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ACCIDENT INFORMATION — STORING AND RETRIEVING

By William Russler†

I. Introduction

EVERY AGENCY concerned with aircraft accidents—civil or military, foreign or domestic—has its own investigation, reporting and record keeping system. These systems vary procedurally and in substance, but all are motivated by the same primary objective, which is to prevent the recurrence of accidents. Even though each agency goes about its job in a different manner, the various systems of the different agencies certainly have many characteristics in common.

Since my experience in this area is with the United States Air Force, I shall discuss accident information, reporting, and retrieving from the Air Force viewpoint, and tell you a little about what we do and how we do it. This may or may not be representative and may or may not be universally applicable. Despite similarities in the systems of the various agencies, there are some profound differences. For example, only since 1965 have the three United States military services agreed on the criteria as to what constitutes an aircraft accident. In the last four months, the Army, the Navy, and the Air Force safety centers have had to have several conferences to resolve technical differences in interpretation of our agreed upon definitions. Since standardization seems to be the order of the day, I would not be at all surprised to see a movement toward entering into discussions with our civil authorities in the not too distant future, to determine whether we cannot all agree on aircraft accident reporting criteria, nomenclature and terminology.

II. Air Safety—A Command Function

Air safety and accident prevention in the Air Force is a function of command. This means that every commander, including those of the active and reserve forces, is charged with the responsibility for accident prevention and with establishing and conducting formal, aggressive, effective and integrated safety programs to prevent aircraft, ground, explosive, missile and space accidents. The Air Force follows what might be called an integrated or consolidated concept of accident prevention. This total safety concept stems from the basic consideration that every commander and supervisor within the Air Force is charged with the responsibility of safeguarding from injury *all* of his military and civilian personnel, and all non-Air Force personnel and property from accidental injury and damage which could result from Air Force activities; and each commander

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is charged with protecting from accidental damage or destruction *all* equipment, facilities, and properties assigned to him or under his jurisdiction. Thus, effective accident prevention programs require the coordination and integration of flight, missile, space, explosives and ground safety efforts. For these programs to meet current needs and reflect the rapid changes in technology and operations, commanders must, therefore, have consolidated safety staffs with specialists in the various safety disciplines.

III. Air Safety—The Directorate

At the pinnacle, at headquarters United States Air Force, there is a single agency with air staff responsibility for monitoring all accident prevention programs in the Air Force (other than nuclear safety). This is the Directorate of Aerospace Safety in the office of the Deputy Inspector General for Inspection and Safety—which even though a part of the headquarters United States Air Force, at Pentagon level, is physically located in southern California, at Norton Air Force Base, in San Bernadino. The Directorate of Aerospace Safety has some 250 people—air, ground, explosive and missile safety specialists, engineers, investigators, statisticians, flight surgeons, psychologists, analysts, project officers, programmers, electronic data processors, writers, artists, and a host of other types of technicians, clerks, and of course secretaries—who are devoted to developing and monitoring policies, standards, procedures, and programs for preventing aircraft, missile, ground, and explosive accidents/incidents; conducting studies, surveys and accident investigations; analyzing safety reports and data; determining safety educational requirements; and administering safety incentive and awards programs. The Directorate is organized by function into flight, missile and space, and ground safety divisions and safety education, life sciences, systems safety engineering, and records and statistics groups. The chief of our systems safety engineering group, Colonel James Keel, will speak to us tomorrow.

The safety effort requires careful evaluation of past experience and detailed analysis of accidents and incidents which occur daily throughout the Air Force. It requires monitoring of all activities in which accident potentials exist. Our most important functions are as follows: to identify areas of concern and to disseminate analyzed data and related recommendations. Among many other functions the Directorate is charged with:

(1) establishing Air Force-wide programs and procedures for investigating and reporting accidents, incidents, and hazards; monitoring and determining the adequacy of investigations and reports of accidents and incidents; acting as final reviewing authority on reports submitted in accordance with the directives that we issue; and

(2) determining statistical and data requirements to support aerospace safety programs; providing a repository for all aerospace safety accident reports; collecting, indexing, and summarizing reports of accidents, incidents, hazards, and safety deficiencies for analysis and research; and publishing and issuing refined data and studies as ap-

propriate to accident prevention.

Many of these tasks fall within the area of responsibility of the records and statistics group. The records and statistics group serves all the functional safety areas.

Our mission within the Directorate of Aerospace Safety is the basic job of administering the reporting programs and thereby collecting, processing, analyzing, presenting and disseminating all accident and hazard statistics required for the support of the United States Air Force safety programs. We are the office of origin for the consolidated directive covering the policy and responsibilities for investigating and reporting all accidents throughout the Air Force as directed by Air Force Regulation 127-4. The resource and service group coordinates the requirements of each functional safety area and integrates these into a consolidated reporting program to avoid overlap, eliminate gaps and insure comparable definitions and standards. All of the aircraft, missile, ground and explosive reports required by AFR 127-4 flow into the resource and service group. We act as custodian of these documents. Each accident and incident report is reviewed for conformity with the reporting regulation. Questions concerning accident classification and reportability are resolved, and policy files are maintained to provide consistency of interpretation and continuity of policy. A variety of code systems are used to record information or put it into machine language so that data may be processed.

We are a resource and service agency for the divisions within our own organization and for any agency within (or outside) the Air Force that has a legitimate interest or need for data in accident prevention. We provide the statistical support, maintain the official, permanent records, and make the necessary statistical evaluations. We publish such reports as are pertinent to our area of responsibility ranging from a daily accident summary to an annual accident bulletin and special analytical studies. As many as fifty special reports each month are prepared to meet requests from the staff, project officers within the Directorate, other Air Force offices, and the Congress and safety agencies outside the Air Force.

The United States Air Force has an exceedingly comprehensive accident reporting system. Through a structure of initial and follow-up reports our system accomplishes two main purposes, which are:

(1) the need to notify proper authorities rapidly that a mishap of stated proportions and impact occurred, and

(2) the need to report the results of the investigation so that corrective action can be taken.

These are accomplished through telephonic reports, teletype messages, and ultimately a formal report. This report is a detailed record of the investigation and is submitted on the Air Force Form 711 Series.

In our business, literally bales of accident reports, incident reports, flight records, and operational hazard reports are received every day. Annually the Air Force experiences—and we process—over 7,000 aircraft accidents and incidents, 11,000 ground accidents, 500 missile accidents

and incidents, close to 1,000 non-nuclear explosive mishaps, and 1,200 operational hazard and barrier contact reports. In addition, 300,000 flight records were received last year. Individually each accident and incident is an event of extreme importance and vital concern. But nobody can remember every accident and all its details. Taken together all these mishaps present only a quantity of perhaps bewildering documents. To use a trite cliche, we may find ourselves in the position of not being able to see the forest because of the trees. Before we can see the forest, the facts present in each accident report must be organized.

Our analysis system provides a method of bringing order out of chaos or, in other words, of seeing the whole picture and all its details in appropriate and accurate perspective. We have, therefore, developed sophisticated analytical coding schemes so that narrative reports of investigations may be indexed and recalled for ultimate use as manageable and useful accident prevention information. This analysis system digests the masses of reports by organizing and categorizing batches of information which may, on the surface, appear to be unrelated and distilling this information down to clear, simple, descriptive, and understandable terms. In 1967 the Air Force had 332 major aircraft accidents. This in itself is a statistic. But, when we are able to say that 36 percent or over 100 occurred during final approach and landing, we have an important fact which is of significance in any accident prevention program. Our analytical system thus permits us to gain a better overall comprehension of our subject matter and provides the means for dealing with problems which could not otherwise be handled.

When an aircraft accident report is received in our office, it is exhaustively reviewed by trained analysts to evaluate whether or not there has been an adequate investigation which has in turn disclosed all the factors involved in the accident, whether conclusions or findings as to the cause or causes of the accident are valid and whether or not the proper corrective action has been or will be taken. In conjunction with its individual review, each aircraft accident is coded according to a complex system developed and refined over the years; it is then introduced into our computer bank. From our continuing experience, this coding scheme is modernized from time to time to meet newer concepts and revised necessities. At the present time, close to 200 individual variables are coded for each aircraft accident to include such items, for example, as the damage, injury, mission of flight, fire, ejection seat use, clearance, flight reference, personnel duty of the people involved, aircraft and engine hours since manufacture or overhaul, pilot's flying experience, and organization. Because of its complexity and detail, the accident coding system provides us with a mechanism which is intentionally designed for versatility.

The coding system provides the basis for the following:

(1) tabulating accident data for analysis of factors in accidents by frequency of occurrence, and

(2) indexing of accident data, for reference, research, and the

high-lighting of correctable causes.

From the standpoint of aircraft accident prevention, the most important part of the analysis is the identification of the various human errors and material failures which cause aircraft accidents. No factor which had any bearing on the mishap is omitted from coding. Even though a specific factor may seem to have been remote in a particular accident, frequent repetition of that factor is an important guide to prevention. We classify all causes into unsafe acts and unsafe conditions and environmental factors. Unsafe acts include all personnel errors committed and/or omissions or failures of personnel to take action which lead directly to accidents. The unsafe conditions and environmental factors apply to deficiencies in the aircraft, malfunctions of material, and conditions outside the aircraft, such as on airports, airway facilities, or weather which may cause or contribute to an accident.

Our accident cause factor classification procedure calls for the identification of one primary cause factor in each accident. We recognize that all accidents are the result of a sequence of events or a combination of factors. However, the primary cause factor is defined as that point in the sequence of events and/or that factor without which the probability for accident occurrence would be reduced to a minimum. In other words, the primary cause is that factor which made the accident most likely or inevitable—and it is not necessarily the first event in the chronological sequence of occurrences. Although there is only one primary cause per accident, as many secondary or contributing causes as are described in the report of accident investigation are coded. Some systems of analysis have attempted to allocate a percentage value or weight to each of the elements contributing to the accident. The wide variations in allocating values in a particular accident by experienced analysts have made use of this system impractical. We found it impossible to maintain consistency between analysts in allocating percentage values, and the percentage system has not worked out well in practice. Accordingly, it is the policy of the Directorate of Aerospace Safety to record a primary cause factor in each accident and all other contributory factors on an equal basis. The pattern for preventative action is disclosed by the frequency of occurrence of each factor.

We have in our office one of the world's largest collections of information on accidents. This repository includes data, reports, files, or summaries on approximately 100,000 military aircraft accidents which have occurred since the first military accident in 1908, in which Lt. Selfridge was killed and Mr. Orville Wright suffered a broken thigh. We also have the complete flight history of every rated, that is, flying officer in the Air Force. This office directs operation of the individual flight records program throughout the Air Force. Their main usage is in direct support of studies correlating age, proficiency, and experience versus accidents; they are used for trend analyses and other research. The flight history of every active rated officer will soon be in our computer memory bank which will enhance our ability to evaluate this data. Other data reported and avail-

able to us include personnel strengths, flying hours, aircraft landings, inventories, in and out-of-commission data by type and model and organization. These records permit calculations on the frequency of accident occurrence against exposure.

Up until quite recently, we were equipped with punch card accounting machines; consequently, we were limited in our capability to accomplish the kinds of data processing necessary to satisfy the Air Force's requirements. For example, 80 percent of the recurring and special statistical reports were being produced manually because of the inability to compute accident rates, percentages, and means standard deviations automatically. This manual processing involved a large number of ledgers, logs, and workbooks requiring considerable time for manual maintenance.

Several years ago, realizing that something had to be done to improve our situation, a comprehensive data system review was initiated. This culminated in the preparation of a data automation proposal in which it was recommended that a computer be obtained. This proposal was approved and after much work in developing the data system specifications and evaluating equipment configurations, we obtained and had delivered to us last November an IBM 360 model 40 computer. This machine is a third generation computer which provides us with very powerful capability. The implementation of the new system required modification of our organization. Many jobs were changed, with a rearrangement of people and skills. The implementation of the new system also required an extensive training program to acquaint personnel with the capability of the new equipment system and the manner in which the new data system operates.

Much has been written about the tremendous increase in information storage capacity and speed of retrieval that computers provide, and this is true also of our equipment. The volume of aircraft, missile, and ground accident information which we maintain is so large that punch card processing was too cumbersome and too slow. Automatic data processing, using core storage, magnetic tapes and magnetic discs, enables us to retrieve and tabulate information very rapidly. The computer provides us with the means to produce more timely and informative reports. But we also recognize the great potential the computer offers for research and for more intensive investigation of significant trends and measurement of relationships of accident variables. To explore this potential, we have established a statistical research section. Emphasis is on the application of correlation analysis, tests of significance, analysis of variance, construction of mathematical models, and probability measures to accident data. The mathematical statistician's technical knowledge and the computational capability of the computer to perform statistical routines are vital factors in promoting an aggressive Air Force accident research program.

We have designed our computerized data system so that the vast amount of information in our data bank will be more useful than it has been in the past. Our information system is greatly expanded and we have the

capability of accomplishing greater in-depth studies. We have modified some of our reports and designed new ones; we have looked for means of providing more rapid and positive detection of adverse trends. We have standardized our accident/incident reporting system; in all of our systems we have made full use of standardized data elements and codes. This enables us to utilize data from other data processing systems and to exchange data with other agencies—within the Air Force and with the Navy and the Army safety activities.

IV. Conclusion

I have tried to give you a brief overview of the Air Force's accident reporting, record keeping, storage, and retrieval program. At the headquarters level this takes some 50 people and equipment that costs us over $300,000 per year to rent. Just what role and what value does this vast program play in accident prevention? Why is management willing to pay this price? Why not just put the accident reports in file drawers and leave them there? While these may sound like rhetorical questions, may I point out four important factors:

(1) The statistics we produce provide a yardstick by which the safety performance of the Air Force as a whole, of individual organizations, and of the different types of equipment can be measured. The assessment of performance in most military applications is usually a value judgment. In safety, however, we can produce objective yardsticks—accident rates. Air Force management, therefore, can know what is happening in accident frequency over a period of time, be able to follow the continuous development of trends, and analyze the changes taking place. Thus, we know whether particular programs and prevention efforts are paying off and whether changes should be made.

(2) The data we compile measures the impact of accidents on the Air Force. The seriousness of our accident situation—in terms of economic loss and in terms of losses of personnel and equipment—allows us to gauge accurately the effect that accidents have on operational effectiveness and combat capability.

(3) The information we store and retrieve is fundamental in prevention research. The Directorate does not just write histories. Accident data identifies vital activity areas and provides a basis for corrective action. Our records and analyses help us determine what our problems are—what is failing, where correction is needed. Thus, in implementing the systems safety engineering concept to incorporate safety in the initial conceptual and definition phases of new systems, careful evaluation of past accident experience is especially pertinent in order to avoid repeating design errors and problems encountered in predecessor weapon systems. Our data bank helps to eliminate many hardware problems in new systems.

(4) The output data derived from accidents, incidents, and hazards form not only a basis for air staff and command corrective action, but also help to provide direction for the entire program of safety—which

installations to visit, which surveys to make, which investigations to conduct, what studies to pursue, which problems to attack, and what our safety education efforts should be.

Ultimately, accident data affect major Air Force programs involving training, procurement, supply, maintenance, engineering changes, and the expenditure of funds. You will note that I have said little about dissemination or exchange of air safety information outside the Air Force. This would be the subject of a separate and distinct paper.

Since this is a Symposium on Air Safety sponsored by the *Journal of Air Law and Commerce*, at some point there must inevitably come an interface between air safety and aviation law. Our next speaker, Mr. Robert R. Gray, will address himself to the attorney's role in accident investigation. If there are any questions which may arise concerning accident litigation involving the Air Force, may I say that we have with us, as participants in this Symposium, Colonel Robert A. Prince, Chief of the Litigation Division, Office of the Judge Advocate General, Washington, and Colonel Robert E. Ashman, Legal Advisor to the Deputy Inspector General for Inspection and Safety, Norton AFB, California, who will be pleased to enter into the discussion.