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Nuclear-Power-Safety Reporting System:

Feasibility Analysis

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Prepared by
F. C. Finlayson, J. Ims

Energy and Resources Division
The Aerospace Corporation
Los Angeles, CA 90009

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ABSTRACT

The U.S. Nuclear Regulatory Commission (NRC) is evaluating the possibility of instituting a data gathering system for identifying and quantifying the factors that contribute to the occurrence of significant safety problems involving humans in nuclear power plants. This report presents the results of a brief (6 months) study of the feasibility of developing a voluntary, nonpunitive Nuclear Power Safety Reporting System (NPSRS). Reports collected by the system would be used to create a data base for documenting, analyzing and assessing the significance of the incidents.

Results of The Aerospace Corporation study are presented in two volumes. This document, Volume I, contains a summary of an assessment of the Aviation Safety Reporting System (ASRS). The FAA-sponsored, NASA-managed ASRS was found to be successful, relatively low in cost, generally acceptable to all facets of the aviation community, and the source of much useful data and valuable reports on human factor problems in the nation's airways. Several significant ASRS features were found to be pertinent and applicable for adoption into a NPSRS. The recommended features for adoption include the concepts of a voluntary reporting system; providing anonymity to reporters in order to avoid potential concern over self-incrimination; providing motivational support for report submission by giving a limited warranty of immunity from regulatory redress to principals who participate in the program; and ensuring the promised anonymity and immunity features by conducting the program though a neutral, independent third-party organization outside both the NRC and the nuclear utility industry.

Volume II provides a concept description for the NPSRS. Significant viewpoints of some members of the Nuclear Regulatory Commission, utility management, operational personnel, and the public are presented that must be considered in the development of a NPSRS. The operational aspects and requirements of the system are also outlined. Recommendations are also made for the development of implementation plans and plans for testing the feasibility of the system prior to implementation.

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ACKNOWLEDGEMENTS

The authors wish to thank the management and staff of the Aviation Safety Reporting System (ASRS) for their cooperation and assistance in helping us understand the history and operational methodology of the ASRS. Special thanks should be given to William Reynard, the NASA project chief, Edgar Cheaney, the Program Manager of the Battelle operations of the ASRS; Rex Hardy, the ASRS Output Supervisor, and James Loomis, from Battelle Columbus Labs. In addition, we were given substantial insight into the effectiveness of the ASRS from the viewpoint of the Federal regulatory agency by Tom Kossiaris, the Federal Aviation Administration's Program Manager for the system. Finally, John Winant, Chairman of the NASA Advisory Committee on the ASRS, gave freely of his time and opinions on the effectiveness of the System and shared valuable data with us on the results of the Committee's recent evaluation of the ASRS. We are grateful for the insight we received from all of these individuals.

Our understanding of the technical community's viewpoints that must be considered when evaluating the feasibility of either the Aviation Safety Reporting System (ASRS) or the Nuclear Power Safety Reporting System (NPSRS) was greatly increased by discussions that occurred at a NPSRS concept review meeting sponsored by The Aerospace Corporation. A large number of these viewpoints have been reflected in the body of our report without direct attribution to those who provided them. Many of our insights into methods of coping with potential NPSRS issues have resulted from the discussions of the meeting. We owe a debt of gratitude to the attendees who contributed freely of their time and comments. In addition to the authors, attendees included: Robert J. Breen, NSAC/EPRI; Kay Comer, General Physics Corporation; Paul E. Dietz, INPO: T.A. Hussman, Aerospace; Tom Kossiaris, FAA; James P. Loomis, Battelle Columbus Labs; Ken Murphy, NRC-RES; Charles M. Overbey, NRC-RES; Suzanne R. Phelps, Edison Electric Institute; Thomas G. Ryan, NRC-RES; Paul Shoop, International Brotherhood of Electrical Workers; E. L. Thomas, Duke Power Company; Philip R. Wallace, Tennessee Valley Authority; William Zelinsky, Aerospace.

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NUCLEAR POWER SAFETY REPORTING SYSTEM
VOLUME I. FEASIBILITY ANALYSIS

1.0 INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) is evaluating the possibility of instituting a data gathering system for identifying and quantifying the factors that contribute to the occurrence of significant safety problems involving humans in nuclear power plants. The Aerospace Corporation is assisting the NRC in its evaluation of the feasibility of a formal reporting system of this type. The objectives of this Aerospace study have been twofold: (1) to analyze the existing Federal Aviation Administration (FAA)/National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS) in order to determine whether it would be feasible to apply part (or all) of the ASRS concepts for collecting data on human factor related incidents to the nuclear industry; and (2) to identify and define the basic elements and requirements of a Nuclear Power Safety Reporting System (NPSRS), assuming the feasibility of implementing such a system could be established.

Data developed by the NPSRS would be used to support: (1) quantification of the human reliability elements of probabilistic risk assessments (PRAs); (2) the measurement of baseline human performance characteristics that are needed in order to evaluate the influence of various nuclear power plant systems performance shaping factors on human error-proneness within the system; and (3) the development of design criteria for advanced human-machine safety systems. NPSRS feasibility depends upon a number of issues such as: (a) practicality (e.g., costs and logistical requirements); (b) acceptability to government, industry, and operational personnel; and (c) the utility of data developed by such a system (e.g., its relevance, reliability, biases, and completeness).

This report presents the results of an initial study of the feasibility of developing a voluntary, nonpunitive NPSRS whereby safety related incidents in nuclear power plants may be documented, analyzed and assessed. The implementation of such a system would increase the data base for safety related incidents involving both erroneous and positive human actions substantially beyond the quantity now available. The empirical data that could be derived from such a reporting system would be rich with the diversity of incidents described in its contents. It is reasonable to expect that a greater understanding of the root causes of human errors in the design and operation of nuclear plants, previously unidentified sources of potential human factor problems, and effective problem solving mechanisms could be developed from analyses of NPSRS data.

The data from a NPSRS would also be an important contribution to the Human Reliability Data Bank under development by the NRC in support of research on probabilistic risk assessments. With a NPSRS, PRA analysts would have an important source of data for identifying some of the significant contributing elements of human errors to safety-related incidents in nuclear plants. Data would also be available on the mechanisms by which humans act to resolve errors, once they have been committed - or resolve other accidentally induced problems. An understanding of human problem solving mechanisms would also be an aid to PRA analysts. Moreover, a NPSRS would also provide an important contribution to qualitative assessment of probability data included in a human reliability data bank.

The results of The Aerospace Corporation study are presented in two volumes. This document, Volume I, describes an assessment of the Aviation Safety Reporting System that is sponsored by the Federal Aviation Administration, but actually administered by the National Aeronautics and Space Administration. The ASRS provides a voluntary, nonpunitive mechanism whereby members of the aviation community can report on safety-related incidents occurring in the nation's air space without self-incrimination. In this study, the ASRS has been used as a model for application of similar concepts in the nuclear power industry. Volume 2 describes the elements of a Nuclear Power Safety Reporting System (NPSRS) that might meet the requirements for a safety related incident reporting system in the nuclear industry.

The scope of the brief study reported in these two volumes has been restricted to an assessment of the data collection mechanisms of a NPSRS. No significant consideration was given in this study to the data handling or assessment mechanisms that might be required to provide a complete system that would interface compatibly with all of the other facets of the human factors related development programs of the NRC. These systems aspects could be treated in more detail in subsequent phases of the study, if further research on the NPSRS concept is conducted.

1.1 Background

Human error is recognized as a significant contributor to nuclear power plant risk, yet we have neither a complete understanding of the actual causes of human error nor the magnitude of contributions to human error from various performance-shaping factors, e.g., design or operational procedure induced errors. Current Licensee Event Report (LER) descriptions that are required by the NRC are generally too abbreviated to permit the causal factors associated with incidents of operator error to be ascertained. Little improvement in this area is anticipated under the proposed revisions to LER requirements and formats whereby reports will be made in narrative form. In the revised LER system, reporting requirements would be reduced. Under the proposed new requirements, only significant incidents involving important violations of plant technical specifications must be reported. Unreported incidents or near-miss conditions may involve potentially significant factors contributing to human errors. Other safety-related incident reporting systems are also used by the NRC, including the 766

System File used by the NRC's Office of Inspection and Enforcement to document incidents of utility noncompliance with NRC regulations; the so-called "Gray Book" Data File; the Systematic Assessment of Licensee Performance files, a functional evaluation of plant components; and the Effluent Release Report, a file detailing personnel radiation exposure reports. Though extensive in scope, the nature of these additional reporting mechanisms has not made them an effective mechanism for obtaining the kinds of human-factor related data sought in this study. Consequently, many incidents associated with human errors either go unreported or no procedures exist for isolating such incidents from the existing reporting systems. The unreported errors could be precursors or indicators of situations for which remedial actions of a specific or generic nature could be performed, if the data were available.

The FAA was faced with a similar problem of obtaining reports and data on safety incidents involving flight crew or air traffic control personnel. In 1976, in order to increase their understanding of human-related safety problems, the FAA instituted the Aviation Safety Reporting System. The ASRS was designed to encourage flight crew members, air traffic controllers and others in the national aviation system to voluntarily report any incident, situation, or occurrence which the reporter felt was related to air safety. Two provisions were included in the system as an inducement to motivate voluntary reporting. First, a neutral and independent third-party organization (NASA) was asked to manage and operate the program in order to isolate the report (and the reporter) from direct contact with the FAA, thereby providing anonymity for the reporter. Second, the FAA offered a limited waiver of disciplinary action to reporters who might have violated Federal Air Regulations, as long as criminal offenses or actual accidents were not involved in the incident. The participants in the ASRS feel that these two provisions have contributed in large measure to the success of the program.

The benefits to the reporting system of some of the associated ASRS features such as voluntary report submission, reporting confidentiality, immunity from disciplinary action, and simple initial reporting methods seemed appropriate for consideration in a NPSRS program. There are some strong similarities between the needs of commercial aviation operations and nuclear power facility operations. Both have a particular need for recognizing and modifying operational system factors that promote human errors that may lead to safety hazards in their respective industries. The ASRS has aided the national aviation community to better understand many of the factors associated with human error. It seems logical to assume that a related system for the nuclear power plant community could aid the understanding of human error related problems.

1.2 Program Objectives

The results of a short (approximately six-month) study that was conducted by The Aerospace Corporation for the Human Factors Branch of the

Nuclear Regulatory Research Division of the U.S. Nuclear Regulatory Commission are presented in this report. The overall, long-range objective of this research on the potential for developing a voluntary safety related incident reporting system is to develop a means of ascertaining the root causes of human error and a means of determining the important performance shaping factors (i.e., factors associated with the designs of the man-machine interfaces, written or oral operational procedures, stress levels, etc.) and their influences on the actions of nuclear power plant operating personnel. The Nuclear Power Safety Reporting System (NPSRS), as the concept has been entitled in this report, is being investigated as part of the NRC's larger Human Reliability Research Program to support, in part, the Human Risk Analysis (HRA) segment of the probabilistic risk assessment programs, as well as various other reliability evaluation programs.

In the initial phase of the program described in the two volumes of this report, the objectives were three-fold: (a) to evaluate the feasibility of a voluntary, nonpunitive reporting system (a NPSRS) that might achieve the overall objectives of the program; (b) to identify the basic elements that must be considered in a NPSRS program; and (c) to prepare a program plan for NPSRS development. The objective of the portion of the work described in this volume was to make an assessment of the Aviation Safety Reporting System (ASRS), sponsored by the FAA, with respect to the applicability of the ASRS features to a reporting system for the nuclear industry.

1.3 Scope and Limitations of the Study

In order to evaluate the feasibility of a NPSRS, Aerospace performed an evaluation of the FAA sponsored and NASA managed Aviation Safety Reporting System. The evaluation was conducted in order to determine whether the ASRS concept, or portions thereof, might be appropriate for application to the nuclear industry. The evaluation was based upon an assessment of the results of the ASRS program in terms of: (a) its practicality (i.e., its monetary costs, logistical requirements, etc.); (b) its acceptability to government and industry; and (c) the utility of the data derived from the system (i.e., its usefulness to the U. S. aviation system, its relevance, reliability, biases, completeness, etc.).

The determination of the basic elements of a NPSRS was based on an analysis of the functional requirements of such a system and discussions with the NRC and nuclear industry officials. The purpose of the discussions was to identify potential considerations that might affect the acceptability of a NPSRS to the NRC and the nuclear industry. The major considerations surrounding a NPSRS concept are discussed in Volume 2 of the report.

In this initial phase of the research, the scope of work has been limited to consideration of the data acquisition aspects of such a system. The resolution of issues associated with the mechanisms and methods of data compilation, processing, and storage have been explicitly excluded from the current phase of the research program, although some brief comments on these subjects are presented. At this point, it is sufficient to observe that a taxonomy developed for data retrieval with the NPSRS (i.e., a set of key words and phrases suitable for indexing the significant elements of the data) would have to be flexible and capable of growth. These dynamic characteristics of the NPSRS taxonomy are required because the reports received by the system would be expected to be rich in the kinds of experiences covered because there would be no prescreening of topics in a voluntary reporting system.

Thus the Aerospace study was focussed on the factors, issues, approaches and problems attendant with development of a system for acquiring data on human error-related incidents in the nuclear industry. The problems associated with formatting, validating, and editing the data were set aside for subsequent efforts.

1.4 Organization of the Report

The following sections of this volume describe the results of the assessment of the ASRS program. An analysis is presented of the practicality, acceptability, and utility of the ASRS to the aviation industry. A brief summary of the applicability of portions of the ASRS concept to a NPSRS concept is then provided. The final section of this volume presents a summary assessment of the implications of the ASRS assessment with respect to the feasibility of implementing a NPSRS, the potential benefits of such a system, and recommendations for future research in connection with a NPSRS.

A second volume, ("Nuclear Power Safety Reporting System - Concept Description") describes the results of the Aerospace Corporation study of the major features of a NPSRS. The significant aspects of consideration for those who participate in the program and those affected by it are presented. The potential elements of such a system are considered. A description is provided of the operational processes by which a NPSRS might function. The basic elements of the operational structure required to implement such a system are outlined. The organizational structure is described for the system and its interfaces with parties responsible for input to the system and user elements that obtain data output from the system. Finally, conclusions are provided with respect to the required elements of the system and recommendations are given with respect to future research activities needed to further evaluate the practicality, acceptability, and utility of a NPSRS. The recommendations include development of implementation plans in which the system description and procedures for implementing it would be described in detail, and preparation of test plans in which the mechanisms would be outlined for preliminary field demonstrations of the feasibility of implementing the system.

2.0 AVIATION SAFETY REPORTING SYSTEM (ASRS) ASSESSMENT

Human error has always been a significant contributor to accidents in the national aviation system. (Where the national aviation system is used in this report, it includes all aspects of the air transportation system involving the safety of aircraft operations, including departure, enroute, approach and landing operations and procedures, air traffic control procedures and equipment, pilot/controller communications, aircraft movement on the airport and near mid-air collisions.) In this sense, the nuclear industry shares a parallel interest in human-factor problems with the aviation industry. In order to increase the statistical data base on human-error related problems and improve the flow of information on the causes of safety-related incidents, before they became contributors to serious accidents, the FAA instituted the Aviation Safety Reporting System (ASRS), a voluntary, nonpunitive reporting system for members of the aviation community. (The aviation community is used in this sense to include the human elements of the overall national aviation system, especially pilots and flight controllers.) This section describes an assessment of the ASRS and the applicability of its concepts to the nuclear industry.

2.1 Historical Background of ASRS

Pursuant to a Memorandum of Agreement signed on August 15, 1975 by the Federal Aviation Administration and the National Aeronautics and Space Administration, the NASA Aviation Safety Reporting System (ASRS) became operational on April 15, 1976. The objectives of the ASRS program as set forth in the original ASRS proposal are as follows:

1. To design and implement a confidential reporting system which can be used by any person in the national aviation system;

2. To design and implement a computer-based system for storage and retrieval of processed data;

3. To design and implement an interactive analytical system for routine and special studies of the data;

4. To design and implement a responsive system for communication of data and analyses to those responsible for aviation safety;

   a. regulatory and other government agencies
   b. airlines and commercial operators
   c. aviation manufacturers
   d. civil and military pilots
   e. air traffic controllers
   f. aviation safety research and development groups

The creation of the ASRS was a response to many different requirements and circumstances that existed within the aviation community. Prior to 1975 there existed a substantial body of undocumented safety incident information accumulated over years of aviation system operation, primarily in the form of pilot lore. Fear of individual exposure, self-incrimination, individual/corporate legal liability, and regulatory/managerial disciplinary actions had severely limited formal dissemination of this information. As long as the information was in the form of pilot lore, it was of limited value to many who might have used it to systematically combat hazards in the aviation system.

As it was implemented in 1976, the ASRS was not an entirely new idea. Other attempts had been made to institute a safety reporting system to collect and analyze safety incident data. However, all of the earlier attempts to institute a formal program of information dissemination had been stymied by a pervading fear of legal consequences. One such program, conducted entirely by the FAA in the late 1960's, was intended to be nonpunitive in nature in order to encourage reports of near midair collisions. Although some reports were filed under the program, the response was generally apathetic among pilots because they lacked confidence in the promised immunity provisions. A similar lack of response was encountered in several other attempts at report gathering by both private and corporate-sponsored projects. In time, these attempts at information gathering became essentially dormant until the status quo was altered by the crash of Trans World Airlines (TWA) Flight 514.

On December 1, 1974 the flight crew of TWA Flight 514, inbound to Dulles Airport through cloudy skies, misinterpreted certain ambiguous flight control procedures and collided with a Virginia mountainside. During the National Transportation Safety Board's investigation of the accident, it was discovered that only six weeks before the TWA crash, a United Airlines crew, executing the same approach and in the same location, had very narrowly escaped the same fate. The ambiguous nature of the flight control procedures had been brought to the attention of other United Airlines pilots through a company-sponsored safety reporting program and United Airlines had notified the FAA of the circumstances. Regrettably, there was no generally accepted avenue for spreading the word.

The events of 1974 produced a quick response in the FAA. Almost immediately, they announced the inauguration of a confidential, nonpunitive incident reporting scheme - the Aviation Safety Reporting Program (ASRP). The ASRP was intended to encourage the reporting and categorization of discrepancies in the aviation system before they resulted in accidents. ASRP offered limited immunity and anonymity to reporters, except in the case of criminal actions and accidents. However, the aviation community remained skeptical of the promised immunity and was reticent about reporting the occurrence of incidents to any degree due once again to fear of consequences. The FAA was not perceived as a properly disinterested referee of its own program of data collection about incidents where regulations might have been violated. The FAA was, however, determined to implement a concept like the ASRP. Its response to the failure of its initial program was to turn to a neutral, independent third party - NASA - to collect, process and analyze the voluntarily submitted reports. The two agencies collaborated in generating, in August, 1975, a Memorandum of Agreement under which, funded by FAA, NASA would act as the manager of the newly established Aviation Safety Reporting System (ASRS).

The Memorandum of Agreement described the proposed ASRS functions as "(1) receipt, deidentification and initial processing; (2) analysis and interpretation; (3) dissemination of reports and other data; and (4) system evaluation and review". Procedures were outlined in the Memorandum to deal with the screening of incoming reports to exclude those involving criminal offenses and aircraft accidents and to assure adequate deidentification, anonymity, and confidentiality for reporters.

In addition to the procedural principles, three other matters were initiated during the early development of the ASRS. One was the provision of a waiver of disciplinary action to be offered to reporters. The second was the provision to form a NASA Advisory Committee on the ASRS to advise NASA on the design and performance of the ASRS program and to provide an additional means of communication with the aviation community. Committee membership was to be appointed on a representative basis from all elements involved in the operational aspects of the national aviation system, including the FAA and the Department of Defense (DOD). The Advisory Committee was also charged with surveillance responsibility over the security provisions required in connection with the preservation of anonymity inherent in the system. Finally, in the allocation of funds for the projected ASRS, FAA had recognized that NASA would need to utilize outside contract aid in order to recruit an operationally experienced staff. In October, 1975, a formal Request for Proposal was issued to select candidate firms and institutions appropriate for operating the ASRS. On April 6, 1976, the contract was awarded to Battelle Memorial Institute's Columbus Laboratories. Less than one month later, only about 1 1/2 years after the catastrophic crash of the TWA 514 flight, Battelle pulled together an operational staff and initiated the development and implementation of the system.

The Battelle staff includes the researchers, data processing people and administrators necessary to maintain and expand the ASRS data base. Battelle also has developed a staff of experienced report analysts capable of interpreting incident reports and interacting with reporters from the aviation community. The staff includes a number of retired professional pilots who have spent their careers in the airlines, the military services, in flight testing, and in corporate aviation. The staff also includes air traffic controllers, flight surgeons and aviation lawyers. Most staff members have backgrounds in private as well as commercial aviation and provide an effective communication link between the ASRS system and its reporting and using population.

2.2 Current Status and Managerial Structure of the ASRS

The ASRS has been considered a fully operational system since 1978. It has provided for the receipt, analysis, and deidentification of aviation safety reports, and for processing of the reports into a computerized data bank. In addition, periodic reports of findings obtained through the reporting program have been published and distributed to the public, the aviation community and the FAA.

Any person who observes or is involved in an incident or occurrence that poses a threat to flight safety is encouraged to report it to the ASRS. The FAA is prohibited from using any report thus submitted to NASA under the ASRS (or information derived therefrom) in any disciplinary action with the exception of information concerning criminal offenses or accidents. The ASRS security system is designed and operated by NASA to ensure the confidentiality and anonymity of the reporter and all other parties involved in a reported incident or occurrence. The FAA does not seek and NASA does not release or make available to the FAA any direct copies of reports filed with NASA under ASRS or any other information that might reveal the identity of any party involved in an occurrence or incident reported under ASRS. NASA operational personnel are justifiably proud that there has been no known breach of confidentiality in the entire period of ASRS operation, during which over 32,000 reports have been filed with the system.

The ASRS was designed as an analytical information gathering system in support of aviation safety. It has been found that data derived from individual occurrences are valuable for highlighting deficiencies and discrepancies in the national aviation system. Perhaps even more valuable are the insights into overall system problems that can only be gained by studying the large data base of safety incident data. The ASRS was structured to facilitate such studies and permits automated retrieval of information based on a wide variety of qualitative and quantitative descriptors. A number of statistical and other information handling tools for analysis of the data have also been developed to answer questions related to aviation safety. A long-range aim of the ASRS is to facilitate interactive analyses of the data by members of the aviation community in support of their own efforts to improve safety.

The funding of the ASRS is accomplished jointly by both NASA and the FAA, although the latter agency has no direct role in its management. The FAA participates in the management of the program only through representation on an Advisory Committee. NASA provides top-level management of the ASRS through the Life Sciences Directorate of the Ames Research Center located at Moffett Field, California. The senior operating officer for the ASRS is the Chief, Aviation Safety Reporting System Program Office. Most of the ASRS functions are performed under a contract with the current ASRS contractor, Battelle Columbus Laboratories, Battelle Memorial Institute, Columbus, Ohio.

An ASRS Advisory Committee has been appointed by the Administrator of NASA as a subelement of the NASA Aeronautical Advisory Committee. The membership is comprised of aviation safety experts who possess backgrounds in general aviation and airline piloting, manufacturing, engineering, air traffic control, consumer interests and airport management. The DOD and FAA are also represented on the ASRS Advisory Committee. The Committee advises the ASRS program managers regarding the design and performance of the system, and advises the FAA Administrator of its evaluations of the program and its performance and effectiveness. A security group functions within the Committee specifically to advise the NASA Project Manager of the ASRS and the aviation community regarding the confidentiality of the ASRS reports. It also examines the system periodically to ensure that confidentiality is maintained and reporter anonymity is protected.

2.3 ASRS Functional Characteristics and Data Processing Procedures

The ASRS is designed to provide a mechanism for collecting reports that may provide valuable safety information, for cataloging and storing the data from the reports in a computerized data bank, for extracting and analyzing the safety-related data, and for informing those who can do something about the safety problems that are revealed by the data. By acting as a central point for the collection of such data and for its dissemination, ASRS analysts can also detect trends and situations which may serve to alert the aviation system to developing problems. The complete system for handling ASRS reports can be seen in Figure 1.

The ASRS solicits reports from any person in the national aviation system who witnesses or is involved in an occurrence or situation which he or she believes poses a potential threat to flight safety. While NASA will accept data in any format in which it is reported, it urges that an ASRS report form be used if possible. ASRS report forms are distributed by the FAA to its facilities, by airline operations offices, and by the ASRS offices. The form consists of a single self-addressed and postage guaranteed sheet that is easily and quickly completed. The report form includes: the submitter's identification that is located on a tear-off portion of the top of the report form; a checklist of descriptive parameters for a top-level summary of a number of generally applicable factors related to the incident; and space for a first-hand narrative description of the incident. The checklist of descriptive parameters includes items such as geographic location, type of operation, type of aircraft, time-of-day and lighting conditions, flight phase, and weather conditions. The identification section, which is eventually returned as a receipt to the sender, is also on the form because NASA has found that the maximum

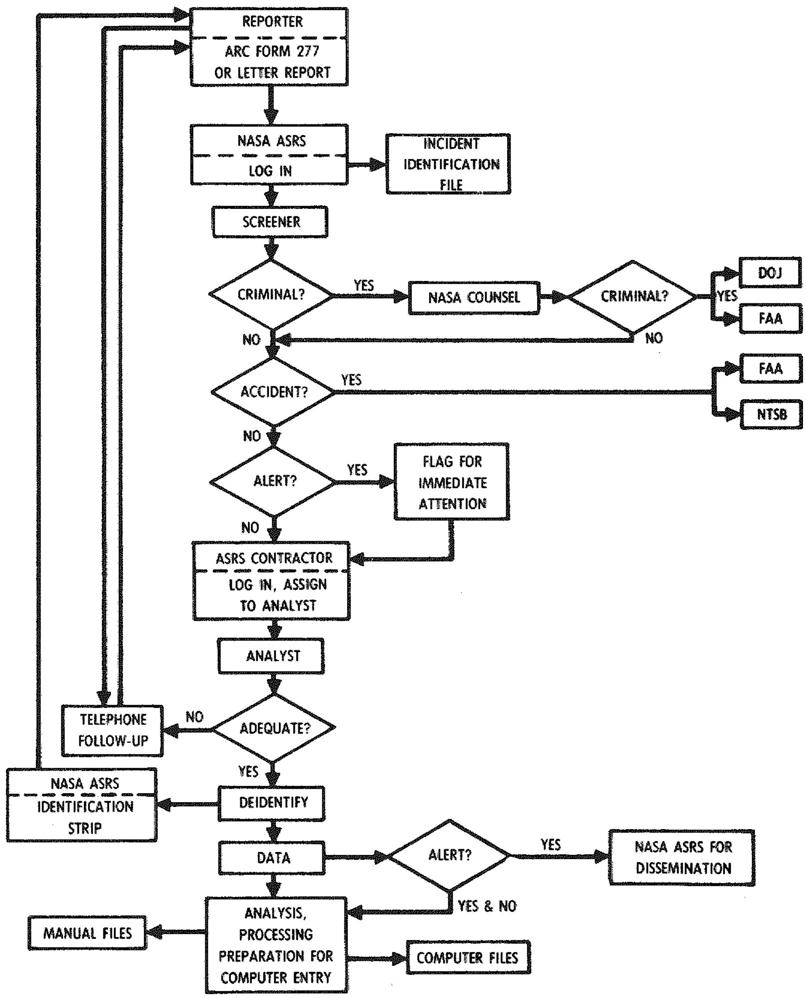

Figure 1. Processing Procedures for the NASA Aviation Safety Reporting System

information from a report is often realized only when an experienced data analyst can talk directly (generally by telephone) with the person who submitted the report. Whenever the analysts believe that supplementary information is needed about a report or that it could be made more useful by such interaction, they conduct any needed interviews with the reporter before final processing of the report.

In the flow diagram of Figure 1, it can be seen that upon receipt of a safety report NASA is obligated to screen it for information that may relate the incident to a criminal offense or to an aircraft accident. The screening is done by the NASA Program Manager, an attorney who is also a qualified pilot. If a report contains information about a criminal offense or accident (which they rarely do), it is forwarded without further ASRS processing to the appropriate agency. In the case of a criminal offense, the report is forwarded to the Department of Justice (DOJ), and in the case of an accident, to the National Transportation Safety Board (NTSB). NASA does not screen safety reports for violations of Federal Aviation Regulations. To do so would seriously compromise the willingness of pilots and controllers to report conditions or situations which pose a threat to air safety. NASA has been granted an exemption by the FAA and will not notify the FAA of any violation noted during the processing of a report.

Concurrently with the screening process for criminal offenses or aircraft accidents, NASA examines each safety report to identify any situation or condition that poses an immediate, urgent threat to aviation safety. If such a situation is suspected, the safety report is given directly to a report analyst along with a request for priority handling.

After the initial processing for criminal, accident or hazard alert information, as shown in Figure 1, the report is assigned on a routine basis to an analyst for detailed processing. Analysts are selected on the basis of expertise in various facets of aviation operations, for example, air traffic control, general aviation or commercial airline operations. If, after examining a report, an analyst believes that further details would improve the clarity of the report, the analyst will attempt to contact the reporter by telephone.

When the analyst decides that the report is complete or when further information cannot be obtained, the report is deidentified by removal of the identification strip and obliteration of other identifying information in the body of the report. As indicated in Figure 1, the identity slip is returned to the addressee as proof of submission of the report to the ASRS program and the remainder of the report form is filed for computer processing along with the results of the analyst's investigation.

It should be noted that the filing of a report with the ASRS concerning an incident involving a violation of Federal Aviation Regulations is considered by the FAA to be indicative of a constructive attitude on the part of the reporter. It is, of course, possible that a violation of regulations could come to the attention of the FAA from a source other than a report filed with ASRS. If this occurred, the FAA investigation might lead to a finding of a violation. However, in accordance with FAA commitments, neither a civil penalty nor suspension will be imposed upon someone who has reported an event to the ASRS if:

1. the violation was inadvertent
2. the violation did not involve an accident or criminal offense
3. the reporter has not been the subject of a prior FAA enforcement action for a violation in the previous 5 years
4. the person proves that, within 10 days after the violation, a written report of the incident was submitted to the ASRS. The returned identification strip from the ASRS serves as an accredited record of report submittal.

In the final steps outlined in Figure 1, following report deidentification the ASRS analyst prepares the report for computer processing. The analyst then makes the needed judgments regarding the coding of information in the report and passes the resultant file of data and information to a clerk for computer entry. The original deidentified report is subsequently destroyed. However, a verbatim transcript of the deidentified narrative portion of the original report is filed as part of the computerized version of the report.

Although some reports may contain information that is obviously critical to aviation safety, many other reports contain information that in isolation may not clearly identify a hazard. Several such reports, however, may help to identify a hazard or show a trend that points the way to a problem. For this reason the reports must be analyzed not only for what they contain on an individual basis, but also for what they contain in relationship to the content of other reports.

The taxonomy of the system (i.e., the set of descriptive words and phrases that are used to categorize the subject matter of the report) is one of its most important aspects. The purpose of the ASRS taxonomy is to provide a descriptive summary of the ASRS reports in terms of a relatively small set of recurring associated parameters that are generally related to what the analysts feel are causal factors for the incident. The taxonomy also provides a method of indexing and cross-indexing the data in order to study the importance of one or several contributions of any of these parameters. The structure of the data base includes parameters such as human behavioral attributes found frequently in association with ASRS reports (distraction, forgetting, failure to monitor, complacency); aviation system attributes found frequently in association with ASRS problem reports (degraded information, ambiguous procedures, equipment failure); and incident descriptors (weather conditions, traffic characteristics, flight phase).

The taxonomy of the ASRS information system provides an extensive indexing subsystem to facilitate retrieval and analysis of reports. Up to 2500 keyword parameters may be employed to access the 30,000 plus reports received to date. Thus a relatively large number of reports can be summarized and described in terms of a relatively smaller number of descriptive parameters. The descriptive parameters used in the taxonomy for the ASRS have been very dynamic. The parameter list in the taxonomy has evolved steadily over the life of the current system and is expected to continue to evolve throughout the remainder of the system's life.

Should the need arise, ASRS analysts are capable of accessing the transcript of the narrative portion of the original incident report. These narrative portions of the original reports are maintained in the data base to provide further insight into a specific incident that may not have been captured by the descriptive parameters that were initially selected to characterize the incident. The narrative portions of the reports have frequently provided insights into incidents whose significance has only been recognized long after the initial filing of the computerized report.

The information in the data base is routinely searched for trends that may identify an existing or developing problem. Special technical reports describing findings and system results are issued on occasion by the ASRS staff. Hazard notification reports on time-critical safety issues are issued promptly to those with a specific need for the information. The ASRS program also publishes a monthly newsletter/safety bulletin (the "Callback") to provide a regular forum in which aviation system problems are highlighted. The topics publicized in the "Callback" have generally been derived from problem areas revealed in the course of the ASRS analysis process. The newsletter publication provides a forum for such subjects prior to formal publication of generic studies on the problems.

As previously indicated, reports with urgent safety implications are occasionally identified during the initial NASA processing or by the report analysts. Once a report is "flagged" for priority handling, the analyst promptly processes the report and makes telephone contact with the submitter of the report, if necessary, to ensure that the information is as complete as possible. The analyst then deidentifies the report, prepares a synopsis of the reported hazardous condition, including all pertinent data, and forwards the material, along with an Alert Bulletin recommendation to NASA. Following NASA's verification that an Alert Bulletin is warranted, the bulletin is forwarded to the organization that is in the best position to investigate the alleged situation and make any necessary repairs, changes, or improvements. These organizations are often airport managers where equipment failures (runway landing lights, instrument landing system hardware, etc.) may have created hazardous conditions for fliers.

The ASRS attempts to serve the public as well as members of the aviation community. In addition to research initiated by the FAA or the

ASRS staff, requests are occasionally received for special studies of interest to support specific industry organizations or groups, and occasionally members of the press or public. Within the limit of its resources, the ASRS staff designs and conducts such data bank searches and/or special analyses. The results are generally provided in terms of uninterpreted output of the sanitized results from searches of the data bank.

2.4 Assessment of the ASRS Program*

The function of the ASRS Advisory Committee was described in Section 2.2. The Committee has recently reviewed the overall performance of the ASRS in order to evaluate how well the System has met the purpose for which it was established. Three criteria were used to judge the effectiveness of the ASRS:

1. A determination of the extent to which the reports being received by NASA bear on safety in the national aviation system;

2. A determination of the extent to which the ASRS holds unique promise of disclosing or forecasting otherwise undetectable trends related to deficiencies or discrepancies in the national aviation system;

3. A determination of the extent to which the data and products of the ASRS are used as instruments to produce changes in the national aviation system.

The first criterion was evaluated by reviewing a statistically representative sample of 353 ASRS reports. It was felt that the degree to which ASRS reports that were being received into the system were relevant to safety could be determined from such a representative sample. "Relevancy" was defined by the review committee as either a report which was related to general aviation safety or to a specific "unique" safety incident. The committee found that 97.7% of the sampled reports were unequivocally relevant to aviation safety. Only 2.3% of the reports in the sample did not clearly identify an incident or problem that was directly related to safety.

The second criterion, related to forecasting trends in potential system deficiencies, was evaluated by statistically analyzing the same set

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* Results of the ASRS Advisory Committee assessment of the effectiveness of the reporting system are contained in a letter report dated April 5, 1982, submitted by the committee to NASA and the FAA. We are indebted to John H. Winant, Chairman of the ASRS Advisory Committee, for providing us with a copy of the letter report during an interview conducted December 16, 1982.

of ASRS reports used in the previous criterion assessment. However, in this analysis, the reports were used as the basis for identifying "suspect" areas for a meaningful interrogation of the computer data base for trend information. The committee members sought to determine whether the reports showed that the ASRS had been successful in collecting data on incidents, situations, practices, etc., bearing on safety which had not been reported elsewhere and for which there was no other readily available reporting process. It was these kinds of data that, in the opinion of the committee members, when taken collectively could provide a "relief map" of the potential problems of the aviation operational environment -- the environment inside the aircraft, in terms of equipment and crew duty loads, and the environment outside the aircraft as represented by traffic density, airports and airport systems, airways, traffic control systems, weather, etc.

As previously stated, the sample of 353 reports was used to help identify salient features of the data base for an initial evaluation overview of significant trends in the data base. The list of subjects analyzed in the evaluation review included such items as altitude deviations, communications problems, near mid-air collisions, and workload related incidents. It was concluded from the study that the ASRS data base does contain a large amount of information that is of significance to aviation hazard trends. Moreover, the ASRS Advisory Committee found that the data could be readily retrieved and analyzed, and was not available through other sources. The committee's study utilized a time series trend analysis and identified, in particular, problem areas in altitude deviations and communications from the relatively small subset of ASRS data analyzed. The committee concluded that more detailed analysis of the factors contributing to these problems might also suggest effective solutions. Thus, the committee concluded that the ASRS data base was effective with respect to its capability to show growing hazards in today's system that might otherwise go unrecognized until a disaster occurred.

The third criterion, associated with the use that has been made of the system by the aviation community, was evaluated by reviewing ASRS reports, publications, and data. This analysis also included an assessment of some of the intangible products of the ASRS such as (1) benefits of reporter anonymity, (2) benefits of general recognition of the existence of the ASRS, and (3) synergistic benefits of ASRS when coupled with information and data from other sources available to the FAA, such as the NTSB accident evaluation reports, etc. In order to determine the effectiveness and value of the publications and reports, a questionnaire was mailed to a reasonable cross-section of the aviation community. The responses revealed that the overwhelming majority of recipients of these publications held the following views about the ASRS:

1. The information in ASRS reports is unavailable from any other source;

2. The publications have made recipients aware of new safety considerations for the first time;

3. The information in the publications has augmented the recipients' knowledge of aviation safety needs;

4. Aviation safety is being enhanced by ASRS;

5. Information from the publications has been used for training purposes, answering questions regarding aviation safety, and actions have been taken by recipients to correct or improve safety in their own areas of operation on the basis of the published data;

6. The monthly newsletter has received wide and enthusiastic acceptance as a valuable and effective publication that also has public relations value.

The committee concluded that the subject matter of the published ASRS reports provides information which, if properly used, can help to enhance understanding in some very critical areas, hence enhancing safety.

In order to determine the effectiveness and value of the specialized, individually requested studies and data printouts provided by the ASRS, another Advisory Committee questionnaire was sent out to a cross-section of those who had requested specialized data from the system. The responses of this group were as follows:

1. The information was requested for safety purposes;

2. The information received met the needs and expectations of the recipients;

3. The specialized data available from the ASRS was acknowledged as a source of safety information that would not otherwise be available to the recipients;

4. Specific action had been taken by the recipients to improve safety as a result of the information received.

The intangible products of the ASRS were evaluated by relying on the judgment of knowledgeable people active in the aviation community, as a means of qualitative measurement of the value of the ASRS products. It was the consensus of all sources of comment and opinion that <u>anonymity is essential</u> to an effective safety reporting system. If anonymity of the reporters was not assured, reports would not be submitted and needed information would otherwise be unobtainable. Concerning the benefits of general recognition of the existence of the ASRS, the review committee judged that the aviation community's understanding and recognition of the ASRS increases people's awareness of the need for, and understanding of the benefits of the kind of safety information being developed by the system. The community's recognition of the existence of the ASRS also helps to increase their awareness of the significance of the ASRS data with respect to the enhancement of aviation safety. Finally, it has been noted that the ASRS data, when used in conjunction with other data available to the FAA, NTSB, and others serves to complement the other data. This enhances the benefits of both sets of data and can well result in an enhanced understanding of a given incident or series of incidents.

Thus the Advisory Committee concluded that the ASRS had proven itself to be a practical, acceptable, and useful system for gathering safety-related data about the national aviation system. The program has operated smoothly over the past six years and its acceptability to the aviation community during this period has been well established. Over 32,000 reports have been collected during the period of ASRS operation. The reports have been analyzed and the results integrated into a well-indexed data base. Significant trends in safety-related incidents can be (and have been) identified from the data. The entire system is operated at a relatively low cost of about $1.5 million per year. Members of the Advisory Committee and FAA personnel with ASRS oversight responsibilities have indicated that they believe that such costs are very nominal considering the value and usefulness of the data collected by the system. The usefulness of the data developed by the system was shown by the survey of the aviation community that indicated their support for the system and demonstrated the benefits that the community had received from reports and special studies provided by the ASRS since its inception.

3.0 CONCLUSIONS AND RECOMMENDATIONS WITH RESPECT TO ASRS APPLICATIONS FOR THE NPSRS

In December, 1974 TWA Flight 514 crashed into a Virginia mountain side. The tragedy was subjected to the full glare of media publicity and contributed to the forces that engendered the ASRS. The effects of the TWA 514 crash on the FAA may be considered analogous to those of the Three Mile Island incident on the NRC. Specifically, both incidents resulted in a heightened concern with respect to human safety related incidents in each of the respective government organizations. There are strong similarities between the needs of national aviation operations and nuclear power facility operations. Both systems are built upon Federally regulated industries. Moreover, their operations are, in both cases, associated with individual and public risks of potential large consequence accidents where human errors represent a significant contributor to the risks. Consequently, both types of operations are also faced with an urgent need to recognize and modify the operational system factors that tend to promote human errors that lead to such safety hazards. Given the similarities in top level needs and objectives, it is clear that some of the ASRS features are appropriate for consideration in a Nuclear Power Safety Reporting System (NPSRS).

3.1 NPSRS Feasibility

The success of the ASRS program gives solid evidence that a similar, voluntary, nonpunitive safety reporting system could provide similar benefits to the nuclear industry. It seems reasonable to assume that the NPSRS objectives would be similar in character to those of the ASRS. For example, an overall goal for the NPSRS might be to provide a reporting method whereby factors that contribute to the occurrence of human errors in nuclear power plants may be identified and their relative frequency and significance quantified. Moreover, some of the basic methods used by the NPSRS could also be similar to the ASRS. In an effective NPSRS, first hand reports of safety-related incidents would be collected, safety-related data would be extracted and analyzed, trends leading to problems would be detected and identified, and relevant parties and policymakers would be informed about the perceived problems so that they could be corrected. Appropriate objectives for application of the data developed by a NPSRS could be to:

- Describe and catalog safety incidents involving human performance in nuclear power plants,
- Identify significant aspects and trends in human performance characteristics within the nuclear power plant environment,
- Provide a sound basis for human factor related safety improvements,
- Support development of human behavioral data (including both human errors and mechanisms for resolving error-induced conditions) for probabilistic risk assessments (PRAs).

3.1.1 Implications of Nuclear Industry Characteristics on NPSRS Features

As indicated in Section 2.4, the ASRS has proven to be useful, acceptable, and practical to the aviation community. The dominant features that have contributed to the feasibility and success of the ASRS are the concepts of anonymity for reporters, their immunity from regulatory disciplinary action, and the use of a third-party management organization to shield and isolate reporters from the regulatory agency. These ASRS feature seem to be the most likely candidates for consideration in the methods used by a NPSRS.

There are, however, some significant differences between the characteristics of the nuclear power industry and the regulatory procedures used by the NRC and those of the aviation industry and the regulatory procedures of the FAA. For example, in the aviation system the FAA takes regulatory action directly against individual pilots for violations of Federal Aviation Regulations. The FAA does not generally hold the commercial airline companies responsible for the actions of their pilots; and regulatory actions are rarely taken against the corporate airline bodies. In the nuclear industry, on the other hand, the NRC customarily holds utilities responsible for the safe operation of their facilities. NRC regulatory actions are ordinarily taken against the corporate utility bodies. Direct regulatory action is rarely taken against individual members of the operational staff of the nuclear plants, even though direct responsibility for violations of the NRC's regulations may ultimately have rested upon an individual member of the operational staff.

Another major difference between the aviation system and the nuclear industry is associated with the numbers of potential sites and independent opportunities for safety-related incidents in the two industries. There are literally thousands of commercial aircraft flights occurring every day over the U.S. air space. In addition to the commercial flights, there are perhaps five times more private flights per day than commercial flights. Thus there may be tens of thousands of independent opportunities for safety-related incidents involving different individual pilots at innumerable potential locations every day.

In the nuclear industry, on the other hand, there are 75 operational nuclear power plants. These plants will ordinarily operate three shifts, around the clock, every day providing opportunities for hundreds of different operators to exercise responsibility over the control of the plants, in some degree. However, these same operators operate the same plants at the same locations day-in and day-out.

Therefore the potential numbers of operators and flexibility of location for safety-related incidents is much smaller in the nuclear industry than in the aviation system. Thus, if reporter anonymity is important to the success of the operation of the safety incident reporting system, it will certainly be more difficult to ensure in the nuclear industry than in the national aviation system.

These two system differences (one in the procedures for taking regulatory actions against individuals vs corporations, and the other in the numbers of operational personnel and the potential locations for safety-related incidents) must have an impact on required features of the safety reporting systems for the two industries. The impact of the two system differences will be discussed in more detail subsequently.

Although there are differences between the national aviation system and the nuclear industry, the experience with the ASRS provides strong general evidence for the feasibility of a NPSRS. In spite of potential issues arising from the self interests of the members of the aviation community (pilots, controllers, airline corporations, regulators, etc.), the ASRS has proven itself to be acceptable to the community in general. Its practicality has been demonstrated by its performance in receiving processing, and analyzing reports, in disseminating publications describing the system results and observations, and maintaining its record of preserving the anonymity of the reporters who have supported the system. The costs of performing the functions ($1.5 million per year) have been relatively low compared to the volume of reports handled (an average of about 100 reports per week). All of the critical reviewers of the ASRS have concluded that the system meets reasonable standards for practical operation. Though in many respects the impact of operating the ASRS on aviation system safety is somewhat intangible, all critical reviewers agree that the system has been useful. There is general agreement that the data made available through the system could not have been obtained through other mechanisms, and that safety improvements have resulted from the results of analyses of the data.

It seems reasonable to conclude that the nuclear industry would be well served by a safety reporting system of a similar nature to the ASRS. Though the unique characteristics of the nuclear industry may require the major features of the ASRS to be modified to fit the needs of a NPSRS, the concepts of reporter anonymity, immunity from regulatory disciplinary action, and the use of a third-party management agency would appear to be important to a NPSRS.

3.1.2 Alternative Concepts for a NPSRS Program

There are several ways in which a NPSRS might be implemented within the nuclear community. The three most evident alternatives are: (1) to append a strong human factors reporting element to an existing NRC program, such as the LER program; (2) to work within the utilities self-regulating framework and append the reporting system to an Institute for Nuclear Power Operations (INPO) program; (3) to develop an entirely new reporting system outside of both the NRC regulatory channels and the utilities INPO organization. A brief discussion is presented in the following paragraphs of each of the three alternative concepts.

3.1.2.1 Supplementing an Existing NRC Program

If the NRC were to decide to implement a specialized human-factor reporting system, the simplest mechanism for doing it would be to add the program to an existing reporting system. As previously noted, there are already several reporting systems functioning within the NRC, including: (1) the Licensee Event Reports; (2) the 766 System File used by the NRC Office of Inspection and Enforcement; (3) the Gray Book Data; and (4) the Systematic Assessment of Licensee Performance (SALP) program. Although reports related to human errors are to some extent already part of these systems, some supplementary reporting elements would be needed for them to approach the level of quantity and quality of reporting achieved in the ASRS.

A simplified report form for voluntary reporting of human factor related events could be developed to supplement an existing NRC program. Additional reports could probably be handled by the staff of the NRC organizations under which the current programs are operated. For example, if the system were attached to the LER program, the Office of Analysis and Evaluation of Operational Data (AEOD) would seem to be the logical organization within the NRC to conduct the program. Some additional staff might be required, but the implementation could probably be accomplished in a relatively straightforward fashion.

The principal problem with the concept of incorporating the NPSRS directly into an existing NRC reporting system would be related to the ASRS experience that occurred when the FAA conducted as well as sponsored an earlier version of the aviation reporting system. Under those circumstances very few reports were filed because reporters feared that they would be incriminating themselves. Individuals were reluctant to file reports even though the FAA had promised immunity to the reporters. Such reluctance to report would probably also characterize a nuclear power safety-reporting program if it were conducted directly in-house by the NRC.

3.1.2.2 Supplementing an INPO Program

The utilities support several safety-related reporting programs through INPO. These INPO programs include the Nuclear Plant Reliability Data System (NPRDS) and a Plant Incident Report (PIR) System that is currently under development. The NPRDS is a voluntary reporting system that is heavily oriented towards nuclear plant hardware with little emphasis currently placed upon human factor related experiences. The heavy hardware emphasis of the NPRDS probably explains why the INPO decided to develop the new PIR System for human factor related incidents instead of modifying the NPRDS.

An alleged benefit of using the PIR System is that the reporting procedure calls for all reports to be passed through the management chain within a plant before submission to INPO for incorporation into a central data bank for cataloging the reports. This procedure would (in principle) permit plant managers to become aware of potential problem areas and to attempt to correct those that they considered significant as soon as the report circulated through the management chain.

A disadvantage of such a procedure is that the INPO reporting systems apparently do not offer either anonymity or immunity to reporters. Thus incidents which might result in some substantial embarrassment to reporters would probably go unreported. This would be especially true if the operators were concerned that their association with the incident might jeopardize their jobs at the plant. A second disadvantage is associated with the reporting procedure for passing reports up the management chain from the reporter to INPO. Under such a procedure, the abrasive edges of fact in reports would be continually polished away by the forces of self-interest and diplomacy associated with each additional reviewer/filterer in the report processing chain.. A third disadvantage is associated with the availability of public access (and, it should be noted, NRC access) to the basic input report data. If public access to the raw data in the INPO system were to be available at all, it would probably only be available under heavily "sanitized" conditions.

3.1.2.3 Developing a New NPSRS Program

A new NPSRS program could also be developed and supported for implementation by the NRC. Under these circumstances, the most beneficial aspects of the ASRS program experience could be incorporated into the new system.

Reporter anonymity and immunity arrangements could be arranged for such a program that would improve the probability of incident reporting. In accordance with the differences between the nuclear power and the aviation communities and the regulatory procedures for conducting their businesses, it would probably be necessary to broaden the NPSRS immunity relationships when compared to those of the ASRS. It seems reasonable that the NRC might have to give serious consideration to development of a plan to provide immunity of the plants and utilities from which reports were received before substantial freedom of information flow in the reporting system could be achieved as a result of the relatively small number of plants from which the reports could originate. The relatively small number of nuclear plants could make deduction of the origin of the report and hence the identity of the reporter a relatively high probability prospect. A neutral, independent third party system manager could also be used to conduct the program thereby isolating the reporters and their reports from immediate contact with either the NRC or the utilities.

It should be noted that the concepts of warranties of anonymity and immunity from regulatory action are a source of concern to nuclear regulators and utility management. Their concerns are primarily related to the potential for loss of regulatory control and of some management prerogatives. Limiting the scope of warranties of immunities, as was done with the ASRS, could probably relieve many of the concerns of nuclear regulators. Extending the limited immunity concepts from individuals to include utilities and plants might also help to reduce utility concerns over the potential loss of management prerogatives. In fact, in an appropriately designed NPSRS, incentives should be provided to management to encourage plant personnel to participate in the system. More detailed discussions will be presented in Volume II of this report of the potential issues associated with the concept of developing a new NPSRS program that is implemented outside of the direct management and control of either the NRC or INPO. These discussions will include analyses of methods for designing the system to cope with some of the more significant issues that might be associated with it.

3.1.3 Characteristics of a New NPSRS Program

Like the ASRS, an ideal NPSRS should provide a simplified method for submitting initial reports of safety incidents. In addition to a simplified format, the reporting method should be designed to permit personnel to report an incident without feeling that its submission would jeopardize their jobs or careers. The ASRS experience has shown that reporter anonymity has been an important feature in assuring uninhibited, nonthreatening information transfer from reporters to the data collecting system. As indicated above, it also seems that it may be necessary to consider deidentification of the specific nuclear plants involved in the incident and probably their parent utilities as well, in order to preserve reporter anonymity, to increase their confidence that report submission does not inherently jeopardize their job security, and hence to assure the free flow of data to the NPSRS.

Like the ASRS, the reporting method under consideration for the NPSRS would ideally be conducted in two steps. Personnel involved in a safety-related incident or aware of a system deficiency which might precipitate a safety incident would be encouraged to submit a brief and simple initial report to the NPSRS. A single-sheet report form would be provided to the reporter population. The form would include the name, address, and residential phone number of the reporting individual; a small number of multiple choice, fill-in-the-blank data alternatives related to the characteristics of the plant and the nature of the event; as well as space for a brief narrative description of the event.

Similar to the ASRS, incident reports may need to be followed up to ensure that their content was as detailed as possible so that problem areas could be properly identified and the methods that may have been used by operational personnel for corrective actions could be clearly and accurately defined. The ASRS method of making follow-up telephone calls, if they are needed, to obtain more detailed information on specific aspects of the reported event would also seem to be applicable to the NPSRS. Further after the telephone interview, it would seem reasonable to follow the ASRS pattern of separating the reporter identification information from the initial report form and returning it to the reporter. As in the ASRS, the returned identification strip would provide evidence to the NPSRS reporter that the report had been submitted, and that it had been acted upon. Receipt of the identification strip would also provide some assurance to the reporters that their anonymity was being preserved.

One of the significant differences that exist between the aviation environment and the nuclear power environment involves the motivational factors that might encourage report submittal. This is associated with the earlier observation that in the aviation environment disciplinary actions for a violation of FAA regulations are normally taken against individual pilots, air traffic controllers, etc. However, in the nuclear power industry, utilities rather than individuals are usually the recipients of discipline for violations of NRC regulations. The FAA gives motivation to reporters to support the ASRS by providing a limited waiver (for one incident per five year period) of disciplinary action for any regulatory misdeeds short of accidents and clearly illegal activities. The NRC's regulatory procedures would not provide such an attractive "carrot" to individual nuclear power plant operational personnel because they probably would not feel an immediate threat (on an individual basis) from NRC disciplinary actions. This difference between the ASRS and the potential NPSRS suggests that some other method needs to be found to raise the motivational level of nuclear power plant operational personnel to report safety incidents. Thus, in connection with the suggested concept of granting some form of immunity to utilities from disciplinary action, perhaps the NRC could consider granting limited waivers for specific violations to power plants based upon the extent to which power plant personnel were participating in the NPSRS. Under these circumstances, power plant management would be rewarded for encouraging power plant personnel participation in the safety incident reporting program.

Other similarities between the ASRS and the potential NPSRS might involve the management concept for the NPSRS. As previously discussed, a large measure of the ASRS success has been attributed to the NASA management of the system as a properly neutral and unbiased referee. The same concept appears to be important to the management of the NPSRS. Specifically, the NRC, both the maker and enforcer of regulatory requirements, would almost certainly need a neutral, independent third party to alleviate the fears of power plant management and plant operational personnel with respect to potential consequences for reporting safety incidents. An independent, neutral third party could be an asset to the collection, processing and analysis of the voluntarily submitted reports. The third party would reduce the probability of exposure of individuals as well as protect the identities of power plants. If the procedures suggested above were incorporated into the program, a utility might be eligible for waiver of disciplinary actions as a result of prior submission of reports related to the event in question and as part of the utility's participation and support of the safety incident reporting program. If the NRC took action against a power plant for some incident (on the basis of information gleaned from sources other than the NPSRS) the system could be designed so that the NRC could request a reading from the NPSRS with respect to the eligibility of the power plant in alleged violation of regulations for such a disciplinary waiver.

Finally, the success of a NPSRS would clearly depend upon the support of all of the members of the nuclear power community, including representatives of operational personnel such as unions, utility management personnel, plant contractors, and government agencies. Like the members of the aviation community, these nuclear industry participants will need a forum to present their interests and to work out compromises needed to make a NPSRS effective, mutually acceptable to all members of the community, and to monitor and evaluate the performance of the system. A NASA advisory committee for the ASRS provides this type of support to the national aviation community. An advisory committee to the NPSRS would be a useful adjunct to representation of the nuclear community. The advisory committee should also regularly review the NPSRS security system to insure that individuals and power plant identities remain anonymous.

3.2 NPSRS Benefits

Implementation of a new NPSRS program would result in some benefits accruing to the nuclear power community that could not be achieved with other alternative concepts. As indicated in the brief summaries of the alternatives in Section 3.1 above, each concept has certain advantages and disadvantages. In this section, the attention will be concentrated upon the potential benefits accruing from implementation of a new NPSRS program.

Perhaps the most significant benefit to be expected would be an essentially unrestricted volume and flow of reports of safety-related incidents into the system. These benefits can only be achieved with a system that incorporates a third-party management concept, together with provisions for warranties for reporters of anonymity and immunity from punitive measures resulting from potential self-incrimination. As discussed above, the system's freedom of data flow could also be enhanced by providing some incentives to utilities to encourage reporting. As indicated, this might be achieved by providing increasing degrees of utility immunity from punitive NRC actions depending upon how well reporters from a given utility supported the system. Achievement of a nominal level of reporting from the personnel at a power plant could be interpreted as an indication of good faith in recognition of a need to improve operating procedures at the facility.

With a relatively unrestricted flow of reports into the NPSRS, several side benefits would result to the system and the nuclear community. First, the larger the flow of incident reports, the more diversity of types of incidents that would be reported. Diversity is desirable in the data since it provides a greater base of experience in the types of incidents reported. This would provide PRA systems analysts with more data on qualitative types of contributing factors for modeling safety-related incidents.

Another side benefit of large volumes of reports is the ability to extract reports with relatively large amounts of detail from the submitted material. This is also a benefit accruing from direct transmission from reporter to a third-party managing organization for the system. With direct submission without management screening and editorializing on the reports, as well as high volumes of reports submitted, the detail available for PRA systems analysts with human factor model development responsibilities should be enhanced. Detailed data provides opportunities for more source information than would be available from abbreviated reports for use in attempting to evaluate root causes of human error related incidents and to study the influences of performance shaping factors on human actions.

There are several significant potential uses for a new NPSRS. First and foremost, the results would provide a greatly enhanced source of data for addition to a PRA human reliability data bank. A great need exists for a substantial increment in this data base. At this point in time many of the quantitative human reliability estimates for PRA elements are based upon non-nuclear industry data and the judgment of human reliability specialists. A substantially increased data base for the human reliability data bank could substantially aid in solidifying the basis for many of the judgmental decisions for PRA analysis work. It should not be expected that the new data will provide an instant basis for quantification of the reliability estimates used in PRAs. However, a major increase in the size of the data base available would provide a better basis for making qualitative judgments with respect to human error contributions to accident sequences in the PRAs.

3.3 Recommendations

The results of this evaluation of the FAA-supported, NASA-administered Aviation Safety Reporting System show that the program has been proven feasible, practical, acceptable and useful. As discussed in earlier portions of this section, many ASRS features seem directly appropriate for transfer to a Nuclear Power Safety Reporting System. The success of the ASRS system provides a basis for concluding that a NPSRS would also have a good chance to be equally feasible, practical, acceptable and useful. The earlier portions of this section of the report have provided an indication of the potential features and benefits of a NPSRS.

Volume II of this report provides an additional description of the features of a NPSRS as a basis for a system description. Critical considerations affecting the acceptability of the system to the nuclear community are also identified in Volume II. These considerations are used as a basis for identifying the significant elements required for a functioning system. From the elements defined for the system, the requirements are identified that are needed for defining the operational structure of the system and its organization.

In addition to the above short-range activities to complete the preliminary assessment of the NPSRS, long-range plans should also be developed for the program. These long-range planning activities are beyond the scope of the present Aerospace Corporation contract. They should, however, be considered for future work to firmly establish NPSRS feasibility.

In this regard, Volume II contains recommendations that two critical steps should be taken to demonstrate the system feasibility. First, implementation plans for developing the system should be prepared in detail. Secondly, a test plan should be prepared for demonstrating that the NPSRS concept outlined in the implementation plans is indeed feasible. The test plan should outline mechanisms for demonstrating that the system would be practical, acceptable and useful for the nuclear community.