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Report of the requirements for a Nuclear Power Safety Reporting System (NPSRS), to gather information on significant nuclear power plant safety-related events involving human error.

This report is the second of two volumes, and describes the elements of an anonymous, non-punitive, third party managed NPSRS. Additionally, viewpoints of NRC staff, nuclear utility management, operational personnel, and the public are presented that must be taken into consideration in the development of an NPSRS. Finally, recommendations are made for the development of an implementation package and plan for testing the feasibility of the NPSRS concept.

The first volume in this series describes the results of an analysis of the Federal Aviation Administration sponsored Aviation Safety Reporting System (ASRS), to determine ASRS features which might be adopted to a nuclear utility setting.

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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. 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.

This document, 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 of Volumes I and II of this report 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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1.0 INTRODUCTION

This report presents the results of an Aerospace Corporation study of a Nuclear Power Safety Reporting System (NPSRS). This volume (Volume II) presents an analysis of some of the basic elements of the NPSRS and the considerations that must be taken to produce a workable system. The system description was developed as an end product of a short (6 month) study of the feasibility of implementing a NPSRS within the nuclear industry. The previous volume, Volume I (Ref. 1), contains a review of The Aerospace Corporation's assessment of the Aviation Safety Reporting System (ASRS), a system that was used as a model for a NPSRS. The ASRS is sponsored by the Federal Aviation Administration (FAA) but managed and operated by the National Aeronautics and Space Administration (NASA). One of the fundamental objectives of the ASRS is to provide insight into human factor related events that occur in the national aviation system in order to improve the system safety. In this volume, an assessment is provided of the implications of developing and applying a safety reporting system that might be extrapolated from the model of the ASRS to the nuclear industry. If the system were developed, its purpose would be to gain a better understanding of human behavior within nuclear power plants and a better understanding of the influences of features within the plants that affect that behavior.

1.1 Summary of the Feasibility Analysis Results of Volume I

As noted above, Volume I contains the results of an assessment of the ASRS as a model for a nuclear power industry safety reporting system. The ASRS is a voluntary, nonpunitive reporting system used by the U.S. aviation community to document, analyze, and assess human factor related incidents occurring within the nation's airways. The Aerospace Corporation assessment of the ASRS was aided by an evaluation that had been conducted by an independent NASA subcommittee consisting of a cross-section of the U.S. aviation community and public representatives (Ref. 2). The unqualified conclusion of the NASA subcommittee members was that the ASRS was a practical and useful system that was widely accepted within the aviation community. Thus the feasibility of conducting an industry-wide safety reporting system has been demonstrated within the national aviation community. The successful performance of the ASRS provides substantial support for the assumption that a similar concept could be applied within the nuclear industry.

1.1.1 Significant Features of the ASRS

There are three principal features of the ASRS that have made it a successful and feasible operation. First is the concept of reporter anonymity. Second, a limited warranty of immunity from FAA disciplinary action has been provided to reporters. A third significant feature contributing to the success of the ASRS has been the use of a neutral, independent third-party management organization for the system in order to provide isolation of the system (along with its reports, and its associated reporters) from the FAA. These three features have given reporters confidence that the reports they submit will not lead to self-incrimination.

This confidence has induced reporters to submit a large number of reports to the system. Over 32,000 reports have been received, edited, and documented since the ASRS was made operational in 1976. The codified data from the reports have been maintained in a computerized data bank within the ASRS. The data are periodically analyzed by ASRS analysts for significant safety trends within the aviation community. The large volume of information flowing into the ASRS has brought with it a broad range of diversified subject matter from the reports. The breadth of the material in the reports has enriched the ASRS data base and strengthened the understanding of human factor causes and effects in the aviation system. In the consensus of aviation community opinion, the ASRS data and analyses have contributed to safety improvements within the aviation system in a variety of ways.

1.1.2 Applicability of ASRS Features to the Nuclear Industry

In Volume I it was concluded that the three principal features described above contributed uniquely to the successful operation of the ASRS, and that similar features would also be needed for a successful NPSRS. In particular, the features of reporter anonymity, immunity from regulatory disciplinary actions, and use of a neutral, independent, third-party system management organization would all be as significant to a NPSRS as they were to the success of the ASRS. However, it was observed that some inherent differences between the two industries (the aviation and nuclear power industries) would mean that modifications would be needed to some of these three features before they could be applied directly to the NPSRS.

For example, it was observed that the relatively small number of nuclear power plants in the nuclear community would make the maintenance of the anonymity of reporters more difficult than its preservation is within the aviation community. Moreover, it was observed that the FAA's warranty of immunity within the aviation community provides a greater incentive for individuals to report to the ASRS than a similar promise of individual immunity would provide in the nuclear community. In the judgment of the authors of Volume I, this would occur because the FAA takes regulatory disciplinary action directly against individuals rather than against the organizations for whom the individuals work. In the nuclear industry, on the other hand, the NRC customarily takes regulatory action against organizations rather than individuals. Consequently, the conclusion was drawn in Volume I that individual reporters in the nuclear community would need a different incentive to support a NPSRS. Under such circumstances, it was recommended that consideration should be given to providing warranties of limited immunity to power plants and their associated utilities as well as to the individuals filing the reports. The limited immunity to utilities and power plants would become applicable in accordance with verified receipt of NPSRS reports on the specific incident and upon demonstration that the overall number of reports that had been filed with the system from the plant met some minimum standards for support of the system. This limited immunity feature for utilities might provide plant management with sufficient motivation for them to encourage operational personnel to participate in the program through some system of rewards of the utility's own initiative. Localized motivation by promises of immunity for nuclear operational personnel at the plant level might be sufficient to achieve the direct individual motivational levels achieved within the aviation industry by the FAA's promises of immunity through the ASRS.

1.1.3 Benefits of a NPSRS Concept

One of the most significant benefits to be expected from a NPSRS would be the development of a substantial data base on human-factor related incidents within the nuclear industry. A great need exists for development of a data base of this kind. Many current quantitative estimates of human reliability are based upon non-nuclear industry data and the judgment of human factor specialists. A nuclear industry related data base could provide a more solid basis for human reliability estimates for Probabilistic Risk Assessments (PRAs). The data could also be used by those developing fault and event tree models for PRAs and for projecting trends in factors contributing to human errors. In addition, the results would be useful for evaluating the influences of generic (and possibly plant-specific) performance shaping factors for hardware design, operating procedures or other factors that affect human behavior in a positive or negative manner within nuclear power facilities. The richness of the content of the data obtained by a voluntary, nonpunitive NPSRS would be a great asset to understanding the root causes of human error and for improving the current models of the positive, problem solving mechanisms by which humans resolve incidents induced by mechanical and human failures.

1.2 Objectives of a NPSRS Concept Description

The objectives of the research described in this volume were threefold. The first objective was to identify and assess some of the significant considerations held by potential participants in a NPSRS that could influence the feasibility of implementing the system. These considerations were considered in the assessment of critical NPSRS features and the system requirements needed to support those design features. Thus the second objective of the study was to describe the principal elements and requirements of a NPSRS concept. The final objective of the work described in this volume was to provide recommendations for future activities that would be needed in order to prepare for NPSRS implementation.

1.3 Organization of the Text

Volume I of this report presents the results of an assessment of the ASRS program, the applicability of certain ASRS features to the nuclear industry, and the benefits of implementing a NPSRS concept. Volume II reviews some of the more significant considerations that have been advanced with respect to NPSRS feasibility. An analysis is provided of some of the significant considerations related to the practicality, acceptability, and utility of the system. A discussion is presented of the operational processes associated with a functioning NPSRS. The elements required to support the operational processes are briefly described. The requirements for interfacing the system with the external world are briefly outlined in terms of needed input and output features. Finally, conclusions are presented with respect to the significant aspects of system elements and requirements. Recommendations for additional research needed to plan for implementation and testing of the system are also provided.

2.0 SIGNIFICANT ASPECTS OF CONSIDERATION IN A NUCLEAR POWER SAFETY REPORTING SYSTEM

A NPSRS could provide a substantial, diverse source of data for assessing the influence of human factors data in the nuclear industry. As in any new system, there are a number of viewpoints representing a variety of considerations that must be addressed with respect to the feasibility of implementing a NPSRS. This section of the report addresses some of the more significant views on a NPSRS. In subsequent sections the operational and organizational elements of a NPSRS are presented as they might be structured in order to cope with the viewpoints addressed in this section.

2.1 NPSRS Overview

A brief overview is presented here of the highlights of the NPSRS recommendations documented in Volume I. The conclusions that were derived for the NPSRS concept in Volume I have been used as basic assumptions in the concept description developed in this portion of the study. A brief presentation is given of the basis for these assumptions. Several alternative concepts for implementing a NPSRS were also considered in Volume I. These are reviewed briefly as a basis for the NPSRS considerations to be evaluated subsequently in this section. The benefits of adopting a new, independent system are also reviewed.

2.1.1 Assumptions Employed in Developing a NPSRS Concept Description

One of the major conclusions of Volume I was that the success of the ASRS, and the apparent transferability of several aspects of its methodology, justified the conclusion that it was feasible to consider implementation of a NPSRS in the nuclear power industry. Thus the research described in this volume was conducted with the assumption that certain particularly beneficial elements of the ASRS would be transferable to a NPSRS. In particular, the ASRS system features that have contributed most to its success have been assumed to be applicable to the NPSRS. These include: the voluntary nature of its reporting system; the concept of reporter anonymity; the motivational benefits of providing a limited form of immunity from regulatory system redress for the participants involved in report submission; and finally, the concept of separating the reporting system from direct NRC intervention by having a neutral, independent third-party management for the system.

In spite of many divergent special interest viewpoints held by aviation industry participants in the ASRS, the system has been found to be acceptable by most of the members of the aviation community (Ref. 2). The analyses of the ASRS data have resulted in useful reports and special studies. There is general agreement that these reports and special studies have resulted in safety improvements in the aviation system. For example, significant changes in local and industry-wide system procedures and safety-related equipment have resulted from the published ASRS reports. The monetary costs of implementing the ASRS have been nominal. The operational costs for the entire system, including data collection, analysis, computerized data bank development and maintenance, as well as administrative costs have been about $1.5 million per year (Ref. 1, p. 18). Thus, there is general agreement that the ASRS has been a practical system. Therefore, the conclusion was reached in Volume I that the demonstrated feasibility of the ASRS system provided a solid basis for anticipation that any divergent viewpoints in the nuclear power community could also be resolved (especially if the NRC provides strong, vocal support for the NPSRS) and that a practical and useful NPSRS system could be developed and implemented.

2.1.2 Alternative NPSRS Concepts

Several alternative concepts for implementing a NPSRS were reviewed in Volume I. The three principal alternatives considered were: (1) to integrate a voluntary human factors reporting system with an existing NRC reporting system such as the Licensee Event Report (LER) system; (2) to integrate the reporting system into an existing Institute of Nuclear Power Operations (INPO) program; and (3) to develop and conduct an entirely new and independent NPSRS with a neutral, independent third-party manager.

The advantages and disadvantages of each of the alternatives were discussed in Volume I. The dominant advantage of integrating the reporting system into an existing NRC program would be the general ease of bringing the program to an operational status. The most significant disadvantage could be that such close system ties with the agency responsible for enforcement of regulations has been shown by early ASRS experience (in which the FAA conducted a closely related program itself) to produce a very limited volume of reporting. It has been suggested that a general fear of self-incrimination is the probable explanation for reporter reluctance to openly submit reports of safety-related incidents of human error to a regulatory agency when regulations may have been bent and perhaps broken in the incident.

Although an INPO-supported reporting system might also be relatively simple to initiate, similar problems with fear of self-incrimination could be expected if a nuclear reporting system were integrated into any of the current INPO programs. Moreover, it was observed that if the system were attached to an INPO program, that there is a certain natural reluctance of industry members to share their potential problems with the NRC (and the general public) without substantial sanitization of the details of the safety-related events.

2.1.3 Development of a New, Independent NPSRS

There are a number of benefits to be expected from a new, independent NPSRS. A voluntary system is free of the constraints and criteria of a mandatory system so that diversity of subject matter and richness in detail are likely to be associated with the reports. Providing reporters with assurances of anonymity removes one of the constraints of the potential for self-incrimination. This tends to remove one of the major potential constraints on the volume of flow of reports into the system. As previously noted, when the FAA acted as its own manager for a voluntary human error reporting system, the program was singularly unsuccessful. During the trial period for the FAA's own program, the volume of reports submitted to the FAA was very low, evidently as a result of the reporters' fear of self-incrimination. When the FAA instituted the ASRS with an independent, third-party manager, the system achieved added assurance of reporter anonymity. Consequently, substantial numbers of reports were received by the ASRS almost immediately after its initiation (cf, Ref. 1, pp. 7 & 22). Thus warranties of immunity for reporters together with a system supported by a third-party management would be important features for removing the constraints against self-incrimination in voluntary reporting in a new system.

The concept of providing a limited warranty of immunity from regulatory redress (assuming that a related report has been filed on the safety related incident in question) also provides some additional motivation for submitting reports. In the nuclear industry, it has been observed that the motivation to report could be increased if the immunity concept were extended to the utility associated with the incident as well as extending immunity to individual reporters. It was recommended in Volume I that consideration should be given to providing the utility with a limited warranty of immunity from regulatory action against an incident if a report has been filed with the NPSRS about the incident, and if the plant has maintained some minimum standard level of reporting in the past with respect to other incidents (Ref. 1, pp. 23-25). In the recommended concept, the utility's eligibility for immunity would only be publicized to the NRC if regulatory action were taken against the plant for an incident covered by the NPSRS for which action was initiated through conventional regulatory processes.

Overall, a new, entirely independent NPSRS would be expected to provide the highest volume of flow of reports into the system of any of the alternatives considered. High reporting volume and diversity of subject matter is the key to development of a well-stocked bank of human factor related event data. As previously noted, there is a need for more data of this type to enrich the NRC's data banks for human reliability in nuclear plant environments. A new, independent system should provide the greatest probability of successfully accumulating the desired data.

2.2 Considerations Influencing System Feasibility

A number of areas must be given consideration prior to NPSRS implementation. The prime areas for a diversity of viewpoints that should be considered are the practicality of the system, its acceptability, and the probable usefulness of the system data and results. Other questions might be raised in connection with the mechanisms for interfacing the system with the NRC-sponsored Human Reliability Data Bank (HRDB) (Ref. 4) and whether there is a potential duplication of effort with the HRDB. These and other related questions are addressed in this section of the report.

2.2.1 Practicality of the System

One of the first order considerations that should be addressed is related to the legal implications of establishing a reporting system outside of the direct control of the NRC that might provide warranty of immunity from regulatory action for reporters and possibly for utilities as well. The ASRS provides a clear precedent for the legality of such provisions. The FAA grants such immunity to members of the aviation community without any apparent major impacts on the FAA's regulatory responsibilities or capacity.

However, the legal basis for the regulatory responsibilities of the NRC may not be identical to those of the FAA. Thus, in the future, an investigation should be conducted of the legal implications of establishing an independent NPSRS outside of the direct control of the NRC. The investigations should also address the implications of limiting the NRC's regulatory prerogatives in connection with an individual's submission of an incident report where public safety may have been threatened in some degree.

Another consideration deals with the logistics and potential costs of implementing a NPSRS. The logistical requirements for the system are heavily dependent upon the volume of reports that might be received and processed by the NPSRS. The primary costs of the system will be associated with the size of the required staff needed to receive, process, codify, and perform some analyses of the reports and with the other direct and overhead costs needed to support the system.

At this time, it is difficult to estimate the number of reports that a NPSRS might receive. However, the ASRS experience provides some background for estimating the logistics and costs of a NPSRS. The logistical requirements of the ASRS for receiving and processing reports should represent a reasonable first order model for those of a NPSRS. The annual budget for the ASRS is about $1.5 million. This covers the costs of labor, other direct charges, and overhead charges (including building space, computer costs, etc). Within this budget, the ASRS receives and processes about 400 reports per month from the aviation community. As noted in Volume I, the potential base for reports involving commercial aircraft flights for the ASRS is perhaps 5 to 10 times larger than the corresponding base for reports from licensed nuclear power plant operators to a NPSRS (cf, Ref. 1, p.20). If, however, unlicensed operators and maintenance personnel were included in the NPSRS base, the potential bases for reports from the two systems might be quite similar.

By way of comparison, about 300 to 400 events per month are submitted and processed as Licensee Event Reports (LERs) in accordance with NRC requirements. The number of required LERs submitted gives some insight into the prospects for the reporting volume of a voluntary system. About one-third to one-half of the LERs have been found to be related to human factors or operational procedures in some way. Thus an average volume of between 100 and 200 human factor related reports per month are obtained through LERs. As a first approximation, a successful voluntary NPSRS program would be expected to produce at least as many reports as the involuntary LER system, on the basis of the professional attitudes and concern for plant safety exhibited by licensed and nonlicensed operational personnel in nuclear power plants.

Thus, the LER experience suggests that the volume of reports to a NPSRS might be about equivalent to those of the ASRS. Consequently, as a first order estimate of NPSRS logistics and costs, it is projected that the requirements would approximately equal those of the ASRS. Therefore, a projected rough estimate of the annual costs of operation of a NPSRS therefore might be between $1 to $2 million. A budget of this magnitude would support a staff or 10 to 15 full-time equivalent analysts. This would appear to be adequate for the anticipated volume of NPSRS reports.

Costs of this order of magnitude seem relatively nominal for a system that has the potential for making an important contribution to the safety of the nuclear industry. Costs for supporting the NPSRS could be shared with other Federal agencies besides the NRC, such as the DOE. However, considering the objectives of the NPSRS and the direct support that the system would provide to NRC programs, it would seem to be appropriate for the NRC to provide exclusive support for the system. In that way, responsibility for system oversight would not need to be arbitrarily divided between more than one Federal agency.

2.2.2 Acceptability of the System

A number of viewpoints have been raised with respect to the acceptability of the NPSRS to the nuclear community that deserve consideration. These are discussed in terms of the acceptability of the system to NRC regulatory personnel, nuclear utility management, operational personnel within the nuclear power plants, and the public.

2.2.2.1 Acceptability Considerations from the NRC Regulatory Point of View

A frequently raised consideration deals with potential regulatory impacts associated with providing anonymity for reporters and warranties of immunity from regulatory procedures. As previously discussed, the relatively small size of the nuclear community will almost certainly mean that facilities involved in an incident must be deidentified in the codified NPSRS data, if reporter anonymity is to be preserved at all. This would effectively eliminate the possibility of use of the raw NPSRS data for regulatory action. However, as a minimum, the NPSRS would be expected to provide generic data on incident trends to the NRC that could be evaluated from the system. Trend data of this sort would almost certainly seem to be significant to NRC regulatory personnel.

It is almost certainly true that provisions for reporter anonymity and warranties of immunity would constrain some regulatory activities. FAA regulatory personnel in the field vocalized similar complaints about ASRS constraints on their enforcement activities. In spite of the constraints, the FAA field personnel generally favored continuation of the program and did not feel unduly inhibited by working with the ASRS. Since the FAA has proposed to limit the warranty of immunity to one reported event per individual per five year period, the concerns of FAA field personnel have been sharply reduced. Some similar limitations on warranty periods would seem appropriate for a NPSRS.

The principal consideration associated with the concerns over potential regulatory constraints seems to be associated with the question of whether the constraints might result in decreases in operational safety within the nuclear community and hence contribute to increased risks. By comparison, the aviation community feels in general that the ASRS has contributed positively to decreasing the risks within the national airway system. In the opinion of the author, a NPSRS would not increase risks, but would raise the consciousness level of operational personnel with respect to the role of human factor elements in their work with positive net cumulative effects on safety related incidents. Moreover, the availability of the NPSRS would provide operational personnel with a mechanism for discretely raising the attention level for potential safety related problems so that they might be observed before they became serious. Thus, it appears probable that a NPSRS would provide net benefits to the risk balance for the nuclear community that should outweigh the potential constraints, if any, on the NRC's regulatory activity.

Some suggestions have been made that the effectiveness of the LER system may be inhibited by a NPSRS. Assuming that the NPSRS was implemented as a separate reporting system, operated and managed by an agency that was independent of the NRC, it is not clear how LER system effectiveness could be significantly affected. Since the LER is an NRC operated system that functions under NRC specifications and regulatory requirements, it would not appear that an additional non-intrusive, voluntary reporting system could interfere with LER operation in any substantial way.

Some questions have been raised with respect to the availability of qualified analysts to support the NPSRS since the nuclear industry is relatively youthful (that is, in comparison to the aviation industry). The ASRS employs retired aviation system personnel with many years of experience as analysts for its reports. Though there would not currently be as many such retired operational personnel in the nuclear industry, no insurmountable obstacles would seem to be apparent to finding and retaining a well-qualified staff of analysts from the nuclear community as long as salaries for operationally experienced analysts were competitive with industry standards. This seems particularly apparent when consideration is given to the relatively small staff that is expected to be required for the NPSRS (approximately 10 to 15 analysts, as noted above).

Others nave questioned whether the editing of NPSRS reports that would be required to ensure reporter and utility anonymity would eliminate too much needed background information from the reports before the results became available to the NRC. This is alleged to potentially cause the reports to be less useful to the NRC than they would be if they could be accessed in less "sanitized" versions. In response, the required level of deidentification and sanitization that must be utilized prior to making a NPSRS report available for public dissemination from the data bank has not yet been fully determined. Before that determination can be made with assurance, the mechanism for providing immunity to reporters and utilities must be resolved in concert with the NRC. The required level of report deidentification should depend upon the degree of isolation that must exist between the NRC and the reporter, the utility, and the power plant associated with the report. If some limited immunity is provided to the utility associated with the report (as well as providing immunity to the reporter), then the deidentification of the report may not have to be as complete as it would be without any proffered immunity to the utility.

Moreover, those who have been associated with the ASRS have occasionally suggested that anonymity and immunity are not absolutely essential to continued ASRS success. They have suggested that the reporting level might not be substantially diminished if these features were eliminated. Some evidence for the validity of this observation exists. Three years ago, the practice of granting blanket immunity to reporters for each reported incident was terminated by the FAA, and a limited immunity concept was initiated. In the revised concept, immunity was granted to a reporter for only one reported event instead of providing unlimited immunity for any number of reported events to any given reporter. Thus, second (or other additional) offenses are now subject to the full force of FAA regulation, irrespective of whether reports have been submitted on the given events or whether the type of Federal Aviation Regulation violation involved in the current event is different from the one for which immunity was granted originally to the offender. In spite of this reduction in reporter immunity levels, reports have continued to come to the ASRS at levels that are about equivalent to those that existed under the previous blanket immunity provisions. However, no serious proposals were made in any of the Aerospace interviews conducted with ASRS participants that suggested that the immunity waiver should (or would) be totally eliminated from the successful formula now applied in the ASRS operating procedures. (Serious consideration is being given to relaxing the current single event per reporter (lifetime) immunity restriction to a single event per reporter per five year period limit.)

It is, however, useful to consider that total anonymity and immunity warranties may not be an absolutely essential ingredient to NPSRS success. A test of the effectiveness of different levels of promised anonymity and warranties of immunity could be made in a preoperational testing phase of a NPSRS in order to determine how essential this feature would be to the volume of flow of reports into the system. Depending upon the results of the test, it might be possible to make more meaningful decisions about the potential impact of report editing on the usefulness and the plant-to-plant specificity of the reports that could be made available from the system to the NRC or to other participants in the program.

2.2.2.2 Utility Management Acceptability Considerations

One of the principal considerations expressed by management is that a NPSRS could bypass the management communication chain with a subsequent loss of a mechanism for detecting the existence of potential safety hazards in the plant. This concern has a legitimate basis. However, it should be noted that under normal circumstances, operational personnel would frequently be reluctant to report potentially embarrassing incidents through the line management chain anyway. Most frequently, operational personnel would probably feel, with justification, that informing management directly about an error-related incident (no matter how "human" the triggering error might have been) could jeopardize their job and future with the plant. It is very unlikely that the existence of the NPSRS voluntary route for anonymously reporting an incident, outside the management chain, would substantially reduce the number of incidents that are freely reported to management under the present circumstances.

Actually, if the recommendations for granting limited immunity to utilities were followed, the number of reports that could be obtained by management might increase. If an incentive plan was provided within the facility by line management that was designed to increase employee utilization of the NPSRS program, it could result in substantial increases in reported incidents. If this plant-level incentive concept were successful, and with proper NPSRS program design, it might be possible to return reports (from which the identification of the reporter had been deleted) to the facility of origin for the information of line management.

A similar consideration raised by management suggests that warranties of reporter amnesty would interfere with the disciplinary prerogatives of line management. While this observation may be true in part, it too could probably be reduced to a relatively small concern by appropriate NPSRS design. Under the recommended NPSRS program features, a first-order warranty of amnesty from regulatory disciplinary procedures would be extended directly to the utility and power plant involved in an incident, if an incident under NRC investigation had been reported in accordance with NPSRS requirements (and the power plant had maintained a minimum volume level of reporting over and above the actual reporting of the particular incident under review). The filing of a report concerning the incident under investigation and the the demonstrated support of the NPSRS program by the utility owners of the plant would be considered by the NRC to be an indication of a good faith effort to improve safety conditions within the plant. As was the case with the ASRS, the utility's warranty of amnesty would, of course, be subject to certain limitations with respect to frequency of usage. Repeated requirements for use of the NPSRS amnesty conditions by a facility could invalidate the evidence of the good faith effort on the part of the utility to improve safety conditions in the plant.

It has also been suggested that consideration should be given to the possibility that disgruntled employees could use a NPSRS as a mechanism for taking revenge on a utility. Under the suggested scenario, a disaffected employee could file fabricated reports about imaginary incidents in order to discredit the plant or utility management in retaliation for slights or to justify substandard performance on the part of the employee.

Some ASRS personnel have hypothesized that such "ballot stuffing" procedures may have occurred in the past with the ASRS. Although the evidence is purely circumstantial, there is a possibility that air traffic controllers belonging to PATCO (the Professional Air Traffic Controllers Organization) may have tried to build a justification for certain work load claims that they were attempting to negotiate in their union/management labor agreements by excessive (and perhaps even unwarranted) filing of ASRS reports. ASRS analysts were reportedly concerned that controllers might have been taking improper advantage of the system in this way prior to the PATCO strike. Prior to the strike, about half of all ASRS reports filed were submitted by air traffic controllers. As evidence of possible misuse, ASRS analysts have noted that during and immediately after the strike, the number of reports filed by air traffic controllers dropped to nearly negligible levels. Only recently have reports begun to be received in any significant numbers by the ASRS from the nonunion air traffic controllers now working the system. However, the current volume of reports filed by air traffic controllers is less than 1/4 of its level before the strike. Other explanations are, of course, possible for the reduction in the number of air traffic controller reports submitted. One reasonable alternative explanation is that the controllers were simply too busy to file reports during the initial period of the strike. In spite of the apparent potential soundness of this alternative explanation, the existence of the hypothesized "ballot stuffing" explanation must also be acknowledged.

Thus this concern for the potential fabrication of reports about imaginary (or trivial) incidents requires some consideration. Misuse of the system in this way could cause undue weight to be given to the significance of certain types of incidents and could potentially skew the judgments of analysts concerning the frequency of (and possibly the significance of) the fabricated events. This could clearly be an unfortunate and undesirable result.

In a voluntary reporting system like the NPSRS (or ASRS), it is probably impossible to completely eliminate the potential for submission of fabricated reports. Furthermore, it is possible that restrictive measures that might be designed to substantially reduce the chances for such misuse might also place anonymity mechanisms for reporters in jeopardy. The best methods for reducing the probability of misuse of the system through fabricated reports are not easy to determine. Mechanisms for resolving the issue would require negotiations to be conducted between the parties involved as the NPSRS nears operability. However, the following concept is an example of the kinds of approaches that might be taken to reduce the possibility of system misuse. With the recommended concept of limited utility amnesty, as well as reporter amnesty, it is possible that deidentified plant-specific incident reports could be made available to the particular plants involved on some regular basis. Under these circumstances, informational feedback paths between the ASRS and the utilities might be made available to identify possible conditions where misuse of the system was suspected. Irrespective of the mechanisms that might ultimately be selected to resolve the issue, NPSRS analysts would have to be alert for the possibility of misuse of the system through unwarranted filing of fabricated or aggrandized reports of incidents in nuclear plants.

2.2.2.3 Operational Personnel Acceptability Considerations

It has been observed that guarantees of reporter anonymity and warranties of immunity from punitive action could be very important to the cause of maintaining a free-flow of incident reports into a NPSRS. However, it has also been noted that operational personnel may be concerned that bypassing utility line management with safety-related reports could result in the potential for either immediate or long-term management retaliation if reporter anonymity were ultimately lost (either by failure of the NPSRS security system or by a process of deduction on the part of line management). Because there are a relatively small number of nuclear power facilities and also a relatively small number of operational personnel within the facilities, this issue represents a potential dilemma for operational personnel.

However, a possible solution for this problem exists in the recommended form for implementing the NPSRS. As previously noted, if a limited warranty of immunity was extended to the utility as well as to the reporter, mutual benefits could be achieved by both management and operational personnel for submitting NPSRS reports. Based upon mutual benefit considerations, management might recognize that it was to their advantage to encourage filing of NPSRS reports and also to discourage attempts to identify or punish reporters.

In any case, there is substantial agreement that a neutral, third-party NPSRS management agency would need to be utilized in order to provide an acceptable system to operational personnel. It would be important to show that the NPSRS management agency has a demonstrated independence from the NRC and the utilities. It has been noted that such independence appears to be necessary in order to provide adequate assurance of reporter and utility isolation from either regulatory disciplinary actions or management disciplinary actions. Anything short of this degree of isolation from management and the NRC would probably leave the reporter with a feeling of concern for the possibility of self-incrimination associated with filing a report to the NPSRS. Experience with the ASRS has shown that until the FAA brought in a third-party manager for the system the volume of reporting was very low. This experience has been attributed to the reporters' concern over the potential for self-incrimination in a reporting system that was conducted by the same organization that wrote and administered the regulations affecting the performance of personnel within the national aviation system. The lessons learned by the ASRS seem directly appropriate to the NPSRS.

2.2.2.4 NPSRS Acceptability Considerations Among Other System Users

In the course of the Aerospace study, concerns were expressed over the potential that many "near miss" but potentially significant safety-related incidents may currently go unreported. It has been hypothesized that such incidents may not be reported because they are a potential source of embarrassment to operational personnel or because personnel are concerned that reporting the incidents will potentially subject the reporter to punitive actions, perhaps even placing their jobs in jeopardy. There is also concern that if reports are being made by operational personnel under current NRC procedural requirements (such as those for LERS), that such reports are being extensively edited by utility management in order to limit the probability of the NRC taking regulatory disciplinary action against the facility or because management is concerned with damaging the utility's public image. The implementation of a NPSRS could help to alleviate this area of concern among potential users of the system.

However, as with the operational personnel, discussions have indicated that other system users apparently also feel the need for a neutral, third-party management agency for the NPSRS. They feel that a third party management is needed to ensure the independence of data analysis and to ensure that neither the NRC nor utilities manipulate or censor the reports obtained by the system. Though the public's concern in this area may be excessive, it is nonetheless real.

The potential availability of public access to NPSRS data is also important for increasing public confidence in plant safety. Third-party management should provide greater assurance to the public that the NPSRS data would be accessible. If demands for public participation in analysis of the data from the NPSRS were to become excessive, it could be necessary to establish user fees for access to the data. It should be noted, however, that public requests for ASRS data have been relatively infrequent. When such requests have been received, they have commonly been met by providing the requester with a simple listing of reports associated with one or more topical descriptors from the ASRS taxonomy. The Aerospace investigation did not uncover any extensive requests for research or analysis by ASRS personnel that had been received from people outside of the participating aviation community. It seems probable that public requests for NPSRS data would be similarly infrequent.

The ASRS experience may, however, not be an entirely valid basis for estimating the magnitude of public demands for processed data from the NPSRS. Unlike the nuclear industry, the aviation community has no organized militant anti-industry groups opposing its operations. To resolve this area of uncertainty and to avoid this potential aspect for abuse of the NPSRS, it may be necessary to establish criteria for access to the system data. The development of these criteria were beyond the scope of this feasibility study.

2.2.3 Utility of System Data

The potential utility of the NPSRS data has been assessed with respect to its probable completeness, the probability of its use by members of the nuclear power community, and the implications of the data to probabilistic risk assessment (PRA) analysts. The considerations associated with these areas are discussed in the following paragraphs.

2.2.3.1 Completeness of the NPSRS Data Set

Several opinions have been expressed concerning the possibility that operational personnel would apply their own, potentially widely divergent criteria with regards to the significance of events and the consequent need to report them. As a result, it has been suggested, reporters could pass over events of real significance because they were felt to be too insignificant to justify report preparation. Hence, it has been suggested that the data set could be incomplete because some significant events might go unreported since the voluntary nature of the NPSRS did not sufficiently motivate reporters to file reports on the incidents in question.

It is undoubtedly true that not every event that might occur in any given nuclear power plant would be reported. It is no doubt equally true that some of these unreported events could be subsequently judged to have been significant by someone with the benefits of historical perspective. However, it appears to be equally true that any human reporting system would be subject to this criticism, whether it was designed to be a voluntary or mandatory system. There will always be some limiting subset of events that will be judged by reporters as being too trivial to report. The interface between trivial and nontrivial events is too ambiguous to prevent some losses of potential reports of historically significant events that might be considered trivial at the time they occurred.

Some evidence for this can be seen in the ASRS reports. As previously observed (Volume I, Section 3.1.1), there are literally tens of thousands of independent opportunities for safety-related incidents to occur each day in commercial and private aircraft operations. This translates into millions of opportunities for safety-related events each month. Yet, reports are filed with the ASRS at rates of only a few hundred per month. If the ASRS data set were considered absolutely complete, the rate of human and mechanical failures in aircraft would have to be considered to be very low (i.e., on the order of 1/10,000). Such rates are substantially lower than the customary expectations for the human reliabilities of aircraft operational personnel. For example, estimates of the human error probability of trained operational personnel for task performance (in nuclear plants) where checklists and guides are available, range from 1/10 to 1/1000 (Ref. 3). Human reliability estimates for aircraft operational personnel should resemble estimates used for nuclear personnel. This is particularly true since the nuclear reliability estimates have drawn heavily on aircraft operational personnel human reliability data.

Thus, it appears that probably only about one to ten percent of the total human error incidents in aircraft are reported to the ASRS. However, the ASRS still represents the most complete set of data available for safety-related events involving humans in the national aviation system. Similar results could be expected for the data set available from a NPSRS.

2.2.3.2 Probability of Use of the Data Set

Some views have been expressed that only a limited use would be made of the NPSRS data set. Particular concern has been expressed over the possible limited use by nongovernment organizations. It is probably true that the immediate use of the NPSRS by both participating and nonparticipating organizations would be limited. However, regularly increasing use of the system by such organizations would be expected over a period of time as members of the nuclear industry and other potential NPSRS users became more aware of the existence and value of the system and its data.

The ASRS experience with use of its data set is probably pertinent in this regard. The use of data from the system by organizations other than NASA and FAA-sponsored institutions has been slow growing and time-dependent. Some evidence suggests that the growth rate for use of the ASRS data could be accelerated by increasing "public" awareness of the system's availability through more effective publicity concerning the existence of the ASRS and its activities and the content of its data set (Ref. 2). This evidence suggests that the use of the ASRS by nonparticipating agencies is still limited. Nevertheless, the demand for special investigations of the data set is growing from other members of the aviation community. Both the FAA and NASA are satisfied that the usefulness and use of the data has been established by the past history of satisfied requesters for data from the ASRS. It is reasonable to assume that over the passage of time, the history of usage of a NPSRS would also show regular growth and satisfied users.

2.2.3.3 Potential Use of NPSRS in Probabilistic Risk Assessments

Substantial interest exists in the potential benefits of the NPSRS data for use in Probabilistic Risk Assessments (PRAs). As previously noted (cf, Section 1.1.3), a need exists for a more substantial data base for assessing human error probabilities (HEP) for PRAs. Many of our current quantitative estimates of both human error probabilities and human reliability in the nuclear industry are based upon non-nuclear data.

A substantial increase in the data base for human performance in nuclear power plants would provide benefits to PRA analysts. However, the results would not necessarily be a panacea for all of the PRA analysts needs for improving quantitative estimates of HEP. HEP projections require the analyst to have valid data on both the known numbers of occurrences of errors of a given type and the total number of opportunities for such an error to occur under the conditions of interest. With this data, the HEP for errors of a given type can be expressed as (Ref. 3, p. 2-9):

$$HEP = \frac{\text{Number of occurrences of an error}}{\text{Total number of opportunities for the error}}$$

A reporting system such as a NPSRS gives information primarily about the numerator of the relationship for the HEP. Only indirect, inferential information about the denominator of the HEP relationship (the total number of opportunities for an error) can be obtained from a safety incident reporting system. Moreover, there is no known method of developing a complete actuarial base for statistics for the denominator of the HEP relationship. Estimates of the magnitudes of the denominators of HEPs will always be substantially dependent on the judgment of analysts for their evaluation.

As mentioned, information about the numerator of the HEP relationship, that is the number of occurrences of an error of a certain type, may be determined in part from the NPSRS. However, as discussed in Section 2.2.3.1, data collected by a NPSRS cannot be certified to be complete. In fact, as previously noted from estimates of ASRS experience, it is unlikely that more than one to ten percent of all the safety related incidents will be reported that might be considered significant (by one or more analysts). Thus, it would not be possible to certify that even the data related to the numerator of the HEP relationship would be complete as determined from the NPSRS.

Therefore, the NPSRS data could not be expected to validate (or define with absolute precision) the quantitative values of either human reliability or human error probabilities. The most that could be expected from a NPSRS (or any other empirically based data set) would be better quantitative data about relative frequencies of various types of incidents. This information would be very useful to PRA analysts. Quantitative data on relative frequencies of particular types of incidents would provide a more solid base for evaluating the validity of current judgmental projections of human reliability. Relative values would also be useful in the definition and evaluation of fault and event trees in PRAs.

Moreover, the NPSRS results would aid in the evaluation of the generic influences of performance shaping factors for hardware design, operating procedures, or other factors that could affect human behavior in either a positive or negative manner. With proper NPSRS design, in which utility management whole heartedly supported a NPSRS program, the statistical results of analyses of the data set might also support assessment of plant-specific performance shaping factor effects on human performance in a particular plant.

A voluntarily based reporting system would also be expected to have a very broad scope of topical subject material included in it. The diversity of the material in the data base would aid PRA analysts and human factor modelists in fault and event tree development. The data would contribute to a better understanding of the root causes of human error and the mechanisms by which problems are resolved once they have been initiated. The creative problem solving methods of humans by which they attempt to minimize the impacts of equipment (or human) failures have always been difficult to model. A NPSRS, which by its nature is associated with "near-miss" incidents, should yield a great amount of data on such problem solving mechanisms that would be useful to PRA model developers.

Thus, a great deal of benefit would be expected from a NPSRS to PRA analysts. These benefits would, however, be more directed towards qualitative aids to model development than they would be to explicit quantification of human error probabilities. However, contributions to evaluation of human reliability estimates should be provided through assessment of the NPSRS data for relative frequencies of events. Therefore, as indicated, the NPSRS data would be expected to benefit PRAs in many ways.

2.2.4 Interfaces with the Human Reliability Data Bank

A Human Reliability Data Bank (HRDB) is under concurrent development by the NRC (Ref. 4). The HRDB is being designed as a central collection and processing point for human reliability data from many sources, including existing NRC and industry data bases, simulation experiments, field data, etc. The NPSRS represents one of several complementary sources of input data to the HRDB. As a field data collection source, the NPSRS has no competing objectives with the HRDB and no apparent areas of overlapping responsibilities.

The scope of the Aerospace study reported on in this Volume was restricted to an assessment of the data collection mechanisms for the NPSRS. In this phase of the study no significant consideration was given to the data handling or assessment mechanisms required for a complete system that would interface compatibly with all other facets of the NRC's human reliability program.

Thus the details of the interface between the NPSRS and the HRDB have not yet been defined. However, the most significant aspect of the systems' interface would appear to be the taxonomies of the two systems. Ideally, the taxonomies for the NPSRS and the HRDB would be identical, although this would be a practical improbability. If the dynamicism of the ASRS taxonomy were to be indicative of the characteristics of the NPSRS taxonomy, then a large amount of growth and modification to the indexing subsystem would be expected over the long-term history of NPSRS implementation. Thus, flexibility in the makeup of the taxonomies for the HRDB and the NPSRS collection system is important. Major topical elements of the HRDB taxonomy and that of the NPSRS would be expected to be similar or identical. However, it is probable that the set of descriptors in the HRDB taxonomy would lag that of the NPSRS. This would be expected because the HRDB taxonomic structure is closely related to the current requirements of PRA analysts. The NPSRS taxonomy, on the other hand, would be structured by the manifold demands of incident codification. The growing NPSRS data base would be used by model developers that were making improvements to current PRAs. Thus, the taxonomy of the NPSRS might be expected to be larger and more dynamic than that of the HRDB.

3.0 ELEMENTS OF A NUCLEAR POWER SAFETY REPORTING SYSTEM

A schematic diagram of the functional relationships of the operational processes of a NPSRS is shown in Figure 1. The process flow of data from original reports from individual plants and reporters through the NPSRS and the output to system users is shown in the figure. This section of the report outlines the elements of the system and its processes and defines the essential requirements needed to support the system.

3.1 Description of System Form and Operational Processes

The principal features of the operational processes and flow of a NPSRS are shown in Figure 1. The NPSRS itself is shown inside the dashed lines of the central portion of the figure in terms of the elements of the process flow from input of the original reports to storage and ultimate output of the codified data from the reports. In Figure 1, the dashed lines surrounding the NPSRS symbolize the system's relationship to the third-party management organization. The dashed lines are symbolic of the protective barrier provided by the third-party management to prevent direct contact between the NPSRS, the input sources, and the exterior delivery points for the output from the system. The symbolic barrier is suggestive of the security measures that would be taken for the system in order to prevent output data from being identified with input sources and of the measures that would be taken to assure the isolation of reporters and utilities from regulatory action.

3.1.1 Relationship of the NPSRS to the NRC

In Figure 1, the NRC is shown as the directing agency for the NPSRS. It is conceivable that funding responsibilities for the NPSRS could be shared with other agencies. However, the NPSRS objectives of providing data sources to improve the understanding of human factor related incidents within the nuclear industry seem appropriate for justification for NRC sponsorship.

The interface between the NRC and the NPSRS is established at the third-party manager level. As indicated in the figure, relationships between the NRC and the third-party manager would be defined and maintained by a memorandum of understanding (MOU) between the two organizations.

Selection of a third-party manager will be a critical step in implementation of a NPSRS. All participating and using parties to the system must acknowledge that the management organization selected is: first of all, objective and impartial with respect to the treatment of the data collected; and second, possessed of a solid background in nuclear power and human factors relationships for nuclear plants. As a result of the first requirement, it would be difficult for an industry supported organization such as EPRI or INPO or a DOE laboratory to present acceptable credentials for objectivity and impartiality. However, some type of government sponsored agency would be desirable for providing this sort of impartial third-party management support for the system. Consideration could be given

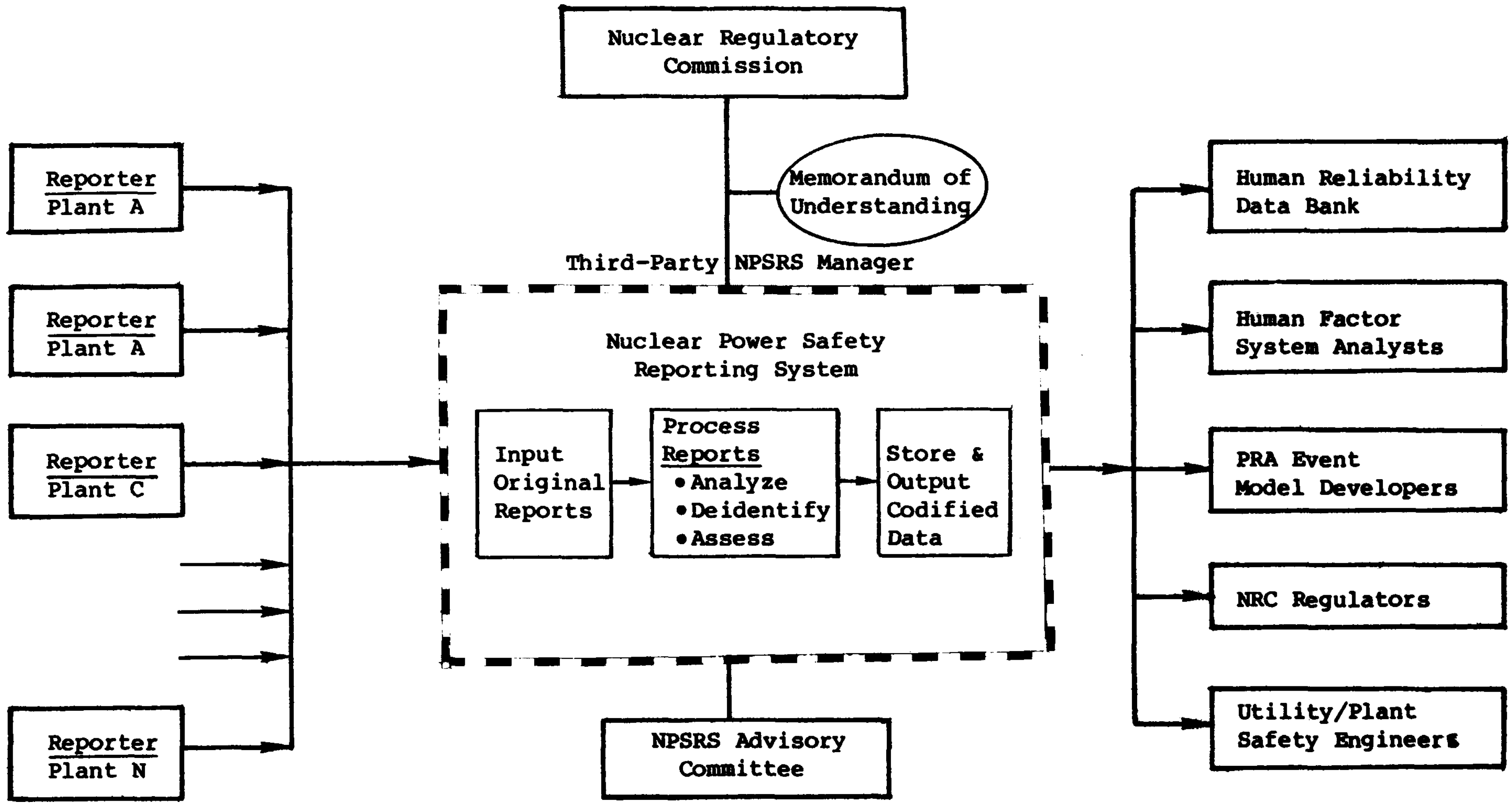

Figure 1. Functional Diagram of Operational Relationships and Processes of a Nuclear Power Safety Reporting System

to using a branch of the National Bureau of Standards, or to a DOD supported agency as the third-party management organization. Identification of potential candidates for a third-party management agency should be a high priority activity in future NPSRS considerations.

3.1.2 Relationship to the Advisory Committee

The NPSRS would also be supported by an Advisory Committee, as shown in Figure 1. The Advisory Committee should be structured as a working committee. An appropriate size for a functional committee of this sort would be about 10 to 15 members. The NPSRS Advisory Committee members should be selected from representative bodies of the nuclear power industry, the NRC, and the public. Membership should include representatives from nuclear power industry organizations such as the Atomic Industrial Forum (AIF), the Electric Power Research Institute (EPRI), the Institute of Nuclear Power Operations (INPO), and perhaps representatives of specific nuclear reactor manufacturers and/or nuclear utilities as well. Specific representation from organizations representing operational personnel should also be provided on the Committee. Professional societies, unions, or other representative organizations for operational personnel should be included to provide a voice that would be representative of the views of individual reporters. In order for the Committee to be fully representative of the regulated nature of the nuclear power industry, representatives of the NRC should also be included on the Committee. Representatives of the general public may also need to be considered for membership on the Committee to ensure an appropriate balance.

In spite of the diversity of opinions potentially represented by the Committee's membership, it would be important for the Committee to function in a nonadversarial fashion. Thus, the mission, objectives and responsibilities of the Committee should be clearly defined in an initial charter in a way that would establish a positive, philosophically supportive role for the Committee with respect to the NPSRS. Though it might be necessary to review and revise the Committee charter from time to time, it would be important to maintain a philosophical base of this type so that an objective but supportive NPSRS Advisory Committee would always be provided. One of the principal goals of the committee should be to evaluate the performance of the NPSRS. However, the charter for the Committee should clearly indicate that objective, constructive criticism is sought, not divisive, destructive criticism, applied with the goal of emasculating or destroying the system.

The ASRS Advisory Committee provides a model for the successful operation of such a committee. Formed of a representative cross-section of the aviation community, with the potential for widely diverging viewpoints on system needs, the Committee has worked together in a positive fashion to both evaluate and support the role of the ASRS. The relationship between the ASRS and its Advisory Committee has been a beneficial one. The Advisory Committee has helped to eliminate rough spots in ASRS operation and smoothed potential differences between the ASRS, reporters, the FAA, and using organizations within the aviation industry.

3.1.3 Flow of NPSRS Operational Processes

In Figure 1, the process flow of the system begins at the far left of the figure with the preparation of individual reports. Reports would be submitted initially to the third-party manager of the NPSRS. Prior to submission of the original report to the NPSRS for analysis, the third-party manager would prescreen reports to determine whether the incident involved any violations of law or accidents which should have been reported under other NRC regulations, such as required LER submissions. If the incident involved some illegal action or was associated with a regulatory requirement for reporting under another system, the report would be sent directly to the appropriate action agency without necessarily disassociating the identification of the reporter from the report.

Assuming that the report passed the prescreening tests, it would be sent to the NPSRS and assigned to an analyst. The analyst's first steps would include an initial assessment of the significance of the event. In order to evaluate event significance, events would be assessed against key initiating incidents that could lead to serious accidents, as they have been determined from PRAs. If the event appeared to belong to the same generic family of conditions associated with key PRA initiating events, it would be "flagged" for special processing. A "flagged" report would be given special priority and prompt handling by a NPSRS analyst. The output distribution for flagged reports remains to be determined. However, such reports (after deidentification) might be sent directly to PRA model developers or to INPO for inclusion on their NOTEPAD communication network in order to alert utilities to the occurrence; or perhaps they might be submitted directly to other users.

For either priority or normally processed reports, the NPSRS analyst would prepare the report for codification by evaluating it against the system taxonomy. If questions existed about some aspects of the report, the analyst would contact the reporter directly by telephone to interview him in detail about the incident.

When all of the analyst's questions were satisfied, the identification strip would be separated from the report and mailed to the reporter. The identification strip would show the date that the report was received by the third-party manager for the system. When returned to the originating reporter, the strip would act as his receipt in case the incident should become a subject of NRC or utility investigation by some other process.

In addition to separating the reporter's identification from the report, the report would be assessed for other aspects that might tie it to the originating reporter. References to things such as the particular plant in which the incident occurred, or the specific time of the incident, or other such potentially compromising elements of the report might have to be removed in order to assure that the anonymity of the author of the report could be maintained.

After the report was deidentified and the significant indexing parameters were selected for the report from the NPSRS taxonomy, the analyst would submit the codified data and the report to a clerk for computer processing. The clerk would then process the data for computer storage. Output to users from the system would be provided only from the data stored in the computer files. Original documents would be destroyed after a quality control check to assure that they were properly filed for and on the computer.

As shown in Figure 1, NPSRS data could be obtained by users only from the third-party managers of the system. Stockpiling of results in a holding queue prior to their dissemination would be one method that could be used to help preserve the anonymity of reporters. After a suitable holding period, all codified results would ordinarily be sent to the HRDB for inclusion with other sources as part of the data bank. In addition, regular reports on the status and results of the NPSRS would be sent to the NRC, along with specialized reports of the assessment of the NPSRS data. Portions of the codified data could be obtained directly from the NPSRS by individual users upon request for specific subject matters. Using organizations and individuals, including the NRC, could request specific data from the system for their own requirements. Where applicable, user costs could be levied against the magnitude of output requirements for data requests that exceeded some nominal retrieval levels.

In summary, the key elements in the process flow of the NPSRS would be as follows. Incident reports would be submitted by individual reporters. The third-party management would preprocess reports to screen for legal eligibility requirements. Processing of reports would be conducted by NPSRS analysts who would analyze and codify the data from the report. The analysts would remove critical identification from the report that could compromise the anonymity of the reporter. The analysts would then assess the significance of the report to determine whether some priority notification of hazards should be prepared. Codified data would then be transferred by the third-party manager to users. Ultimately, the users would process the data for their own particular applications.

3.2 System Operational Structure Elements

In order for the processes of the NPSRS to flow smoothly, certain system elements must be defined and provided. The purpose of this section is to identify some of the critical system elements. Detailed descriptions of the elements will be provided in subsequent phases of research for the NPSRS.

3.2.1 Input Procedural Elements

Forms for submitting reports would be one of the key elements that should be developed for the system. Drawing on ASRS experience, report forms should be simple and concise. Based upon that experience, a single-sheet report form is recommended. The form should include a detachable portion for reporter identification that would ultimately become the receipt for report submission. The detachable portion would include room for the name, address and residential phone number of the reporter. A limited set of multiple-choice, fill-in-the-blank data alternatives would be provided on the remainder of the sheet that would permit the reporter to specify some of the principal generic features related to the event, and the more significant characteristics of the plant where the incident occurred. Finally, the form should include space for a brief narrative description of the event. The form should be designed so that when it was folded, it would become a self-addressed, postage-paid envelope in which the report could be mailed to the NPSRS.

A communication corridor must also be established for routing reports from reporters to NPSRS analysts. The basic route for receiving incoming NPSRS reports would probably be best served by the U.S. mail. However, some consideration should be given to establishing a toll-free telephone line for reports. Both mail and phone routes should be considered because some reporters may be reluctant to use one or the other of these means of communications. Other types of communication links might be considered. However, assuming that anonymity of the reporter is important, either the mail or the phone would be effective means of preserving the security of the individuals involved.

Screening criteria should also be established for the reports. One of the first issues that would arise when the reports reached the NPSRS would be the question of whether the reports involved incidents that should be processed by the NPSRS, or whether the incident represented an illegal act or one that should have been reported under other NRC required reporting processes (such as the LERs). In conjunction with the NRC, a set of screening criteria should be established for these reports. The criteria should provide definitive standards for what constitutes either illegal actions or an incident that must be reported directly to the NRC. These criteria might have to be facility specific, assuming that they would include conditions that might be violations of Technical Specifications for individual plants. Since the Technical Specifications for plants as well as being facility unique (to some extent) may be time dependent, maintenance of these screening criteria could be an important ongoing interface task between the NRC and the NPSRS third-party management organization.

3.2.2 System Operational Support Elements

In designing the communication interface between the HRDB and the NPSRS, consideration should be given to the development of compatible taxonomies between the reporting system and the data bank. As previously noted, it is not obvious that the taxonomies for the two activities should be identical. It is probable that a basic framework of similar descriptors for indexing and cataloging the subject matter of the reports could be identical for the two systems. However, the dynamic nature of the topics expected to be brought before the NPSRS suggests that its taxonomy could be more extensive than that of the HRDB and might have a time-dependent lead with respect to the HRDB taxonomy structure. This could occur because the HRDB must reflect the current needs and concerns of PRA analysts, while the NPSRS, on the other hand, should be a potential source of new data and concepts for model development by PRA analysts. Thus the HRDB taxonomy would reflect more nearly the status quo of PRA practice, while the NPSRS taxonomy would probably need more descriptors in order to define and structure a growing source of human factors experience from the field.

Procedural mechanisms should be established for permitting other users to attain access to the NPSRS data, besides the obvious data transfer mechanism from the NPSRS to the HRDB. Criteria for acceptability of data requests from outside users should also be established. A financial compensation mechanism for transferring costs of large data requests may also need to be established. These procedures should be worked out in connection with both the NRC, nuclear industry members, and other potential user organizations. Procedures should also be developed for public users such as newspapers or other representatives of public information media.

3.3 System Organizational Interfaces and Requirements

Critical organizational interfaces would exist between the NPSRS and the reporters and utilities supplying input to the system, the recipients of the codified data from the system, the NRC, and the NPSRS Advisory Committee. The definition of the organizational structure and relationships for all of these interfacing systems was beyond the scope of this study. Therefore, the study results presented in this section of the report have been concentrated on identifying the areas that require interface definition. The details of the interface definition will be provided in subsequent phases of the research for this NPSRS project.

In addition to the support organization for staffing the NPSRS itself, the critical components of the supporting organizational structure needed to complete the operational processes of the system are: a third-party management organization to direct NPSRS activities; the NRC and/or other sponsoring agencies to provide direct financial support and legal backing for the system; sources supplying input reports (individual operators or utilities); and user organizations such as the NRC, the utility industry and others. Interface descriptions should be defined between all these parties.

A memorandum of understanding (MOU) should be prepared between the NRC and the third-party management organization for the NPSRS. The MOU should define the working relationships between the NRC and the third-party management organization. It should establish the basic goals and objectives of the system. It should provide the basic agreements ensuring that the system can function within a legal framework while providing anonymity for reporters and warranties of immunity for the critical participants in the reporting system (i.e., the reporters and the associated nuclear power facilities).

Similar agreements could have to be prepared to establish the legal relationships between nuclear utilities and the NRC in order to permit the utilities to participate in the system. The basis for warranties of immunity for reporting operational personnel and the power plants themselves may need to be established between the NRC and participating utilities, as well as with the third-party management organization for the NPSRS.

The Advisory Committee for the NPSRS should also have a charter established for it. The charter for the Committee should establish its guidelines and objectives and also define the duties and responsibilities for the Committee and its members. It should also identify anticipated generic budgetary items and sources of revenue for the Committee. It is probable that membership on the Committee could be a voluntary service for some, or all, of its participants. Nevertheless, a financial basis for Committee support should be identified. The definition of the financial basis would be needed because there would be some expenses that would be inherent to the Committee. These would be associated with compensation for necessary travel for Committee members, for direct expenses incurred in evaluating NPSRS operations, for report preparation and publication, and for other miscellaneous expenses.

Formal interface descriptions should also be prepared for the operational elements associated with external transfer of the codified output data from the system. These should include, in part, the interface descriptions for: the HRDB, human factor analysts, PRA event model developers, the NRC regulatory personnel, system users from the nuclear utilities and plants, and public organizations. The interface descriptions for these participants would help to define system requirements and boundary conditions that would be needed to permit the flow of information out of the NPSRS to its users.

4.0 CONCLUSIONS AND RECOMMENDATIONS

In this volume of the NPSRS study report, a brief discussion is presented of some of the significant viewpoints that should be considered in establishing and operating a NPSRS. The critical elements of a NPSRS are also outlined. The elements described for the system and relationships and processes of the system are outlined with the intent of providing a preliminary concept description for the system that could cope with some of the major considerations described in the previous sections of this volume.

4.1 Observations

If a successful NPSRS were to be established, a variety of competing viewpoints would have to be satisfied among the participating organizations associated with the system. These viewpoints may be only partly articulated in this document (and elsewhere) at this point in time. It is probable that consideration of all the needs, viewpoints, and requirements of NRC regulators, utility management, operational personnel, users and others could require organizational and philosophical compromises beyond those outlined for the somewhat idealized NPSRS described in this document. These could be needed in order to achieve an acceptable system for all parties. One of the purposes of the discussions presented in this volume of the report was to present a summary of the significant viewpoints to be considered so that potential participants in the program could evaluate their own views with respect to the NPSRS.

It seems, however, that even though compromises may be needed, it should be possible to meet the several needs and requirements of nuclear industry participants in such a way that a feasible NPSRS could be developed. The merits of the system seem to outweigh its potential inconveniences. The NPSRS appears to be practical (i.e., its logistical requirements appear to be relatively straightforward, and its projected operational costs appear to be relatively low). In addition, the concept of the NPSRS appears to be useful. Its data would have many applications to the needs of the nuclear industry, especially for the needs of the HRDB and those of the PRA event model developers. Finally, no clearly insurmountable considerations were identified that would be expected to cause the system to be unacceptable to its participants.

To make the system thoroughly successful, however, it would be most important to have the vigorous support of the NRC. It is evident that one of the key elements in resolving the disparate opinions of the participants in the Aviation Safety Reporting System was the vigorous support of the FAA for the embroyonic system. Without the announced intention of the FAA to support and maintain such a system, it is probable that the differences of opinion between pilots, flight control personnel, FAA staff administrators, aircraft manufacturers, and airlines would have caused the premature collapse of the system in an unending round of arguments over protocol and the details of operational methods. With the vigorous support of the FAA, it seems to have been evident to the participants that it was to their advantage to efficiently and effectively develop a practical, working system. Thus, it was possible to quickly achieve a workable system that has become broadly acceptable to the aviation community. It appears that similar strong support from the NRC to the NPSRS would also be essential to bridge the potential differences of opinion that may exist within the nuclear power community with respect to implementation of such a system.

4.2 Conclusions

The key elements of the NPSRS are shown schematically in Figure 1. The procedures and requirements that should be provided for the system have also been outlined in this volume of the report. The key system elements include a third-party management organization for the NPSRS that would provide a buffer between the support provided for the system by the NRC and reporters who submit their incident descriptions to the NPSRS. The third-party management buffer would apparently be essential to the success of the NPSRS in order to assure participants that if reports were submitted the reporters would remain anonymous and that they would not incriminate themselves.

Another key element of the system is the NPSRS Advisory Committee. The Advisory Committee should be made up of a representative sample of the significant participants in the system, both those providing input to the system and the users who receive output from the system. A working committee of perhaps 10 to 15 members is recommended. The committee should include representatives of the NRC, the nuclear utilities, plant operational personnel, and perhaps the public.

One of the earliest functions of the NPSRS Advisory Committee should be to provide an initial, critical review of the system charter and functional descriptions. The Committee should be tasked to recommend any needed modifications to the system in order to assure system acceptability to the nuclear community. The long-term functions of the Committee should include a continuing assessment of the effectiveness of NPSRS Operations. Another recommended function of the standing Committee would be to provide a continuing evaluation of the security of the system in order to ensure that reporter anonymity was maintained and to verify that warranties of immunity were not abridged.

The Human Reliability Data Bank would probably be the principal recipient of all codified data results from the NPSRS. Human factor system analysts, model developers for PRA events, utility and plant safety engineers, the NRC regulatory staff, and the public, as appropriate would also be expected to be major users of NPSRS data. The relatively richness of the material content of the data from the NPSRS would provide valuable insight into root causes of human errors and the influences of various performance shaping factors for human factor systems analysts in the nuclear power community. Model developers for PRA events would also find the system data a rich resource of information on significant precursors of potentially severe accidents and the mechanisms by which positive human intervention can reduce the probability of near-miss incidents turning into severe accidents.

The HRDB would obtain a substantial new source of data on human reliability as a result of the NPSRS. This data would provide increased data on the relative frequency of various categories of events that should aid the HRDB analysts in arriving at their estimates of human error frequencies. Staff reports from NPSRS analysts on cumulative, generic trends in reported incidents should also provide a new source of insight to NRC staff members with respect to the potential needs and impacts of safety regulations.

In order to support the operational processes of the system, as shown in the functional diagram of Figure 1, the basic system requirements have been outlined in this volume of the report. For the information input side of the system, these included: development of the basic forms for initial filing of reports; preparation of the appropriate communication channels between reporters, the NPSRS, and users; definition of criteria for acceptability of NPSRS reports so that they could be prescreened for violations of NRC regulations or criminal activities. Areas requiring interface definition were identified. Foremost among these were the relationships between the third-party management organization for the NPSRS, the NRC, sources supplying input reports, and user organizations.

4.3 Recommendations

A comprehensive implementation plan for the NPSRS should be developed for a NPSRS as part of the continuing research for the system concept. As part of the plan, detailed system operating procedures should be developed. Development of the procedures should include preparation of preliminary data reporting and tabulating forms. Preliminary descriptions of the system taxonomy should be developed. In order to develop the detailed configurations of the taxonomy the system itself would need to be tested and ultimately implemented. The system taxonomy would be expected to consist of a flexible, growing set of descriptive parameters that would be needed to adequately codify and categorize the data developed from the NPSRS reports. The outline provided by the system taxonomy should aid in development of procedures for interfacing the NPSRS with the HRDB. A preliminary definition of the taxonomy would also be needed as part of the development of user familiarization materials and user data request forms. Drafts showing the details of these user-related materials should be developed as part of the recommended implementation plan development.

In addition, interface requirements should be developed in order to define the permissible relationships between the NPSRS and the NRC, the Advisory Committee, reporters and utilities, and the users of the system. A draft memorandum of understanding (MOU) should be prepared in order to define the relationship between the NRC and the third-party management organization of the system. Similar definitions of relationships could be needed in order to define the relationships between participating utilities, the NPSRS, and the NRC. The issue of granting limited immunity to participating nuclear plants/utilities, as well as individual immunity, to reporters should also be resolved in such documentation. The charter should be developed for the NPSRS that defines the basic agreements permitting the granting of anonymity to reporters and establishing the conditions for limited immunity from regulatory redress for reporters and participating plants/utilities as described above. Documents defining the functions and charter of the NPSRS Advisory Committee should also be prepared.

The implementation plan should describe the procedures, materials, and schedules for developing, testing, and implementing a NPSRS. In the development of the plan, consideration should be given to the range of potential opportunities for testing and evaluating the implementation of the system in conjunction with actual nuclear power reactors, at simulator training facilities, or possibly at research reactors. The plan should be developed so that it would utilize such facilities as they were appropriate and available for evaluation of the system feasibility.

In addition to development of an overall implementation plan as recommended above, a detailed test plan should also be developed for performing a preliminary evaluation of the NPSRS concept. The test plan should include mechanisms for conducting a preliminary assessment of the practicality, acceptability, and usefulness of the system and its data.

Evaluating system practicality would require assessment of logistical aspects of the system including the financial aspects of system implementation, hardware requirements, manpower requirements and legal constraints. The logistical aspects of the system would be difficult to predict from a limited test of the system. However, the test would be expected to yield a much more solid basis for extrapolation (although much judgment could still be required) of estimates of the overall financial, manpower, and hardware requirements of the system.

The issues of acceptability are related to the viewpoints and responses of the NRC, utility management, operational personnel and public to a NPSRS. Some of the conflicting viewpoints of these participants in the system were outlined in Section 2 of this volume of the report. The test design should provide a basis for assessing whether the NPSRS concept under development has successfully come to grips with the more significant of these potentially conflicting viewpoints. It should be noted, however, that a firm commitment from the NRC to support a NPSRS and the establishment of a NPSRS Advisory Committee would undoubtedly have a positive influence on the cooperation of participants in resolving conflicting viewpoints, that might not be present during the period in which the test would be conducted. In the absence of such NRC commitments, a test could suggest that some acceptability issues might exist that could be more readily resolved if the NRC had announced its intention to support the NPSRS. Nevertheless, a test should provide useful information with regard to potential areas of conflict where compromises in the structure of the NPSRS might be necessary or desirable.

The tests should also be designed to assess the aspect of the usefulness of the NPSRS. The concept of usefulness involves issues such as the validity and reliability of the NPSRS data. Data validity is related to the degree to which data obtained on an incident accurately reflect the event that generated the data. Under controlled circumstances, such as conditions that might be available at a simulator, it could be possible to evaluate validity of some test data. If test conditions were not carefully controlled, it would be difficult to determine whether first-hand information about an event, seen only by the reporter, was truly valid or strongly reflected the observers' biases, directly or indirectly. On the other hand, the concept of reliability of data is related to the degree to which reports of data generated from several events with similar circumstances would be described in similar fashions in the several reports. Again, the reliability of reported data is difficult to evaluate without assuring the similarity of test conditions that provide the basis for the reports through carefully controlled experimental measures. Again, this could probably be best assured under conditions that might exist in a simulator.

Thus, in order to evaluate the reliability and/or validity of data potentially generated under a NPSRS, it would probably be necessary to conduct some of the tests at one or more nuclear power plant simulators. The psychological conditions associated with such tests might not precisely match the conditions for a reporter in an actual nuclear power plant. Therefore, it might only be possible to partially assess the reliability and validity of data that was developed from reports of experimental events in order to test the usefulness of data from a NPSRS. Again, however, the test data would give an empirical basis unavailable through other mechanisms upon which to project the ultimate results of the reliability and validity of data from an operational NPSRS. However, observations over an extended period of time with a fully operational system might be required before the ultimate assessment of the reliability and validity of NPSRS data could be provided.

Nevertheless, the test plan should be designed to investigate as completely as possible the practicality, acceptability and usefulness of a NPSRS concept. The plan should specify the test objectives, scope, approach, organizational responsibilities, test methodology, data requirements, resource requirements, schedule and funding requirements. The plan should be designed to take advantage of available facilities and to investigate a range of field applications of a NPSRS in realistic environments.

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