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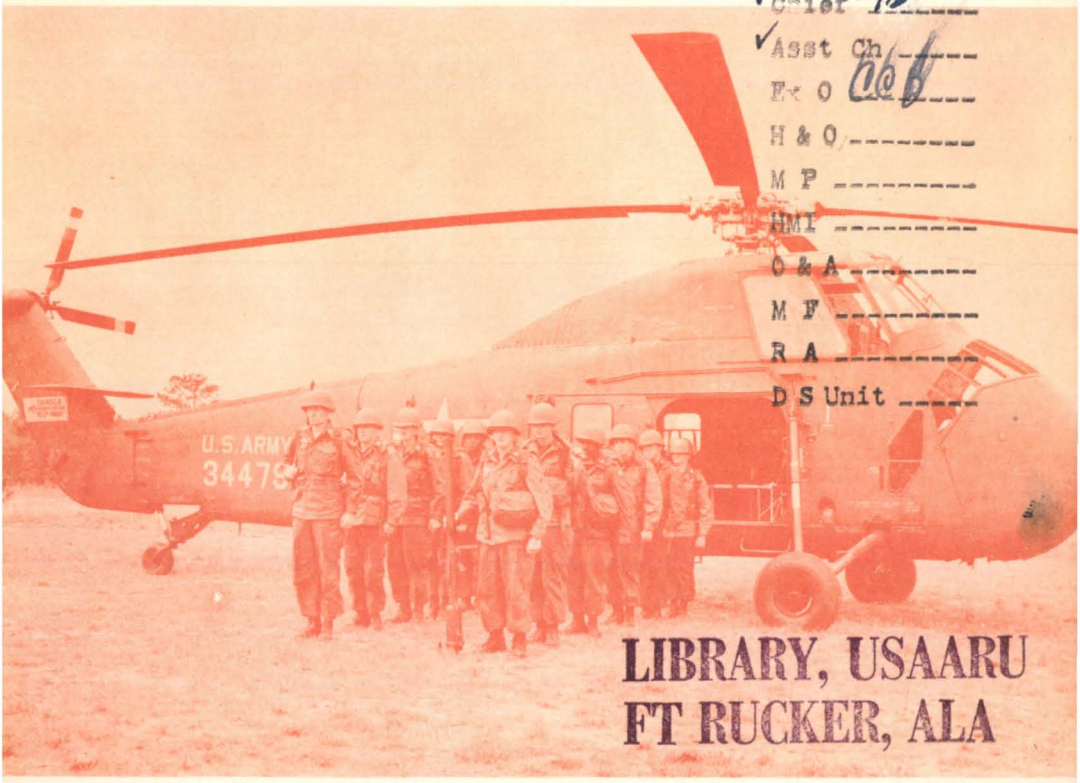

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AUGUST 1955 VOLUME 1 NUMBER 7

ARMY AVIATION SCHOOL

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ARMY AVIATION
DIGEST

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COVER: The H-34, Army troop transport, is an enlarged version of the H-19, featuring all metal 4 bladed rotor systems, folding tail pylon, a Wright 1820-84 engine, wide tread tricycle landing gear, and is in the 100 mile per hour class.

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The printing of this publication has been approved by the Director of the Bureau of the Budget, 13 August 1954.

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Manuscripts, photographs, and other illustrations pertaining to the above subjects of interest to personnel concerned with Army aviation are invited. Direct communication is authorized to: Editor–in–Chief, ARMY AVIATION DIGEST, Army Aviation School, Camp Rucker, Alabama.

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THE COMMANDANT'S COLUMN

Brigadier General Carl I. Hutton, *USA*

The views expressed in this article are the author's and are not necessarily those of the Department of the Army.—The Editor

Imbalance between Firepower and Mobility

This column suggests a method of looking at recent military history in terms of balance between firepower and mobility. It is necessarily generalized and, therefore, may be of limited validity. Nevertheless, the method suggests a line of experimental approach for the immediate future.

Prior to the invention of repeating rifles, machine guns, and rapid fire artillery, mobility and firepower were substantially in balance. Basic military tactics changed slowly and the tactical lessons of military history had continuing applicability. During World War I firepower surged ahead of mobility. This imbalance resulted in the static fronts of that war. The soldier still moved across country at the same rate he had been moving for centuries, but firepower (including the concomitant industrial mobilization) laid down a beaten zone through which he could not advance. He was forced to dig elaborate trench systems to live on the battlefield at all.

In World War II the balance between firepower and mobility was restored momentarily, from the historical view. Tanks, trucks, and dive bombers increased mobility while firepower remained constant and, as a result, there were great movements of armies back and forth across Europe. Rapid and far reaching operations were again possible.

Then at the end of World War II, the explosion of the atomic bomb gave the signal that a new surge had carried

firepower enormously ahead of mobility. There is the prospect that warfare under present conditions would revert to something resembling the static trench warfare of World War I. The possibility of movement would cease under atomic attacks or the threat of such attacks. The soldier would go to earth in deep, protective dugouts.

This suggests that the problem which faces the soldier now is how to rebalance firepower and mobility. Man still walks at about 1½ miles per hour across country, and track-laying vehicles have about the same speed which they had in World War II. The 60 miles per hour tank has not been a decisive factor because the places on the earth's surface where such speed across country is possible are extremely rare.

Really great increases in mobility do not appear possible as long as the fighting vehicle has to move through mountainous terrain, swamps, jungles, rice paddies, and rivers. On the other hand, fighting vehicles which can move through the air are not impeded by accidents of terrain. The pace of the soldier across the earth may be increased a hundred fold, or two or three hundred fold, if he can move in the air above all obstacles. Therefore, if this method of looking at recent military history is valid, we should begin immediate experiments to determine the extent that air fighting mobility will balance atomic firepower.

This is the fifth in a series of columns written by Brigadier General Carl I. Hutton, Commandant of the Army Aviation School, for the ARMY AVIATION DIGEST.—The Editor

HURRICANES

Major Joseph H. Hall, *USAF*

The views expressed in this article are the author's and are not necessarily those of the Department of the Army or of The Army Aviation School.—The Editor

"Because of its great size and intensity, the tropical cyclone, when fully developed, is the most destructive of all storms. Winds of the tornado blow with greater fury but they are confined to a narrow path, 1,000 feet in average width, whereas it is not unusual for the violent winds of the tropical cyclone to cover thousands of square miles.

"Mountainous waves accompany intense tropical storms at sea; their destructive forces are revealed in the appalling record of ships sunk or cast ashore. They cause high tides that inundate low coastal areas. Storm waves break on the shore, in some situations like a wall of water or a series of great waves. Cities and towns have been wiped out, never to be rebuilt. Though borne of the tropics, some of these storms move long distances and occasionally devastate sections far remote from their place of origin. In some of the most severe tropical storms, loss of human life has been estimated at more than fifty thousand and property damage at many millions of dollars."

The above description of a fully developed tropical cyclone was borrowed from the book "Hurricanes," published in 1942 by Ivan Ray Tannerhill, Chief of the Marine Division, U. S. Weather Bureau. It is, in the opinion of this writer, a vivid description of the destructive power of nature's most destructive weather phenomena.

Tropical cyclones have their genesis near, but not directly over, the equator. They form over all tropical oceans except the South Atlantic, but not over the continents. In the western North Pacific Ocean, they are known as typhoons; in the Bay of Bengal and the northern Indian Ocean, as cyclones; in the South Pacific, eastern North Pacific, southern Indian, and North Atlantic Oceans (including the Gulf of Mexico and Caribbean Sea), they are known as hurricanes. Hurricanes of Australia are sometimes called "willy-willies" and the typhoons of the Philippines, "baguios." All are of the same general character and as a class are known as tropical cyclones.

The term "cyclone" (meaning coil of a snake) was first suggested about the middle of the last century by Henry Piddington, president of the Marine Courts at Calcutta. The word has come into universal use as a term to designate all classes of storms with low atmospheric pressure at the center.

The tropical cyclone, in its genesis, differs from the ex-tropical cyclone only in its geographical location. However, as it develops it acquires a more circular motion, a higher intensity of continuous windspeed, and a more intense deepening of atmospheric pressure. The average pressure of the tropical cyclone is above 28.00 inches of mercury; however, in several individual storms the pressure has been recorded below 28.00 inches and during the storm that passed over West Palm Beach, Florida, in September 1928, the barometer fell to a record low of 27.43 inches. This record held until 2 September 1935, when a hurricane of very small diameter but one of the most intense on record anywhere in the world crossed the Florida Keys with its center on Lower Matecumbe Key. The pressure recorded was 26.35 inches, the world's lowest record of pressure at a land station. It is reasonable to expect lower readings from ships than from land stations, because tropical cyclones are usually more intense over water than over the land. Furthermore, nearly all ships are equipped with barometers, while they are frequently not available in the sparsely settled coastal regions where many tropical storms have moved inland. Two such lower readings were recorded on the Dutch steamship, *Sapoeroca*, in the Pacific 460 miles east of Luzon (Philippines) on 18 August 1927 and the *SS Arethusa* located 13°55′ N.—134°30′ E. on 16 December 1900. The former reading was 26.185 inches, the latter 26.16 inches.

At the outer limits of the hurricane, the winds are light

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to moderate, and gusty. As the center approaches, they increase gradually, growing to squalls, then furious gales, and finally, in the fully developed hurricane, the winds immediately surrounding the center blow with indescribable fury.

Words fail to present an adequate description of the fury of a great hurricane. A shipmaster, who passed through the center of the hurricane which destroyed Santa Cruz Del Sur in November 1932, wrote in his log a description of the winds he experienced. His notations followed the Beaufort Scale, until he wrote that it was a full hurricane, force 12, the highest number of the scale. Then finding no adjectives to describe the violence of the winds which continued to increase, he wrote in his log, "winds, infinite."

It is very difficult to determine the velocity of hurricanes' winds. On board ships at sea, wind velocities are estimated by the effects of the winds upon the water. On land, measurements are made by instruments; however, there are too few instances where the center of the hurricane passed directly over the instruments and in many such instances, the instrument was blown away prior to the arrival of the center of the storm. There are, however, records which indicate that winds of the hurricane are sometimes sustained for intervals of five minutes at an average rate of more than 150 miles per hour. There is good reason to believe that the gusts of the hurricane represent air movements for brief intervals that may reach as high as 250 miles an hour in the most violent storms.

Eye

In nearly all tropical cyclones the highest winds are those which immediately encompass the calm center or "eye of the storm." The average diameter of the calm center is approximately 14 miles, though there are wide variations in individual cases. There is sometimes a complete calm, though in many instances there are light variable breezes. Over the ocean, the seas are usually pyramidal, mountainous, and confused in the calm center. The clouds sometimes break away; sunlight succeeds the torrential rain by day and at night the stars appear. In contrast to the surrounding air there is a gentle settling and drying of air inside the calm area which

is usually accompanied by a sharp rise in temperature.

If a storm is divided into four quadrants, with the quadrants labeled right front, left front, right rear, and left rear as they would be to an observer looking forward along the line of progress from the storm center, the stronger winds would be in the right front quadrant, since the wind speed is superimposed upon the forward movement of the storm. The weakest winds will be in the left rear quadrant since the forward movement of the storm is subtracted from the wind speed. Thus, when a storm of great force passes across a coast line, the area of greatest destruction will be to the right of the center. This condition is reversed in the southern hemisphere.

Wind velocity in tropical storms of small diameter is probably as high or higher than in the great storms of large diameter. Destruction is confined to a much smaller path, however, and due to their size there is less chance for records to be obtained. In some of them the barometer at the center is in the neighborhood of 27.50 inches and in rare instances much lower, which compares favorably in that respect with the greatest of hurricanes. Since the diameter of the small storm is much less, the barometric gradient is much steeper and hence the wind velocities must be higher.

Tornadoes Within the Hurricane

There are few authentic records of tornadoes or violent local storms of tornadic nature occurring within a hurricane. The few reported in recent years were confined to the state of Florida. When tornadoes do occur they are usually in the northern semi-circle of the storm.

Flying debris in hurricane winds has caused the death of thousands of people. Thousands more have lost their lives in ships at sea. Yet more than three-fourths of all the loss of human lives in tropical cyclones have been due to inundations. The rise of the sea over low coastal areas not subject to overflow by ordinary tides is sometimes sudden and overwhelming and in some situations there is no escape.

The Storm Wave

The true storm wave is not developed unless the slope of

the ocean bed and the contour of the coast line is favorable. Like the gravitational tide, it reaches its greatest height in certain situations. If there is a bay to the right of the point where the cyclone center moves inland, the waters are driven into the bay. With a gentle sloping bed, the water is piled up by resistance and becomes a great wave or series of waves which move forward and to the left, the principle inundation usually taking place on the left bay shore. Great storm waves which have taken an enormous toll of human lives have, so far as records are available, occurred in nearly every case in a situation of this kind.

Notable instances of inundation occurred at Indianola, Texas, on 16 September 1875 and again on 19 August 1886. A similar inundation occurred at Galveston, Texas, in 1900 and Corpus Christi in 1919. The maximum storms' waves recorded along the Gulf Coast have ranged from 10 to 16 feet in height, while storm waves on shores of the Bay of Bengal have been measured up to 40 feet and in the southern Marshall Islands on 30 June 1905 a storm wave at Millie was reported to be 46 feet.

Fortunately, along the Gulf and South Atlantic Coast of the United States, storm waves are not so readily developed as on the coast of India, probably due to less favorable contours of shore and ocean bed and because the tide from gravitational forces is of a smaller range so that its coincidence with the hurricane tide does not result in such great rise.

Rainfall in Tropical Cyclones

In tropical cyclones, rainfall is nearly always heavy and frequently it is torrential, reaching on some occasions to the proportions of what is commonly termed a "cloudburst." A fall of one inch of rain in a period of twenty–four consecutive hours is considered heavy in temperate latitudes. Yet, in tropical cyclones there has been over 25 inches of rain recorded in a twenty–four hour period. This amount was recorded on 13–14 September 1928 in the Luquillo Mountains in Puerto Rico and at Adjuntas the fall was 29.60 inches during the passage of the same storm. Probably the world's heaviest rainfall in twenty–four consecutive hours was that measured at Baquio in the Philippines in July 1911. The

amount was 46 inches. During the same storm an additional 42 inches of rain fell at Baquio, totaling 88 inches in four days.

Falls exceeding 20 inches in twenty-four consecutive hours have been recorded in hurricanes in the United States. In 1916 a hurricane caused the greatest floods known in the southern Appalachians. At Altapass, N. C., the rainfall accompanying the hurricane amounted to 22.22 inches. The greatest twenty-four hour rainfall of record in the United States resulted from a tropical storm in September 1921. It moved westward across the southwestern Gulf of Mexico and passed inland over Mexico, after which it turned northward and crossed the Rio Grande Valley into Texas. After passing inland the storm rapidly dissipated and by the time it reached Texas could scarcely be identified as a cyclone except by the torrential rains which continued northward into Texas. Within twenty-four consecutive hours, 23.11 inches of rain fell at Taylor, Texas. Torrential rains accompanying this disturbance caused the most destructive flood in the history of San Antonio. Water rose so rapidly in the streets that automobiles were deserted and the occupants sought safety in the high buildings. Five to nine feet of water stood in the large hotels, theaters, and stores. Fifty-one lives were lost and property damage amounted to $5,000,000.

Rainfall in a single day in tropical cyclones in the instances cited equals or exceeds the average annual rainfall at Paris, 21 inches; London, 25 inches; Chicago, 33 inches; and San Francisco, 22 inches. These amounts also include melted snow measurements.

Distribution of Rain Intensity in the Hurricane Studies show that the maximum rainfall in a moving hurricane is in the right front quadrant and that there is relatively little rainfall in the rear half of the storm. On the other hand there is a maximum of lightning and thunder after the center of the storm has passed. This has led to a belief among natives of tropical climates that when a thunderstorm occurs the storm is diminishing.

Signs of the Approaching Hurricane

One of the first signs of an approaching tropical cyclone is the storm swell. The winds in the distant storm create waves on the sea. Moving outward from the storm area, they

traverse great distances and break upon shore 400 to 500 miles away. When the wind is light, the booming sound of the surf at fairly regular intervals is ominous.

Winds create waves which move with a speed a little less than the speed of the wind which produces them. Waves quickly outrun the tropical storm in which they are formed. The West Indian hurricane moves at an average rate of about 12 miles an hour while the waves move at rates sometimes exceeding 30 miles an hour. As the wave moves ahead of the storm it takes on the smooth characteristics of a swell and arrives at the shore hours and sometimes days ahead of the storm.

Intermittent breaking of heavy swells on shore when the wind is light is one of the signs of the hurricane. Ordinary waves produce a more or less continuous sound.

As a precursory sign the tide is noteworthy. Ordinarily, a continuation of offshore winds will result in a tide below the normal, and winds blowing for a considerable period toward the shore will cause a high tide. When a tropical storm approaches the coast, the tide rises even when winds are blowing offshore.

In the tropics where there is very little change in atmospheric pressure, except for the diurnal variation, a fall of 0.1 inch or more of pressure, exclusive of the diurnal change, is significant. In temperate regions, the barometer is of little value until the storm is close at hand.

Cirrus clouds extend outward to the limits of the storm and sometimes beyond. Shortly after the appearance of the cirrus clouds, a veil appears, gradually increasing in density, so that the high clouds are distinctly seen through it. Solar and lunar halos are sometimes observed after the appearance of the veil.

There next appears on the horizon, at about the point where the cirrus clouds diverge, an arc of dense clouds, which is the body of the hurricane itself. Its color is whitish or grayish at first, changing to dark gray, sometimes with a copperish hue. At this time low clouds appear in the direction from which the hurricane moves, gradually extending over the entire sky. They are broken clouds moving swiftly at almost right angles to the cirrus clouds, so that the observer, directly facing the hurricane, sees the clouds move

from his left to his right. The outline of these low clouds, called fractostratus, or scud, are indistinct through the haze. If they appear early the observer may not be able to see the bar of the hurricane.

If the hurricane is moving directly toward the observer, the bar of the hurricane will remain at the same point on the horizon, gradually rising. If the hurricane is moving to his left or right, he will see the bar move slowly along the horizon.

Hurricane Tracks

If all known tracks of West Indian hurricanes were assembled on a chart it would exhibit an intricate and dense pattern, covering practically every part of the Gulf of Mexico and Caribbean Sea and much of the North Atlantic Ocean. The outstanding feature of any chart of hurricane tracks for a considerable period of years is the presence of many sweeping curves which extend westward or northwestward, then turning northward or northeastward. While a large percentage of these tracks are described as "parabolic," there are many exceptions.

There is, however, a decided variation in the movement of hurricanes from one month to another. This variation is revealed in an examination of tracks by months.

During the early part of the hurricane season, in June and sometimes July, hurricanes originate in the western Caribbean Sea. From that region nearly all of them move in a northwesterly direction into the Gulf of Mexico, crossing the coast line into Mexico or the Gulf States. During August and September, hurricanes develop over the eastern North Atlantic Ocean south of the Cape Verde Islands. The majority of these move in a westerly direction across the Atlantic, some of them reaching the coast of the United States before they recurve to the northward and northeastward.

In the latter part of September, and in October and November, hurricanes are again found originating in the western Caribbean Sea. Those of the latter part of September follow much the same paths as storms from that region in June, but in October and November they are more likely to turn northward and northeastward in lower latitudes, sweeping out over Florida or the Greater Antilles.

(*Continued on page 39*)

RADIO HINTS FOR INSTRUMENT PILOTS

N. G. Howell

The views expressed in this article are the author's and are not necessarily those of the Department of the Army or of The Army Aviation School.—The Editor

The following hints on use of radios while flying instruments include techniques often used by experienced pilots, but usually overlooked by the authors of instrument textbooks. Perhaps these hints will make your instrument flights easier and safer.

Use the communication receiver to receive communications. This appears to be a trite and obvious statement. Is it? Receiving ATC instruction on the primary navigation facility frequency is sometimes a convenient and easy system to use, but it may involve complications. Suppose a pilot makes a position report on a victor airway and requests a change in altitude, asking that reply be made on VOR frequency. The operator to whom the report was made will no doubt acknowledge the transmission and request the pilot to stand by for further clearance. The operator will then try to call his ATC center to get clearance for the change in altitude. If lines to ATC are busy this could take several minutes. All the while the pilot is moving closer to his next VOR station and may want to tune to it rather than remain on the frequency of the station last passed in order to receive the clearance. Had he used an assigned communication frequency, he would have felt free to tune the navigation receiver at will. Perhaps this presents only a minor problem in instrument flying, but minor problems add up to form major problems.

Tuning

The proper tuning of radios is of vital importance. Concentrate on the radio being tuned; turn the volume down

momentarily on the other radios to eliminate confusion and provide for clear reception of the proper signal. Once that signal is accurately tuned and identified, readjust the various volume controls as required. Re-check the tuning occasionally. This is especially important when a radio has been tuned near the transmitter and the distance from the transmitter is increasing. The OFF flag of the VOR or ILS receiver may start up as the distance from the transmitter increases, leading you to believe that the signal is becoming too weak for accurate track guidance. In many cases the flag can be made to go down by re-tuning, thus providing many more miles of accurate track guidance. The quadrant signal of a low frequency range can be reversed near a beam by improper tuning. The calibrated tuning dial is not always accurate. Tune above and below the assigned frequency in order to get a bracket on the best position of the dial.

Tune every radio that can be of service. If you are flying a low frequency clearance under conditions of poor recep tion and desire to receive the scheduled weather broadcast, tune in any BVOR station within range, preferably one along the route of flight because that station will probably report the weather of stations you are most interested in. Leave the volume down on the VOR station until scheduled broadcast time, and then turn the low frequency volume down and the VOR volume up until the broadcast has been completed. The transmitting station reports its weather at the beginning and end of the weather transmission and thus you are provided with two opportunities to receive enroute weather.

Another reason for utilizing enroute stations in many cases is to take advantage of their signals for secondary

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track guidance or to check progress along a low frequency beam. These stations can often be used to help you identify a cone of silence by setting the proper radial on the course selector and noting movement of the deviation indicator as the cone is crossed. Tune your radios early when approaching an area containing several navigational facilities. If you are cleared to the station on a victor airway and expect to make a VOR low approach, why not tune the ADF to the low frequency station in that vicinity? This procedure offers different advantages under varying situations, but it always offers you the advantage of being set up to remain oriented in case the primary navigational system fails.

The practice of tuning radios early as you approach a congested area is commendable, but some stations can be satisfactorily tuned much farther out than others. For example the middle marker and outer marker compass locator stations are low-powered and have a serviceable range of fifteen to twenty–five miles from the station. It is generally a waste of time to try and tune in one of these stations while fifty miles from the transmitter. The ADF could probably be put to better use by tuning it to a more powerful facility or to a closer facility until within about fifteen miles of the compass locator.

Volume Control

Use of the volume control takes on added importance as more and more radios are used simultaneously. Audible volume on all results in good reception of none. VOR and ILS usually provide voice transmissions on the facility frequency. The accuracy of the ground track on these systems is independent of the volume so either system can be used for track guidance with no audible signal. When one of these systems is being used as a primary navigational aid it is good procedure to keep the volume just high enough to make you aware of any signal interruption. The signal will then be low enough not to cause irritation or fatigue, yet it will be high enough to alert you if a voice broadcast is made.

Getting to a VOR station from an unknown position when close to the transmitter sometimes presents a confusing

problem. Nearness to the transmitter is indicated when the course selector must be rotated almost constantly to keep the deviation indicator centered or when the deviation indicator rapidly moves from the center to an extreme position with a constant course selector setting.

Close-in Procedure

The confusion of a VOR close-in problem can be eliminated by use of the following procedure. Rotate the course selector to center the deviation indicator with the TO—FROM indicator reading TO. Start turning the aircraft in the proper direction to turn to the heading indicated by the large arrow of the course selector. As this turn progresses, the deviation indicator will move from the center position. As it starts to move, rotate the course selector to keep the deviation indicator centered. When the heading of the aircraft approaches the value indicated by the large arrow of the course selector, start rolling out of the turn. This will place the aircraft on a heading almost directly toward the VOR station and corresponding very closely with the value set on the course selector. Only slight changes in heading will normally be required from this point to the station.

Microphones

Carbon type microphones are subject to deterioration with age. The carbon granules may become packed to the extent that the transmitter signal is weak or garbled. If you have trouble making transmissions readable, cease transmitting and gently tap the microphone against the palm of your hand several times. Subsequent transmissions may be improved because of the loosening of packed carbon granules.

Conclusion

These are but a few hints to improve technique in radio instrument flying. Perfection is the goal and it can be attained only by the pilot who thoroughly understands the capabilities and limitations of his radio equipment and who is well trained in its use.

A FIX FOR DOWNTIME

Raymond L. Chaney

The views expressed in this article are the author's and are not necessarily those of the Department of the Army or of The Army Aviation School.—The Editor

For discussion purposes, this fix will be defined as "maximum utilization of ease of maintenance concepts." The most chronic and, therefore, the most critical downtime is caused by mechanical failures which render the aircraft "out of commission." A fix can be applied in this case to minimize downtime by effectively reducing the maintenance man–hour input and the skill levels required to repair, adjust, or replace those items experiencing mechanical failures.

Experience with Army aircraft in combat has emphasized a requirement for maintenance which can be performed quickly and easily under difficult and often hazardous conditions. Recognizing this requirement, the Chief of Transportation has assigned the Army Aviation Division, Transportation Research and Development Command (TRADCOM) the responsibility of aircraft maintenance operations evaluations. Within this responsibility, the Army Aviation Division pursues "ease of maintenance" for Army aircraft as one of its objectives.

"Ease-of-Maintenance" Program

Ease of maintenance is a measure of the relative time and effort required to service, adjust, and repair machinery properly. It is not a measure of the amount or frequency of maintenance, but an index of the ease and minimum time in which each maintenance operation can be accomplished. Most of us agree that, at times, it appears a deliberate attempt was made to make the maintenance of aircraft difficult. Some of these difficulties are evidenced by poor installation designs and arrangement of components. From a mainte-

nance viewpoint, it is axiomatic that for maximum or most efficient equipment performance provisions must be made for simple and easy performance of maintenance.

Any inaccessible area which requires frequent or regular maintenance attention is vulnerable to neglect. In such areas it is self-evident that easier and simpler preventive maintenance features will allow maintenance personnel to perform their functions with reduced skill requirements and less supervision. In addition, the aircraft is more assured of receiving the timely and adequate maintenance required for safety.

Not only does the foregoing represent large savings in dollars, but, more important, it provides for a combat mission that life insurance which guarantees on-target, on-time, with the required number of aircraft.

Consideration of these facts gives rise to the logical questions of how and when this ease-of-maintenance program is going to come about.

TRADCOM has within its Army Aviation Division a group of engineers and maintenance technicians highly experienced in the field of aircraft maintenance. This group has carefully examined the many previous studies written on ease of maintenance and investigated the ease-of-maintenance programs presently in effect by other military agencies. Based on this information, TRADCOM personnel have developed an ease-of-maintenance program which, they believe, will effectively measure and systematically improve the maintainability of the Army's aircraft.

TRADCOM's treatment of ease of maintenance prescribes both immediate and long range objectives—each of which should be considered separately.

Mr. Raymond L. Chaney is Chief of the Army Aircraft Maintainability Program, Transportation Research and Development Command. He received his B. S. degree in aeronautical engineering from the University of Oklahoma in 1950. During World War II he served as a pilot in the Army Air Corps and as an Army Aviator during the Korean War. Subsequent to his Korean tour he was employed by the Bell Aircraft Corporation as a rotor analyst, and in September, 1954, joined TRADCOM as a mechanical engineer.—The Editor

Immediate Objectives

The immediate objective is to establish practical ease-of-maintenance features for incorporation on the Army's adopted aircraft and those new aircraft being phased into the system. Due to their relative complexity and immediate urgency the Army's more recent helicopters will be subjected to these evaluations first. Detailed maintenance data is being collected from AF Phase VI Functional Development tests and selected Army TC Helicopter Battalions. This data will provide a basis for determining which areas of the aircraft are requiring the most maintenance attention. The corresponding type of helicopter will be subjected to a comprehensive maintenance evaluation at TRADCOM to measure this machine's maintenance requirement. Special emphasis will be given to the investigation of those areas demanding excessive maintenance with an objective towards reducing the time, tool, and personnel required. Wherever possible, ease-of-maintenance principles will be applied to achieve this objective. Based on results of these tests all features deemed practical and economically feasible will be recommended for use in the field. However, the time lag before aircraft in the field will incorporate these features will be necessarily dependent upon the complexity of the modification required.

In all probability, the more complex modifications will be accomplished at depot installations. However, it is anticipated that most of the approved ease-of-maintenance features can be incorporated on the aircraft at field maintenance level.

Long Range Objective

Long range objective of the ease of maintenance program is to establish a maximum number of sound, proven ease-of-maintenance principles. Ultimately, these proven features should be incorporated as maintenance design criteria in military characteristics and specifications developed for the Army's future aircraft.

The possibilities of simplifying and improving maintenance in the field appear unlimited. At present, it is conservative to say that there are few, if any, aircraft in the

Army system that would not profit if subjected to impartial tests and evaluations. Some of the obvious areas that require ease of maintenance attention can be brought to light by asking some pertinent questions.

Is access to fastenings or mounting devices of specific assemblies or structures unduly restricted? For example: What about the fuel pump installation of a certain helicopter? Examination of the installation reveals it takes eight man-hours to complete this task, which consists of removal of other assemblies, replacement of the pump, and re-installation of removed assemblies. Yet, to remove and replace the pump after gaining access takes only twenty minutes. Relocation of the fuel pump may be the obvious solution to this problem. Another classic example is the removal of a helicopter engine to permit repairs on the accessory drive installation. There are, obviously, many other such cases.

Anything other than productive man-hours on an item requiring repair is lost motion and serves to keep the aircraft grounded for a longer period of time. This should make an ease-of-maintenance principle evident: "All assemblies and sub-assemblies requiring regular service and maintenance should be positioned so as to be replaced without removal of other assemblies or structures."

Are technical instructions complete, understandable, and usable in the field by maintenance personnel? Do not ask a mechanic in the field this question unless you are prepared for a lengthy, impassioned discourse in the negative. A recent survey disclosed that a very small percentage of the Army's aircraft mechanics could understand the technical instructions as presently written. When one considers that these mechanics possess at least average intelligence and have mechanical and technical experience, the inadequacy of present technical instructions is alarming. If additional features were provided in the technical instructions, such as a listing of the complete tools required for an engine change, the time saved could mean the difference between one and possibly twenty trips to the tool crib for tools, and, the time could be applied towards getting the aircraft back in the air that much earlier.

Another ease-of-maintenance feature can now be described as "All technical instructions should employ the basic

principle of writing workman's words for working people."

Can aligning devices, quick disconnects, color coding, sectionalization, or other modern engineering practices be employed to speed up maintenance tasks? Make a job easier to do and the possibility of error is minimized; also, the job can be performed by less skilled personnel with minimum supervision. An example can be cited in applying this basic thought to aircraft lubrication. A requirement exists for three grades of lubricants at various locations for this machine. Paint all grade 5 lube fittings blue; grade 15 yellow; and grade 25 green. Further, paint each of three available grease guns a color corresponding to each of the three grades of lubricants required. Now to lubricate all fittings requiring grade 5 lubricant the blue grease gun is merely applied to all the blue grease fittings. Very little instruction is required even for an inexperienced mechanic to insure that the job is done quickly, easily, and without error.

Another area notorious for violation of simplified maintenance is the engine installation. Visual study of this complex maze of wires, hoses, tubes, attachments, baffles, etc., reminds one of a well decorated Christmas tree. Is it illogical to assume this could be an efficient, compact package that could be completely disconnected and removed and re-installed in forty-five minutes or less, utilizing less skilled personnel and one or two common tools?

Visualize the following possibilities:

a. A lifting eye permanently installed on the top center of the power package.

b. Color coded, self-sealing, quick disconnects for all oil, fuel, and hydraulic lines. These lines terminate at a junction box on the fire wall.

c. Electrical lines possessing plugs which connect to a polarized junction block on the fire wall.

d. The engine mount using double safety, quick disconnect fasteners of the lever and eccentric type.

e. The use of tapered dowell tracking devices and blank splines to ease alignment and eliminate error of engine re-installation.

The foregoing indicates that the next axiom lending itself to ease of maintenance is: "Maximum use of modern

engineering practices should be utilized to facilitate removal, installation, and correct phasing of assemblies within the major item."

Can tool requirements be reduced? One of the Army's oldest and least complex helicopters requires the use of 125 special tools to provide field maintenance. In a fluid combat situation, the loss of one or several of these tools could have a disastrous effect on this helicopter's availability. Special tool requirements are excessive for all of the Army's helicopters. A more realistic approach by the design engineer is the solution for this basic problem.

Examination of some of our aircraft reveals the design engineer failed to pass the test for minimum number of common tools required to perform a maintenance task. Take, for example, the removal of flooring to gain access to the control system. Removal of the floor requires use of a socket–wrench, dzus, phillips, and a cross–slot screwdriver or a corresponding variety of fasteners. All of these fasteners have the same function. Why not standardize these hardware items to relieve tool requirements?

Another example of multiple tool requirements is the case of a recessed square and hexagonal drain plug on the oil sumps, and a raised square and hexagonal plug on the transmission drains. Here, four special tools are required where a little more design consideration for maintenance would require use of only one common tool. But the most extreme case occurs in the special and common tool combinations required to maintain the geometry of the rotor systems of helicopters. It would require a separate book to list the improvements that are possible in this area. Thus, another rule which facilitates "ease of maintenance" has been represented: "Reduce special tool requirement by redesign to accommodate common tools, and minimize the number of common tools required for maintenance tasks for standardization of hardware items."

Summary

This discussion highlights some of the "ease–of–maintenance" features to be tested in Transportation Research and Development Command's program. (*Continued on page 40*)

FOOTNOTES FOR WRITERS

W. T. Burkett

The views expressed in this article are the author's and are not necessarily those of the Department of the Army or of The Army Aviation School.—The Editor

At one time or another most officers in Army aviation are asked to write informative articles about their work, specialties, or experiences. Written reports about accidents, training activities, administrative details, training projects, command functions, and flight procedures are also often called for. Occasionally they must provide technical information for a manual, or formulate the scope and plan of a new subject to be taught, or describe for a visiting VIP certain areas of command, doctrine, or flight. Now and then they may want to express some highly original idea, hoping it will meet a unique need or improve some unhandy situation, method, or technique.

Often they are unprepared, either in experience or in natural talent, to meet and further the writing challenge. Usually though, if they are willing to put forth the effort and if other responsibilities are not too urgent, they produce a fairly comprehensive and finished product. What is said hereafter is not a criticism but is merely an effort to point out a few common faults in writing.

First of all, very few individuals can transfer from their brains to a piece of paper the precise duplicate of their thoughts. Even to approximate such an exchange of medium requires the most difficult and tiring of all mental effort. However brilliant the writer's mind, however much he has wrestled with grammar, language, and style, he cannot express his notions or knowledge without some slight confusion, some degree of inexactness.

Think

Obviously, the first requirement, in order to write with clarity, is to think. An individual cannot afford an excess

word or an irrelevant phrase. Each word chosen, each sentence fragment must serve a definite, clearcut purpose. Even *the* cannot be used unless it is needed; nor can *all* be attached when unessential or when already implied:

> POOR: All personnel are to become familiar with all the questions and all the blanks on the form before taking the test.
>
> BETTER: The questions and blanks on the form must be examined before taking the test.
>
> POOR: All the applicants for an instrument rating must qualify on all the maneuvers in order to receive a satisfactory rating.
>
> BETTER: Applicants for an instrument rating must qualify on all maneuvers to receive a satisfactory rating.

Wordiness

To qualify the terms of a statement in too many ways in the same sentence is a practice partially derived from the reading of Army Regulations, which, by their nature, must set forth in detail and within limited space every possibility of interpretation. Normally an individual is not required to address so large an audience or to express so many ideas in such a small space. The reader is frequently confused by the excess wordiness of an individual.

> POOR: The Sikorsky Helicopter Company's H–19 helicopter is used in the Helicopter Company of . . .
>
> BETTER: The Sikorsky H–19 is used in the Helicopter Company of . . .
>
> POOR: In order to produce the desired effect

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during the maneuver and in order to facilitate economy of fuel after making the turn, the pilot will insure that he has previously completed his estimates of the . . .

BETTER: The pilot completes his estimates of the . . . before beginning the maneuver. He thus maneuvers correctly and saves fuel after making the turn.

Repetition

Another detriment to a reader's progress is seen in the unnecessary repetition of a lengthy term and of repetition of words such as *increase* and *decrease*. But the writer must not think that every type of repetition is bad; he should only remember that when he repeats something, he should repeat from a fresh angle of approach. Observe how the following examples come up for air with the changes made:

POOR: A transportation army aircraft maintenance battalion is assigned to the field army to provide field maintenance and supply for all aviation units. Normally transportation army aircraft maintenance companies of the transportation army aircraft maintenance battalion will be disposed throughout the field army area so as to facilitate maintenance support, but will remain assigned to and under the command control of the transportation army aircraft maintenance battalion.

BETTER: A transportation army aircraft maintenance battalion is assigned to the field army to provide field maintenance and supply for aviation units. Normally its companies are disposed throughout the field army area to improve maintenance support but they remain assigned to and under the command control of the aircraft maintenance battalion.

POOR: Under normal conditions, an increase in altitude brings a decrease in pressure and a decrease in altitude brings an increase in

pressure. The pressure increase or decrease will vary if the moisture increases or decreases.

BETTER: Under normal conditions, an increase in altitude reduces pressure and a decrease in altitude results in a higher pressure. Variation of this standard is caused by moisture content changes.

Pronouns

In the example above, concerning the maintenance battalion, the use of the possessive pronoun *its* has eliminated two repetitions of the long term. Readability is improved but a word of caution about the use of pronouns.

The farther the pronoun is placed from the word or term for which it is substituted (called the pronoun antecedent) the greater the likelihood of its confusion with another word or term. For example, in the previous sentence *it* and *its* are substituted for *pronoun;* the antecedent reference is an easy mental process. But writers often let their thoughts get ahead of their paper work; for instance, the same sentence reworded:

> "The farther the *pronoun* is placed from the word or term for which *they* are substituted (called the pronoun antecedents), the greater the likelihood of *their* confusion with another word or term."

The writer's mind went out of bounds after his singular use of *pronoun.* He was thinking in terms of *pronouns,* the plural, but began by letting the singular form of the word stand for all pronouns as a group. He then reverted to the plural form and used *they* and *their.* As the sentence is written, his plural pronouns have only one possible antecedent, which also must be plural (*word or term* in the first line) and the reader is hopelessly confused.

Carelessness in the use of pronouns is a common cause of the reader's misunderstanding of the writer's thoughts. Look at this example in which the pronouns are italicized:

> POOR: Army airfield surveillance/approach radars are established at corps, corps artillery, and field army base airfields. *These* radars are

> the primary navigation facility within their respective control zones and are the primary instrument letdown facility of the airfield at which located. *These* radars may also be used as a secondary navigation facility by Army aircraft on airways to the limits of *their* surveillance range and spatial coverage.

The antecedent of the first italicized pronoun is simple enough to find, although the reader's original impulse when he begins the second sentence with *these*, before reaching *radars*, is to attach the plural pronoun to the last plural term in the previous sentence, *corps, corps artillery, and field army base airfields.* That impulse is corrected by *radars* immediately after the pronoun.

The second pronoun in our example, *their*, can refer to either of the plural antecedents used in the first sentence; but the reader is more likely to choose the proper one, *radars*, since the term has been repeated and fixed by the previous pronoun. The final pronoun italicized in the example probably makes its reference clear to the reader in the same manner; nevertheless, in this case he is more strongly tempted than before to attach *their* to the wrong antecedent since two separate plural terms, *aircraft* and *airways*, have just been passed.

The writer should have been more careful; he should have reviewed his work and made changes similar to these:

> BETTER: Army airfield surveillance/approach radars are established at corps, corps artillery, and field army base airfields as the primary navigation facility to control primary instrument letdown. Radars of this type may also be used as a secondary navigation facility to the extent of their surveillance range and spatial coverage.

Why *primary* is repeated should determine whether or not its repetition is essential. Offhand, the first use of the word seems to be enough.

One last word about pronouns, the indefinites. With very rare exception such as "*It* is raining" or "*They* say brain cells work like electrical units," the indefinite use of a pronoun is weak. The second inserted exception has less to

offer than the first because *they* could have an antecedent but *it* cannot. Other examples:

POOR: *It* is our job to see that they keep at it.

The sentence should begin with *our job*. The last phrase, *keep at it*, is an idiom of speech, meaning to *continue it* or *stick to it* or *keep it up*. Such idioms are permissible if not out of tune with the writing and if not overused.

POOR: *It* is our intention to show that . . .

BETTER: Our intention is to show that . . ., or,

We will try to show that . . .

Do not worry too much about whether to use *shall* or *will* with *I* or *we*.

POOR: *It* is at this phase that . . .

BETTER: At this phase . . . *This* is our plan . . .

Ordinarily, the construction is improved by beginning with the subject of the statement, in this case *our plan;* but brief introductory sentences sometimes get a paragraph underway with effectiveness. Just keep them very brief if you use the indefinite pronoun or the pronoun ahead of its antecedent.

Split Infinitive

Quite often a writer finds himself in the dilemma of deciding whether or not to split an infinitive. Do not, if you gain nothing by doing so; do, if readability and meaning are improved. Split infinitives absolutely insult some people; students used to be schooled to NEVER split an infinitive. *To never split* is a split infinitive. An infinitive, by the way, is the verb form made up of *to* plus the verb: *to be, to run, to fly*. You split one by inserting a word or phrase between the *to* and the verb:

To never in any way at all *succeed* is . . .

The *never* split would hardly grate on the purist's ear. The split with *in any way at all*, which should properly follow the verb, rubs against the grain of even the least formal of readers.

Military writers, even the more experienced ones, commit a grosser writing sin than splitting infinitives when they compile a list of activities or items carelessly. Each item in the list should follow a single form. When the first item

begins with a verb, so should the others, or at least with a verbal construction:

1. To keep the orderly room in . . .
2. To check the sign–out sheet before . . .

Decide ahead of the actual listing how to shape the items. Will nouns or noun phrases be better than verbals (infinitives and *–ing* verbs)? In the introductory statement can a substitution of words or phrases prevent its repetition in each item? For example, "The Officer of the Day will:

"1. Insure that accidents are . . .
"2. Insure that firearms are . . .
"3. He will insure that quarters are . . .
"4. Insure that retreat formation is . . ."

This is an unbalanced listing; and the repetition of *insure* can be avoided by including it in the introductory statement—"The Officer of the Day will insure that:

"1. Accidents are . . .
"2. Firearms are . . .
"3. Quarters are . . .
"4. Retreat formation is . . ."

Conclusion

To conclude this brief treatment of a highly complex subject, realize that no one expects a writer to be letter perfect every time. But the reader deserves the fair play of clarity and unity of thought. We write for his benefit, not for our own. The fact that he must, let us say, read what we write to receive credit for a course of training is all the more reason for exerting our best writing effort. Ease the reader's burden by making the compulsion less disagreeable. He might even want to read more if the writer:

1. Plans his subject.
2. Thinks through his plans.
3. Writes a first draft.
4. Proofreads once for unity and rearranges.
5. Proofreads again for clarity, corrects and tightens.
6. Eliminates negative asides.
7. Accents positive approaches.
8. Rewrites into final form.

BOOKS FOR THE ARMY AVIATOR

DEVELOPMENT OF THE GUIDED MISSILE—Gatland, Kenneth W., F. R. A. S. (The Philosophical Library, Inc., 15 East 40th St., New York 16, N. Y., 1954. $4.75)

This is the second edition of a book which presents factually the main information available on the contemporary development of guided weapons and rockets for military and peaceful purposes. The author, who is an aircraft design engineer and a founder–member of the British Interplanetary Society, describes the potentialities of the rocket as a weapon of offense or defense, as an instrument of research into the upper atmosphere and outer space, and eventually as a vehicle of interplanetary travel.

The first edition has been completely revised and a number of useful features have been added. New chapters deal with problems of propulsion, research into rocket techniques and requirements, and postwar work on guided bombs. Of particular importance is the detailed survey of Russian potentialities for long range rocket development. An appendix reveals some details of the telemetering equipment used in British missiles, and another appendix shows photographs, to scale, of over 40 notable rockets from various countries. The table of characteristics, which was an important feature of the first edition, has also been enlarged and now provides data on 140 powered rockets from eight countries.

The book is illustrated by over 100 photographs and drawings of exceptional interest. Anyone who wishes to understand the significance of the guided missile—both the threat it holds as a weapon of war and its promise of Man's adventuring into space—should read Mr. Gatland's book.

THE AMERICAN TRADITION IN FOREIGN POLICY—Tannenbaum, Frank (University of Oklahoma Press, Norman, Oklahoma, 1955. $3.50)

Two sharply divergent doctrines of foreign policy are being debated today in America. One doctrine, called *realpolitik*, insists that relations between nations be built upon a balance of power and power politics, while the other—the principle of the coordinate state—holds that the best relations can be maintained by friendship among nations, the right of the little nation to survive without fear, and the enhancement of human dignity and freedom.

Mr. Tannenbaum, a professor at Columbia University, states the case for the coordinate state. His conclusions are based upon study of the progress of nations in the past and the ethical and constitutional foundation of the United States. Whereas the exponents of *realpolitik* adhere to the principles of Machiavelli, Richelieu, Clemenceau, and Bismarck, believing that wars are inevitable and that the individual is the servant of the state, the author points out that the United States and its government (along with the British Commonwealth and the Swiss Federation) are founded on that revolutionary principle of the state's being the servant of the individual. Such a foundation philosophy made possible the equality of Texas and Rhode Island.

He further states that nations subscribing to a policy of power politics (the German Empire under the Kaiser and Hitler, Italy under the Borgias and Mussolini, Imperial Japan, Richelieu's France, for example) have usually ended disastrously.

The debate between these opposing policies will come to our attention more and more. Anyone would do well to read this book which advocates Christian principles and mutual sovereignty among nations in the face of the Communist threat.

TWO YEARS IN THE ANTARCTIC—Walton, E. W. Kevin (The Philosophical Library, Inc., 15 East 40th St., New York 16, N. Y., 1955. $4.75)

Considerable publicity has been given in recent years to the conflicting claims of Britain, Chile, and the Argentine to the area of Antarctica south of Cape Horn. The yearly

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departure of the Survey ship *John Biscoe* receives increasing publicity in the press and on the airwaves.

This is the first personal account of two years spent in that area of British Antarctica since the war. Kevin Walton went to the Antarctic as a member of the newly formed Falkland Islands Dependencies Survey which has been engaged ever since in exploring the region. The Survey party established the first base inside the Antarctic circle at Marguerite Bay in Graham Land, and spent their first year training both themselves and their dogs to live and travel in this difficult country.

The next year, an American expedition arrived, and later both parties combined to complete a survey of the East Coast of the Graham Land peninsula. At the same time a party from the Survey's northern base at Hope Bay sledged over 500 miles southwards to a pre-arranged rendezvous, and were escorted over the formidable plateau to Marguerite Bay.

These journeys marked the climax of two years' work, and it was a measure of their success that they were accomplished without dramatic incidents. The expedition as a whole did not lack excitement, however, for their aircraft crashed seventy miles from base, and the occupants had to walk home; and on two occasions a member of the party was rescued from the depths of a crevasse, once by the author himself.

Some of the most interesting chapters of the book are those that describe how the Expedition actually lived in Antarctica, how they organized their base, trained their dog teams, and worked out a sound routine for polar sledge journeys, based in large measure on the recorded experience of previous polar travellers. Mr. Walton emphasizes the logical approach to polar life—how every accident must teach a lesson, and the value of careful planning and meticulous attention to the preparation of equipment. It is a country where success, and life itself, may depend on the strength of a dog trace or the weight of a ration box.

The book evokes the wildness and beauty of the Antarctic, the combined isolation and close companionship of Expedition life, and explains why the author left determined to return.

Gray Hair

IP Error

A unit instructor pilot was giving an orientation ride and check-out to a newly assigned pilot in an H–23B. They had been flying for about an hour, practicing landings on pinnacles and ridgelines in mountainous terrain. Finally an approach was made to a shallow slope which was approximately 2000 feet M. S. L. The pilot terminated the approach

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Beginning this month, very senior Army aviators will be featured in the Gray Hair department. Lieutenant Colonel Ford E. Alcorn, pictured above, graduated in Army Pilot Class No. 2, October 1942, and is currently assigned to TC AFFCO. Colonel Alcorn, who started flying as a civilian in 1936, is qualified in all types of Army fixed wing aircraft, instrument qualified, and has logged over 5,000 hours pilot time. During World War II he served as Third Infantry Division Air Officer in the invasion of North Africa, as IV Corps Artillery Air Officer in Italy, and with the Sixth Army group in France. Prior to receiving his present assignment on 15 June 1955, he was assigned, for a period of three years, to the Office of the Assistant Chief of Staff, G–3, Department of the Army.—The Editor

in a hover then attempted a slope landing. The left skid was placed on the slope and at this moment the helicopter began drifting and turning slowly to the right. With the intention of re-aligning the helicopter for another attempt at a landing, the pilot brought it to a hover, but the rate of turn increased rapidly. The instructor pilot shouted to the student, "What are you doing?" The student answered, "I believe we have a tail rotor failure." The instructor said, "Cut the power and get it on the ground."

The student cut the power and the helicopter rotated 180 degrees heading down wind and down slope. It hit the ground and bounced. The main rotor struck the tail boom and upon second contact with the ground the helicopter nosed into an almost vertical position, then rolled over on its right side.

Fortunately, neither the student nor instructor was injured. Due to the extent of damage there was not enough evidence available for the accident investigation board to determine the cause or contributing factors of the accident.

Poor judgment on the part of the instructor pilot was conspicuous. He gave responsibilities to the student which were beyond the student's ability and experience. The tag of instructor pinned on a pilot also pins on him responsibility. Unit instructor pilots should be well versed in their aircraft and especially adept in recognizing serious situations in order to prevent accidents. In this case, the IP should have acted first and asked questions later.

Unbalanced

No matter how extenuating the circumstances, an aircraft cannot be flown safely when the center of gravity limitations are exceeded. It is especially critical in helicopters. The following accident was a result of a pilot being too

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The Gray Hair department is prepared by the ARMY AVIATION DIGEST staff with information obtained from the files of the world wide aircraft accident safety review board. The views expressed in this department are not necessarily those of the Department of the Army or of The Army Aviation School.—The Editor

anxious to expedite his mission and failing to exercise good judgment.

During field maneuvers a regimental pilot was flying the commanding officer in an H–13E. In the course of their flight they were informed that a soldier with a broken leg needed evacuation. The colonel directed the pilot to pick up the patient and fly him to the collecting company. They proceeded to the pick up point, placed the patient on the left–hand litter, and took off for the collecting company.

Upon arrival at the designated grid coordinates they discovered the company had displaced to an unknown location. The colonel then decided that the best method of locating it was to return to the regimental CP for information. The pilot, after arriving at regiment, had flown approximately 2 hours and 10 minutes without refueling.

While the colonel was in the CP obtaining the information, the pilot, because of his suffering patient and the fact that darkness was coming on, decided to hover to a refueling point 150 yards away. He realized that the center of gravity would be critical without the colonel's weight in the right seat so he hovered the helicopter in order to determine whether there would be enough cyclic control.

Weather was clear with wind approximately 30 miles per hour and extremely turbulent. The helicopter was brought to a hover and after a few moments the pilot became satisfied that he had enough cyclic control. As he moved forward a strong gust of wind struck from the right, resulting in the pilot using up what little right cyclic he had; also, he ran out of pedal and the helicopter began turning to the right. Unable to control direction and lateral movement any longer the pilot lowered pitch. The helicopter touched down moving to the left then, according to the pilot, "struck the only stump in the area which caused the helicopter to turn over." He further stated, "I am confident that if I had missed the one and only stump in the area that I would have successfully landed the helicopter."

Lady Luck was riding this ill–fated flight and the pilot fortunately emerged unhurt and, amazingly, the patient did not receive further injury, although pinned under the wreckage.

The pilot, having a patient on board, being low on fuel,

and faced with approaching darkness, was no doubt under some strain and very anxious to complete his mission. However, there is no excuse for failure to use good judgment and especially no excuse for taking unnecessary risks.

Ballast on the right litter probably would have prevented the accident, but, better still, hauling a couple of five gallon cans of gas from the refueling point, 150 yards away, would have prevented it.

Contributing Factor

Faulty navigation has long been a prominent contributing factor leading to aircraft accidents. Examples of this type of accident, picked at random from the world wide accident files, are given below.

One

A pilot was flying a passenger in an L–19 on a night administrative cross–country. Prior to take–off the pilot planned the course of the flight, filed his flight plan, and thoroughly checked his aircraft and radios. All were in good order. Shortly after becoming airborne, they left the local flying area and the pilot turned all radios off.

The first check point was passed on schedule, but a few minutes afterward a bird came through the propeller and struck the lower portion of the right windshield and right wing. An inspection was made by the pilot and passenger from the cockpit with flashlights and no damage to the aircraft nor unusual vibrations of the propeller were detected.

Shortly after the bird incident, the passenger fell asleep. Some time later he awoke and asked the pilot where they were. The pilot pointed out a small town they were flying over and stated its name. The passenger, being familiar with the terrain near their destination and over this particular route, disagreed.

The pilot pointed out a rotating beacon ahead of them to substantiate his belief, and gave the name of a military air base. However, upon checking closer, it turned out to be a civilian field, and, although there was activity on the field, the runway was unlighted. The pilot rechecked his map then attempted to use radio aids but was unsuccessful. He checked

his map again and turned to a westerly heading, 90 degrees from that which they had been fiying.

They continued on the new course for approximately twenty minutes when another rotating beacon came into view. The pilot thought that it marked another military base, but it was an unlighted, civilian field, which proved later to be 115 miles NNW of their destination.

At this time neither the pilot nor passenger had any idea where they were, and the pilot made another attempt to use his radio. They circled the nearby town for approximately 15 minutes, trying all radio channels and calling "Mayday," but to no avail. The pilot returned to the field and circled several times, flashing his landing lights on and off to attract attention on the ground and in hopes of having the runway lights turned on. He was unsuccessful.

Finally the pilot made several passes over the field for reconnaissance and to determine wind direction. Upon being satisfied that the field was clear of obstructions he established an approach. During the initial phase of the approach the pilot told his passenger that he thought he saw an aircraft's landing lights coming on a collision course and that he should watch for them. The passenger stated that he scanned the sky and could find no lights other than the stars shining above. While the passenger was looking up, the aircraft hit the ground, bounced and cartwheeled.

The pilot was killed instantly and the passenger suffered serious injuries. The airplane had crashed two miles from the emergency field and 115 miles from the destination.

Two

A pilot, with his mechanic as passenger in an H–13G, was returning to his home base after completing temporary duty. The weather, during the flight, was ceiling 1000 feet overcast with occasional broken clouds at 800 feet, visibility, three miles with snow showers. The intended flight path was to follow a river to a main highway then follow the highway to the point of first intended landing.

The river was followed without difficulty; however, the pilot mistook another highway for his turn–off point.

After flying down the wrong highway for approximately five miles the pilot discovered the error and elected to let

down and check a highway sign in an effort to determine his exact location. There was a layer of condensation on the inside of the bubble, which made it impossible to read the highway sign; also, the aircraft was not equipped with a heater or defroster to remove this condensation.

The pilot decided to land in a nearby plowed field and send his mechanic to read the sign. He circled the field several times in order to ascertain the presence of obstacles or other hazards which would impair his approach and landing. The field appeared to be clear of all obstructions and the pilot established a normal approach.

Approximately 50 feet from the ground and with 25 miles per hour air speed, the pilot suddenly saw that he was letting down into wires. In an attempt to avoid them he applied full throttle and pulled full pitch, but too late. The wires caught the vertical stabilizer and the helicopter pitched downward, almost 90 degrees. The pilot applied back cyclic, cutting the tail boom, and the helicopter fell to the ground, crashing on its bubble then turning over onto its back. The pilot and passenger walked away without injury.

We could give a long dissertation about errors made in the above accidents, but the primary mistake and contributing factor was a lack of self discipline among pilots in the observance of good navigation practices.

In the first accident, the pilot was not making use of his radio aids, at least not until he was hopelessly lost. He then discovered that the static was so great that he could not receive anything, nor did he know if he was transmitting. By failing to utilize his radios, he used poor judgment and violated regulations which require a radio listening watch of appropriate radio facilities, and which also require at least one position report every hour (Flight Regulations for Army Aircraft, par. 21, AR 95–8). A position report, which was due over the first check point, would have indicated the condition of his radios.

In the second accident there were several contributing factors but the one which started the chain of events that led to an accident was *faulty* navigation.

In flight planning a pilot must study weather conditions along his route, consider the wind and figure it into headings, calculate time between check points, and record the in-

formation in his flight log. (An example of a simple flight log can be found on page 8, May 1955 issue of the ARMY AVIATION DIGEST.) Further, a pilot should use all radio navigational facilities available. Finally, he should follow his flight plan accurately, and if he does become "dis-oriented," he should not let pride cause him to hesitate. He should immediately tune his radio to 121.5 and announce his predicament in order to get help. This is using good judgment, and it is the type of action that gains respect.

Hanger fliers sometimes grin when a gray haired pilot walks to the plotting table in operations, pulls out maps, blank paper, Weems plotter, and his E6B computer to plan a simple 50 mile cross-country which follows a prominent highway, but he always gets where he is headed for.

(*HURRICANES continued from page 12*)

Hurricane Advisory Service

A great deal of time and space could be consumed elaborating on the advancement of storm warning service, from the time of Professor H. W. Brande's first synoptic weather chart to the present; however, this section will be restricted to a brief description of the present day hurricane advisory service.

Information regarding storms and hurricanes is issued to the public and civilian agencies by the United States Weather Bureau. Hurricane warning service is provided to the Air Force and Army Commanders within the continental United States, eastern Pacific, North Atlantic, and Caribbean areas by the Air Weather Service.

Types of Forecast

(1) *Weather Bureau Advisory*—This includes the location of the tropical cyclone with a six hour forecast on its movement with appropriate area warnings.

(2) *Air Force Bulletins*—This bulletin consists of the U. S. Weather Bureau six hour advisory, a twelve and twenty-four hour forecast on the movement of the tropical cyclone and the radius of winds of 50 knots or higher for each forecast position.

Types of Warnings

(1) *Warnings*—Area(s) forecast to be in or near path of the tropical cyclone during the valid time of the bulletin but the surface winds will be less than 34 knots.

(2) *Gale Warning*—Cited area(s) forecast to be affected by winds of 34 to 47 knots during the valid time of the warning.

(3) *Storm Warning*—Cited area(s) forecast to be affected by winds of 48 to 63 knots during valid time of the warning.

(4) *Hurricane Warning*—Cited area(s) forecast to be affected by winds of 64 knots or more during valid time of warning.

The above advisories are issued each six hours that a storm is in progress with special bulletins issued when warranted.

The United States Weather Bureau maintains hurricane warning centers in all major sea coast cities. Air Weather Service maintains a Hurricane Liaison Officer at all major centers and the Air Force and Navy maintain weather reconnaissance units in all areas that might be affected by tropical storms.

The tremendous record of deaths and property damage caused by tropical cyclones in the past was due primarily to the lack of hurricane warning service. This is no longer true. Today, with the combined team of the Weather Bureau, Air Weather Service, and the U. S. Navy forecasting, tracking, and escorting the storms, it is improbable if not impossible that a tropical storm could approach any land mass in the western hemisphere without the population being forewarned.

(*A FIX FOR DOWNTIME continued from page 22*) To summarize: ease-of-maintenance evaluations are for the purpose of minimizing the time, tools, and mechanical skills required to perform maintenance of Army aircraft. An urgent requirement exists that specific, well-defined maintenance design criteria be developed and clearly expressed in military characteristics and design specifications. These maintenance design criteria must be enforced without compromise by either the military or industry if the Army aviation program is ever to receive aircraft that are inherently "easy to maintain."

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For explanation of abbreviations used see SR 320-50-1.

ARMY AVIATION SCHOOL CREST

When reproduced in full color, the colors red, blue, and yellow are used in the crest to indicate representation of all branches of the Army in The Army Aviation School. The school's aviation training mission is symbolized by the perched falcon denoting the art of falconry with its patient training of swift, keen birds for hunting. The mailed fist depicts the military ground arm which exercises the control, training, and direction of the flight.