded with over ten times this amount and, until the loadmaster reported that the passengers were having difficulty breathing, the air packs were not on.

Cause factors in this incident were listed by the investigating officer as: Primary—Approximately 2050 pounds of dry ice used vs. 194 pounds being the safe limit. Contributing—Failure to document and label the boxes as "dangerous material" or "special handling required." (Dry ice is listed in AFR 71-4, AFM 146-2 and MM 76-1 as a "dangerous material" and 76-1 requires "special handling" labeling.) Failure to surround and cover the boxes with insulating blankets and tarpaulins as required by AFR 7-4. Instructions to "overpack with dry ice"—a phase that has about as many meanings as there are people interpreting it. ☆

WELL DONE

1st Lt. George F. Baker Jr

401 TACTICAL FIGHTER WING, ENGLAND AIR FORCE BASE, LA.

First Lieutenant George F. Baker, Jr., was on a dart towing mission in an F-100D. As he reached the firing range, his TACAN system failed and he could not establish contact with GCI. Unable to maintain a positive position within the range area over the Gulf of Mexico, he decided to return to Chennault AFB and land. He rolled out on his pre-computed heading and the control stick moved suddenly to the full aft position. The aircraft nosed up abruptly. By pushing forward on the stick with both hands, Lieutenant Baker was able to maintain straight and level flight. Emergency procedures failed to correct the difficulty because the trim system was completely shorted. By placing his knee against the stick, Lieutenant Baker found that he could release one hand for short periods to adjust the throttle, change radio frequencies and still hold the aircraft generally level. He realized a dart drop at Chennault would be extremely difficult and dangerous so he attempted the drop over a clear area in the Gulf, but the release system malfunctioned. To prevent damage to persons and property off the end of the landing runway, Lieutenant Baker decided to drag the dart off in the designated drag-off area. He then climbed to a downwind leg and, using the knee and arm method, lowered gear and flaps. Despite difficulties adjusting power on final approach, he made a safe landing.

Through skill, knowledge and strength, Lieutenant Baker safely recovered a disabled aircraft without damage to property or personnel. He accomplished an outstanding feat of airmanship that reflects credit upon himself and the United States Air Force. Well Done!

WINTER'S GRIP

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