AEROSPACE

SAFETY

UNITED STATES AIR FORCE

FALL SAFE · Page Thirteen ··· JANUARY 1963

WHAT I SAW

Lieutenant General William H. Blanchard
The Inspector General, USAF

I SAW A NEED for developing an on-the-spot *emergency action checklist* at missile units. If you aren't quite sure you know what I mean, you aren't alone — some of the individuals at Norton and Vandenberg with whom I recently discussed this subject weren't quite sure either. However, the people who had previously found themselves in a situation similar to the one I'm about to describe got the point pronto! Perhaps the *emergency action checklist* should be an addendum to the disaster control procedures, perhaps it would be more logical to include it somewhere else, but the point is—we need it. We need it NOW and we don't have it. NOW is the time to be considering and planning for an emergency—NOW, while things are relatively normal and routine.

As a case in point, let's take the incident which made this need apparent. As the commander of an Atlas F unit, you have had a serious accident through a series of mishaps, malfunctions, malpractices, and perhaps some grossness. The LOX tank has collapsed on an alert missile and the only thing that has kept the reentry vehicle from crashing to the bottom of the silo is that the RV is precariously hung upon a work platform near the top. No other damage was done and there were no injuries to personnel. Your job now is to untangle the mess without creating another accident. There are no red bordered pages in the Dash One, no predetermined back out procedures for this one, no factory personnel handy to fall back on. You have some time to organize and think, but you know you don't have forever. So, you make your estimate of the situation, lay out the broad details of your plan, assign specific tasks, and ask for outside help where obviously needed.

Right here is where I see a need for some immediate help to you as a commander. You got into this situation because these birds are nearly as complex as the human body—and sometimes as mysterious. If volumes of tech data, repeatedly studied and rehearsed, were not enough to keep you out of the trouble you're in, the one page in the Dash One, or your mental estimate of the situation and comparatively hurried verbal field order almost surely are not going to let you recover before the first accident is compounded and a more serious one, perhaps a real disaster, is created.

We have found through experience—some of it bitter—that the checklist is *required* to keep us out of trouble. But checklists are evolved after months of analysis, study, test, etc. Time does not permit such preparation. Are we now going to discard the practice which we so fastidiously require in our daily operation? What then is the next best step?

I suggest an outline form tailored for each different type of missile. In the outline form, blanks would be provided which would require insertion of the appropriate action and its sequence, and the specific assignment of responsibilities to individuals for each such task, keeping foremost in mind the configuration required throughout the complex to permit you to take each step safely. Obviously the Atlas D, E or F, or other missiles will each have a different outline because there are different switches, valves, crew positions, etc., to be considered in every step. The prepared blank checklist will prevent omission—or at least help prevent omission—of mature deliberation regarding each item, particularly with respect to its influence during the operation contemplated.

To be more specific, you quickly confirm your broad plan of action with the best authority available. Let's say there are five initial, main, sequential tasks, all interdependent. With the thousands of circuits, valves, switches, etc., there is a proper configuration for each sequential task which must be compatible with the other tasks. If any task proves to be incompatible you must change the technique to achieve compatibility. If this is not possible, your broad plan is inadequate and you must take a new approach.

For example, after Broken Arrow actions have been taken in our Atlas F situation, the following steps, based on consultation with the technical experts available, could follow:

a. Remove the pyrotechnics.
b. Secure the RV.
c. Secure the collapsed LOX tank.
d. Detach the RV and remove.
e. Now re-estimate the situation.

Must we cut the LOX tank loose? Will the Rocket Propellant tank stay pressurized? Can we drain it? Etc., etc.

Going back to item a. To make specific task assignments we can use our standard checklists and our regular crew. Not so item b. We don't have the equipment. Make it or send for it?—or both? Who is best qualified to foreman the job? Specifically who will do what jobs? What is the total configuration? Who needs to be on site? Who doesn't?

I don't think I need go any further. I've asked the Directorate of Missile Safety at Norton to work with the 1st Strategic Aerospace Division at Vandenberg and to take it from here. Perhaps a short course for our missile squadron commanders is also in order. For they are the gents who will be out there faced with the task of picking up the pieces after any accident. In the interim, each unit missile safety officer should go to work with his commander and work up his *Procedure for Developing an Emergency Action Checklist.* ★

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FALLOUT

Accident Investigation

A recent aircraft accident involved an F-100 that crashed following takeoff. Because of the distance involved and weather conditions en route, it was 24 hours before the accident investigating board arrived at the scene.

In order to clear the runway for use, the fuel tanks and pylons, which had been jettisoned, were picked up from the runway and held for the accident board. However, in clearing the area, several small pieces of wreckage were not saved but merely thrown clear of the runway, apparently being considered of no value by the personnel engaged in this work.

Immediately after the accident, a maintenance officer, not connected with the investigation, had observed and left undisturbed, several fragments on the runway which he presumed would be held for the board. Four weeks later, this same officer, while in the base reclamation yard, noticed a hole in the wing from the crashed aircraft. He surmised that the fragments he had seen might have come through this hole. He later discussed this with the local flying safety officer and learned that the accident board had never found these fragments. He returned to the runway and found these fragments still lying in the grass 25 feet off the side of the runway. These pieces not only fitted together but also fitted perfectly into the hole in the integral wing fuel tank.

This evidence was highly significant because up to this time the board had been unable to determine whether the wing tank rupture occurred before or after the crash impact. The accident investigation had been seriously hampered and delayed by the carelessness with which the wing fragments were disposed.

It was only through good fortune and the alertness of the maintenance officer that the pieces were ever found and an accurate sequence of events reported. In the interest of flying safety, it is requested that this information be published in *Aerospace Safety* as an example of the importance of proper safeguarding of any aircraft wreckage for the investigating team.

Capt George F. Gary
FSO, Hq 48th Tac Ftr Wg
APO 179, New York, N. Y.

Thanks, Pat

The Aerospace Safety Magazine comes through our office and I always take time out to glance through it. Recently, I read an article by Capt. C. Z. Chumley and I have one question: IS HE FOR REAL???!!

Miss Pat Myers
McDonnell Acft Corp

P.S. Who does the artwork for the magazine? I think the cartoons are terrific!

CMSgt Steve Hotch and Dave Baer are responsible for the artwork and we are proud to have them on our staff. As for Chumley, we'll ask him if he's real the next time we see him.

THE COVER

Our parachutist on the front cover might be an Air Force crewman who has just ejected or bailed out of a stricken aircraft. Actually the photo was taken during preparation of the article Fall Safe *beginning on page 13. The photographer was Robert Sinclair of Para Ventures, Inc. The author, James C. Hall, is a former B-29 flight engineer and currently a captain in the Air Force Reserve. General Manager of Para Ventures, Inc., and of the Elsinore, Calif., Para Center, Inc., Jim has been a professional parachutist for 13 years. His experience includes test and experimental work as well as three and one-half years in cargo delivery by parachute of exploration, rescue and other expeditionary equipment. He originated the "In Free-fall Parachuting Instruction Method" being evaluated by the USAF. A graduate geologist-mining engineer, he is the highest paid professional parachutist in the United States.*

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VOLUME NINETEEN NUMBER ONE — USAF RECURRING PUBLICATION 62-1

ACCIDENT 1963 PREVENTION

Last summer the largest group of Air Force safety officers ever assembled met for a five-day session at Sandia Base, N.M., to hammer out the U.S. Air Force accident prevention program for 1963. In this, the Third Annual Safety Congress, delegates dug into present problem areas, looked at probable future problems, and came up with a plan they feel gives most promise of lowering the accident rate this year.

FLIGHT

Maintenance and materiel problems and personnel error are considered the areas most worthy of attention if accident prevention gains are to be made this year. Analysis disclosed that during 1961 materiel and maintenance cause factors accounted for approximately 42 per cent of all accidents (45 per cent for the first six months of 1962) and personnel error accounted for approximately 47 per cent.

Because of this the Flight Safety Seminar was divided into these two main study groups. Each probed into deficiencies, as disclosed by past investigations and statistics, then came up with recommendations. Frequently, these recommendations were directed at major commands supporting or supplying the user — particularly in the case of materiel deficiencies. But there was also a strong pitch made to encourage careful inspection and observation by the using command, then prompt reporting of all deficiencies. Major objectives of the 1963 Flying Safety program as resolved by the seminar are:

Develop a system for early detection of incipient engine and accessory failures.

Reduce the time interval from discovery of a materiel deficiency until a corrective fix has been intalled in the aircraft.

Improve the correlation between Teardown Deficiency Reports and aircraft accidents and incidents.

Develop within the USAF a better system of accountability for safety of flight TO compliance.

Devise a means of insuring high qualification of instructor pilots.

Develop procedures to insure pilots are sufficiently knowledgeable of aircraft systems and emergency procedures.

Improve the quality of supervision in CRT and support type flying.

Improve procedures for the dissemination of accident prevention data.

Nine recommendations made to aid in realizing these objectives were:

1. Adoption of a spectographic analysis system as a more effective means of before-the-fact determination of engine failure.

2. Realize improvement in modification fixes, particularly critical safety hazard mods that have been identified as a result of accident or mishap. To achieve this end it was further recommended that each major command establish a monthly priority listing of the top ten materiel safety problems within the command and that emergency URs be used to identify flight safety materiel deficiencies.

3. Revise the TDR program to insure more timely and accurate reports as to why failed parts actually failed.

4. Revise the time compliance tech order system to provide for completion on a safety priority basis. Also, make other changes in the system to permit reduction of the outstanding manhour maintenance TCTO workload requirements.

5. Reduction of the number of aircraft accidents chargeable to lack of aircrew discipline and pilot proficiency through greater major command amphasis on and participation in:

- Standardization, original checkout and currency flight checks.
- More effective use of flying hours.
- Recurring training.
- Preflight planning.
- Use of synthetic trainers.

Elaboration of these main points was in the form of recommendations that:

All IPs should be graduates of the pilot instructor school.

Flight participation should be on a monthly basis to achieve maximum retention of proficiency.

Means be found to create within personnel the desire for self discipline and safe flying habits.

Weak, marginal and poorly disciplined crewmembers should be identified and put up for elimination.

Improve the system of advising pilots of airborne aircraft of deteriorating destination weather and other pertinent inflight information. This problem is considered particularly acute for CRT and support aircraft. AFR 55-48 provides guidance for establishing inflight monitoring procedures. A stepped-up educational program is planned to better acquaint aircrew personnel of inflight assistance available.

Better dissemination of accident prevention information is listed as another means of improving the flight safety picture. A direct inter-command communication policy is urged, as well as review of intra-command procedures to insure that all interested agencies receive pertinent information promptly. Major commands have been asked to determine 66-1 critical safety data they desire and forward this info to DIG/Safety. It is proposed that, once these requirements are known, arrangements can be made with AFLC to extract this information. It is felt that such information can be of great value in identifying and eliminating potential accident factors caused by inadequate maintenance procedures, poor quality control and materiel failures.

Reduction of accidents and incidents caused by personnel error other than aircrew. Over 14 per cent of the 432 major accidents of 1961 were attributed to such cause. These accidents were due in whole or part to inadequate management, lax supervision or substandard individual performance. Three major areas in which deficiencies have been noted were cited as:

- Training facilities not fully utilized and weaknesses in on-the-line application of training programs.
- Varying degrees of laxness in complying with checklists, SOPs, tech orders and other publications.
- Tech orders and other directives containing conflicting and erroneous instructions.

Improvement of adequacy and accuracy of flight information publications. Three ways in which improvement is suggested are:

- Submission of accurate information by field units.
- Prompt review of such publications, as required by AFR 96-12, and reporting of discrepancies discovered.
- Immediate reporting by aircrews of errors discovered.

MISSILE

The 1963 missile safety program is one in which many of the recommended improvements can be effected only at supervisory level. Some are in the area of special projects and others call for assistance from command headquarters and industry. There are, however, basic safety improvement areas that can use the support of every individual in the missile field. Here are the four objectives as outlined in the seminar report:

In keynoting the congress, Lt. General William H. Blanchard, the Inspector General, predicted that the degree of success will depend, to a large extent, upon a positive attitude. Major General Perry B. Griffith, the Deputy Inspector General for Safety, echoed this opinion and declared that safety must be mandatory and a way of life. Anything less, he said, compromises mission effectiveness.

Seminar sessions, as in past years, were separated into the four main safety areas of flight, missile, ground and nuclear. These were in turn broken down into smaller working groups made up of delegates with common specialties. At the end of the week, with the working group plans drafted and combined into the overall plan, the framework for the 1963 effort was complete. Subsequently, this outline was polished, coordinated and resolved as the accident prevention program for 1963.

Generals talk safety. Lt General William H. Blanchard, The Inspector General USAF, left, and Maj General Perry B. Griffith, Deputy Inspector General for Safety USAF, kicked off Third USAF Safety Congress.

- Increase commanders support of safety programs.
- Improve safety policy, guidance, directives and programs.
- Integrate safety education into all phases of training, maintenance and operations.
- Seek further improvement of the over-all accident prevention program.

In addition to these goals they have listed three special emphasis subjects for 1963:

- Emphasize the personnel error prevention program.
- Refine and implement provisions of the program for safety in missile and space systems management.
- Study and develop information on total environment safety.

Four "E's", engineering, education, evaluation and enforcement, have been earmarked as the methods to be used in identifying and eliminating personnel error mishaps (see page 29).

Indicative of specific areas of concern is the close watch of the School of Aviation Medicine study on fatigue as a means of minimizing this as a cause factor

ACCIDENT PREVENTION 1963

in missile and space mishaps.

Special problem areas outlined in greater detail include:

- Continuation of the missile safety function as necessitated by transfer of safety management functions from AFSC to AFLC after suitability testing.
- Implementation of a reporting procedure that will assure reporting of mishaps at research and development activities. Many of these have implications of concern to the Air Force.
- Making provision for cross-training of airmen and NCOs into the missile safety field to provide adequate manning.
- Revision of the hazard reporting system. It is possible for hazards to occur that involve flying, nuclear, missile and ground safety. Under present reporting procedure two or more reports are required under separate directives. Failure to render reports in each area has resulted in inadequate dissemination of information and incomplete corrective action. It is felt that a single Air Force directive could provide an all inclusive hazard reporting system and offer many advantages over the present system.
- A safety standard for evaluating gross hazards. Current safety standards are inadequate from the standpoint of protecting personnel and facilities against the effects of gross hazards such as fire, toxicity, acoustics and fragmentation. The seminar group recommended that a study be initiated to determine an acceptable level of risk on which to base the development of safety standards and policy.

GROUND Ground safety conferees went about planning a 1963 program by first defining the major areas that cost the Air Force lives and man-days lost, then setting up a program designed to combat these problems. They came up with a listing of 13 areas of prime concern, and recommendations designed to reduce accidents in these areas. Seminar recommendations for each are:

1. Injuries resulting from sports activities cost over 25,000 man days and $3,000,000 annually. Accident losses from sports rank second only to those from private vehicle operation.

- The four broad areas identified as primary cause areas are facilities, equipment, leadership and the individual, Proper attention to these by responsible personnel is the key to reduction of such accidents.

2. Vehicle operations continue to be the major accident and fatality source in the Air Force. Following are four remedial steps proposed:

- That it be made mandatory for all USAF passenger carrying vehicles to be seat belt equipped, and that use of seat belts be required.
- That all traffic accidents and moving traffic violations be recorded in airmen personnel records.
- That a 40 hour driver education and training course be established at Lackland.
- That the point system and remedial training requirements of AFR 125-14 be firmly and objectively implemented.

3. Revision of AFR 32-3 is required. Drafts of proposed changes were given to each conferee with the instruction that they should be reviewed and any comment forwarded to the Directorate of Ground Safety at Norton.

4. Evaluation is needed of airless spray painting of

aircraft in hangars. Spray painting poses a hazard, and evaluation by AFLC and the Regional Environmental Laboratory is proposed. Upon completion of this evaluation, specific guidance for airless spraying is anticipated.

5. Toxicity, fire, explosion and corrosive hazards related to surface and air transportation of dangerous materials are of continuing concern. Continued determination of the hazard potential of materials in this category is proposed, with centralized evaluation and coordination with other services.

6. Improper use of lifting equipment causes injuries and materiel and equipment damage. Additional guidance is proposed for operation of such equipment, together with standards for testing and licensing of operators. Local equipment modifications, lack of preventive maintenance, inadequate inspection guidance and insufficient knowledge of weight capacities are additional factors that have detrimental bearing.

7. Waivers continue to be used as a substitute for compliance with mandatory explosives safety criteria. Remedial actions proposed were: give high priority to programming and construction of facilities to eliminate requirement for waivers; that operational planning consider the capability for explosives support prior to the assignment of missions; that controls or procedures be established for waivers to assure that aggressive remedial corrective actions are taken to minimize and eliminate waivers.

8. Hazards are created by locating aircraft loaded with explosives too close to other aircraft and inhabited areas. The recommendation is to provide additional parking areas and to revise or rescind waiver authority.

9. Egress system explosive accidents are a continuing problem and publication of an Air Force manual or tech order is suggested.

10. Existing storage facilities are inadequate for some weapons. Increased spacing, intervening structural barriers, development of new facilities or shielding — the solution most appropriate — is recommended here.

11. An explosives safety training course is needed — action should be taken to establish such a course by ATC after major commands have advised ATC of their requirements.

12. Explosives safety manpower spaces are lacking — define requirements in conjunction with the manpower validation program.

13. The explosives safety program is not in alignment with the ground safety program. In this, consolidated action is proposed.

NUCLEAR

The nuclear safety seminars placed particular emphasis on Personnel Error Prevention (PEP), the theme of the congress, and have used it as the basis for the 1963 program. A monthly stress plan was decided upon as follows:

January	— Promotion
February	— Programming
March	— Probe causes of human error.
April	— Personnel motivation
May	— Effect checklist discipline.
June	— Enforce two-man concept.
July	— Emergency URs
August	— Establish storage and loading safety.
September	— Proper supervision
October	— Procedures (investigative and reporting)
November	— Push quality control
December	— Perfect system check-out

Supervision, training and the human reliability program are listed as the broad areas in which the fight must be continued against complacency and personnel error. The need for concern was underscored by pointing out that in none of the incidents to date has there even been anything close to a nuclear explosion. The goal of 1963 has been set as continuance of this record and reduction in the number of mishaps.

Specific problems, solutions of which have been established as among the objectives of the safety program for 1963, include:

- To improve qualifications, training and selection of nuclear safety officers.
- Reduction of personnel error through use of standardization boards.
- Development of ideas on supervision and the two-man concept in the reduction of personnel error mishaps.
- Utilization of commanders' safety tools in the reduction of personnel error mishaps.
- Reduction of nuclear incidents caused by personnel error.
- Reduction of nuclear incidents caused by noncompliance with and inadequacy of technical procedures.
- Determination of the effects of electromagnetic radiation, including lightning, on weapon systems and the corrective measures needed.
- Reduction of the number of nuclear mishaps caused by personnel error in which equipment design was a contributing factor.
- Determination of whether the maximum permissible amounts of plutonium presently allowed for storage and transportation can be modified to permit better utilization of existing logistic and operational capabilities.
- Better nuclear safety training for USAF personnel with weapons responsibilities. ★

A SHOCKING STORY

AIRMAN STANLEY was making a routine inspection of a Homing Beacon site 15 miles from his base.

He told the government vehicle driver to wait outside the building—he would just be a short while. Inside the building Stanley noted an inoperative transmitter. Although he knew he was supposed to have a buddy present while working on electrical equipment, he decided to make a quick check of the trouble.

To make sure he was taking no chances he switched off the high voltage circuits. Then, removing the equipment panel, he reached inside and pulled out a rectifier tube, looked at it and laid it down by the equipment. He then stuck his head inside the transmitter for a visual inspection. While in this position he touched a terminal carrying 110 volts. The shock caused him to jerk to the left which placed his left shoulder and right eye between two other 110 volt terminals. The current through his head was sufficient to knock him unconscious. He remained in this position, in contact with the 110 volts, for about 15 minutes.

The vehicle driver, tiring of waiting, decided to go inside. Here he discovered Stanley's body. Stanley was pronounced dead upon arrival at the base hospital, another victim of "harmless" electric current.

In another recent accident at an Air Force base the boom of a loading crane touched a high voltage transmission line. At the time of contact, one airman was electrocuted. In the confusion that followed two more airmen were electrocuted and another shocked and injured while jumping from the crane, touching energized equipment, or attempting rescue.

In each of the above accidents the primary underlying cause was lack of basic knowledge of the characteristics of electricity. Some understanding of these characteristics should be fundamental to all Air Force personnel. For those who frequently work in the presence of electricity, ignorance of the true nature of shock can be extremely dangerous.

Most people believe that only high voltage electricity kills and that this is because hot currents burn their victims to death. Nothing could be farther from the truth. Knowing what actually happens is the first step toward prevention.

Electricity kills by taking over primary control of the body's operation. Normally the parts and functions of the body are controlled by a complicated electrochemical wiring circuit that we refer to as the nervous system. When overriden by an outside source of electricity, the nervous system loses control. This is particularly dangerous when the outside current is applied in such a way that the loss of control centers in either the heart, brain, or respiratory center. Therefore, one deciding factor in death by electrical shock is the path that the induced current takes through the body. Another primary factor is the magnitude of this current.

Death by shock is invariably the result of one of two things: cessation of respiratory action or ventricular fibrillation. An outside current can easily paralyze the delicate stimulus which causes regular breathing. Death results from the lack of oxygen in the same manner as if the victim had drowned. In the case of ventricular fibrillation, it is the heart action that is disrupted. Instead of pulsing steady regulated beats, the heart may twitch and jerk in a manner that renders it useless as a pump.

No one knows the exact amount of current necessary to cause death. A current of only .015 amperes passing through the chest may cause breathing paralysis. Currents of .017 to .018 amperes may result in ventricular fibrillation if they pass through the heart. When either of these situations occurs death may result unless outside help is rendered immediately.

The following table shows shock current intensities and their effects:

CURRENT IN AMPERES	EFFECT
.0002-.0003	Tap
.00075	Pinch
.005	Grip
.005-.015	Unpleasant stimulation
.025	Possible permanent damage to tissues and blood vessels.
.07 and higher	May be lethal

Many times currents that would normally not be lethal when applied for short periods result in electrocution because the victim is "held" by the current and is unable to release himself. This probably happened in the case of Airman Stanley. If a buddy had been present and if prompt artificial respiration and closed chest heart massage had been rendered his life may have been saved.

Voltage is the force that pushes the current through a conductor or the body. The amount of current for a given applied voltage depends upon resistance. This varies widely depending upon the path of the current through the body, moisture content, condition of the body, etc. Thirty-two volt circuits in wet areas have been known to kill, yet under most conditions the 120 volt house lighting system only causes minor shock and discomfort.

Strange as it may seem, very high voltages, i.e., over 1000 volts, are often less dangerous than lower voltages because they cause sudden and complete reaction. The victim often drops away from contact and the heart may resume normal action because ventricular fibrillation did not occur. One research study reported a recovery rate of 62 per cent among cases where persons were knocked out by potentials above 1000 volts. The corresponding rate at much lower voltages was only 39 per cent.

In case of shock, quick action is imperative. First, disrupt the flow of electricity through the victim. This may be done by shutting off the current, removing

Jack B. Scott, Ground Safety Director, AFCS, Scott AFB, Ill.

the victim from the current or removing the source of current from the victim. In any case, the action should be accomplished without subjecting yourself to the path of the electricity. Use a piece of wood or other non-conducting object. Send for help, then apply artificial respiration and closed chest heart massage. Speed is essential! In over 70 per cent of the persons revived from electrical shock the artificial respiration was started within three minutes.

In the Air Force Communications Service we have had an intensive program to train all personnel who work with high voltage electricity in the procedures for closed chest heart massage and artificial respiration. We feel confident that it is only a matter of time until lives will be saved through the use of these procedures.

During the past year all AFCS communications facilities have been equipped with emergency safety boards containing: a hook with a hardwood handle for removing sources of electricity from a person, a length of manila rope for pulling people away from a source of electricity, a spare shorting stick, first aid kit, resuscitube, artificial respiration and closed chest heart massage instructions, emergency telephone numbers, flashlight, and other items such as snake bite kits, that apply to particular areas. A training film has been produced which, by way of a simulated accident, provides instructions in the use of the equipment on our standard safety boards. ★

• • •

REASONS!

In the pages of this magazine, and in every other communication media available to safety, there is never ending emphasis on the need for training, standardization, supervision, crew discipline, professionalism — there are more. The reason for this is simply that in every accident, deficiencies usually appear. Occasionally, when primary and support personnel *have not* done their jobs well, and investigators *have* done their jobs well, it seems that all these deficiencies show up in one accident. Following is such a case. To recount the accident sequence would only add to Air Force self embarrassment; only the findings are reported.

Primary cause was pilot factor. The pilot failed to properly analyze the emergency by visual inspection of engines and instruments in flight prior to initiating prescribed emergency procedures. He consequently shut down two good engines instead of the two that had failed.

Other cause factors and deficiencies noted included:

Materiel failure: The Nr 3 compressor rotor disc of the Nr 2 engine failed along its periphery. Chunk size pieces of the disc were discharged through the compressor case and into the Nr 3 engine, thus causing both engines to fail at a critical phase of flight.

Materiel malfunction: Just prior to takeoff, during throttle advance, engine hangup occurred twice on Nr 4 engine. Corrective action was taken with satisfactory results. The pilot's improper response in coping with the ensuing engine emergency was influenced by this factor.

Copilot factor: The copilot, in his report to the pilot, incorrectly identified the damaged engines. The copilot lowered the flaps without prior or subsequent crew coordination.

Supervisory factor: The fuel load did not conform to a wing maintenance directive requiring a specified fuel load at engine start for functional check flights.

Probable contributing: An atmosphere of emergency was cast over the entire sequence of events which could have led to the pilot's incorrect application of emergency procedures.

Other findings: The Dash-One does not outline aircraft performance immediately after takeoff with loss of more than two engines. Some published charts for marginal thrust performance are misleading and impractical.

Operation of the altitude start-test ignition switches is not standardized in the aircraft and the simulators.

One urgent action technical order and nine routine TOs, of which five were depot level, had not been complied with prior to flight.

Administrative errors were found in the aircraft maintenance records.

The aircraft commander's written instrument examination was not completed within 120 days prior to his instrument flight check.

Lap safety belts were not standardized.

The crew did not complete their overwater bailout and descent procedures prior to entering the water.

Visual signal equipment was not contained in the life preservers.

The aircraft commander lost his helmet during the ejection because of improper fit.

One crewmember was killed and, from the evidence available, it is apparent he had not properly connected the parachute lanyard key to his lap belt. He used improper "preparation for bailout procedures." ★

keep a cool head in cold weather

CHANCES ARE — if you're north of the Mason-Dixon — there's snow on the ground and the red line on that thermometer outside is shorter than it used to be.

If you're a maintenance type you may have started your day by removing snow from the wings of an aircraft; if you're a pilot you've had some anxious moments lately while taxiing on slick concrete. If a weather man, you've had to give the troops some pretty dismal forecasts lately; if a medic, you've been looking down a lot of red throats.

So, no matter what your job, winter brings a special set of problems and we are in the middle of them about now. People have been living with cold weather for who knows how long, but we still have a lot of mishaps, many of them resulting from oversight, carelessness or forgetfulness. Trouble is, some of these mishaps are major accidents, some fatal.

Preparations for winter took place last summer and fall. Apparently, however, some items were overlooked. The following is offered as a reminder for those who need to be reminded.

Is the snow and ice removal equipment being used properly? Is a thorough job being done, or are the overruns obscured by snow? Are piles of snow alongside the runways and taxiways allowed to get deep enough to interfere with moving aircraft? Not long ago an F-100 landed short and wiped out the gear because the overrun was not cleared.

Then there's the problem of ice on the aircraft structure. There have been cases in which some snow or moisture was left on the wings, then froze during taxi or takeoff. Exterior inspection is extremely important and should be done carefully and thoroughly. A light coat of snow may be no problem but a slight rise in temperature may melt this snow which then may refreeze during taxi or takeoff. Specific attention should be paid to the horizontal stabilizer, tabs, wing fillets, static ports and top of the wings.

If wet snow is falling it may be necessary to apply de-icing fluid shortly before takeoff. For jet aircraft consider application of fluid to the lower surfaces of the ailerons, horizontal stabilizer and elevators whenever wet snow conditions exist or when takeoff will be made on a slush covered runway.

There should be an adequate supply of de-icing fluid available. However, use a little care. De-icing fluid should not be drained or allowed to run onto the ramp, because it may eat away the joint seal in concrete expansion joints. And it should not be allowed to drain into the sewage system. Mixed with other flammables and touched off by a spark this alcohol material may explode. Such explosions have blown manhole covers several feet into the air.

Aircraft should be carefully checked for ice on the controls and in engines. It may be necessary to preheat engines. Hydraulic systems are very susceptible to cold and care should be taken in operating those systems until they have been warmed to operating range. In extreme cold, seals contract, causing leakage, and pumps may be damaged by abrupt and heavy pressures in the hydraulic system. To prevent this, actuate controls gingerly until the system is within normal operating range.

Snow, frost or ice should be removed with de-icing fluid, heat or a broom, never by chipping. When an aircraft that has been in a warm hangar is moved outside, condensation and freezing may take place and must be guarded against. Also panels stored in a warm area may not fit properly when installed on a cold aircraft.

Oil dilution and proper engine preheating are important. This may seem academic, but early this year a C-47 bought it because the crew forgot to dilute the oil.

When starting engines it may be necessary to motor each engine first to reduce excessive hydraulic, engine and alternator oil pressures. Operate engines at idle until oil pressure stabilizes in the operating range. Frequency in the AC power generator will normally remain high until the fluid in the constant-speed drive is warmed up. Take care not to place the generator on the bus until the frequency stabilizes at accepted values.

Crew compartments should be warmed not only for crew comfort, but to remove or prevent frost on glass and to insure normal operation of instruments and electronic equipment.

Nosewheel steering may be sluggish so very gentle turns should be made initially. Never operate nosewheel steering while the aircraft is stationary. Reduce speed and increase the distance between moving aircraft. To avoid blowing snow and slush take care when maneuvering near other aircraft and avoid taxiing in deep snow or slush — brakes and gear may accumulate moisture and freeze during takeoff. If most of the runway will be required for takeoff, check the far end. Other departing and landing aircraft may have compacted snow on the first half of the runway only. After clearing the ground, cycle the gear up and down once or twice before final retraction as an aid in removing moisture and slush that might freeze.

Pay close attention to carburetor heat. Basically, as long as it is in the green there's no problem. However, see what the Dash One says for your aircraft.

For aircraft in flight the most serious winter problems result from engine and structural icing. The important thing is the prevention of ice formation rather than removal of ice once it has formed. Known icing conditions should be avoided whenever possible. Don't be chintzy about getting an altitude change — quickly.

At this point it's a bit late to worry about your supply of de-icing fluid. You should have checked that back on the ground.

Jet aircraft can get into serious trouble if ice forms on the intake, breaks off and is ingested into the engine. We had several cases of that last winter with tragic

results. And we still haven't licked the problem of ice in the pitot-static system. Vigilance and the judicious use of heat is necessary. However, if ice should render the system inoperable there's an old trick that might help. Break the glass in the instruments affected for an alternate static source. This will give at least an approximate indication.

Careful planning is essential prior to winter flight. Many an airplane has been lost on the ground, many miles back, because careful attention was not paid to the details of planning for emergencies. During adverse winter weather almost every emergency is a compound emergency. Loss of a generator may require minimizing the electrical load and repositioning of circuit selectors to continue de-icing. Loss of one engine often means loss of accessories such as generators, alternators and hydraulic pumps. Preservation of wing and tail heat capability may be necessary. Habitual use of heating units in "start" or "low" position should not be a deterrent to the use of "high" position when there is reason to suspect moderate to heavy icing.

Just a word on propeller de-icing. The fluid level and condition of both fluid and electrical systems should be checked on the ground. When the pump is turned on it should first be positioned in "high". Otherwise there might not be enough voltage to get it going. After a minute or two adjust it as required. Have the engineer keep an eye on the tank. This is mentioned because a bird crash-landed last winter with the de-ice tank empty. There was a good supply of the stuff in the cabin but it didn't help much *there.*

Approach and landing problems can be pretty sticky. For several reasons — fog, blowing snow, soot, smoke — the visibility may be poor, the runway and taxiways may be as slick as greased pigs, and ice can be particularly nasty. Watch for carburetor ice — this is no place to lose one or maybe all of the engines. Any ice that may have formed on jet engine intakes frequently will begin to melt at lower altitudes and pieces can fly back into the engine. And freezing rain! If there's any of that around, the pilot should know about it and take appropriate action, like go to his alternate.

This is a good place to get in a word about passing the word. This concerns weathermen and controllers. Hazardous conditions, such as freezing rain, must be passed promptly from WX to the tower or approach control. Needless to say, those gents had better get the message to the pilot, especially if he is in the landing phase. The November issue of Aerospace Safety contained a picture of a T-33 with iced windshield. Notice that the aircraft is lying on its belly after a crash landing.

As for landing and taxiing, just this. Don't get trapped, as more than one crew has, by landing on a runway that is shorter and narrower because of snow banks. Be very cautious on the ground. Taxiway widths are often reduced when there is snow on the ground. Overhanging jet pods and propellers may not clear — this is especially true at bases used primarily for smaller aircraft. Finally, it might be wise to clear the runway, shutdown and have 'er towed to the ramp.

Now a word about personal equipment. Take a long look at the terrain along your planned flight route and dress accordingly, Replace those gloves your fingers poke through, sew up the holes in that flying suit. Jet fighter pilots usually fly pretty well equipped because of the high altitudes they encounter. Troops flying transports are apt to be lulled by a cozy cockpit.

Passengers can be a problem. Make sure they are carrying equipment that would enable them to survive any place where you might be forced down. The records show far too many cases of crewmembers and passengers surviving cold weather situations by luck alone. Other records cover those who didn't have that kind of luck.

Some people may be fooled by the warm climate at their base. The southwestern states can be warm all winter. But there are a lot of places where within 10 minutes you can be in real arctic type trouble if you have to go down.

These are some of the high spots. The material came from many sources, pretty reliable sources because they speak from bitter experience. Heed what they say and you'll have a good chance of being around when that red line on the thermometer is a lot longer than it is now. ★

A large Air Force aircraft on final for a touch and go (intended), landed gear up at an international airport. For a more basic reminder of this recurring problem, we present . . .

FEET OUT!

"MYRTLE, look at that!" Myrtle had to flap her wings to keep her balance as she twisted quickly on the piling. There was an alarming urgency in the command of the pelican next to her.

"Look at what?" The airfield looked like it always did.

"That airplane, the big one coming down there. See, no feet."

"Gracious me. That's really going to smart. Maybe he's just going to take a close look."

"I don't think so. Usually they have their feet down, then fold them up after they have looked and start to go."

"He'd better . . . he'd . . . Oh Clara, did you ever see such sparks?"

Both birds clutched their wings tightly across their ample bosoms in sympathetic misery as the huge, four-engine transport slid to a smoking stop on its belly.

When the smoke had begun to dissipate and the noise had died out, Clara said, "I think that is the most horrible sound I've ever heard."

"You know it must hurt," Myrtle agreed, tenderly massaging the forward, upper section of her torso, "I can't think of a more delicate area."

"Ya know, Myrtle, I can't understand it. I saw the same thing happen a couple times before, and I understand it happens all the time. I'd think they'd learn some day. When I was little and just learning to fly, my mother took me over to a fenced-in area where they store their broken ones. She showed me what can happen when the men forget to put the feet down on those things. I tell you Myrtle, the whole underside was ripped to pieces on some. Another thing, the other night I was perched out at the end of the dock and this salesman fellow dropped in beside me. We got to talking and he said he saw one, smaller than the one out there, that only got the front foot down. They must have known it, or wanted to give the poor guy a real thrill, cause they put that foamy stuff down where he was going to light and he slid more than two miles—just on his front foot and his belly. Can you imagine that?"

"I can hardly believe that. This salesman fellow. Was he —"

"Oh, he swore it was true. He had quite a line though. Along about midnight I told him I was getting sleepy and asked him if he planned to talk all night or did he have a bit of romance in mind."

"You didn't! Clara, you're a devil. What happened?"

"Well, nothing—really. I must have really shocked him. He flat fell off the piling."

"But did . . ."

"Myrt, don't be an idiot. A sopping wet, shivering pelican is about the most unromantic sight I can think of." She took another look over where trucks had gathered around the big airplane that rested on its belly. "That foam stuff they put down there," she hitched a wing toward the wreck, "I have a bruised spot where a mackeral flipped me the other day. Do you suppose it

Major T. J. Slaybaugh

would be any good?"

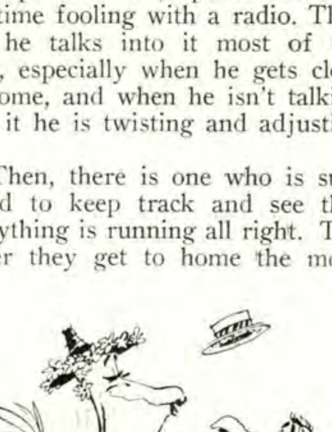
"Naw, I scooped up a sample one day. It tastes horrible, and isn't even cold."

Both birds were silent a few moments, reflecting, then Myrt said, "You know, those men are not near as smart as they'd like us to believe. I understand they have horns that blow and lights that shine red when they come in and forget to put their feet down. Some places they have a guy in a little glass trailer to watch for things like that."

"Yes, I don't understand it either. A big plane like that must have more than one man to keep track of things."

"Oh, they do, they do. But they get so busy doing other things they just forget about their feet. I understand that one of them, one who sits up front too, spends most of his time fooling with a radio. They say he talks into it most of the time, especially when he gets close to home, and when he isn't talking into it he is twisting and adjusting it.

"Then, there is one who is supposed to keep track and see that everything is running all right. The closer they get to home the more



and more he reads out of a little book. And he only reads a word or two, then waits for one of the guys up front to answer him. A fella told me that there is stuff in this little book about putting the feet out and pulling the feet in, but that sometimes they get so busy, or so interested in other things that they skip some of the reading. Also, they can read everything, get an answer, but still not do what the little book says."

"It's beyond me," Myrt shook her head in sympathy, then noted a 10 incher close by and said,

"'Scuse me, back in a moment." She made two flaps, tucked her wings, streamlined the ungainly body and dove. In a moment she was back, munching.

"Good one?" Clara asked.

"Not bad," Myrtle gulped once, "Fins were a little sharp, but not bad."

"You know," Clara went on, "what we were talking about—I don't see how they can do it. I just can't spread my wings and lean back without my feet come out. It's automatic. I don't see why they don't come up with an airplane that does the same thing. They'd ought to protect their men; I'm sure it would save them an awful lot."

"It's hopeless," Myrt said. "Soon as they figure out something new, one of them figures out a way to get around it. Guys who have forgot have said that they couldn't hear that a guy was yelling over the radio to warn them because the horn was blowing so loud. Then there was one case where they put a paper cup over the red light 'cause it glared in the cockpit. That one was even bigger than that three-tailed belly scraper they have out there, I understand."

"Maybe, when you're young," Clara was trying to puzzle it out. "But we only had one case of that kind I remember of."

"No, that doesn't seem to make any difference. New ones do it, and they had one guy with over 10,000 hours."

"Do tell! Do you think they'll *ever* get onto it?"

"Not without they fasten their feet down like they used to be when they first started. They're too stubborn. They have to go on to the next thing before they perfect what they're doing now. You know, not too long ago I was down on the east coast and saw a guy crawl into the top of one of them big skyrockets they have down there. I thought maybe he was going to fix something and you know what, while he was in there, some guys down below lit that thing. I tell you," Myrtle was getting excited and nearly knocked Clara off the next piling with a gesture of her right wing, "that thing really took out of there, belching smoke and flame and making seven kinds of thunder—all with that poor guy inside. Well, it scared me so I just took out to sea, even faster than last year on the first day of goose season. Anyway, a few minutes later I was out there, flapping around and trying to get calmed down, when down comes the nose section of this thing, hanging by a parachute, and with this poor guy inside. Of course, he splashed into that old ocean. Well, I hung around, he climbed out, and in a little while one of those big gnats of theirs came by and fished him out. Then another one came by and pulled out the nose part. Clara, I swooped down for a look, and guess what. It's a good thing he went into the water because that one didn't even have any feet."

Clara got ready to wing off.

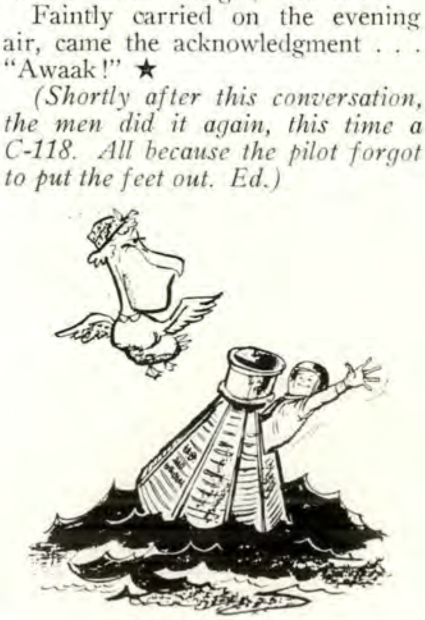
"Where you goin?" Myrtle asked.

"That's the tallest story I've heard yet. I think I'll go back out to the end of the dock just in case that salesman fellow passes by again this evening. His line is easier to swallow than yours." Clara winged off her roost.

"Have a good trip," Myrtle called. "Don't forget, feet out!"

Faintly carried on the evening air, came the acknowledgment . . . "Awaak!" ★

(Shortly after this conversation, the men did it again, this time a C-118. All because the pilot forgot to put the feet out. Ed.)



WELL DONE

★

CAPTAIN WILBERT ROGERS

★

CAPTAIN WILBERT S. ROGERS, Flight Test Engineer for the Director of Maintenance, Middletown Air Materiel Area, took off in an F-101 from Olmsted Air Force Base on a functional test flight in the late morning 10 April.

At 3500 feet, in a shallow right climbing turn, afterburners off and 450 KIAS, the aircraft suddenly pitched down violently and the stick stiffened forward of neutral position requiring some 50 to 60 pounds of force rearward to restore the aircraft to climb.

While exerting force on the stick to keep the nose up, Capt Rogers abruptly found the force was no longer required and that the aircraft had entered a buffet and a near pitchup condition. Using both hands, he forced the stick full forward to get out of the pitch-up boundary. Regaining control and in a climb at 6000 feet and 300 knots indicated, he again encountered pitchdown with similar conditions, including horn, buffet and near pitchup.

Capt Rogers said the force during pitchdown was as though the AFCS had cut in and during recovery had suddenly released causing conversion of the rearward stick forces to a near pitchup condition. (The AFCS and pitch inhibitor switches were OFF and remained OFF throughout the flight.)

At 8000 feet, with 280 knots indicated, another pitchdown occurred, this time less violent and less difficult to control, however, the aircraft slipped into the horn boundary. Again both hands were required to force the stick to avoid a nose up condition.

At 9000 feet, 250 knots clean seemed to be the optimum airspeed since the aircraft responded normally for several minutes at this altitude and configuration.

Electing to attempt a landing, Capt Rogers restricted stick movements to a minimum, lowered landing gear and flaps, and began a gradual descent toward Runway 31 from about nine miles out. He maintained 250 KIAS on final approach, controlling the pitch with throttles. Landing was made without further incident.

Cause of the incident was determined to be water contamination of the AFCS summing network which caused arcing of several pins. This, in turn, caused the stabilator portion of the AFCS to be activated, calling for nose-down attitude. Because of the nature of the malfunction, the emergency AC release on the stick and the AFCS circuit breaker did not eliminate the nose down pitch encounters.

This is one of the few instances in which bailout did not result when this condition developed. Capt Rogers demonstrated superb airmanship and knowledge of the aircraft. His outstanding performance saved the USAF a valuable first-line aircraft and possibly, his life. WELL DONE! ★

Aircrews are trained in the use of their escape equipment — up to a point. In physiological training you are taught how the equipment works and how to use it. If your aircraft is equipped with an ejection seat you are taught the use of the zero second lanyard and the lap belt key, where the handles that operate the system are located and how to activate them. You are taught how to get out of the seat, if you don't have a seat-man separator. From there on you're on your own. Let's take you there and see if we can get you down to the ground and free of your parachute unbent and ready for what comes next.

BODY CONTROL

Upon separation from the ejection seat, or after bailing out, an inexperienced person will invariably tense up which will cause him to flip onto his back and go into a spin. Since the buttock area is the body's center of gravity he will fall face up with a rate of spin depending upon whether an arm or leg is out of balance. It is possible to spin at a rate of up to three revolutions per second within 2000 feet. This is fast enough to possibly cause brain damage and, at the very least, cause you to red out and be unable to untangle yourself from the parachute lines and canopy in the event you become entangled upon opening. Entanglement with suspension lines or parachute canopy may result in broken arms or legs.

To get out of this flat spin position, arch your back hard and spread your arms and legs wide. This will flip you over and you will fall in a stable position face down. Study the sequence on this page. In this position you can obtain horizontal movement by pulling your arms back into a delta configuration. This increases your vertical speed so return to the flat, stable position prior to pulling the ripcord or before automatic opener activates.

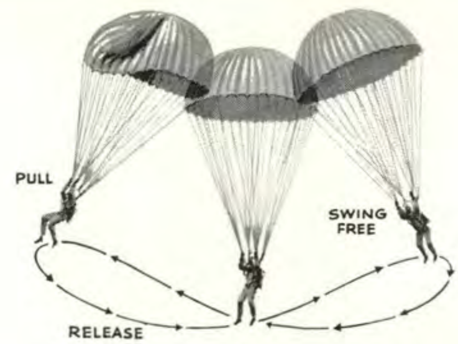
If you cannot obtain this flat stable position, put your feet together tightly, cross your arms over your chest with the right hand grasping the ripcord. Tuck your chin into your chest, bend at the waist and relax. This will reduce the viciousness of the spin. If you are spinning rapidly and feel that your are going to red out, pull the ripcord. Better to open high than take a chance on wrapping up in your lines and canopy. When you pull the ripcord, pull it fast and hard and completely out of the ripcord housing. Use both hands.

fall safe

James C. Hall, Para Ventures Inc., Elsinore, Calif.

THE OPENING

After the opening shock, look up and check the condition of your canopy. If you have a suspension line or a group of lines over the canopy, grasp the offending lines and shake them off. In the rare instance when the line stays over the canopy, cut the line with your survival knife. It is possible to cut as many as three adjacent suspension lines without appreciably increasing your rate of descent.



Checking Oscillations:

Oscillations should be checked by pulling or pumping the front risers. If a two riser slip is used to check oscillations it should be held only when the jumper is in the forward half of the arc—the slip actually helps increase the oscillation if held through the backward part of the arc. Each forward slip should be gradually released as you swing back through the center of the arc since a sudden release of the slip will also increase the oscillation. Two riser slips are best applied at the very moment you are stationary at the forward most part of the arc since your body is at rest and both the jetting of air out the back of the canopy and the off-center position of the body during the slip tend to retard the force of the oscillation. Another method

THE LANDING

CANOPY CONTROL

of checking oscillation is to pull one front and one back riser. While this allows you to work against both ends of the arc, a one riser slip, even when done twice as often as a regular two hand slip, cannot jet as much air or, therefore, exert as much force. It is essential to stop oscillations as soon as they start. Usually, two hand front riser pumping is used to stop the slips that have just begun. This pumping should be done *at the forward part of the arc*. The thing to remember is that the greater the oscillations the longer it takes to dampen them, and the most important thing is to have no oscillations during the landing.

Guiding the Chute!

One riser dumping slips are used to lose excess altitude to keep from drifting off a given area. The rapid spiraling of the jumper during the dumping slip usually causes the jumper to give up the slip after a thousand feet or so of descent. These slips are made by climbing hand over hand up either front riser until you are hanging on to the lines three or four arm lengths above the connector links. These dumping slips should be released gradually hand over hand and extreme care must be taken so that slack lines do not catch on part of the jumper or his equipment during the release.

Dumping slips are usually used between 2000 and 1000 feet above the ground. Above 2000 feet it is difficult to tell your exact drift and releasing a dumping slip below 1000 feet is dangerous as it might not allow the jumper enough time to untangle any snaps encountered during the release or to check oscillations before landing.

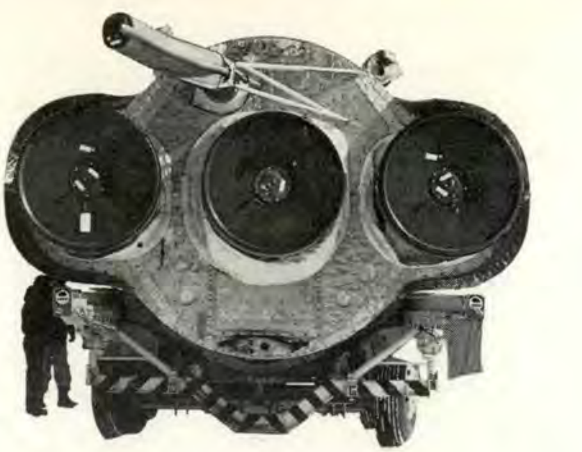
Right and left hand turns of the canopy are made simply by making milder dumping slips, usually one arm length into the lines above the connector links. The right riser is climbed for a right turn and the left riser for a left turn. On a turning slip the jumper simply climbs to the desired height on the lines and then hangs on until the turn (spiral) starts. When he has spiralled around to the desired direction he simply lets go and then uses shorter one riser slips to maintain heading.

Landing requires both a good landing position of the jumper and a good landing attitude of the parachute canopy. Just how good your landing will be is usually dependent upon whether your canopy is neutralized (not oscillating). Any crewman can take the normal landing shock when the canopy is fully inflated and descending at the rate of 19 or 20 feet per second. Broken bones occur when the crewman lands on an oscillation without the benefit of a full canopy.

Assume landing position at tree-top level or about 50 feet above the ground. Feet and knees are held tightly together. Don't look at the ground. Look straight ahead until you touch down. The initial contact with the ground should be made on the balls of the feet. Keep knees and hips unlocked and roll toward the parachute drift on contact with the ground. Hands should be well up on the risers to avoid contact with the ground by the elbows. Keep your body muscles tense enough to absorb the hardest part of the landing shock. If there is any wind blowing activate a canopy release. Do not attempt to run around the canopy to collapse it.

Try to land facing obliquely upwind at an angle of 45 degrees to your right or left. This will allow you to take the landing shock on the leg, trunk and shoulder muscles and not on the bone structure.

If you land in wind immediately roll over on your back. If you are jumping a parachute with one canopy release, grasp the left set of risers with the left hand pulling down to take some of the force off the male canopy release fitting. With the right hand pull the safety clip out and down. Squeeze both buttons inward and rotate latch arm out and down. Release left riser group with left hand.



Speed with SAFETY

Adapted from a Speech by Maj Gen W. Austin Davis, Commander, Ballistic Systems Division, AFSC, to the 2nd BSD Safety Symposium at Hill AFB, Utah, 17 October 1962.

THE IMPORTANCE of an effective safety program to our ballistic systems mission cannot be overestimated. Accidents — and the latent potential for accidents within our weapon systems — can cost us irreplaceable human lives, resources and time which we cannot afford to lose. They can also jeopardize the operational effectiveness of our Strategic Air Command.

We are now entering upon a phase of the missile program in which safety considerations become even more important than in the past. All of the sites now being activated are hardened bases presenting the multiple difficulties and hazards of silo work. Both money and time are becoming increasingly tight. We have virtually no latitude in either to compensate for the disruptions to programming which result from accidents.

At the same time, we must not permit the urgency of our deadlines to pressure us into dangerous short-cuts in our safety program. To do so would cost us human lives and resources. General LeMay himself has stressed the fact that safety is not to be compromised to meet turnover schedules.

I do not think that we must sacrifice *either* safety *or* timely delivery schedules. If something has to give, it must be management; we must give our utmost management skill to attaining the dual objective of *speed with safety*.

Last June we held a Safety Symposium. The records indicate that a good job was done at that meeting in breaking out the areas requiring major concentration of effort, and outlining approaches to remedial action. Measures that have since been taken to strengthen the safety program are a promising indication of what can be accomplished by a concerted attack on safety problems. Some of these measures are:

- BSD Exhibit 62-41, System Safety Engineering: General Specification for the Development of Air Force Ballistic Missile Systems. Originally issued in April 1962, it has been revised in light of experience gained and to bring the exhibit into consonance with the proposed military standard.
- When placed on new contracts, Exhibit 62-41 provides necessary machinery for effective management of safety engineering activities from conception to completion of a weapon system. The purpose and application of the exhibit have been discussed with contractors and briefings on the requirements of the new exhibit are being given each contractor in the MMRBM program.
- Many BSD contractors have revised their safety organizations and safety programs to more adequately fulfill safety engineering requirements. These changes were made because of apparent difficulties in meeting BSD safety engineering requirements.

We must be constantly aware of the fact that safety begins on the drawing board. If it is not designed into a weapon system, no subsequent complex safety regulations, no amount of painstaking safety policing can wholly compensate for the vulnerability inherent in the system. If our design is predicated upon unrealistic requirements for operational caution and safety procedures, we are playing Russian Roulette with the future safety of a weapon system. Sooner or later the human operator will come along whose mind is not yet sufficiently disengaged from a quarrel with his wife, a traffic accident, or tax worries to remember paragraph 15 of the regulation or step 12 of the safety procedure.

If we have to buttress a development with over-elaborate safety precautions and complex and critical safety operating procedures that invite human fallibility, we should question it seriously. We probably have not wrung out the basic design sufficiently. No matter how highly automated these systems may be, they are still, in the ultimate sense, manned systems. We *must* be realistic in designing into them an absolute minimum of susceptibility to human error.

We are now, of course, far down the road from the initial design phase in all of the systems except the MMRBM, but the principle of *designing for safety* still applies to development re-design and retrofit. The rapid technological evolution of the ballistic systems presents a constant requirement for some degree of design adjustment and revision. In accomplishing these we must be alert to give safety factors their full weight of importance.

In our Air Force safety approach we are attempting to get at this "root of the matter" in a number of ways. We are including Safety Exhibit 62-41 on new contracts to drive home the importance of organizing and designing safety into the weapon systems. Design proposals are being evaluated in part on a basis of programmed application of safety engineering, organization and management. Where applicable, safety considerations will have a definite bearing on future source selections.

At the same time that we are bearing down on the design and development factors in weapon system safety, we must also intensify our emphasis on the human factor. The high rate of personnel error which has contributed to the accident record to date indicates the need for better training and safety discipline of our people. Regardless of our degree of success in safety design of these advanced weapon systems, we are never going to achieve the pushbutton simplicity of operation and maintenance which was optimistically envisioned by some when the missiles were still pretty much of an unknown quantity.

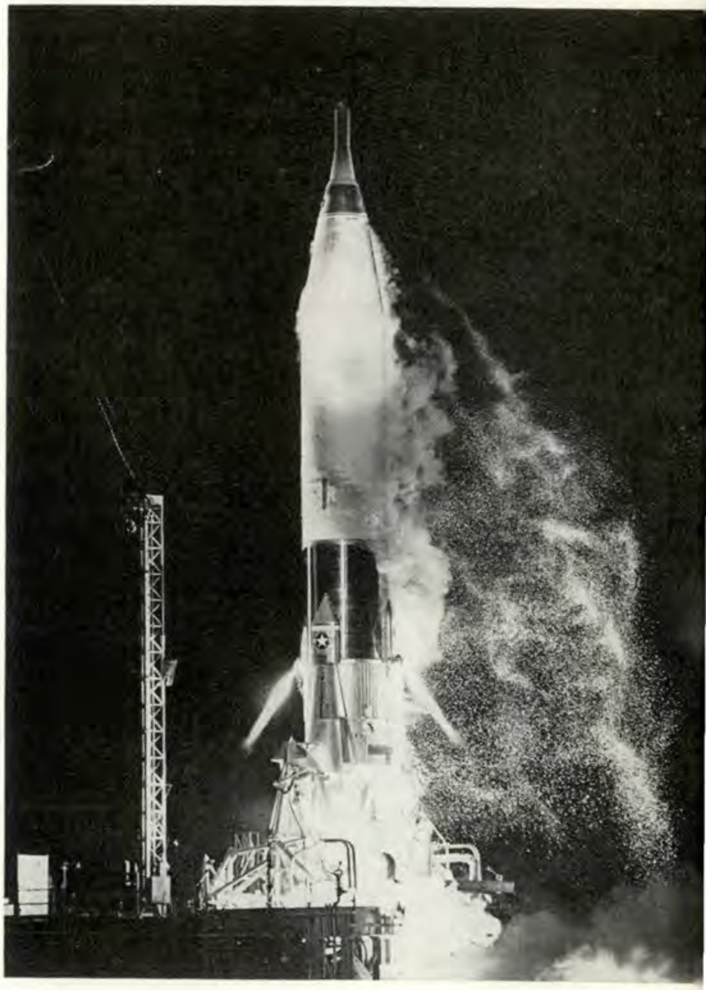
On the contrary, we need the most intelligent and skilled people we can get, and we must make certain that our safety training and discipline become an integral, inseparable element of their working skills. The *regulations* must be converted to *reflexes* if we are to reduce personnel errors to the lowest incidence humanly possible. Here again, let's put our primary reliance upon positive training of the individual, rather than complicated policing routines. An effective safety check system is essential, but the best preventive safety discipline consists of the conditioned reflexes of the individual himself.

One final point should be stressed with respect to our whole safety program. We are interested in maximum results with a minimum burden of administrative paper, procedures, time and expense. An accident-free record will speak more loudly for a contractor than reams of generalized safety reports or the fanciest safety organization. One aspect of management responsibility—and gauge of real effectiveness—is to be able to keep safety operations in proper perspective for a well-balanced program and at the same time get results.

Some paperwork is vital to progress on our safety problems. Reporting aimed at the correction of potential hazards, and after-the-fact feedback on the causes of accidents which do occur, must be correlated, analyzed and studied if we are to forestall recurrence of similar situations throughout our missile program. The clearer the accident profile available to us, the better we can focus our safety management for corrective action. I trust that top management will give this kind of feedback reporting its personal attention and full support. Such information is invaluable to us in learning the evolving safety requirements of our ballistic systems.

We have before us now a formidable task in completing development and test of the big missiles and fielding the preponderance of our intercontinental missile force. In spite of the fact that we do now have a rapidly growing force of operational weapons, we are still in the Freshman year of acquiring our total programmed missile strength. We have neither the time nor the resources for accidents, and we must insure that the weapon systems turned over to the Strategic Air Command are as reliably safe as our all-out, concerted Air Force-Industry efforts can make them. Our success in this will be a material factor in the effectiveness of our operational missile units.

A shower of ice crystals cascades from a super-cooled airframe of an Atlas missile. Complex missile systems require built-in safety features.



As I visit the sites, I shall be particularly alert for indications of an improved, applied safety program which can make 1963 the safest year yet in our racing build-up of deterrent missile power. ★

To find out what caused the accident, skilled investigators probed every conceivable cause factor in minute detail, and didn't discount a single one until it had been positively . . .

RULED OUT

WE HAD JUST COMPLETED TEN DAYS of intensive investigation to determine the cause of an accident that had resulted in the destruction of a 3½ million dollar first-line aircraft and fatal injuries to all on board. Ten days of working 16 to 18 hours a day—10 days of grueling search by 25 experts and specialists, amidst charred wreckage, bits and pieces strewn in thick forest underbrush on the side of a mountain. We were searching for a single clue which could possibly have explained why the aircraft crashed into a mountain at approximately half the indicated minimum altitude. This was the crux of the problem. If we could explain this, we could take necessary corrective action to preclude recurrence.

THE PRIMARY CAUSE: As stated in AFM 62-5, all accidents are the result of a sequence of events and a combination of factors; however, there can be only one primary cause. That is the one factor which made the accident most likely or inevitable. This is the unrelenting task of the board—to find this one factor.

Now, how does an investigator or a board do this? Suppose you follow through the investigation of this accident. By doing so you should gain some insight as to how investigations are conducted and also be apprised of the lessons to be learned from this tragedy—lessons, if applied, that should prevent similar accidents in the future.

The president convened the board and each individual was assigned to a working group with specific instructions on the conduct of the investigation. The board president briefed the other members and, to make it crystal clear, he reiterated that our sole purpose was to find the cause of this accident so that recurrence could be prevented.

As advisor, it was my job to bring everyone up to date on the available facts and circumstances involved and to guide the investigation to its ultimate goal—to identify the cause. We started with the facts—in this case only one fact—that the aircraft crashed on the side of a mountain at about half the prescribed minimum altitude.

I briefed the board members—"We'll start on the premise that the pilot flew the aircraft as required. That some factor, still unknown, forced the aircraft to descend. Find the factor. Locate, test, examine, inspect and tear down every component that could have caused uncontrolled flight, or forced the aircraft to descend below 8000 feet—engines, flight controls, etc."

Early the following morning, 16 officers of the board, an equal number of NCO and airmen specialists, three experts from the manufacturer, a surveying team and photographers arrived at the crash site to begin their search for a single clue amidst the strewn wreckage. A five-man team of experts from the prime AMA and a tear down expert from the engine AMA joined us later that day. The investigation had begun.

Necessary photographs were taken and we then trekked up and down the mountainside in search of clues, through the wreckage, examining the underbrush, both at the site and for several hundred yards through the forest back along the flight path. The engines were located and major components identified. The impact point was ascertained and marked, and the entire area, including the trees that were clipped by the aircraft while still in flight, was surveyed.

I would like at this time to acknowledge the tremendous support we received from the acting wing commander and the base commander. Without their continued help we never could have done our job.

The base cut a temporary road, several hundred yards long, on the side of the mountain to provide access to the crash site. An around-the-clock operation was established by the board president at field headquarters to remove engines and needed components for subsequent teardown inspection. We had to find what,

Maj. Murray Marks, Director of Safety, 22 Bomb Wg., March AFB, Calif.

Minute examination of engines revealed no internal malfunction or damage prior to impact. All engines were determined to be operating at 80 to 85 per cent at impact.

if anything, failed. We had to isolate the one factor which caused the aircraft to go below the minimum altitude. Once we learned this, we could alert the parent command, the manufacturer, and all users of like equipment so that a fix could be made and future accidents averted.

The reports of detailed and painstaking investigations of even the smallest components began to come in. Our fire and explosion expert and the structures engineer from the prime AMA reported that exhaustive investigations revealed no evidence of inflight fire and/or explosion and that the aircraft was intact upon impact. This possibility of malfunction which could have caused the accident was therefore ruled out.

Next came the report on the engines. Teardown was completed on all engines and revealed: No evidence of malfunction or materiel failure on any of the engine accessories prior to impact. No evidence of oil starvation or impending bearing failure was present. The anti-icing valves were all found in the open position. Measurement of rotational damage indicated all four engines were operating at between 80 to 85 per cent at impact. The possibility of engine failure or power loss which could have caused or contributed to this accident was now also ruled out.

Search on, find the instruments, check all flight control components—the clue must be found.

Fuel samples were recovered from the engines and sent to the laboratory for analysis. Further, samples of fuel from the aircraft and the pit which serviced the aircraft prior to its flight were analyzed with negative results—every detail was being checked out.

The report from our structure and flight controls group was submitted—structural components and skin fragments were carefully examined and analyzed. No evidence of corrosion, fatigue damage or inflight failure was found. No structural components or skin fragments were found in the area along the flight path prior to initial tree impact—corroboration—the aircraft was structurally intact at impact. All trailing edge flap actuator jack screws were carefully examined; flaps were full up at impact. Rudder, rudder balance panels, elevators, and elevator balance panels did not reveal any discrepancies which would have restricted movements of these controls. All 15 link adapter fittings were recovered and no discrepancies found. Controls, stability and trim tabs and associated linkage were recovered, inspected and found to be in operable condition. It was determined that 1.5 units nose left and 0.6 units nose down trim were set in. Six of the spoiler actuators were recovered, inspected and found to be in the fully retracted position. Examination of the ailerons and tabs revealed no discrepancies and indicated zero degrees aileron trim setting. Again corroboration, no evidence of materiel failure or equipment malfunction of the structure or flight controls could be found which could have caused or contributed to this accident. Still another factor ruled out.

Instruments were recovered, but due to impact damage and subsequent washout by rain, black light failed to reveal anything significant. It was, however, determined that the altimeter settings were proper for approach and landing and that the cabin pressure control was set properly. The EPR transducers were recovered and found to be set at 1.82. Company engineers confirmed, therefrom, that the engine speed was approximately 86 per cent for the altitude and atmospheric conditions present. Generators, transformer-rectifier, power-transformer, instrument generator and the stabilizer trim actuator drive unit were recovered, inspected and revealed no malfunction or failure which could have contributed to this accident. More items ruled out.

The TACAN was recovered and found to have been set at the proper channel with the indicator drums frozen and positively identifying the mileage reading. The OMNI was torn down in detail and it was positively established that it was set at the proper frequency for the station on which the penetration was made. The rotating card on the ID-250 (RMI) showed the heading. It was the same as the heading that the aircraft was on at impact as determined by the surveyors.

Components of the pressurization, oxygen and hydraulic systems were recovered, inspected and analyzed. No evidence could be found of malfunction or materiel failure in any of these systems which could have contributed to this accident. Ruled out.

With all of the above reports in, it was time for the board to regroup, consider and analyze the evidence. Detailed and exhaustive search, teardown, inspection, and analysis had eliminated materiel malfunction or failure as a factor which could have caused or contributed to this accident, with the exception of the AN/APN-59 (Search Radar) which investigation revealed had a long history of malfunctions.

Now what? And where do we go from here? The question still remained unanswered. What caused this accident? So, let's review as much of the flight path of the aircraft as we knew it to be in hopes that we could determine whether an operational problem could have caused the pilot to descend below minimum altitude.

The flight path was normal and without deviation from takeoff through arrival over the VOR. Cleared for a VOR/ILS penetration, the aircraft reported "departing high station" and was observed on RAPCON's radar to actually be five NM north of the VOR. Two minutes and nine seconds later, penetration turn was reported at which time it was plotted on radar to be 20 NM from the VOR on the 349 degree radial. The penetration turn should have been initiated at about 15,000 feet and there was no indication that the aircraft was

RULED OUT · *cont.*

not at the proper altitude during the penetration until lost on the radar scope at a point 17 miles from the VOR on the 018 degree radial. The aircraft crashed approximately one minute later, 12 nautical miles from the VOR on the appropriate radial. The surveyor's report revealed that the aircraft was longitudinally level in a six degree right wing low attitude immediately prior to impact.

We also knew that the gear was down, flaps were up and speed brakes down. No evidence of materiel malfunction or failure could be found which could have adversely affected normal flight. Aircraft configuration, power, level flight attitude and the fact that no radio transmission was received to indicate trouble led to the conclusion that the aircraft was under the pilot's positive control throughout the penetration, and that the pilot had flown the aircraft to a level-off altitude nearly 4000 feet lower than the minimum shown on the approach plate. In short, *the aircraft was where the pilot wanted it to be.*

Now the problem was to try to determine the reason why the pilot flew to this point below the prescribed minimum altitude. We discounted materiel considerations. What could we find now which could justify the pilot's action? What other factor could have justified his decision. Search on.

The following possible cause factors were considered and investigated—weight and balance? Verified normal and ruled out. Icing? Weather was conducive, but the anti-icing system was on. Ruled out. Incapacitation of pilot? Both pilots were exceptionally well qualified. If either had trouble, the other could have taken over. The crew was in radio contact with RAPCON and no problem was reported. Ruled out.

Altimeter reading error? Had a 10,000-foot interpretation error been the case, the aircraft would have crashed at a point 3 NM past the penetration turn point. The crash occurred 22 NM past this point. Ruled out.

Altimeter indices set at 10,000 instead of zero? There would have had to be an error in all three altimeters otherwise the difference would have been noted by comparison. In any event, such an error would have been noted, since the first portion of the flight was in VFR conditions and an actual altitude of 13,000 feet would have been readily discernible over the high mountainous terrain en route. Ruled out.

Uncontrollable aircraft attitude? Could the pilot have been in an uncontrollable attitude from which he could not recover? Disorientation seldom occurs to more than one pilot simultaneously and there were two pilots available to the controls. Other pilots reported that only light to moderate turbulence was experienced along the flight path at the time of occurrence. The flight path just prior to and at impact was nearly level. Zero rate of descent and only six degrees right wing low indicated the aircraft was controlled. Engine RPM was 80 to 85 per cent, which is normal for weather penetration and initial level-off at minimum altitude. No erratic course change was observed by the RAPCON controller. No pilot report of any difficulty was received. Uncontrollable aircraft was ruled out.

Reliability of the VOR? Was it possible that the pilot received an indication of false station passage so that he would think he was over the fix and prematurely let down below the minimum altitude? We found that the VOR was fully operational. A flight test conducted after the accident verified reliability on the radials involved in the penetration. Reverse sensing of the station transmitter is not possible due to electronic design. If failure of the aircraft receiver occurred, the alarm flag would have alerted the pilot. Therefore, false station passage indication could not have occurred. Ruled out.

Could the pilot have misinterpreted erratic instrument presentation to cause him to believe he had passed the station and prematurely descend below the minimum altitude. Simple dead reckoning would place the aircraft some distance out from the station. The TACAN distance indication would also substantiate aircraft position. Furthermore, the ARN-14 was not tuned to the ILS, which would be expected after VOR station passage. Misinterpretation by the pilot of false station passage was ruled out.

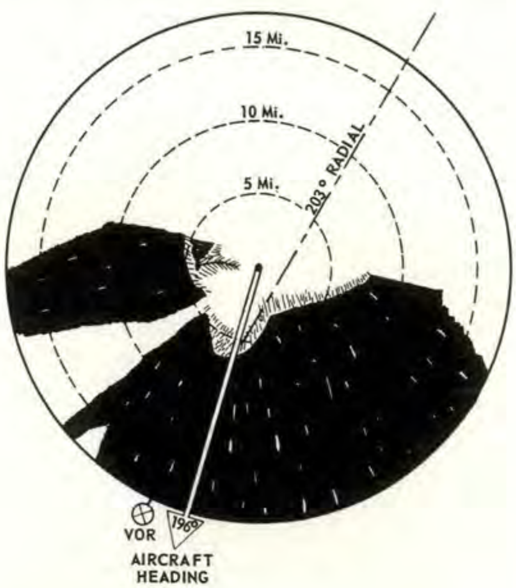
Now that we had reasonably ruled out all external influence which could have caused the pilot to descend below the minimum altitude, what were we left with? By process of elimination, only pilot and crew factors.

Unfamiliarity with the VOR approach? No evidence could be found to indicate that this crew had made a previous penetration on this VOR. It couldn't be determined that the crew had been briefed on the specific plate. That the pilots and the navigator were unfamiliar with the penetration and the approach, and that they had not studied the plate as required in the Dash One was a reasonable deduction in view of the resultant accident. This then became a factor which probably contributed to the accident.

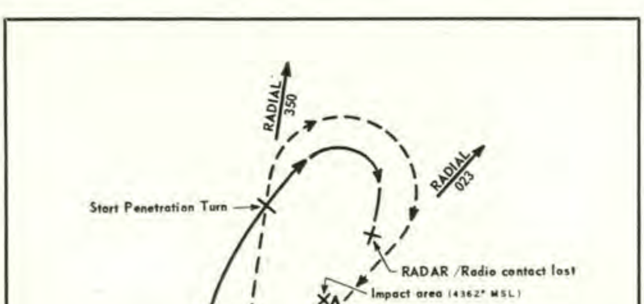
Crew Coordination? The descent below minimum altitude before passing the VOR is prohibited IAW the pattern outlined on the FLIP Terminal Approach Plate. In the absence of any known or suspected factor which would have precluded the pilot from maintaining the proper minimum altitude, had the pilot, other than the one flying the aircraft, or the navigator been monitoring the penetration and complied with their crew duties as outlined in the Dash One, it is conceivable that descent below minimum altitude prior to arriving over the VOR fix would have been averted. Therefore, crew coordination, failure of the pilot and copilot, and specifically the failure of the navigator to perform required duties (calling off altitudes) during penetration became a factor in this accident.

Did They Use a Checklist? Had the descent checklist been used as required with altitude calls and acknowledgment by the pilot, copilot and navigator, it is conceivable that descent below minimum altitude would have been averted. In view of the results, it was reasonable to deduce that the crew had not used a checklist. Therefore, failure to comply with this requirement became a factor which probably contributed to this accident.

What about the AN/APN-59 (search radar)? Radar scope interpretation by a navigator on a subsequent test flight revealed adequate presentation for the navigator to see the mountains during the penetration. Had this aid then been available, it is conceivable that the navigator, in monitoring the flight path, would have observed the mountain peaks or actual position over the ground. It was a reasonable assumption that had this been the case, he would have taken normal corrective action, alerted the pilot, and possibly would have possibly averted the accident. But the accident did happen! Investigation revealed that the equipment installed in this aircraft had a history of numerous and various malfunctions over a period in excess of one year. Since navigator corrective action probably was not taken and reliability of the equipment installed in



Sketch above, observed by test aircraft after crash, shows aircraft radar presentation at point where ground radar lost contact. This is what navigator would have seen on radar scope if search radar in the aircraft was operating. High terrain was apparent. Below, reconstruction of flight path.



this aircraft was questionable, it was conceivable that search radar was not available and therefore became a possible factor which could have contributed to this accident.

* * *

What have we learned from this tragic experience and how can we apply these excessively costly lessons to prevent accidents?

• We learned, as we *all* undoubtedly knew before, that pilots and crewmembers should become completely familiar with the approach plate prior to initiating penetration.

• We learned, as we have learned over and over again from previous accidents, that navigators should monitor the penetrations and approach and call off altitudes as required.

• We learned, what we already knew, that checklists were meant to be used and complied with.

• We learned that to expect quality and reliable performance of airborne equipment, adequate correction of malfunctions and quality maintenance are required.

• We learned, what we already knew, that aircrew discipline is a prerequisite to professionalism and that supervisors must be alert to detect and correct any weakness in this area, no matter how minor it may appear to be.

• We learned that, although not specifically required, had the RAPCON Controller advised the pilot of the minimum level-off altitude on this penetration this accident probably would have been averted. To apply this lesson we have recommended that a communication procedure be established, both FAA and Military, to make this a mandatory requirement.

• We learned that the location of the VOR and the penetration track one-fourth of a mile from a 6000 foot mountain is a flying hazard. To apply this lesson we recommend that all operations and safety personnel critically review their approach plates to insure the best possible penetration track that will provide maximum separation from obstructions.

• We learned that, the physical composition of the FLIP Terminal Area booklet and the presentation of the profiles on the plates can and should be improved. The manner in which the booklet is assembled makes it difficult for the pilot to handle when making a jet penetration. The profiles depicted on the plates do not always indicate a level-off when level-off is required. In many instances the profile indicates a continuous descent, and mountainous terrain is not portrayed. To apply this lesson we recommend that approach plates be labeled both at the top and bottom of the page to preclude misidentification; that the terrain profile be depicted under the penetration track so that terrain features can be readily determined by the pilot; that approach plates clearly depict a level-off flight path in the profile, and that the binding used for this publication be discontinued and a plastic spiral binding be used which will provide for easy folding of the booklet and ease of handling.

Learning from the tragic mistakes of others that resulted in fatal accidents is "Learning the Hard Way." We who investigated this accident did. I trust that you, the readers, have learned too, or were already aware of the lessons above. If we all apply them, WE CAN PREVENT ACCIDENTS. ★

WHEELS BRAKES AND TIRES

Don Stuck, Experimental Test Pilot,

THE THREE ITEMS outlined in the title, coupled together into one integrated unit and hung on the ends of the struts, comprise a package which is taken pretty much for granted, takes a phenomenal amount of punishment in the normal course of events, and can be severely mistreated by a pilot unmindful of the abnormal energy inputs he is capable of making from the cockpit.

Up to this time the problem has generally been to teach pilots to treat tires with the respect which is due, which is no small task in itself. We now have come up with a new problem which, although not caused directly by pilot input, can be aggravated by the pilot. The problem is wheel fatigue failure.

As of this date there have been several instances of failures on Air Force and Navy fighter aircraft. The failures have usually occurred in the hub and bearing area, so it can be easily seen that after the failure the wheel becomes a fairly inefficient "roller."

All interested parties have their heads together to determine what the exact problem is, and what can be done about it from immediate maintenance type action to complete wheel redesign. Until all of this gets worked out, however, it behooves the pilot to learn what the score is and what he can contribute to help ease the situation.

To better understand the problem, let's start from the beginning:

Wheels are designed by a contractor to meet certain MIL-SPEC conditions. Taking numbers from a recent military research and development report, we find that the average fighter aircraft wheels roll 30,000 feet per mission. This six-mile approximate total is broken down as follows:

- 27 per cent taxi out.
- 17 per cent takeoff.
- 25 per cent landing.
- 26 per cent taxi in.
- 5 per cent turning (average 12.7 knots on 73.5 foot radius).

The normal fatigue qual test called out for the wheel is to lab-run it under full gross weight conditions for 1000 miles. Although a wheel passes the qual test requirements for roll life, the design specs do not require rolling of the wheel under side load or high temperature conditions.

In addition, although the normal fighter wheel is supposed to have a service life of about 1000 miles and then be discarded, there is apparently at present no firm universal military practice for keeping track of expended service life.

The modern fighter MLG wheel is either forged aluminum or cast magnesium for strength coupled with light weight. Since the wheel incloses the brake assembly, the heat potential is naturally severe, and the properties of aluminum and magnesium under severe, extended heating periods can change radically.

For example, a qualified aluminum wheel capable of rolling 1000 plus miles under full gross weight conditions loses 33 per cent of its allowable design stress and 60 per cent of its potential fatigue life under operating conditions of 400°F. The same wheel heated to 600°F has lost 85 per cent of its allowable operating stress, whereas heating to 300°F only reduces allowable stress by 18 per cent.

Permanent change to the strength factor of the aluminum or magnesium wheel can occur if heating is applied for extended periods of time.

The aluminum wheel, which lost 18 per cent of its allowable stress when operated at 300°F, is back to normal strength when returned to normal temperature. If the wheel is heated to 400°F and held there for 10 hours, it will have permanently lost 20 per cent of its allowable stress when returned to normal temperature. The same wheel heated to 600°F and held at that temperature for only 30 minutes will suffer a permanent 55 per cent loss of allowable stress when returned to normal temperature.

A lab run of a qualified aluminum wheel included holding it at 475°F for seven hours, cooling it to normal temperature, and then putting it on the 1000-mile treadmill. Cracks appeared when the wheel went 146 miles. It failed at 206 miles.

The examples given are for a forged aluminum wheel, but cast magnesium, such as used on the F-101, can start showing the same type strength degradation under heating in excess of about 350°F. Although the temperature and exposure times in the above lab examples may seem high, keep in mind that temperatures in excess of 500°F have been recorded during extreme

McDonnell Aircraft Corp.

test conditions. In addition, it is a known fact that the wheel and tire temperatures after heavy braking reach a maximum between 15 and 30 minutes after the braking application. Therefore, if a fusible plug blows out on the tire or the tire itself blows after an aborted takeoff, it's anyone's guess as to how high the temperature of the wheel has risen.

The high temperature, half hour exposure, permanent degradation of wheel strength now starts to look pretty realistic and leads you to believe that possibly we should consider scrapping wheels which have been heated to the fuse plug actuation or tire blowing point. This is all part of what is being considered; but what can we do right now?

When we talk of heat, we're naturally talking brakes. If you stop to consider the amount of energy that is involved in stopping the mass represented by a modern fighter such as the F-101 or the F4H, and converting it to heat, you can readily imagine that a lot of heat is manufactured by the brake. This spells out a rehash of proper braking techniques.

Don't fly an aircraft which you suspect has a dragging brake.

Don't ride the brakes.

Don't taxi fast; this requires more than normal use of brakes.

Don't pump the brakes; use steadily increasing pressure to the amount needed, for as long as needed, then get off them.

Use nose steering for directional control.

The other factor in premature wheel failure to be considered by the pilot is side load. Obviously, we can't stop making turns in taiing, but we do have control over how we make the turn. Therefore, for the given number of turns required for a given mission, the pilot, and the pilot only, dictates the amount of side load that is applied to the aircraft.

Let's go back to the lab again to determine what happens under given test side load conditions and then see if we can't reduce this force to "pilot in the cockpit" type parameters.

As we pointed out earlier, the military report which laid out the average fighter aircraft mission stated that the "average" turn is 73.5 feet radius at 12.7 knots. Now how they arrived at that figure I can't say, but in looks pretty realistic, so let's use it as a base point.

It is centrifugal force which gets into the act to cause our side loads around corners. Taking a given side load, speed, and turning radius, note that, if we double our speed, we must increase the radius by a factor of four to stay in the same side load conditions. Therefore, that little bit of speed increase "around the corner" during taxiing can do astronomical things to side loads applied to the wheels and tires, since, at a given radius, the forces increase as a square of the speed increases. The greater the mass, the greater the problem, which means that taxiing out at the higher gross weights is even more critical than taxiing back.

In F-101, F4H, and other aircraft ground-run programs with which I have been associated, I have always been startled at the amount of error between the pilot estimate of taxi speed and the actual speed of the aircraft. I think it can be safely said that the average pilot taxies aircraft at roughly twice the speed that he thinks he does.

Getting back to the lab and the 1000 mile test: a qualified wheel under high takeoff gross weight conditions was placed on the treadmill at the equivalent side load of a 100-foot radius turn at 20 knots. This wheel failed in fatigue after only 21 miles of rolling. This was a severe test and, while it is of course not conclusive, it surely is indicative of what's going on when we try the "hot rod" technique to and from the parking area.

The tire wear and blowout problem shouldn't have to be even mentioned, but let's go through it again anyway.

First and foremost is tire service. Although it isn't expected that pilots should be checking tire pressures before flight, you can check with Maintenance to assure that tires are being pressurized to exact TO figures for the gross weights you are flying. I bring this up only because I personally ran into a maintenance outfit which was purposely under-inflating the tires in an attempt to prevent "chunk losses" on the wearing surface.

There were only two problems—the cause of "chunk losses" was excessive side loads (high speed cornering) and not over inflation, and the excessive rolling flex caused by the under inflated tire was generating so much heat that tires were blowing with great

WHEELS, BRAKES AND TIRES / continued

regularity while taxiing out to takeoff. Inflating the tires properly and enforcing proper taxi speeds "magically" solved both the blowout and chunk loss problems. A lot of study went into those book figures—don't sell them short.

Now to get to the cockpit.

There are several ways to ruin aircraft tires, which incidently cost about $100 each. You, the pilot, again directly control the parameters which can cause this ruin.

Excessive side loads cause abrasive scrubbing and "roll over," which lends itself to losing large chunks if you happen to run over a small sharp stone while under high side load conditions.

Improper use of brakes can cause permanent cumulative deterioration and possible blowout due to heat.

Excessive centrifugal speed. If you check the max design rolling (ground) speed your tires are good for, I venture you'll be surprised. For the F-101 it's a speed between 180 and 217 knots, depending on the tire being used. Those hot landings can hurt here too, in addition to having that much more energy to dissipate in stopping.

We've already gone over the use of brakes and nose gear steering in taxiing, so, if we add the proper techniques to avoid excessive side loads on both the wheels and tires, we can wind it up:

Cut down taxi speeds, as we pointed out earlier; in particular, slow way down before entering a turn.

Make turns as wide as practicable.

Take it especially easy at high gross weights.

When it comes to abnormal punishment for wheels, brakes, and tires, there's nothing like a lousy final approach and landing to really "set the stage."

Take the very familiar 10-30 knots hot on final approach. If you desire to touch down "on speed," you're forced to use a lot of runway to float over to get down to proper touchdown speed. This results in abnormally hard braking to get stopped in the remaining runway, with possible blown tires, and maybe even off the end. The other alternative is to "cram" it on the ground as soon as you get over it. Here you stand a chance of exceeding the design ground speed of the tires, or at the very least, losing a lot more rubber on touchdown than necessary. Then, after we're on the ground, we've got a "few" extra knots to take care of with the brakes. Remember, energy increases as a square of the speed, so that extra 10 or 20 knots isn't "peanuts."

Basic Rehash

Proper final approach and touchdown speed.

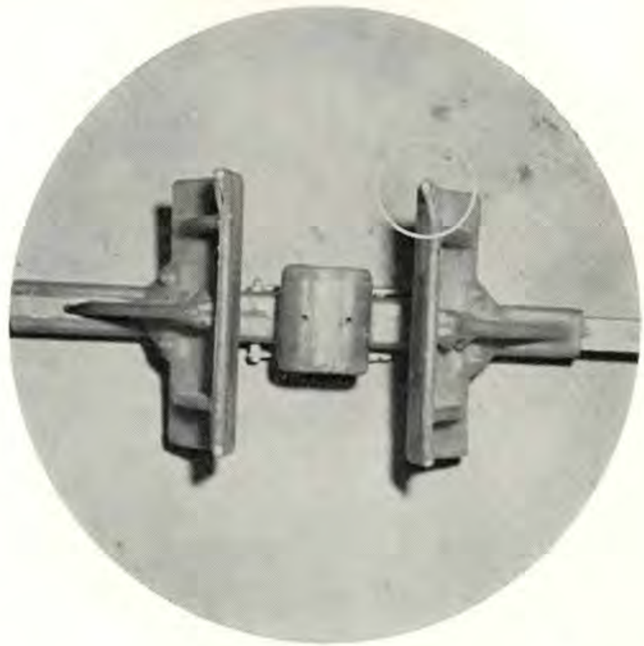
Utilize all drag devices possible to the best advantage. Aerodynamic drag, drag chute, flaps, speed brakes —all help you get slowed down to the speed where wheel braking becomes the most effective way to get the aircraft decelerated.

At proper speed bring the nose gear down and use what braking is needed to get stopped.

It sounds so simple and straight-forward that it hardly seems worth mentioning, but study the taxi, takeoff, and landing techniques of other pilots or other squadrons. Are they treating the wheels, brakes, and tires with the respect due them? Now—how about you? ★

MISSILANEA

AN F-106 AIRCRAFT had returned from a cross-country with a spare drag chute stowed in the armament bay. The aircraft was loaded with GARs and the rails retracted. During pilot preflight, some difficulty was encountered in closing the armament bay doors and the launcher rails had to be cycled down and up a couple of times to get the doors closed. During post-flight after the mission the ground crew discovered that the GAR-3As were damaged and the drag chute was still in the armament bay. A real classic for heads-up-and-locked personnel error.



GAR DAMAGE—From the accompanying photograph, visualize what would happen to the thin-skinned fuselage of a Falcon missile if the handling bar were firmly attached and clamped down. Sure enough! It happened to 14 GARs before the damage was discovered. Four of the GARs were not reparable locally and were shipped back to the depot.

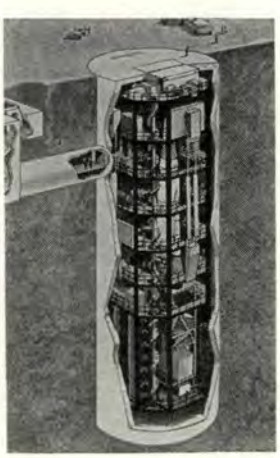
It started when an Alert loading crew member discovered dents in the side of a missile during downloading of a hot bird. The GARs on another "deuce" being downloaded had the same problem. A check of all missiles that had been loaded during the two previous weeks revealed a total of 14 damaged.

Armament personnel determined that the missile damage was caused by defective handling bars. Apparently these bars had been dropped at some time with sufficient force to bend the lower corners. As the locking handle was pulled down to clamp the side plates firmly against the missile fuselage, the skin naturally gave.

A check of all the handling bars in the squadron revealed a total of four with bent corners. On some of the others, the corners were cracked and scratched, showing evidence of rough usage in the past.

The moral: *Check your equipment for serviceability before using it.*

Lt Col Randall L. Earl, DMS



DURING REPLACEMENT OF DESSICANT CYLINDERS on level seven in an Atlas F silo, the crewman left a used cylinder lying unsecured on the grating. The cylinder dropped from level seven to level eight, approximately 50 feet, rebounded and struck a brass fitting in the lower liquid oxygen sampling line which was screwed into the LOX storage tank. The fitting was sheared off, venting the base of the LOX storage tank to the atmosphere. The resulting ⅜-inch hole dumped LOX into the silo sump area. The silo cap doors were opened and the missile placed on stretch. The contractor's field service engineer stopped the flow of LOX by driving a steel taper pin wrapped in teflon into the hole. The locally manufactured taper pin had two eyes welded to the large end. A nylon rope was passed around the tank and fastened through the two eyes to hold the pin in place. The squadron then removed the re-entry vehicle and proceeded with clean-up operations.

This mishap was caused by careless handling of used dessicant cylinders during their replacement and failure to heed precautions in tech orders which point out the necessity of securing loose items while working in and around missile silos. ★

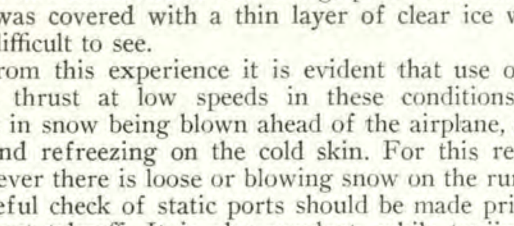
Maj C. W. Flanders, DMS

AEROBITS

REVERSE THRUST IN SNOW. Keep in mind the possibility of ice formation on various parts of the fuselage when reversing on a snow-covered runway. One operator landed on a runway covered with light powdered snow, and used reverse thrust down to about 40 knots. Subsequent airplane inspection revealed all static ports on each side of the fuselage to be covered with a thin coat of clear ice. A large part of the fuselage also was covered with a thin layer of clear ice which was difficult to see.

From this experience it is evident that use of reverse thrust at low speeds in these conditions can result in snow being blown ahead of the airplane, melting and refreezing on the cold skin. For this reason, whenever there is loose or blowing snow on the runway a careful check of static ports should be made prior to the next takeoff. It is also prudent, while taxiing, to avoid placing your airplane in a position where it might be in the path of snow blown by another airplane.

Flight Safety Foundation



FOR WANT OF A PIN — The pilot had returned from a cross-country flight and was parked in front of base operations where the T-33 was to undergo a postflight inspection. The canopy was full up, engine was shut down, wheels chocked, and the cockpit ladder placed in position. According to the pilot, he had installed the seat ejection and seat armrest safety pins, but not the canopy jettison initiator safety pin, which had been lost on an earlier leg of the flight. Now comes the clincher; without waiting for or requesting a pin from the ground crew before debarking, the pilot rose and, facing aft, reached to the starboard side of the seat to remove some stowed items (how many of us T-Bird jocks have done this?). As he lifted a shoe which had wedged over the canopy initiator, the initiator fired. The canopy slammed down on his head, no, I mean the ladder.

Fortunately this pilot was not half way in — half way out of the cockpit, as is usual when performing these little details. In addition he must have been a midget, for he still has his head. If it were me, in this half raised position, I would have been hard put to remove my helmet and head from between my shoulder blades, and I'm no giant.

The T-Bird was pretty well broken up. For the edification of all concerned, here's a partial list of the damage: aileron and elevator torque tube destroyed; hydraulic and access air lines bent; floor well torn and bent; canopy rail destroyed; canopy actuator bracket torn from mounts; canopy actuator chains and sprockets destroyed; forward control stick grip damaged; turtle back cover torn and bent; canopy access plate bent; all canopy equipment damaged or destroyed.

Seems pins come a little expensive nowadays.

Lt Col Anthony S. Cavallo, Editor, Aerospace Acdt & Maint Rev

EXPERIMENTING? This is an account of a flight condition experienced by a pilot flying a '2, that may have its worth:

"While returning from a high altitude target mission (54,000), in an F-102, the aircraft was pulled out of afterburner and allowed to descend to 48,000 feet in AFCS attitude hold. At 48,000 feet the altitude hold was engaged and altitude held positively and firmly at 48,000 feet. The pilot, being an 'experimenter,' pulled the throttle back to idle and watched the speed dissipate from 190 to 90 KIAS with the altitude being held within 40 feet of engaged altitude. In previous minimum slow flight attempts, it was found that at 90 KIAS the elevator control would be against the stops; however, in this case, the airspeed went down to 80 knots.

"As the airspeed went through 80 knots, the AFCS disengaged and the engine went into a series of moderate compressor stalls with the EGT rising slowly. The nose of the aircraft dropped to about 15 degrees below the horizon and started yawing about 30 degrees either side of center with sufficient force to slam the pilot from one canopy rail to the other. Moving stick and rudder to the limits of their travel had no effect whatsoever except to demoralize the pilot. All this time the wings remained almost level and the compressor stalls continued with the EGT staying around 500 degrees. Rate of descent was five to six thousand feet per minute.

"The center of the lateral oscillation moved gradually to the right in such a manner that the aircraft eventually turned about 270 degrees right of initial heading and it felt as though it would either snap roll or go into a spin. At this point I was wishing it would go into any other phenomena with which I was more familiar.

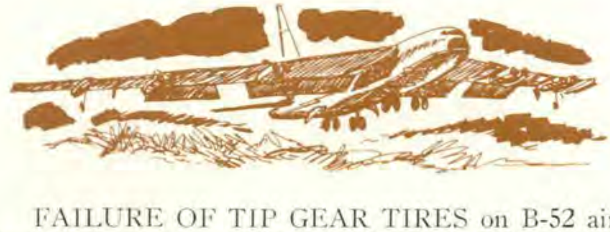
"The yaw damper was alternately turned on and off with no noticeable effect, the stick was held full forward, then full back, rudder was moved so as to counter the yaw, then with the yaw, all to no avail. At this point, serious thought was given to taking the bus home. The engine would not accelerate due to continuing compressor stalls which grew more violent as the throttle was advanced. Somewhere between 25,000 and 30,000, with the stick held full forward and the rudder neutral, the nose gradually began to drop, with what I thought was a tremendous increase in rate of descent and a very slow increase in airspeed. At about 20,000 feet, the engine was nursed to full power and normal flight resumed at 12,000.

"The aircraft was configured with empty external tanks, and missile ballast. Landing gear was up, speed brakes closed. Fuel at start of oscillation was about 1400 pounds, equally divided between the wings. While returning to base, various maneuvers were tried (cautiously) in an attempt to see if the aircraft was improperly rigged. High and low speed turns with and without dampers resulted in normal behavior and buffeting. Visual inspection of the aircraft after landing revealed nothing out of the ordinary."

Since this condition was something this pilot had never before experienced, he naturally had some questions. He wanted to know what caused it and how to handle it. He also wondered if it had ever before been encountered in an F-102 and, if so, felt it should be mentioned in the flight manual.

All the flight tests were conducted at Edwards AFB under controlled conditions. That's how the AF Flight Test Center came up with a recommended minimum airspeed of 125 knots. There is absolutely no requirements to fly the F-102 below the minimum recommended airspeeds. Serious engine damage can occur from compressor stalls. While flight characteristics are *generally* predictable below 125 KIAS, this is no guarantee that the aircraft will do the same thing every time. It's lucky this experiment was not tried in an F-106, as there is a good chance the pilot would have ejected (this actually happened when a troop experimented with an F-106 at below recommended minimum airspeed). Rather expensive experiment, I'd say.

Capt Martin O. Detlie, Defense Br, Fighter Div



FAILURE OF TIP GEAR TIRES on B-52 aircraft during heavy weight crosswind takeoffs has caused three serious incidents during the past year. In two of these, the tire separated from the wheel and the wheel shattered, allowing the axle and tiptank to contact the runway. Fuel poured from the ruptured tiptank and sparks from the dragging strut ignited the fuel on the runway. Fortunately, both aircraft were near decision speed when the difficulty was noted and the pilots continued their takeoff roll.

Loss of fuel from the tiptank did not pose a control problem for either aircraft as fuel transfer procedures were initiated to maintain lateral balance. Both aircraft landed without further difficulty.

Tire failure in the most recent incident occurred at a higher speed and did not result in the tiptank contacting the runway; however, the fairing was damaged and a six-inch crack developed in the tiptank from stresses caused by the loose fairing beating against the tiptank in flight.

Tip gear tire failure appears to be due to excessive loads imposed during heavy weight takeoffs in gusty crosswind conditions with high crown runways aggravating the condition.

Heavy weight crosswind technique should include holding runway centerline with a minimum of heading changes, to prevent tire scrubbing, and raising the downwind wing as soon as possible. Considerable initial control wheel deflection may be required to promptly level a heeled over, downwind wing.

Lt Col Robert P. Rothrock, Bomber Br, DFS

LOSS OF ARTIFICIAL FEEL. The rudder and elevator artificial feel (Q-spring) system on B-52 aircraft has a long-standing reputation for reliability; yet, since a single instance of artificial feel loss can produce structural damage, personnel should be constantly on guard against system problems.

To date, three types of feel loss have occurred intermittently on B-52 aircraft. All three render the artificial feel system inoperative by blocking the ram airflow to the Q-spring mechanisms.

- *The Missing Link.* During fin folding and other maintenance or modification, it is necessary to disconnect the flexible duct spanning the gap between the Q-spring ram air duct in the fin and the Q-spring pressure tubing in the fuselage. Failure to reconnect this ducting will eliminate artificial feel, a loss which may not be discovered until unstick and climbout on the next flight.
- *The Water Trap.* A water trap is produced if the flexible air duct connecting to the Q-spring ram air duct is allowed to sag in a loop during installation. Such a droop permits sizable quantities of water to collect in the flexible ducting where it subsequently freezes to block ram airflow.
- *The Icy Deluge.* Loss of artificial feel is occasionally caused by flight through freezing rain, snow, and similar conditions. In such situations, enough freezing moisture can be ingested to clog the system with ice. Pilots should be alert for feel loss from this source during and for some time after encountering extremely adverse weather conditions.

Two of these conditions can be avoided by careful, conscientious installation of the flexible ducting and fasteners. The third is best parried by avoiding or departing areas of extremely adverse climate conditions when possible.

Should artificial feel be lost from any of the three conditions, it will be apparent through the abnormally light control forces required to move the elevators and rudder. When light forces are encountered, cautiously avoid any abrupt movement of the control column or rudder pedals. If the loss occurs at high airspeed, first reduce speed to normal or slightly below normal cruising airspeed for altitude, then attempt some gentle maneuvers. If aircraft response is normal, it is certain that control remains and only artificial feel has been

. . . AEROBITS

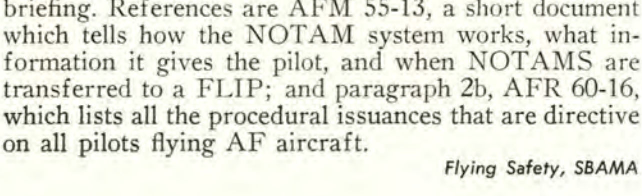
lost. This is not particularly hazardous as long as the remainder of the flight is conducted with care. Avoid rapid control movements and violent maneuvers to prevent overstressing the aircraft.

Boeing Service News—

NOTE NOTAMS — A base safety officer reported that failure to consult the airdrome facility remarks in a FLIP Enroute Supplement resulted in the filing of about 10 flight plans for arrival during the hours an airfield was closed. In fact, the airfield was programmed to be closed for the next several months. Departing under these erroneous plans created operational hazards which could have resulted in serious accidents or incidents.

In the interest of both accident prevention and efficient mission accomplishment, it was recommended that commanders assign required reading at their next briefing. References are AFM 55-13, a short document which tells how the NOTAM system works, what information it gives the pilot, and when NOTAMS are transferred to a FLIP; and paragraph 2b, AFR 60-16, which lists all the procedural issuances that are directive on all pilots flying AF aircraft.

Flying Safety, SBAMA



GROUND RULES? Two years ago in *Aerospace Safety,* Rex Riley asked, "What are your ground rules for acceleration and brake checks? If you have rules, will they prevent a similar incident, and do all pilots know them?" One squadron did not heed Rex's admonition. Let's take a look at the events leading up to the resulting major accident.

Two F-101 pilots had difficulty landing due to wet runway and one of the aircraft rolled into the overrun before coming to a stop. Because of the slippery runway conditions, flying was called off. Maintenance control asked operations for a pilot to perform a taxi check following wheel brake and anti-skid maintenance. The pilot reported to the flight commander whose aircraft had just rolled into the overrun. Taxi and high speed checks were discussed, the flight commander advising the pilot that because of the runway conditions it would be a bad day to use afterburners. Since the pilot did not know what was required or how fast the check should be made, he decided to check with maintenance control and was told that a taxi check only was needed but, to be certain, he should check with the crew chief.

Still uncertain of the requirements, the pilot arrived at the aircraft and asked the flight chief whether a high speed check was required. The reply was that he should taxi at whatever speed was needed to check the system. The brakes and anti-skid were checked at normal taxi speed and found to be operating normally. The pilot then took the runway (13,100 feet) and lit both burners. At approximately 150 kts the throttles were retarded to idle and the drag chute deployed. Aerodynamic braking was used, followed by normal braking. The pilot thought he had slowed down enough to turn off the runway at the end, but the aircraft slid off the runway, collapsing the landing gear.

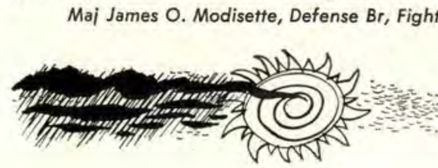
Investigation revealed:

- The tires were satisfactory prior to the skid sequence.
- Both brakes and anti-skid systems were operating normally.
- The pilot did not use the speed boards during deceleration.
- There were no published squadron SOPs on requirements and procedures for taxi checks.

By now you have guessed the accident board's findings: Primary cause — Pilot Factor. Contributory cause — Supervisory Error: a. Responsible operations and maintenance personnel did not monitor and control ground activities involving the taxi check. b. Inadequate procedures. The pilot did not know how to conduct the taxi check even though he made an attempt to obtain the necessary briefing from available operations and maintenance personnel.

Heed Rex Riley's warning. Be sure you have definitive requirements for both taxi checks and high speed checks. Be sure that adequate procedures are established to safely conduct these checks. Again, we ask, "Do your personnel know the ground rules?"

Maj James O. Modisette, Defense Br, Fighter Div, DFS

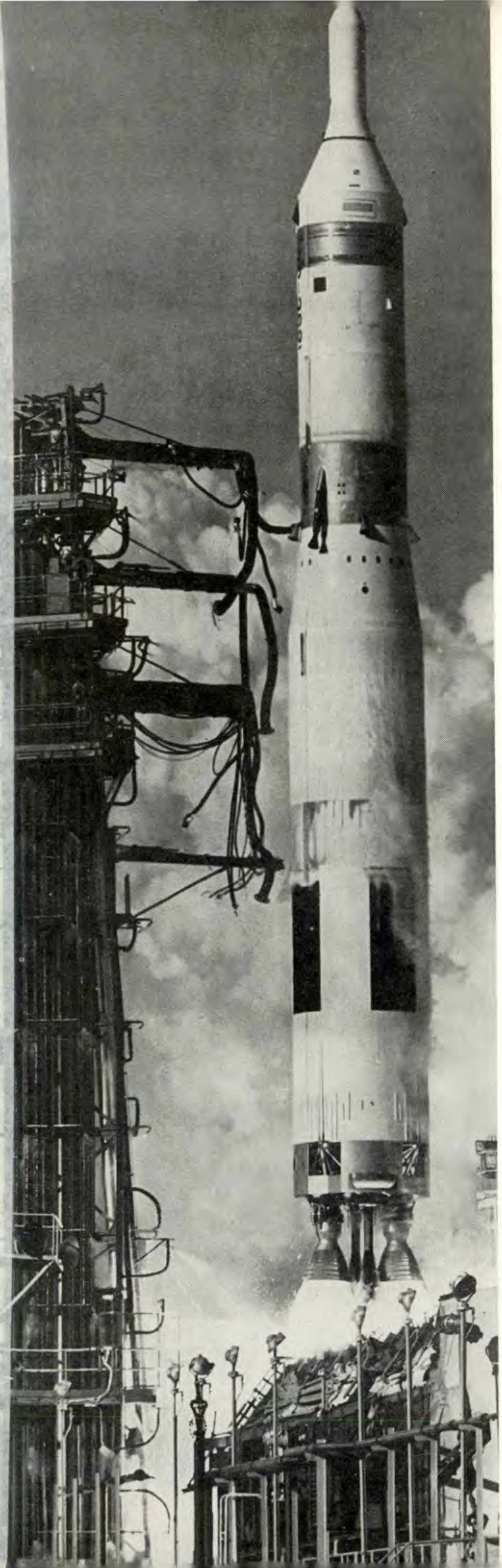


IFR OPERATION IN VFR CONDITIONS is a gray area where midair collisions and near misses are most probable. Under existing Air Force and Civil Air Regulations, you can be IFR on an airway in less than VFR visibility conditions and still have to worry about dodging civil aircraft. They are legally VFR, since VFR visibility restrictions under the CAR are less stringent than those of the Air Force.

An allied false security notion that many pilots have is that an IFR clearance gives them priority and unquestionable rights to a direct and undisturbed approach to an airport. Not so! On an IFR clearance you may find yourself directed to adjust your flight path to enter a traffic pattern in sequence with other arriving flights, both IFR and, weather permitting, VFR.

An important point to remember is that when you are operating in VFR weather, regardless of your clearance, the primary responsibility for avoiding collisions rests on the pilot.

Maj Leo J. Lee, Chief,
Flying Safety Div SBAMA, Norton AFB, Calif.



"PEP" IN '63

Colonel George T. Buck
Director of Missile Safety

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THE PERSONNEL ERROR PREVENTION (PEP) program to be emphasized by missile safety in 1963 will include many components. As in the design of missiles, our design for PEP must be based on sound guidance and principles. To continue the analogy of a missile, the four major elements of our program—engineering, education, evaluation, enforcement—will become the four stages of a missile or space booster.

ENGINEERING will be the first stage of our missile in the research and development phase. Recognizing that "to err is human," the systems, subsystems, and operating ground equipment must be engineered, built and tested to provide *man*-age-ability. Human engineering, life support systems, and sound safety specifications are needed to get the bird off the ground!

EDUCATION, the term broadly applied to the second stage, is a *must* to get the vehicle up to speed. Safety and accident prevention principles will be integrated into the professional and technical training of carefully selected individuals. These courses, together with all the ingredients necessary to develop a professional approach to missile/space operations, will comprise this stage. Without it, the vehicle will not go very far.

EVALUATION, the third stage, consists of standardization, proficiency tests, and constant supervision and surveillance to assure that our vehicle stays on course. Without this stage, our personnel error prevention program will not reach its apogee.

ENFORCEMENT of safety principles by proper command and supervision comprises our fourth and final stage, and is vitally necessary for the program to be error free. Motivation, leadership, job prestige, programs, discipline, investigations are paramount components to insure hitting the target with Personnel Error Prevention — PEP.

The umbilical tower carries program guidance signals, feedback of information, product improvement, EURs and tech data changes, as well as crossfeed of information through command channels.

Based on these four "Es," the stages of our missile, we are planning to elaborate on these subjects throughout 1963 by articles in the Safety Magazines, MSO Kits, and FEEDBACK bulletins. Let's not resign ourselves to the idea that "to err is human," but rather project our plans, programs, and actions to prevent these errors through safety Engineering, Education, Evaluation, and Enforcement. ★

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