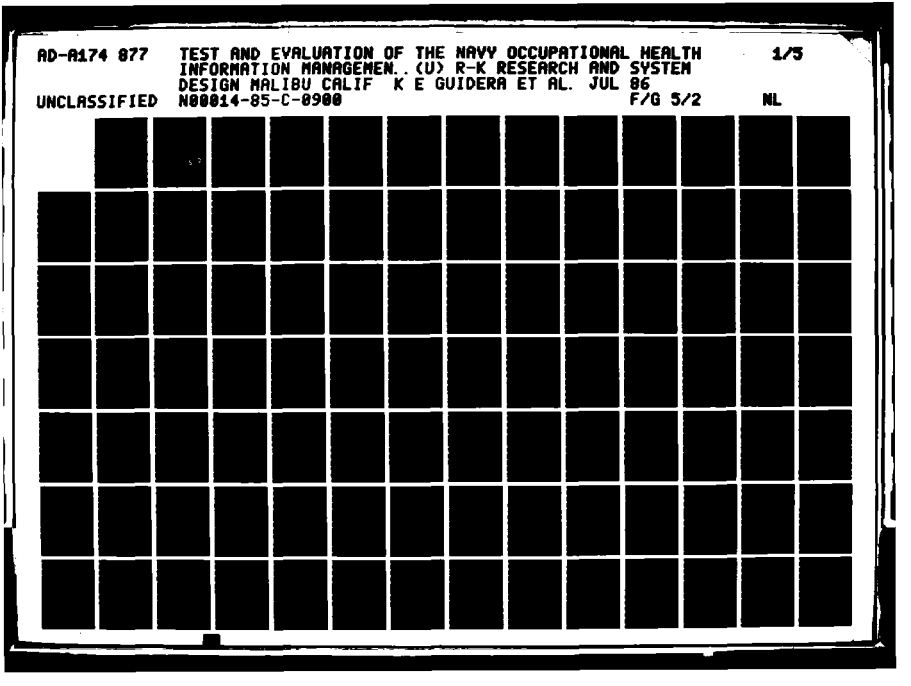
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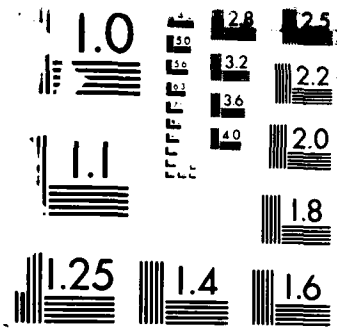

RESOLUTION TEST CHART

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(11)

R-K RESEARCH AND SYSTEM DESIGN

TEST AND EVALUATION OF THE NAVY OCCUPATIONAL HEALTH INFORMATION MANAGEMENT SYSTEM (NOHIMS)

FINAL REPORT

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EXECUTIVE SUMMARY AND RECOMMENDATIONS

The Navy Occupational Health Information Management System (NOHIMS) was tested and evaluated under Phase II of a Department of Defense Small Business Innovation Research award over the period September 1985 through February 1986. A prototype version of NOHIMS was implemented at two industrial sites--the Naval Air Rework Facility (NARF) and Occupational Health Unit (OHU), North Island, San Diego, California, and the Puget Sound Naval Shipyard, Bremerton, Washington. The evaluation team conducted extensive interviews with the users of the prototype system at the NARF and the Puget Sound Naval Shipyard, and with Navy management involved with the system, the developers of the system, and additional other people having contact or potential contact with the system. In addition, resource materials on NOHIMS, such as OPNAVINST 5100.23B, the NOHIMS MENS, the NOHIMS System Decision Paper, the Battelle Conference Proceedings (June 1979), the NOHIMS documentation, and various published articles were reviewed. The medical component software we evaluated consisted of COSTAR--the Computer Stored Ambulatory Record which had been customized to the needs of NOHIMS. We also evaluated Version 1.0 of the industrial component software.

FINDINGS

Based on this extensive review of materials and the interview process, the evaluation team reports findings in four major areas: realization of system objectives, operational testing, administrative deficiencies, and requested enhancements.

Realization of System Objectives

In its present form, NOHIMS has the potential to meet and surpass both the goals required by Navy directives and the goals of the system developers and system users. NOHIMS provides almost all of the system functions as mandated by the stated Navy goals for the system including workplace monitoring, hazard surveillance, medical monitoring, administrative reporting, legal evidence, and epidemiologic research. NOHIMS, however, does need capability to retrieve historical workplace monitoring data, to enter injury and illness care data, and a statistical capability. NOHIMS has limited abilities to process management data.

The system has been judged by the users to be very user friendly, relatively easy to learn and use, useful in their daily work tasks, and generally very suitable for Navy information needs. All of the users were very positive about the general performance of NOHIMS. The evaluation team was impressed by the users' enthusiasm for the system despite the fact that the users were often only aware of or using a fraction of the system's capabilities. The users and system developers felt that the benefits of NOHIMS were great and that it will have a major beneficial impact on occupational health at Navy industrial sites.

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The users and system developers generally felt that NOHIMS will be adaptable to other Navy industrial sites provided that adequate manpower resources and training are available for the new sites. The design of the system is highly compatible with the Navy objective of transferability because there is a high degree of inherent flexibility in the data collection and storage processes within both the industrial and medical components. Also, both system components contain an extensive amount of intrinsic user help, a necessary component for easy transferability of the system.

Operational Testing

The evaluation team found few operational deficiencies in NOHIMS. The system is stable at both test sites and the majority of system users are satisfied with system performance. For the most part, they rated NOHIMS as being acceptable in its present state. Generally, NOHIMS provided users with the information and functions required and performed these functions in a timely and appropriate manner. Areas of dissatisfaction for NARF users included occasional slow response time and problems with communications equipment. These were mostly a function of the fact that NOHIMS was resident on a computer that was used for many other developmental purposes and was at a remote location necessitating use of telephone lines to connect users to the mainframe. Users at the Puget Sound Naval Shipyard reported some hardware problems mostly during initial implementation and occasional slow response time.

Extensive system testing against both the functional description of the system and against the user documentation showed that all modules were fully operational and that the documentation, with a few very minor exceptions, adequately and accurately described the system operation. The exceptions included items such as options in the medical component of NOHIMS that were not initialized and should therefore be eliminated from the option menus and minor inconsistencies in the documentation instructions. These problems are not design flaws, but rather represent "fine-tuning" of the system requiring simple changes to either the system or to the documentation. We also feel that it would be helpful to the user if examples were added to the documentation for the industrial component.

The evaluation revealed that the medical component directory contains a code for ethnicity and the codes for a comprehensive occupational history and a medical history, although the ethnicity data item and the history forms have not been accepted as part of the prototype forms at the Occupational Health Unit. Thus, these areas of data collection still need to be implemented in some form.

Administrative Deficiencies

The major problems that we found during the evaluation of NOHIMS were administrative deficiencies revolving around the implementation of the system. These problems are not inherent to the NOHIMS design but have arisen as the system has been put into operational use. These problems have been in the areas of training, manpower, source data, and paperwork.

Nearly all the users that were interviewed felt that they had received inadequate training in the use of NOHIMS and, therefore, often did not feel comfortable with all aspects of the system. In many instances, users were unaware of the full capabilities of the system. In other areas, users were

aware of certain system functions, but had never or rarely used these functions. System users often had a limited understanding of potential applications for the system, such as generating data for administrative reports; thus, NOHIMS was not fully integrated into the workloads at the various sites. This deficiency seemed to be more true of the users of the medical component than of the industrial component, perhaps owing to the fact that the industrial component has been operational for a longer period of time. Remarkably, despite inadequate training and a limited understanding of the system's capabilities, the users were all very enthusiastic about NOHIMS and its potential benefits for occupational health. It should be noted that the system developers were not specifically tasked with providing training; therefore, system users received minimal training in operating NOHIMS. The Naval Health Research Center (NHRC) played a greater role in training users at the Occupational Health Unit, but the NOHIMS implementers at NHRC were themselves at this time learning the system.

One of the reasons why users were not fully aware of NOHIMS capabilities was because they did not have adequate time allotted in their work schedule for learning and using the system. Although users felt that NOHIMS made them more productive and efficient in their work, NOHIMS often added tasks to their workload (e.g., entering data, completing data collection forms, etc.). In addition, NOHIMS now made deficiencies in their workscope, such as inadequate sampling of environments or insufficient numbers of protective equipment examinations, more obvious. Thus, NOHIMS increased the workload of the workplace and medical monitoring personnel by bringing the programs more in line with mandated requirements. When users were asked what problems they foresee when NOHIMS is transferred to other industrial sites, many people felt that the transfers will not be successful if the Navy does not provide adequate manpower resources for NOHIMS. It is clear from the experience at the test sites that if sufficient numbers of billets to operate NOHIMS and to allow for maximum utilization of the system are not allocated, the effectiveness of NOHIMS as an occupational health information management system will be diluted.

Inaccurate and incomplete source data created problems in the industrial component. The personnel module of the industrial component depends on the Personnel Extract File (PEF) produced by the NARF Personnel Department to update personnel data and assign workers to the proper environments. Inaccurate information in the PEF producing subsequent inaccuracies in NOHIMS has been a major performance flaw. The design concept of transferring data from the PEF to NOHIMS is adequate; however, NOHIMS will only be able to produce data as accurate and complete as what are fed into it.

Medical users complained about the increase in paperwork required by NOHIMS. As of the time of the interviews, the Occupational Health Unit was required to complete the NOHIMS data collection forms in addition to the standard Navy medical forms. This requirement necessitated a significant increase in the amount of time involved to record the results of a physical examination both for the physician and for the occupational health technician. Also, because the NOHIMS forms are not accepted as the standard medical record and because the NOHIMS prototype forms are bulky, the NOHIMS data collection forms are not stored with the medical record, necessitating additional storage for the forms. The summary reports generated by NOHIMS are not reproductions of the standard medical forms, and therefore, have limited usefulness as a medical record. The paperwork increase was not noticed by the industrial component users at the NARF because the NOHIMS forms have been accepted as the standard

industrial hygiene data collection forms for the entire San Diego region. Puget Sound users reported a slight increase in paperwork, but felt that the increase was acceptable.

Requested Enhancements

The NOHIMS users requested three major enhancements to NOHIMS. Both industrial and medical users, and system developers requested a more sophisticated data retrieval system. The system's current capabilities are quite extensive, but users requested interfaces with statistical packages. While data are stored historically in the industrial component of NOHIMS, NOHIMS lacks the function to retrieve the historical data. Also, the mechanisms to retrieve correlated data from both the industrial and medical components are very limited.

Several of the industrial hygienists would like to have the Hazardous Agent Table expanded to include hazardous product names to aid in looking up agents. The industrial component of NOHIMS has a function that will allow new agents and names to be added to the table, but the update that the hygienists want would require tremendous personnel resources for data entry. They also wanted the software to be modified to allow all data in the Material Safety Data Sheet to be included for each agent in the table. If these data were added to NOHIMS, the system could replace many of their other reference materials such as CHEM-LINE.

The Navy managers interviewed felt that the omission of data collection instruments for the walk-in side of the Occupational Health Unit (OHU) was a major weakness of NOHIMS. Because of the inherent flexibility of the NOHIMS directories, there is no system limitation on including this portion of the OHU data in NOHIMS. Currently, NHRC is designing prototype data collection forms for the walk-in clinic and is integrating these data items into NOHIMS.

RECOMMENDATIONS

Based on a thorough analysis of the comments and suggestions of those interviewed, the evaluation team makes the following 14 recommendations concerning NOHIMS.

1. Adequate configurations of hardware should be procured in order to minimize downtime and maximize system performance. The Navy should be prepared to adequately fund this aspect of NOHIMS and not compromise the performance of NOHIMS.

2. An entity within the Navy should be designated as being responsible for performing the installation and implementation of NOHIMS at each site, for maintaining the systems once they are operational, and for interfacing with the individual sites to be certain that the design of data collection forms and use of the system is compatible with NOHIMS and with overall Navy objectives.

3. The Navy should provide ample resources for extensive training of system users. Because of the inherent flexibility and scope of NOHIMS, the system is complex. The skills to effectively and appropriately utilize the system cannot be learned overnight. It

is essential that an entity within the Navy be tasked with the responsibility for this system training. The personnel responsible for the training should have a thorough comprehension of the objectives of NOHIMS, the system capabilities and parameters, and the functions of the environments in which NOHIMS will be implemented. The training provided by this task force must be appropriate for each class of system users (system managers, industrial hygienists, professional medical personnel, ancillary medical personnel, clerical personnel, etc.).

4. Consideration should be given to establishing NOHIMS regions. In addition, we feel that each region should have a NOHIMS system manager who is both intimately familiar with the capabilities and parameters of NOHIMS and is cognizant of the day-to-day workings of both the occupational health units and the industrial hygiene divisions. This system manager would then be able to continue to support users after their initial training. Since he/she would have an understanding of both NOHIMS and the working environments, he/she could help the end users to integrate NOHIMS functions into their daily work routine and requirements. Issues that could be addressed by the regional system manager include appropriateness of data collection instruments, coordination of unit/department objectives with overall Navy objectives, system support, integration of data collection procedures into work flow, and use of the system to meet administrative requirements and to enhance the quality of work conducted. In addition, the system manager could coordinate a regional users' group during at least the first year of operation so that experiences with NOHIMS would be shared and lessons that are learned would be passed on to others in the region. The users' group could be an ideal vehicle for ongoing support and training, group problem solving, and disseminating information about NOHIMS.

5. A local site system manager should be designated at each implementation site to be responsible for the coordination of information between the local site and the regional and national agencies, and between the industrial hygiene division and the occupational health units. This person would be responsible for maintaining the integrity of that site's database and would be the first line of support for the end users of the system. In the first phases of implementation we see this task as being quite time-consuming, although the demands will lessen as users become familiar with the system and the site passes from the implementation and testing phase to the operational phase.

6. It is essential that there be adequate dialogue between the Navy NOHIMS technical experts and the medical personnel at each industrial site to insure that the data collection forms are both useful to and appropriate for the occupational health unit and compatible with the system parameters of the medical component of NOHIMS and the intended future uses of the NOHIMS database. If knowledgeable decisions about data collection are not made at the beginning, the usefulness of the database for future analysis and functionality of the data collection forms may be compromised.

7. Adequate billets should be allotted for departments receiving NOHIMS to allow for the time required to learn and use NOHIMS and for the increased workload that will result from having workplace and medical monitoring programs that more stringently meet Navy standards. As stressed in our summary, if NOHIMS is not given priority to receive adequate resources, the usefulness of the system to the end user will be greatly limited. If NOHIMS is regarded as merely a collateral duty, the users may come to resent the additional responsibilities that NOHIMS brings, ultimately hindering the acceptance of NOHIMS.

8. The billets for each site receiving NOHIMS should include a billet for a data entry clerk for both the medical and industrial components. The North Island test site does not have a data entry billet for the industrial hygiene division; instead industrial hygienists enter the survey data themselves. The consequence is that they are behind on survey data entry and the number of surveys the hygienists are able to perform is decreased. The Puget Sound Naval Shipyard, on the other hand, has a billet for data entry. A data clerk who does data entry half-time keeps the survey data entered up to the minute, thereby increasing the effectiveness of that industrial hygiene division.

9. When the additional personnel are added to the NOHIMS sites, it is essential that site management distribute the workload evenly among personnel so that all personnel are freed up to spend some time working with NOHIMS. It would be easy to use the additional billets for direct patient care or for industrial hygiene activities; however, it is our belief that providing time for working with NOHIMS will be a better way to ultimately improve the quality of occupational health care provided to the workers at each industrial site.

10. NOHIMS data collection forms and NOHIMS generated reports should be accepted in lieu of the standard Navy medical record and reports in order to lessen the workload for occupational health personnel and to decrease the amount of paperwork and storage required for the paperwork. If the standard NOHIMS reports are deemed to be insufficient for Navy records, then the capability of producing facsimile reports and records from NOHIMS should be added to NOHIMS.

11. The Navy needs to create explicit policy guidelines for the data collection forms to ensure that a minimum standard set of data is collected so that Navy-wide data analysis may be conducted. The compatibility of the directories between systems must also be preserved. To help accomplish this, we recommend that the industrial sites not have access to the system maintenance functions for the directories; rather a central entity would have the responsibility for maintaining the directories. As the directories may not contain all data items that each occupational health unit or industrial hygiene division may desire, the central entity should establish a mechanism whereby the central entity

would properly add new items to the directories as required. It is our understanding that the prototype data collection forms (especially the medical and occupational history forms) that were developed by the North Island Occupational Health Unit are being reviewed by other potential users to determine if they will be adequate for other occupational health units in the Navy. The results of this review will determine whether the current medical directory will be adequate for other industrial sites.

12. Adequate administrative instruction and resources should be provided to the personnel departments at the industrial sites to insure that the Personnel Extract File is accurate, complete, and timely, thereby insuring the integrity of the personnel data in the NOHIMS database.

13. The few minor inconsistencies between the system documentation and NOHIMS operation should be corrected. If resources are available, examples should be added to the industrial component documentation.

14. Additional resources should be provided to enhance the system as requested by the system developers and users. Most of the enhancements suggested by the system developers and users are reasonable requests and if added to the system would increase the effectiveness of NOHIMS. These include a statistical interface between the database and a MUMPS-based statistical package, the capability of retrieving historical data from the industrial component, the capability of retrieving correlated data from both the industrial and medical components, the development of data collection forms and directory codes for injury and illness care provided by the Occupational Health Unit, and a software modification to add further detail to the Hazardous Agent Table. The statistical interface could either be developed from scratch or NOHIMS could be linked with existing statistical software such as MEDINFO, BMD, SPSS, and/or SAS. Additional programs will need to be written to retrieve historical data from the industrial database. The limitations on retrieving correlated data from both components could possibly be overcome by integrating the Medical Query Language (MQL) with NOHIMS and using it to select attributes of interest from the two components and then to interrelate these data items. NHRC is currently developing data collection forms and directory codes for the walk-in clinic at the North Island OHU to meet that requested enhancement. The Hazardous Agent Table should be modified so that all of the items on the Material Safety Data Sheet can be included in the table. Since NOHIMS already contains a large number of agents and new agents may be added to the Hazardous Agent Table as needed, we feel that the current HAZARD DATA module is adequate. As to adding the agents found in resources such as CHEM-LINE, we recommend that the Navy explore the need for these data further before additional personnel resources are allocated for the data entry task. The NOHIMS contracted developers also recommend that NOHIMS be enhanced with certain routines from COSTAR Version 5.81 (such as the routines for the stand-alone Mailbox module) to provide special features not available in previous versions of COSTAR.

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SECTION I
INTRODUCTION

The Navy Occupational Health Information Management System (NOHIMS) has been undergoing design and development by the Naval Health Research Center (NHRC), San Diego, California since early 1980. NOHIMS consists of two subsystems: (1) an industrial component and (2) a medical information component. The industrial component (Version 1.0) performs all the functions required to identify individuals at risk and to insure that they are examined periodically. Therefore, the industrial subsystem contains the personnel and environmental data. The medical information component consists of COSTAR--the Computer Stored Ambulatory Record system. Each of these two components of NOHIMS can operate as a stand-alone system, or they can function as a single, integrated system because both components use the same system conventions wherein users interact with the database at increasing levels of specificity by making choices from a hierarchical series of option menus. In addition, both components incorporate extensive user help, aids, and explanation techniques.

The prototype version of NOHIMS has been tested and evaluated by NHRC at two industrial sites--the Naval Air Rework Facility (NARF) and Occupational Health Unit (OHU), North Island, San Diego, California and the Puget Sound Naval Shipyard, Bremerton, Washington. Both the industrial and medical information components of NOHIMS have been implemented at the North Island site; to date only the industrial component has been implemented at the Puget Sound Naval Shipyard. Table and file building for the industrial component at the North Island NARF began in December 1983 and is now complete, with industrial data currently being entered routinely. The medical information component was phased into work routines at the North Island Occupational Health Unit beginning in July of 1984.

As part of the implementation effort at the North Island site, a series of encounter forms were developed to capture the required medical data. A User's Reference Manual for the medical component of NOHIMS and a variety of job aids were developed to facilitate the data entry process. A less elaborate user's manual was developed for the industrial component of NOHIMS because this component contains an extensive amount of intrinsic user help. These training materials were used to train data entry clerks, medical personnel, industrial hygienists, and safety officers in the use of NOHIMS.

Under Phase I of a Department of Defense Small Business Innovation Research award, R-K Research and System Design developed a Test and Evaluation Master Plan (TEMP) to independently test and evaluate NOHIMS at both the North Island NARF/OHU and the Puget Sound Naval Shipyard. The TEMP considered seven major areas of system functioning: (1) responsiveness of NOHIMS to Navy needs and requirements, (2) suitability of the NOHIMS design, (3) efficiency of NOHIMS performance, (4) enhancement of medical monitoring and care by NOHIMS, (5) use of the NOHIMS database for legal evidence, (6) usability of NOHIMS, and (7) transferability of NOHIMS. It also touched on NOHIMS as an aid to epidemiologic research and the costs versus benefits of the system. (These last

two areas were considered only briefly per direction of our sponsor, the Naval Medical Research and Development Command [NMRDC]).

The Test and Evaluation Master Plan was carried out in six steps:

1. The evaluation team interviewed personnel involved in the development and/or testing of NOHIMS at the Naval Air Rework Facility (NARF), North Island, San Diego, California and the Puget Sound Naval Shipyard, Bremerton, Washington test sites. These personnel included people from various divisions of the Occupational Health and Preventive Medicine Department, San Diego, California; the Occupational Health Unit, North Island, San Diego, California; the NARF Safety Office, North Island, San Diego, California; and the Occupational Health and Preventive Medicine Department, Bremerton, Washington. Individuals from other Navy entities, including the Navy Environmental Health Center (NEHC), Norfolk, Virginia; the Naval Health Research Center (NHRC), San Diego, California; the Injury Compensation Program, Naval Air Station/Naval Air Rework Facility, North Island, San Diego, California; and the Naval Hospital, San Diego (Balboa) were also interviewed. We used the interview guides contained in Appendix A of this report to conduct these interviews. Appendix B contains a list of the people who were interviewed and the guides that we used to interview them. Some individuals were interviewed with more than one interview guide if they had multiple roles with NOHIMS. The interviews at North Island and other San Diego locations were conducted from September 9, 1985 through September 24, 1985. The interviews at the Puget Sound Naval Shipyard were conducted from November 18, 1985 through November 20, 1985. Each person was interviewed by at least two members of the interview team so that responses could be cross-validated. The interview guides were not used as a rigid schedule, but rather were used to direct the flow of discussion. We encouraged interviewees to digress from the question at hand or go into further detail if it seemed appropriate. Questions, and sometimes complete sections, were omitted if the interviewees could not comment on that topic or if it was not applicable to them.

2. We then collated the interviews, and the data gathered by the individual evaluation team members were compared to identify any inconsistencies. These inconsistencies were resolved through discussion, or if required, by follow-up with the interviewee.

3. During the development of the TEMP, we had identified several materials as resources for the evaluation of NOHIMS. These included OPNAVINST 5100.23B, the NOHIMS MENS, the NOHIMS System Decision Paper, the Battelle Conference Proceedings (June, 1979), the NOHIMS documentation, and various published articles. We reviewed these materials and gathered information required for the evaluation report.

4. To test the operational characteristics of NOHIMS, we performed two kinds of system testing. First, individuals unfamiliar with NOHIMS used the NOHIMS user's manuals to perform the tasks described in the documentation. These tasks included entering registration and medical data for a patient, generating standard reports and some typical user-defined reports, entering survey data, and looking up hazardous agents. Second, we performed various tasks related to system maintenance and produced the reports required by the Navy to determine if NOHIMS met the Navy's functional requirements.

5. Next we collated the information from the interviews and integrated it with the data from the resource materials and system testing to produce a draft of our Evaluation Report for review by NMRDC. The preliminary outline of the final report produced during Phase I of this project was used as the guide for determining the contents of the Evaluation Report.

6. Based on feedback from NMRDC, we revised the draft Evaluation Report and submitted our final Evaluation Report as called for in Phase II.

The Evaluation Report consists of nine sections. This Introduction is preceded by the Executive Summary and Recommendations. Seven sections, each of which covers an area of the NOHIMS evaluation, follow the Introduction. These sections include the evaluation of the goals of NOHIMS, an evaluation of NOHIMS system design, results of operational testing of NOHIMS, an evaluation of the uses of NOHIMS, an assessment of the transferability of NOHIMS to other Navy industrial sites, a brief economic analysis of NOHIMS, and a brief comparison of NOHIMS to other occupational health information systems.

SECTION II
EVALUATION OF NOHIMS GOALS

BACKGROUND OF NAVY GOALS FOR NOHIMS

In 1970 Congress enacted the Occupational Safety and Health Act (Public Law 91-596) (OSHA) requiring all employers to provide safe and healthful working conditions for their employees. Executive Order 12196 mandated that these occupational health services be applied to all civilian workers of the Federal agencies, including the Department of the Navy. The Order specifically ordered Federal agencies to develop and implement automated data processing applications for OSHA-related data needs. By authority of DODINST 6055.5, OSHA standards also were applicable to most active duty military personnel.

To implement OSHA in the Navy, the Secretary of the Navy and the Chief of Naval Operations issued SECNAVINST 5100.10D, OPNAVINST 5100.8E, and OPNAVINST 5100.23A. SECNAVINST 5100.10D established the Department of the Navy occupational safety and health policy and assigned responsibility for Navy programs. This instruction directs that a "comprehensive, aggressive, and effective occupational safety and health program..." be established.

In response, OPNAVINST 5100.8E created the Navy Safety and Occupational Health (SOH) program. This instruction specified that the Chief of Naval Material; Chief, Bureau of Medicine and Surgery; Chief of Naval Personnel; and the Commander, Naval Safety Center were to develop procedures and provide instructions for each support area specified, and outlined the role that each activity was to take in the SOH program.

OPNAVINST 5100.23B established the Navy Occupational Safety and Health (NAVOSH) program, which is somewhat more limited than SOH. It also established the Navy Occupational Safety and Health Inspection Program (NOSHIP) that employs an Oversight Inspection Unit to provide an inspection system covering the entire NAVOSH program. This instruction specifically identified the following activities: (1) "design and provide comprehensive workplace monitoring plans," (2) "develop and implement personnel medical surveillance," (3) "provide other industrial hygiene and occupational health support," (4) "conduct annual audits of each industrial/operational activity workplace monitoring program," (5) "provide training and certification for command personnel assigned to perform workplace monitoring," and (6) "establish appropriate records relating to workplace monitoring and the comprehensive occupational health program" (Pugh & Beck, 1981). The instruction also assigned responsibility for the provision of occupational health and industrial hygiene medical services to the Commander, Naval Medical Command. NAVMEDCOMINST 5450.16 delegated much of the Naval Medical Command responsibilities to the Naval Health Research Center (NHRC).

The problems and strategies of implementing Navy occupational health and safety programs were addressed in a conference on Navy occupational health held at Battelle Human Affairs Research Centers, Seattle, Washington, on January 29-30, 1979. The purpose of this conference was to provide a forum where persons from diverse professional and disciplinary perspectives could address issues of

implementing Navy occupational health and safety programs. The conference objectives were to consider organizational factors in the implementation of Navy occupational health programs, to address issues of cost effectiveness in Navy occupational health programs, and to facilitate the development of a meaningful research program in this area. The conference itself was sponsored by the Naval Medical Research and Development Command and by the Office of Naval Research. It was jointly hosted by Battelle and by the Naval Health Research Center (Drexler, Jones, & Gunderson, 1979).

A major conclusion from this conference was that structural decisions about occupational health care must be accompanied by effective information systems that are designed to meet both short-term and long-term needs. Foremost among sho' -term needs were information about type and duration of exposure to hazards and potential hazards, evidence of compliance with standards and guidelines, and measures of program effectiveness. Long-term needs were data oriented towards the discovery of currently unrecognized risks, portrayal of career profiles, and the design of future programs; performance of a wide variety of epidemiological tasks; and display of essential technical information related to toxic properties of chemicals and materials (System Decision Paper, 1984; Drexler, Jones, & Gunderson, 1979).

In 1979 it was generally agreed that the establishment and implementation of an effective Navy occupational health program would require a clearly stated set of occupational health goals and priorities to which upper-level managment is firmly committed and which they will support through policy decisions and resource allocation. It was also recognized that a systematic and integrated information and monitoring system was an important tool to be used in obtaining necessary data. The system must merge exposure data, illness episodes, and biomedical hazard monitoring data into a single, usable information system with appropriate storage and retrieval capability. The major conclusion of the Information Systems Topic Group of the conference was that the Navy did not have a comprehensive occupational health information system that met user needs. The Industrial Hygiene Working Group reported a need for the development of an effective information system for providing guidance required in conducting industrial hygiene and occupational health programs. Finally, the Epidemiology/Environmental Health Working Group stated a need to develop a computerized occupational and medical surveillance system that could serve as a database that is easily accessible and available for epidemiologic analyses (System Decision Paper, 1984; Drexler, Jones, & Gunderson, 1979).

In 1980, after a review of commercially available occupational health information systems found that these were inadequate for the Navy's needs and requirements, the Naval Health Research Center undertook the development of an occupational health monitoring system. The resulting system was named the Navy Occupational Health and Information Monitoring System, which was later changed to the Navy Occupational Health and Information Management System (NOHIMS). The Mission Element Needs Statement (MENS) for NOHIMS was approved by the Chief of Naval Operations in February, 1984. During that same month, NOHIMS also received its project charter. The System Decision Paper was presented to the Commander, Naval Data Automation Command via the Chief of Naval Operations in July, 1984.

The NOHIMS MENS identified areas of deficiency or nonperformance around five Navy organizational levels, namely, the local occupational health clinic,

the local industrial hygiene unit, the chiefs of occupational and environmental health services, the Naval Health Research Center, and the Naval Medical Research and Development Command. The areas of deficiency for each level included the following.

Local Occupational Health Clinic

- Efficient provision of examinations for all hazards
- Prompt provision of worker exposure history
- Recording and transmittal of medical job certifications to line authorities
- Provision of composite summaries of work force physical examinations
- Provision of accurate medical information on individuals for legal needs
- Provision of exposure and health data for epidemiologic and research purposes
- Provision of workload summaries to higher authorities

Local Industrial Hygiene Unit

- Retrieval of exposure parameters by location or hazard type
- Provision of current exposure information to medical personnel to direct medical examinations for possible harmful work exposure
- Furnish historical exposure information on individual workers or a defined cohort
- Demonstrate past and present levels of workplace exposures for compliance with NAVOSH standards
- Provision of accurate workplace exposure data for Workers' Compensation or environmental differential pay determinations
- Provision of workload summaries to higher authorities

Chiefs of Occupational and Environmental Health Services

- Tracking and direction of resource utilization
- Identification and prompt response to adverse workplace exposures
- Identification and prompt response to adverse work-related health trends
- Provision of summary data on extent of disease and injury by hazard type and work location

- Provision of summary medical and industrial hygiene data for epidemiology, research, reports to higher authority, and administrative proceedings

Naval Health Research Center

- Provision of a consistent, authoritative, single source for the summary and analysis of Navy-wide occupational health problems
- Access to accurate information on which to provide resource recommendations directed toward solving Navy occupational health issues
- Response to reports of new or alleged occupational health hazards
- Integration of disparate data and performance of trend analysis of events over a prolonged time frame

Naval Medical Research and Development Command

- Response to requests to investigate occupational health issues when sufficient information is not otherwise available
- Performance of Navy occupational health-related research, development, and test and evaluation projects

The NOHIMS System Decision Paper outlined the features of the basic approach that would be used in developing and implementing NOHIMS and defined the general system requirements as follows.

Approach to NOHIMS

- NOHIMS to be used to integrate important occupational health data elements from industrial hygiene, medical, and personnel records for management and epidemiologic purposes
- Industrial hygiene data to include selected information on work environments; the full survey data are kept in a suitable noncomputerized form and referenced in NOHIMS
- Medical information to include selected data from all occupational health services, including preplacement/employment physical examinations, medical surveillance examinations, job certification examinations, injury/illness care, fitness for duty and return to work interactions, but not to replace the ambulatory care record; computer-assisted hard copy of medical reports used where possible
- Personnel data to be extracted from existing computerized databases wherever possible; compatibility and linkage with Uniformed Chart of Accounts, military personnel/pay systems, TRIMIS, or other suitable databases should be actively explored, developed, and demonstrated where possible; NOHIMS medical files set up

prospectively for each person served by a clinic prior to any health encounter

- NOHIMS to incorporate or replace existing central Asbestos Medical Surveillance Program (AMSP) and Hearing Conservation Management Information System (HECMIS) databases when NOHIMS is implemented Navy-wide; ability to utilize all historical AMSP and HECMIS data

General System Requirements

- A distributed interactive network to address needs of Navy health providers and managers

- Ability to input, store, process, and display occupational health data to include work history, exposure episodes, audiometric data, biomedical monitoring data, preplacement and routine physicals, associated environmental monitoring and industrial hygiene data, basic medical and demographic data, and other information as required by the user

- Capability of access to and display of information from intra- and extra-Navy databases, such as hazardous material information systems, and Federal, DOD, or Navy standards and instructions

- Hazard and risk assessment through the performance of retrospective and prospective epidemiologic investigations on medical record data files

- Input, store, process, and display occupational health program management data to include manpower, time-in-motion, equipment lists, inspection requirements, and other appropriate resource data required to document current and projected workload, equipment, and resources for manpower planning and budgeting purposes

NOHIMS, then, came out of a need to coordinate the components of the Navy Occupational Safety and Health Program. The two main goals of the system were to manage information from the medical surveillance program and the workplace monitoring program. In addition, NOHIMS would provide data for a variety of purposes, including management reports and functions, short-term and long-term research activities, workman's compensation and environmental pay decisions, and resource and manpower utilization. Indirectly it would improve the occupational health care provided to the worker at Navy sites by bringing it in line with Navy Occupational Safety and Health standards and OSHA directives of 1970.

EVALUATION OF SYSTEM GOALS

From the background information described above, we compiled a list of eleven goals for NOHIMS for use during the interviews of the NHRC NOHIMS developers, higher level managers, test site administrators, and the system users in both San Diego, California and Bremerton, Washington. These goals were as follows.

- Meet OSHA requirements
- Improve medical surveillance
- Improve workplace monitoring
- Provide data for epidemiologic analysis
- Improve patient care
- Improve coordination between departments
- Provide management data
- Improve access to care
- Improve manpower utilization
- Improve resources utilization
- Provide data for legal functions

Using this list of goals, we asked the NHRC NOHIMS developers and the higher level managers to tell us which of the eleven goals they thought were stated Navy goals for NOHIMS and what their personal goals for the system were. We then asked them to evaluate how well NOHIMS was meeting each of these sets of goals. In almost every interview, the interviewees did not make a distinction between their understanding of the Navy goals and their personal goals for NOHIMS, so we have presented only one set of answers for the NHRC NOHIMS developers and Navy management. System users and test site administrators were asked to identify which of the eleven were goals for NOHIMS and how well NOHIMS was meeting these goals. The questions that we used for this portion of the interviews may be found in Appendix A, Components 1 and 2. If an interviewee was required to answer the questions about goals in two interviews, the answers were combined and included in only one category of the following tables. We based the category on what was the interviewee's main function with NOHIMS. The difference between higher level managers and test site administrators, as we defined them, is that the work location of the test site administrators is the test site and they presumably have more first-hand knowledge and/or experience with NOHIMS.

NHRC NOHIMS Developers and Higher Level Managers

At least three-quarters of the NHRC NOHIMS developers/higher level managers mentioned the four goals of improving medical surveillance, meeting OSHA requirements, improving workplace monitoring, and providing data for epidemiologic analysis. The other goals were all mentioned by several of the developers/managers, but to a lesser degree than these four (see Table 1). One interviewee thought that NOHIMS would be used as a resource in training physicians in medical monitoring (Other category). The goals noted by the NHRC NOHIMS developers and by the higher level managers did not differ greatly. A somewhat higher percentage of developers mentioned providing management data, improving access to care, and improving coordination between departments than

TABLE 1
NOHIMS Goals
According to NHRC NOHIMS Developers and Higher Level Managers
(Number who mentioned goal; multiple answers allowed)

	NHRC NOHIMS Developers	Higher Level Managers	TOTAL	% of Total Interviewed
Improve medical surveillance	4	6	10	91
Meet OSHA requirements	4	5	9	82
Improve workplace monitoring	3	6	9	82
Provide data for epidemiologic analysis	4	5	9	82
Provide management data	4	4	8	73
Improve patient care	3	4	7	64
Improve resources utilization	3	4	7	64
Provide data for legal functions	3	4	7	64
Improve coordination between departments	3	3	6	54
Improve access to care	3	2	5	45
Improve manpower utilization	1	4	5	45
Other	0	1	1	9
TOTAL INTERVIEWED	4	7	11	100

the managers. A slightly higher percentage of managers mentioned improving manpower utilization than did the developers.

Table 2 shows that 82 percent of the NHRC NOHIMS developers/higher level managers rated NOHIMS as meeting the goals either very well or somewhat well. In Table 3 the three areas mentioned most often by the NHRC NOHIMS developers and higher level managers as areas in which NOHIMS is not fully meeting the goals were providing management data, improving medical surveillance, and providing data for epidemiologic analysis, although in each case only half or less of those interviewed mentioned these goals as not being fully met. Everyone interviewed thought NOHIMS was helping to meet OSHA requirements.

Table 4 contains a summary of the comments that the interviewees made explaining why they thought that NOHIMS was not meeting the system goals. The main comments that the NHRC NOHIMS developers/higher level managers made were that they had not seen enough output from the system (55% of those who answered), they needed more training/documentation for the system (55%), a statistical/analytical capability was required (55%), and that there were problems with the accuracy/completeness of the database (44%).

The managers felt that they have seen very little data come out of the system. The lack of output was reflected in the comment by a manager that "we are not getting enough industrial hygiene data back out for what we are putting into the system." Another manager stated that he would like to see regular monthly feedback to the users. One NOHIMS developer stated that the system had not been used enough yet to provide management data. The criticism generally levied was not that NOHIMS could not provide the appropriate output, but rather that the system was not being utilized properly to obtain the needed data. The lack of output contributed to the assessment that NOHIMS fell short of many of the goals, especially the workplace monitoring and management data goals.

Several of the managers that were interviewed stated that they or people under them had received inadequate training in the use of NOHIMS. They felt that training was required in both an overview of NOHIMS functions as well as in specific areas of operation. Developers expressed concern that adequate training be provided to future users to ensure the usefulness of the system. They clearly felt that the system could be very powerful if users were properly trained, but if users were not trained and there was not enough user involvement, then NOHIMS could fail to achieve its goals.

The main criticism that developers and managers made in regard to NOHIMS adequately providing data for epidemiologic analysis was that NOHIMS lacked statistical and analytical capabilities. These capabilities would also be useful in short-term investigations in the workplace monitoring program.

Questions about the accuracy and completeness of the database revolved around two problems. Several of those interviewed in San Diego stated that the Personnel Extract File was not up-to-date, and therefore, made the personnel data in NOHIMS inaccurate. Also, two of those interviewed stated that some of the data for the occupational health clinic examinations were inaccurate. NOHIMS showed that very few respirator examinations were conducted during a 6-month period; however, the clinic personnel had done many examinations. We looked into this problem and found that the data collection forms do have a data item for the number of respirator examinations conducted at the occupational

TABLE 2
Rating of How Well NOHIMS Is Meeting Goals
by NHRC NOHIMS Developers and Higher Level Managers
(Number who mentioned rating)

	NHRC NOHIMS Developers	Higher Level Managers	TOTAL	% of Total Interviewed
Very well	2	0	2	18
Somewhat well	2	5	7	64
Somewhat not well	0	1	1	9
Not well	0	1	1	9
TOTAL INTERVIEWED	4	7	11	100

TABLE 3
Goals That NOHIMS Is Not Meeting Well
According to NHRC NOHIMS Developers and Higher Level Managers
(Number who mentioned goal; multiple answers allowed)

	NHRC NOHIMS Developers	Higher Level Managers	TOTAL	% of Total Who Answered
Provide management data	1	3	4	44
Improve medical surveillance	2	1	3	33
Provide data for epidemiologic analysis	1	2	3	33
Improve patient care	0	2	2	22
Improve manpower utilization	1	1	2	22
Improve workplace monitoring	1	1	2	22
Improve resources utilization	1	0	1	11
Improve coordination between departments	0	1	1	11
Improve access to care	0	1	1	11
Provide data for legal functions	0	1	1	11
Meet OSHA requirements	0	0	0	0
No specific goals	0	2	2	22
TOTAL WHO ANSWERED	3	6	9	100
No Comment	1	1	2	
TOTAL INTERVIEWED	4	7	11	

TABLE 4
Criticisms of NOHIMS
by NHRC NOHIMS Developers and Higher Level Managers
(Number who mentioned criticism; multiple answers allowed)

	NHRC NOHIMS Developers	Higher Level Managers	TOTAL	% of Total Who Answered
Need more output	2	3	5	55
Need training/ documentation	2	3	5	55
Need statistical/analysis capability	3	2	5	55
Problems with accuracy/ completeness of database	1	3	4	44
Need more equipment	0	2	2	22
Problems with access	0	2	2	22
Need ability to retrieve historical data	2	0	2	22
Need more personnel	1	1	2	22
Need additional data				
MSDS information	0	2	2	22
Injury/illness	0	1	1	11
Safety data	1	0	1	11
Modules/components not implemented	0	1	1	11
Need special survey data forms	1	0	1	11
TOTAL WHO ANSWERED	3	6	9	100
No Comment	1	1	2	
TOTAL INTERVIEWED	4	7	11	

health clinic. Clinic personnel claimed to be marking this item, but very few respirator exams were actually entered into the database. In April 1986 we checked back with the two interviewees who mentioned this problem and found that the trouble had been resolved. The San Diego system manager set up an environment called "Respirator Program" in the industrial component to call in individuals in the respirator program for a physical examination and require a mandatory Pulmonary Function Test. The medical personnel marked the respirator box on the data entry form and tallies now appeared in the semi-annual reports.

The remaining criticisms of NOHIMS were mentioned by only one or two of those interviewed. Nevertheless, they were serious drawbacks to the interviewee who mentioned them. Problems with access, mentioned by two industrial hygiene managers, reflected their concern as to whether there would be adequate access to NOHIMS in terms of equipment, training, and 24-hour availability. There were concerns about having adequate resources, namely personnel and equipment, to be able to fully utilize all of NOHIMS capabilities. Two of the developers mentioned that NOHIMS needed a function that would retrieve historical industrial hygiene data. The two industrial hygiene managers felt that it was essential that the NOHIMS hazard table contain all of the data on the Material Safety Data Sheet (MSDS) for each hazard. It was also suggested that the table be augmented with additional hazards so that NOHIMS would provide more of a reference for the industrial hygienist. This suggestion was mentioned as one way of increasing the output from NOHIMS. A medical manager felt that it was a great oversight that NOHIMS was not set up to handle data from the illness/injury side of the occupational health unit. The special data collection forms that one developer mentioned were for collecting certain industrial hygiene survey data, especially data on noise and heat. The reference to modules/components not implemented is because Bremerton has not implemented the medical module and does not have access to personnel data yet.

System Users and Test Site Administrators

Table 5 contains the goals for NOHIMS mentioned by the system users and test site administrators. All but one person mentioned the goals of improving medical surveillance and improving workplace monitoring. More than half of those interviewed mentioned each of the other goals, except improving access to care which was mentioned by 46 percent of those interviewed. The industrial hygienists made the biggest difference in the number of people mentioning a goal. One-fifth or less of the industrial hygienists felt that improving coordination between departments, improving manpower utilization, improving resources utilization, improving patient care, and improving access to care were goals for NOHIMS. This finding suggests that they, in general, have a more focused view of the goals for NOHIMS than the medical users or test site administrators.

Nine out of eleven (82%) of those who rated NOHIMS on how it was meeting the goals felt that it was meeting them very well or somewhat well (see Table 6). One person each rated NOHIMS on how it was meeting the goals as somewhat not well and not well; both of these individuals were medical users.

In Table 7, we see that almost all of the mentions of goals that NOHIMS was not meeting were by the medical users. The goal that was mentioned by the most people was improving medical surveillance, and five out of six of these mentions

TABLE 5
NOHIMS Goals
According to Medical Care Providers,
Industrial Hygienists, and Test Site Administrators
(Number who mentioned goal; multiple answers allowed)

	Medical Care Providers	Industrial Hygienists	Test Site Admin.	TOTAL	% of Total Interviewed
Improve medical surveillance	6	4	2	12	92
Improve workplace monitoring	6	4	2	12	92
Provide data for epidemiologic analysis	5	3	2	10	77
Provide management data	5	3	2	10	77
Provide data for legal functions	4	3	2	9	69
Meet OSHA requirements	4	2	2	8	62
Improve coordination between departments	5	0	2	7	54
Improve manpower utilization	4	1	2	7	54
Improve resources utilization	5	0	2	7	54
Improve patient care	5	0	2	7	54
Improve access to care	5	0	1	6	46
TOTAL INTERVIEWED	6	5	2	13	100

TABLE 6
Rating of How Well NOHIMS Is Meeting Goals
by Medical Care Providers, Industrial Hygienists,
and Test Site Administrators
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	Test Site Admin.	TOTAL	% of Total Who Answered
Very well	2	2	1	5	46
Somewhat well	2	2	0	4	36
Somewhat not well	1	0	0	1	9
Not well	1	0	0	1	9
TOTAL WHO ANSWERED	6	4	1	11	100
No Comment	0	1	1	2	
TOTAL INTERVIEWED	6	5	2	13	

TABLE 7
Goals That NOHIMS Is Not Meeting Well
According to Medical Care Providers, Industrial Hygienists, and Test Site Administrators
(Number who mentioned goal; multiple answers allowed)

	Medical Care Providers	Industrial Hygienists	Test Site Admin.	TOTAL	% of Total Who Answered
Improve medical surveillance	5	1	0	6	54
Improve workplace monitoring	4	0	0	4	36
Provide data for epidemiologic analysis	3	0	1	4	36
Improve patient care	3	0	1	4	36
Improve coordination between departments	3	0	0	3	27
Improve resources utilization	2	0	0	2	18
Provide management data	2	0	0	2	18
Improve manpower utilization	2	0	0	2	18
Improve access to care	2	0	0	2	18
Meet OSHA requirements	2	0	0	2	18
Provide data for legal functions	2	0	0	2	18
No specific goals	0	1	0	1	9
TOTAL WHO ANSWERED	6	4	1	11	100
No Comment	0	1	1	2	
TOTAL INTERVIEWED	6	5	2	13	

were by the medical users. Providing data for epidemiologic analysis, improving patient care, and improving workplace monitoring were mentioned next most often in frequency.

Table 8 presents the system users' and test site administrators' criticisms of NOHIMS. A striking finding is that 82 percent of the users and administrators questioned the accuracy or completeness of the database. The criticisms about the accuracy or completeness of the database fall into two main categories, namely, problems with personnel data and problems with exposure data. Both industrial hygiene and medical users in San Diego said that there were inaccuracies in the personnel data file. These errors were attributed to inaccuracies in the source database, the Personnel Extract File produced by the NARF. At Bremerton, personnel data were lacking completely, as the shipyard had not been directed to participate in NOHIMS.

Every one of the medical users in San Diego who questioned the accuracy or completeness of the database specifically questioned the exposure data. They had concerns about whether NOHIMS adequately tracked workers, especially those who move from job site to job site such as those in corrosion control, and whether other government-required examinations were being tracked. In addition, several individuals expressed concern over incomplete or old survey data leading to inaccurate exposure information. Other concerns about the exposure data were not related to NOHIMS in particular, such as questioning the accuracy of exposure measurement values or treating the exposure measurement values as a minimum. But some of the specific concerns expressed were particular to NOHIMS such as seeing noise measures that were over the threshold limit but no noise examination was required by NOHIMS, or no measurements for substances known to be in the work environment. Because of their distrust of the exposure data, the medical users expressed ambivalent feelings about the management functions of NOHIMS. NOHIMS makes their jobs easier, but they are uncomfortable with allowing NOHIMS to make medical monitoring decisions because they do not fully trust the NOHIMS decision-making processes and the database.

In April 1986 we checked back with one of the medical care providers (two others who had expressed concern were no longer with the Occupational Health Unit) to see if these data inaccuracies had been remedied. The medical care provider we talked with stated that most of the problems had been resolved because the users have become more familiar with NOHIMS and now know when to override its recommendations and because methods have been developed within NOHIMS to cover former "gaps," such as calling up workers in certain hazardous occupations. They are still experiencing some problems but these are a result of inaccurate personnel data or out-of-date survey data and are not because of inherent NOHIMS design flaws.

Ten other criticisms were made of NOHIMS, although each was mentioned at most twice. One medical care provider and one industrial hygienist felt that more training/documentation was required to properly use NOHIMS. Two of the hygienists at North Island commented that they had inadequate personnel and, therefore, they were behind on survey data input to the system. Other comments that were made included that NOHIMS did not provide enough output, NOHIMS needs a statistical package, changes to medical data collection forms are needed, and NOHIMS needs to include all data from the Material Safety Data Sheet and data on injury/illness care. Also, one medical user stated that he would like the data on the Individual Exposure Examination Report to include all exposures (instead

TABLE 8
Criticisms of NOHIMS
by Medical Care Providers, Industrial Hygienists,
and Test Site Administrators
(Number who mentioned criticism; multiple answers allowed)

	Medical Care Providers	Industrial Hygienists	Test Site Admin.	TOTAL	% of Total Who Answered
Problems with accuracy/ completeness of database	5	4	0	9	82
Need training/ documentation	1	1	0	2	18
Need more personnel	0	2	0	2	18
Need more output	1	0	0	1	9
Need statistical/analysis capability	1	0	0	1	9
Problems with access	1	0	0	1	9
Need display of historical data	1	0	0	1	9
Modules/components not implemented	0	0	1	1	9
Need changes to medical data collection forms	1	0	0	1	9
Need additional data					
MSDS information	0	1	0	1	9
Injury/illness	1	0	0	1	9
Safety data	0	0	0	0	0
Need more equipment	0	0	0	0	0
TOTAL WHO ANSWERED	4	6	1	11	100
No Comment	1	0	1	2	
TOTAL INTERVIEWED	5	6	2	13	

of just those over the threshold) as well as historical exposures. Another medical user requested access to the industrial hygiene component to verify exposure data. The mentions of modules/components of NOHIMS that have not been implemented are again because the personnel files and the medical component have not yet been implemented at Bremerton.

Summary

Table 9 shows the goals that NOHIMS is not meeting well for all interviewees combined. For each goal, less than half of the users thought that NOHIMS was not meeting that goal, although each goal was mentioned at least twice. The goals that were cited most frequently as not being met well were improving medical surveillance and providing data for epidemiologic analysis. These were mentioned by 45 percent and 35 percent of all individuals interviewed, respectively. The main reasons why the interviewees felt that NOHIMS was not meeting these goals was because there was distrust of the personnel and exposure data, more output was needed, and because the system needed statistical capabilities. In addition, the managers and developers thought that more training was required to fully utilize the system. Three of the eight people in the industrial hygiene area requested that the Material Safety Data Sheet information be included in NOHIMS. Two of those in the medical area thought that injury/illness data were essential to NOHIMS. Other less frequent comments included needing more equipment and personnel, greater access to the system, the ability to retrieve historical exposure data, the inclusion of safety data, and the need for special survey data collection forms.

Most of the major problems stem from the implementation of NOHIMS rather than errors in the design of the system. The inaccuracy of personnel data is due to inaccuracies in the source database; the distrust of the exposure data is because the survey data are not up-to-date owing to inadequate personnel; and some criticism is the result of inadequate training in the system's functions and capabilities. Criticisms that are design-oriented include the need for statistical capabilities, retrieval of historical exposure data, and injury/illness data. It is not clear whether the need for more output is a design problem or if it is because the users lack experience with or knowledge of the system's functions in this area.

TABLE 9
Goals That NOHIMS Is Not Meeting Well
According to All Individuals Interviewed
(Number who mentioned goal; multiple answers allowed)

	TOTAL	% of Total Who Answered
Improve medical surveillance	9	45
Provide data for epidemiologic analysis	7	35
Improve patient care	6	30
Provide management data	6	30
Improve workplace monitoring	6	30
Improve manpower utilization	4	20
Improve coordination between departments	4	20
Improve resources utilization	3	15
Improve access to care	3	15
Provide data for legal functions	3	15
Meet OSHA requirements	2	10
No specific goals	3	15
TOTAL WHO ANSWERED	20	100
No Comment	4	
TOTAL INTERVIEWED	24	

SECTION III
EVALUATION OF NOHIMS SYSTEM DESIGN

The NOHIMS system design has been evaluated in eleven areas: an overall description of NOHIMS; software quality attributes; operational characteristics, including user friendliness, data manipulation tasks, and information retrieval; NOHIMS security features; hardware and software support requirements; available system support; scenario descriptions to maintain the system; organizational requirements; minimum hardware requirements; suitability of NOHIMS to the information processing needs of the Navy; and assessment of system performance. Each topic has been covered in its own subsection. Descriptive data for these subsections were drawn from both interviews with the Naval Health Research Center (NHRC) NOHIMS developers and from the NOHIMS documentation. Some subsections include subjective assessments of various attributes of NOHIMS by each of the user categories consisting of NHRC NOHIMS developers, higher level Navy managers, medical care providers, industrial hygienists, data entry clerks, and system managers, as appropriate.

DESCRIPTION OF NOHIMS

The following text on NOHIMS describes the overall organization of NOHIMS, the software language used and the programming structure, and a description of the industrial and medical components of NOHIMS.

Overall Organization of NOHIMS

NOHIMS is composed of two subsystems: an industrial component and a medical component. Each of the two subsystems can operate as a stand-alone system, but in NOHIMS they function as an integrated system.

The NOHIMS industrial component is designed as a management tool to assess the extent of exposure of personnel to hazardous substances and other workplace stressors and to provide an accurate determination of health care requirements for each worker based upon that assessment. While serving this purpose, it also provides many other procedures and features that aid industrial management tasks. The industrial component functions in a manner that is as close as possible to the "real world" operation of a Navy agency. With a few exceptions, all of the terminology, configurations, names, and other descriptive attributes normally used by the agency can be used in the operation of the industrial component.

The medical component is a comprehensive and flexible medical information and communication system that has been adapted for Navy occupational medicine. Using special forms designed to collect medical record data, the medical component captures, stores, displays, and prints relevant, complete, and standardized clinical information so that it is immediately and perpetually accessible. Further, the system has the capability to generate data for

administrative reports in a timely manner, tabulate population statistics, and answer research queries.

Software Language Used and Programming Structure

Both the industrial and medical components of NOHIMS are written in ANSI Standard MUMPS. MUMPS is an acronym for the Massachusetts General Hospital Utility Multi-Programming System. It is a compact, high-level interpretive data management system. It was originally designed for medical applications, but it has since become a general purpose language. It is particularly suited for interactive applications that require a large shared database and the rapid, efficient manipulation of textual data. MUMPS contains its own file manager and interpreter. Some versions of MUMPS contain an operating system while others run under a general purpose operating system.

The system routines for the industrial component of NOHIMS were written by Donald D. Beck, a consultant with R-K Research and System Design, Malibu, California and The MITRE Corporation, McLean, Virginia under contract to the Naval Health Research Center (NHRC), San Diego, California. The routines were specifically designed and written for NOHIMS, but they would be useful in a variety of occupational health settings. The programming structure used is modular programming. The file system is characterized by hierarchical direct access B-tree files. The data files are of variable length and file space is dynamically allocated. The industrial component uses foreground processing.

The operation of the industrial component system routines was verified through pilot operation and routine operational use at the Occupational Health and Preventive Medicine Department, Industrial Hygiene Division of the Naval Air Rework Facility, North Island, San Diego, California and the Puget Sound Naval Shipyard, Bremerton, Washington in conjunction with staff from NHRC. The Description of Implementation Process at the Test Sites subsection of the Evaluation of Transferability of NOHIMS to other Navy Industrial Sites section of this report contains further detail on the individuals involved in the development of the industrial component of NOHIMS. The industrial component software is currently being maintained by NHRC. NHRC has plans to expand the Query/Report function of the system and to modify the software to provide alternative methods of producing personnel exposure reports.

The medical component of NOHIMS is from COSTAR--the Computer STored Ambulatory Record system. The system routines for COSTAR were orginally developed by the Laboratory of Computer Science at Massachusetts General Hospital and Harvard Medical School in collaboration with the Harvard Community Health Plan. Funding for this endeavor was provided by the National Center for Health Services Research. In 1975, the system was rewritten as COSTAR V in ANSI Standard MUMPS with expanded capabilities and flexibility. The COSTAR Users' Group has since overseen several updates of the COSTAR software. The medical component of NOHIMS is based on COSTAR V.7. Application programming modifications specific to NOHIMS were made to COSTAR V.7 by Kathryn E. Guidera, MSPH, and Anton S. Roberts of R-K Research and System Design under the supervision of NHRC. The programming structure for the medical component could be described as mostly hierarchical direct access B-tree files with a few pointer files that are key indexed files. The files are variable length files and file space is dynamically allocated. The medical component uses

approximately ten percent foreground processing and 90 percent background processing. All encounter data filing is background processing; some registration filing and system maintenance filing is done in the foreground.

The operation of the system routines for the medical component was tested by staff at NHRC and staff at the Occupational Health Unit, North Island, San Diego, California through pilot operation and routine operational use. Again, the reader is referred to the Description of Implementation Process at the Test Sites subsection of this report for further detail on individuals involved in the development process for the medical component of NOHIMS. The software is presently being maintained by NHRC. No further software enhancements are planned; however, NHRC is currently modifying the COSTAR directory to allow the processing of illness and injury care data. The implementation of an occupational history form and a medical history form have not been completed yet.

Description of the Industrial Component

The following describes the main function and features of each module and option in the industrial component. The reports generated by the industrial component, data collection forms, and other sources of data for the system are also described.

Description of Industrial Component System Modules

There are eight main operational modules in the industrial portion of NOHIMS. Five of these modules deal with the general areas of occupational health, namely, industrial organization, workforce personnel, workplace environments, survey information, and hazardous substances information. The other three primary modules are an ad hoc query function for the retrieval of information in a user-defined context, a system maintenance function that is used to control security and system file integrity and to perform any necessary alterations to the contents of the component's internal tables and data directories, and a transaction/message process module that integrates personnel data from Navy personnel records with NOHIMS. These eight primary modules are the first level menu choices of the industrial component and are named as follows:

AGENCY DATA
PERSONNEL DATA
ENVIRONMENT DATA
SURVEY DATA
HAZARD DATA
MAINTENANCE
TRANSACTION/MESSAGE PROCESS
QUERY/REPORT

Agency Data Module. This module deals exclusively with the organizational configuration of the activity to be managed by NOHIMS. The term "agency" is used as the generic term for this activity. NOHIMS must have a complete description of the agency in order to properly relate and manage personnel and

workplace environment data in a "real world" context. The Agency Data module contains three options as follows:

ORGANIZATION DEFINITION
EDIT ORGANIZATION
DISPLAY ORGANIZATION

These options provide all of the transactional facility necessary to completely define, alter, and display the organization of an agency of any size or configuration. The agency configuration may range from a single organizational unit located at one physical site to an activity of practically any organizational complexity having a multitude of geographically located facilities. The system will accept nearly any form of terminology that is in use to describe the geographical and organizational attributes of the agency.

Organization Definition. The Organization Definition option allows definition of organizational components of the agency called units. The system permits each unit to have both a full name (which can be the actual name) and a code (which can be a number, acronym, or abbreviated name). The code can be any actual identification convention in use as long as it uniquely identifies that agency unit. This code is usually the primary identifying term used for agency unit look-up purposes throughout the industrial component. A unit name may also be looked up instead of the code, however. All of the agency units are associated with their actual hierarchical level titles, such as department, shop, etc. They are also associated with their geographical locations, which are generically called "sites" in the system. The applicable industrial sites (there can be any number) are defined using the Maintenance module of the industrial component.

Edit Organization. Edit Organization allows all aspects of the current organizational definition to be altered. Suboptions allow the user to edit the agency's name, acronym, generic title, industry type, primary site, or secondary sites; add level(s) to the organization; edit level title(s); or edit characteristics of each agency level.

Display Organization. Using this option, the user may display all or any portion of the agency organization. The display is organized so that the hierarchical configuration of the unit is portrayed. The normal display for each agency unit includes the unit's name, code, site location, and the number of environments attached to it. Also, additional information such as personnel and workplace environments applicable to each agency unit may be included in the display output. If this latter option is selected, a complete description of each environment is displayed, along with the names, employee identification numbers, and the dates that the persons were assigned to the particular agency unit.

Personnel Data Module. This module contains the functions necessary to manage the general employee workforce and other individuals as may be associated with the agency. This includes introducing new personnel, terminating personnel, and transferring personnel within the agency. The module contains the following options:

PERSONNEL DATA ENTRY
WORKPLACE ASSIGNMENT/TERMINATION
HAZARD EXPOSURE/EXAMINATION REPORT
TRAINING HISTORY
SAFETY EQUIPMENT
EDIT PERSONNEL DATA
DISPLAY PERSONNEL DATA

Personnel Data Entry. Personnel Data Entry provides the capabilities required to introduce new employees into the system and to assign them to their initial agency unit. The system accepts the worker's name, sex, date of birth, social security number, employee number (in accordance with local conventions), and occupation code. If an employee has been terminated, this option may also be used to reinstate the worker.

Workplace Assignment and Termination. This option allows employees to be independently associated with both an agency unit and as many work environments as are applicable. For each environment that is assigned, the user may specify the number of hours per week that the person is usually present in the environment. The worker may also be disassociated from a work environment(s), transferred from one agency unit to another, terminated from active status, or the proportion of time a person spends in each of the assigned environments may be edited.

Hazard Exposure/Examination Report. The Hazard Exposure/ Examination Report option produces the hazard exposure summary and medical examination requirement reports (Individual Exposure Examination Reports) for the workers that are selected. In addition, the Occupational Health Roster (a roster listing employees who require medical examinations within each applicable agency unit) and a Physical Exam Notification Report (a medical examination notice) for each employee in the Occupational Health Roster may also be produced.

There are a variety of ways to select individuals for generating reports. Usually the Periodic Exam Preparation suboption is used to select all personnel within the agency who were born in a specified month and need an annual physical examination. NOHIMS will select a worker for a physical examination only if the environments associated with the worker contain an agent with mandatory medical requirements or if a measured hazardous agent concentration value of an agent in the worker's environment(s) has exceeded the applicable medical action level limits. The reports can be produced using criteria for preplacement examinations, termination examinations, or normal periodic examinations. The user may also select specific individuals or all of the employees of a specific agency unit by using the Special Examination Preparation suboption. This suboption also produces a general exposure and examination report for environments rather than personnel. All reports will list all pertinent hazardous agents, concentration sample values, and associated medical requirements.

Once a particular report has been generated, multiple copies of the report may also be

restarted at a failure point or at the beginning of the report using the Restart a Prepared Report suboption. The Occupational Health Roster and Physical Examination Reports can also be printed any number of times. The Delete Old Reports suboption is used to erase sets of report specifications stored in the system.

Training History. This option was intended to allow the user to keep track of all formal training classes the employee has completed. Classes about hazardous substances, equipment use, first-aid, and other emergency procedures would be included. When utilizing this option, data such as title of class and date of completion of the class would become a permanent part of the employee's personnel record. Although Training History is included in the option menu, it was not implemented in Version 1.0 of NOHIMS.

Safety Equipment. The Safety Equipment option was intended to be used to enter and retrieve information about safety equipment (e.g., earplugs, safety shoes, safety glasses, and respirators) issued to an employee. The make, model, and serial number of the equipment issued, along with the date of issue and date of return, would be stored for each piece of equipment issued. Again, it was not implemented in Version 1.0 of NOHIMS.

Edit Personnel Data. Using this option, the user may alter any portion of the employee's personnel record in NOHIMS. Suboptions differentiate between edit (correction) operations and update operations on the worker's name. Editing of the name replaces the previous worker name. Updating the name causes an historical audit trail to the previous name, allowing the system to recognize the worker by both the old and new name. The social security number, employee number, sex, and date of birth may also be edited with this function.

Display Personnel Data. This function allows a user to display the personnel data for a selected worker or all workers for a selected agency unit. The display that is produced includes personnel demographic data, the current agency unit to which the worker is assigned, the date the worker was assigned to that unit, and information for the worker's currently assigned work environment. The user may also opt to include the medical examination information in the display. The medical examination information includes current medical examination recommendations, examination status, and hazardous agent exposure information.

Environment Data Module. The functions of the Environment Data module allow a user to compile a list of environments contained in the agency. In NOHIMS, an environment may be one of three distinct types: a physical workplace; an occupational category; or a circumstance, event, or other situation that is descriptive of the location or conditions affecting working personnel such as an industrial accident. The Environment Data module contains options that allow the user to create environments and then to assign the environment to applicable agency units. Environment Data has five options that are accessed through the module's primary option menu:

CREATE ENVIRONMENTS
DISPLAY ENVIRONMENT USERS
REVIEW ENVIRONMENT INFORMATION
EDIT ENVIRONMENT DATA
ASSIGN ENVIRONMENT TO ORGANIZATIONAL UNITS

Create Environments. Create Environments is used to initially define any type of environment. The user is simple asked to specify the environment type and furnish the environment name. Building and room numbers, areas, incident names, or other textual terms of user choice may be used to describe the environment. Since certain environments cannot be surveyed, such as occupational categories, this option allows a user to specify a set of mandatory medical requirements for an environment. These requirements will then always be applied to all personnel associated with the environment in exposure reporting functions. Such requirements are used to supplement the exposure data that are normally derived from survey information.

Display Environment Users, Review Environment Information. The Display Environment Users option is used to quickly retrieve and list environment descriptions and the associated agency units. No other information is provided in the display. The user may select any agency unit environment(s) for display. The environment(s) for display may be selected by their association with agency units or by keyword content of their description (such as "spill"). The Review Environment Information option will retrieve environments in the same manner as the Display Environment Users. However, the user may also display any one or combination of the following: environment description, organizational users, personnel assigned to the environment, mandatory medical requirements, survey references, or material inventory.

Edit Environment Data. This option allows alteration of the environment description and user-specified medical requirements, if any have been defined. The previous environment description is archived in the system along with the date of the edit or update.

Assign Environment to Organizational Units. The Assign Environment to Organizational Units option is used to associate or disassociate an environment with the organizational units within the agency that have personnel who may be working in the environment. An environment may be associated with any number of organizational units. If an environment is de-assigned from an agency unit, all personnel within that agency unit who are currently associated with the environment will be de-assigned.

Survey Data Module. The Survey Data module is used to enter, edit, and display data from the surveys of the industrial hygienists. The term survey denotes the industrial hygienist's collection of observed and measured information concerning the contents and conditions of an environment. Data for a survey are collected using three forms. The Industrial Hygienist Survey (IHS) is used to collect facts and conditions about the general workplace. The Occupational Hazard Data Sheet (OHDS) is used for gathering material sampling

and exposure data and is prepared for each hazardous agent sampled in an environment. The Material Inventory (MI) is used to record the presence of each agent, material, or product found in the environment. The following options are available under the Survey Data module:

CREATE SURVEY
EDIT SURVEY DATA
DISPLAY SURVEY DATA

Create Survey. The Create Survey option is used to enter the survey data collected with the IHS, OHDS, and MI forms. NOHIMS allows local conventions to be used to identify each set of survey data as long as the terms used uniquely identify the survey. Data are entered via a series of system prompts. The contents and order of the prompt sequence is set by the system manager using the Maintenance module. To enter a survey, the data entry clerk first enters the data from the IHS form. Once these data have been entered, the data entry clerk selects suboptions that drive the prompt sequence for the OHDS or the MI. One set of OHDS data is entered for each agent that was sampled in the environment or for each different set of concentration measurements for the same hazardous agent. The data entry clerk may enter as many OHDSs as are required to describe the environment.

Edit Survey Data. The data that are first entered for an environment are used as a base-line survey. Whenever new data are gathered or changes are observed in subsequent surveys of the same environment, the Edit Survey Data option is used to alter the base-line survey and to keep the survey information up-to-date. Sample and measurement data for agents are kept historically. Edit Survey Data contains selection options for the IHS, OHDS, and MI, so data from any of these three forms may be edited with this option. Survey data that are obsolete may also be deleted with this option.

Display Survey Data. The Display Survey Data option will display a selected survey, or any or all surveys associated with the agency unit(s) or environment(s) selected for display. The environment(s) may be selected by their association with agency units or by keyword content of their description. The user may select to include data from any or all of the survey data forms. The Industrial Hygienist Survey form display retrieves general workplace facts and conditions; the Occupational Hazard Data Sheet display contains material sampling and exposure data; and the Material Inventory display is a list of the agents, materials, or products found in the environment(s) associated with the survey.

Hazard Data Module. NOHIMS has a table that contains all chemical agents, materials, conditions, and other physical phenomena and their attributes that are found in the work environments. The table is an extensive collection of information pertinent to the identification, industrial control, sampling, and medical exposure effects and examination requirements for each of the hazards. For example, the table includes Threshold Limit Values (TLVs), Permissible Exposure Levels (PELs), NIOSH and Navy exposure limits, agent synonyms, and CAS codes. The data contained in the table are derived from many sources and reflect commonly used standards and other attributes. Some of the information

for certain agents is not included in the system because the data are unknown, data have not been established by an authoritative body, or because there are conflicting opinions on certain attributes of the agents. The Hazard Data module creates and maintains the data in the table. It allows each local site to review, alter, and add to the table so that it will agree with local standards, practices, and procedures. The following options are available under Hazard Data:

EDIT HAZARD DATA
HAZARD DATA ENTRY
DISPLAY HAZARD DATA

Edit Hazard Data. The attributes of an agent in the table may be edited and kept up-to-date with the Edit Hazard Data option. The date of the update is also stored as part of the record.

Hazard Data Entry. New agents may be added to the table with this option. For each new agent, NOHIMS solicits the agent primary and synonymous names; code numbers; medical monitoring status; classification category(ies); analytical method number; sampling and analytical error; exposure limits including scale, authority, and various limits; body parts and organ systems affected; medical surveillance; and protocol for the recommended procedures used to monitor for effects of the agent.

Display Hazard Data. All current information contained in the Hazard Table for a selected agent(s) may be displayed via this option. The user may also select to include in the display those environments that contain the selected agent using the Locations suboption.

The ease of identification and retrieval of agents is an important characteristic of the NOHIMS design. It is practically impossible for a user to remember the exact spelling and other distinguishing attributes of the hundreds of agents and compounds contained in the hazardous agent table. Also, most agents have many synonyms, as well as a primary name. Therefore, NOHIMS allows any number of synonyms to be associated with an agent for identification purposes. An agent can be identified by either one of two NOHIMS codes or a partial entry of the agent name. The system then returns a candidate list containing agents whose names contain the partial entry and the user selects the desired agent.

Maintenance Module. The Maintenance module is used to both initialize and maintain the system. During initialization, the agency that NOHIMS is to serve, required system table data, information concerning the hardware configuration, and control information for each system user are defined. Most of these data items require periodic inspection, additions, changes, or deletions to keep the information consistent with current operating needs and up-to-date with latest information. Via the following options, the NOHIMS system manager defines initial parameters, controls security, maintains system file integrity, and performs any necessary alteration to the industrial component's internal tables and data directories.

AGENCY/SITE DEVICE DEFAULTS
SECURITY FUNCTIONS
INTEGRITY CHECK & CRASH RECOVERY
SYSTEM TABLE EDIT
DEVICE DEFINITION/EDIT
ERROR REPORT
DEFINE AGENCIES/SITES
DIRECTORY MAINTENANCE
GENERAL REPORTS

Agency/Site Device Defaults. This option is used to temporarily alter the default agency and site values for a specific device for a specific work session. It is useful only when a single industrial component is operating with multiple agencies rather than a single agency. It allows the system manager to work in any agency during a session without making a permanent change to the agency and site defaults that happen to be assigned to the particular device in use.

Security Functions. Each user of the industrial component must be assigned a three to five character identification code. This is the ID Code used to gain access to NOHIMS during the log-on procedure. Using this option, a list of system modules and options that the user is allowed to access is defined and edited. A similar sort of options list is also associated with each terminal device. A user is then allowed access to only those options that are on both his/her option list and the option list for the device in use. The Security Functions option is also used to define, edit, or delete "domains" that may be associated with users. The domains are used as an address for report or message transmittal within the system. A domain includes an agency and the person within the agency to be targeted.

Integrity Check & Crash Recovery. If a "hard" computer crash occurs during a filing operation, it is likely to cause corruption of the global files. The integrity check operations search the filed configuration of the global files and record any erroneous filing conditions that are found. Usually, the condition can be corrected through execution of an automatic correction process which is capable of interpreting the error records that were recorded by the integrity checking routines and perform the necessary corrections to the files. The integrity check routines are run on a hardcopy device in order to obtain descriptions of errors that are found.

System Table Edit. This option allows editing of all industrial component tables. These tables are, for the most part, translation tables used to encode and decode data. The tables and their mnemonic identifiers are as follows:

HIS: Medical history examination code to text
LAB: Medical laboratory examination code to text
PEX: Medical physical examination code to text
SAM: Sample media code to text
CON: List of concentration scales and units
FLG: Medical examination applicability flag codes
OCC: Occupation code to text

PPR: Physical restrictions code to text
BOD: Body part and organ systems code to text
MED: Mandatory medical requirements (Medical Program codes and associated examination and flag sets)
QES: Question "?" entry response table

The System Table Edit option also allows access to the device and user option tables via separate suboptions. The Users suboption calls the Security Functions main menu, and a Devices suboption invokes the Device Definition/Edit option. A Response-to-? suboption invokes an editor routine for the user question response table. The other system tables are accessed via a Tables suboption.

Device Definition/Edit. This suboption allows definition and editing of the parameters for each hardware input/output device to the industrial component. The system must have each device defined in an internal table because many items of information concerning the specific device are required for the correct performance of tasks throughout the system. This option defines various control characters, default agency and site, the location of the device, and various display parameters. Each device is defined during system initialization; however, any change of device ports, device additions, or device deletions will require alteration of the internal device table via this option.

Error Report. This option is used as a monitor and aid to identification of system routine or file malfunction. The industrial component has the capability of intercepting operational error interrupts during routine execution. Such an interrupt aborts the ongoing task when the error is detected and logs the error and associated memory contents in an error file so that it can be reviewed via this option by system programmers. Old or corrected error reports can be deleted by using a Kill suboption.

Define Agencies/Sites. This option allows definition of any number of industrial sites using both a full name and a short acronym for site identification. The sites describe the geographical or physical locations of facilities associated with the agency. Since it is possible for agency units to have the same name and/or code yet be located at different geographical sites, the only way to uniquely identify these agency units is to include site locations in their identification. Site names and acronyms may also be edited with this option.

Directory Maintenance. This option allows the system manager to add codes to the directories, edit parameters for existing codes, review parameters for specified codes, or to display all or part of the directories. It also has suboptions for editing filing control, input control, creating an alphabetic directory for look-up by names, forms edit/display, subdirectory member edit, and division edit.

General Reports. This option accesses a general report selection menu. The menu provides a place to link any new reports written for

the industrial component. Selection of an option under General Reports causes the specified report to be executed.

Transaction/Message Process Module. This module provides NOHIMS with the functions to process personnel transactions from an outside personnel file. It was also intended to be used to transmit to and receive messages and/or reports from users via the system. The module has the following three options:

RECEIVED MESSAGE PROCESSING
TRANSMIT MESSAGE PREPARATION
PERSONNEL TRANSACTION PROCESSING

Received Message Processing. This option was not implemented in Version 1.0 of NOHIMS. The intention was that it would be used to read/receive any reports or messages that were transmitted through the system.

Transmit Message Processing. This option was intended to be used for creating a message for another system user or to send an industrial component report, such as a personnel file, to another user. It was not implemented in NOHIMS Version 1.0.

Personnel Transaction Processing. The Personnel Transaction Processing option is used to process external personnel data and store it in the NOHIMS database. This option has four suboptions:

PROCESS AN EXTERNAL TRANSACTION FILE
PROCESS AN INTERNAL TRANSACTION FILE
MANUAL ERROR CORRECTION AND PROCESSING
DELETE AN INTERNAL TRANSACTION FILE

Process An External Transaction File. This suboption is used on a monthly basis to update the NOHIMS personnel records from the agency's personnel files. The agency personnel file, called an "external" transaction file, is processed by this suboption to produce an "internal" personnel transaction file. The external file may be introduced to NOHIMS via three different methods: Tape input, DMC network transmission input, or ASYNCHRONOUS terminal device input. A copy of the most recent transmission file is stored internally, labeled with the processing month. The current transmission file is compared to the previously stored one to determine the personnel transactions that occurred during the intervening time period.

Process An Internal Transaction File. The Process An Internal Transaction File suboption automatically processes and updates the NOHIMS personnel data files. It is automatic in that when an error is detected in a personnel file, an error message is displayed and the record is flagged as an error record and is not processed. If records are flagged as in error, the Manual Error Correction and Processing suboption must be run in order to correct the errors. If the sex of a newly hired worker is missing from the personnel record during automatic processing, NOHIMS will prompt for the sex. The

system will display the employee number and name to assist the user in determining the worker's sex. NOHIMS must know the worker's sex to enter him/her into the database.

Manual Error Correction and Processing. This suboption processes the internal transaction file, but allows interactive correction of errors at the time they are found. If the user can provide correct data, the record will be processed as normal. If not, it will be flagged as an error record. The errored record may be corrected at a later date by re-running the Manual Error Correction and Processing suboption or by using the Edit Personnel Data option in the Personnel Data module. If the Manual Error Correction and Processing suboption is run on an internal transaction file that has already been processed by the Process An Internal Transaction File suboption, only those records that were flagged as in error will be processed.

Delete An Internal Transaction File. When the user is satisfied that all of the transactions in an internal transaction file have been processed into the database properly, the internal file is deleted with this suboption.

Query/Report Module. The Query/Report module provides an ad hoc information retrieval and display capability that extends to almost every data item in the industrial component of NOHIMS. This module contains the following options:

CREATE A NEW QUERY
DISPLAY A QUERY FILE
ERASE A QUERY FILE
TEST OR RUN A QUERY

Create a New Query. To generate a query, the user first defines a "command set" using the Create a New Query File option. The command set contains the user's selections from a menu progression. The presentation of the data selection menus follows a logical progression through the various industrial component data groups. The menu at any point in the selection process allows selection of only those data groups that are possible given the previous data group selections and the interrelationships of those data groups with other data groups in the component. The command set specifies only general data groups and data items, the sequence of information retrieved, and the user's desire to specify target subjects within each data group. It does not identify individual target subjects. The selection of individual target subjects within the data group is accomplished interactively during the initial portion of the query execution process. Therefore, the same command set may be used to retrieve unlimited combinations of specific target data accessible by the sequence of the general query command set. When a set of individual data items is selected for the query, the user can select any or all of the data items in the group for retrieval. Conditional testing of a data item is planned as a future enhancement. Possible testing conditions for the industrial component will include comparison to a given numeric value, comparison to a given numeric interval, testing for the presence or absence of a

data item, comparison to a given literal value, a search of the data item content for a given single- or multi-word literal, and comparison to an associated table of values if applicable to the data item. There is no capability to edit command sets. A command set is so easily built, that it is simpler to create a new command set than to modify an existing one.

Display a Query File. The query command sets may be displayed for review using the Display a Query File option.

Erase a Query File. A command set is stored in the system under a user selected name until the command set is deleted with the Erase a Query File option.

Test or Run a Query. To run a query set, the user selects a query command set and runs it. If the user indicated a desire to select specific target subjects of each data group, the system will prompt for the target subject during the initial portion of the query execution process. A run interprets the command set and displays the desired information. The output display format of the retrieved data is not under control of the user. The query performs a simple progressive indentation of the information for each unique data group, much like an outline. The absence of format control makes the interactive query a simple and quick way to retrieve data.

Description of Industrial Component Data Collection Forms

The industrial component of NOHIMS uses three data collection forms to collect industrial hygiene survey data. These are the Industrial Hygiene Survey (IHS) form, the Occupational Hazard Data Sheet (OHDS) and the Material Inventory (MI). Personnel data are entered into the industrial component via a link between NOHIMS and the Personnel Extract File (PEF) of the Naval Air Rework Facility. The contents of these data collection vehicles are described in further detail below.

Industrial Hygiene Survey (IHS) Form. The IHS form is used to collect facts and conditions about the general workplace. The industrial hygienist or safety specialist conducting the survey completes one of these forms for every survey that is performed. The form contains the following data items: the agency surveyed, the environments surveyed, the date the survey was conducted, the type of survey conducted, the supervisor and telephone number of the workplace surveyed, who prepared the survey report, a description of operations at the workplace, adverse health effects reported (including the worker's name, social security number, employee number, and reported symptoms), engineering controls, personal protective equipment required and for what operations the equipment is required, deficiencies in the environment(s), and recommended actions for implementation.

Occupational Hazard Data Sheet (OHDS). The OHDS is used for gathering material sampling and exposure data and is prepared for each hazardous agent sampled in an environment. When the survey data are entered into NOHIMS, the data entry clerk may enter data from as many OHDSs as is necessary to fully describe the sampling that was performed. A separate OHDS is used for each

measurement of the same agent, as well as for each agent sampled. The OHDS collects the following data: building and shop identification, the date the survey was conducted, the agent sampled, the work environment/operation/source, the person who was sampled, personal protective equipment in use, the measured concentration for the agent, hazard type, sampling strategy, mode of entry, weekly usage rate, continuity of process, analytical method, sample number, date the sample was taken, sample media, flow rate, duration, potential hazard severity, mishap probability, medical monitoring recommendation, and rationale for the medical monitoring recommendation.

Material Inventory (MI). The MI is used to record the presence of each agent, material, or product found in the environment. The Material Inventory form collects the environments surveyed; the date of the survey; the preparer of the report; the work areas covered; and a list of the products, including specifications and manufacturer, the agents contained in the products, the weekly amount used, and the sampling decision.

Personnel Extract File (PEF). The PEF is used to automatically transmit personnel data for Naval Air Rework Facility (NARF) workers to NOHIMS. The data include the worker's name, social security number, employee number, sex, date of birth, occupational code, and current work location. The data from this file are used to track employees' work history. By linking the workers to specific environments that have in turn been linked with industrial hygiene surveys, the exposures of the individual workers can be determined.

Description of the Medical Component

The following describes the main function and features of each module and option in the medical component of NOHIMS. The reports generated by the medical component and the data collection forms used to gather and enter data into the system are also described.

Description of Medical Component System Modules

There are eight primary system modules available for use in the medical component of NOHIMS. Two of these modules--Registration and Enter Medical Data--are used to either enter data into the database or to edit already existing data. Three modules--Display Medical Data, Print Medical Data, and COSTAR Report Generator--are used to retrieve and display the medical component information. A Mailbox module allows the system users to send messages to and receive messages from other system users. The Occupational Health Information module has not yet been implemented. The intention is that it will take the system user to the primary system menu of the industrial component. The eighth module is Systems Maintenance. This module is used to initialize system parameters such as security files, to maintain the system directories, and to assure the integrity of the database. The primary system menu is as follows:

REGISTRATION
ENTER MEDICAL DATA
DISPLAY MEDICAL DATA
PRINT MEDICAL DATA
COSTAR REPORT GENERATOR
SYSTEMS MAINTENANCE
MAILBOX
OCCUPATIONAL HEALTH INFORMATION

Registration Module. This module provides for the entry, edit, and display of all identifying and demographic data for the patient. A patient must be registered in the medical component before any encounter data or history data can be entered into the patient's medical record. The Registration module has the following two system options:

PATIENT REGISTRATION/EDIT
DISPLAY REGISTRATION

Patient Registration/Edit. This option is used to enter a patient and his/her demographic information into NOHIMS. Only three data elements must be collected during registration: the patient's name, sex, and date of birth. The NOHIMS registration sequence has been set up to gather other data elements required for Navy purposes. These data items include a person to notify in emergency, telephone number in emergency, date of registration, social security number (also used as the unit number to uniquely identify the patient in NOHIMS), duty station or activity, and primary clinic. It was also intended that the patient registration would include the ethnic background of the patient. This variable has not yet been implemented in NOHIMS. A policy decision needs to be made first on appropriate categories for the ethnicity code.

The registration sequence can be modified using the Registration Functions option in the Systems Maintenance module. The Systems Maintenance module tells the system which data elements are to be collected, in what order they are to be collected, and how the registration data are to be displayed on a terminal. Help text is available throughout the registration process to assist the data entry clerk in properly entering the data. The entries that have been made are usually displayed on the CRT screen as the data entry clerk registers the patient. Any incorrect entries can be edited before the registration is filed.

This option is also used to edit an already existing patient registration. None of the registration data items except the name and social security number is kept historically, that is, the new value replaces the previous value for the given data item. If either the patient's name or social security number are modified, NOHIMS will enter the new value into the patient's record and cross reference the file to the old value.

Display Registration. Display Registration allows the user to view, on either a CRT or printer, the complete set of registration data for a patient. The registration display for NOHIMS contains the

patient's name, sex, date of birth, person to notify in emergency, phone number in emergency, date of registration, social security number, duty station or activity, and primary clinic.

The patient to be displayed can be identified by name or by social security number. The social security number is the unit number that uniquely identifies the patient in the system. The patient to be displayed can be identified with an ambiguous entry of the name. The minimum number of letters of the patient's name that must be entered at the Identify Patient prompt is two letters of the last name. NOHIMS will then list all patient registered in the medical component that meet the criteria entered. NOHIMS does not search for patient names by phonetics. This option only displays registration data. No changes can be made to the registration record while in this option. If the user desires to edit the registration record, the Patient Registration/Edit option must be used to display and then edit the registration record.

The registration display format may be formatted as a consensus of the users desire. The specifications for the registration display are set up and altered via the Registration Functions option of the Systems Maintenance module.

Enter Medical Data Module. The Enter Medical Data Module allows entry and editing of patient encounter or history data and laboratory results. In NOHIMS, an encounter is a set of data that describes a medical visit, a physical examination, or a patient's occupational or medical history. More than one encounter can be entered on a given day; however, the COSTAR Report Generator does not always retrieve the data properly when this is done. The Enter Medical Data module has the following three options:

ENCOUNTER ENTRY
LAB RESULTS
MEDICAL EDIT

Encounter Entry. This option is used to initially enter all encounter data. The encounter entry format has two parts--the Header and the Body of the encounter. The Header contains primarily administrative information that identifies the patient, the date and site of the encounter, the name of the care provider(s), and the nature of the visit and service provided. The order of data items entered in the Header is fixed. Entry of data items in the Body of the encounter can be in any order; however, the order of data entry should follow the items on the medical component encounter forms. Lab test codes are usually entered at the time of entering the encounter data. Lab results can be entered at encounter entry or they can be entered at a later date using the Lab Results option. Data items are entered into the Body of an encounter by entering the data entry code along with any associated items, such as modifiers, statuses, or textual comments. Only data items that have been predefined in the medical component directory can be entered. Some of the codes have special conditions that perform value checking; some codes prompt for textual comment while others require a modifier to be entered. If an error is made during encounter entry, incorrect entries can be

corrected by re-entering the code and associated data in the correct manner. The new entry will automatically take precedence over the previous entry. Data items may be flagged as an erroneous entry by typing an "E/" before the code. Errored out data items no longer appear in the patient's medical record.

Lab Results. The Lab Results option is used to enter laboratory results if encounter entry has already been completed. Lab Results uses three types of entry methods. Single result tests simply prompt for the results of the test. Multiple result tests call special programs that prompt for a series of results. Common laboratory tests of this type include Urinalysis and the Pulmonary Function Tests. Individual results, such as Forced Expiratory Volume, cannot be retrieved separately from the main code, Pulmonary Function Test. A third type of entry, called a listcode, is a single code that causes the system to prompt for a series of results all of which are separate codes in the system. Complete Blood Count, the SMAC panels, and the audiograms are examples of listcodes. When a listcode is used, the results are stored with the individual codes and are only retrievable via the individual codes. A listcode makes data entry faster because only the listcode and the individual results need to be entered; the system automatically prompts for the individual results. The sequence and list of codes for a listcode can be modified by selecting the Directory option of the Systems Maintenance module. Conditions can be associated with each of the laboratory test codes to perform value checking to determine if a result is allowable and/or if a status flag of abnormal should be set. Textual comments may also be entered along with the test results.

Medical Edit. Once Encounter Entry has been terminated, edits to the encounter record must be made through the Medical Edit option. After selecting to edit the encounter, data from the header of the encounter will be displayed. The user may then edit each header data item or accept the current value for the data item. In the body of the encounter, corrected entries of codes and associated data will replace previous entries. The user may also modify, delete, or add text for a data item that was previously enterd by re-entering the code and selecting to edit the text. Data items may also be flagged as erroneous input with the "E/" status code entry. An entire encounter may be flagged as erroneous by entering "ERROR" at the type of encounter prompt in the Header of the encounter. Errored entries are not deleted from the patient's record in order to maintain an audit trail. They are merely flagged as an error entry and bypassed by data retrieval functions.

Display Medical Data Module. The Display Medical Data module allows data in the medical record file to be displayed or printed in a variety of formats and sequences. The reports produced by the Display Medical Data module include List Encounters, Encounter Report, Most Recent Encounter, Flowchart, Interactive Flowchart, Index Patient, Status Report, Patient Summary, and Registration Data Check (exactly the same as the Patient Display in the Display Registration option). Encounter Report and Most Recent Encounter display data from a single encounter. Flowchart, Interactive Flowchart, Index Patient, Status Report, and Patient Summary summarize data across encounters.

Like the Display Registration option, patients for whom data are to be displayed can be identified by either the patient's name or social security number. Ambiguous entries of the patient's name are allowed. In the Display Medical Data module, the patient is identified prior to selecting the report that is desired. Thus, a variety of reports may be displayed or printed for a patient without having to identify the patient each time. All of the previously described options are merely display options; data may not be edited while in the Display Medical Data module. Each of the options contains help text at the various system prompts to help a user select and display the report that is desired. Softcopies of the reports are obtained by selecting the report option while logged onto a CRT. If the user logs onto a hardcopy device, hardcopies of the reports may be obtained. Hardcopies of the reports may also be obtained via the Print Medical Data module described next. The ability to display reports can be restricted to certain classes of users and to certain devices to maintain confidentiality of the medical data.

List Encounters. This option produces a list of all past encounters for the patient specified. The list includes the date of the encounter, the site and type of the encounter, and the provider(s), thus providing the user with enough information to determine which encounter or encounters should be viewed in more detail.

Encounter Report. The Encounter Report is a display of a single visit to the Occupational Health Unit. There are two main encounter types in NOHIMS. The most common encounter is entered from the Physical Exam Data Sheet (PEDS) and the Physical Examination Findings (PEX) form. If a patient was examined as part of the Asbestos Medical Surveillance Program, he/she will have an additional encounter for the data required by that program. When the occupational and medical history data collection forms are implemented, the data will be entered into additional encounters separate from the basic PEDS and PEX encounter.

The Encounter Report retrieves all data items entered for the encounter. The format for the data in the Encounter Report cannot be changed without programming intervention. The Encounter Report displays a header with the patient's name, sex, date of birth, current age, unit number (SSN), site of the visit, type of visit, visit classification, and medical care providers. The remaining data are organized by divisions of the medical record (Administrative, Diagnosis, Physical Findings, Laboratory, and Disposition). For each coded item, NOHIMS displays the internal code and the long name of the code. Modifier names, statuses, textual comments, and laboratory results are also displayed, if any.

The user selects the encounter to be displayed by date of the encounter. No other criteria may be used to select which encounters are to be displayed with this option except otherwise noted below under Most Recent Encounter.

Most Recent Encounter. Most Recent Encounter allows the user to display or print an encounter report for the most recent encounter in

a patient's medical record or to progressively view several encounters in reverse chronological order.

Flowchart. Flowchart allows the user to track prespecified data items across encounters. The flowcharts present medical information across the horizontal axis of a display with corresponding dates of entry into the medical record displayed on the vertical axis. Modifiers, statuses, textual comments, and results are included in the flowchart, if applicable. Seven standard flowchart specifications have been stored in NOHIMS. These are called Hypertension, Diabetes, Red Blood Cell Count, Congestive Heart Failure, Kidney Failure, Urinalysis, and Liver Function Tests. Additional flowchart formats may be defined using the Flowchart Template Edit suboption in the Directory option of the Systems Maintenance module. The NOHIMS system manager may specify the data items to be included in the flowchart and dictate the specific format of the flowchart to a limited degree. Which encounters are to be summarized by the Flowchart may not be specified.

Interactive Flowchart. This option permits the user to define a flowchart for a particular patient. The specifications for the data items to be included in the flowchart are not stored in the system. If a user enters the same specifications frequently, they can be stored in the system as a standard flowchart using the Flowchart Template Edit suboption. The interactive flowchart is the quickest way to track a single data item through the patient's medical record. Interactive Flowchart has the same limitations and general format as the Flowchart option does.

Index Patient. The Index Patient option displays an index to all of the sections of a patient's medical record, providing a quick review of the main features of the record. After viewing the index list, the user may request a detailed listing of any or all sections, or an interactive flowchart based on the information displayed in the index. The format for this report is fixed. If a data item has a short name, the Index Patient option will display the short name. Since most of the codes in NOHIMS have short names that are used in data entry, this report will not be useful unless the user is very familiar with all of the data entry codes.

Status Report. The Status Report summarizes the medical record for a patient in a predefined format that cannot be changed without programming intervention. It is a summary of and index to all divisions of the patient's medical record. The report may be produced in its entirety or by selected divisions. For each data item, the Status Report displays the internal code, the long name, and the provider who most recently entered the data item into the patient's medical record. Most recent textual comments and laboratory results are also displayed.

Patient Summary. This option summarizes the medical record for a patient in a user-defined format. Using the Patient Summary Functions suboption of the Systems Maintenance module, the system manager may specify for each division the types of data to be included in the display (date, abnormal flag, name of the code, results, text, and

provider), the format of the date and provider name, and the location of each data item on the page. For certain divisions, the system manager can also specify that only data from the previous N encounters and/or the previous N months will be included in the report. In addition, the system manager may specify data items to be included in an optional Data Matrix. The Data Matrix summarizes selected data items for the four most recent encounters. Different Data Matrix criteria may be specified for age and sex groups.

Registration Data Check. The Registration Data Check option allows the user to display or print the registration data for the selected patient without leaving the Display Medical Data Module. The content and format of the data are controlled by the Registration Functions described in the Display Registration section above.

Print Medical Data Module. The Print Medical Data module is used to produce all routine hardcopy medical data printouts. This module contains three usable options: Daily Encounter Reports, Halt Daily Encounter Report on Printer, and Special Print. A fourth option, Scheduled Visit Print that produces Patient Summaries for patients scheduled for an appointment for a given date and provider, is not usable in NOHIMS because the Scheduling module of COSTAR was not implemented. The Scheduling module currently available in COSTAR is usually considered too cumbersome and too slow. A fifth option, Laboratory Result Reporting, also was not implemented in NOHIMS.

Each of the Print Medical Data options contains help text at the various system prompts to help a user select and print the reports that are desired. The ability to print reports can be restricted to certain classes of users and to certain devices to maintain confidentiality of the medical data. The main features of each of the Print Medical Data options are described below.

Daily Encounter Reports. This option allows the user to print reports for patients who had an encounter entered on that day or the five days previous to that day. The user may select to print an encounter report, a status report, all previous encounters, or combinations thereof. The order of the printed reports usually is determined by the system manager. The order may be (1) by patient's last name alphabetically, (2) by order of input, (3) by unit number, or (4) by order of the last two digits of the social security number (the last order would not be useful for the NOHIMS application). The user may specify the device that is to print the reports.

Halt Daily Encounter Report on Printer. The Halt Daily Encounter Report on Printer option permits the device printing daily encounter reports to be halted from another device.

Special Print. Special Print allows the user to specify a group of patients for whom medical reports are to be produced. The reports can be produced according to a list of names that is input, alphabetically by patient's last name, in social security (unit) number order, or by the last digit of the social security number (the last order would not be useful for the NOHIMS application). The reports to be printed (i.e., the Status Report, Most Recent Encounter, all Encounters, Registration Data Check, Flowcharts, or any

combinations thereof) may be specified for each patient individually or for the group of patients as a whole. Once the list of names is created, it is stored in the database associated with the device used to create the list for future use. Special print files may be edited, restarted, and deleted from the system.

COSTAR Report Generator Module. The COSTAR Report Generator module (CRG) has the capability of providing listings and cross tabulations of any variables contained in the NOHIMS database. Additionally, percentages, totals, and subtotals may be computed for any specifed distribution. This module serves to satisfy data retrieval needs not met by the standardized reports described above.

An option called Query Language is also included in the CRG module menu. This option is used to retrieve data with the Medical Query Language, a high-level language that provides an alternative and more powerful method of retrieving data from the database. In addition, the CRG module contains five options that are used in special research functions by the Naval Health Research Center (NRHC), San Diego to retrieve specific medical component data. These options reformat the data into a fixed length record that can be written to tape and interfaced with statistical packages on other systems. The options in the CRG module are as follows:

CREATE/EDIT REPORT
RUN/RESTART REPORT
PRINT TABLES IN WORKING STORAGE
EDIT MANAGEMENT REPORTING VARIABLE DIRECTORY
LIST MANAGEMENT REPORTING VARIABLE DIRECTORY
DELETE, RENAME OR SAVE REPORT
FILE CLEANUP
WRITE REPORT LIST
BUILD ALPHA FILE
QUERY LANGUAGE
CONSTRUCT SSN GLOBAL
CLEAR SSN GLOBAL
PRODUCE FIXED LENGTH RECORD
TRANSFER GLOBAL TO TAPE
MOVE SSNS FROM INDUS UCI

Create/Edit Report. The Create/Edit Report option is used to create or edit the specifications for a CRG report. Through a series of prompts, the user specifies the mode of the search (patient mode or visit mode), selection conditions (if any), variables to be listed and the display format, and variables to be tabulated. The report specifications are stored in the system under a user-selected name of up to 20 characters. The report specifications may be altered at any time. When editing the report specifications, NOHIMS displays each specification. The user may then change the specification or null through the prompt to retain the specification. The edited specifications may be saved to the same report name or to a new report name.

The Create/Edit Report option allows the user to specify whether data will be listed or tabulated in patient mode or in visit mode. If

the patient mode is selected, one line in the list and one tally in a tabulation will be made for each patient that meets the given selection criteria. If the visit mode is chosen, the system will utilize one line in the listing and one tally in the tabulation for each encounter entered in the system for the patient that meets the selection criteria.

The user may also specify up to approximately 22 selection criteria for defining subsets of patients to be listed or tabulated. Selections may be made on the basis of the presence or absence of a data item, the value of a data item, or the presence or absence of data in a particular division, or combinations thereof. The user may specify alternate, necessary, nested alternate, or nested necessary conditions, or a combination thereof. At the time of running the report, the user may specify a range of encounter dates to be included in the tally. If a range of encounter dates is specified, the CRG will only search encounters for those dates for valid data. Otherwise, the CRG will search the entire database for valid encounters/patients.

The listings produced by the CRG may include divisions, actual data items, or data associated with a data item (results, statuses, modifiers, and text). The user may also modify data items with selection criteria such as last, most recent, number of, etc. The format for the listings is defined by the user within certain parameters. Data items are listed across the horizontal axis so the user is limited to 80 columns of data on a CRT or 132 columns of data on a hardcopy device. The system sets default values for all data items, such as field title, field width, and data format. These default values may be overridden by the user. Listings may be produced in one of three ways: (1) order of encounter input, (2) alphabetic order by the patient's name, or (3) encounter date order.

The cross tabulations provided by the CRG may be on divisions, actual data items, or data associated with a data item (results, statuses, modifiers, and text). The user may also modify data items with selection criteria such as last, most recent, number of, etc. The user may define one set of up to 3-way tables and may specify the down, across, and by variables within certain limits. Variables that require a new category for each unique value may not be used in the across position. The user can define groupings by either discrete categories (e.g., male and female) or continuous categories (e.g., 10-19 years of age). The user may select to generate another set of tables that contains percentages and may specify the denominator of the percentages (row, column, or table total, or combinations thereof). NOHIMS does not compute means, deviations from a mean, or other statistics. The CRG does not produce graphic representations of data.

Run/Restart Report. The Run/Restart Report option is used to run a set of report specifications. When starting a CRG run, the user may specify whether the report should be double-spaced, the device to be used to run the report, and when the report should be run. In telling

the system when to run a report, the user may either run the report right away or the user may job queue a CRG report. To job queue a report, the user either specifies the date and time the job is to be run or links the job to previous jobs. The user also specifies the device that is to be used to run the report. Currently, only one CRG report may be run at a time. This is a limitation of the present operating system, however. The device that is being used to run the report will be tied up until the report is completed. Hardcopy of reports may be obtained by running the CRG report on a hardcopy device or by printing the working storage on a hardcopy device. Softcopies of reports may be obtained by running the report on a CRT. Report specifications may be run as many times as desired.

Print Tables in Working Storage. When a CRG run is performed, the listings are produced as the CRG proceeds through the database and are not stored in the system. When a tabulation is produced, the tables are stored in a working file to be printed at a later date, as well as being displayed or printed at the time of the run. The Print Tables in Working Storage option is used to print the tables produced by the CRG run.

Edit Management Reporting Variable Directory. This option allows the system user to edit the variable directory that is used to prepare the CRG reports. Directory variables are used to define the divisions of the medical record; code modifiers such as "most recent," "last," and "number of"; and variables that require special extraction instructions. The directory variables also define default values such as field name, field width, and data format. Directory variables may be added to, deleted from, or modified with this option.

List Management Reporting Variable Directory. With this option, users are allowed to review information about the report variables that have been defined for NOHIMS. The display includes extract instructions and display format default values.

Delete, Rename or Save Report. This option is used to delete report specifications from the report list or to rename report specifications. In either case, tables in working storage under the old report name will be deleted. The Delete, Rename or Save Report option provides a faster way to perform these operations without going through the detailed steps of the Create/Edit Report option.

File Cleanup. This option is used to delete tabulation tables from the CRG working storage. The tables can be deleted for individual reports, or all tables can be deleted at one time.

Write Report List. Write Report List provides a listing of the report specifications stored in the system. The listing includes the report name, the last system user to create/edit the report, the date of the last create/edit operation, and a short user-selected description of the report specifications.

Build Alpha File. This option builds a file of patient names in the order that they were entered into the medical component, and then

inverts the file so that the names appear in alphabetical sequence. This file is then used by the CRG when searching the database in patient name alphabetic order.

Query Language. The Medical Query Language provides a more powerful tool for selecting and retrieving data than the CRG. For complicated queries, however, the Medical Query Language requires more effort on the part of the user to understand the content and format of NOHIMS' data files and the Medical Query Language's programming-like conventions. The Medical Query Language calculates sums, means, sum of squares, and standard deviations. It also has the ability to graph up to three variables. The Naval Health Research Center has a 3-year license to evaluate the potential of the Medical Query Language as an enhancement for NOHIMS. Use of the Medical Query Language could possibly overcome NOHIMS' limitations in retrieving correlated data from both system components.

Construct SSN Global, Clear SSN Global, Produce Fixed Length Record, Transfer Global to Tape, Move SSNs from Indus UCI. These five options are used to retrieve certain data and reformat it into a fixed-length record that can be used with other statistical packages. The Construct SSN Global option uses normal CRG procedures to select specified patients and stores the patients' social security numbers in a special file. The Clear SSN Global is used to delete all of the social security numbers in the special file. The Produce Fixed Length Record option extracts certain demographic data and specified physical examination findings and laboratory results and reorganizes them into a fixed format. The Transfer Global to Tape option writes the fixed format data to tape for transfer to other systems. The Move SSNs from Indus UCI option transfers lists of social security numbers produced via the Query/Report module of the industrial component into the medical component. The lists of social security numbers may be combined with another list in the medical component, or a new list may be created in the medical component.

Systems Maintenance Module. The Systems Maintenance module consists of 13 functions that define and maintain system parameters and directories, manage the activities that insure the integrity of the database, and manage system operations such as the job queue and transaction control. Systems Maintenance contains the following options:

TRANSACTION CONTROL
SECURITY
DIRECTORY
REGISTRATION FUNCTIONS
SCHEDULING FUNCTIONS
ACCOUNTING FUNCTIONS
MEDICAL DATA FUNCTIONS
ZIP CODE EDIT
RECOVERY
JOB QUEUE FUNCTIONS
USER PROFILE
COSTAR DIRECTORY CODE REVIEW
SOFTWARE PERFORMANCE REPORT (SPR)

Transaction Control. Transaction Control managers "Monitor," the background "caretaker" job that secures the system against data loss. Two suboptions--Start Monitor and Halt Monitor--change the status of Monitor. Inquiry describes the current status of Monitor as the system perceives it. It indicates the status of Monitor (normal, crashed, or quiescent) and indicates whether Monitor is caught up with filing transactions. Two other suboptions--Error Display and Print Errors--are used to display or print software and hardware errors recorded by the medical component's error trapping system. A special mode in Error Display will recreate the system parameters at the time of the error to aid in investigating the error.

Security. The Security option allows the system manager to customize the system security for the particular application site. Various levels of security may be specified. The ID File option defines users of the system. The name, job classification, ID code (log-on code), and other identifying information are recorded for each user. This option also allows the system manager to look up users, edit information for users, de-activate users, and to re-active users. List ID File allows the system manager to view the current ID information found in the ID File for each user entered in the system. The Classification File option permits the application site to specify the user categories at the application site. Usually the categories include system managers, programmers, physicians, nurses, and data entry clerks. This option is also used to specify which modules and options are accessible to each class of user. Option Password Edit is used to define and edit passwords for the system options, if this level of security is desired. Device Table allows the system manager to define the devices that will access the system and their characteristics such as softcopy versus hardcopy, lines per screen, characters per line, etc. The system manager also specifies the system options that are accessible with each device. A Cursor Types option is available for use if a new terminal type needs to be defined for the system.

Directory. This option permits the display and manipulation of the medical component directory. Add Code allows you to add a code to the directory. Edit Code permits the system manager to edit characteristics (such as modifiers, names, and check results) of directory codes. Code Review allows the user to view the characteristics for a directory code. Display Directory and Print Directory allow the user to display or print all or part of the medical component directory. Various suboptions determine the amount of information that is displayed or printed. Codes may be listed in either internal code order or alphabetic order by the code name. Initialize Translation Directory and Translation Directory Edit create or maintain translation directories for billing purposes and are, therefore, not used for NOHIMS. Revenue Center Edit permits the definition and editing of revenue centers used in billing functions. Again, this option is not used for NOHIMS. Flowchart Template Edit is used to define, alter, delete, and list specifications for flowcharts that are accessible via the Flowchart option in the Display Medical Data module.

Registration Functions. Registration Functions allows editing of the registration set-up. The parameters in this option tell the system which data elements are to be collected during the registration sequence, in what order they are to be collected, and how the registration data are to be displayed on a terminal. The system manager may format the registration display in any manner that is desired and define item headers (names). Only one registration display format is used by the system at one time. However, two registration display formats may be saved in the system.

Scheduling Functions. These functions initialize the provider schedule templates and create and edit directories for clinic definition, types of visits, and clinic holidays. The Scheduling module was not initialized for NOHIMS.

Accounting Functions. These suboptions create, edit, and purge accounts or accounting directories. Other accounting functions are also maintained via these options. NOHIMS does not use the billing portion of COSTAR.

Medical Data Functions. Medical Data Functions has four suboptions. Patient Summary Functions is used to change the parameters for the Patient Summary report. For each division, the system manager specifies the types of data to be included in the display (date, abnormal flag, name of the code, results, text, and provider), the format of the date and provider name, and the location of each data item in the display. For some divisions, the system manager can also specify that only data from the previous N encounters and/or the previous N months will be included in the report. The system manager may also specify data items to be included in an optional Data Matrix. The Data Matrix summarizes selected data items for the four most recent encounters. Different Data Matrix criteria may be specified for age and sex groups. Edit Encounter Input Parameters may be used to alter certain parameters for the encounter header sequence. The features which can be invoked in this suboption are not applicable to NOHIMS; therefore, this option does not need to be used with NOHIMS. Archive Patient Records may be used to offload inactive patient records to tape or to recall patient records from tape. The user may select individual records or a certain group of records to be archived or de-archived. The Visit Classification Code Listing contains the current Visit Classification Code List as developed for NOHIMS. This option is merely a review function. Changes to the Visit Classification Code Listing are made using the Directory option.

Zip Code Edit. The Zip Code Edit option can be used to add a zip code and its associated city and state to the zip code directory, to delete a zip code from the directory, or to modify the city and state associated with a zip code. A listing of the zip code directory may also be obtained. NOHIMS supports five digit zip codes.

Recovery. The Recovery function must be used when hardware or software malfunctioning has resulted in loss or damage to the

database. If this should occur, programming support will be required to initiate the recovery process. This option restarts operations after the system crash. It essentially duplicates all of the filing activities that have taken place since the last disk or magnetic tape back-up was performed.

Job Queue Functions. Certain jobs may require major system resources to run to completion, such as printing special reports and running report generator reports. Typically, these jobs are placed in a job queue, scheduled to run at a particular point in time. Job Queue Functions allows the system manager to list, edit, or examine the current job queue. Jobs may also be deleted from the job queue with this option.

User Profile. This option displays the current users of the medical component giving the job number, UCI, location of the device, the NOHIMS user, the routine being used, and the device number in use. This option can also be used to verify that the "Monitor" is running.

COSTAR Directory Code Review. This option is the same as the Code Review suboption under Directory. Because it only allows review of the characteristics of a code, it is a safe option to give to system users who should not have access to the directory maintenance options--Edit Code and Add Code.

Software Performance Report (SPR). A system user can use this option to document program errors or system bugs for later review by the system manager. It also has a test function that allows features of the system to be tested while the testing process is automatically being logged.

Mailbox Module. The Mailbox module provides the capability for users of the medical component to send messages to each other. The system manager may also send messages of general importance to all system users. The system manager's messages display automatically following the log-on procedure. If the user has a personal message, NOHIMS will indicate this by announcing "YOU HAVE MAIL" after the acknowledgment of the user during log-on. The Mailbox has the following three system options:

SEND MAIL
PRINT MAIL
DELETE MAIL

Send Mail. This option is used to send mail to another system user or to create a system manager's message. The option has a simple text editor to edit messages before they are filed and sent to the recipient(s).

Print Mail. When the user receives a "YOU HAVE MAIL" message, he/she may use the Print Mail option to view the message(s). If the user has more than one message, he/she may select the messages to be viewed. The messages may be viewed as many times as desired.

Delete Mail. The system users uses the Delete Mail option to delete messages when they are no longer needed. The user may either delete all messages or selectively delete messages.

Occupational Health Information Module. This option was intended to directly take the user to the main menu of the industrial component of NOHIMS. Selection of the Occupational Health Information module would provide the main avenue of access from the medical component of NOHIMS to the industrial component of NOHIMS. This module has not yet been implemented. Instead, if users want to access the industrial component, they must exit the medical component and log on to the industrial component system.

Description of Medical Component Data Collection Forms

The data collection forms for the medical component consist of a Patient Registration form, four encounter forms, and forms that collect laboratory test results. The four encounter forms are the Physical Exam Data Sheet (PEDS) and the Physical Examination Findings (PEX) form which make up one encounter, the Asbestos Surveillance Form (NAVMED 6260/5), a Medical History (MEDHX) form, and an Occupational History (OCCHX) form. All of these forms except the Asbestos Surveillance Form were designed specifically for NOHIMS at the Occupational Health Unit, North Island, San Diego. All but one of the laboratory test and procedure result data collection forms are standard Navy forms. An EKG Results form was designed for entering EKG results and interpretation into NOHIMS. The contents of all of these forms is described below.

Patient Registration Form. The Patient Registration form is completed by the patient the first time that he/she has a physical examination at the Occupational Health Unit. The form collects the following items: patient name, sex, date of birth, person to notify in emergency, telephone number in emergency, date of registration, social security number, duty station or activity, and primary clinic. Once a policy decision is reached on appropriate ethnic categories for NOHIMS, an ethnic background data item will be added to the Registration form.

Physical Exam Data Sheet (PEDS). The first page of the PEDS form is completed by the patient at each encounter. The remaining parts of the form are completed by the occupational health technician based on the Individual Exposure Examination Report produced by the industrial component of NOHIMS. The PEDS form collects the following data: patient name, sex, date of birth, care provider(s), date of the encounter, social security number, site of the encounter, type of examination, visit classification, work information (including job title, work supervisor, building number, shop number, and shop telephone), job certifications (if appropriate), hazardous agent surveillance, protective equipment examinations, laboratory tests (including radiologies, pulmonary function tests, electrocardiograms, and audiograms), and an indication of whether an eye examination is required.

Physical Examination Findings (PEX). The first part of the PEX form is completed by the occupational health technician. These data items include the patient's social security number, type of physician examination, height, weight, and vital signs. The physician completes the rest of the form. These data items include the medical care provider giving the examination, physical

findings for a variety of body systems (including general appearance, skin, eyes, ears, nose, oral cavity, neck, thorax and lungs, female breast, heart, axillae, abdomen, female genitals, male genitals, rectal, back, extremities and joints, neuropsychiatric, vascular system, and other findings), a problem list, and disposition. The physical findings sections allow the physician to record if the examination was omitted or refused, normal, or abnormal. If there are abnormalities, the physician indicates the type(s) of abnormalities. Each examination has room for comments as well. The problem list includes an indication of status (e.g., inactive, history of, or rule out) and the ICD-9-CM code.

Asbestos Surveillance Form (NAVMED 6260/5). The standard form for the Asbestos Medical Surveillance Program is used by NOHIMS to capture data regarding asbestos examinations. The form is completed by the physician. The data entry clerk uses an overlay to enter the data directly from the standard Navy form. The data items that are entered from the Asbestos Surveillance Form are as follows: the patient name, sex, date of birth, date of the encounter, site of the encounter, type of encounter, and all of the data items under the Repiratory Questionnaire and Respiratory Physical Examination. The medical care provider name is taken from the PEX form.

Medical History (MEDHX). The MEDHX form is an experimental form and is not in current use at the Occupational Health Unit. The form was intended to be completed by the patient and then reviewed by the physician. The MEDHX covers the following areas of medical history: family history, past medical history (including allergies, immunizations, medicines, hospitalizations and operations, injuries, and treatments), personal history (including smoking, exercise, and alcohol use history), and review of systems (covering skin, eyes, ears and hearing, nose/throat/sinuses/mouth/teeth/gums, respiratory system, cardiovascular system, gastrointestinal system, urinary and reproductive systems, musculoskeletal system, nervous system, and miscellaneous).

Occupational History (OCCHX). The OCCHX is another experimental form that is not in current use at the Occupational Health Unit. The form is to be completed by the patient and reviewed by one of the medical care providers. The form gathers data on the following: occupational exposure inventory (including work-related illness, injuries, and/or symptoms), environmental history (including home exposures, and hobbies and crafts), and a chronological occupational profile for all jobs after high school or age 18. The chronological profile includes employment status (such as type of job, industry, time worked, and duties), job-related health problems or injuries, health hazards on the job, and protective equipment used.

EKG Results Form. The identifying information on the EKG Results form is completed by the occupational health technician. These data items include the patient name, sex, date of birth, and date of the EKG. The physician reviews the EKG printout and marks whether the EKG was normal, questionable, or abnormal. The physician may also include comments.

Reference Audiogram (DD 2215). The Reference Audiogram is completed by the care provider who administers the audiogram. This is the standard form for the Hearing Conservation Program. The data entry clerk uses an overlay to enter the data into NOHIMS. The data items that are entered into the medical component from the DD 2215 include the following: the date of the audiogram, day of the

week of the audiogram, military time of the audiogram, hours since last noise exposure, and values for the Hearing Threshold Levels for the left and right ears.

Hearing Conservation Data Form (DD 2216). This form is also completed by the care provider who administers the audiogram. This is a standard form for the Hearing Conservation Program. Again, the data entry clerk uses an overlay to enter the data into NOHIMS. The data items that are entered into the medical component from the DD 2216 include the following: the date of the reference audiogram, values for the Hearing Threshold Levels for the left and right ears for both the current audiogram and the reference audiogram, and values for the Threshold Shifts for each Hearing Threshold Level for each ear.

Pulmonary Function Test Results. The data for Pulmonary Function Tests are taken directly from the patient's paper medical record. The results strip from the Pulmonary Function testing machine is stapled to the chart. The physician reviews the results and notes whether the test was normal, abnormal, or questionable. He/she may also write a comment in the chart. The data entry clerk enters the data from the "Best Tests" section of the strip, the physician's impression of the results, and comments, if any.

Report of Radiologic Consultation. The data for radiology procedures are entered into NOHIMS from the Report of Radiologic Consultation. When the physician reviews the radiology report, he/she notes on the report whether the radiograph was within normal limits, no evidence of disease, questionable, or had a positive finding. The physician underlines comments that are to be entered into the medical record as text.

Hematology Results (549), Chemistry Test Results (including SMAC panel read-out), Heavy Metal Test Results (557), Urinalysis Results (550), and Miscellaneous Results (551). These standard Navy lab chits are used to enter the test results into NOHIMS. Once the physician has reviewed the lab chits, the results are entered into the system from the lab chits by the data entry clerk.

DESCRIPTION OF SOFTWARE QUALITY ATTRIBUTES

The following sections describe NOHIMS' software quality attributes. The topics covered are the usability of NOHIMS, the reliability of NOHIMS, NOHIMS' error recovery and back-up procedures, the efficiency of NOHIMS source program code, the hardware independence of NOHIMS, and the maintainability of NOHIMS.

Usability

The industrial component of NOHIMS provides the capabilities necessary to input, store, edit, retrieve, and display various workplace monitoring data, including work history data, data on exposure episodes, environmental monitoring and industrial hygiene data, and worker demographic data. It is limited to retrieving and displaying current data such as present exposures and workplace assignments. Historical data for many variables are retained in the industrial component's data files, although at present these data cannot be retrieved. The

medical component of NOHIMS provides functions for inputting, storing, editing, retrieving, and displaying occupational health data, including data from preplacement/employment physical examinations, medical surveillance examinations, job certification examinations, fitness for duty and return to work interactions, audiometric data, biomedical monitoring data, and basic medical and demographic data. It does not presently have the capability of inputting illness and injury care data. However, the Naval Health Research Center is currently developing data collection forms and making changes to the COSTAR directory to allow illness and injury care data to be processed by NOHIMS. Both components have limited capabilities for storing and processing occupational health program management data. The medical component of NOHIMS can provide tallies of various process measures such as the number of physical examinations conducted and/or the number of laboratory tests performed. NOHIMS can provide composite summaries of various medical and exposure data; however, only a few links between medical data and exposure data exist. Extensive operational testing has been conducted on NOHIMS as part of this evaluation. The results of this functional testing are described in the Operational Testing of NOHIMS section of this report. In addition, subjective assessments of the performance of NOHIMS by the users of the system are contained in the Assessment of Overall System Performance section.

Reliability

NOHIMS is considered to be a very reliable system at this point. No changes were made to the data storage or retrieval functions of public domain COSTAR for NOHIMS. Thus, the medical component of NOHIMS is based on a software package that has been extensively tested in the field for the past ten years. The only bug in data retrieval functions that the contracted NOHIMS developers are aware of is in the COSTAR Report Generator when more than one encounter is entered for a patient on a given day. The COSTAR Report Generator does not differentiate which encounter the data for that date is associated with and may tally data items multiple times if certain precautions are not taken. This problem in public domain COSTAR has been documented by the contracted developers for the Naval Health Research Center (NHRC). The industrial component of NOHIMS has been field tested for three years and all of the known bugs in data retrieval and storage processes have been worked out.

The general user cannot intentionally or unintentionally corrupt the NOHIMS databases. The general user has no access to cross references, pointers, or data files. Extensive error and interrupt trapping prevents the user from gaining access to the operating system. The system manager or someone who enters the system via the programmer's access code could potentially corrupt the databases, so these people must take great care when working in the system.

NOHIMS can resolve extraneous or ambiguous input. In most data fields NOHIMS has some anticipation of the type of input to be expected. Validity of the input is checked either through pattern matching or by whether a data item (such as a code, variable name, or patient name) already exists in the system. If the data item does not exist in the system, NOHIMS will produce a list of choices that closely approximates the input received.

Error Recovery Procedures

Both the medical and industrial components of NOHIMS have system functions that aid in recovering data if an error occurs or if the system crashes. If a "hard" computer crash occurs during a filing operation, the global files may be corrupted. The industrial component has internal integrity check operations that search the global files and record any erroneous filing conditions that are found. Usually, the condition can be corrected through execution of an automatic correction process. This process is capable of both interpreting the error records that the integrity checking routines recorded and performing the necessary corrections to the files.

The medical component of NOHIMS does not have internal integrity check functions in case of a hard crash. Instead, the system relies on operating system utilities to identify and repair system level errors such as physical disk structure pointers and on a manual review of the error log to identify filing sequence errors. If filing sequence errors have occurred, these will require either programming intervention or re-entry of data. Monitor, the background job that directs the filing functions, is a single-feed process. In other words, it files data from one encounter at a time. Therefore, if an error does occur during filing, the damage is limited to at most one patient record. The medical component also logs "soft" errors that occur during filing with system messages to help detect corrupted patient records or flag potential filing problems. A careful review of the error log at least daily for both hard and soft errors will help prevent future or more serious errors through early detection of problems or identification of potential trouble spots.

Back-Up Procedures

It is recommended that the entire NOHIMS system be backed up on another disk at least daily. Another periodic back-up copy should be kept offsite. If these hard disk copies are adequately checked for integrity, they will provide the necessary back-up for the system. In the event of a data crash, a disk back-up can be restored easily. At most, data input since the last back-up was made would need to be re-entered. Since virtually all data entered into NOHIMS are entered from hard copy, it is relatively easy to keep an audit trail of data entry. The operating systems that support MUMPS all support these standard back-up functions. Some MUMPS operating systems support journaling specified global files to disk or magnetic tape as an additional back-up method; however, this process is not recommended because the mechanism has not been adequately tested and this process requires significant system resources and operator time.

Efficiency of Source Program Code

NOHIMS has been written to minimize the amount of system memory required to operate and to make operation as efficient as possible within the parameters of the file structures. In the industrial component of NOHIMS, variables that are referenced frequently are stored in local memory to decrease the amount of disk access required. The use of indirection has been kept to a minimum. Global files are arranged to minimize searching since routines access data files directly through node references rather than through sequential searches.

Because COSTAR (the basis for the medical component of NOHIMS) was written as a multi-purpose package to be used in a wide variety of settings, some trade-offs in efficiency were accepted in order to maximize flexibility and minimize programmer inervention. Thus, COSTAR relies fairly heavily on indirection. For example, indirection is used to reference a patient's file in order to avoid multiple index levels in the patient record globals and to increase disk storage efficiency. On the other hand, COSTAR has built-in efficencies within file indices to keep sequential searches to a minimum. Access into records has been carefully minimized both in the look-up and reporting functions by mechanisms such as the fast visit index. Within the patient files, internal lists point to the most frequently retrieved data items. As in the industrial component, variables that are referenced often are stored in local memory to decrease disk access.

Hardware Independence

NOHIMS will run on any hardware that can support multi-user ANSI Standard MUMPS and that has the minimum hard disk requirements for the particular application. MUMPS systems exist for DEC, Data General, Harris, Plessey, Prime, Tandem, and IBM minicomputers. MUMPS systems also exist for several microcomputers such as Tandy, IBM, Convergent Technologies (Burroughs/NCR equivalents), COMPAQ, Motorola, and Olivetti. The industrial component of NOHIMS requires a minimum of a 10K partition in system memory and 5 megabytes of hard disk storage in addition to the basic memory requirements for MUMPS. The medical component requires a minimum of a 6K partition of system memory, 4-8 megabytes of hard disk storage (dependent on the version of MUMPS used) for the COSTAR routines and directories, and an additional 10-40 megabytes of disk storage for patient record storage (COSTAR uses approximately 1,000-2,000 bytes per encounter stored).

NOHIMS can accommodate a variety of terminal/cursor types including any hardcopy device, Infoton standard or Vistar with number pad, dumb terminals, and smart terminals. NOHIMS, at this point in time, does not support terminals with split screen features.

Maintainability

At the present time, virtually no software support is needed for the industrial component of NOHIMS. The internal integrity checks in the system mean that NOHIMS is reliable and operationally error-free. The industrial component does require system support by a system manager to ensure that the tables and directories are kept up-to-date. The medical component of NOHIMS requires minimal ongoing software support to fix software problems. During the first months of installation and operation of the medical component, outside software support was required frequently, but now the medical component operates relatively free of software support. Unless changes or additions are made to the data collection forms, minimal system support for the tables and directories is required. A system manager should review the error logs and start and stop monitor on an at least daily basis because the error logs may indicate pending system problems. If new versions of existing forms or additional encounter forms are developed, the system support (forms design, directory work, etc.) to implement these forms is expected to be substantial. In addition, NOHIMS will

require long-term file maintenance, record archiving when disks become full, and decisions about file-disk set-ups. The frequency of these functions will depend on the size of the application and hardware constraints.

Summary

NOHIMS provides the functions necessary to input, store, edit, retrieve, and display both various workplace monitoring data and selected occupational health data. The industrial component of NOHIMS needs to be augmented to retrieve historical data. The medical component does not presently handle data from injury and illness care; however, the Naval Health Research Center is developing this capability. Both components of NOHIMS have limited capabilities for storing and processing occupational health program management data. NOHIMS can provide summaries of various medical and exposure data, although there are only a few links between the two databases.

NOHIMS is considered to be a very reliable system. The only known bug is in the COSTAR Report Generator when there is more than one encounter on the same day. This bug is not a result of NOHIMS, but is a design flaw in public domain COSTAR. The user cannot intentionally or unintentionally corrupt the database. The system manager or someone who enters the system via the programmer's access code could potentially corrupt the routines and/or database. NOHIMS can resolve extraneous or ambiguous input. The validity of data input is checked to some degree. Both the medical and industrial components have system functions that aid in recovering data if an error or system crash occurs. The operating systems that support MUMPS support the procedures necessary to back-up the entire NOHIMS system on disk.

NOHIMS has been written to minimize the amount of memory required and to make operation as efficient as possible without jeopardizing the flexibility of NOHIMS while minimizing necessary programmer intervention.

NOHIMS will run on any hardware that can support ANSI Standard MUMPS and has the minimum hard disk requirement for the particular application. NOHIMS can also accommodate a variety of terminal/cursor types.

Very little software support is required to maintain NOHIMS because both NOHIMS components run relatively error free once they have been installed and are operational. Unless changes or additions are made to the data collection forms, minimal system support is needed. If new versions of existing forms or additional forms are required, the system support necessary to implement these forms will be substantial. Long-term system support, such as file maintenance, will also be required. The amount of long-term system support needed will depend on the size of the application and hardware constraints.

ASSESSMENT OF OPERATIONAL CHARACTERISTICS

To evaluate the operational characteristics of NOHIMS, we have described NOHIMS' capabilities with regard to its user friendly features such as option menus, presentation of operational characteristics, on-line assistance functions, error diagnostics and other debugging aids, and database manager

utilities; data manipulation tasks; and information retrieval capabilities, including standard report procedures, ad hoc report procedures, and query response time. In addition, we interviewed the NOHIMS users to determine their assessment of the user friendliness of NOHIMS and their evaluation of the information retrieval capabilities of NOHIMS. Each of these five topics is covered in a subsection below.

Description of User Friendly Features

NOHIMS has a variety of features that make it very user friendly. NOHIMS is a "menu driven" system at all option selection levels. The system presents its operational capabilities to the user in generally clear and helpful ways. It has extensive on-line assistance functions as well as various error diagnostic features and debugging aids. In addition, four manuals and several job aids have been developed as a back-up reference for the user. NOHIMS does not have database manager utilities as they are traditionally defined. These functions can be approximated through other standard NOHIMS options.

Option Menus

NOHIMS works from an option menu at all selection levels. At each point in the option selection process, the user selects the next option level by entering the minimum number of letters of the option to uniquely identify it. Whenever requested by the user, NOHIMS will display those options that are accessible from that point in the selection process and that are accessible to that person on the device in use. The option menu is triggered by entering a "?" at the option selection prompt. Thus, the option menus are generally transparent to the user unless they are deliberately called by the user. In the medical component, the option levels take the user down branches. You may not go directly to an option in another branch. You must first back out of that branch and go down another branch. In the industrial component, NOHIMS allows the user to jump to other modules from within a module when it is appropriate.

Presentation of Operational Characteristics

Option Displays. NOHIMS present system options and prompts in a clear and helpful manner. As mentioned above, NOHIMS is a menu driven system at all option levels. At each option selection point, NOHIMS can display all of the options available to the user on the particular device in use. Some of the system prompts actually contain the options within the text of the prompt such as the File, Edit, or Ignore prompt. In the medical component the option menus are almost always presented in a list that proceeds down the screen. The industrial component uses lists down the screen as well as lists in a line of text across the screen.

The system prompts in both components are descriptive without being too wordy. They are generally easy to understand, although a few (for example, the New Patient Named prompt in the medical component) have been reported to be cryptic to the user until he/she is familiar with the system. In defining the system prompts, the NOHIMS developers tried to strike a balance between user friendliness for new users and speed and simplicity for experienced users.

Report Displays. The NOHIMS designers have endeavored to make report displays easily readable and understandable. In the medical component, the display format for the Encounter Report is fixed. The content of the Encounter Report is self-explanatory. Data are organized by directory code division. The format of the Status Report is also fixed. The format for the Patient Summary may be defined within certain constraints by the system manager through the System Maintenance module. The data in the Status Report and the Patient Summary are also ordered by directory code division. The selection criteria for inclusion of textual comments and historical detail in these reports is not obvious to the user, however. The criteria for the inclusion of these data in the reports are explained in the NOHIMS medical component operational and system manager manuals. The display format of the Flowcharts, the COSTAR Report Generator reports, and the Interactive Flowcharts may be defined by the individual user, although again, they must be within the constraints of each function. The displays of the flowcharts and the COSTAR Report Generator reports are clear once the user has understood how the report specifications are defined. Detailed instructions on the use of these three functions are contained in the system documentation to aid the user in interpreting these reports.

In the industrial component, the display formats for the reports are fixed to the user. For example, the interactive query function simply progressively indents each unique data group much like an outline. This feature allows the query function to be a more simple, efficient, easy-to-use retrieval system rather than a cumbersome report formatting operation. All of the reports produced by the industrial component use titles and headlines to clarify data contained in the reports.

System Messages. NOHIMS uses system messages to indicate to the user how an entry has been interpreted. As a rule, these messages tend to be abbreviated in order to communicate a message quickly and easily. For example, an unacceptable laboratory result in the medical component is indicated by a "???" response and on-line filing is indicated by three dots, "...". Other system messages indicate program errors, invalid codes, and invalid formats of entries. NOHIMS also uses system messages to alert the user to wait while data are being processed.

On-Line Assistance Functions

Help Text. At any industrial component prompt, the user is allowed to enter a "?" character when in doubt as to the proper response or action, or if the necessary response is unknown. NOHIMS will then provide the user with either an explanation of the expected response and/or a list of applicable responses from which the user may select the appropriate response. The help text and/or examples that are provided are specific to NOHIMS and are usually specific to the application environment. For example, if the user is required to enter a department code, NOHIMS will list the departments defined in that application environment and their respective codes. The help text can be changed without programmer intervention by accessing the System Table Edit option in the Maintenance module of the industrial component.

As in the industrial component, the user may also use the "?" response to obtain on-line help in the medical component. If the "?" character is entered, NOHIMS will respond with an explanation, a list of applicable responses, and/or a sample response, as appropriate. The help text will also indicate whether the user may obtain further detail by entering an "^L" at the system prompt. Generally, the "^L" presents the user with lists that are maintained in the system, such as all possible sites of encounters or types of encounters. The question mark help text for system prompts and certain laboratory tests results entry sequences are hard-coded in the software and cannot be altered without a programmer's intervention. Help text for entering results data for administrative, physical findings, or most laboratory tests codes is defined and maintained through the System Maintenance module in the medical component. The contracted NOHIMS developers have modified the public domain help text to make it specific to the needs of the Occupational Health Unit, North Island. These responses can be easily altered through the System Maintenance module.

Supporting Documentation and Job Aids. Both the medical and industrial components of NOHIMS have extensive operations and system maintenance manuals written specifically for NOHIMS to support and augment the system's on-line assistance functions. These are the NOHIMS Users' Reference Manual and the NOHIMS System Manager's Manual for the medical component and the NOHIMS User's Guide and the NOHIMS OHS System Maintenance Manual for the industrial component. These manuals explain the purpose of each module of the system and the options under each module. In addition, the documentation for the medical component contains examples of typical data entry sequences and job aids that contain lists of patient items or codes that may be referenced during data entry. The job aids include Possible Patient Items in Registration and Data Items Specified as Other (Hazardous Agent Surveillance, Laboratory Tests, Radiology, Problem Codes, and ICD-9-CM Diagnoses). The manual also contains three clear plastic overlays to be used in entering data from the Asbestos Medical Surveillance Program and the Hearing Conservation Program. A comparison of the operation of NOHIMS and the documentation was made as part of this test and evaluation. The results of this study may be found in the Operational Testing of NOHIMS section of this report.

Text Editors. Both the industrial and medical components of NOHIMS have simple text editors to aid in the entry or modification of textual entries. The editor automatically controls all line length restrictions by word wrapping and allows simple text editing tasks such as insertion, deletion, and replacement.

Default Values. NOHIMS uses default values to minimize data entry keystrokes. Each prompt for user input in NOHIMS ends with a caret symbol (>) or a triple caret symbol (>>>) to indicate that NOHIMS is awaiting an entry. In many cases, such as during an edit sequence, the value for the prompt is already known or there is an expected response. If the entry value is known or expected, NOHIMS presents the value within carets to give the user the opportunity to accept this default value by simply pressing the Return key, to erase the default value by entering a backslash character (\) or a minus character (-), or to enter a new value.

Error Diagnostics and Debugging Aids

The industrial component of NOHIMS has the capability of intercepting error interrupts during routine operation. Whether due to hardware or software errors, NOHIMS aborts the ongoing task when an error is detected and logs the error and the contents of memory at the time of the error in an error file. This file can be reviewed by the system manager and/or system programmer through the Error Reports option of the Maintenance module. The error log is maintained indefinitely until a system manager deletes old or corrected errors using the Kill option in the Error Reports function.

The medical component of NOHIMS has a function that is similar to the error report of the industrial component. When an error occurs, the medical component logs the program location of the error or the type of hardware error, a descriptive message regarding the error, if any, and the memory contents at the time of the error. These data are stored in the ^ERR global by sequential error number for the date of the error. Not all errors detected by this function cause the task to abort. Some errors are noted to flag potential filing problems. The error log may be reviewed by the system manager or programmer via the Error Log suboption of the Transaction Control option in the System Maintenance module. By entering an "^S" at the Symbol prompt, the system status at the time of the error can be recreated to aid in debugging the error. The errors logged in the error file can only be deleted by programmer's intervention. In addition, the medical component has a Software Performance Report option that aids in system testing and debugging. In this option, a system user can document program errors or system bugs for later review by the system manager. This option also has a test function that allows features of the system to be tested while the testing process is being automatically logged. This option is not used much at other COSTAR installation sites, however. The Mailbox module of the medical component, an internal message storage and retrieval system, may also be used by system users to manually log program errors for the system manager.

Database Manager Utilities

NOHIMS does not have any database manager utilities per se. All data retrieval is performed via the various report functions found in the Display Medical Data, Print Medical Data, and COSTAR Report Generator modules of the medical component or found in the Query/Report module and the Display options of the Hazard Data, Survey Data, Agency Data, Environment Data, and Personnel Data modules of the industrial component. Using these functions, all current data items can be retrieved in some form. In addition, the medical component will retrieve historical data items.

The data manipulation capabilities of NOHIMS are limited. Neither component supports the creation of new variables based on variables already in the system such as ratios or percentage ratings. Patients/workers cannot be recategorized on the basis of selected criteria and actual data files may not be sorted or reordered permanently. However, the intent of these functions can be approximated by selecting subsets of patients/workers for description or study through the normal data retrieval functions.

Summary

NOHIMS has a variety of features that make it very user friendly. NOHIMS is a "menu driven" system at all option selection levels. The system presents system options and prompts in a clear and helpful mannner. The prompts are descriptive without being too wordy. In defining the system prompts, the NOHIMS developers tried to strike a balance between user friendliness for new users and speed and simplicity for experienced users. The NOHIMS designers have endeavored to make report displays easily readable and understandable. NOHIMS uses system messages to indicate to the user how an entry has been interpreted. The system has extensive on-line assistance functions including help text at all prompts, simple to use text editors for textual entries, and default values to aid data entry. In addition, four operational manuals and several job aids were developed specifically for NOHIMS as a back-up reference for the user. NOHIMS has error diagnostic features and debugging aids. These include error intercepts, error reports, and a feature in the medical component that recreates the system status at the time of a problem to aid in debugging the error. The medical component has a Software Performance Report option that allows the system users to document program errors or system bugs for later review by the system manager. This option also has a test function that allows features of the system to be tested while the testing process is being automatically logged. NOHIMS does not have database manager utilities as they are traditionally defined; however, these functions can be approximated through other standard NOHIMS options.

Evaluation of User Friendliness

We asked the people who were most likely to have hands-on experience with NOHIMS, namely, the medical care providers, industrial hygienists, data entry clerks, and system managers to assess the user friendliness of NOHIMS. We interviewed six medical care providers, five industrial hygienists, two data entry clerks, and two system managers. The questions on user friendliness covered the ease of learning NOHIMS, the users' confidence level in using NOHIMS, how easy NOHIMS is to operate compared to other systems they have used, and overall user friendliness. In addition, we asked the users to rate each of eleven features as to how helpful they were in operating the system. Finally, we solicited suggestions that the interviewee thought would improve the user friendliness of NOHIMS. The exact wording of the questions that we asked may be found in Appendix A, Component 10.

Table 10 shows how the users rated NOHIMS on ease of learning. Three of the medical providers (the physicians) had not had hands-on experience with NOHIMS. Of those having experience with NOHIMS, 84 percent thought that learning NOHIMS was somewhat easy or very easy. An industrial hygienist rated NOHIMS as somewhat difficult to learn. One of the system managers said that the ease of learning depended on the part of the system that he had learned; the Interactive Query function in the industrial component and the COSTAR Report Generator in the medical component were more difficult to learn than the rest of NOHIMS. The Bremerton users generally rated NOHIMS as less easy to learn than the users in San Diego. They commented that they did not receive training and very little system documentation was available. The person who rated NOHIMS as somewhat difficult to learn stated that now it is very easy to use.

TABLE 10
Ease of Learning NOHIMS
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	Data Entry Clerks	System Managers	TOTAL	% of Total With Experience
Very easy	2	2	1	0	5	42
Somewhat easy	1	2	1	1	5	42
Somewhat difficult	0	1	0	0	1	8
Very difficult	0	0	0	0	0	0
Other	0	0	0	1	1	8
TOTAL WITH EXPERIENCE	3	5	2	2	12	100
No hands-on experience	3	0	0	0	3	
TOTAL INTERVIEWED	6	5	2	2	15	

In Table 11 we see that 84 percent of those with hands-on experience with NOHIMS now feel very confident or somewhat confident with using NOHIMS, although more of these respondents feel somewhat confident than very confident. Again, one industrial hygienist gave a rating of somewhat unsure of using NOHIMS, although this is not the same person that said NOHIMS was somewhat difficult to learn. The system manager who gave a mixed rating to NOHIMS on ease of learning stated that he felt confident about most of the system, but somewhat unsure about the Interactive Query and COSTAR Report Generator functions. He felt that confidence in these areas would come with experience, however.

Seven out of twelve of those with hands-on experience with NOHIMS had had experience with other information systems. Of these seven, five thought that NOHIMS was easier to use. One person thought that NOHIMS was somewhat easier, and one thought there was no difference in ease of use (see Table 12).

Table 13 contains the users' ratings of each of eleven NOHIMS features that are designed to aid the user in learning and operating the system. The last column in the table is the percentage of the people with hands-on experience who rated NOHIMS as very helpful. Everyone with experience with the feature rated the screen displays, system prompts/menus, environment look-up, hazardous agent look-up, and directory item look-up as very helpful. The two features with the poorest helpfulness ratings were survey data look-up and system messages with ratings of 75 percent and 60 percent of users, respectively. The respondents did not make any specific criticisms about the system messages. However, users commented that the survey data look-up function needed a way to narrow the search. Other anecdotal comments on the user friendly features included "the screen displays slow down the entry process once you're familiar with the system," "the intent of system prompts/menus is not always clear," "create/edit survey is very awkward...doesn't flow...can't correct errors...[and] is rigid," and "some things don't work smoothly with material inventory items (product names)." It should be noted that none of the user friendly features received even a single rating of not helpful.

Ninety-one percent of those who rated the overall user friendliness of NOHIMS gave NOHIMS a rating of very user friendly (see Table 14). The only person who gave NOHIMS an overall rating of somewhat friendly was one of the system managers. He felt that "new people find it unfriendly at first approach" and that "doctors seem intimidated [by NOHIMS]." One industrial hygienist summed up her thoughts about the user friendliness of NOHIMS by saying that "[NOHIMS] gives you a chance."

The interviewees mentioned a number of ways in which the user friendliness of NOHIMS could be improved; however, none of these ways was mentioned by more than one person. These suggestions are listed in Table 15. Several of the suggestions were made with the thought that although the feature was already helpful, it could be made even more helpful. The ideas included improving the help text and system prompts, adding a type ahead capability, improving look-ups in the materials inventory by adding more products to the hazardous agent table, expanding NOHIMS to do functions other than occupational health, improving list code entry, putting normal and abnormal boxes on the same line on the Physical Examination form, adding the ability to repeat survey data for multiple agents, and creating a text editor for industrial data. An industrial hygienist at Bremerton suggested adding the risk assessment code which combines the elements of hazard severity and mishap probability to the survey data collection forms

TABLE 11
Confidence in Use of NOHIMS
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	Data Entry Clerks	System Managers	TOTAL	% of Total Interviewed
Very confident	1	1	1	1	4	34
Somewhat confident	2	3	1	0	6	50
Somewhat unsure	0	1	0	0	1	8
Very unsure	0	0	0	0	0	0
Other	0	0	0	1	1	8
TOTAL INTERVIEWED	3	5	2	2	12	100

TABLE 12
Ease of Use of NOHIMS Compared to Other Systems
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	Data Entry Clerks	System Managers	TOTAL	% of Total Who Used Other Systems
Easier	0	3	1	1	5	72
Somewhat easier	0	0	1	0	1	14
No difference	1	0	0	0	1	14
Somewhat more difficult	0	0	0	0	0	0
More difficult	0	0	0	0	0	0
TOTAL WHO USED OTHER SYSTEMS	1	3	2	1	7	100
Not used other	2	2	0	1	5	
TOTAL INTERVIEWED	3	5	2	2	12	

TABLE 13
Helpfulness of NOHIMS Features
(Number who mentioned rating)

	Very Helpful	Somewhat Helpful	Not Helpful	TOTAL	% Very Helpful of Total*
Screen displays	12	0	0	12	100
System promts/ menus	11	0	0	11	100
System messages	6	4	0	10	60
Help text/ assistance functions	10	2	0	12	83
Report formats	9	1	0	10	90
Techniques for looking up an individual	9	1	0	10	90
Agency unit look-up	5	1	0	6	83
Environment look-up	8	0	0	8	100
Survey data look-up	6	2	0	8	75
Hazardous agent look-up	7	0	0	7	100
Directory item look-up	4	0	0	4	100

* Percentage of those people answering the question who stated that the NOHIMS feature was very helpful. The total number answering the question varies because some people could not comment on some features.

TABLE 14
Overall User Friendliness of NOHIMS
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	Data Entry Clerks	System Managers	TOTAL	% of Total Who Answered
Very user friendly	2	5	2	1	10	91
Somewhat user friendly	0	0	0	1	1	9
Somewhat user unfriendly	0	0	0	0	0	0
Very user unfriendly	0	0	0	0	0	0
TOTAL WHO ANSWERED	2	5	2	2	11	100
No Comment	1	0	0	0	1	
TOTAL INTERVIEWED	3	5	2	2	12	

TABLE 15
Suggestions for Improving User Friendliness
(All mentioned once)

- Improve help text
- Improve prompts
- Add type ahead capability
- Add more products to the hazardous agent table so that an agent may be looked up by both the product name and the component hazardous agents to make hazardous agent look-ups easier
- Expand to do functions other than occupational health
- Improve list code entry (to be able to back up)
- Put normal and abnormal boxes on same line of the Physical Examination form
- Add ability to repeat survey data for multiple agents
- Create text editor for industrial data
- Add risk assessment code for hazards to survey data entry [Requested by Bremerton; new forms put into use at Bremerton in April 1986 contained the risk assessment code as requested.]

and survey data entry. In April 1986 the Bremerton industrial hygienists reported receiving new survey data collection forms that contained the risk assessment code as was desired.

Summary

The system users with hands-on experience generally thought that NOHIMS was at least somewhat easy to learn and is easier to use than other systems. Eighty-four percent of those who rated the ease of learning NOHIMS thought that NOHIMS was at least somewhat easy to learn; 72 percent of those who had used other systems thought that NOHIMS was easier to use than other systems. Almost all of the interviewees (84%) were somewhat confident or very confident in using the system. The system has several features that users rated as being very helpful in using the system. The features with the highest helpfulness ratings included screen displays, system prompts/menus, environment look-up, hazardous agent look-up, and directory item look-up; everyone who had used these features thought that they were very helpful. Overall, 91 percent of those respondents with hands-on experience thought that NOHIMS was very user friendly.

Description of Data Manipulation Tasks

The following subsection describes aspects of the data manipulation tasks of NOHIMS. Topics covered include average entry time per input form, edit capabilities, search-in-context capability, general filing procedures, and downloading to magnetic tape.

Average Entry Time Per Input Form

The data entry clerk for the medical component of NOHIMS at the Occupational Health Unit, North Island, San Diego, California estimated that he can enter between 30 and 40 complete medical encounters per day of data entry (12-16 minutes per encounter). Complete data entry includes registering the patients, entering all encounter data, and entering all laboratory results data. The time required to input the data from an encounter varies greatly. The length of time is dependent on the response time of the system and the amount of data for the encounter. Approximately one-third of the medical encounters have only a Pulmonary Function Test or Audiogram and no other laboratory tests. When this is the case, data entry goes much faster.

The data entry clerk at Bremerton, Washington who enters industrial data was reported to enter 8 to 10 Industrial Hygiene Survey forms per hour (6-7.5 minutes per survey form). If the survey required the entry of Occupational Hazard Data Sheets and a Material Inventory, the number of surveys entered per hour dropped to 3 to 4 (15-20 minutes per survey). This data entry clerk was reported to be a skilled typist, and therefore, very fast at data entry.

No one person at the Industrial Hygiene Division, San Diego, was tasked with entering the survey data. The data entry clerk for the medical component reported doing some survey data entry. He estimated that he was entering two complete surveys per hour (30 minutes per survey); however, he did not feel that he had a great deal of experience doing survey data entry. A data entry clerk

at the Naval Health Research Center, San Diego reported averaging two complete survey forms per hour (30 minutes per survey). The time required was dependent on the number of Occupational Hazard Data Sheets. He estimated that each survey had five Occupational Hazard Data Sheets on the average.

Edit Capabilities

Both the industrial and medical components have extensive edit capabilities to add, change, or delete data from the database. An edit function in the five data modules of the industrial component is used to edit or change information that has already been entered in the system. In the Agency Data module, the Edit Organization option allows the user to change names, acronyms, or codes for any of the groups within the organization. It also allows one to add groups to or delete groups from the organization as necessary. Any alterations that are made are reflected throughout the applicable levels of the hierarchical structure. The Edit Personnel Data option in the Personnel Data module allows the user to make any corrections that may be necessary to an existing personnel record. Suboptions differentiate between edit (correction) operations and update operations on the worker's name. Editing of the name replaces the previous worker name. Updating the name causes a historical audit trail to the previous name, allowing the system to recognize the worker by both the old and new name. In the Environment Data module, the Edit option allows the user to edit any of the environments in the system (e.g., change BLDG 100, RM 205 from "Painting Area" to "Sandblasting Area"). The previous environment description is archived in the system along with the date of the edit or update. The Edit Survey Data option in the Survey Data module is used to correct errors in survey data that have been entered in NOHIMS. In the Hazard Data module, the Edit Hazard Data option allows the user to edit or update information that has been entered for a particular substance (e.g., the Navy may set new exposure limits for a substance). The edit/update process is also controlled by the edit/update mode selection process when the user logs onto the industrial component. If the user selects the edit process, an historical record of changes is not made unless historical storage is mandatory for the data item edited (e.g., concentration measurements require historical storage of all edits). If the update mode is chosen, historical records of edits are stored in the database. The date of the edit update is also stored as part of the record. The general format for the edit function is to direct the user through each set of prompts and display the current value within carets. The user may either accept the current value, erase the value, or enter a new value. Sometimes, the user must select a separate suboption in order to delete a data item.

In the medical component of NOHIMS, additions, deletions, and edits to the patient database may be made through the Patient Registration/Edit option of the Registration module and the Encounter Entry, Medical Edit, and Lab Results options of the Enter Medical Data module. Both during initial registration of a patient and at a later date, the Patient Registration/Edit option can be used to edit any of the registration data items. None of the registration data items except the name and social security number is kept historically, that is, the new value replaces the previous value for the given data item. If either the patient's name or social security number are modified, NOHIMS will enter the new value into the patient's record and cross reference the file to the old value. During encounter entry, incorrect entries can be corrected by re-entering the code and associated data in the correct manner. The new entry will

automatically take precedence over the previous entry. Data items may be flagged as an erroneous entry by typing an "E/" before the code. Once encounter entry has been terminated, edits to the encounter record must be made through the Medical Edit option. After selecting to edit the encounter, data from the header of the encounter will be displayed. The user may then edit each header data item or accept the current value for the data item. In the body of the encounter, corrected entries of codes and associated data will replace previous entries. The user may also modify, delete, or add text for a data item that was previously entered by re-entering the code and selecting to edit the text. Data items may also be flagged as erroneous input with the "E/" entry. Lab results may be edited through re-entry of the code and the result while in the Medical Edit or Lab Results options. Previously entered lab results will not be saved. An entire encounter may be deleted from displays of the patient's data by entering "ERROR" at the type of encounter prompt in the header of the encounter. "E/" error entries of data items or "ERROR" entries at the type of encounter prompt do not actually delete a data item(s) from the patient's record in the database. Instead, the encounter and/or codes are flagged as an incorrect entry and are bypassed during retrieval functions. Thus, errored entries still require disk storage space and can be accessed in the system files for audit purposes.

Search-in-Context Capability

NOHIMS has an extensive search-in-context capability in that it can search for the co-occurence of data items in a worker/patient record. The NOHIMS file structure in both components provides pointers from one type of data element to another within the component. Both components use the patient/worker's social security number to uniquely identify the patient in the system, so it is possible to track workers by social security number through their entire work history and medical encounters, or to retrieve co-occuring data items. For example, given any organizational unit of the agency, both the personnel in that unit and the work environments used by the unit are known, or all patients who had all of three laboratory tests performed can be retrieved within a component.

NOHIMS will also search in context on a patient/worker name. Given at least two letters of the patient/worker's last name, NOHIMS will display all patient/workers who match the search criteria. Partial response input may also be used at all system prompts to identify uniquely the option desired. Partial response input of directory code names will produce an alphabetic list of code names that contain the partial response as a subset of the directory name.

If further search-in-context capabilities are desired for NOHIMS, the system can be linked with the Medical Query Language (MQL), a proprietary enhancement for COSTAR developed by the Laboratory of Computer Science, Massachusetts General Hospital, Boston, Massachusetts. MQL is a high-level procedural language that allows nonprogramming COSTAR users to search their database. MQL provides powerful and flexible retrieval and output capabilities as well as the ability to select subsets of the database for further analysis. The Naval Health Research Center, San Diego has acquired a 3-year license for MQL to evaluate its potential as an enhancement for NOHIMS.

General Filing Procedures

In the industrial component, NOHIMS uses a prompt to ask the user if the data that have been entered should be recorded in the database. This prompt usually asks if the user wishes to file, edit, or ignore the data entered. The "E" for Edit response allows the user to edit the data that have just been entered by returning to the beginning of the data prompt sequence. The previously entered data are displayed as the default value for each data item. The user may null through the items accepting the default values, or enter a new value. This process is done until the file, edit, or ignore prompt is reached again. The "I" for Ignore response nullifies all new data that have been entered and then returns the user to the previous option selection level. If "F" for File is entered, NOHIMS files the data in the database in a foreground process. The user is informed of filing actions with a "Filing [.....]" message. When filing is completed, the user can proceed with NOHIMS operation.

In the medical component, the user choses to file, edit, or ignore in a fashion similar to the industrial component. The filing process will occur in one of two ways. In some instances, such as the registration and system maintenance filing procedures, NOHIMS does foreground processing and indicates that it is filing with a "Please wait while filing..." or "..." message. In other cases, such as encounter, medical edit, or lab results entry, NOHIMS files the transactions in a log to be accessed by a background caretaker job called Monitor. Monitor then files the data into the patient record in a background process. Monitor protects the system against data loss by filing one patient's data at a time and speeds up data entry by eliminating waiting time while filing.

Downloading to Magnetic Tape

All of the data and routines of NOHIMS can be downloaded to magnetic tape using operating system utilities. Specific routines and/or specific globals (containing patient records or system parameters) may be selected for downloading. Within NOHIMS, the only feature that facilitates downloading of data is the Archive Patient Records suboption in the medical component of NOHIMS. This function was designed to offload inactive patient records to tape or to recall patient records from tape. The user may select individual records or a certain group of records to be archived or recalled. Some problems were reported to the COSTAR Users' Group when other COSTAR sites attempted to execute the Archive Patient Records suboption in version V.7. Therefore, the Archive Patient Records function in NOHIMS (based on COSTAR version V.7) should be tested thoroughly before it is relied upon for system maintenance. The documentation that was generated for the COSTAR version V.8 release, however, stated that the archiving, de-archiving, and selective recall functions in version V.8 have been tested and are now functioning properly. Another way to be sure that the archiving function in NOHIMS is working properly would be to selectively move the version V.8 Archive Patient Records routines into NOHIMS in place of the V.7 routines.

Summary

The data entry clerk for the medical component of NOHIMS at the Occupational Health Unit, North Island, San Diego, California estimated that he can enter between 30 and 40 complete medical encounters per day of data entry (12-16 minutes per encounter). The time required to enter an encounter depends on the number of data items that must be entered. The estimate for the amount of time required to enter data from an industrial survey depends greatly on the number of Occupational Hazard Data Sheets that must be entered as part of the survey. The estimates for the average number of surveys that could be entered in a day ranged from a low of 16 to a high of 80.

Both the industrial and medical components of NOHIMS have extensive edit capabilities to add, change, or delete data from the database. An edit function in the five data modules of the industrial component is used to edit or change information that has already been entered into the system. Whether or not edited values are retained in the system depends on the function used to perform the edit and the data item that is edited. In the medical component, additions, deletions, and edits to the patient database may be made through the Patient Registration/Edit option of the Registration module and the Encounter Entry, Medical Edit, and Lab Results options of the Enter Medical Data module. None of the edited values for the registration items is stored historically in the system. Edits to the encounter record are retained in the patient files, but are bypassed by data retrieval functions.

NOHIMS can search for the co-occurence of data items in a worker/patient record. Both components use the patient/worker's social security number to uniquely identify the patient in the system, so it is possible to track workers by social security number through their entire work history and medical encounters, or to retrieve co-occuring data items within a component. NOHIMS will search-in-context on a patient/worker name. If further search-in-context capabilities are desired for NOHIMS, the system can be linked with the Medical Query Language (MQL). The Naval Health Research Center, San Diego has acquired a 3-year license for MQL to evaluate its potential as an enhancement for NOHIMS.

Both the components of NOHIMS use a prompt to ask the user if the data that have been entered should be recorded in the database. In the industrial component, filing is performed as a foreground process. The medical component uses a background caretaker job called "Monitor" to perform almost all of the filing tasks.

All of the data and routines of NOHIMS can be downloaded to magnetic tape using operating system utilities. The medical component of NOHIMS has an Archive Patient Records suboption that was designed to offload inactive patient records to tape or to recall patient records from tape. Other COSTAR users have found problems when using this option, however. This option is reported to be fixed in COSTAR Version V.8.

Description of Information Retrieval Capabilities

The following describes the system modules that are involved with information retrieval for each component of NOHIMS, and the main functions and features of each module involved with information retrieval.

Industrial Component Information Retrieval Capabilities

There are eight functions in the industrial component of NOHIMS that will retrieve data from the industrial database. These are the display functions of the five data modules--(1) Display Organization, (2) Display Personnel Data, (3) Display Environment Users, (4) Review Environment Information, (5) Display Survey Data, and (6) Display Hazard Data; the Hazard Exposure/Examination Report option in the Personnel Data module; and the Query/Report module. The following paragraphs describe the main features of each of these retrieval functions.

Agency Data: Display Organization. Using this option, the user may display all or any portion of the agency organization. The display is organized so that the hierarchical configuration of the unit is portrayed. The normal display for each agency unit includes the unit's name, code, site location, and the number of environments attached to it. Also, additional information such as personnel and workplace environments applicable to each agency unit may be included in the display output. If this latter option is selected, a complete description of each environment is displayed, along with the names, employee identification numbers, and the date that the persons were assigned to the particular agency unit.

Personnel Data: Display Personnel Data. This function allows a user to display the personnel data for a selected worker or all workers for a selected agency unit. The display that is produced includes personnel demographic data, the current agency unit to which the worker is assigned, the date the worker was assigned to that unit, and information for the worker's currently assigned work environment. The user may also opt to include the medical examination information in the display. The medical examination information includes current medical examination recommendations, examination status, and hazardous agent exposure information.

Environment Data: Display Environment Users, Review Environment Information. The Display Environment Users option is used to quickly retrieve and list environment descriptions and the associated agency units. No other information is provided in the display. The user may select any agency unit environment(s) for display. The environment(s) for display may be selected by their association with agency units or by keyword content of their description (such as "spill"). The Review Environment Information option will retrieve environments in the same manner as the Display Environment Users. However, the user may also display any one or combination of the following: environment description, organizational users, personnel assigned to the environment, mandatory medical requirements, survey references, or material inventory.

Survey Data: Display Survey Data. The Display Survey Data option will display a selected survey, or any or all surveys associated with the agency unit(s) or environment(s) selected for display. The environment(s) may be selected by their association with agency units or by keyword content of their description. The user may select to include data from any or all of the survey data forms. The Industrial Hygienist Survey form display retrieves general workplace facts and conditions; the Occupational Hazard Data Sheet display contains material sampling and exposure data; and the Material Inventory is a

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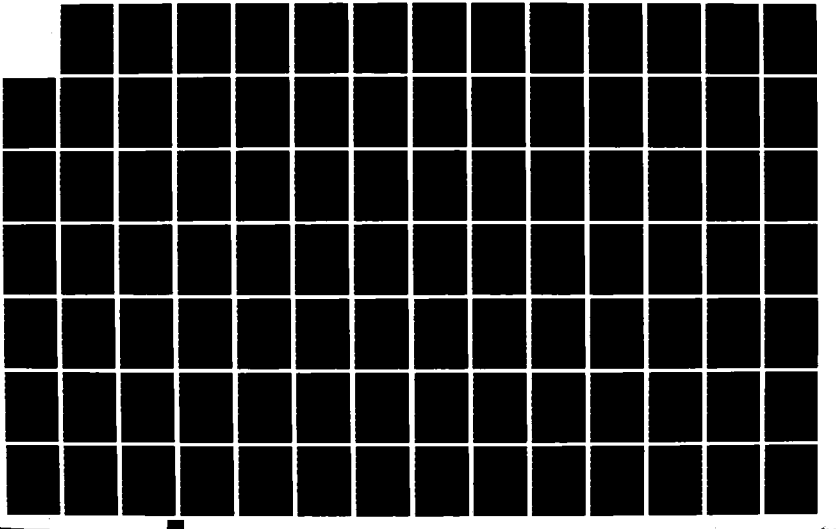
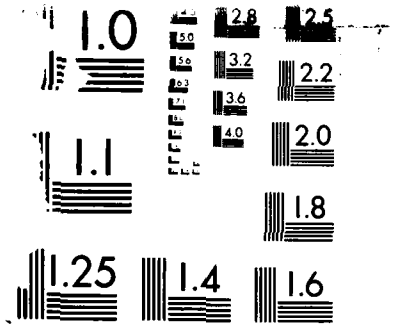




RESOLUTION TEST CHART

list of the agents, materials, or products found in the environments associated with the survey.

Hazard Data: Display Hazard Data. All current information contained in the Hazard Table for a selected agent(s) may be displayed via this option. The display includes the agent names, code numbers, medical monitoring status, classification category, analytical method number, sampling and analytical error, exposure limits, scale, authority, action level, time-weighted average limit, short-term exposure limit, ceiling limit, body parts or organ systems affected by the agent, and medical surveillance protocol for the agent. The user may also select to include in the display those environments that contain the selected agent.

Personnel Data: Hazard Exposure/Examination Report. The Hazard Exposure/Examination Report produces the hazard exposure summary and medical examination requirement reports (Individual Exposure Examination Reports) for the workers that are selected. In addition, the Occupational Health Roster (a roster listing employees who require medical examinations within each applicable agency unit) and a Physical Exam Notification Report (a medical examination notice) for each employee in the Occupational Health Roster may also be produced.

There are a variety of ways to select individuals for generating reports. Usually the Periodic Exam Preparation suboption is used to select all personnel within the agency who were born in a specified month and need an annual physical examination. NOHIMS will select a worker for a physical examination only if the environments associated with the worker contain an agent with mandatory medical requirements or if a measured hazardous agent concentration value of an agent in the worker's environment(s) has exceeded the applicable medical action level limits. The reports can be produced using criteria for pre-placement examinations, termination examinations, or normal periodic examinations. The user may also select specific individuals or all of the employees of a specific agency unit by using the Special Examination Preparation suboption. This suboption also produces a general exposure and examination report for environments rather than personnel. All reports will list all pertinent hazardous agents, concentration sample values, and associated medical requirements.

Once a particular report has been generated, multiple copies of the report may be printed. The printing of a report may also be restarted at a failure point or at the beginning of the report. The Occupational Health Roster and Physical Examination Reports can also be printed any number of times. The Delete Old Reports suboption is used to erase sets of report specifications stored in the system.

Query/Report. The Query/Report module provides an ad hoc information retrieval and display capability that extends to almost every data item in the industrial component. To generate a query, the user first defines a "command set." The command set contains the user's selections from a menu progression. The presentation of the data selection menus follows a logical progression through the various industrial component data groups. The menu at any point in the selection process allows selection of only those data groups that are possible given the previous data group selections and the interrelationships of those data groups with other data groups in the component. The command set

specifies only general data groups and data items, the sequence of information retrieved, and the user's desire to specify target subjects within each data group. It does not identify individual target subjects. The selection of individual target subjects within the data group is accomplished interactively during the initial portion of the query execution process. Therefore, the same command set may be used to retrieve unlimited combinations of specific target data accessible by the sequence of the general query command set. When a set of individual data items is selected for the query, the user can select any or all of the data items in the group for retrieval. Conditional testing of a data item is planned as a future enhancement. Possible testing conditions for the industrial component will include comparison to a given numeric value, comparison to a given numeric interval, testing for the presence or absence of a data item, comparison to a given literal value, a search of the data item content for a given single- or multi-word literal, and comparison to an associated table of values if applicable to the data item.

A command set is stored in the system under a user selected name until the command set is deleted with the Erase a Query File option. The query command sets may be displayed for review using the Display a Query File option. There is no capability to edit command sets. A command set is so easily built, that it is simpler to create a new command set than to modify an existing one. The output display format of the retrieved data is not under control of the user. The query performs a simple progressive indentation of the information for each unique data group, much like an outline. The absence of format control makes the interactive query a simple and quick way to retrieve data.

Medical Component Information Retrieval Capabilities

Four modules are used to retrieve data in the medical component of NOHIMS. These are the Registration module, the Display Medical Data module, the Print Medical Data module, and the COSTAR Report Generator. The Display Registration option in the Registration module and the Registration Data Check option in the Display Medical Data module are used to retrieve registration data. The COSTAR Report Generator module option menu covers three different functions. These are the actual COSTAR Report Generator, the Medical Query Language, and a function that retrieves and reformats certain data for research purposes.

Registration: Display Registration. Display Registration allows the user to view, on either a CRT or printer, the complete set of registration data for a patient. The registration display for NOHIMS contains the patient's name, sex, date of birth, person to notify in emergency, phone number in emergency, date of registration, social security number, duty station or activity, and primary clinic. It was also intended that the patient registration would include the ethnic background of the patient. This variable has not yet been implemented in NOHIMS.

The patient to be displayed can be identified by name or by social security number. The social security number is the unit number that uniquely identifies the patient in the system. The patient to be displayed can be identified with an ambiguous entry of the name. The minimum number of letters of the patient's name that must be entered at the Identify Patient prompt is two letters of the last name. NOHIMS will then list all patient registered in the medical component that meet the criteria entered. NOHIMS does not search for patient

names by phonetics. This option only displays registration data. No changes can be made to the registration record while in this option. If the user desires to edit the registration record, the Patient Registration/Edit option must be used to display and then edit the registration record.

The registration display format may be formatted as a consensus of the users desire. The specifications for the registration display are set up and altered via the Registration Functions option of the System Maintenance module. Only one registration display format is allowed at one time. However, two registration display formats may be saved in the system.

Display Medical Data. The Display Medical Data module allows data in the medical record file to be displayed or printed in a variety of formats and sequences. The reports produced by the Display Medical Data module include List Encounters, Encounter Report, Most Recent Encounter, Flowchart, Interactive Flowchart, Index Patient, Status Report, Patient Summary, and Registration Data Check (exactly the same as the Patient Display in the Display Registration option). Like the Display Registration option, patients for whom data are to be displayed can be identified by either the patient's name or social security number. Ambiguous entries of the patient's name are allowed. In the Display Medical Data module, the patient is identified prior to selecting the report that is desired. Thus, a variety of reports may be displayed or printed for a patient without having to identify the patient each time.

List Encounters. This option produces a list of all past encounters for the specific patient. The list includes the date of the encounter, the site and type of the encounter, and the provider(s), thus providing the user with enough information to determine which encounter or encounters should be viewed in more detail.

Encounter Report. The Encounter Report is a display of a single visit to the Occupational Health Unit. There are two main encounter types in NOHIMS. The most common encounter is entered from the Physical Exam Data Sheet (PEDS) and the Physical Examination Findings (PEX) form. If a patient was examined as part of the Asbestos Medical Surveillance Program, he/she will have an additional encounter for the data required by that program. When the occupational and medical history data collection forms are implemented, the data will be entered into encounters separate from the basic PEDS and PEX encounter.

The Encounter Report retrieves all data items entered for the encounter. The format for the data in the Encounter Report cannot be changed without programming intervention. The Encounter Report displays a header with the patient's name, sex, date of birth, current age, unit number (SSN), site of the visit, type of visit, visit classification, and medical care providers. The remaining data are organized by divisions of the medical record (Administrative, Diagnosis, Physical Findings, Laboratory, and Disposition). For each coded item, NOHIMS displays the internal code and the long name of the code. Modifier names, statuses, textual comments, and laboratory results are also displayed, if any.

The user selects the encounter to be displayed by date of the encounter. No other criteria may be used to select which encounters are to be displayed with this option except otherwise noted below under Most Recent Encounter.

Most Recent Encounter. Most Recent Encounter allows the user to display or print an encounter report for the most recent encounter in a patient's medical record or to progressively view several encounters in reverse chronological order.

The following Display Medical Data options summarize data across encounters.

Flowchart. Flowchart allows the user to track prespecified data items across encounters. The flowcharts present medical information across the horizontal axis of a display with corresponding dates of entry into the medical record displayed on the vertical axis. Modifiers, statuses, textual comments, and results are included in the flowchart, if applicable. Seven standard flowchart specifications have been stored in NOHIMS. These are called Hypertension, Diabetes, Red Blood Cell Count, Congestive Heart Failure, Kidney Failure, Urinalysis, and Liver Function Tests. Additional flowchart formats may be defined using the Flowchart Template Edit suboption in the Directory option of the System Maintenance module. The NOHIMS system manager may specify the data items to be included in the flowchart and dictate the specific format of the flowchart to a limited degree. Which encounters are to be summarized by the Flowchart may not be specified.

Interactive Flowchart. This option permits the user to define a flowchart for a particular patient. The specifications for the data items to be included in the flowchart are not stored in the system. If a user enters the same specifications frequently, they can be stored in the system as a standard flowchart using the Flowchart Template Edit suboption. The interactive flowchart is the quickest way to track a single data item through the patient's medical record. Interactive Flowchart has the same limitations and general format as the Flowchart option does.

Index Patient. The Index Patient option displays an index to all of the sections of a patient's medical record, providing a quick review of the main features of the record. After viewing the index list, the user may request a detailed listing of any or all sections, or an interactive flowchart based on the information displayed in the index. The format for this report is fixed. If a data item has a short name, the Index Patient option will display the short name. Since most of the codes in NOHIMS have short names that are used in data entry, this report will not be useful unless the user is very familiar with all of the data entry codes.

Status Report. The Status Report summarizes the medical record for a patient in a predefined format that cannot be changed without programming intervention. It is a summary of and index to all divisions of the patient's medical record. The report may be produced in its entirety or by selected divisions. For each data item, the Status Report displays the internal code, the long name, and the provider who most recently entered the data item into the patient's medical record. Most recent textual comments and laboratory results are also displayed.

Patient Summary. This option summarizes the medical record for a patient in a user-defined format. Using the Patient Summary Functions suboption of the System Maintenance module, the system manager specifies for each division the types of data to be included in the display (date, abnormal flag, name of the code, results, text, and provider), the format of the date and provider name, and the location of each data item on the page. For certain divisions, the system manager can also specify that only data from the previous N encounters and/or the previous N months will be included in the report. In addition, the system manager may specify data items to be included in an optional Data Matrix. The Data Matrix summarizes selected data items for the four most recent encounters. Different Data Matrix criteria may be specified for age and sex groups.

Registration Data Check. The Registration Data Check option allows the user to display or print the registration data for the selected patient without leaving the Display Medical Data Module. The content and format of the data are controlled by the Registration Functions described in the Display Registration section above.

All of the previously described options are merely display options; data may not be edited while in the Display Medical Data module. Each of the options contains help text at the various system prompts to help a user select and display the report that is desired. Softcopies of the reports are obtained by selecting the report option while logged onto a CRT. If the user logs onto a hardcopy device, hardcopies of the reports may be obtained. Hardcopies of the reports may also be obtained via the Print Medical Data module described next. The ability to display reports can be restricted to certain classes of users and to certain devices to maintain confidentiality of the medical data.

Print Medical Data. The Print Medical Data module is used to produce all routine hardcopy medical data printouts. This module contains three usable options: Daily Encounter Reports, Halt Daily Encounter Report on Printer, and Special Print. A fourth option, Scheduled Visit Print that produces Patient Summaries for patients scheduled for an appointment for a given date and provider, is not usable in NOHIMS because the Scheduling module of COSTAR was not implemented. The Scheduling module currently available in COSTAR is usually considered too cumbersome and too slow. A fifth option, Laboratory Result Reporting, was not implemented in NOHIMS. The main features of each of the Print Medical Data options are described below.

Daily Encounter Reports. This option allows the user to print reports for patients who had an encounter entered on that day or the five days previous to that day. The user may select to print an encounter report, a status report, all previous encounters, or combinations thereof. The order of the printed reports usually is determined by the system manager. The order may be (1) by patient's last name alphabetically, (2) by order of input, (3) by unit number, or (4) by order of the last two digits of the social security number (the last order would not be useful for the NOHIMS application). The user may specify the device that is to print the reports.

Halt Daily Encounter Report on Printer. The Halt Daily Encounter Report on Printer option permits the device printing daily encounter reports to be halted from another device.

Special Print. Special Print allows the user to specify a group of patients for whom medical reports are to be produced. The reports can be produced according to a list of names that is input, alphabetically by patient's last name, in unit number order, or by the last digit of the unit number (the last order would not be useful for the NOHIMS application). The reports to be printed (i.e., the Status Report, Most Recent Encounter, all Encounters, Registration Data Check, Flowcharts, or any combinations thereof) may be specified for each patient individually or for the group of patients as a whole. Once the list of names is created, it is stored in the database associated with the device used to create the list for future use. Special print files may be edited, restarted, and deleted from the system.

Each of the Print Medical Data options contains help text at the various system prompts to help a user select and print the reports that are desired. The ability to print reports can be restricted to certain classes of users and to certain devices to maintain confidentiality of the medical data.

COSTAR Report Generator. The COSTAR Report Generator (CRG) has the capability of providing listings and cross tabulations of any variables contained in the NOHIMS database. Additionally, percentages, totals, and subtotals may be computed for any specifed distribution. This option serves to satisfy data retrieval needs not met by the standardized reports described above.

The listings produced by the CRG may include divisions, actual data items, or data associated with a data item (results, statuses, modifiers, and text). The user may also modify data items with selection criteria such as last, most recent, number of, etc. The format for the listings is defined by the user within certain parameters. Data items are listed across the horizontal axis, so the user is limited to 80 columns of data on a CRT or 132 columns of data on a hardcopy device. The system sets default values for all data items, such as field title, field width, and data format. These default values may be overridden by the user. Listings may be produced in one of three ways: (1) order of encounter input, (2) alphabetic order by the patient's name, or (3) encounter date order.

The cross tabulations provided by the CRG may be on divisions, actual data items, or data associated with a data item (results, statuses, modifiers, and text). The user may also modify data items with selection criteria such as last, most recent, number of, etc. The user may define one set of up to 3-way tables and may specify the down, across, and by variables within certain limits. Variables that require a new category for each unique value may not be used in the across position. The user can define groupings by either discrete categories (e.g., male and female) or continuous categories (e.g., 10-19 years of age). The user may select to generate another set of tables that contains percentages and may specify the denominator of the percentages (row, column, or table total, or combinations thereof). NOHIMS does not compute means, deviations from a mean, or other statistics. The CRG does not produce graphic representations of data.

The user may specify up to approximately 22 selection criteria for defining subsets of patients to be listed or tabulated. Selections may be made on the basis of the presence or absence of a data item, the value of a data item, or the presence or absence of data in a particular division, or combinations thereof. The user may specify alternate, necessary, nested alternate, or nested necessary conditions, or a combination thereof. At the time of running the report, the user may specify a range of encounter dates to be included in the tally. If a range of encounter dates is specified, the CRG will only search encounters for those dates for valid data. Otherwise, the CRG will search the entire database for valid encounters/patients.

The CRG also allows the user to specify whether data will be listed or tabulated in patient mode or in visit mode. If the patient mode is selected, one line in the list and one tally in a tabulation will be made for each patient that meets the given selection criteria. If the visit mode is chosen, the system will utilize one line in the listing and one tally in the tabulation for each encounter entered in the system for the patient that meets the selection criteria.

To run a CRG report, the user first defines a set of report specifications. These specifications are stored in the system under a user-selected name of up to 20 characters. The report specifications may be altered at any time, run as many times as desired, renamed, and deleted when no longer needed. When editing the report specifications, NOHIMS displays each specification. The user may change the specification or null through the prompt to retain the specification. The edited specifications may be saved to the same report name or to a new report name. NOHIMS will display a list of reports stored in the system along with the last time the specifications were edited.

When a CRG run is performed, the tabulations produced by the report are stored in a working file to be printed at a later date. Listings, on the other hand, are produced as the CRG proceeds through the database and are not stored in the system. Tabulations that are no longer needed may be deleted from the working storage.

The user may job queue a CRG report. The user may specify the date and time the job is to be run, may link the job to previous jobs, and may specify the device that is to be used to run the report. Currently, only one CRG report may be run at a time. This is a limitation of the present operating system,

however. The device that is being used to run the report will be tied up until the report is completed. Hardcopy of reports may be obtained by running the CRG report on a hardcopy device or by printing the working storage on a hardcopy device. Softcopies of reports may be obtained by running the report on a CRT. These reports are useful for quick investigations into the database or for testing new report specifications. Extensive help text enables the user to utilize the job queue and all other CRG functions.

Query Language. The Medical Query Language provides a more powerful tool for selecting and retrieving data than the CRG. For complicated queries, however, the Medical Query Language requires more effort on the part of the user to understand the content and format of NOHIMS' data files and the Medical Query Language's programming-like conventions. The Medical Query Language calculates sums, means, sum of squares, and standard deviations. It also has the ability to graph up to three variables. The Naval Health Research Center has a 3-year license to evaluate the potential of the Medical Query Language as an enhancement for NOHIMS.

Construct SSN Global, Clear SSN Global, Produce Fixed Length Record, Transfer Global to Tape, Move SSNs from Indus UCI. These five options are used to retrieve certain data and reformat it into a fixed-length record that can be used with other statistical packages. The Construct SSN Global option uses normal CRG procedures to select specified patients and stores the patients' social security numbers in a special file. The Clear SSN Global is used to delete all of the social security numbers in the special file. The Produce Fixed Length Record option extracts certain demographic data and specified physical examination findings and laboratory results and reorganizes them into a fixed format. The Transfer Global to Tape option writes the fixed-format data to tape for transfer to other systems. The Move SSNs from Indus UCI option transfers lists of social security numbers produced via the Query/Report module of the industrial component into the medical component. The lists of social security numbers may be combined with another list in the medical component, or a new list may be created in the medical component.

Summary

There are eight functions in the industrial component of NOHIMS that will retrieve data from the industrial database. These are the display functions of the five data modules--Display Organization, Display Personnel Data, Display Environment Users, Review Environment Information, Display Survey Data, and Display Hazard Data; the Hazard Exposure/Examination Report option in the Personnel Data module; and the Query/Report module. The display options of the five data modules can retrieve and display information both specific to the data module (e.g., agent names and exposure limits) and from relationships between the modules (e.g., environments that contain a particular agent). The Hazard Exposure/Examination Report option produces the hazard exposure summary and medical examination requirement reports for selected workers. The Query/Report module provides an ad hoc information retrieval and display capability that extends to almost every data item in the industrial component.

Four modules are used to retrieve data in the medical component of NOHIMS. These are the Registration module, the Display Medical Data module, the Print Medical Data module, and the COSTAR Report Generator. The Display Registration

option in the Registration module and the Registration Data Check option in the Display Medical Data module are used to retrieve registration data. Three of the options in the Display Medical Data module retrieve information about individual encounters; five other options summarize data across encounters. The Print Medical Data options print hardcopies of Encounter Reports, Patient Summaries, Status Reports, and/or Flowcharts for particular groups of individuals. The COSTAR Report Generator options cover three different functions. These are the actual COSTAR Report Generator, the Medical Query Language, and a function that retrieves and reformats certain data for research purposes. The COSTAR Report Generator produces listings and cross tabulations according to user-defined criteria. The Medical Query Language is a more powerful data retrieval language that is under examination as a future enhancement for NOHIMS. Five options produce a fixed length, fixed format record from COSTAR data for use in research functions.

Evaluation of Information Retrieval Capabilities

The six medical care providers, five industrial hygienists, and two system managers were asked to evaluate NOHIMS' information retrieval capabilities. The questions divided the capabilities into two functions: (1) standard reports produced by NOHIMS and (2) user-defined report functions such as the COSTAR Report Generator in the medical component and the Query/Report module in the industrial component. The interviewees were asked to name the standard reports that they use or receive and the ways in which they use them. They also assessed the adequacy and usefulness of both the standard and user-defined reports. The questions we used to evaluate NOHIMS' information retrieval capabilities may be found in Appendix A, Component 7.

Table 16 shows the standard reports that each group of NOHIMS users receives or uses. All of the medical care providers use the Individual Exposure Examination Report; half or less of the medical care providers use the other standard reports. Since the Physical Exam Notification Report and the Occupational Health Roster were designed for use by the occupational health technicians in scheduling physical examinations, it is not surprising that few other medical care providers use these. The Encounter Report, Patient Data Sheet, and Flowcharts display medical data, yet few providers utilize these reports. Only one person has used the Status Report; however, this is consistent with the NOHIMS developers recommendation that this report not be used because of its awkward format.

The main standard report that the industrial hygienists use is the Industrial Hygiene Survey. All of the industrial hygienists use this report. Three of the five hygienists (60%) also use or receive the Individual Exposure Examination Report. The San Diego system manager receives or uses all of the reports, except the Status Report, Flowcharts, and the Industrial Hygiene Survey. The Bremerton system manager uses or receives only the Industrial Hygiene Survey, a reflection of the fact that the medical module has not been implemented at Bremerton yet and he has a collateral position as an industrial hygienist.

Table 17 presents the ways in which the users utilize the standard NOHIMS reports. The interviewees use the standard reports for a variety of purposes. The use that was mentioned most frequently is to communicate with others which

TABLE 16
Standard NOHIMS Reports Used
(Number who mentioned report; percentage of group who uses report)

	Medical Care Providers	%	Industrial Hygienists	%	System Managers	%
Industrial Hygiene Survey	N/A	-	5	100	1	50
Physical Exam Notification Report	1	17	0	0	1	50
Occupational Health Examination Roster	2	33	0	0	1	50
Individual Exposure Examination Report	6	100	3	60	1	50
Patient Data Sheet (Patient Summary)	3	50	N/A	-	1	50
Encounter Report	3	50	N/A	-	1	50
Status Report	1	17	N/A	-	0	0
Flowcharts	2	33	N/A	-	0	0
TOTAL INTERVIEWED	6	100	5	100	2	100

TABLE 17
Uses for Standard NOHIMS Reports
(Number who mentioned use; multiple answers allowed)

	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Interviewed
Communicate with others	4	4	2	10	77
Prepare required reports	1	5	1	7	54
Plan workloads	1	4	1	6	46
Provide direct patient care	5	0	0	5	38
Other: Replace lost charts/chits	1	0	0	1	8
TOTAL INTERVIEWED	6	5	2	13	100

was mentioned by 77 percent of those interviewed. This percentage included people who provide data for others, such as the San Diego system manager. The standard reports are also used to prepare required reports by 54 percent of those interviewed. Forty-six percent of the people interviewed said they use the standard reports to plan workloads. Almost all of the industrial hygienists mentioned specifically that they use the Industrial Hygiene Survey to plan future surveys. Five out of six of the medical care providers said that they used the standard reports in direct patient care. One medical care provider mentioned the usefulness of having a NOHIMS medical record when paper charts or lab chits were lost.

Tables 18-19 contain the users' ratings of the adequacy and usefulness of the standard NOHIMS reports. All of the individuals interviewed thought that the NOHIMS standard reports at least adequately meet their needs, and two of the industrial hygienists (15% of the total) rated the standard NOHIMS reports as more than adequately meeting their needs (see Table 18). Table 19 shows that every one interviewed thought that the standard NOHIMS reports were very useful.

We also asked the medical care providers to evaluate the usefulness of the standard medical reports in the day-to-day provision of medical care and to assess the effect of the standard reports on the quality of medical care provided (see Tables 20-21). Eighty-three percent of the medical care providers thought that the standard medical reports were very useful and also that the reports had had at least a beneficial effect on the quality of medical care. One of the physicians stated that "the data collected now are better than the old data in the charts." Another physician was very negative about the usefulness of the standard reports and the effect of the reports on the quality of medical care provided. He felt that the reports had a detrimental effect because the Navy administration has not yet accepted NOHIMS as the standard. The medical care providers are required to duplicate efforts to produce the reports taking away resources from direct patient care.

We then asked the interviewees to comment on additional standard information or reports that would be helpful to have. Table 22 contains the suggestions that were made. Each of these items was mentioned by only one of the interviewees. Suggestions included reports of calibration data, equipment data, lab data for certain industrial hygiene tests, and personnel data; auto triggering of monthly reports; ability to generate a list of workers above a certain agent measurement level; flagging of agent measurements over 50 percent of the Threshold Limit Value and of extreme abnormalities; and periodic reports of medical process data by provider. One occupational health technician wanted to access the industrial component to obtain exposure and normal levels for patients who come to the clinic on their own. A physician wanted to see previous exposure and work history data for patients. One industrial hygienist requested the ability to generate reports that contain agent measurement values for the sampled worker for inclusion in his medical record and in the medical records of other workers in the same shop. An even more useful capability would be a mechanism that would automatically pass the agent measurement value(s) to the electronic medical record. Reports of the risk assessment code for hazards were also requested. New survey data forms that contain data on the risk assessment code were put into use at Bremerton in April 1986. It should now be possible to produce these codes in some form of a report.

TABLE 18
Adequacy of Standard NOHIMS Reports
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Interviewed
More than adequately meets needs	0	2	0	2	15
Adequately meets needs	6	3	2	11	85
Less than adequately meets needs	0	0	0	0	0
Is not relevant	0	0	0	0	0
TOTAL INTERVIEWED	6	5	2	13	100

TABLE 19
Usefulness of Standard Reports
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Interviewed
Very useful	6	5	2	13	100
Somewhat useful	0	0	0	0	0
Not useful	0	0	0	0	0
TOTAL INTERVIEWED	6	5	2	13	100

TABLE 20
Usefulness of Standard Medical Reports
in Day-to-Day Provision of Medical Care
According to Medical Care Providers
(Number who mentioned rating)

	TOTAL	% of Total Interviewed
Very useful	5	83
Somewhat useful	0	0
Not useful	1	17
Not used	0	0
TOTAL INTERVIEWED	6	100

TABLE 21
Effect of Standard Medical Reports on Quality of Medical Care
According to Medical Care Providers
(Number who mentioned rating)

	TOTAL	% of Total Interviewed
Very beneficial	3	50
Beneficial*	2	33
Somewhat beneficial	0	0
No effect	0	0
Somewhat detrimental	0	0
Very detrimental	1	17
TOTAL INTERVIEWED	6	100

* Category added by respondents

TABLE 22
Additional Information/Reports That Would Be Helpful
(All mentioned once)

- Calibration data
- Equipment data
- Lab data for certain IH tests
- Personnel data
- Risk assessment code for hazards [New survey forms put into use at Bremerton in April 1986 contained this information]
- Auto triggering of monthly reports
- Access to IH data to obtain exposure and normal levels
- Periodic Medical Director's report with basic process data by provider
- Previous exposure and work history data
- Flagging of measurements over 50% of TLV
- Flagging of extreme abnormalities
- Generating a list of people above a certain agent measurement level
- Reports of the agent measurement value for the person sampled for inclusion in his/her medical record and the medical records of other workers in the shop

We next asked the users to evaluate the NOHIMS user-defined reporting capabilities, including the Interactive Flowchart and the COSTAR Report Generator in the medical component and the on-line look-up and the Query/Report module in the industrial component. Table 23 shows that none of the medical care providers used either of the medical component's user-defined reporting capabilities, although the system manager at San Diego has used both. All of the industrial hygienists and both of the system managers had used both the on-line look-up and the Query/Report module.

Since only one person had used the medical component user-defined report capabilities, we are unable to fully evaluate the uses and usefulness of these capabilities to NOHIMS users. The San Diego system manager who had used the options, however, thought that they were very useful. He used them to provide information for other users.

Table 24 shows that the main information retrieved with the on-line look-up and the Query/Report module in the industrial component are survey-specific information which is retrieved by 100 percent of the users, and shop-specific information which is accessed by 83 percent of the users. The industrial hygienists and system managers also retrieve patient-specific exposures (33% of users), administrative data (33%), survey lab results (17%), environment-related data (17%), and hazard-related data (17%), but to a lesser degree.

The main use for the data retrieved with these industrial component user-defined report functions is resource management (see Table 25). Again, the industrial hygienists mentioned using the data to plan surveys and workloads. Other less frequent responses included use in direct patient care, assessment of quality of care, tracking a hazard, and responding to compensation claims. The direct patient care and quality of care uses were mentioned by one industrial hygienist who checks to see if and how often workers have been called up for examinations; if they are sick, she looks up their exposures in NOHIMS. One system manager retrieves data for use by others. Table 26 shows that 100 percent of the industrial hygienists and system managers rated the on-line look-up and/or Query/Report module as very useful.

Summary

The Individual Exposure Examination Report is the most frequently used standard report; nearly everyone uses it. The standard NOHIMS reports produced by the medical component are used by half or less of the medical care providers. The main uses for the standard reports are communicating with others (77% of users mentioned use), preparing required reports (54%), planning workloads (46%), and in providing direct patient care (38%). All of the users rated the standard NOHIMS reports as at least adequate for meeting needs and all of the users thought that they were very useful. The medical care providers generally thought that the standard reports were very useful in the day-to-day provision of medical care and that the standard reports have had a beneficial effect on the quality of medical care. The medical care providers are not using the user-defined reporting capabilities in the medical component so we could not evaluate the usefulness of these functions. All of the industrial hygienists and system managers use the on-line look-up and Query/Report module in the industrial component. These are used mostly for resource management (83% mentioned use) and to look up survey-specific information (100% mentioned this information) and

TABLE 23
User-Defined Information Retrieval Capabilities Used
(Number who mentioned capability; multiple answers allowed)

	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Interviewed
Medical component					
Interactive Flowchart	0	-	1	1	14
Report Generator runs	0	-	1	1	14
None	6	-	0	6	86
NUMBER INTERVIEWED	6	-	1	7	
Industrial component					
On-line look-up	-	5	2	7	100
Query/Report Module	-	5	2	7	100
NUMBER INTERVIEWED	-	5	2	7	
TOTAL INTERVIEWED	6	5	2*	13*	

* Two system managers were interviewed. The one from San Diego has access to both the industrial and medical components. The one from Bremerton does not have access to the medical component since it has not been implemented yet.

TABLE 24
Information Retrieved with On-Line Look-Up and/or the Query/Report Module
(Number who mentioned type of information; multiple answers allowed)

	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
Survey-specific information	4	2	6	100
Shop-specific exposures	3	2	5	83
Verify or look-up administrative data	1	1	2	33
Patient-specific exposures	1	1	2	33
Environment-related data	1	0	1	17
Hazard-related data	1	0	1	17
Survey lab results	1	0	1	17
TOTAL WHO ANSWERED	4	2	6	100
No Comment	1	0	1	
TOTAL INTERVIEWED	5	2	7	

TABLE 25
Uses for On-Line Look-Up or Query/Report Module
(Number who mentioned use; multiple answers allowed)

	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
Resource management	4	1	5	83
Direct patient care	1	0	1	17
Assessment of quality of care	1	0	1	17
Other:				
Track a particular hazard	1	0	1	17
Respond to compensation claims	1	0	1	17
For use by others	0	1	1	17
TOTAL WHO ANSWERED	4	2	6	100
No Comment	1	0	1	
TOTAL INTERVIEWED	5	2	7	

TABLE 26
Usefulness of On-Line Look-Up and/or Query/Report Module
(Number who mentioned rating)

	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
Very useful	4	2	6	100
Somewhat useful	0	0	0	0
Not useful	0	0	0	0
TOTAL WHO ANSWERED	4	2	6	100
No Comment	1	0	1	
TOTAL INTERVIEWED	5	2	7	

shop-specific exposures (83%). All of the industrial hygienists and system managers rated the industrial component user-defined information retrieval capabilities as very useful.

ASSESSMENT OF SECURITY FEATURES

Since NOHIMS contains confidential medical information, it is very critical that NOHIMS have adequate security protection to ensure the privacy of the data stored in the database. In addition, data obtained from NOHIMS are used for medical monitoring and may be used as legal evidence in various Navy legal proceedings; therefore, the system must be protected from both internal and external corruption. This section of the Evaluation Report documents the efforts we made to determine if NOHIMS adequately meets the security needs of the Navy. The first section contains an objective verification that NOHIMS contains the logical and physical security controls that were outlined in the NOHIMS System Decision Paper (SDP) written in June of 1984. The second section is a subjective evaluation of the adequacy, usage, and necessity of the NOHIMS security features by the NOHIMS developers at the Naval Health Research Center (NHRC), higher level Navy managers, and system users at San Diego and Bremerton.

Description of NOHIMS Security Features

The SDP clearly spells out both the logical and physical security controls that NOHIMS should have. The logical controls include: (1) passwords to log-on, (2) limiting access to certain functions by password, (3) limiting access to files by device, (4) time-outs if a terminal is not used for a period of time, (5) scrambled identification codes, (6) separate files for personnel information and for medical information, and (7) masked fields. Physical security controls as outlined in the SDP are to include: (1) use of cipher locks on the computer room door, (2) log book entry of noncomputer staff entering the main computer room, and (3) a record of batch programs that the operator initiates on the system. The developers of the SDP felt that these physical security controls should prevent unauthorized access to the system. The following sections document the NOHIMS logical and physical security controls.

NOHIMS Logical Security Features

The following are descriptions of the logical security features of NOHIMS.

Sign-On/Off Procedures. Each user of NOHIMS is assigned an identification code of from three to five characters. This code is entered during the log-on procedure. The log-on codes are stored in files accessed by the security options in the System Maintenance modules of the medical and industrial components. The log-on codes may be changed through the security options. Users who are no longer qualified to access NOHIMS may be inactivated.

Limiting Access to Certain Functions by Passwords. Password protection may be applied to any of the modules in the medical component. The system manager may designate and/or change the password at will through the System Maintenance

module. Access to that password protected module is restricted unless the correct password is entered by the user. This feature is not invoked at the San Diego test site, however. The industrial component of NOHIMS does not have this capability.

Limiting Access to Functions by Device. Both the industrial and medical components have a security feature that limits access to modules and/or options depending on the device that is being used to access the system. Thus, access at a given terminal or printer can be limited to any combination of modules and options. The list of options that can be accessed with each device may be specified and/or edited by the NOHIMS system manager using the security option in the system maintenance modules. Actual data files may only be reached by logging on to NOHIMS with the programmer's access code. This access may be restricted for each device by indicating whether the log-on sequence for the device should be in normal mode or programmer's mode.

Time-Outs. In each component, if a command is not received by the terminal within a predetermined time period (for example, 60 seconds) NOHIMS will "back-out" one level in the option driver. This backing-out process continues until the system is exited. The purpose of this feature is to hinder unauthorized access to NOHIMS if the terminal is left unattended for an extended period of time. However, if the user has proceeded deep enough into the system, such as to the Directory Edit option in the medical component, this time-out feature will not be invoked.

Scrambled Identification Codes. NOHIMS does not have scrambled identification codes. Instead, during log-on, the user's identification code either is masked over with symbols on a printing terminal or not shown at all on a video terminal to preserve the integrity of the log-on codes.

Separate Files for Personnel Information and Medical Information. The industrial component and the medical component reside in different partitions on the mainframe called UCIs. All data files and security files (containing user identification codes, device tables, etc.) are kept separately in these two UCIs. Users of the industrial component may not access the medical database or the medical modules from the industrial component UCI. The medical component has an OCCUPATIONAL HEALTH INFORMATION option in the main option driver that was intended to provide access to the industrial component; however, this link has not been established yet. Currently, a medical component user is required to back-out of the medical component UCI and log-on to the industrial component UCI in order to access the industrial component. In practice, the medical users do not have access codes for the industrial component and, therefore, do not access the industrial component.

The only existing interfaces between the industrial component and the medical component are part of the PATIENT SUMMARY option in the Display Medical Data module of the medical component and the MOVE SSNS FROM INDUS UCI option in the COSTAR Report Generator module of the medical component. The PATIENT SUMMARY option displays current exposure data from the industrial component for the patient selected. The exposure data are obtained from a special global in the industrial UCI that is separate from the industrial database globals. The MOVE SSNS FROM INDUS UCI option accesses the same special global and copies a series of worker Social Security Numbers into a special global in the medical component. This latter function is part of a series of five options designed to

generate data for use by the Naval Health Research Center. The operational site users will not have access to these options.

Masked Fields. NOHIMS does not use masked fields in the data files. The developers considered the other NOHIMS logical security controls to be sufficient to protect the database.

NOHIMS has four other logical security features that were not described in the NOHIMS SDP.

Limiting Access to Functions by Class of User/Identification Code of the User. In the medical component of NOHIMS, the system manager may specify and/or change the modules and/or options that a particular class of users may access. For example, personnel not involved in data entry may be limited to display and retrieval functions, and access to important functions such as the System Maintenance module may be limited. The industrial component goes to one more level of specificity and allows the system manager to limit access to modules and/or options for each individual user, rather just a class of users.

Interplay of Access Limitations by Device and by Class of User/Identification Code of User. The access specifications for a given user and the device currently being used are combined to determine the modules and/or options that may be accessed by that user using that device. Only those modules and/or options that are allowed for both the user and the device will be accessible.

Confidentiality Warnings. The Encounter Report and Patient Summary produced by the medical component of NOHIMS either display or print the confidentiality warning "FOR OFFICAL USE ONLY. Data Contained Herein Are Subject to the Privacy Act of 1974."

Interrupt Trap. NOHIMS options in the medical component that run for long periods of time may be interrupted by the user. These functions have an interrupt trap that will return the user to the system option menu if the function is interrupted. This security feature prevents the user from falling out of NOHIMS into the operating system. None of the processes in the industrial component may be interrupted and so this feature is not needed in the industrial component.

Error Trap. Both the industrial and medical components have extensive error trapping mechanisms. If a program error occurs, the error is recorded in one of the NOHIMS error logs and the user is returned to a system option menu. These traps prevent inadvertent access to the operating system.

NOHIMS Physical Security Features

NOHIMS physical security as outlined in the SDP includes cipher locks on doors, a log book for people entering the computer room, and a record of batch programs. Currently, the mainframe PDP 11/24 on which NOHIMS resides for the San Diego test site is located at the Naval Health Research Center (NHRC). There are cipher locks on the door to the computer room at NHRC. However, they do not keep a log book of noncomputer personnel entering the room nor do the rooms that contain terminals and printers connected to the PDP have cipher

locks. At the North Island test site, neither the Occupational Health Unit nor the Industrial Hygiene Division rooms that contain the terminals and printers have cipher locks. At Bremerton, the door to the room that contains the Plessey mainframe has cipher locks. There is no log book for people entering this computer room. As no batch programs are run for NOHIMS, the third physical security feature is not applicable to either site.

Summary

NOHIMS has all of the logical security features that were described in the SDP except for one. NOHIMS limits access to certain functions by password and limits access to files by device. It has passwords to log-on, time-outs at system prompts, concealed identification codes, and separate files for personnel and medical information. It does not store data using masked fields. In addition, NOHIMS limits access to functions by class of user in the medical component and by individual user in the industrial component. It also has interplay between the access limitations by device and the access limitations by class of user/identification code of user, confidentiality warnings on medical displays/reports, and interrupt traps and extensive error trapping to prevent inadvertent access to the operating system.

Access to the two NOHIMS mainframes is limited by cipher locks on the doors to the computer rooms. Cipher locks are not used on rooms containing printers and terminals at the San Diego test site. Neither test site uses log books to record entry of noncomputer personnel to the computer room. Records of batch programs are not applicable to NOHIMS.

Evaluation of Adequacy of Security Features

We asked three NHRC NOHIMS developers, seven higher level Navy managers, six medical care providers, five industrial hygienists, and two system managers to assess the adequacy of NOHIMS security features. (One system manager has been categorized as both an NHRC NOHIMS developer and as a system manager in this evaluation. He was counted as a system manager for the purposes of this section.) We questioned the interviewees about the adequacy of certain security features, to what degree in their opinion the security features are being utilized, how sufficient the security protection provided by NOHIMS is, areas of protection that are lacking, and, lastly, whether the security protection provided by NOHIMS is necessary. Component 13 of Appendix A contains the questions that we used for this portion of the evaluation. In general, the tables show that a large number of people made no comment for each question. Many of these people felt that they did not know the feature well enough to comment.

Table 27 presents the respondents' assessment of the adequacy of sign-on/off procedures to prevent unauthorized access to NOHIMS. Sixty-five percent of those who responded to this question felt that the protection provided by the sign-on/off procedures (including the log-on identification code) were adequate or very adequate to prevent unauthorized access to NOHIMS. Two higher level managers (14% of the respondents) gave NOHIMS a somewhat adequate rating, one medical care provider (7%) gave NOHIMS a somewhat inadequate rating, and one higher level manager and one industrial hygienist (14%) gave NOHIMS a rating of

TABLE 27
Adequacy of Sign-On/Off Procedures To Prevent Unauthorized Access to NOHIMS
(Number who mentioned rating)

	NHRC NOHIMS Developers	Higher Level Managers	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
Very adequate	1	2	1	2	2	8	58
Adequate*	1	0	0	0	0	1	7
Somewhat adequate	0	2	0	0	0	2	14
Somewhat inadequate	0	0	1	0	0	1	7
Very inadequate	0	1	0	1	0	2	14
TOTAL WHO ANSWERED	2	5	2	3	2	14	100
No Comment	1	2	4	2	0	9	
TOTAL INTERVIEWED	3	7	6	5	2	23	

* Category added by respondent

very inadequate with regard to the sign-on/off procedures. Both the higher level manager and the industrial hygienist who gave the sign-on/off procedures a rating of very inadequate felt that not enough characters were used in the log-on identification codes. NOHIMS allows identification codes of from three to five characters. Most of the codes used at the test sites are just three characters. An industrial hygienist at Bremerton commented that he likes the identification codes. Two individuals expressed concern that anyone who wishes can gain access to the system. One of these people, a higher level manager, felt that there was a need to "increase the sign-on/off feature somehow," but did not have specific improvements in mind.

An NHRC NOHIMS developer raised two security issues that relate more to "database integrity protection issues than confidentiality issues." He saw a potential for misuse of the MUMPS operating system via the programmer's access code and problems with MUMPS itself. For example, he thought that an interrupt in the Interactive Query of the industrial component could exit the user to programmer's mode rather than a system menu. The contracted NOHIMS developer reports that the Interactive Query cannot be interrupted, however.

Table 28 shows the interviewees' assessment of the adequacy of the various security levels in NOHIMS (by device, by user identification code or user classification, and through passwords for specific options) to prevent unauthorized access to NOHIMS. A large number of the interviewees were not aware of these NOHIMS security features and, therefore, could not assess their adequacy. Of those who rated the adequacy of these NOHIMS features, nine (90%) felt that these various security levels were very adequate or adequate to prevent unauthorized access to NOHIMS. One higher level manager (10% of all respondents) gave NOHIMS a rating of somewhat inadequate in this area, although he did not explain why. An NHRC NOHIMS developer felt that the option choices for setting device and user access limitations should be more detailed. For example, access to Survey Data should be broken down into access to Survey Data and to Environment Data since NOHIMS may automatically allow the user access to Environment Data from the Survey Data option.

Only three interviewees commented on the adequacy of the confidentiality warnings on the medical input and output documents to maintain the confidentiality of patient/worker data. The rest of the interviewees had not seen the warning messages (see Table 29). Two of the respondents thought that the confidentiality warnings were very adequate and one thought that they were somewhat adequate. The system manager who rated the adequacy of the confidentiality warnings stated that they "met Navy regulations." The NHRC NOHIMS developer who assessed the adequacy of the messages felt that they should be on the Individual Exposure Examination Report as well as on the medical component reports.

We next asked the NHRC NOHIMS developers, medical care providers, industrial hygienists, and system managers to what degree the security protection features provided by NOHIMS are utilized at the test sites. Of the seven people who responded to this question, six (86%) thought that the features were fully utilized (see Table 30). The system manager at the Bremerton test site thought that the utilization of the features was "somewhere between fully and loosely utilized." One industrial hygienist at Bremerton commented that "everyone knows each other's ID code," although he did not seem to feel that this has presented any security problems.

TABLE 28
Adequacy of Various Security Levels To Prevent Unauthorized Access to NOHIMS
(Number who mentioned rating)

	NHRC NOHIMS Developers	Higher Level Managers	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
Very adequate	1	2	0	3	2	8	80
Adequate*	1	0	0	0	0	1	10
Somewhat adequate	0	0	0	0	0	0	0
Somewhat inadequate	0	1	0	0	0	1	10
Very inadequate	0	0	0	0	0	0	0
TOTAL WHO ANSWERED	2	3	0	3	2	10	100
No Comment	1	4	6	2	0	13	
TOTAL INTERVIEWED	3	7	6	5	2	23	

* Category added by respondent

TABLE 29
Adequacy of Confidentiality Warnings on Medical Input and Output Documents
To Maintain the Confidentiality of Patient/Worker Data
(Number who mentioned rating)

	NHRC NOHIMS Developers	Higher Level Managers	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
Very adequate	0	1	0	0	1	2	67
Somewhat adequate	1	0	0	0	0	1	33
Somewhat inadequate	0	0	0	0	0	0	0
Very inadequate	0	0	0	0	0	0	0
TOTAL WHO ANSWERED	1	1	0	0	1	3	100
No Comment	2	6	6	5	1	20	
TOTAL INTERVIEWED	3	7	6	5	2	23	

TABLE 30
Utilization of NOHIMS Security Protection Features
(Number who mentioned category)

	NHRC NOHIMS Developers	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
Fully utilized	1	0	4	1	6	86
Between fully and loosely utilized*	0	0	0	1	1	14
Loosely utilized	0	0	0	0	0	0
Ignored	0	0	0	0	0	0
Bypassed	0	0	0	0	0	0
TOTAL WHO ANSWERED	1	0	4	2	7	100
No Comment	2	6	1	0	9	
TOTAL INTERVIEWED	3	6	5	2	16	

* Category added by respondent

Table 31 presents the interviewees' general assessment of the sufficiency of NOHIMS security protection. Seventy percent of those who rated the general sufficiency of the NOHIMS security protection gave NOHIMS a rating of sufficient. One medical care provider (6% of the respondents) gave NOHIMS a rating of somewhat sufficient. Two users (12%) said that the security protection was somewhat insufficient and two users (12%) felt that the protection was insufficient. A medical care provider commented that "physical security is lacking" and that "codes are too easy to figure out since people's initials are used." A system manager reported that the ID codes print on some printers that do not recognize a backspace character. An industrial hygienist reported that some terminals do not always time-out if left unattended. Another industrial hygienist felt that the identification codes should contain more characters. A higher level manager also felt that the sign-on codes had too few characters. Another higher level manager expressed concern over inadequate sign-on/off procedures and the physical accessibility of the system.

Nearly all of the interviewees heartily agreed that the security protection provided by NOHIMS is necessary because of the sensitive nature of the medical data (see Table 32). One higher level manager commented that database security is an "important issue with workers [in order] to keep their confidence [in NOHIMS]." The medical care provider who gave an "other" rating to this question felt that all of the security features were very appropriate, but that the protection is "probably too much if medical care providers are limited by class."

Summary

Sixty-five percent of the respondents felt that the NOHIMS sign-on/off procedures are adequate or very adequate to prevent unauthorized access to NOHIMS. Four people felt that the sign-on procedures should be augmented in some fashion, however. Two of these people felt that the sign-on identification codes should have more characters. Ninety percent of the interviewees who rated the adequacy of the various security levels in NOHIMS felt that they were adequate or very adequate to prevent unauthorized access to NOHIMS. A large number of the people interviewed were not even aware of these features, however. Only three people commented on the adequacy of confidentiality warnings in the medical input and output documents. All three respondents thought that they were somewhat to very adequate. The NOHIMS security protection features are pretty much fully utilized at the test sites, although ID codes are not kept strictly secret. Seventy percent of those who rated the general sufficiency of the NOHIMS security protection felt that it was sufficient. Areas of weakness that were mentioned included the nature of the log-on identification codes and physical security controls. All but one interviewee agreed that the security protection provided by NOHIMS is necessary.

DESCRIPTION OF HARDWARE AND SOFTWARE SUPPORT REQUIREMENTS

The following describes the hardware and software support requirements for NOHIMS.

TABLE 31
Sufficiency of NOHIMS Security Protection
(Number who mentioned rating)

	NHRC NOHIMS Developers	Higher Level Managers	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
Sufficient	2	3	0	4	2	11	70
Somewhat sufficient	0	0	1	0	0	1	6
Somewhat insufficient	0	1	0	1	0	2	12
Insufficient	0	1	1	0	0	2	12
TOTAL WHO ANSWERED	2	5	2	5	2	16	100
No Comment	1	2	4	0	0	7	
TOTAL INTERVIEWED	3	7	6	5	2	23	

TABLE 32
Necessity of NOHIMS Security Protection
(Number who mentioned rating)

	NHRC NOHIMS Developers	Higher Level Managers	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
Necessary	3	7	2	5	2	19	95
Somewhat necessary	0	0	0	0	0	0	0
Somewhat unnecessary	0	0	0	0	0	0	0
Unnecessary	0	0	0	0	0	0	0
Other*	0	0	1	0	0	1	5
TOTAL WHO ANSWERED	3	7	3	5	2	20	100
No Comment	0	0	3	0	0	3	
TOTAL INTERVIEWED	3	7	6	5	2	23	

* Category added by respondent

Hardware Support Requirements

Currently in San Diego, NOHIMS resides on a Digital Equipment Corporation PDP 11/24 located at the Naval Health Research Center (NHRC). NHRC personnel estimate that they have required a system manager two hours per week (.05 FTE) and an electronic technician four hours per week (.1 FTE) to support the system. In addition, they have utilized one outside consultant on demand for telecommunication problems and have maintenance contracts with two vendors, Digital Equipment Corporation (for the central processing unit) and Systems Industries (for the disk packs and tape drive). These support personnel presently perform a variety of functions including installation and configuration of hardware, reconfiguration of hardware, periodic maintenance, weekly system back-ups, repacking of disks, and repairs. The NHRC NOHIMS developers estimate that in the future one FTE system manager, 1 FTE assistant system manager, and one vendor for several hours per month would be able to maintain NOHIMS for the entire San Diego region.

In Bremerton, NOHIMS runs on a Plessey 11/23. Hardware support has been provided through one half-time system manager and a maintenance contract with Plessey Peripherals. Only 15 hour per month of the system manager's time is devoted to hardware support, however. The support functions that have been provided include periodic maintenance and system back-ups which are performed every two weeks.

In the future, NOHIMS will require long-term file maintenance, record archiving when disks become full, and decisions about file-disk set-ups. The frequency of these functions will depend on the size of the applications and hardware constraints.

Software Support Requirements

Virtually no software support is needed for the industrial component of NOHIMS. The internal integrity checks in the system mean that NOHIMS is reliable and operationally error-free. The industrial component does require system support by a system manager to ensure that the tables and directories are kept up-to-date and to review the error reports. The contracted NOHIMS developer for the industrial component estimates that 20 hours per month of system support (.12 FTE) will be required to maintain each NOHIMS site.

The medical component of NOHIMS requires minimal ongoing software support to fix software problems. During the first months of installation and operation of the medical component, outside software support was required frequently, but now the medical component operates relatively free of software support. Unless changes or additions are made to the data collection forms, minimal system support for the tables and directories is required. A system manager should review the error logs and start and stop monitor on an at least daily basis because the error logs may indicate impending system problems. The contracted NOHIMS developers for the medical component estimate that a minimum of 20 hours per month of system support (.12 FTE) will be required to maintain each NOHIMS site. If new versions of existing forms or additional encounter forms are developed, the system support (forms design, directory work, etc.) to implement these forms is expected to be substantial.

Summary

Hardware short-term support functions for NOHIMS include installation and configuration of hardware, reconfiguration of hardware, periodic maintenance, system back-ups, repacking of disks, and repairs. Long-term support requirements include file maintenance, record archival, and decisions about file disk set-ups. The frequency of these functions and the amount of support personnel or contracts required will depend on the size of the application.

Very little software support is required to maintain the industrial component of NOHIMS. Approximately 20 hours per month of system support will be required to maintain each NOHIMS industrial site. The medical component requires minimal ongoing system support, unless changes or additions are made to the data collection forms. Again, approximately 20 hours per month of basic system support will be required to maintain each medical component site.

DESCRIPTION OF AVAILABLE SYSTEM SUPPORT

NOHIMS will require system support in four areas: the initial training of NOHIMS users, ongoing and update training of NOHIMS users, NOHIMS hardware and operating system support, and NOHIMS software support. The following subsection discusses the resources that are available for these areas of NOHIMS system support.

System Support for Initial and Ongoing Training

The system support resources that will be available for initial and ongoing training in the use of NOHIMS include a Computer-Aided Instructional (CAI) module, the Navy Regional Data Automation Center (NARDAC), the COSTAR Users' Group (CUG), extensive system documentation, and regional/local NOHIMS system managers.

The Naval Medical Research and Development Command (NMRDC) under the auspices of the Department of Defense Small Business Innovation Research program recently funded R-K Research and System Design, Malibu, California to develop a Computer-Aided Instructional (CAI) module for NOHIMS. During the first year of this contract, adaptable instructional software will be incorporated into the NOHIMS CAI module for the industrial component. If the contract is funded for a second year, the medical component will be incorporated into the CAI module in the second year. When completed, the interactive CAI module for NOHIMS will be useful for both initial and ongoing training of personnel in the use of the industrial and medical components. The module will be geared for different levels of NOHIMS users such as data entry clerks, system managers, industrial hygienists, and medical care providers. The CAI system will also have features that allow curriculum designers and training specialists to author, modify, and maintain the NOHIMS CAI module.

Currently, technical support for NOHIMS is provided by the Naval Health Research Center (NHRC), San Diego, California. NHRC, through its own staff and

contractors, has provided some training to the two NOHIMS sites. When NOHIMS is installed at other Navy industrial sites, the Navy Regional Data Automation Center (NARDAC), Washington, D.C. will be responsible for conducting on-site initial training and subsequent ongoing and update training. Presently, NARDAC is learning to implement and support NOHIMS in preparation for these upcoming endeavors. In the future, NARDAC may wish to contract with the original NOHIMS developers for assistance or support in the training functions.

The COSTAR Users' Group (CUG), a national organization of people involved with COSTAR (the basis for the medical component of NOHIMS), is another resource for NOHIMS training support. CUG provides a variety of COSTAR support services. It distributes public domain documentation for COSTAR along with other brochures and handouts for a nominal fee. CUG also publishes The COSTAR Times (a monthly newsletter) to keep CUG members informed of COSTAR events and developments and distributes a list of COSTAR consultants and vendors. In addition, CUG sponsors an annual series of meetings and tutorials in conjunction with the MUMPS Users' Group annual meeting. This week-long meeting is held each year at a major city in the United States, alternating East Coast, Midwest, and West Coast locations. The COSTAR tutorials at the meeting cover both introductory material such as installation considerations as well as advanced topics including the COSTAR Report Generator and the Medical Query Language.

NOHIMS has voluminous system documentation. Both the medical and industrial components have extensive operations and system maintenance manuals written specifically for NOHIMS to support and augment the system's on-line assistance functions. These are the NOHIMS Users' Reference Manual and the NOHIMS System Manager's Manual for the medical component and the NOHIMS User's Guide and the NOHIMS OHS System Maintenance Manual for the industrial component. These manuals explain the purpose of each module of the system and the options under each module. In addition, the documentation for the medical component contains examples of typical data entry sequences and job aids that contain lists of patient items or codes that may be referenced during data entry. The job aids include Possible Patient Items in Registration and Data Items Specified as Other (Hazardous Agent Surveillance, Laboratory Tests, Radiology, Problem Codes, and ICD-9-CM Diagnoses). The manual also contains three clear plastic overlays to be used in entering data from the Asbestos Medical Surveillance Program and the Hearing Conservation Program. These manuals and job aids will be useful for training by NARDAC as well as self-training of NOHIMS users. Also, NARDAC has obtained a copy of the COSTAR public domain documentation from CUG for use in training NOHIMS users.

Since the Navy has frequent turnover of staff positions, it is essential that a resource for ongoing support and training be readily accessible. Once a region (or site) has received initial training in the use of NOHIMS, the regional (or local) NOHIMS system manager should be able to support NARDAC in the ongoing training of system users.

System Support for NOHIMS Hardware and Operating System

The system support that is required for the NOHIMS hardware and operating system will depend greatly on the hardware and operating system that are selected for NOHIMS. Currently in San Diego, hardware and operating system support for NOHIMS is provided through maintenance contracts with hardware and

operating system vendors (including technical hot lines to the vendors) and support personnel at NHRC. The NHRC NOHIMS developers estimate that one full-time system manager, one full-time assistant system manager, and one vendor contracted for several hours per month will be required to maintain NOHIMS for an entire region similar to the San Diego region. In Bremerton, hardware support is provided for several hours per month by the system manager and also through a maintenance contract with the hardware vendor. In the future, the Navy Regional Data Automation Center (NARDAC) will also be responsible for providing hardware support.

System Support for NOHIMS Software

The system support for NOHIMS software is presently being provided by the Naval Health Research Center (NHRC). When NHRC personnel have been unable to troubleshoot software problems, they have called upon the NOHIMS contracted developers. When NOHIMS is installed at Navy industrial sites other than the two test sites, the Navy Regional Data Automation Center (NARDAC), Washington, D.C. will provide the ongoing technical support for NOHIMS.

The local system manager will also be able to provide some software system support through the Maintenance module in the industrial component and the Systems Maintenance module in the medical component. Both of the maintenance modules have options that allow the system manager to view hardware and software errors that have been detected by the system. The industrial component also has an option that performs integrity checking on the industrial component database to maintain data integrity. Many of the errors detected by this function can be automatically corrected by the system. The medical component relies on operating system utilities to test the integrity of the database in the event of a system crash. If data or routines are lost, however, programming intervention from NARDAC will probably be required.

Summary

The system support resources that will be available for initial and ongoing training in the use of NOHIMS include a Computer-Aided Instructional (CAI) module, the Navy Regional Data Automation Center (NARDAC), the COSTAR Users' Group (CUG), extensive system documentation, and regional/local NOHIMS system managers. Possible sources for hardware support include contracts with hardware vendors (many of whom have technical hot lines), local/regional system managers, and NARDAC. Both NARDAC and the local system managers will be able to provide system support for the NOHIMS software.

DESCRIPTION OF SCENARIOS TO MAINTAIN NOHIMS

The scenarios to maintain NOHIMS fall into three categories: (1) prime-time system maintenance functions, (2) off-shift system maintenance functions, and (3) record archiving.

Prime-Time System Maintenance Functions

A NOHIMS system manager must perform a few tasks on a daily basis in order to maintain NOHIMS. Both the industrial and medical components require that the system manager review the error log/error reports on an at least daily basis. If errors have been detected, the system manager will be required to investigate or obtain assistance in investigating the source of the error in order to resolve the problem. The review of the error logs/error reports is an important function because the error logs may indicate an impending system problem. In the medical component, the system manager must also review the status of Monitor (the caretaker job that manages filing transactions) to be certain that it is running. If Monitor has crashed, the system manager must restart the Monitor. The Monitor should also be started and halted on a daily basis to allow the medical component to perform housekeeping chores.

Off-Shift System Maintenance Functions

Three off-shift system maintenance functions are required to maintain NOHIMS. A system image back-up of all of the NOHIMS routines, files, and database should be made to another disk on a daily basis. This will insure that the most data that would need to be re-entered in the event of a system crash would be one day's worth of entry. If a NOHIMS site has minimal entry to the system, the frequency of back-ups could be adjusted downward accordingly. Currently, the Naval Health Research Center (NHRC) is making disk-to-disk back-ups of each component on a weekly basis and disk-to-tape back-ups on a monthly basis. Other off-shift tasks include repacking data disks periodically and recreating the medical component alphabetic directory on an as needed basis. NHRC estimates that it has repacked NOHIMS data disks every six months. The alphabetic directory needs to be recreated if changes or additions are made to modifier short names.

Record Archiving

Record archiving only needs to be performed as often as required to maintain enough disk storage space for new records. Thus, it is very dependent on the hardware configuration and the size of the application. Periodic repacking of data disks will minimize the amount of record archiving that is required. So far, neither NOHIMS test site has needed to archive worker/patient records. As an alternative to record archiving, additional disk packs could be purchased keeping data on-line and accessible at all times.

Summary

Prime-time system maintenance functions include at least daily review of error logs for both components, and daily starting and halting of Monitor and review of the status of Monitor in the medical component. Off-shift system maintenance functions include daily system back-up to disk, periodic back-up to tape, periodic repacking of data disks, and recreation of the medical component alphabetic directory as needed. Record archiving will need to be performed when data disks become full unless additional disks are purchased.

DESCRIPTION OF ORGANIZATIONAL REQUIREMENTS

The organizational requirements for operation of NOHIMS are described below. This discussion covers the degree of MUMPS programming knowledge that is required to operate NOHIMS, the level of comprehension of source code required, a personnel staffing description, and requirements for installation area configurations.

MUMPS Programming Knowledge

NOHIMS users do not need to have any knowledge of the MUMPS programming language in order to use NOHIMS. Both the medical and industrial components of NOHIMS have user-friendly log-on procedures and utilize option menus to direct the user through the system. Extensive intrinsic on-line assistance aids the user in operating the system.

The NOHIMS system managers do not need to have programming skills to perform the maintenance functions accessible through the system options. A minimal amount of MUMPS knowledge would be useful to a system manager for resolving some of the minor system problems that occur, such as freeing a busy record in the medical component. Familiarity with MUMPS global file structures and access to the operating system manual would be useful in deciphering error logs/error reports.

NOHIMS Source Code Comprehension

Comprehension of NOHIMS source code is not necessary in order to operate NOHIMS. If the system manager understands some of the source code, however, this would be useful in debugging system errors or in assisting technical support in doing the same. Knowledge of NOHIMS source code is essential, however, if changes in software functions not alterable through the maintenance modules are required, or if special input or output conditions or pattern matches are required for a directory code. However, the software for both components is extremely complex. Software modifications should only be made by people who have a thorough understanding of both MUMPS and the NOHIMS source code. Changes should always be made in a test system first.

Personnel Staffing Description

The staff required to operate a NOHIMS installation include data collection personnel, data entry personnel, system managers, and support personnel. At the two test sites, the data collection tasks were added to the already existing industrial hygiene and medical personnel functions. This created additional work for both types of personnel. Currently, the medical personnel at the Occupational Health Unit (OHU), North Island are required to maintain a dual medical record: both the traditional paper chart and the new NOHIMS record are required. Personnel allocations for NOHIMS sites will need to take into account the additional work required by NOHIMS.

Both the industrial and medical components of NOHIMS will require data entry personnel. At present, the OHU has one full-time data entry clerk, while

the Bremerton industrial component site requires a half-time data entry clerk. The San Diego industrial component site does not have data entry personnel and, consequently, is behind on survey data entry. The number of data entry personnel required can be determined using the average number of entries per day at the two test sites. A full-time data entry clerk could probably enter data for 16-24 average-sized surveys per day, while the medical component data entry clerk could probably enter 30-40 complete medical records per day.

Both the industrial and medical components require a local system manager approximately 20 hours per month for system software support such as error log review. Even more of the system manager's time will be required if he/she becomes involved in troubleshooting hardware problems, data entry verification, ongoing training, and/or data retrieval functions such as queries and report generator reports. If the hardware resides at the actual application site, the system manager will also need several hours per month to make system back-ups.

NOHIMS requires some degree of support personnel to provide hardware support and to augment the system support provided by the local system manager. The NOHIMS developers at the Naval Health Research Center estimate that an application such as the San Diego region would require one full-time system manager, one full-time assistant manager, and a vendor contracted for several hours per month to maintain NOHIMS. This estimate assumes that the region has a centralized host computer with remote work stations.

Installation Area Configuration

The requirements for the NOHIMS installation areas will depend greatly on whether the installation has a computer resident at the application site or whether the central processing unit resides off-site. It will also depend on the hardware selected. Issues that should be considered in configuring the work areas include electrical/power source requirements such as power conditioning, surge suppressors, and/or battery back-up; lighting requirements; communications requirements such as the type of communication lines used; heating/cooling requirements; space and room requirements such as raised floors and room dimensions; furniture equipment requirements; and other requirements such as a non-water fire suppression system. The installation should be managed by the hardware vendor and should comply with all government and vendor requirements. Each hardware manufacturer publishes environment requirements such as power requirements, air conditioning requirements, and line specifications for its equipment which can be used as guidelines during the installation process.

Area configuration requirements should be considered carefully before hardware installation. If these issues are not adequately addressed prior to installation, deficiencies in the environment can lead to serious problems. These performance problems may include system downtime and database degradation, possibly resulting in loss of data and/or operating time.

Summary

System users and system managers do not need to have any knowledge of the MUMPS programming language in order to use NOHIMS; however, a minimal amount of MUMPS knowledge would be useful to a system manager for resolving minor system

errors. Comprehension of MUMPS source code is not necessary, although again, a system manager would find a little understanding useful during error debugging. Staffing allocations at NOHIMS sites should take into account the additional time required by regular personnel to collect NOHIMS data. Appropriate numbers of data entry personnel, system managers, and support personnel will also be required to operate a NOHIMS installation. The number required will depend on the size of the application and the hardware configuration (remote versus centralized, for example). The installation area configuration will also greatly depend on the application size and hardware configuration. Issues to be considered in planning the installation area include electrical/power source requirements, lighting requirements, communications requirements, heating/cooling requirements, space and room requirements, furniture and equipment requirements, and other requirements. These issues must be adequately addressed prior to installation in order to prevent serious system performance problems.

DESCRIPTION OF MINIMUM HARDWARE REQUIREMENTS

The following describes the minimum hardware requirements for NOHIMS in terms of the host computer configuration, remote work station requirements, and telecommunication requirements.

Host Computer Configuration

The minimum host computer configuration for NOHIMS can vary depending on the size of the NOHIMS application. NOHIMS will run on any hardware that can support multi-user ANSI Standard MUMPS and that has the minimum hard disk requirements for the particular application. MUMPS systems exist for DEC, Data General, Harris, Plessey, Prime, Tandem, and IBM minicomputers. MUMPS systems also exist for several microcomputers such as Tandy, IBM, Convergent Technologies (Burroughs/NCR equivalents), COMPAQ, Motorola, and Olivetti. The industrial component of NOHIMS requires a minimum of a 10K partition in system memory and 5 megabytes of hard disk storage in addition to the basic memory requirements for MUMPS. The medical component requires a minimum of a 6K partition of system memory, 4-8 megabytes of hard disk storage for the COSTAR routines and directories (dependent on the version of MUMPS used), and an additional 10-40 megabytes of disk storage for patient record storage (COSTAR uses approximately 1,000-2,000 bytes per encounter stored). In addition, the system will require some sort of back-up mechanism, either a streaming cassette or cartridge, magnetic tape drive, or removable disk packs. Ideally, the system would have a combination of back-up mechanisms. If NOHIMS is run on a microcomputer, a Bernoulli box can also be used for back-ups. The decision as to whether dial-up ports are required will depend on the type of data lines used to access the system. The Telecommunications Requirements section below discusses data line requirements in further detail.

Remote Work Station Description

At remote sites, the minimum configuration for running NOHIMS would be a CRT terminal. NOHIMS can accommodate a variety of terminal/cursor types including any hardcopy device, Infoton standard or Vistar with number pad, dumb

terminals, and smart terminals. NOHIMS at this point in time does not support terminals with split screen features. If a softcopy device is chosen for a remote site, the users must also have access to a printer or printing terminal (with keyboard) for producing hardcopies of reports. Printing terminals are useful as a second device because although they are slower to operate, they can serve as a back-up instrument for the CRT should it fail.

Telecommunication Requirements

Telecommunication requirements vary with the hardware configuration. Generally, remote sites within 100 feet of the host computer can be linked directly by cable. Beyond 100 feet, dedicated data lines or nondedicated local lines with dial-in capability would be required. Microwave circuits can also be used; however, they are usually more costly. If utilization will be low, local nondedicated lines with modems at either end will probably be adequate. Dedicated lines (point-to-point circuits) would be a better choice if utilization will be high or if there will be several simultaneous users. A multiplexor can be connected to a dedicated line to allow multiple users on the same line.

With either type of communication line, a single connection can be used to alternately link two devices if a Y-junction (sometimes called a printer selector switch) is used. The users determine which device is to be connected to the computer by flipping the switch.

Summary

The minimum host computer configuration for NOHIMS varies depending on the size of the application. Minimum requirements include a central processing unit with 16K of system memory in addition to the memory requirements for MUMPS, a hard disk drive and disk pack with 20-55 megabytes of storage, and a back-up mechanism such as a streaming cassette or cartridge, magnetic tape drive, or removable disk packs. A remote site requires a minimum of one CRT terminal. A printing terminal (with keyboard) would also be useful. Remote sites will require access to at least one local line or one dedicated data line. If local telephone lines are used, a dial-up port on the host computer and a modem at each end of the line will be necessary.

EVALUATION OF THE SUITABILITY OF NOHIMS TO NAVY INFORMATION PROCESSING NEEDS

We investigated the suitability of NOHIMS to Navy information processing needs in three areas: information collection, information retrieval, and information manipulation. We interviewed the four Naval Health Research Center (NHRC) NOHIMS developers, seven higher level managers, five industrial hygienists, and six medical care providers using the interview guide on suitability found in Appendix A, Component 19. The Bremerton system manager was also inadvertently asked this series of questions. We included his results with the industrial hygienists as his comments were useful and relevant to his collateral position as an industrial hygienist.

The questions we asked attempted to elicit the respondents' assessment of the suitability of NOHIMS to Navy information collection, information retrieval, and information manipulation needs, and an overall assessment of the adequacy of NOHIMS for Navy information processing needs. In addition, we solicited comments on areas of NOHIMS that required changes to make it more suitable for Navy needs.

Four of the medical care providers did not respond to the questions on the assessment of suitability of NOHIMS because we were running short of time and we felt that other questions were more important for them to answer. We did ask the medical care providers to indicate if there were changes that were required to make the system more suitable, and what their overall assessment of the adequacy of NOHIMS for Navy information processing needs was.

Navy Information Collection Needs

Table 33 shows that 100 percent of those who assessed the suitability of NOHIMS for Navy information collection needs thought that NOHIMS was very suitable. Currently, NOHIMS either collects or is planned to collect data in the following six categories.

- Personnel data
- Hazardous materials characteristics
- Presence of hazardous materials
- Data on health of workers

  Illness and injuries (planned)
  Routine examinations
  Test and procedure results
  Medical histories (planned)

- Individual exposures and exposure histories
- Occupational histories (planned)

Table 34 contains the categories of additional data that respondents would like to see collected in order to make NOHIMS more suitable for Navy information collection needs. The most frequently mentioned category is data relating to accidents and/or incidents which was mentioned by 43 percent of those interviewed. Currently, these data are not being gathered by NOHIMS, although the developers intended that these data be collected. Environmental accidents and incidents may be stored in the industrial component of NOHIMS by defining the accident or incident as an environment (such as "May 1 spill of agent X") and assigning personnel affected by the accident or incident to the environment. The industrial hygienists, however, have not been trained to use NOHIMS in this manner.

In order of frequency of mention, occupational history data, illness and injury data, and medical history data are the next three types of additional data required in order to make NOHIMS more suitable according to the

TABLE 33
Assessment of Suitability of NOHIMS to Navy Information Collection Needs
(Number who mentioned rating)

	NHRC NOHIMS Developers	Higher Level Managers	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Who Answered
Very suitable	4	7	2	6	19	100
Somewhat suitable	0	0	0	0	0	0
Somewhat unsuitable	0	0	0	0	0	0
Very unsuitable	0	0	0	0	0	0
TOTAL WHO ANSWERED	4	7	2	6	19	100
No Comment	0	0	4	0	4	
TOTAL INTERVIEWED	4	7	6	6	23	

TABLE 34

Additional Information Collection Categories Required
(Number who mentioned category; multiple answers allowed)

	NHRC NOHIMS Developers	Higher Level Managers	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Interviewed
Accidents/ incidents (not implemented)	4	3	1	2	10	43
Occupational history (planned)	4	3	1	1	9	39
Illness and injury data (planned)	2	5	1	1	9	39
Medical history (planned)	3	2	1	1	7	30
Sick leave/ absenteeism	1	3	1	1	6	26
Mortality data	2	2	1	0	5	22
Ventilation data	0	1	0	1	2	9
More materials inventory	1	1	0	0	2	9
Automated entry of medical test results	0	0	1	0	1	4
TOTAL INTERVIEWED	4	7	6	6	23	

respondents. These categories were mentioned by 39 percent, 39 percent, and 30 percent of the respondents, respectively. Although each of these types of data were planned as a part of NOHIMS, as of the time that we evaluated the system they had not yet been implemented. Since NOHIMS is a directory-driven system, medical encounters for injury and illness care may be input to the system if data collection instruments and directory codes are created. As part of the implementation, lengthy encounter forms were developed and codes were added to the NOHIMS directory for the occupational and medical histories. Implementation of these forms is awaiting approval of the forms by other medical care providers and final testing of the forms.

Two other types of required data that were mentioned by the interviewees included sick leave or absenteeism data and mortality data which were mentioned by 26 percent and 22 percent of those interviewed, respectively. There is no plan to include either of these types of data in NOHIMS at this time. Adding ventilation data, additional materials inventory data, and automated entry of medical test results were also mentioned, but by only two or fewer of the respondents. Comments regarding the material inventory data were that more materials should be added to the inventory and that all of the information on the Material Safety Data Sheet should be included in the database. Also, distinctions should be made between hazards (e.g., benzene) and materials (e.g., cleaning fluid).

The respondents made several other notable comments in regard to the suitability of NOHIMS for Navy information collection needs. One NHRC NOHIMS developer stated that while the data were suitable for medical and industrial hygiene purposes, it was not suitable for safety purposes. An industrial hygienist commented that "NOHIMS has made the Navy improve its information collection and [has made it] standardize what is collected." Another industrial hygienist brought up the issue of access to the medical database at this point in the interviews. NOHIMS collects certain medical data that the industrial hygienist would like to see. However, since industrial hygienists have not been given access to the medical component of NOHIMS, the data are not readily available for use. A higher level manager feels that NOHIMS is "an excellent tool for the Navy Asbestos Medical Surveillance Program." Finally, one of the medical care providers commented that "[the NOHIMS] database is very thorough and professional [but] at the expense of more forms."

Navy Information Retrieval Needs

In Table 35, we see that 72 percent of those who evaluated the suitability of NOHIMS for Navy information retrieval needs thought that NOHIMS was very suitable. One person (6% of respondents) gave NOHIMS a rating of suitable, while four people (22%) rated NOHIMS as somewhat suitable for Navy information retrieval needs. The respondents who gave NOHIMS a somewhat suitable rating felt that NOHIMS was "lacking in some areas" of data retrieval capabilities.

The respondents suggested a variety of information retrieval needs that if met would make NOHIMS more suitable for Navy needs. Table 36 contains a list of the needs that the interviewees identified by user category. Within a category usually one, and at most two, of those in the category mentioned the need. None of the suggestions were made consistently through or across groups of respondents with the exception of the ability to retrieve historical exposure

TABLE 35

Assessment of Suitability of NOHIMS to Navy Information Retrieval Needs
(Number who mentioned rating)

	NHRC NOHIMS Developers	Higher Level Managers	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Who Answered
Very suitable	1	6	1	5	13	72
Suitable*	1	0	0	0	1	6
Somewhat suitable	2	1	0	1	4	22
Somewhat unsuitable	0	0	0	0	0	0
Very unsuitable	0	0	0	0	0	0
TOTAL WHO ANSWERED	4	7	1	6	18	100
No Comment	0	0	5	0	5	
TOTAL INTERVIEWED	4	7	6	6	23	

* Category added by respondent

TABLE 36
Information Retrieval Needs
(Mentioned once unless otherwise noted)

NHRC NOHIMS Developers

- Generate encounter forms from data items
- More management reports
- Links between medical and exposure data (two mentions)
- Retrieval of historical exposure data
- Tickler list of environmental surveys to be done

Higher Level Managers

- Spreadsheet capability
- Medical reports in standard Navy format
- Letters of referral to physicians
- Provide patient summary to worker

Medical Care Providers

- Assistance with creating and generating reports
- Retrieval of historical exposure data

Industrial Hygienists

- User-defined report formats
- Graphics capability
- Ability to retrieve data by testing variable values in industrial component
- Retrieval of historical exposure data
- Expanded word processing for generating narrative reports
- Additional training in retrieval capabilities (two mentions)

data. This need was mentioned by one NHRC NOHIMS developer, one industrial hygienist, and one medical care provider.

Other suggestions by the NHRC NOHIMS developers included the following. One developer would like to be able to automatically generate encounter forms from the data items in the NOHIMS directories. There was one mention each that NOHIMS should produce more management reports and produce a tickler list of environmental surveys to be conducted. Two developers mentioned that NOHIMS needs to be able to link exposure and medical data. Presently, one NOHIMS feature retrieves laboratory test and physical examination results for selected individuals. The selection criteria may include either exposure or medical data items. Another NOHIMS function prints exposure data from the industrial component in the Patient Data Sheet in the medical component. These developers felt that more capabilities such as these should be developed.

The higher level managers noted four changes to make NOHIMS more suitable for Navy information retrieval needs. A spreadsheet capability, medical reports produced in standard Navy format, ability to produce letters of referral to physicians, and production of some sort of a patient summary for the worker at the end of the physical examination were each mentioned once by the managers.

Medical care providers made two suggestions for improving the suitability of NOHIMS. One provider requested the ability to retrieve historical exposure data and another would like assistance with creating and generating reports. The medical care provider who mentioned this last need stated that "no one was bridging the gap from input to how to get it out to help count beans."

Finally, the industrial hygienists felt there were several changes that could be made to make NOHIMS more suitable to Navy needs. They requested user-defined formats for reports, a graphics capability, retrieval of historical exposure data, expanded word processing for generating narrative reports, and the ability to retrieve data by testing variable values in the industrial component. In addition, two of the industrial hygienists requested additional training in NOHIMS' existing information retrieval capabilities, especially the Query/Report module in the industrial component.

Navy Information Manipulation Needs

Table 37 shows the respondents' ratings of the suitability of NOHIMS to Navy information manipulation needs. Seventy-three percent of the respondents rated NOHIMS as very suitable or suitable. The other 27 percent gave NOHIMS a somewhat suitable rating. The NHRC NOHIMS developers and industrial hygienists thought that NOHIMS was less suitable for Navy manipulation needs than the higher level managers and the medical care providers did. All of the higher level managers and medical care providers gave NOHIMS a very suitable rating, while half of the NHRC NOHIMS developers and industrial hygienists gave NOHIMS a somewhat suitable evaluation.

The major criticisms of NOHIMS' data manipulation capabilities were that NOHIMS needs "a fuller capability to manipulate data....and needs more complex and sophisticated techniques [for data analysis]." Table 38 presents the additional data manipulation capabilities that the interviewees mentioned. Four of the 15 persons (27%) who assessed the data manipulation capabilities of

TABLE 37

Assessment of Suitability of NOHIMS to Navy Information Manipulation Needs
(Number who mentioned rating)

	NHRC NOHIMS Developers	Higher Level Managers	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Who Answered
Very suitable	1	6	1	2	10	67
Suitable*	1	0	0	0	1	6
Somewhat suitable	2	0	0	2	4	27
Somewhat unsuitable	0	0	0	0	0	0
Very unsuitable	0	0	0	0	0	0
TOTAL WHO ANSWERED	4	6	1	4	15	100
No Comment	0	1	5	2	8	
TOTAL INTERVIEWED	4	7	6	6	23	

* Category added by respondent

TABLE 38

Additional Data Manipulation Capabilities Required
(Number who mentioned capability; multiple answers allowed)

	NHRC NOHIMS Developers	Higher Level Managers	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Who Answered
Statistical interface	1	2	0	1	4	27
More analytical capabilities	3	0	0	0	3	20
More output of linked data to tape	1	0	0	0	1	7
TOTAL WHO ANSWERED	4	6	1	4	15	100
No Comment	0	1	5	2	8	
TOTAL INTERVIEWED	4	7	6	6	23	

NOHIMS specifically mentioned the need for statistics in some form. Three of the NHRC NOHIMS developers (20% of total respondents) suggested that NOHIMS should be enhanced with additional analytical capabilites. One developer suggested creating more abilities to output medical and exposure data to tape for analysis in other statistical/analytical software packages. As mentioned above, NOHIMS extracts laboratory test and physical examination findings values, reorganizes the data into a fixed length record format, and outputs the data to tape so that it can be used in standard statistical software packages. The records can be produced for subsets of patients defined by either the industrial or medical components or by combining lists from both components. It can also extract data for subsets of laboratory tests and physical examination results. It does not extract other types of medical data such as diagnoses, and does not extract data from the industrial component. The NHRC developer was suggesting that more capabilities such as this one should be developed.

Overall Assessment

Table 39 shows the respondents' overall assessment of the adequacy of NOHIMS for Navy information processing needs. Ninety-five percent of those who responded to the question gave NOHIMS a rating of adequate or better. Approximately two-thirds of these people (or 63% of the total who responded) gave NOHIMS a rating of very adequate for Navy information processing needs. The NHRC NOHIMS developers gave NOHIMS a lower rating than the other groups of respondents. Three of the four developers evaluated NOHIMS as adequate rather than very adequate. This may be a reflection of their strong desire for expanded data manipulation capabilities. Although we skipped over most of the previous questions with the medical care providers because of lack of time, we did ask the medical care providers to assess the overall adequacy of NOHIMS for Navy information processing needs. Half of the providers felt that they could not evaluate this aspect of NOHIMS; the other half gave NOHIMS a rating of adequate or better for meeting Navy information processing needs.

Summary

All of the interviewees who assessed the suitability of NOHIMS for Navy information collection needs thought that NOHIMS was very suitable. Nevertheless, there were several additional categories of data that they felt NOHIMS should collect. The six that were mentioned most frequently were data relating to accidents and incidents (43%), occupational history data (39%), illness and injury data (39%), medical history data (30%), sick leave or absenteeism data (26%), and mortality data (22%). NOHIMS already has the design potential to collect the first four types of data, but the features have not yet been implemented. Modifications to NOHIMS design would be required to collect sick leave or absenteeism data and/or mortality data.

Seventy-two percent of those who evaluated NOHIMS with regard to suitability for Navy data retrieval needs rated NOHIMS as very suitable. Many changes were suggested by the interviewees in order to make NOHIMS more suitable. The most frequently mentioned need was the ability to retrieve historical exposure data, which was mentioned by three of the 18 respondents (17%).

TABLE 39
Overall Assessment of Adequacy of NOHIMS
for Navy Information Processing Needs
(Number who mentioned rating)

	NHRC NOHIMS Developers	Higher Level Managers	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Who Answered
Very adequate	1	4	2	5	12	63
Adequate	3	1	1	1	6	32
Somewhat adequate	0	1	0	0	1	5
Somewhat inadequate	0	0	0	0	0	0
Inadequate	0	0	0	0	0	0
Very inadequate	0	0	0	0	0	0
TOTAL WHO ANSWERED	4	6	3	6	19	100
No Comment	0	1	3	0	4	
TOTAL INTERVIEWED	4	7	6	6	23	

Sixty-seven percent of the respondents rated NOHIMS as very suitable for Navy information manipulation needs. The main criticisms of NOHIMS' data manipulation capabilities were that NOHIMS needs more analytical capabilities and a statistical interface. Six out of 15 respondents (40%) mentioned the need for either statistical or analytical capabilities (one NHRC NOHIMS developer mentioned both statistics and analytical capabilities). These capabilities were of special concern to the NHRC NOHIMS developers who intend to use the database for research purposes.

Overall, 95 percent of the interviewees thought that NOHIMS was adequate or very adequate for Navy information processing needs.

ASSESSMENT OF OVERALL SYSTEM PERFORMANCE

The overall system performance of NOHIMS has been evaluated in two ways. The first subsection below describes the users' assessment of NOHIMS in twelve areas of performance. The second subsection contains the results of a structured attitude appraisal of the same users to determine their opinions of the usefulness and importance of NOHIMS in their jobs.

Evaluation of NOHIMS Performance

In order to assess the performance of NOHIMS from the system user's perspective, we generated a set of twelve ratings to gain an insight into how well NOHIMS users felt the system was performing. Since length of experience with using NOHIMS most likely would affect these ratings, we also asked how many months an individual had used or been exposed to NOHIMS. Fourteen users consisting of five medical care providers, five industrial hygienists, two data entry personnel, and two system managers made these ratings. A sixth medical care provider felt he could not rate NOHIMS performance because he had had so little exposure to the system. The users sometimes felt that they could not comment on a particular aspect of NOHIMS performance because of lack of familiarity with that area of performance. Thus, the number of users who responded varies from question to question.

The first four ratings addressed problems that NOHIMS may have given in the areas of reliability, downtime, communication lines, and the man-machine interface. Table 40 presents the users' assessment of NOHIMS reliability. Of those individuals interviewed who felt they could make this rating, 44 percent had encountered no problems and 56 percent reported some problems. Of the NOHIMS users who experienced some problems with system reliability, all reported that these troubles stemmed from early problems with terminal equipment and software bugs that subsequently were fixed when they were discovered. They considered NOHIMS software to be reliable at the time of the interviews in September and November of 1985. As one medical ancillary put it, "I have never even seen an error message." One system manager reported that "software errors are very rare now; basically, the software is clean."

Table 41 shows how system users were affected by NOHIMS downtime. Seventeen percent of the individuals who made this rating reported no problems with system downtime, 75 percent experienced some problems, and another eight

TABLE 40
Rating of Problems NOHIMS Has Given in the Area of Reliability
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	Data Entry Clerks	System Managers	TOTAL	% of Total Who Answered
No problems	1	1	2	0	4	44
Some problems	1	3	0	1	5	56
Many problems	0	0	0	0	0	0
TOTAL WHO ANSWERED	2	4	2	1	9	100
No Comment	4	1	0	1	6	
TOTAL INTERVIEWED	6	5	2	2	15	

TABLE 41

Rating of Problems NOHIMS Has Given in the Area of Downtime
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	Data Entry Clerks	System Managers	TOTAL	% of Total Who Answered
No problems	1	0	1	0	2	17
Some problems	2	4	1	2	9	75
Many problems	1	0	0	0	1	8
TOTAL WHO ANSWERED	4	4	2	2	12	100
No Comment	2	1	0	0	3	
TOTAL INTERVIEWED	6	5	2	2	15	

percent encountered many problems. The individual who reported many problems with system downtime was a medical care provider in San Diego who found the occasional inaccessibility of NOHIMS when the system was down to be "a pain in the neck."

The troubles that NOHIMS users who experienced some problems with system downtime had early on were related to hardware. These problems subsequently were resolved. The system is stable now in Bremerton. The system in San Diego experienced some additional downtime during the last half of 1985 when NHRC pre-empted the operational hardware to conduct NOHIMS bench marking in preparation for Navy-wide NOHIMS hardware acquisition.

Of the ten individuals interviewed who felt that they could rate problems with NOHIMS' communication lines (see Table 42), 20 percent had experienced no problems and 80 percent reported some problems. No one had encountered many problems with communication lines, and those that did occur were generally during NOHIMS implementation. In San Diego, the industrial hygienists reported temporary problems with communication lines and occasional disconnects. The data entry clerk and medical care providers in San Diego mentioned being down a few times because of modem problems. The nature of the problem with communication lines in Bremerton was that they experienced difficulty in obtaining a new telephone line for use with NOHIMS. This problem was resolved by borrowing one line from an industrial hygienist.

Nine of the 15 individuals interviewed refrained from rating problems in the area of NOHIMS' man-machine interface (see Table 43). Of the six persons who felt that they could make this rating, half reported no problems and half reported some problems. No one had experienced many problems with the man-machine interface. The data entry clerk in San Diego complained of being locked out of the system from time to time when system resources were stretched to capacity. The lock table problem is a function of the MUMPS operating system currently in use on the PDP 11/24 at NHRC and will be resolved when the operating system is upgraded.

The individuals interviewed were invited to comment on any other performance problems with NOHIMS that they had encountered (Other category). One medical care provider was concerned in certain cases when the exposure measurement for a worker did not correspond to the medical tests recommended by NOHIMS. One example she pointed out was the scheduling of medical monitoring examinations for asbestos exposure when the worker's measured exposure did not exceed the Threshold Limit Value (TLV). This apparent discrepancy can be explained by Navy policy, namely, all workers exposed to asbestos are monitored medically regardless of the level of their exposure. This same medical care provider had also seen noise measurements over the TLV without a noise examination being triggered by NOHIMS. Follow-up in April 1986 found that most of these kinds of problems had been resolved. The medical care provider interviewed reported that the problems that remain are a result of inaccurate personnel data and out-of-date survey data.

Table 44 presents the magnitude and trend of noticeable system failures as rated by NOHIMS users. Nine individuals commented on how often a system failure that is noticeable to the user occurs. All of these noticeable failures were attributed to hardware downtime, power failures, and problems with the communication lines/modem. The system manager in San Diego said that failures

TABLE 42

Rating of Problems NOHIMS Has Given in the Area of Communication Lines
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	Data Entry Clerks	System Managers	TOTAL	% of Total Who Answered
No problems	1	0	1	0	2	20
Some problems	2	3	1	2	8	80
Many problems	0	0	0	0	0	0
TOTAL WHO ANSWERED	3	3	2	2	10	100
No Comment	3	2	0	0	5	
TOTAL INTERVIEWED	6	5	2	2	15	

TABLE 43

Rating of Problems NOHIMS Has Given in the Area of Man-Machine Interface
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	Data Entry Clerks	System Managers	TOTAL	% of Total Who Answered
No problems	1	0	1	1	3	50
Some problems	1	1	1	0	3	50
Many problems	0	0	0	0	0	0
TOTAL WHO ANSWERED	2	1	2	1	6	100
No Comment	4	4	0	1	9	
TOTAL INTERVIEWED	6	5	2	2	15	

TABLE 44

Rating of Magnitude and Trend of Noticeable System Failures
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	Data Entry Clerks	System Managers	TOTAL	% of Total Who Answered
A noticeable (to the user) failure happens:						
Never/None	1	0	2	0	3	34
Once	0	1	0	0	1	11
Very seldom	0	0	0	1	1	11
Once/week	0	1	0	1	2	22
Once/day	0	1	0	0	1	11
Often in the past	1	0	0	0	1	11
TOTAL WHO ANSWERED	2	3	2	2	9	100
No Comment	4	2	0	0	6	
TOTAL INTERVIEWED	6	5	2	2	15	
And that number has been:						
Improving	1	3	0	2	6	100
Steady	0	0	0	0	0	0
Getting worse	0	0	0	0	0	0
TOTAL WHO ANSWERED	1	3	0	2	6	100
No Comment	5	2	2	0	9	
TOTAL INTERVIEWED	6	5	2	2	15	

of the NOHIMS software (program errors) were rare. Six NOHIMS users commented on whether the number of system failures has been improving, remaining steady, or getting worse. All six agreed that NOHIMS' failure record has been improving. The two data entry clerks did not comment on the trend of system failures since they had never noticed a failure and had no basis for judging a change.

In Table 45 we see that nine of the eleven NOHIMS users who made a rating on the acceptability of the number of NOHIMS failures or errors felt that the current number of failures or errors encountered in the system is acceptable. One industrial hygienist thought the current failure/error rate was somewhat unacceptable. One medical ancillary said that the amount of downtime was unacceptable.

Table 46 shows how heavy system usage affects NOHIMS' response time and delays data entry as rated by NOHIMS users. The upper half of Table 46 contains the ratings of heavy NOHIMS usage on system response time. Eight of the eleven respondents who rated the effect of heavy NOHIMS usage on system response time concurred that there would be a system slowdown but of varying degrees, most likely a direct reflection of how much they use NOHIMS. All three of the individuals who detected no effect on NOHIMS response time with heavy system usage were at Bremerton--two industrial hygienists and the data entry clerk. Only the industrial component of NOHIMS is running at Bremerton in an environment where no other users are competing for the use of system resources. The system manager at Bremerton, however, experiences an annoying system slowdown when there is heavy NOHIMS usage. He is hoping that when production hardware is installed at his site, rather than the prototype test hardware currently in use, system response will improve even with heavy NOHIMS usage. In contrast, the system manager and one industrial hygienist in San Diego find that there is a terrible slowdown with heavy NOHIMS usage. It is made even worse when other MUMPS users not interacting with NOHIMS are competing for the PDP 11/24's limited resources.

In the lower half of Table 46, eight individuals rated how data entry is affected by heavy NOHIMS usage. None of the six medical care providers made this rating because they are not involved in the entry of NOHIMS data. One industrial hygienist in San Diego with no experience in entering survey data also abstained from making this rating. The two industrial hygienists who said that data entry is never delayed by system response time were at Bremerton, as was the data entry clerk who chose the never delayed rating. The Bremerton system manager reported that data entry at his NOHIMS site is rarely delayed by system response time. The two San Diego industrial hygienists felt that entry of survey data is rarely delayed by system response time. The data entry clerk for medical data in San Diego responded that data entry is occasionally delayed by system response time, while the San Diego system manager, who may have a larger picture of all aspects of NOHIMS data entry operations, indicated that data entry is often delayed by system response time.

In Table 47, NOHIMS users were asked to rate the time required to obtain a display of NOHIMS data from fast to slow. Thirteen of the 15 individuals interviewed made this rating, of which 92 percent felt that NOHIMS displays either came up fast (38%) or somewhat fast (54%). No one thought all NOHIMS displays were slow or somewhat slow. One medical ancillary observed that the time varies and ranges from slow to fast. The industrial hygienists generally

TABLE 45
Rating of Acceptability of the Number of NOHIMS Failures or Errors
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	Data Entry Clerks	System Managers	TOTAL	% of Total Who Answered
Acceptable	2	3	2	2	9	82
Somewhat acceptable	0	1	0	0	1	9
Somewhat unacceptable	0	0	0	0	0	0
Unacceptable	1	0	0	0	1	9
TOTAL WHO ANSWERED	3	4	2	2	11	100
No Comment	3	1	0	0	4	
TOTAL INTERVIEWED	6	5	2	2	15	

TABLE 46

How Heavy System Usage Affects NOHIMS Response Time and Delays Data Entry
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	Data Entry Clerks	System Managers	TOTAL	% of Total Who Answered
Heavy NOHIMS usage causes:						
A terrible slowdown	0	1	0	1	2	18
An annoying slowdown	1	1	1	1	4	37
A noticeable slowdown	1	1	0	0	2	18
No effect	0	2	1	0	3	27
TOTAL WHO ANSWERED	2	5	2	2	11	100
No Comment	4	0	0	0	4	
TOTAL INTERVIEWED	6	5	2	2	15	
Data entry is:						
Never	0	2	1	0	3	37
Rarely	0	2	0	1	3	37
Occasionally	0	0	1	0	1	13
Often	0	0	0	1	1	13
delayed by system response time						
TOTAL WHO ANSWERED	0	4	2	2	8	100
No Comment	6	1	0	0	7	
TOTAL INTERVIEWED	6	5	2	2	15	

TABLE 47
Time Required To Obtain a Display of NOHIMS Data
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	Data Entry Clerks	System Managers	TOTAL	% of Total Who Answered
Fast	0	4	1	0	5	38
Somewhat fast	3	1	1	2	7	54
Somewhat slow	0	0	0	0	0	0
Slow	0	0	0	0	0	0
Varies	1	0	0	0	1	8
TOTAL WHO ANSWERED	4	5	2	2	13	100
No Comment	2	0	0	0	2	
TOTAL INTERVIEWED	6	5	2	2	15	

rated NOHIMS as having a faster response time, suggesting that the industrial component responds faster than the medical component.

Six medical care providers and the San Diego system manager were asked to evaluate the effect of a NOHIMS failure on the day-to-day provision of medical care, that is, when the system is down for any reason (see Table 48). Since the NOHIMS medical component is not operational yet at Bremerton, the system manager at that test site was not asked to make this rating. The effect that was mentioned by the most people (83%) was that medical charts are held up in data entry. Half of those individuals responding mentioned that NOHIMS failures affect medical care because on-line look-ups cannot be done. One-third of those responding indicated that reports usually used in care are not available and that work procedures must be changed when NOHIMS is down. One medical professional commented that a more extensive examination may have to be done if needed information in NOHIMS is not accessible, which would increase the time that the care provider sees the patient. One care provider who is concerned with the timely input of industrial survey data mentioned that survey data would also be held up in entry. Only one care provider felt that when NOHIMS was down, it would have no effect on the provision of medical care. One physician newly exposed to NOHIMS felt unqualified to comment because of his lack of experience with the system.

Eleven NOHIMS users evaluated the effect of a NOHIMS failure on the administration of the Occupational Health Unit (see Table 49). The most frequent effect cited was that on-line look-ups cannot be done, mentioned by over half of the respondents. Next in frequency of mention were that survey data are held up in entry (36%) and that data entry gets backlogged (36%). Of those individuals responding, 27 percent mentioned that medical charts would be held up in data entry. Another 27 percent thought that when NOHIMS was down, it would have no effect on the administration of the Occupational Health Unit. Two of these three respondents were at Bremerton. A few NOHIMS users thought work procedures must be changed (to do other useful work while the system is down) and that reports usually used in care would not be available.

In Table 50, NOHIMS users were asked to rate the number of major "bugs" in the NOHIMS software that affect system performance. Almost three-quarters of the interviewees who made this rating felt that NOHIMS software has no major bugs (73%). These eight respondents included the data entry personnel and system managers at both San Diego and Bremerton, individuals that log more time on the system than any other NOHIMS users. One medical care provider and one industrial hygienist reported noticing one or two major bugs. The medical care provider, an ancillary, did not mention what the bugs were. The industrial hygienist qualified his response by stating that most bugs have been worked out now. The lone industrial hygienist who reported several major bugs identified them as "incorrectly assigned environments, incorrectly assigned lab tests, and personnel assigned to environments incorrectly," which are really database errors, not software bugs. This individual had been exposed to NOHIMS for only one month and probably was noticing that the personnel data in NOHIMS are inaccurate because the Personnel Extract File (PEF) passed over to NOHIMS monthly is not up-to-date. None of the individuals making this rating felt that there were many major bugs in the NOHIMS software, probably reflecting the maturity of NOHIMS which has been running in a production mode in both San Diego and Bremerton for a considerable length of time.

TABLE 48

Effect of a NOHIMS Failure on Day-to Day Provision of Medical Care
(Number who mentioned rating; multiple answers allowed)

	Medical Care Providers	San Diego System Manager	TOTAL	% of Total Who Answered
Medical charts are held up in data entry	4	1	5	83
On-line look-ups cannot be done	2	1	3	50
Reports usually used in care are not available	1	1	2	33
Work procedures must be changed	1	1	2	33
Survey data are held up in entry	1	0	1	17
No effect on medical care	1	0	1	17
TOTAL WHO ANSWERED	5	1	6	100
No Comment	1	0	1	
TOTAL INTERVIEWED	6	1	7	

TABLE 49

Effect of a NOHIMS Failure on the Administration of the Occupational Health Unit

(Number who mentioned effect; multiple answers allowed)

	Medical Care Providers	Industrial Hygienists	Data Entry Clerks	System Managers	TOTAL	% of Total Who Answered
On-line look-ups cannot be done	2	2	0	2	6	55
Survey data are held up in entry	1	2	0	1	4	36
Data entry gets backlogged	1	0	1	2	4	36
Medical charts are held up in data entry	2	0	0	1	3	27
No effect on administration	0	2	1	0	3	27
Work procedures must be changed	0	1	1	0	2	18
Reports usually used in care are not available	0	1	0	0	1	9
TOTAL WHO ANSWERED	2	5	2	2	11	100
No Comment	4	0	0	0	4	
TOTAL INTERVIEWED	6	5	2	2	15	

TABLE 50

Number of Major Bugs in the NOHIMS Software That Affect System Performance
(Number who mentioned frequency)

	Medical Care Providers	Industrial Hygienists	Data Entry Clerks	System Managers	TOTAL	% of Total Who Answered
None	1	3	2	2	8	73
One or two	1	1	0	0	2	18
A few	0	0	0	0	0	0
Several	0	1	0	0	1	9
Many	0	0	0	0	0	0
TOTAL WHO ANSWERED	2	5	2	2	11	100
No Comment	4	0	0	0	4	
TOTAL INTERVIEWED	6	5	2	2	15	

Analysis of NOHIMS users' responses to our inquiry about how many months they have used or been exposed to the system resulted in the following findings presented here by class of NOHIMS users. Of the medical care providers, the longest involvement was 36 months by the Head of the Occupational Health Unit at North Island, San Diego who wore two hats. He participated heavily initially in the design of the medical encounter forms and then later on as a medical care provider user. The next most significant longevity was that reported by one of the medical ancillaries who had interacted with the medical component of NOHIMS for 15 months. The second medical ancillary and one of the physicians had each worked with NOHIMS for 12 months. One physician's assistant had two-and-one half months' experience with NOHIMS at the time of our interviews in September of 1985 and one physician was so newly arrived at the North Island Occupational Health Unit that he had had virtually no exposure to NOHIMS. The average length of exposure to NOHIMS for medical care providers as of September 1985 was 15.5 months.

One of the industrial hygienists at the Industrial Hygiene Division (IHD) in San Diego also wore two hats in the development of NOHIMS. This individual spent 48 months in her role as a system developer and then later on 30 months as an industrial hygienist user. One of her IHD colleagues had been exposed to NOHIMS for 10 to 11 months. The industrial hygienist at the San Diego Naval Air Rework Facility (NARF) had one month of exposure to NOHIMS at the time of our interviews. The two industrial hygienists in Bremerton each reported approximately 11 months' use of the industrial component of NOHIMS at that test site. The average length of exposure to NOHIMS for industrial hygienists as of September 1985 was 16.3 months, slightly longer than that for medical care providers since the industrial component of NOHIMS was developed before the medical component was implemented.

At the time of our interviews in San Diego during September of 1985, the data entry clerk at the North Island Occupational Health Unit had been on the job just two months. He was preceded by two other data entry clerks whom we were unable to interview. The first and only data entry clerk at Bremerton had been on the job six months as of September 1985. The average length of exposure to NOHIMS for the data entry personnel we interviewed was 4 months.

Of the two NOHIMS system managers, the one in San Diego had been involved with the system for 36 months at the time of our interviews. The Bremerton system manager had held this position for 18 months as of September 1985, yielding an average of 27 months of exposure to NOHIMS for the two system managers. Thus, in terms of length of exposure to NOHIMS, the system managers on the average had the greatest amount of exposure to NOHIMS, while the data entry clerks had the least amount of exposure.

Summary

In the area of possible problems with NOHIMS performance, the following findings emerged from our interviews with the 15 NOHIMS users. NOHIMS software was considered reliable at the time of our interviews. Early system downtime was related to hardware. The system is stable now in Bremerton. There is occasional system downtime in San Diego caused by hardware problems. There were some problems with communication lines in the beginning but the situation is

fairly stable now. The most significant problem mentioned in the NOHIMS man-machine interface was the lock table problem that causes users to be locked out of NOHIMS when the PDP 11/24 system resources are stretched to capacity. This problem will be resolved when the operating system is upgraded. The problem mentioned by one medical care provider of seeing noise measurements over the Threshold Limit Value without a noise examination being triggered by NOHIMS was investigated. Problems that still exist are a result of out-of-date survey data and inaccurate personnel data, not performance problems.

All noticeable system failures were attributed to hardware downtime, power failures, and problems with communication lines and the modem. Failures of the NOHIMS software (program errors) were rare. All respondents agreed that NOHIMS' failure record has been improving and 60 percent felt that the current number of failures or errors is acceptable.

Eight of eleven individuals rating the effect of heavy NOHIMS usage on system response time concurred that there would be a system slowdown but of varying degrees. The three individuals who detected no effect on NOHIMS response time with heavy system usage were at Bremerton. Most respondents agreed that data entry would be delayed in varying amounts by slow system response time except for three NOHIMS users at Bremerton who reported that data entry is never delayed by system response time at that test site.

Of 13 NOHIMS users, 92 percent felt that NOHIMS displays either came up fast or somewhat fast. The medical component was rated somewhat slower than the industrial component.

The effects of a NOHIMS failure on the day-to-day provision of medical care mentioned most frequently by respondents were that medical charts are held up in data entry (83%), that on-line look-ups cannot be done (50%), that reports usually used in care are not available (33%), and that work procedures must be changed when NOHIMS is down (33%). The effects on the administration of the Occupational Health Unit when a NOHIMS failure occurs mentioned most frequently by respondents were that on-line look-ups cannot be done (55%), that survey data are held up in entry (36%), and that data entry gets backlogged (36%).

Almost three-quarters of the respondents felt that NOHIMS software has no major bugs.

As of September 1985, the average length of exposure to NOHIMS was 15.5 months for medical care providers, 16.3 months for industrial hygienists, 27 months for the two NOHIMS system managers, and 4 months for data entry clerks.

In summary, NOHIMS has been running in a production mode in both San Diego and Bremerton for a considerable length of time. The system is stable at both test sites and the majority of NOHIMS users are satisfied with system software and hardware performance, with hardware downtime being a much more likely system failure than software program errors. System response time can be expected to improve when NOHIMS is migrated onto operational hardware from its present installation on R&D hardware and is running under an upgraded MUMPS operating system.

Structured Appraisal of the Performance of NOHIMS

In addition to analyzing the responses of NOHIMS users to the set of twelve ratings assessing NOHIMS performance presented in the previous subsection, interviewees were asked to respond to 22 statements reflecting possible attitudes or opinions that users of NOHIMS might hold. In this structured appraisal of the performance of NOHIMS, respondents were instructed to rate each of the 22 statements on a 5-point scale consisting of the following consecutive points: Strongly Agree, Agree, Neutral Opinion, Disagree, and Strongly Disagree. The rating form that was used may be found in Component 21 of Appendix A.

Of the 15 NOHIMS users interviewed, 14 individuals responded to this structured appraisal by placing an "X" at the point on the scale indicating their extent of agreement or disagreement with each statement. Those responding to this short exercise consisted of five medical care providers, five industrial hygienists, two data entry personnel, and two system managers. A sixth medical care provider abstained from responding because he had had so little exposure to NOHIMS. We ended up with one extra set of ratings from an individual we were unable to identify. Since ratings from all of those interviewed were accounted for and because we did not know if the mystery return came from a legitimate NOHIMS user, we decided to omit this individual's ratings from the analysis. However, it should be noted that these ratings were more negative than those we analyzed. One medical care provider and one of the data entry clerks did not return their ratings to us until early April 1986 whereas all of the other NOHIMS users made their ratings in September 1985. It is not known if this delay in responding affected their ratings in any way.

Histograms depicting the ratings made by the 14 respondents for each of the 22 statements are shown in Figure 1 along with the overall average rating. The location of where on the 5-point scale the "X" was placed by each respondent is represented by a letter D, I, M, or S denoting the class of NOHIMS users to which each respondent belonged (D=Data Entry Personnel, I=Industrial Hygienists, M=Medical Care Providers, and S=System Managers). All 14 individuals participating in this exarcise rated Statements 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 15, 17, 18, 20, 21, and 22; 13 respondents rated Statements 5, 13, 16, and 19; and eleven people rated Statement 14.

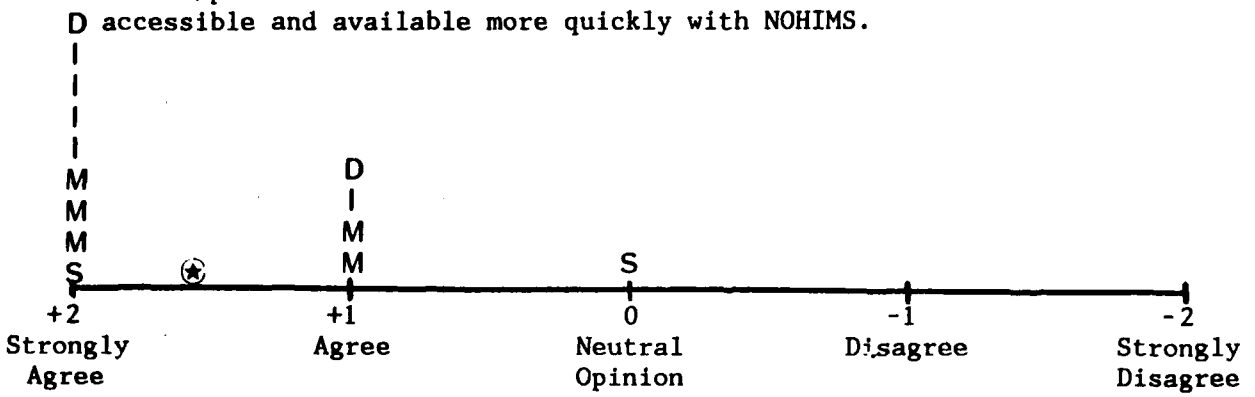
In the analysis of the ratings, the response scale was assigned weights from +2 to -2 in the following mannner:

Strongly Agree	+2
Agree	+1
Neutral Opinion	0
Disagree	-1
Strongly Disagree	-2

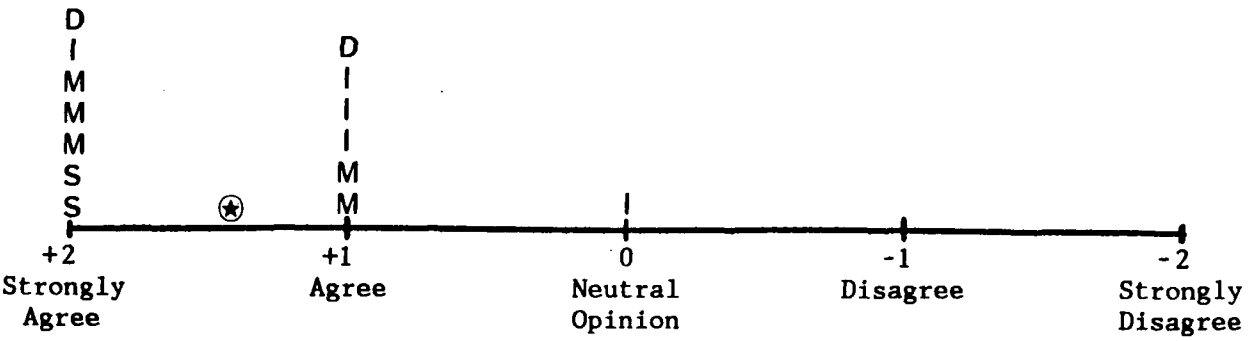
If a NOHIMS user selected "Strongly Agree" as his or her response to all 22 statements, this individual's summated score on the attitude scale would be +44. Conversely, if this individual selected "Strongly Disagree" as his or her response to all 22 statements, the summated score would be -44. Thus, the range of possible scores for an individual on this attitude scale is -44 to +44. The weights assigned to Statements 3, 6, 9, 11, 15, and 20 were reversed since these

Figure 1. Histograms Depicting Ratings by 14 Respondents to 22 Statements about the Performance of NOHIMS.

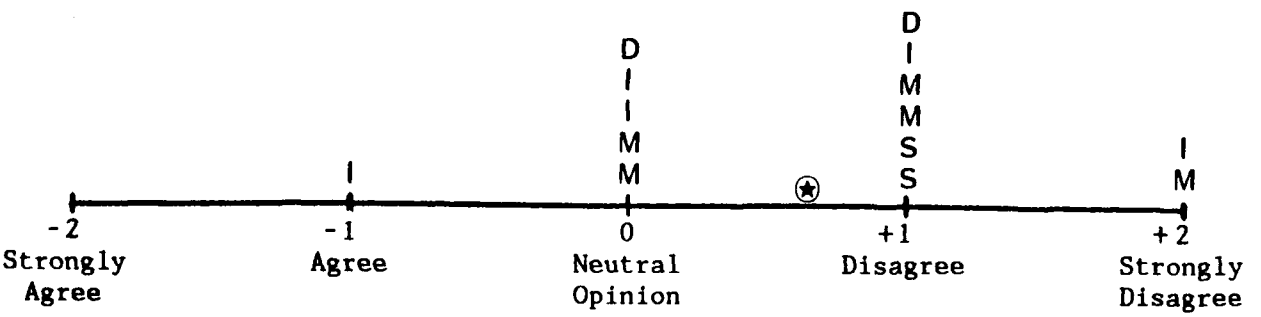
1. Worker/patient-related information is more accessible and available more quickly with NOHIMS.



2. As a result of NOHIMS, I am able to do a better job.



3. The performance of NOHIMS falls short of what I expected.

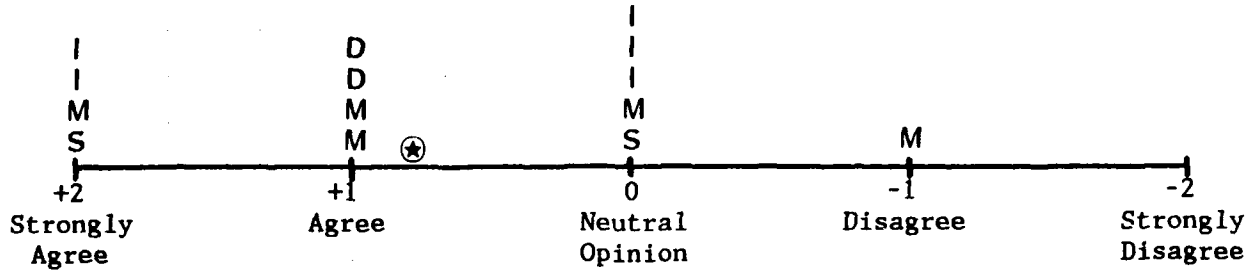


LEGEND: D = Data Entry Personnel, I = Industrial Hygienists, M = Medical Care Providers, S = System Managers.

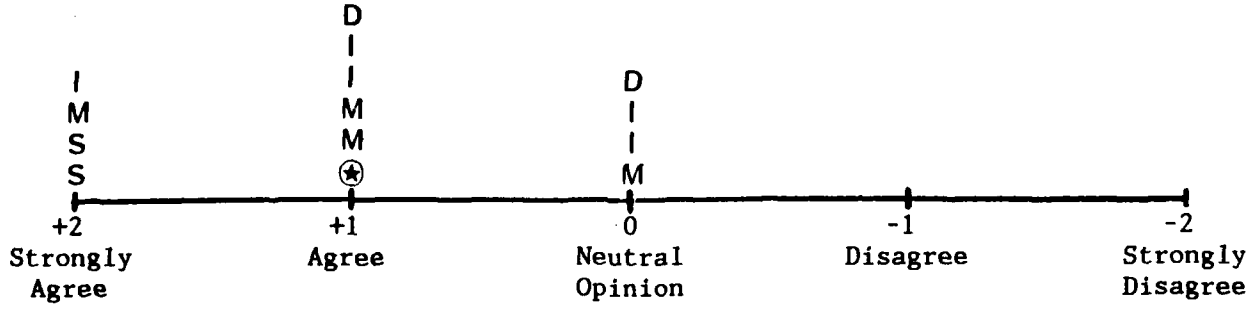
⊛ = Overall Average

Figure 1. (Cont.) Histograms Depicting Ratings by 14 Respondents to 22 Statements about the Performance of NOHIMS.

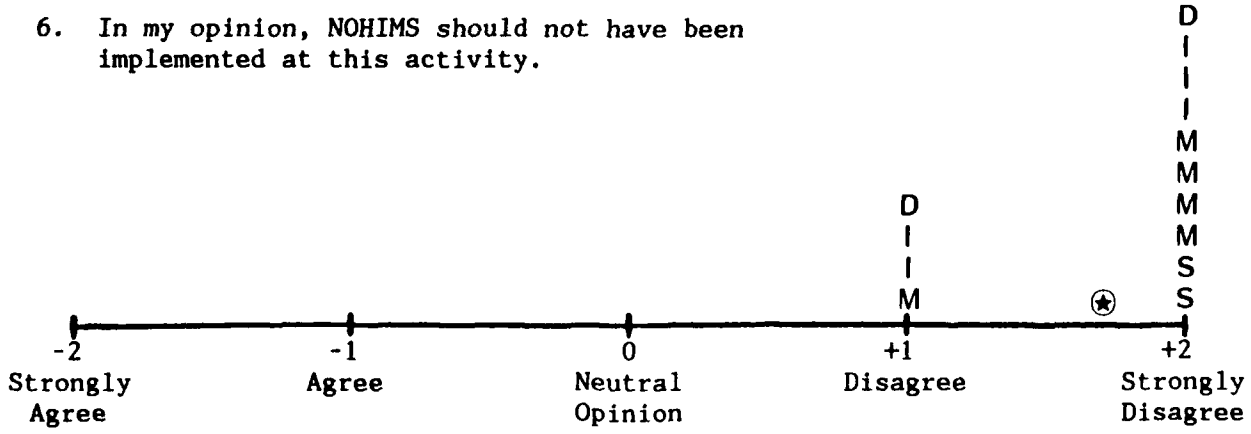
4. I could never go back to using the old manual record system now that I have been using NOHIMS.



5. NOHIMS catches more human errors than the old manual system did.



6. In my opinion, NOHIMS should not have been implemented at this activity.

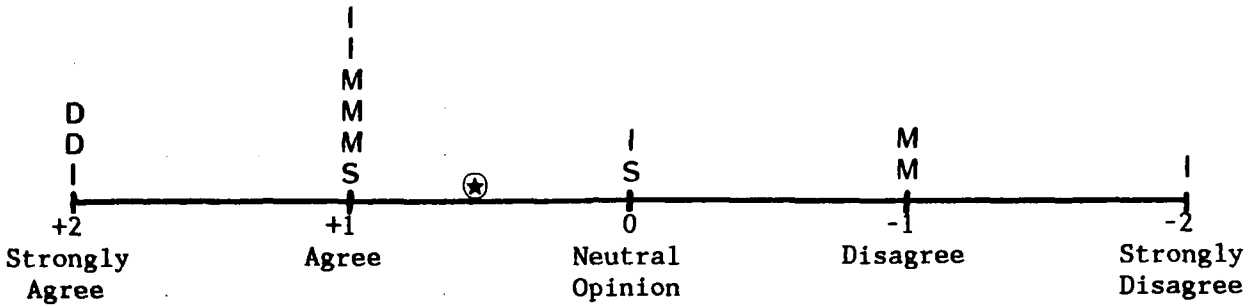


LEGEND: D = Data Entry Personnel, I = Industrial Hygienists, M = Medical Care Providers, S = System Managers.

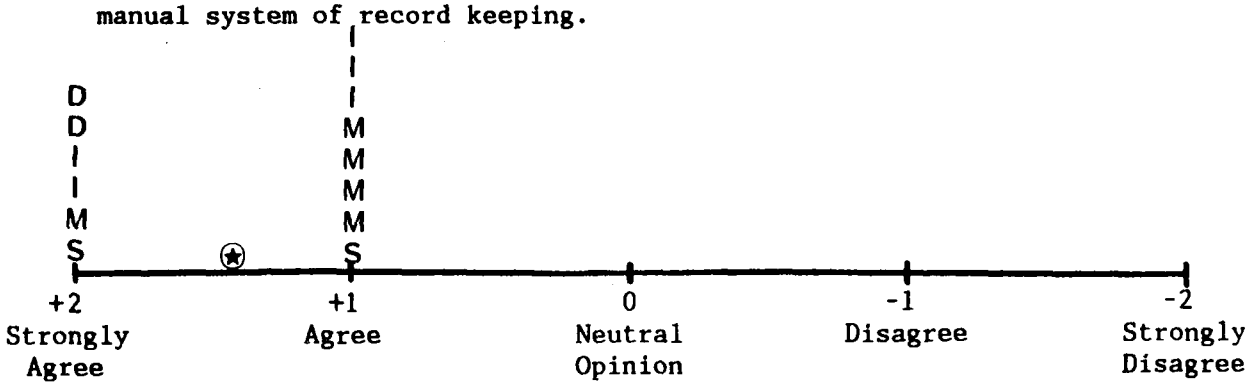
⊛ = Overall Average

Figure 1. (Cont.) Histograms Depicting Ratings by 14 Respondents to 22 Statements about the Performance of NOHIMS.

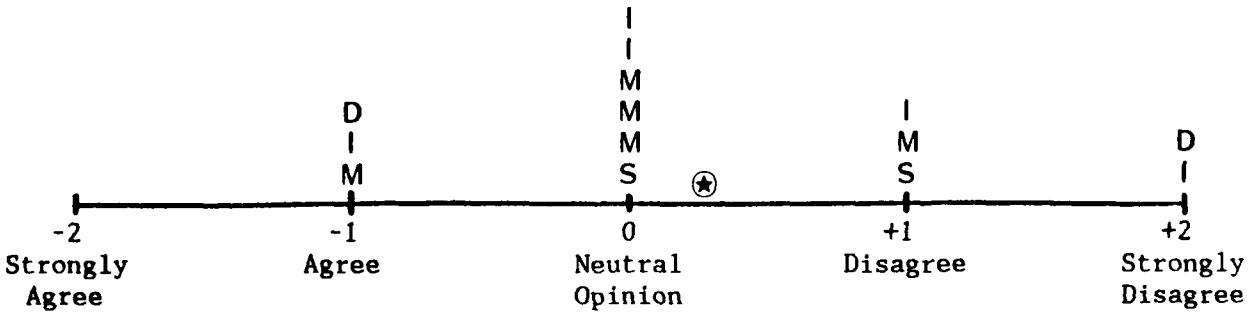
7. I rarely have to wait for necessary worker/patient information because the NOHIMS system is down.



8. In general, NOHIMS is better than the old manual system of record keeping.



9. NOHIMS has some major problems that need correction.

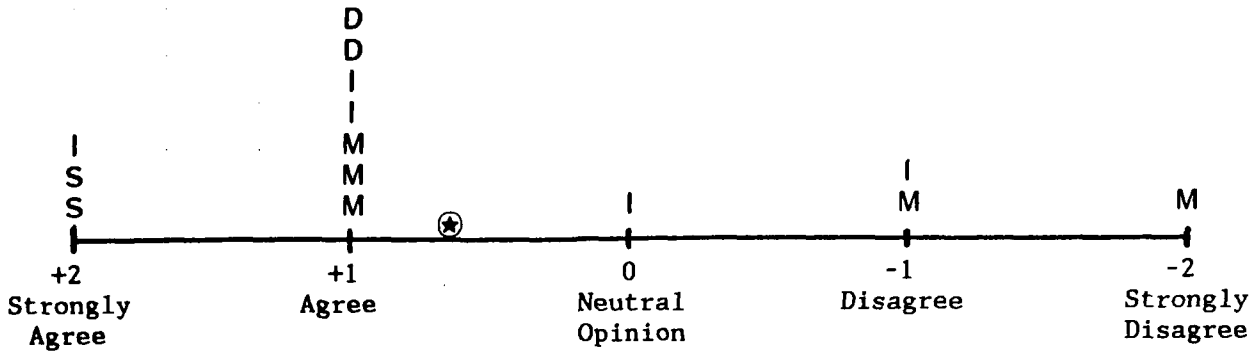


LEGEND: D = Data Entry Personnel, I = Industrial Hygienists, M = Medical Care Providers, S = System Managers.

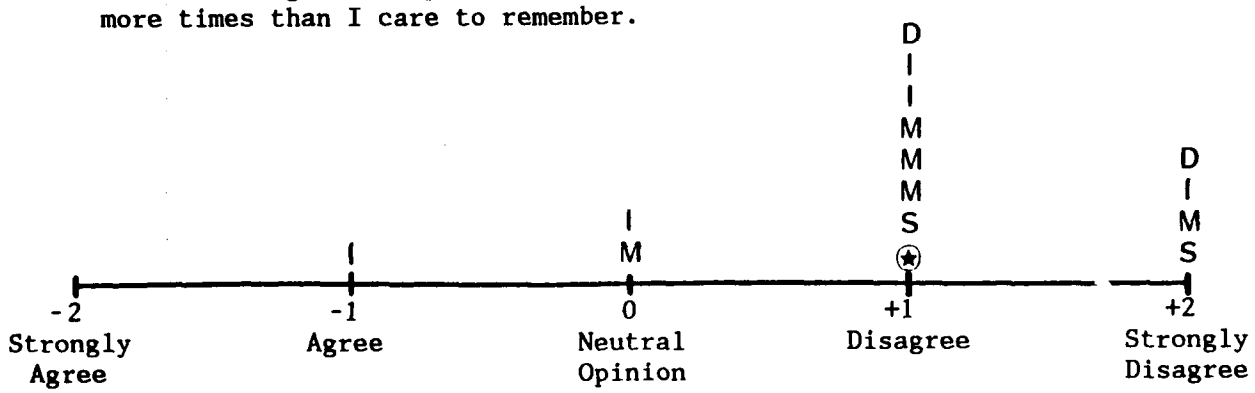
⊛ = Overall Average

Figure 1. (Cont.) Histograms Depicting Ratings by 14 Respondents to 22 Statements about the Performance of NOHIMS.

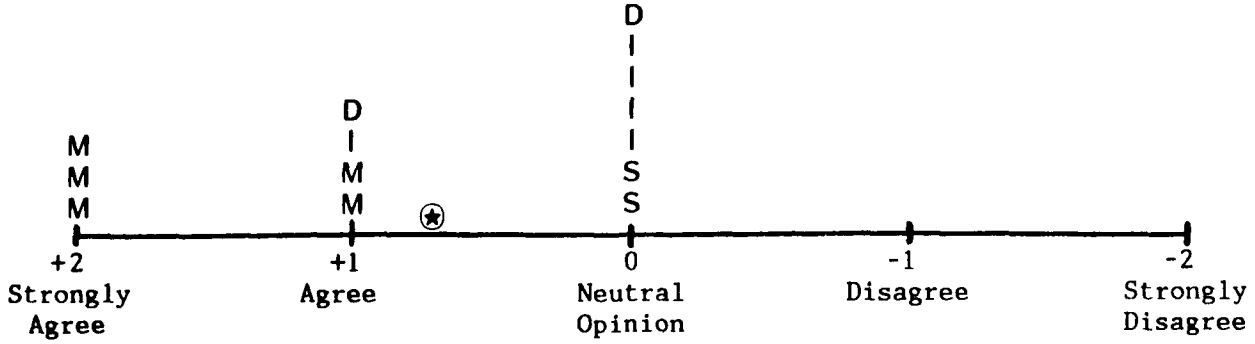
10. If there were budget cuts at this activity, I would rather see other services that I need cut before I lost NOHIMS.



11. NOHIMS has "goofed" up worker/patient records more times than I care to remember.



12. I truly feel that the quality of care has been improved as a result of NOHIMS.



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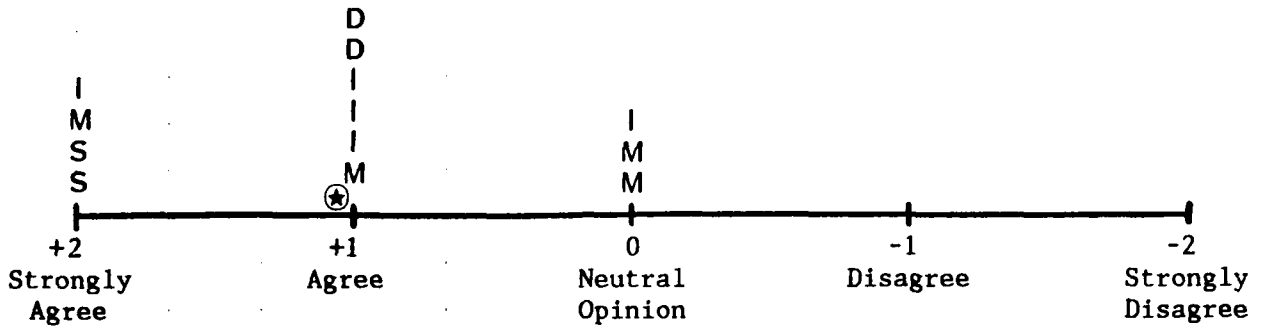
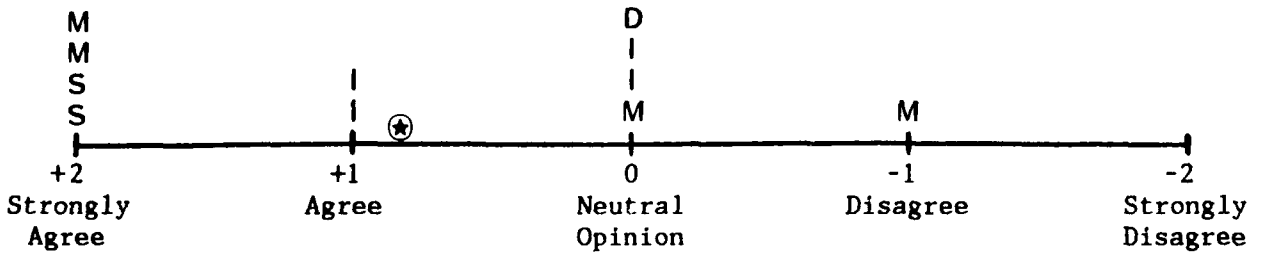
⊛ = Overall Average

Figure 1. (Cont.) Histograms Depicting Ratings by 14 Respondents to 22 Statements about the Performance of NOHIMS.

13. From an administrative point of view, NOHIMS provides timely data for making management decisions that were not available with the previous manual system.



14. Scheduling and staffing patterns have been improved since the advent of NOHIMS.



15. NOHIMS does not benefit me much personally.

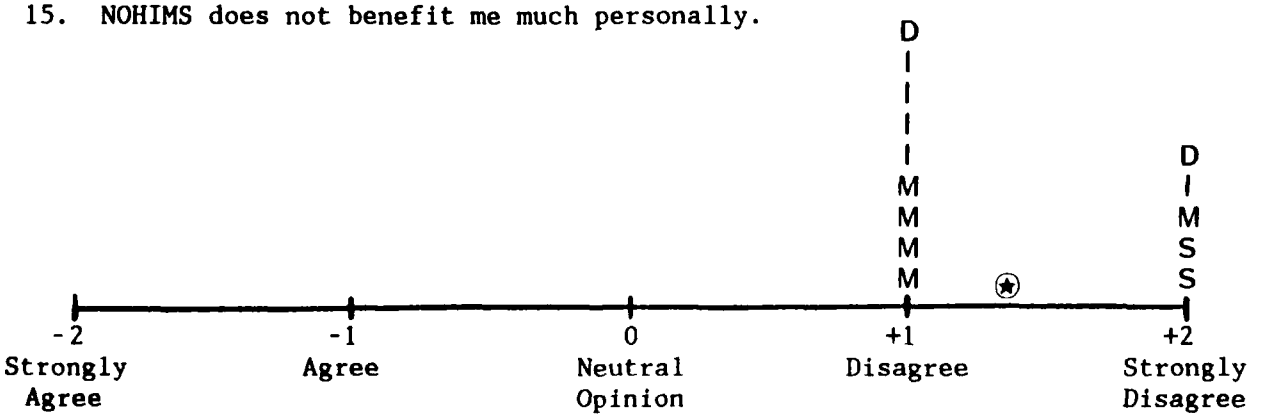


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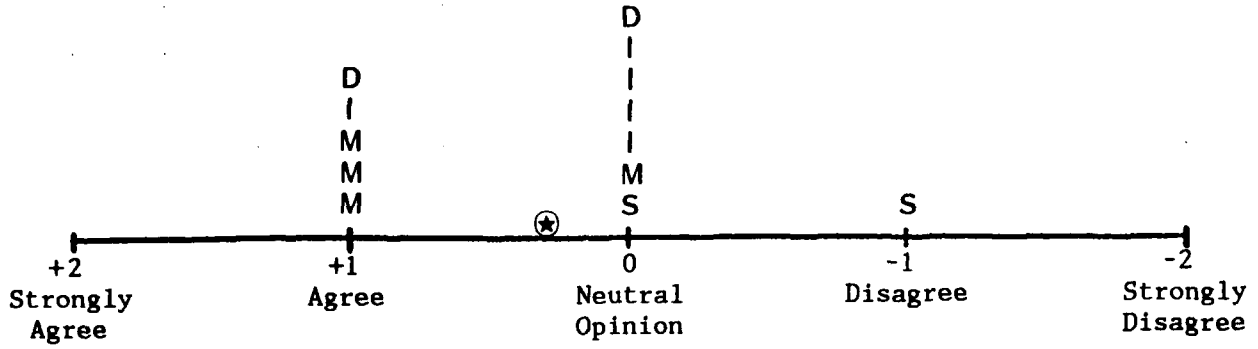
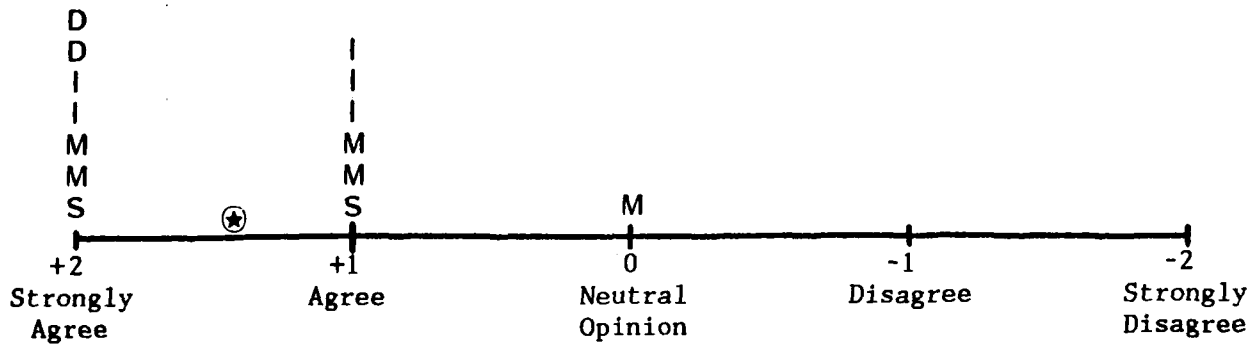
Figure 1. (Cont.) Histograms Depicting Ratings by 14 Respondents to 22 Statements about the Performance of NOHIMS.

16. Worker/patient satisfaction seems to be running higher since NOHIMS was introduced.



17. I can see how NOHIMS can be a boon to other users.



18. With NOHIMS, I am able to get more done in a day.

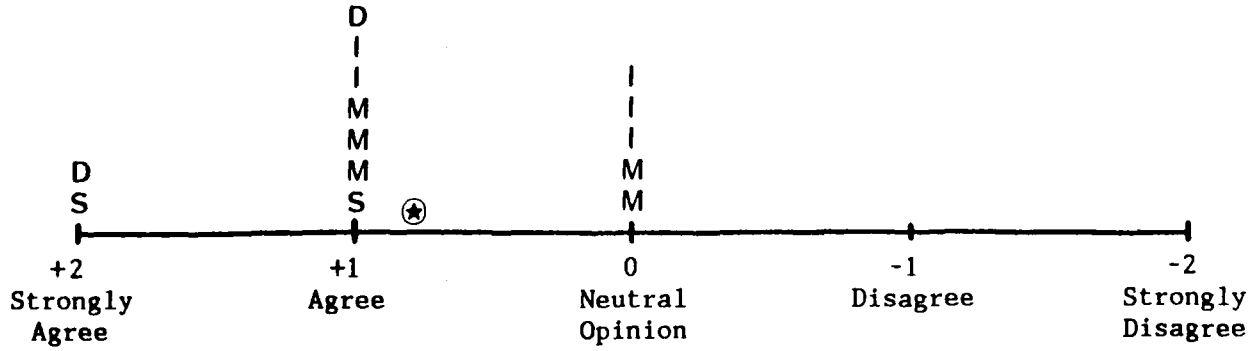


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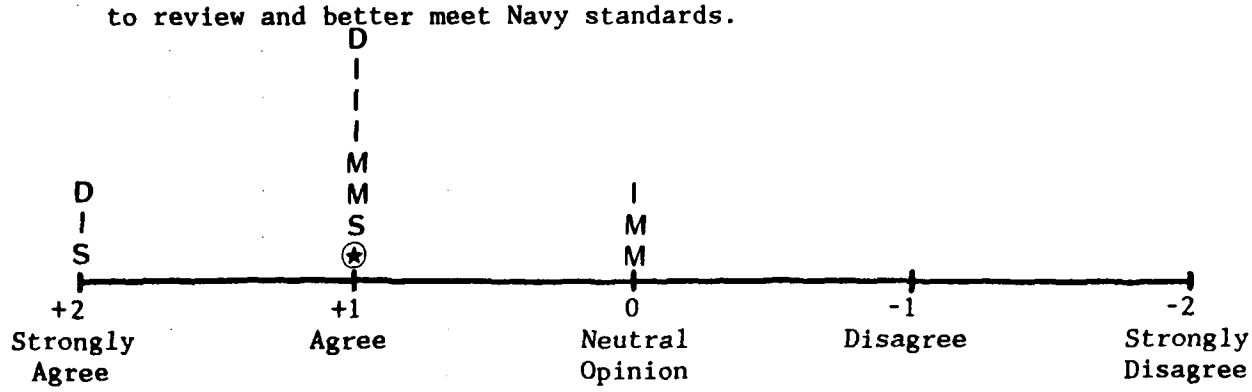
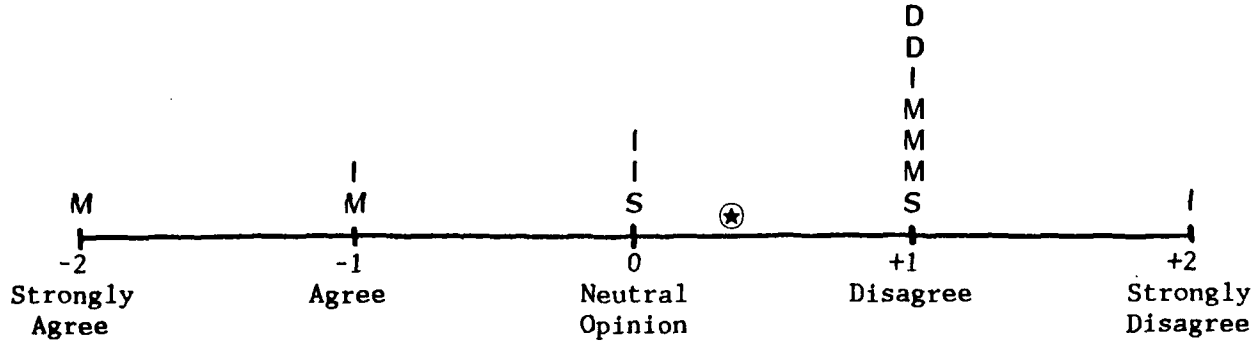
Figure 1. (Cont.) Histograms Depicting Ratings by 14 Respondents to 22 Statements about the Performance of NOHIMS.

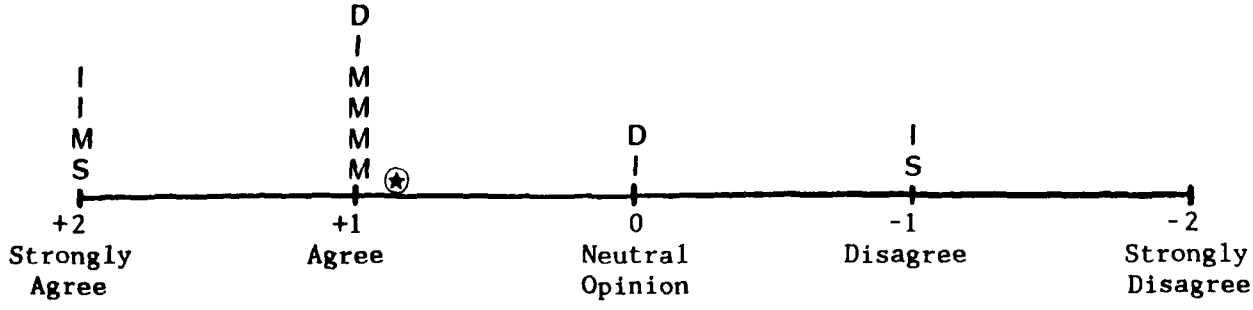
19. The records produced by NOHIMS are more amenable to review and better meet Navy standards.



20. The confidentiality of the worker's/patient's record is more vulnerable with NOHIMS than it was with the manual system.



21. I don't care much what NOHIMS costs to operate, we need it to handle our workload efficiently.



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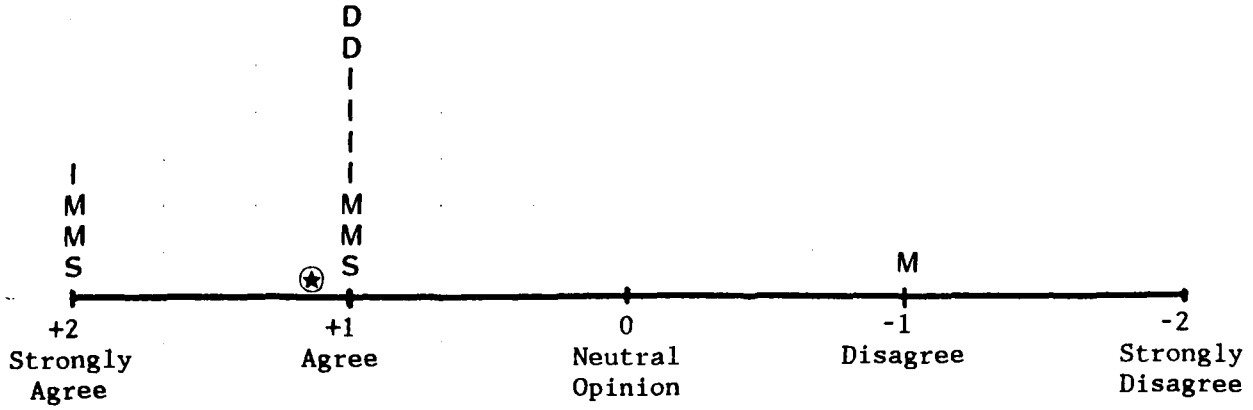
⊛ = Overall Average

Figure 1. (Cont.) Histograms Depicting Ratings by 14 Respondents to 22 Statements about the Performance of NOHIMS.

22. If NOHIMS were to be taken out, I would be willing to make a reasonable effort to get it back in service.



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⊛ = Overall Average

statements reflect negative rather than positive attitudes toward NOHIMS. A discussion of the rating results for each statement is presented below.

For Statement 1, 13 of the 14 respondents either agreed or strongly agreed that worker/patient-related information is more accessible and available more quickly with NOHIMS. One respondent expressed a neutral opinion. The overall average rating for this statement was +1.6, approximately halfway between Agree and Strongly Agree. Industrial hygienists agreed more strongly with this statement than any other class of NOHIMS users.

Thirteen of the 14 individuals responding to Statement 2 either agreed or strongly agreed that "as a result of NOHIMS, I am able to do a better job." One respondent expressed a neutral opinion. The overall average rating for this statement was +1.4. The two system managers as a NOHIMS user class agreed the most strongly with this statement, followed by medical care providers, data entry personnel, and lastly industrial hygienists.

The distribution of ratings for Statement 3, "the performance of NOHIMS falls short of what I expected," is more dispersed, probably reflecting more than anything else a wide divergence in expectations for NOHIMS. If one's expectations for NOHIMS' performance were unrealistically high initially, then most likely the system will fall short of meeting these expectations, particularly in the early stages of system development and implementation. On the other hand, if one is skeptical initially about the expected performance of NOHIMS, then one is likely to be pleasantly surprised as the system takes shape and form. It is notable that five individuals held a neutral opinion. The overall average rating was +0.6, indicating more disagreement with this statement than agreement since this was a negative statement about NOHIMS. As a class, the system managers disagreed the most strongly that NOHIMS fell short of their expectations.

The distribution of ratings for Statement 4, "I could never go back to using the old manual record system now that I have been using NOHIMS," is also quite dispersed. The overall average rating was +0.8 indicating that there was substantially more agreement with this statement than disagreement. The system managers and data entry personnel expressed more agreement with the statement than the other two classes of NOHIMS users, and industrial hygienists agreed more with the statement than medical care providers. This is not a surprising finding because medical care providers can always return to the traditional manual method of keeping medical records that they learned in medical school.

The majority opinion in response to Statement 5 is that NOHIMS catches more human errors than the old manual system did. However, of the 13 individuals responding to this statement, four held a neutral opinion. The overall average rating was +1.0, exactly at the Agree point on the histogram. The two system managers as a class agreed the most strongly with this statement.

All 14 respondents to Statement 6 disagreed to some extent that NOHIMS should not have been implemented at their activity. The overall average rating was +1.7, closer to Strongly Disagree than to Disagree. Again, the two system managers as a class held the strongest opinion on this statement. The rating results for this statement are interesting in light of some of the criticisms of NOHIMS revealed in the analysis of other statements in this structured attitude appraisal. The findings here suggest that frustration with and negativism

toward NOHIMS may relate to early and current problems of system implementation and not to the users' long-range view of the potential of NOHIMS.

The distribution of ratings for Statement 7, "I rarely have to wait for necessary worker/patient information because the NOHIMS system is down," is very dispersed with the overall average rating being +0.6, approximately halfway between Agree and Neutral Opinion. Those respondents who disagreed with this statement probably were expressing their frustration with any system downtime although downtime is not a regular occurrence at present, particularly at Bremerton.

All 14 respondents to Statement 8 agreed that, in general, NOHIMS is better than the old manual system of record keeping. The overall average rating was +1.4, about halfway between Agree and Strongly Agree.

Six of the 14 respondents to Statement 9 expressed a neutral opinion regarding whether or not NOHIMS has some major problems that need correction, three respondents agreed, and five respondents either disagreed or disagreed strongly. The overall average rating was +0.3, slightly in the direction of Disagree from Neutral Opinion. One gratuitous comment on the rating form for an industrial hygienist who agreed that NOHIMS had major problems that need correction indicated that these were problems in the past that "seem to have been worked out."

Statement 10 poses a difficult choice for the NOHIMS user, and the responses to this statement reflect this dilemma. If there were budget cuts at a system user's activity, what other needed services would a user be willing to give up before losing NOHIMS? Most respondents appear to have dealt with this statement in terms of their own perception of what the alternate valuable services might be that they would have to give up in order to retain NOHIMS. One respondent out of 14 straddled the fence by expressing a neutral opinion. Three respondents opted in favor of other needed services, but ten respondents agreed that they would prefer to see cuts in other services before losing NOHIMS. The overall average rating was +0.6, closer to Agree than to Neutral Opinion. The two system managers as a class voted the most strongly for NOHIMS. The medical care providers expressed the most disagreement with Statement 10, although three of the five medical care providers expressed agreement.

Eleven out of 14 respondents disagreed or strongly disagreed with Statement 11 that "NOHIMS has 'goofed' up worker/patient records more times than I care to remember." Two respondents held a neutral opinion, and one respondent agreed with this statement. This latter individual was an industrial hygienist, exposed to NOHIMS for only one month, who probably was reacting to the inaccuracies in the Personnel Extract File discussed in the previous subsection. Since these personnel data are passed over to NOHIMS on a monthly basis from the NARF Personnel Department in San Diego, NOHIMS has no control at present over either their accuracy or currency. The overall average rating for Statement 11 was +1.0, squarely at Disagree on the 5-point rating scale.

Of the 14 NOHIMS users responding to Statement 12, seven individuals either agreed or strongly agreed that the quality of care has been improved as a result of NOHIMS. The other seven respondents held a neutral opinion. Both system managers, four industrial hygienists, and one data entry clerk chose the neutral opinion rating. All five medical care providers agreed or strongly agreed that

the quality of care has been improved as a result of NOHIMS. Their average rating was +1.6, more than halfway between Agree and Strongly Agree compared to an overall average rating of +0.7, influenced by 50 percent of the respondents expressing a neutral opinion. If it is agreed that medical care providers are in the best position to judge the quality of care since the advent of NOHIMS, then they have expressed a strong vote of confidence in the system.

Of the 13 NOHIMS users who responded to Statement 13, ten either agreed or strongly agreed that from an administrative point of view, NOHIMS provides timely data for making management decisions that were not available with the previous manual system. Three respondents expressed a neutral opinion regarding this statement. The overall average rating was +1.1, just a hair above Agree on the 5-point rating scale. The two system managers as a class agreed the most strongly with this statement.

Only eleven NOHIMS users responded to Statement 14, "scheduling and staffing patterns have been improved since the advent of NOHIMS." Of these eleven respondents, six either agreed or strongly agreed with the statement. Four respondents expressed a neutral opinion, and one individual disagreed. The overall average rating was +0.8, close to Agree on the 5-point rating scale. Both system managers as a class strongly agreed with this statement. One data entry clerk expressed a neutral opinion, and the other data entry clerk abstained from making the rating. The medical care providers who responded were slightly more in agreement with this statement than the industrial hygienists were.

Of the 14 NOHIMS users who responded to Statement 15, 14 either disagreed or strongly disageed with the statement that NOHIMS does not benefit me much personally. The overall average rating was +1.4 for this statement, approximately one-third of the way from Disagree to Strongly Disagree. The two system managers as a class disagreed the most strongly that NOHIMS does not benefit them much personally, followed by data entry personnel, and then industrial hygienists and medical care providers equally.

Of the 13 NOHIMS users who responded to Statement 16, "worker/patient satisfaction seems to be running higher since NOHIMS was introduced," seven expressed a neutral opinion, five ageed with the statement, and one disagreed. Those individuals expressing a neutral opinion consisted of one system manager, one data entry clerk, one medical care provider, and four industrial hygienists. Their choice to remain neutral with regard to Statement 16 may reflect a lack of contact with the NOHIMS worker/patient population in order to assess satisfaction. The overall average rating was +0.3, approximately one-third of the way from Neutral Opinion to Agree on the 5-point rating scale.

Thirteen of the 14 individuals responding to Statement 17 either agreed or strongly agreed that they can see how NOHIMS can be a boon to other users. One respondent remained neutral. The overall average rating was +1.4, slightly less than halfway between Agree and Strongly Agree. Data entry personnel agreed the most strongly with this statement.

Of the 14 NOHIMS users who responded to Statement 18, "with NOHIMS I am able to get more done in a day," nine individuals either agreed or strongly agreed and five respondents expressed a neutral opinion. The overall average rating was +0.8, approximately three-quarters of the way from Neutral Opinion to

Agree. As a NOHIMS user class, the system managers and data entry personnel agreed the most strongly that they were able to get more done in a day with NOHIMS, followed by medical care providers and then industrial hygienists.

Ten of the 13 individuals responding to Statement 19 either ageed or strongly agreed that the records produced by NOHIMS are more amenable to review and better meet Navy standards. Three respondents expressed a neutral opinion. The overall average rating was +1.0, exactly at Agree on the rating scale. The system managers and data entry personnel agreed the most strongly with this statement, followed by industrial hygienists, and then medical care providers.

The distribution of ratings for Statement 20, "the confidentiality of the worker's/patient's record is more vulnerable with NOHIMS than it was with the manual system," is quite dispersed with eight individuals in disagreement, three in agreement, and three expressing a neutral opinion. The overall average rating was +0.4, approximately one-third of the way from Neutral Opinion to Disagree. Of the three respondents agreeing that the confidentiality of records is more vulnerable with NOHIMS than with the manual system, two were medical care providers and one was an industrial hygienist. Perhaps these three individuals were reflecting concern that worker/patient data are displayed on the video screens of terminals, that unauthorized persons may be able to access worker/patient data via a terminal or special telephone number, or that worker/patient data are stored in computer memory accessible to computer operations personnel. It is generally assumed that the patient's paper record is either well protected in the files of the medical records room or safe in the custody of the patient's medical care provider. This protection of privacy of the paper record is not always the case, however. It may be that potential opportunities to gain illicit access to patient record data in automated information systems are more visible, and consequently, users are more conscious of the vulnerability of the automated system to violations of privacy than they are to the vulnerability of the paper record. Users' attitudes concerning the adequacy of NOHIMS' security features are explored in more detail in the Evaluation of System Design section of this report.

Of the 14 NOHIMS users responding to Statement 21, "I don't care much what NOHIMS costs to operate, we need it to handle our workload efficiently," ten individuals either agreed or strongly agreed. Two people held a neutral opinion and two respondents disagreed. The overall average rating was +0.9 for this statement, more than three-quarters of the way from Neutral Opinion to Agree. One system manager and one industrial hygienist were in disagreement with Statement 21.

All but one of the 14 individuals responding to the last statement, Statement 22, either agreed or strongly agreed that if NOHIMS were to be taken out, they would be willing to make a reasonable effort to get it back in service. The lone medical care provider who disagreed with this statement appeared to be reacting to what he considered a level of austerity in his department that precluded any further cuts. As he commented along side of his rating, "If they cut anything else out, they might as well close the doors! We are already at bare bones." The overall average rating for Statement 22 was +1.1, slightly above Agree. Clearly, the current users of NOHIMS at the two test sites value the system and do not want to lose it.

Summary

Fourteen individuals responded to 22 statements reflecting possible attitudes or opinions regarding NOHIMS performance by rating their level of agreement or disagreement with each statement. In general, respondents were in agreement with 12 statements, disagreed with three statements, and showed variation in their ratings of seven other statements.

NOHIMS users on the average agreed with the following 12 statements:

1. Worker/patient-related information is more accessible and available more quickly with NOHIMS.

2. As a result of NOHIMS, I am able to do a better job.

5. NOHIMS catches more human errors than the old manual system did.

8. In general, NOHIMS is better than the old manual system of record keeping.

12. I truly feel that the quality of care has been improved as a result of NOHIMS. (Half of the respondents, including all five medical care providers, agreed; the other half had a neutral opinion.)

13. From an administrative point of view, NOHIMS provides timely data for making management decisions that were not available with the previous manual system.

14. Scheduling and staffing patterns have been improved since the advent of NOHIMS.

17. I can see how NOHIMS can be a boon to other users.

18. With NOHIMS, I am able to get more done in a day.

19. The records produced by NOHIMS are more amenable to review and better meet Navy standards.

21. I don't care much what NOHIMS costs to operate, we need it to handle our workload efficiently.

22. If NOHIMS were to be taken out, I would be willing to make a reasonable effort to get it back in service.

On the average, NOHIMS users disagreed with the following three statements:

6. In my opinion, NOHIMS should not have been implemented at this activity.

11. NOHIMS has "goofed" up worker/patient records more times than I care to remember.

15. NOHIMS does not benefit me much personally.

For the following seven statements, there was variation among respondents in their ratings.

3. The performance of NOHIMS falls short of what I expected.

4. I could never go back to using the old manual record system now that I have been using NOHIMS.

7. I rarely have to wait for necessary worker/patient information because the NOHIMS system is down.

9. NOHIMS has some major problems that need correction.

10. If there were budget cuts at this activity, I would rather see other services that I need cut before I lost NOHIMS.

16. Worker/patient satisfaction seems to be running higher since NOHIMS was introduced.

20. The confidentiality of the worker's/patient's record is more vulnerable with NOHIMS than it was with the manual system.

We also summarized the data from the structured appraisal of the performance of NOHIMS. We summed all of the ratings by class of NOHIMS user and then divided this sum by the total number of statements rated by each class to arrive at an omnibus single average rating for each user class. These results are presented in Table 51. The range for this single average rating was +2 to -2. The average rating was positive for all four classes of system users. System Managers were the most positive in their omnibus rating of NOHIMS performance, followed by data entry personnel, medical care providers, and industrial hygienists. This finding parallels the knowledge of and exposure to NOHIMS experienced by these four user classes. Medical care providers and industrial hygienists have the least day-to-day contact with the system, and the omnibus average rating for these two user classes was the lowest and almost the same.

We also computed an omnibus average rating for all four user classes combined. The resulting rating was +1.0, almost at +1 on the 5-point rating scale. In the aggregate, Table 51 paints a picture of good marks for the performance of NOHIMS.

TABLE 51
Omnibus Average Rating of the Performance of NOHIMS
by Four Classes of System Users
(Range of +2 to -2)

	Medical Care Providers	Industrial Hygienists	Data Entry Clerks	System Managers	TOTAL
Sum of ratings	93	90	49	55	287
No. of statements rated	105	109	43	44	301
Average rating	+0.9	+0.8	+1.1	+1.2	+1.0

SECTION IV
OPERATIONAL TESTING OF NOHIMS

The operational testing of NOHIMS was conducted in three phases: (1) system integration testing, (2) operational testing against the documentation, and (3) performance testing. Various functions and tasks were performed following the users' guides and a performance testing plan that we designed to ensure NOHIMS functionality. The results of each of these aspects of operational testing are presented in the three subsections below.

SYSTEM INTEGRATION TESTING

The integrated NOHIMS consists of: (1) two subsystems called components, namely, the medical component and the industrial component, (2) system hardware, (3) the operating system, and (4) communications equipment. The integrated system is different for the Naval Air Rework Facility, San Diego test site than the Puget Sound Naval Shipyard, Bremerton test site.

In San Diego, both components of NOHIMS reside on a Digital Equipment Corporation PDP 11/24. It has a random access memory of 384 megabytes. The system has two System Industries hard disk drives with an 80 megabyte disk and a 160 megabyte disk for a total of 260 megabytes of hard disk storage space. Communications equipment includes two Micom 8000 concentrator modems, two Micom 2000 bus drivers, and one 212A Bell modem. Connected to this system are three Digital Equipment Corporation LA120 printing terminals, eight Televideo 950 terminals, a System Industries 9800 controller, and a System Industries 1953 tape drive. The current operating system is Digital Systems Mumps (DSM) Version 2.0. Approximately 35 percent of the system's processing capability and 35 percent of the file capability is used for NOHIMS.

At Bremerton, the industrial component of NOHIMS resides on a Plessey 11/23 with an 80 megabyte Winchester hard disk drive. The only communications equipment used is one Bell 212A equivalent modem. One Digital Equipment Corporation LA120 printing terminal and six Plessey VT-100 equivalent CRT terminals are connected to the Plessey 11/23. A 20 megabyte streaming cassette is used for system back-ups. The operating system is InterSystems Mumps. One hundred percent of the system's processing capability is used for NOHIMS. As of November 1985, 50 percent of the file capability was in use for NOHIMS. The medical component is not part of the integrated system at the Puget Sound Naval Shipyard.

We did not conduct system integration testing on NOHIMS since NOHIMS has been operational at two test sites for the past two to three years. We felt that documenting the actual experiences of testing and operating NOHIMS in a live environment would be a more thorough and accurate evaluation of NOHIMS integration than any testing that we could perform. We asked 15 NOHIMS users to rate the performance of NOHIMS. Six medical care providers, five industrial hygienists, two data entry clerks, and two system managers rated NOHIMS in the

areas of problems with reliability, downtime, communication lines, and the man-machine interface; magnitude and trend of noticeable system failures; acceptability of the number of NOHIMS failures or errors; effect of heavy system usage on response time and data entry; time required to obtain a display; effect of a NOHIMS failure on the day-to-day provision of medical care; effect of a NOHIMS failure on the day-to-day administration of the Occupational Health Unit; and, lastly, the number of major "bugs" in the NOHIMS software. A detailed discussion of their ratings and comments may be found in the Assessment of the Overall System Performance subsection of the Evaluation of NOHIMS System Design section of this report. The following is a summary of the NOHIMS users' rating of NOHIMS performance.

The NOHIMS software was considered reliable at the time of our interviews last fall. Early system downtime was due to hardware problems. There were some problems with communication lines in the beginning, but the situation is fairly stable now. The most significant problem mentioned in the man-machine interface was the lock table problem that causes San Diego users to be locked out of NOHIMS when the PDP 11/24 system resources are stretched to capacity. This problem will be resolved when the operating system is upgraded. All noticeable system failures were attributed to hardware downtime, power failures, and problems with communication lines and the modems. Failures of the NOHIMS software (program errors) were rare. Most of the users concurred that heavy NOHIMS usage created a system slowdown but of varying degrees. Users at Bremerton generally reported no effect on response time. Most repondents agreed that data entry would be delayed in varying amounts by slow system response time except three users at Bremerton who reported that data entry is never delayed by system response time. Almost all of the users felt that NOHIMS displays either came up fast or somewhat fast. The industrial component was rated somewhat faster than the medical component. Almost three-quarters of NOHIMS users felt that the NOHIMS software has no major bugs; the other quarter of NOHIMS users did not report bugs of major significance.

Summary

NOHIMS has been running in a production mode in both San Diego and Bremerton for a considerable length of time. The system is stable at both test sites and the majority of NOHIMS users are satisfied with system software and hardware performance, with hardware downtime being a much more likely system problem than software program errors. System response time can be expected to improve when NOHIMS is migrated onto operational hardware and is running under an upgraded MUMPS operating system.

OPERATIONAL TESTING AGAINST THE DOCUMENTATION

The following are the findings and conclusions of our evaluation of NOHIMS operation against the NOHIMS user documentation, namely, the NOHIMS Users' Reference Manual, the NOHIMS System Manager's Manual, the NOHIMS User's Guide, and the NOHIMS OHS Component System Maintenance Manual. Evaluations of operation against the user documentation for both the medical component of NOHIMS and the industrial component of NOHIMS are included in this report. To evaluate the medical component documentation, we had one member of our

evaluation team read the documentation and perform all of the tasks described in the operating manuals. This person was familiar with COSTAR (the basis for the medical component of NOHIMS) prior to the testing, but had not been exposed to the adaptations that were made to the medical component of NOHIMS or to its specific data collection forms. The two people who reviewed the industrial component documentation had no or little exposure to the industrial component of NOHIMS. The reviewers noted both discrepancies between the user documentation and NOHIMS operation and software errors or other problems that occurred during system testing.

Medical Component of NOHIMS

In general, the user documentation for the medical component of NOHIMS is informative, well written, easy to follow and comprehend, and complete. The use of examples, exhibits, and job aids clarifies specific data entry procedures and informs the user exactly how a screen or sequence of prompts should appear. The sections of the documentation correspond to specific modules in the NOHIMS system, and are arranged in the order that the modules are used. This arrangement not only makes the manual an easy reference tool, but also allows the user to learn the use of one or more modules without necessarily having to learn the use of all modules (i.e., a user may learn to use the Registration and Enter Medical Data modules without learning how to use the COSTAR Report Generator).

The documentation follows NOHIMS operation closely; however, a number of discrepancies between NOHIMS operation and the user documentation were found. All but two are minor problems; simple corrections to the user documentation would eliminate these minor discrepancies. They have no damaging influence on the capability of a user to operate NOHIMS. In many instances, however, correction and/or clarification would make the documentation easier to follow and/or would more accurately reflect NOHIMS operation.

The first major problem that was found is a discrepancy in the display during Registration entry. At the Duty Station or Activity prompt, the Primary Clinic prompt, and the Ethnic Background prompt, the user enters a number for which NOHIMS echoes back the appropriate description. The documentation illustrates the correct way the screen should display the information. However, upon entry of a number at any one of these prompts, the system echoes back both the number and the corresponding description (i.e., "1 Naval Air Rework Facility" appears as "11 Naval Air Rework Facility"). This display problem occurs only at the entry prompt; NOHIMS does file and retrieve the correct number and display format. Therefore, the user should be advised to overlook the duplication of numbers in the display at these three Registration prompts as long as the correct information is shown in the Patient Registration Display, or programming changes should be made to resolve this display problem.

The second major problem that was encountered entailed the General Appearance section of the Physical Examination Findings (PEX) encounter form. The example illustrated in the documentation indicates that the General Appearance of the patient was Normal and a textual comment indicates that the patient appeared obese. In the General Appearance section of the PEX form, the only space available for textual comments is under the heading "If any ABNORMALITIES, describe:". This could be confusing to a data entry operator

unless the textual comment is clearly a condition that the user would know is not considered an abnormality. Therefore, it is recommended that the space for textual comments be clarified with the heading "Concise Comments(*):" as is done in other sections of the PEX form.

The minor problems that were found in the medical component documentation, along with any recommended changes, are described below. They are organized by sections of the NOHIMS Users' Reference Manual and the NOHIMS System Manager's Manual.

NOHIMS Users' Reference Manual

Title Page

- Add "Medical Component" to the title page to clarify that this manual refers to the medical component only.

Contents

- On page iii, the page number for Section 8. Mailbox should be "8-1" instead of "81". [Developers' Note: Correction was made in June 1986.]

List of Exhibits

No problems were encountered.

Section 1. Introduction to COSTAR---The Medical Information Component of NOHIMS

No problems were encountered.

Section 2. NOHIMS Conventions

- On page 2-3, the first example of the permissible forms used to identify and select a patient (LAST;) is an invalid name format. The fourth example (LE,R,;;20) has an extra comma after the R which needs to be deleted for the example to be a valid name format.

Section 3. Registration

- On page 3-2, the words "Exhibit 1" should be typed near the bottom of the page to make the location consistent with other exhibits. Also, the Ethnic Background field described in the text does not appear on the form. This field should be included on the Patient Registration form. [Developers' Note: When the documentation was written for the medical component of NOHIMS, Ethnic Background was a field on the Patient Registration form. Shortly after the form was put into use, there was criticism of the categories that had been chosen for Ethnic Background. This field was temporarily removed from the Patient Registration form until an acceptable set of ethnic

categories could be agreed upon. A response to the prompt was made optional so that it could be skipped in Registration data entry. However, the question mark response still displays the initial Ethnic Background categories. Description of the prompt was left in the text of the documentation because it was expected that at some point this field would be reincorporated in the system. To date this has not happened. A policy decision needs to be made at a higher level concerning a standard breakout of Ethnic Background categories. From a research perspective, it is important to collect this variable so that the incidence of disease in different ethnic groups can be assessed.]

- On page 3-9, paragraph 1, sentence 3, the words "date of birth" should be changed to "age".

Section 4. Enter Medical Data

- On page 4-2, the words "Exhibit 2" should be typed near the bottom of the page to make the location consistent with other exhibits.

- On page 4-14, last paragraph, it is unclear when and how an abnormal status code would be entered preceding a Hazardous Agent Surveillance data item. The text should be changed to clarify this entry.

- On page 4-31, last paragraph, sentence 3, "were" should be changed to "are", "entered" should be changed to "will enter".

- On page 4-61, the words "Exhibit 16" and the page number should be typed near the bottom of the page to make the location consistent with other exhibits.

- On page 4-80, the Cynthia Rigger example did not work because her name and social security number had been changed in the system. Her name in the system appeared as Cynthia Rogger and her SSN was 312-56-7894. [Developers' Note: The demonstration UCI is not frozen as a training UCI. Therefore, display examples may not exactly match the system displays, although formats will always be the same.]

- On page 4-82, ">>> AACQ1-D" should be ">>> DSP-D" to be consistent with page 4-74.

- It is unclear where and when the NOHIMS JOB AID FOR HOBBY HAZARDS is used. This should be clarified. [Developers' Note: The NOHIMS JOB AID FOR HOBBY HAZARDS is used for data entry of the occupational history. Documentation has not yet been written for entering occupational history data pending a final decision on the data collection forms.]

Section 5. Display Medical Data

- On page 5-6, code NBAJ1-N appears after code CBAV2, not before. [Developers' Note: The demonstration UCI is not frozen as a training UCI. Therefore, display examples may not exactly match the system displays, although formats will always be the same.]

- On page 5-7, no administrative data appeared in the encounter report for James Greeley on 9/26/84. Administrative data did appear on other dates. [Developers' Note: The administrative data should be deleted from the documentation example. A sentence should be added to the documentation that explains that the Encounter Report administrative variables are not historically retained, therefore, data for administrative items only appears in the most recent encounter for the patient for which an item has been entered.

- On page 5-11, "NAVAL AIR REWORK FACILITY" should be preceded by a "1".

- On page 5-13, the order of the PHYSICAL EXAMINATION DATA AND FINDINGS codes was different in NOHIMS than in the documentation, although all of the same codes were displayed. [Developers' Note: The demonstration UCI is not frozen as a training UCI. Therefore, display examples may not exactly match the system displays, although formats will always be the same.]

Section 6. Print Medical Data

- On page 6-1, "HALT DAILY ER PRINTER" should be "HALT DAILY ENCOUNTER REPORT ON PRINTER". Also, "LABORATORY RESULT REPORTING" should be added to the list of options.

- On page 6-2, prior to the prompt for OUTPUT TYPE, and on page 6-3, prior to the prompt for RESTART OUTPUT TYPE, the message "***NOTE-BE SURE ALL ENCOUNTERS HAVE BEEN ENTERED FOR THIS DATE AND MONITOR IS CAUGHT UP" is displayed. This message should be added to the documentation.

- On page 6-2, the BREAK key should be clarified as the interrupt or Ctrl C function.

- On page 6-3, the text after the last prompt should be identified as the ? response to that prompt.

- On page 6-9, after the SPECIAL PRINT OPTION prompt, there should be a prompt for IDENTIFY LAST CORRECTLY PRINTED REPORT BY NAME OR UNIT #:>. Also, "DEVICE #4 STARTED" should be "JOB STARTED".

- Pages 6-11 through 6-14 should be eliminated, as the scheduling system has not been initialized.

- If Laboratory Result Reporting is a viable option, a subsection should be added to explain the use of this option.

- All subsections should be completely capitalized, instead of being a mixture of upper and lower case letters. All subsections in other sections are completely capitalized.

[Developers' Note: Since no programming changes were made to the Print Medical Data module, the public domain COSTAR documentation for this module was used for the NOHIMS documentation. It is known that discrepancies exist between the public domain documentation and the public domain software because the software was modified further after the documentation was written.]

Section 7. Report Generator

No problems were encountered.

Section 8. Mailbox

- On page 8-5, the BREAK key should be clarified as the interrupt or Ctrl C function.

- On page 8-10, "See commands on page 7" should be changed to "See commands on page 8-9".

[Developers' Note: Since no programming changes were made to the Mailbox module, the public domain COSTAR documentation for this module was used for the NOHIMS documentation. It is known that discrepancies exist between the public domain documentation and the public domain software.]

NOHIMS System Manager's Manual

Title Page

- Add "Medical Component" to the title page to clarify that this manual only refers to the medical component.

No other problems encountered in the manual.

Industrial Component of NOHIMS

The user documentation for the industrial component of NOHIMS is also informative and well organized. Again, the sections of the documentation correspond to specific modules in the NOHIMS system, and are arranged in the order the modules are used. This documentation, however, utilizes few examples which, if included, could clarify data entry procedures. Because there are few data entry examples, the operational instructions are often cryptic and difficult to follow for a novice NOHIMS user. The industrial component often automatically proceeds from one module to another module during data entry which

is not explained in the documentation. Therefore, the documentation for the industrial component of NOHMIS is not as easy to follow and comprehend as the documentation for the medical component of NOHIMS. Areas of function that would be especially amenable to detailed examples are noted below.

As in the case of the medical component, a number of discrepancies between the documentation and NOHIMS operation were found. Most of the problems are minor and can be easily corrected, such as the numerous typographical errors found throughout the manual. The problems found are as follow, by chapters of the NOHIMS User's Guide and the NOHIMS OHS Component System Maintenance Manual. Only those typographical errors essential to the organization of the manual have been documented here.

NOHIMS User's Guide

Title Page

- Add "Industrial Component" to the title page to clarify that it refers to only the industrial component of NOHIMS.

Table of Contents

- In Chapter 6, Section 6.8 should be "DISPLAY AND REVIEW ENVIRONMENT DATA", found on page 6-4. The current Section 6.8 should be changed to 6.9 and the current Section 6.9 should be changed to 6.10.

Chapter 1. Introduction

No problems encountered.

Chapter 2. Using NOHIMS

- On page 2-2, Section 2.5, number 3, the [/] character should be clarified as being the Delete or Rubout key.

Chapter 3. NOHIMS Functions

- On page 3-1, "TRANSACTION/MESSAGE PROCESS" should be added to the list of options, and should be explained if it is a viable option.

- On page 3-2, under B. PERSONNEL DATA, the suboptions "TRAINING HISTORY" and "SAFETY EQUIPMENT" should be added to the documentation or they should be deleted from the option driver. [Developers' Note: These options were never implemented in NOHIMS. They will be deleted from the option driver.]

- On page 3-2, the option "TRANSACTION/MESSAGE PROCESS" should be added, with the suboptions "RECEIVED MESSAGE PROCESSING", "TRANSMIT/MESSAGE PREPARATION", and "PERSONNEL TRANSACTION PROCESSING".

Chapter 4. Agency Function

- On page 4-3, last paragraph, if the initial definition process is necessary at any time other than during OHS System implementation, there should be an explanation and example of how the procedure is done. [Developers' Note: The initial definition process is always accomplished during system implementation. Deleting the word "usually" from the text will make this clearer.]

- On page 4-4, under edit options, "QUIT" should be changed to "QUIT EDIT MENU", "EDIT AGENCY DATA ITEMS" should be changed to "EDIT FACILITY DATA ITEMS". [Developers' Note: The word "agency" is used generically in the documentation. The system will use the term that is appropriate for the industry such as "facility" or "company."]

- On page 4-4, under item 1, "Agency Name" should be changed to "Full Name", "Generic Title" should be changed to "Generic Title for the Industry", and "Agency Type" should be changed to "Industry Type". [Developers' Note: The terms used here were intended to simply describe the data items and not duplicate the prompts exactly.]

Chapter 5. Personnel Function

- On page 5-1, paragraph 2 under Section 5.2, the normal agency unit method should be clarified.

- On page 5-2, at the last Item # or Quit> prompt, "[Q]" should be added as a possible response.

- On page 5-3, in the transaction option list under Section 5.4, the word "ENVIRONMENT" in option numbers 2, 3, and 4 should be changed to "WORKPLACE". In the last paragraph, second sentence, it should be clarified whether the environment assignments are terminated automatically by the system or whether the user needs to terminate them.

- On page 5-4, the list of subfunctions should include "0=QUIT" and "7=DISPLAY EXAMINATION DATA". The current "7" should be changed to "8" and "8" should be changed to "9".

- In trying to use the EXAM ROSTER PRINT function, it was unclear what the Report File # was and where the user should obtain it (one of many places in the documentation where examples showing prompt sequences and appropriate user responses would be helpful).

- On page 5-5, the occupation codes are clearly explained, but it is unclear where the data entry operator would obtain a patient's occupation code for entry.

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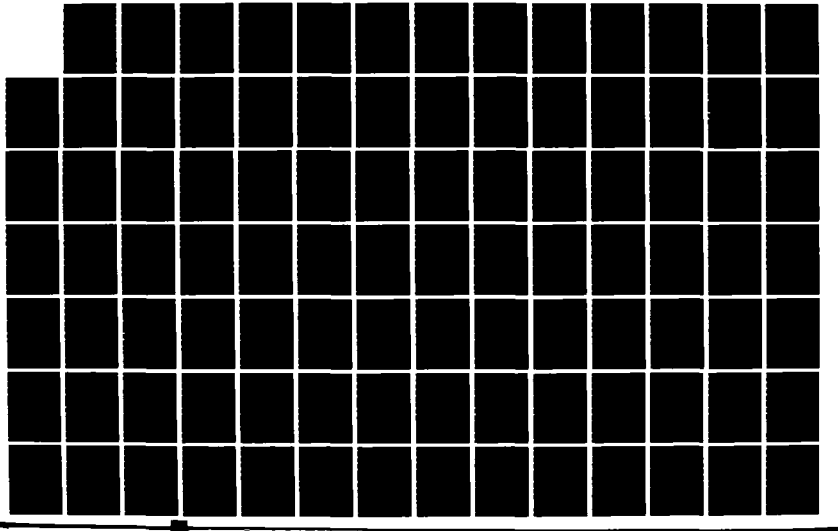

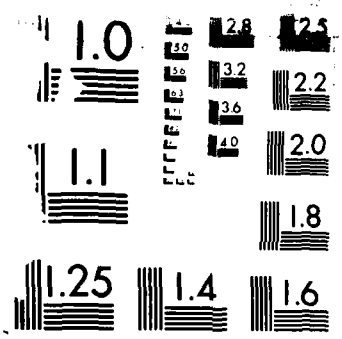

MICROCOPY RESOLUTION TEST CHART

Chapter 6. Environment Function

- On page 6-3, in the option list, "QUIT" should be changed to "QUIT ENVIRONMENT SELECTION", "AGENCY" should be changed to "FACILITY", "A" should be deleted from option numbers 2 and 3, and "AN" should be deleted from option numbers 1 and 4. In the fourth paragraph, "1 or 2" should be changed to "2 or 3". [Developers' Note: The word "agency" is used generically in the documentation. The system will use the term that is appropriate for the industry such as "facility" or "company."]

- On page 6-4, the DISPLAY AND REVIEW ENVIRONMENT DATA section should be numbered "6.8", not "6.6".

- On page 6-5, the EDIT ENVIRONMENTS section should be numbered "6.9", not "6.8".

- On page 6-6, the ASSIGNING ENVIRONMENTS section should be numbered "6.10", not "6.9".

Chapter 7. Survey Data Function

- On page 7-1, paragraph 1 under 7.2, it is unclear whether the three types of surveys are entered the same or differently. An example of survey data entry is necessary here.

- On page 7-2, paragraph 10 states that a general textual comment is solicited under Adverse Health Effects Reported. A space for text was not found on the IHS Form on page E-1.

Chapter 8. Hazardous Material Function

- On page 8-4, it is unclear where the data entry operator obtains the NIOSH method number and the type of standard for data entry.

Chapter 9. Query Function

- No problems encountered with the documentation. This section contained examples of data entry and reports that were very helpful in understanding the operation of this module.

Chapter 10. Personnel Transaction File Processing

- On page 10-1, in the first paragraph after the list of operations, "option 1 or 2 above" should be changed to "option 2 or 3 above". Under MESSAGE protocol, it should be clarified how the user can determine if a terminal device has been programmed for this protocol.

- On page 10-2, the number 10.2 should be followed by the section heading of "TRANSACTION PROCESSING".

- If RECEIVED MESSAGE PROCESSING and TRANSMIT/MESSAGE PREPARATION are viable options, each of these should be explained.

Appendices

- The appendices should be arranged in the order they are referenced in the text. Currently, Appendix A is the first one referenced on page 5-5, then Appendix E is the next one referenced on page 7-1.

- Appendix D is referenced on page 8-4 under Scale. The examples listed on page 8-4 (PPM, MG/M3, DBA) should be included in Appendix D. The table looks as if it contains codes for media not units.

- Page E-1 should be identified as Appendix E at the top of the page.

NOHIMS OHS Component System Maintenance Manual

No problems were encountered in the sections that have been written thus far.

Summary

Although this report documents in detail the discrepancies found between the user documentation and NOHIMS operation, most problems are minor, and simple corrections or additions to the user documentation would clarify the processes for the user. On the whole, the user documentation was found to be informative and well written. With the information provided in the manuals, the user will be capable of utilizing all of the operational and functional aspects of NOHIMS. It is essential, however, that more examples of data entry be added to the NOHIMS User's Guide for the industrial component.

SYSTEM PERFORMANCE TESTING

From the deficiencies and requirements laid out in the NOHIMS Mission Element Needs Statement (MENS) and the NOHIMS System Decision Paper, we compiled a list of functions that NOHIMS should have in order to meet the Navy functional description for NOHIMS. Under each function we defined tasks for NOHIMS to perform to determine if NOHIMS adequately met that functional requirement. We would like to note that many of the functions are very broad in scope. For these functions we performed one or more tasks designed to demonstrate the kinds of tasks NOHIMS can perform in the area of that function. NOHIMS may or may not meet specific functional needs once they are defined by the Navy. Many of the tasks were performed in the process of conducting the operational testing of NOHIMS. The results of the system performance testing done in the demonstration UCIs are as follows. The results are organized by function and then by task under the function.

Function 1: Ability to input, store, retrieve, and display selected workplace monitoring data including work history data, data on exposure episodes, environmental monitoring and industrial hygiene data, and demographic data. Specific functions to include: (1) retrieval of exposure parameters by location or hazard type, (2) provision of historical data on exposures for individual workers or a cohort, and (3) demonstration of past and present levels of workplace exposures for compliance with NAVOSH standards.

Task A: Create, edit, and display personnel data (work history and demographic data) for selected individuals.

RESULTS: Using the Personnel Data Entry option, an imaginary worker named John Q. Worker was entered into the system. He was assigned to the hull repair department and Bldg. 1, Room 100, Office. Using the Edit Personnel Data option, his date of birth was changed. The personnel data for John Q. Worker and another imaginary worker named Carol P. Jones were displayed. These data included demographic data and workplace assignments. At present, only current workplace assignments can be displayed. No problems were encountered.

Task B: Create, edit, and display survey data for selected surveys.

RESULTS: Using the Survey Data Entry option, data from a survey of Bldg. 1, Room 100 was entered into the system. One Occupational Hazard Data Sheet for asbestos was entered and asbestos was added to the materials inventory for the shop. The supervisor and telephone for the shop and the measurement value for the asbestos were edited. The Industrial Hygiene Survey form, Occupational Hazard Data Sheet, and the Materials Inventory for the survey were displayed. No problems were encountered.

Task C: Generate a report that shows historical exposure data for selected individuals; for a group of individuals.

RESULTS: NOHIMS does not currently have a capability to retrieve historical exposure data from the industrial component. The only way to get historical exposure data would be to generate a COSTAR Report Generator report that would retrieve past examinations for hazardous agents and infer that these were the patient's exposures. This would not provide information about actual levels of exposures. An alternative would be to permanently store the Individual Exposure Examination Report (IEER) that is generated each year at the time of the individual's annual examination report. The IEER contains exposure data for the individual as of the month they are due for a physical. A third alternative would be to augment the Interactive Query function in the industrial component with the ability to retrieve historical exposure data.

Task D: Generate a report that shows past and present workplace exposures for a selected environment.

RESULTS: Using the Environment Data option, the personnel assigned to, the surveys done on, the materials located in, and the most current measurement value for the materials present in shop Bldg. 1, Room 100, Office were displayed. NOHIMS will not display past workplace exposures. No problems were encountered.

Task E: Generate a report that shows exposure measurements and persons exposed for a selected agent.

RESULTS: Using the Query/Report module in the industrial component of NOHIMS, a report that listed the workers who are exposed to asbestos and the latest exposure measurement for asbestos for each environment that contains asbestos was generated. Three workers in two environments were displayed. No problems were encountered.

Function 2: Ability to input, store, retrieve, and display selected occupational health data, including preplacement/employment physical examinations, medical surveillance examinations, job certification examinations, injury/illness care, fitness for duty and return to work interactions, audiometric data, biomedical monitoring data, and basic medical and demographic data.

Task A: Create, edit, and display a medical encounter for a preplacement/employment physical examination, a medical surveillance examination, a job certification examination, a fitness for duty interaction, and a return to work interaction. (Note: A medical encounter may contain medical data, demographic data, and biomedical monitoring data.)

RESULTS: A periodic examination for an imaginary patient named James C. Greeley was entered into NOHIMS. His encounter included work information, hazardous agent surveillance data, laboratory tests ordered, physical examination findings, problems, and a disposition. Demographic data had been previously entered using Patient Registration. Separate encounters for all of the categories above were not entered because the procedures are the same for all of the types of examinations. Medical edit entries were made for two imaginary patients, Jason P. Pilot and Cynthia T. Rigger. Codes were added to encounters, textual comments were edited, textual comments were deleted, textual comments were added, codes were deleted, and laboratory and physical examination results were edited. Encounter reports for James C. Greeley, Jason P. Pilot, and Cynthia T. Rigger were displayed. No problems were encountered.

Task B: Create, edit, and display a medical encounter for injury and illness care.

RESULTS: NOHIMS does not currently have encounter forms or directory codes for entering illness/injury care.

Task C: Enter and display data for an audiogram.

RESULTS: Two audiograms were entered into NOHIMS for an imaginary patient named Chester Cowrey. One audiogram was a reference audiogram and the other was a follow-up audiogram. The standard Hearing Conservation Data forms (DD 2215 and DD 2216) with plastic overlays containing data entry codes were used to enter these data. The Lab Results option was used to edit the date of the reference audiogram for the follow-up audiogram. The audiogram data were retrieved as part of a periodic examination Encounter Report display and as part of the summary reports--the Status Report and the Patient Summary. No problems were encountered.

Task D: Demonstrate utilization of historical Hearing Conservation Management Information System (HECMIS) data.

RESULTS: NOHIMS does not have a direct interface with historical HECMIS data. The audiogram data stored in NOHIMS are entered using the data collection forms from the HECMIS database ensuring compatibility with the historical database. However, special programming is required to directly link the two databases.

Function 3: Identification of individuals exposed to hazards in the workplace and the level of exposure.

Generate a list of individuals exposed to a selected hazard and the level of exposure.

RESULTS: See Function 1, Task E.

Function 4: Identification of exposed or potentially exposed individuals requiring physical examinations for all hazards.

Generate an Occupational Health Roster and a Notification of Individual Exposures for selected individuals.

RESULTS: Using the Hazard/Examination Report option, an Occupational Health Roster and Physical Examination Notification Reports for personnel due for a physical examination in September 1986 were generated. No problems were encountered.

Function 5: Provision of exposure history, current exposures, and a list of recommended tests and procedures to medical personnel.

Task A: Generate an Individual Exposure Examination Report for selected individuals.

RESULTS: Using the Hazard/Examination Report option, all workers who were due for a physical examination in March 1986 were selected and Individual Exposure Examination Reports were produced for each worker selected. No problems were encountered.

Task B: Generate a Patient Data Sheet for selected individuals.

RESULTS: A Patient Summary report was generated for imaginary patients James C. Greeley, Chester Cowrey, and Industrial Worker. This report contained summary medical data across encounters and current exposure data obtained from the industrial component. No problems were encountered.

Function 6: Provision of medical job certifications to line authorities.

Generate a medical job certification form for selected individuals.

RESULTS: NOHIMS does not generate a medical certification form. Because virtually every worker examined is returned to work, the medical care providers simply note the worker's return time on the Physical Examination Notification Report and send the worker back to the job. If the worker's disposition is other than a return to full duty, the physician contacts the work supervisor directly, usually by telephone.

Function 7: Provision of composite summaries of medical and exposure data to higher authorities, including summaries of work force physical examination results.

Task A: Generate a report containing the number of people exposed to selected substances during a selected time period.

RESULTS: See Function 1, Task C.

Task B: Generate a report containing the number of people with an abnormal test finding during a selected time period; the number of people with an abnormal physical examination during a selected time period.

RESULTS: Using the COSTAR Report Generator in the medical component, a list of patients who had a Differential test with an abnormal result during March 1, 1986 through March 8, 1986 was generated. The list included the patient's name, date of visit, and the abnormal Differential result. A list of patients with an abnormal heart examination during March 1986 was also produced. This list contained the patient's name, date of visit, and the modifier(s) for the portion(s) of the heart examination that was(were) abnormal. No problems were encountered.

Function 8: Incorporation or replacement of existing central Asbestos Medical Surveillance Program (AMSP) and Hearing Conservation Management Information System (HECMIS) data and utilization of historical data.

Task A: Create, edit, and display an asbestos surveillance encounter.

RESULTS: An asbestos surveillance encounter for James C. Greeley was entered into NOHIMS using data provided in the NOHIMS User's Reference Manual. The standard Navy Asbestos Medical Surveillance Program form (NAVMED 6260/5) with plastic overlays containing data entry codes was used to enter these data. The Medical Edit option was used to edit the age the worker began smoking. The asbestos data were retrieved as a separate Encounter Report display and as part of the summary reports--the Status Report and the Patient Summary. There is no linkage with historical data although the same data items are collected. No problems were encountered.

Task B: Create, edit, and display hearing conservation data.

RESULTS: See Function 2, Tasks C and D.

Function 9: Provision of summary data for reports to higher authorities and administrative proceedings, including workload summaries.

Generate the COSTAR Report Generator reports in the medical component that provide data for the 6260/1 semi-annual report, namely, ACTIVITY6260, CIVMIL6260, HAZARD6260, JOB6260, LAB6260, LABTEST6260, RADIOLOGY6260, TYPE6260C, and TYPE6260M.

RESULTS: All of these reports were run on subsets of patient records defined by date of encounter. No problems were encountered. The NOHIMS reports do not produce the data in the same format as required for the 6260/1 semi-annual report, however; manual transfer of data to the standard report is necessary. These NOHIMS reports provide tallies of physical examinations done and laboratory and radiology tests conducted. NOHIMS does not keep track of manpower. These reports are used to count procedures performed and examinations conducted. NOHIMS does not tally any workload parameters in the industrial component, such as number of surveys conducted during a given time period.

Function 10: Ability to input, store, process, and display occupational health program management data to include manpower, time-in-motion, equipment lists, inspection requirements, and other appropriate resource data required to track and direct manpower, equipment, and budget resources.

NOHIMS does not track any of these kinds of data. NOHIMS will provide tallies of medical procedures performed, as described in Function 9.

Function 11: Compilation of standardized information on exposures and health for short-term and long-term epidemiologic analysis and other research purposes.

The NOHIMS function tested in Function 12, Task B can generate standardized data for various laboratory tests and certain physical examination results for exposed workers that are suitable for epidemiologic analysis and research purposes. Although NOHIMS collects a multitude of other standardized data suitable for epidemiologic analysis, new software to extract and/or manipulate these data will most likely be required.

Function 12: Correlation of exposure data with medical data such as summary data on the extent of disease and injury by hazard type and work location.

Task A: Generate a report that correlates diagnosis with hazard type and work location.

RESULTS: We created a COSTAR Report Generator report in the medical component of NOHIMS that tallies diagnoses by two hazardous agent surveillances, mercury and carbon monoxide, for Building 32415. This report creates tables of the frequency of all diagnosis codes for each of the hazard agent surveillances. Since there is no function that retrieves data from the medical component and industrial component simultaneously, there is no existing way to correlate diagnosis with actual exposure measurements.

Task B: Generate selected laboratory test result data for individuals exposed to selected agents for use in other statistical packages.

RESULTS: Using the CONSTRUCT SSN GLOBAL and PRODUCE FIXED LENGTH RECORDS options in the COSTAR Report Generator module of the NOHIMS' medical component, we selected patients who had an encounter between January 1, 1986 and January 10, 1986. We then produced fixed-length records that contained results for any Pulmonary Function tests these people had during the same time period. The fixed-length record contains limited patient identifying data, limited demographic data (age, sex, and ethnic background), date of the test, COSTAR code of the test, and results of the test. Next, we used the MOVE SSNS FROM INDUS UCI option to transfer a list of 17 social security numbers that had been selected in the industrial component and merge them with a list of two patient social security numbers in the medical component. We then produced fixed-length records that contained results from any Differential and/or Pulmonary Function tests that these people had. No problems were encountered. We did not test transferring the fixed-length records to tape.

Function 13: Provision of accurate medical and exposure information on individuals for use in legal functions, including Workers' Compensation and environmental differential pay determinations.

Task A: Generate a list of historical workplace assignments and the exposures at each workplace for a selected individual.

RESULTS: A listing of the current workplace and hazardous exposures for a given individual may be obtained using the Query/Report module. NOHIMS does not presently have a capability for retrieving historical data from the industrial component database. See Function 1.

Function 14: Compatibility and linkage with other suitable databases where possible, for example, military personnel/pay systems, TRIMIS, etc. Access to and display of information from other databases such as hazardous material information systems, and Federal, DOD, or Navy standards and instructions.

Task A: Demonstrate compatibility with other suitable databases where possible, for example, military personnel/pay systems, TRIMIS, etc.

RESULTS: The personnel data contained in the industrial component of NOHIMS are obtained from the Personnel Extract File ensuring compatibility between the two systems. Compatibility between NOHIMS and TRIMIS cannot be demonstrated as the development of TRIMIS has not proceeded far enough to make a comparison.

Task B: Demonstrate linkage with suitable databases such as military personnel/pay systems, TRIMIS, etc.

RESULTS: NOHIMS does not have any direct links with other Navy databases. It has an indirect link with military personnel/pay systems because the Personnel Extract File is loaded onto tape and reloaded into NOHIMS on a monthly basis to update NOHIMS personnel files. We did not test this specific link because this task has been done at the San Diego test site for 30 months. No linkage problems are encountered during routine transfers of data to NOHIMS.

Task C: Test interfaces with other information databases such as hazardous material information systems, and Federal, DOD, or Navy standards and instructions.

RESULTS: NOHIMS does not currently have interfaces with other information databases.

Summary

The industrial component of NOHIMS provides the capabilities necessary to input, store, edit, retrieve, and display various workplace monitoring data, including work history data, data on exposure episodes, environmental monitoring and industrial hygiene data, and worker demographic data. It is limited to retrieving and displaying current data such as present exposures and workplace assignments. Historical data for many variables are retained in the industrial component's data files, although at present these data cannot be retrieved.

The medical component of NOHIMS provides functions for entering, storing, editing, retrieving, and displaying occupational health data, including data from preplacement/employment physical examinations, medical surveillance examinations, job certification examinations, fitness for duty and return to work interactions, audiometric data, biomedical monitoring data, and basic medical and demographic data. It does not have a capability for entering illness and injury care data. However, the Naval Health Research Center is currently developing data collection forms and making changes to the COSTAR directory to allow illness and injury care data to be processed by NOHIMS. NOHIMS has functions for entering and displaying Hearing Conservation Management Information System (HECMIS) audiogram data. NOHIMS does not have a direct interface with the HECMIS database. NOHIMS also incorporates data from the Asbestos Medical Surveillance Program.

Both components have limited capabilities for storing and processing occupational health program management data. The medical component of NOHIMS can provide tallies of various process measures such as the number of physical examinations conducted and/or the number of laboratory tests performed. NOHIMS can provide composite summaries of various medical and exposure data, although the industrial component is limited to retrieving current values. NOHIMS collects a multitude of standardized data suitable for epidemiologic analysis; however, the software to extract and/or manipulate these data is limited. There is no function in NOHIMS that retrieves data from the medical and industrial components simultaneously. NOHIMS does have a few links between the two components. The Patient Summary in the medical component displays current exposure information. Also, social security numbers from the industrial component can be used to select patients in the medical component for reformatting of data using the fixed-length record options. An individual's current exposures and workplace assignments can be retrieved from the database for use in legal functions; however, NOHIMS presently cannot retrieve historical exposures or workplace assignments. NOHIMS has compatibility with military personnel/pay systems such as the the Personnel Extract File produced by the Naval Air Rework Facility. NOHIMS does not have any direct links with other Navy or outside databases.

SECTION V
EVALUATION OF USES OF NOHIMS

NOHIMS and its database may be used for a variety of purposes in addition to the basic functions of workplace monitoring and medical surveillance. We evaluated the usefulness of NOHIMS in four other areas: the assessment of medical monitoring and care, legal evidence for compensation claims and other legal purposes, epidemiologic research, and administrative functions. To assess the uses of NOHIMS in medical monitoring and care, we questioned the medical care providers, NHRC NOHIMS developers, and the higher level managers about the goals for NOHIMS in the area of medical monitoring and care. We also described ways in which reports generated by NOHIMS could be used in monitoring medical surveillance. To evaluate the usefulness of NOHIMS as a database for legal evidence, we questioned employees involved with compensation claims at the Naval Air Rework Facility (NARF), San Diego; compensation specialists at the Naval Hospital, San Diego; and Navy legal counsel at the Naval Legal Services Office of the Naval Station, San Diego; the Labor Relations and Litigation Branch, Naval Air Station, North Island, San Diego; and the Office of Counsel, Naval Air Rework Facility, Alameda, California about areas in which the NOHIMS database will be useful as legal evidence and the types of data required for these purposes. We questioned the NOHIMS developers at the Naval Health Research Center (NHRC) in order to determine the usefulness and adequacy of NOHIMS as an aid to epidemiologic research. Finally, we interviewed the test site administrators, higher level managers, and the NHRC NOHIMS developers about the usefulness of NOHIMS in administrative functions.

ASSESSMENT OF USEFULNESS OF NOHIMS IN MEDICAL MONITORING AND CARE

The evaluation of the usefulness of NOHIMS in medical monitoring and care has two parts. The first subsection describes the results of our interviews with the NHRC NOHIMS developers, medical care providers, and industrial hygienists. In these interviews, we asked each of the interviewees to identify the medical monitoring and care goals for NOHIMS and we questioned them with regard to how they perceived NOHIMS had influenced medical monitoring and care. The second subsection describes ways that NOHIMS could be used to assess medical monitoring and care in the operational environment.

Evaluation of Medical Monitoring and Care Goals

Based on resource materials from other evaluations of medical information systems, we devised a list of medical monitoring and care goals to use in assessing the goals for NOHIMS and how well the goals were being met. These goals fell into five broad categories: improvement in quality of care, improvement in access to care, improvement in resource utilization, improvement in management aspects of health care, and improvement in compliance with monitoring programs/Navy set standards of care. Using this list of goals, we asked the respondents to identify their perception of the specific goals for

NOHIMS in the area of medical monitoring and care; how well NOHIMS was meeting these goals; the specific goals NOHIMS was not meeting well; the effect of NOHIMS on quality of care, access to care, resource utilization, and compliance with monitoring programs; and reasons for the effects that NOHIMS had on medical monitoring and care. We questioned the medical care providers with regard to the effect of the availability of the NOHIMS medical record and the availability of the individual's exposure history on the quality of patient care. In addition, we asked the medical care providers and industrial hygienists to evaluate the effect of NOHIMS on communication between industrial hygienists and medical personnel. The industrial hygienists also evaluated how NOHIMS had affected communication between industrial hygienists/safety specialists and work center supervisors. We interviewed four NHRC NOHIMS developers, six medical care providers, and five industrial hygienists. The list of goals and the questions that we used in these interviews may be found in Component 23 of Appendix A.

Table 52 shows the specific goals for NOHIMS that the NHRC NOHIMS developers and the medical care providers identified. None of the goals was mentioned by all of the respondents; however, eight out of nine of the respondents (89%) mentioned three goals. These were improvement in database acquisition, problem identification, and research information collection. The next most frequently mentioned goals were improvement in record accuracy, communication, patient follow-up, record availability, medical reports, compliance with periodic physical examinations, and compliance with the asbestos surveillance program, all of which were mentioned by 78 percent of the respondents. The remaining goals were all mentioned by 44 percent or more of the respondents, but to varying degrees.

The goals that the developers mentioned differed somewhat from those mentioned by the medical care providers. Generally, a higher percentage of the medical care providers mentioned the quality of care and access to care goals than did the NHRC NOHIMS developers. Conversely, generally a higher percentage of the NRHC NOHIMS developers mentioned the goals in the areas of resource utilization, management aspects of health care, and compliance with monitoring programs/Navy set standards of care than did the medical care providers. This difference is probably a reflection of the varying perspective of these two groups on how the system will be used.

Table 53 presents the respondents' assessment of how well NOHIMS is meeting the medical and monitoring care goals. All of the respondents felt that NOHIMS was meeting the goals at least somewhat well, and half of the respondents rated NOHIMS as meeting them very well. The NHRC NOHIMS developers gave NOHIMS somewhat better ratings on meeting the goals than did the medical care providers.

Table 54 shows the specific goals that the respondents said NOHIMS was not meeting well. The goal that was mentioned most frequently as one NOHIMS was not meeting well was improvement in management and operations, mentioned by 38 percent of the respondents. Improvement in quality of care, improvement in compliance with monitoring programs, and improvement in resource utilization were mentioned by only 25 percent of those responding to the question.

The NHRC NOHIMS developer who chose improvement in quality of care as a goal that NOHIMS was not meeting selected this goal because despite the system's

TABLE 52
Specific Goals for NOHIMS in the
Area of Medical Monitoring and Care
(Number who mentioned goal; multiple answers allowed)

	NHRC NOHIMS Developers	Higher Level Managers	TOTAL	% of Total Who Answered
Improvement of quality of care via:				
Patient management:				
diagnostic tests	2	4	6	67
database acquisition	3	5	8	89
treatment planning	2	4	6	67
problem identification	3	5	8	89
feedback to physician regarding acheivement of desired outcome	2	4	6	67
Patient compliance with physician orders because of comprehensiveness/ continuity of care	1	3	4	44
Quality of care review procedures	2	4	6	67
Research information collection	3	5	8	89
Training activities	2	3	5	56
Record accuracy	2	5	7	78
Earlier diagnosis of abnormal conditions	1	4	5	56
Earlier notification of patient abnormalities	1	4	5	56
Communication	3	4	7	78
Automated medical testing	0	4	4	44
Improvement of access to care via:				
Patient follow-up	3	4	7	78
Appointment scheduling	2	4	6	67
Record contents	2	4	6	67
Record availability	3	4	7	78
Visit registration	2	4	6	67
Medical reports	3	4	7	78

(Continued)

TABLE 52 (CONT.)

	NHRC NOHIMS Developers	Higher Level Managers	TOTAL	% of Total Who Answered
Improvement of resource utilization via:				
Health manpower utilization/availability	3	1	4	44
Patient services:				
fewer unnecessary visits	3	2	5	56
fewer redundant laboratory tests	3	2	5	56
better referral	2	2	4	44
Improvement of management aspects of health care via:				
Provision of data and analytical tools for:				
utilization review procedures	2	2	4	44
manpower scheduling	3	2	5	56
budgeting and planning	2	2	4	44
long-range manpower planning	2	2	4	44
long-range facility planning	2	2	4	44
regional/Navy-wide health planning	3	3	6	67
Administrative reports	3	3	6	67
Improvement in compliance with monitoring programs/Navy set standards of care:				
Periodic physical examinations	4	3	7	78
Protective equipment	1	3	4	44
Asbestos surveillance program	4	3	7	78
TOTAL WHO ANSWERED	4	5	9	100
No Comment	0	1	1	
TOTAL INTERVIEWED	4	6	10	

TABLE 53
Assessment of How Well NOHIMS Is Meeting
the Medical Monitoring and Care Goals
(Number who mentioned rating)

	NHRC NOHIMS Developers	Medical Care Providers	TOTAL	% of Total Who Answered
Very well	2	2	4	50
Well*	1	0	1	12
Somewhat well	0	3	3	38
Somewhat not well	0	0	0	0
Not well	0	0	0	0
TOTAL WHO ANSWERED	3	5	8	100
No Comment	1	1	2	
TOTAL INTERVIEWED	4	6	10	

* Category added by respondent

TABLE 54
Specific Goals That NOHIMS Is Not Meeting Well
(Number who mentioned goal; multiple answers allowed)

	NHRC NOHIMS Developers	Medical Care Providers	TOTAL	% of Total Who Answered
Improvement in:				
Management and operations	0	3	3	38
Quality of care	1	1	2	25
Compliance with monitoring programs	2	0	2	25
Resource utilization	1	1	2	25
Access to care	0	0	0	0
TOTAL WHO ANSWERED	3	5	8	100
No Comment	1	1	2	
TOTAL INTERVIEWED	4	6	10	

"great potential for improving all aspects of patient care and management," he has concern about whether physicians will actually use the system to its full advantage in clinical/care decisions. He felt that this was a problem of implementation and not design, however. This developer also commented that NOHIMS needs to evolve in the area of management aspects of health care. In his opinion, NOHIMS has not been used much in this area, although he predicts that this will be a significant use for NOHIMS in the future. Two of the NHRC NOHIMS developers identified improvement in compliance with monitoring programs as an area of weakness. One of these developers thought that NOHIMS was not "doing much about compliance" with protective equipment because there was no feedback to supervisors if a worker was not wearing his protective equipment. The other developer felt that NOHIMS had not fully improved compliance with monitoring programs because the implementation of the respiratory programs and job certification programs was not complete. [These programs have since been included into NOHIMS criteria for physical examinations.] The NHRC NOHIMS developer who mentioned that NOHIMS was not meeting resource utilization goals felt that NOHIMS users were not fully utilizing the system's capabilities in this area, probably because of a lack of training on the part of the users.

The medical care providers as a group mentioned three areas of goals that NOHIMS is not meeting well. These included management and operations goals mentioned by three out of five (60%) of the medical care providers, and quality of care goals and resource utilization goals each mentioned by one of the medical care providers. Two of the three medical care providers who mentioned management and operations goals commented that NOHIMS was not providing all of the management reports that were needed. The medical care providers who mentioned other goals NOHIMS was not meeting did not amplify as to why NOHIMS was not meeting these other goals.

The medical care providers did have some general comments with regard to the usefulness of NOHIMS in medical monitoring and care. One medical care provider stated that there was a problem with "people thinking of the system not as a minimum but as an absolute." He himself often augments the list of tests to be performed because of [the patient's] lifestyle, hobbies, etc. Another medical care provider who did not identify any particular goals that NOHIMS is not meeting well felt that there has been "some improvement [in medical monitoring and care] but nowhere near the potential." A third medical care provider felt that "concerns about currency and accuracy of information dictate the usefulness of the system." Also, this provider thought that NOHIMS' usefulness was limited by not having integrated industrial hygiene and medical data. For example, he would like to identify everyone with an abnormal chest X-ray and asbestos exposure. One of the occupational health technicians who did not identify a particular goal that NOHIMS was not meeting mentioned having a problem with patients reporting different exposures than NOHIMS, confusion over protective equipment examination tallies, and some patients reporting that they were never notified of their scheduled examination. [The problem with the protective equipment tallies was resolved since that time.]

Tables 55-58 show how the respondents rated the effect of NOHIMS on quality of care, access to care, resource utilization, and compliance with monitoring programs. Seventy-one percent of those who responded to the question about the effect of NOHIMS on quality of care felt that NOHIMS had increased the quality of care (see Table 55). One of the medical care providers stated that the

TABLE 55
Effect of NOHIMS on Quality of Care
(Number who mentioned rating)

	NHRC NOHIMS Developers	Medical Care Providers	TOTAL	% of Total Who Answered
Increased quality	3	2	5	71
Maintained quality	0	0	0	0
Decreased quality	0	0	0	0
Mixed effect*	0	2	2	29
TOTAL WHO ANSWERED	3	4	7	100
No Comment	1	2	3	
TOTAL INTERVIEWED	4	6	10	

* Category added by respondent

NOHIMS data collection forms manage the physician's behavior, thereby making their physical examinations more complete.

Two of the medical care providers (29% of the respondents) stated that NOHIMS had a mixed effect on the quality of care. One of these medical care providers explained that NOHIMS had a mixed effect on the quality of patient care because "some people previously not caught are examined, but now others are falling through the cracks." The other medical care provider was very excited about the Individual Exposure Examination Report and its influence on the quality of care provided. On the down side, however, he complained that the system does not contain data on illness/injury care and that maintaining a dual system (old manual system and NOHIMS) takes much of the occupational health technicians' time away from patient care. He felt that when the Navy eliminated the need to maintain both systems, NOHIMS would have a more positive effect on the quality of patient care.

Eighty-three percent of the respondents stated that NOHIMS had increased access to care, although three of the medical care providers felt that they could not comment on this issue (see Table 56). Negative comments centered around the concern that NOHIMS was "still losing some [who required an examination]."

Table 57 shows that all of the respondents felt that NOHIMS had increased resource utilization. One specific comment was that the "physicians are learning to use the industrial hygiene data more."

Although 86 percent of the respondents felt that NOHIMS had increased compliance with monitoring programs (see Table 58), there were varying opinions on whether NOHIMS was adequately identifying those who needed examinations. One occupational health technician felt that they were catching more of the people who required asbestos or hearing examinations. One of the physicians, on the other hand, was concerned that NOHIMS was not identifying all people requiring audiometric tests and that some "wanderers" (people who move from location to location in their job) were being missed. This care provider also made the comment that "industrial hygiene surveillance is not up-to-date so I am not confident to deny an examination to workers based on NOHIMS [data] if the worker comes in of his own accord."

Table 59 shows what the NHRC NOHIMS developers and medical care providers identified as the reasons for the effect of NOHIMS on the medical monitoring and care goals. The two reasons that were mentioned most frequently were increased availability of the medical record and availability of patient-specific summary reports, both of which were mentioned by 86 percent of the respondents. More appropriate services provided (mentioned by 71% of the respondents), improved communication between departments (71%), and improved appointment scheduling (71%) were mentioned next most frequently. Eight other reasons were mentioned but to a lesser degree. The percentage of NHRC NOHIMS developers mentioning a particular reason was similar to the percentage of medical care providers mentioning the reason with the exception of increased patient care services provided and improved follow-up of patients with abnormal findings or tests. Three out of four (75%) of the medical care providers who responded felt that there were increased patient care services provided while none of the NHRC NOHIMS developers selected this reason for the effect of NOHIMS. Conversely, all three of the NHRC NOHIMS developers who responded to this question felt that

TABLE 56
Effect of NOHIMS on Access to Care
(Number who mentioned rating)

	NHRC NOHIMS Developers	Medical Care Providers	TOTAL	% of Total Who Answered
Increased access	3	2	5	83
Maintained access	0	0	0	0
Decreased access	0	0	0	0
Mixed effect*	0	1	1	17
TOTAL WHO ANSWERED	3	3	6	100
No Comment	1	3	4	
TOTAL INTERVIEWED	4	6	10	

* Category added by respondent

TABLE 57
Effect of NOHIMS on Resource Utilization
(Number who mentioned rating)

	NHRC NOHIMS Developers	Medical Care Providers	TOTAL	% of Total Who Answered
Increased utilization	3	3	6	100
Maintained utilization	0	0	0	0
Decreased utilization	0	0	0	0
TOTAL WHO ANSWERED	3	3	6	100
No Comment	1	3	4	
TOTAL INTERVIEWED	4	6	10	

TABLE 58
Effect of NOHIMS on Compliance with Monitoring Programs
(Number who mentioned rating)

	NHRC NOHIMS Developers	Medical Care Providers	TOTAL	% of Total Who Answered
Increased compliance	2	4	6	86
Maintained compliance	1	0	1	14
Decreased compliance	0	0	0	0
TOTAL WHO ANSWERED	3	4	7	100
No Comment	1	2	3	
TOTAL INTERVIEWED	4	6	10	

TABLE 59

Reasons for Effect of NOHIMS on Medical Monitoring and Care Goals
(Number who mentioned reason; multiple answers allowed)

	NHRC NOHIMS Developers	Medical Care Providers	TOTAL	% of Total Who Answered
Increased availability of the medical record	3	3	6	86
Availability of patient-specific summary reports	3	3	6	86
More appropriate services provided	3	2	5	71
Improved communication between departments	3	2	5	71
Improved appointment scheduling	2	3	5	71
Availability of on-line look-up of patient-specific data	2	2	4	57
Increased patient care services provided	0	3	3	43
Improved follow-up of patients with abnormal findings or tests	3	0	3	43
More accurate medical records	1	2	3	43
Availability of user-defined reports	1	1	2	29
Earlier diagnosis and notification of problems	1	1	2	29
Improved manpower scheduling	0	1	1	14
Improved quality of care review procedures	0	1	1	14
TOTAL WHO ANSWERED	3	4	7	100
No Comment	1	2	3	
TOTAL INTERVIEWED	4	6	10	

there had been improved follow-up of patients with abnormal findings or tests. None of the medical care providers selected this reason for the effect of NOHIMS on medical monitoring and care.

Table 60 presents how the medical care providers rated the effect of the availability of an accurate medical record on the quality of patient care. Four out of the five medical care providers who made this rating felt that NOHIMS had a very beneficial effect. A fifth medical care provider thought that NOHIMS had the potential to be very beneficial in this area. The sixth provider did not feel he could comment on this issue since he had never actually used the electronic record.

In Table 61 we see that 83 percent of the medical care providers felt that the availability of the individual's exposure history at the time of the physical examination was very beneficial. One medical care provider said that the effect was only somewhat beneficial because too often exposures are incomplete or exposures are not measured at all.

The last two tables in this subsection show data from questions about the effect of NOHIMS on communication between selected groups of people. Table 62 shows how the medical care providers and industrial hygienists rated NOHIMS with regard to the effect on communication between these two groups. Overall, 67 percent of those who responded to the question felt that NOHIMS had improved communication and 33 percent thought that communication between industrial hygienists and medical personnel had been maintained. All five of the industrial hygienists gave NOHIMS a rating of improving communication. Their reasons for these ratings centered around the feeling that the physicians were initiating more contact with the industrial hygienists generally by asking questions and around the availability of reports generated by NOHIMS. One industrial hygienist felt that the medical care providers and industrial hygienists were working together more, providing increased opportunities for interaction.

Generally, the medical care providers were less satisfied with the communication between the industrial hygienists and medical personnel. As one medical care provider perceived it, there was more communication between medical care providers and industrial hygienists because of errors and discrepancies in the data from NOHIMS, but the quality of the communication was no different than before. Two medical care providers complained that they were not getting feedback from the industrial hygienists on follow-up of exposures reported by the patients. Also, one medical care provider wanted to know what surveys are scheduled, including where and when they are scheduled.

We next asked the industrial hygienists to assess the effect of NOHIMS on the communication between the industrial hygienists/safety specialists and work center supervisors. We wanted to also discuss this issue with some work center supervisors. We asked individuals at the NARF Safety Office if they could identify some work center supervisors for us to interview about the communication. These individuals felt, however, that none of the work center supervisors really knew of NOHIMS. Since the only NOHIMS product a work center supervisor comes in direct contact with is the Physical Examination Notification Report, they are largely unaware of NOHIMS and its operation. Table 63 shows that four out of five of the industrial hygienists (80%) felt that communication between the industrial hygienists/safety specialists and the work center

TABLE 60
Effect of the Availability of an Accurate Medical Record
on the Quality of Patient Care
According to the Medical Care Providers
(Number who mentioned rating)

	TOTAL	% of Total Who Answered
Very beneficial	4	80
Somewhat beneficial	0	0
No effect	0	0
Somewhat detrimental	0	0
Very detrimental	0	0
Other: potential to be very beneficial	1	20
TOTAL WHO ANSWERED	5	100
No Comment	1	
TOTAL INTERVIEWED	6	

TABLE 61
Effect of the Availability of an Individual's Exposure History at the Time of the Physical Examination According to the Medical Care Providers
(Number who mentioned rating)

	TOTAL	% of Total Interviewed
Very beneficial	5	83
Somewhat beneficial	1	17
No effect	0	0
Somewhat detrimental	0	0
Very detrimental	0	0
TOTAL INTERVIEWED	6	100

TABLE 62
Effect of NOHIMS on Communication Between
Industrial Hygienists and Medical Personnel
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Who Answered
Improved communication	1	5	6	67
Maintained communication	3	0	3	33
Deteriorated communication	0	0	0	0
TOTAL WHO ANSWERED	4	5	9	100
No Comment	2	0	2	
TOTAL INTERVIEWED	6	5	11	

TABLE 63
Effect of NOHIMS on Communication Between
Industrial Hygienists/Safety Specialists and Work Center Supervisors
According to the Industrial Hygienists
(Number who mentioned rating)

	TOTAL	% of Total Interviewed
Improved communication	4	80
Maintained communication	1	20
Deteriorated communication	0	0
TOTAL INTERVIEWED	5	100

supervisors had improved and that one industrial hygienist (20%) felt that communication had been maintained. The industrial hygienists' comments explain their point of view. One industrial hygienist felt that NOHIMS had forced the industrial hygienists to spend more time in the field. Another reported satisfaction with "being able to answer queries [from the work center supervisors] rapidly." Three of the industrial hygienists thought that having reports from NOHIMS had improved the communication between industrial hygienists and work center supervisors. One of the industrial hygienists described being able to "sit down with the work center supervisor, go over last year's survey, and decide [together] what this year's survey should cover using a printout of the previous year's survey." Two of the hygienists reported having more accurate or complete data to communicate with the work center supervisors.

Summary

Improvement in database acquisition, problem identification, and research information collection were the medical and monitoring care goals for NOHIMS that were mentioned most frequently by the respondents. These were each mentioned by 89 percent of those responding to this question. Seventy-eight percent of the people who identified medical monitoring and care goals for NOHIMS selected improvement in record accuracy, communication, patient follow-up, record availability, medical reports, compliance with periodic physical examinations, and compliance with the asbestos surveillance medical program.

All of the respondents thought that NOHIMS was meeting the medical monitoring and care goals at least somewhat well; 50 percent rated NOHIMS as meeting them very well. The goal that was mentioned most frequently as a goal that NOHIMS was not meeting well was improvement in management and operations which was mentioned by 38 percent of the respondents. The only complaint about NOHIMS that was repeated significantly was that NOHIMS should be providing more data/reports. The interviewees also reported general problems with accuracy of the system. Specific examples included concern over patient reports of exposures versus NOHIMS reports of exposures, incomplete survey data, and specific categories of people requiring examinations being overlooked by the system (since resolved).

Seventy-one percent of those who responded to the questions felt that NOHIMS had increased quality of care, 83 percent felt that NOHIMS had increased access to care, 100 percent rated NOHIMS as increasing resource utilization, and 86 percent felt that NOHIMS had increased compliance with monitoring programs. The main reasons that the interviewees identified for these effects were the increased availability of the medical record and availability of patient-specific summary reports (both mentioned by 86% of the respondents), more appropriate services provided (71%), improved communication between departments (71%), and improved appointment scheduling (71%).

Eighty percent of the medical care providers said that the availability of an accurate medical record with NOHIMS had a very beneficial effect on the quality of patient care. Eighty-three percent of the providers felt that the availability of the individual's exposure history at the time of the physical examination was very beneficial.

The industrial hygienists all thought that communication between the industrial hygienists and medical care providers had improved because physicians

were asking more questions. Generally, the medical care providers felt that communication between the industrial hygienists and medical personnel had been maintained. The medical care providers would like to see more communication with the industrial hygienists. Four out of five of the industrial hygienists felt that communcation between the industrial hygienists/safety specialists and the work center supervisors had improved since the advent of NOHIMS.

Usefulness of NOHIMS in Monitoring Medical Surveillance

This section contains a description of ways that NOHIMS reports would aid in the monitoring of medical surveillance. Essentially the COSTAR Report Generator (CRG) can be set up to produce various reports that would provide data to assist in determining if an occupational health clinic is in compliance with medical surveillance program requirements and to help assess whether there has been any improvement in long-term objectives/outcomes. Since the CRG was not designed for the purpose of monitoring medical care, the reports will only provide raw data for analysis. If ongoing and more detailed reports are required for monitoring medical surveillance, special programming to extract the appropriate data will need to be written or possibly the Medical Query Language could be integrated with NOHIMS to enhance data retrieval mechanisms.

NOHIMS is designed to identify workers who require an annual physical examination and to provide medical care providers with an inventory of workers' exposures and medical examination requirements. If physical examinations or tests yield abnormal findings or results, follow-up is initiated. To monitor medical surveillance, these requirements could be translated into appropriate standards to be verified by utilization reports. The following paragraphs describe examples of such CRG reports.

A CRG report in NOHIMS called List of Examined lists the names, social security numbers, dates of encounters, dates of birth, and types of visit for all people examined during a specified time period. The list of workers requiring examinations for a given month produced by the Hazard Exposure/Examination Report suboption of the industrial component [the Individual Exposure Examination Report (IEER)] could be compared to the List of Examined report to determine the percentage of people requiring examinations who actually received the examination and within what time period they received the examination.

Another CRG report in NOHIMS, Lab & Pe, selects encounters for patients who have had a periodic examination and lists the names, dates of visit, laboratory tests ordered, and physical examinations performed at the encounters. To determine if individual medical surveillance requirements are being met, the examination and test recommendations produced in the IEER could be compared to those services actually provided. The percentage of workers requiring a particular test/procedure who had the test/procedure performed may then be calculated. Variations from acceptable levels of compliance would identify areas of care requiring investigation.

A series of reports called Had PFT, Had SMAC, and Had Audiogram are examples of reports that could be used to determine the percentage of people receiving a particular test/procedure who required the test/procedure. Patients are selected for the report if they had the particular test during a periodic

examination. The CRG reports list the names, dates of visit, results of tests, and physical examinations performed. When compared to the IEER, the percentage of patients receiving a particular test/procedure who required the particular test/procedure according to NOHIMS can be determined. Again, variances from acceptable standards may flag potential compliance problems. However, investigations of this standard would need to take into account the reasons for performing the test/procedure when it was not indicated by NOHIMS.

Analysis of follow-up procedures is a fourth area in which NOHIMS could be used for monitoring medical surveillance. For example, the CRG reports Abnormal Glucose and Abnormal Diff select patients if the status of a Blood Glucose or of a Differential test has been set to Abnormal because of the test results that were entered. These reports list the names, dates of visit, dates of last visit, and results of the abnormal test for patients who had an abnormal test. When compared to a list of patients examined for a given time period and to the last visit date, the percentage of patients with an abnormal test result who had a follow-up visit could be calculated. Variances from acceptable percentages could be investigated to determine if appropriate follow-up procedures are being used.

Once the two databases have been built up over an extended period of time, CRG reports could also be used to measure improvement in patient-specific objectives/outcomes such as months from initial base-line examination to identification of an abnormal diagnos(es) or an abnormal finding(s).

Summary

Some ways in which NOHIMS could aid in monitoring medical surveillance were identified. The COSTAR Report Generator (CRG) contains several sample reports that could be used to determine utilization measures such as the percentage of people requiring annual examinations who received the examination, the percentage of workers requiring a particular test/procedure who had the test/procedure performed, the percentage of people receiving a particular test/procedure who required the test/procedure, and the percentage of patients with an abnormal test result who had a follow-up visit. Eventually CRG reports could be used to assist in determining improvement in patient-specific long-term objectives/outcomes such as earlier identification of disease or abnormal findings. The CRG reports generally will only provide raw data for utilization assessments. If more sophisticated procedures or measures than those discussed above are required, special programming will be required.

EVALUATION OF USEFULNESS OF NOHIMS DATABASE FOR LEGAL EVIDENCE

To assess the usefulness of NOHIMS as a database for legal evidence in Navy proceedings, we reviewed relevant literature and conducted in-person interviews with two people from the Safety Office of the Naval Air Rework Facility (NARF), San Diego; two people from the Production Department of the NARF, San Diego; one person from the Injury Compensation Program for the Naval Air Station and the NARF, San Diego; and two people from the Civilian Personnel Office of the Naval Hospital, San Diego. The four people from the NARF were interviewed as one group, as were the two people from the Naval Hospital. We also contacted

Navy legal counsel by telephone at the Naval Legal Services Office, Naval Station, San Diego; the Labor Relations and Litigation Branch, Naval Air Station, North Island, San Diego; and the Office of Counsel, Naval Air Rework Facility, Alameda, California to discuss the role of NOHIMS in tort claims against the Navy. The following presents our findings with regard to the current status of computer-stored records as legal evidence; an identification of potential uses of NOHIMS data for legal purposes, the types of data required, and the effect of NOHIMS on claims; and an analysis of the NOHIMS design in light of the requirements identified.

Current Status of Computer-Stored Records As Legal Evidence

During the first phase of the test and evaluation of NOHIMS, we conducted an extensive review of literature relevant to occupational health information systems and system evaluation methodology. Our search revealed only one journal article that addressed the appropriateness of computer-stored records as legal evidence.

The first issue that was addressed in this article was compliance with discovery and subpoenas (Watson, 1983). The author also discussed the introduction of computer printouts as evidence. A third issue concerned judicial acceptance of sampling of computer records.

The author concluded that computerized records are now treated as similar to, if not identical with, more traditional records for purposes of discovery and subpoena. Although a discovering party may be required to develop and utilize its own program to access a particular subset of data, cooperation on the part of the records' custodian is clearly appropriate when the discovery has been judicially compelled or agreed to by the parties. The records' custodian may be required to translate the data into usable form (such as a printout) when discovery would be impossible otherwise. The records' custodian, on the other hand, may be protected by the courts from undue burden and expense by restricting discovery and/or by allocating costs. Precedence in court cases has established that Rule 26(b)(3) of the Federal Rules of Civil Procedure applies to computer programs and files in that materials prepared in anticipation of litigation or for trial by another party or the party's representative are protected.

With regard to the introduction of computer printouts as evidence in administrative or judicial proceedings, the acceptability of these printouts depends upon an adequate foundation regarding both the process of recording the data at issue and the software utilized to select the records. Support for or challenge to this foundation will probably form the core of any controversy over the admission of computer-generated records. Computer printouts may be admitted as evidence in court via the business records exception to the hearsay doctrine. In order for documents to be admitted under this exception, it must be shown that the records were made in the ordinary course of business. This is proved by showing that it is part of regular business to make these records and that they were made within a reasonable period of time after the act (data collection in this case). An adequate legal foundation must be laid before these records may be introduced. Generally, witness(es) with relevant educational and occupational backgrounds who are familiar with the computer system, the procedure for entering the information, and the physical plant of the computer

must testify regarding these matters. The representative(s) must also describe the security precautions taken at the location of the computer to restrict access and to protect the information in the database.

The author's discussion of the judicial acceptance of computer records sampling concerned sampling data used to determine reimbursement inaccuracies. The projection of the nature of a large population through the review of a relatively small number of its components has been recognized as a valid technique and approved by Federal courts in a number of cases involving the Social Security Act. The author feels that this sampling and projection technique will receive more widespread application in the future, particularly in the area of quality of care review.

Legal counsel at the Office of Counsel, Naval Air Rework Facility, Alameda, California concurred with this author's opinion that computer-stored records are generally acceptable as legal evidence in court proceedings.

Potential Legal Uses and Effect of NOHIMS Data

The seven people we interviewed identified four possible legal uses for NOHIMS data. All of the respondents mentioned that NOHIMS data would be useful for workmans' compensation claims. They felt that NOHIMS would be useful for claims for an injury-specific incident such as a traumatic injury or spill, as well as claims as a result of long-term occupational exposure. The NARF personnel and the respondents from the Naval Hospital, San Diego both mentioned that NOHIMS would be useful in responding to subpoenas of Navy records. A few months prior to our interviews, the NARF had been subpoenaed with regard to an asbestos claim. Both groups conceded, however, that subpoenas are not common. The NARF personnel also felt that NOHIMS data would be useful in continuation of pay determinations. The San Diego Naval Hospital people thought that Veteran's Administration disability proceedings might be another legal use for NOHIMS data. None of the people we interviewed in person could comment on whether NOHIMS data would be useful for tort claims actions against the Navy. We contacted several Navy legal offices to determine if NOHIMS would be useful in these types of claims. We were told that while tort claims for occupational injuries or diseases were rare, data on historical workplace assignments and hazardous exposures would be useful in litigating these claims.

Eight types of NOHIMS data were identified as being useful for legal purposes. These included data on engineering controls, data on protection used at the worksites, hazardous exposure data, physical examination data, job history data (including work locations), medical history data, demographic data, and illness/injury data. The head of the Injury Compensation Program pointed out that three-quarters of the claims he sees are because of prolonged and/or excessive exposure to noise. He wanted to know whether he would be able to obtain accurate historical data on exposures from NOHIMS. NOHIMS data will not be useful to him until there are 10-15 years of data since today's claims concern exposures that occurred 10-15 years ago. Legal counsel agreed that NOHIMS data would not be particularly useful until an historical database of at least five years was built. The head of the Injury Compensation Program also felt that illness and injury data would be very important for claims. The NARF personnel were concerned about the accuracy of the work records of the workers, and the environment and work location definitions in NOHIMS. They were keenly

aware of the inaccuracies in the NARF Personnel Extract File tape used by NOHIMS to update workplace assignments. These inaccuracies lead to inaccuracies in NOHIMS workplace assignments. They also noted that environment and work location definitions in NOHIMS were not as specific as is often required.

Both the NARF personnel and the head of the Injury Compensation Program believe that NOHIMS will not alter the number of legal claims made against the Navy. The NARF personnel felt, however, that they will be able to respond to claims better with NOHIMS. Down the road, when the database is larger, they feel that NOHIMS will help management defend against claims. The head of the Injury Compensation Program thought that NOHIMS could speed up the claims process and result in better claims determinations. The people at the San Diego Naval Hospital did not comment on the effect of NOHIMS on the number of legal claims.

Analysis of NOHIMS Design for Legal Uses

The preceding discussion of the usefulness of the NOHIMS database in legal proceedings raises three issues related to the NOHIMS design. To be useful as legal evidence or in the adjudication of claims, NOHIMS must gather the proper categories of data, these data must be reliable, and they must be retrievable as needed. The following subsections evaluate the NOHIMS design in light of these three issues.

Proper Categories of Data

The industrial component of NOHIMS provides the capabilities necessary to enter, store, edit, retrieve, and display various workplace monitoring data, including work history data, data on exposure episodes, environmental monitoring and industrial hygiene data such as engineering controls and protective equipment used, and worker demographic data. The medical component of NOHIMS provides functions for entering, storing, editing, retrieving, and displaying occupational health data, including data from preplacement/employment physical examinations, medical surveillance examinations, job certification examinations, fitness for duty and return to work interactions, audiometric data, biomedical monitoring data, and basic medical and demographic data. It does not have capabilities for entering illness and injury care data. However, the Naval Health Research Center is currently developing data collection forms and making changes to the COSTAR directory to allow illness and injury care data to be processed by NOHIMS. Data collection forms for both occupational histories and medical histories were designed for the Occupational Health Unit, North Island. Initial testing showed that they were too lengthy, and they are not in current use. Consequenly, NOHIMS does not contain occupational and medical history data yet.

Reliability of NOHIMS Data

The reliability of NOHIMS data is dependent on both internal design features and external site-dependent implementation features. Internal design features include NOHIMS' general reliability, internal data integrity features, and logical security protection features. External implementation features

include back-up procedures, physical security features, and quality assurance measures for data collection and data entry.

General Reliability. NOHIMS is considered to be a very reliable system at this point. No changes were made to the data storage or retrieval functions of public domain COSTAR (the basis for the medical component of NOHIMS). Thus, the medical component of NOHIMS is based on a software package that has been extensively tested in the field for the past ten years. The only bug in data retrieval functions that the contracted NOHIMS developers are aware of is in the COSTAR Report Generator when more than one encounter is entered for a patient on a given day. The COSTAR Report Generator does not differentiate which encounter the data for that date are associated with and may tally data items multiple times if certain precautions are not taken. This problem in public domain COSTAR has been documented by the contracted developers for the Naval Health Research Center (NHRC). The industrial component of NOHIMS has been field tested for three years and all of the known bugs in data retrieval and storage processes have been worked out.

Internal Data Integrity Features. Both the medical and industrial components of NOHIMS have system functions that aid in restoring the database should an error occur or if the system crashes. If a "hard" computer crash occurs during a filing operation, the global files may be corrupted. The industrial component has internal integrity check operations that search the global files and record any erroneous filing conditions that are found. Usually, the condition can be corrected through execution of an automatic correction process. This process is capable of both interpreting the error records that the integrity checking routines recorded and performing the necessary corrections to the files.

The medical component of NOHIMS does not have internal integrity check functions in case of a hard crash. Instead, the system relies on operating system utilities to identify and repair system level errors (such as physical disk structure pointers) and on a manual review of the error log to identify filing sequence errors. If filing sequence errors have occurred, these will require either programming intervention or re-entry of data. The medical component also logs "soft" errors that occur during filing with system messages to help detect corrupted patient records or flag potential filing problems.

The general user cannot intentionally or unintentionally corrupt the NOHIMS databases. The general user has no access to cross references, pointers, or data files. Extensive error and interrupt trapping prevents the user from gaining access to the operating system. The system manager or someone who enters the system via the programmer's access code could potentially corrupt the databases, so these people must take great care when working in the system.

NOHIMS has some anticipation of the type of input to be expected for most data fields to minimize data entry errors. Validity of the input is checked either through pattern matching or by whether a data item (such as a code, variable name, or patient name) already exists in the system. If the data item does not exist in the system, NOHIMS will produce a list of choices that closely approximates the input received.

Logical Security Features. The logical security features of NOHIMS that ensure the integrity of the database include sign-on/off procedures; concealed

identification codes; limitations on access to functions by passwords, by device, and by class of user/identification code of the user; interplay of access limitations by device and by class of user/identification code of the user; time-outs at system prompts; interrupt traps; and error traps.

Each user of NOHIMS is assigned an identification code of from three to five characters that is used to access NOHIMS. During the log-on procedure, the display or printout of the identification code is concealed to preserve the integrity of the log-on codes. Password protection may be applied to any of the modules in the medical component to restrict unwarranted access to the medical database.

Both the industrial and medical components have a security feature that limits access to modules and/or options depending on the device that is being used to access the system. Thus, access at a given terminal or printer can be limited to any combination of modules and/or options. The medical component also allows the restriction of access to NOHIMS options by class of user. The industrial component, on the other hand, also allows the system manager to limit access to system options by the identification code of the user. The access limitations by device and by class of user/identification code of the user interact in NOHIMS to further restrict access. The access specifications for a given user and the device currently being used are combined to determine the modules and/or options that may be accessed by that user using that device. Only those modules and/or options that are allowed for both the user and the device will be accessible. These three functions are useful for preventing unauthorized access to critical functions or sensitive data in NOHIMS.

Certain options in the NOHIMS medical component have an interrupt trap that will return the user to the system option menu if the function is interrupted. This security feature prevents the user from falling out of NOHIMS into the operating system. None of the processes in the industrial component may be interrupted so this feature is not required in the industrial component. Both the industrial and medical components have extensive error trapping mechanisms. If a program error occurs, the error is recorded in one of the NOHIMS error logs and the user is returned to a system option menu. These traps prevent inadvertent access to the operating system. Time-outs at system prompts also help to prevent unauthorized access to NOHIMS by disconnecting a device from NOHIMS if the device is left unattended for an extended period of time.

Back-Up Procedures. To ensure the reliability of NOHIMS data, adequate back-up procedures must be utilized at the application site. It is recommended that the entire NOHIMS system be backed up on another disk at least daily. Another periodic back-up copy should be kept off-site. If the hard disk copies are adequately checked for integrity, they will provide necessary back-up for the system. In the event of a data crash, a disk back-up can be restored easily. At most, data input since the last back-up was made would need to be re-entered. Since virtually all data entered into NOHIMS are entered from hard copy, it is relatively easy to keep an audit trail of data entry. The operating systems that support MUMPS all support these standard back-up functions.

NOHIMS records may be downloaded to magnetic tape for record archiving. It should be noted, however, that magnetic tape is not considered to be a secure medium. A more appropriate legal medium for storage of downloaded records would

be hardcopy on paper. Paper records could then be microfiched for easier storage and multiple copies of the microfiches made.

Physical Security Features. Adequate physical security must be in force to protect the integrity of the NOHIMS database. Cipher locks on doors and log books for people entering the computer room are two ways to physically restrict access to NOHIMS. The computer room at the Naval Health Research Center (where the mainframe PDP 11/24 on which NOHIMS resides for the San Diego test site is located) has cipher locks. NHRC does not keep a log book of noncomputer personnel entering the room nor do the rooms that contain terminals and printers connected to the PDP have cipher locks. At the North Island test site, neither the Occupational Health Unit nor the Industrial Hygiene Division rooms that contain the terminals and printers have cipher locks. At Bremerton, the door to the room that contains the Plessey mainframe has cipher locks. There is no log book for people entering this computer room.

Quality Assurance Measures for Data Collection and Data Entry. The accuracy of the NOHIMS database relies in part on the accuracy of data input to the system. Adequate measures must be taken to ensure that data collection and data entry personnel have been properly trained in correct procedures. While NOHIMS can check the validity of data input to a degree, some form of data collection and entry verification should be used. Possible methods range from full 100 percent verification of data collection and data entry, to sequential sampling of data collection and entry (e.g., 100 percent verification of every Nth encounter/survey), to full or sequential verification of selected critical data items, to spot-checking, or to verification during training periods only.

Issues regarding inaccurate sources of data must be dealt with quickly and appropriately to preserve the integrity of the NOHIMS database. Since accurate work histories are so essential to NOHIMS functions, the problems with the Personnel Extract File need to be resolved.

To meet the criteria for admission of computer-stored records as legal evidence, data entry to NOHIMS must be completed within a reasonable period of time from data collection. Therefore, adequate personnel must be provided for timely entry of NOHIMS data.

Retrievability of NOHIMS Data

There are eight functions in the industrial component of NOHIMS that will retrieve data from the industrial database. These are the display functions of the five data modules--Display Organization, Display Personnel Data, Display Environment Users, Review Environment Information, Display Survey Data, and Display Hazard Data; the Hazard Exposure/Examination Report option in the Personnel Data module; and the Query/Report module. The display options of the five data modules can retrieve and display information both specific to the data module (e.g., agent names and exposure limits) and from relationships between the modules (e.g., environments that contain a particular agent). The Hazard Exposure/Examination Report option produces the hazard exposure summary and medical examination requirement reports for selected workers. The Query/Report module provides an ad hoc information retrieval and display capability that extends to almost every data item in the industrial component. Retrieval of data in the industrial component is limited to current data such as current

exposures and workplace assignments. Historical data for many variables are retained in the industrial component files, although at present these data cannot be retrieved. Based on the discussions with the interviewees, access to historical NOHIMS data is essential for responding to claims. NOHIMS will require augmentation in order to be useful in the adjudication of claims.

Four modules are used to retrieve data in the medical component of NOHIMS. These are the Registration module, the Display Medical Data module, the Print Medical Data module, and the COSTAR Report Generator. The Display Registration option in the Registration module and the Registration Data Check option in the Display Medical Data module are used to retrieve registration data. Three of the options in the Display Medical Data module retrieve information about individual encounters; five other options summarize data across encounters. The Print Medical Data options print hardcopies of Encounter Reports, Registration Data Checks, Status Reports, and/or Flowcharts for particular groups of individuals. The COSTAR Report Generator options cover three different functions. These are the actual COSTAR Report Generator, the Medical Query Language, and a function that retrieves and reformats certain data for research purposes. The COSTAR Report Generator produces listings and cross tabulations according to user-defined criteria. The Medical Query Language is a more powerful data retrieval language that is under examination as a future enhancement for NOHIMS. Five options in the COSTAR Report Generator module produce a fixed-length, fixed-format record from COSTAR data for use in research functions.

Presently, there are only two links between the two components of NOHIMS in data display or retrieval functions. These are the display of current exposure data in the Patient Summary and the function in the COSTAR Report Generator module that produces the fixed-length, fixed-format records. The patients that are identified for retrieval by this function may be selected using criteria from the industrial component. It is not clear that any links between the data in the two components are required for legal purposes, but if it is determined that links are required, the retrieval functions for NOHIMS will need to be modified accordingly.

Summary

A review of relevant literature revealed one journal article about the use of computer-stored data for legal evidence. The author concluded that it is appropriate for computer records' custodians to respond to subpoena requests for data. Computer-stored records and printouts will be acceptable as legal evidence provided the records have been made in the normal course of business and a firm legal foundation for the validity of the data is established. The use of a sample of records to project to the larger population is an acceptable technique and will probably be used more in the future.

Interviews with personnel from the Naval Air Rework Facility (NARF), North Island; the Naval Hospital, San Diego; and the Injury Compensation Program for the Naval Air Station/NARF, North Island revealed several potential uses for NOHIMS data. NOHIMS will probably be useful in workmans' compensation claims and responses to subpoenas, and possibly useful in continuation of pay determinations and Veterans' Administration disability proceedings. NOHIMS data

will not be used much for tort claims actions because tort claims in the area of occupational health are rare.

Eight types of data were identified as being useful for legal purposes. These were data on engineering controls, data on protective equipment used at worksites, hazardous exposure data, physical examination data, job history data, medical history data, demographic data, and illness/injury data. The interviewees pointed out, however, that NOHIMS would not really be useful until an historical database is built. The interviewees had concerns regarding the accuracy of the work history data and whether historical exposure data would be obtainable. Inaccuracies in the Personnel Extract File that feeds data to NOHIMS need to be corrected and capabilities for retrieval of historical exposure data need to be added to NOHIMS in order to make the NOHIMS database useful for legal purposes. The respondents did not believe that NOHIMS would effect the number of claims made against the Navy; however, there was general agreement that NOHIMS would help management to respond to claims in the future.

The NOHIMS design was analyzed in light of the issues raised in the preceding discussions. To be useful as legal evidence in the adjudication of claims, NOHIMS must gather the proper categories of data, these data must be reliable, and they must be retrievable as needed.

NOHIMS enters, stores, retrieves, and displays most of the types of data required for legal purposes. NOHIMS processes data on engineering controls, protective equipment used, hazardous exposures, physical examination data, and demographic data. At present, NOHIMS does not process illness/injury care data. The Naval Health Research Center is currently adding this capability to NOHIMS. Although occupational and medical history forms were designed for NOHIMS, testing revealed that they were too lengthy and, thus, these two types of data are not implemented in NOHIMS yet.

NOHIMS has a variety of features to ensure the reliability of the database. NOHIMS has been field tested for an extended period of time and has proven to be very reliable. NOHIMS has internal features that ensure data integrity by detecting error conditions and aiding in data recovery if the system crashes. The industrial component has internal integrity check operations that can detect and correct filing errors. Extensive error and interrupt trapping prevents corruption of the database through inadvertent access to the operating system.

NOHIMS has a variety of logical security features that protect the database from corruption. These include limitations on access to certain functions by passwords, by device, and by class of user/identification code of the user. NOHIMS also has interplay between the access limitations by device and the access limitations by class of user/identification code of the user. It has passwords to log-on, time-outs at system prompts, concealed identification codes, and error traps and interrupt traps to prevent inadvertent access to the operating system.

The reliability of NOHIMS also depends on certain external implementation features that are site-dependent. Adequate system back-ups must be made on an at least daily basis. If records are archived, a secure medium such as paper and/or microfiche should be used rather than magnetic tape. Adequate physical features must be in force. Possible physical security measures include cipher locks on doors and log books for people entering computer rooms. Appropriate

quality assurance measures for data collection and entry must be devised to maintain accuracy in the database. Adequate training of both data collection and data entry personnel must be provided. Appropriate verification procedures for both data collection and data entry must be devised and maintained. Features that allow retrieval of historical exposure data must be added to NOHIMS. If links between medical and industrial data are required, modifications to the system will need to be made.

EVALUATION OF NOHIMS AS AN AID TO EPIDEMIOLOGIC RESEARCH

We asked the NOHIMS developers at the Naval Health Research Center (NHRC) to evaluate the usefulness of NOHIMS as an aid to epidemiologic research. We questioned them about the research functions for which NOHIMS will be useful, the kind of data that will be required for these investigations, the features and/or capabilities of NOHIMS that will be useful and, finally, their assessment of the adequacy of NOHIMS for epidemiologic research. A sample questionnaire guide with the questions we used may be found in Appendix A, Component 27.

Table 64 shows that all of the NHRC NOHIMS developers thought that NOHIMS will be useful for the functions we listed in the questionnaire, namely, identifying populations at risk/cohorts; identifying workers exposed, exposure levels, and length of exposure; determining medical effects of exposures; detecting disease trends and outbreaks; and identifying common risk factors among exposed workers. In addition, they suggested five more research functions for which NOHIMS will be useful. These included identifying new risk factors, which was mentioned by two of the four NOHIMS developers; investigating dose/response relationships, assessment of risk, survival analyses, and case-control studies which were each mentioned by one of the respondents.

All of the NHRC NOHIMS developers agreed that the NOHIMS data required to conduct these epidemiologic investigations were demographic data, exposure histories, occupational histories, medical histories, and physical examination data. Three people also thought that mortality data are necessary (see Table 65). Currently, NOHIMS does not collect mortality data, but it could be modified to do so. Exposure data are stored historically, but will require special programming to retrieve them. Data collection forms were designed and directory work was performed to gather occupational and medical history data; however, these forms have not been operationally implemented as yet. Thus, of the data that are required for epidemiologic research, only demographic data and physical examination data are readily available at present.

When we asked the NHRC NOHIMS developers to identify the features and capabilities of NOHIMS that will be useful in epidemiologic research, all of the developers mentioned NOHIMS' cross-referencing ability (see Table 66). One of these developers thought that the potential of tying together medical test data and exposure data was especially important. Three of the four developers interviewed thought that the reference tables, the ability to analyze data at varying levels, and the ad hoc information retrieval capabilities of NOHIMS will be useful in epidemiologic research. Two developers specifically mentioned that having data on an entire population (i.e., both the sick and well, exposed and not exposed) will be very useful.

TABLE 64
Research Functions NOHIMS Will Be Useful for
According to NHRC NOHIMS Developers
(Number who mentioned function; multiple answers allowed)

	TOTAL	% of Total Interviewed
Identifying populations at risk/cohorts	4	100
Identifying workers exposed, exposure levels, and length of exposure	4	100
Determining medical effects of exposures	4	100
Detecting disease trends/ outbreaks	4	100
Identifying common risk factors among exposed workers	4	100
Other:		
Identifying new risk factors	2	50
Investigating dose/ response relationships	1	25
Assessment of risk	1	25
Survival analyses	1	25
Case-control studies	1	25
TOTAL INTERVIEWED	4	100

TABLE 65
Data Required for Epidemiologic Investigation
According to NHRC NOHIMS Developers
(Number who mentioned data; multiple answers allowed)

	TOTAL	% of Total Interviewed
Demographic data	4	100
Worker exposure histories	4	100
Worker occupational histories	4	100
Worker medical histories	4	100
Physical examination data	4	100
Mortality data	3	75
TOTAL INTERVIEWED	4	100

TABLE 66
Features/Capabilities of NOHIMS
That Will Be Useful in Epidemiologic Research
According to NHRC NOHIMS Developers
(Number who mentioned feature; multiple answers allowed)

	TOTAL	% of Total Interviewed
Cross-referencing ability	4	100
Reference tables	3	75
Ability to analyze data at varying levels (individual, selected groups, or population)	3	75
Ad hoc information retrieval capabilities	3	75
Other:		
Population data	2	50
TOTAL INTERVIEWED	4	100

Table 67 contains the NHRC NOHIMS developers' overall assessment of the adequacy of NOHIMS for conducting epidemiologic research. Two of the four NHRC NOHIMS developers gave NOHIMS a rating of very adequate for conducting epidemiologic research. One of the developers gave NOHIMS a rating of adequate. He explained that this rating was for now, but he felt that the system will become very adequate in time as NOHIMS is used more. One developer gave NOHIMS a rating of somewhat adequate because he was concerned about the ability of NOHIMS to adequately extract data for research purposes. He commented that the Medical Query Language, a powerful MUMPS-based data retrieval package which can be linked to NOHIMS, might be useful for achieving this end. Several of the developers mentioned that NOHIMS needs a statistical capability in order to be able to adequately utilize the data. One developer pointed out that NOHIMS simply provides the raw data for research; this raw data will still need to be standardized for use in research because the data are collected for occupational health purposes and not for research.

Summary

The NHRC NOHIMS developers thought that NOHIMS will be adequate for conducting epidemiologic research, provided that methodologies for retrieving the data in a standardized format and that appropriate analytical functions are developed. Medical history and occupational history data must be collected in some form. They felt that there will be many uses for NOHIMS and its database in epidemiologic research. The main functions of NOHIMS will be to provide demographic, exposure history, occupational history, medical history, and physical examination data for use in a variety of epidemiological research investigations such as case-control and prospective studies. With data from NOHIMS, NHRC and other Navy entities will be able to assess and identify risk, perform longitudinal studies on the medical effects of exposures, identify various populations and cohorts, study disease trends, and investigate dose/response relationships. The developers thought that NOHIMS' inherent cross-referencing ability, the capability of analyzing data at varying levels, the reference tables, and the ad hoc information retrieval capabilities will all be useful in epidemiologic research investigations.

ASSESSMENT OF USEFULNESS OF NOHIMS IN ADMINISTRATIVE FUNCTIONS

To assess the usefulness of NOHIMS in administrative functions, we interviewed four NHRC NOHIMS developers, five higher level managers, and four test site administrators using Component 28 of Appendix A. In other sections we interviewed seven higher level managers. However, one of these seven managers was interviewed using the NEHC Project Management Team guide and one of the managers at Bremerton was inadvertently interviewed with a different interview guide, both of which did not contain Component 28. This section reports data for four rather than two test site administrators--two that were classified as test site administrators in other sections of the evaluation and an industrial hygienist and a medical care provider who were classified as system users in other sections. The latter two people have administrative roles in their divisions and so we felt they would have worthwhile comments on the usefulness of NOHIMS in administrative functions. One of the four NHRC NOHIMS developers

TABLE 67
Assessment of the Adequacy of NOHIMS for Conducting Epidemiologic Research According to NHRC NOHIMS Developers
(Number who mentioned rating)

	TOTAL	% of Total Interviewed
Very adequate	2	50
Adequate	1	25
Somewhat adequate	1	25
Somewhat inadequate	0	0
Inadequate	0	0
Very inadequate	0	0
TOTAL INTERVIEWED	4	100

declined to comment on any of the questions in this section of the interview because he was not familiar with NOHIMS' administrative functions.

The NHRC NOHIMS developers, higher level managers, and test site administrators were asked to identify the administrative functions for which they thought NOHIMS would be useful, the kinds of data required for these functions, and the features/capabilities of NOHIMS that will be useful in administrative functions. The higher level managers and test site administrators were asked to rate the effect NOHIMS had had on the amount of required paperwork, the effect of NOHIMS on the standardization of reports and forms, and the usefulness of having timely and perpetual access to administrative data.

Table 68 presents the administrative functions for which the interviewees thought NOHIMS would be of use. Every one of the respondents thought that NOHIMS would be useful in increasing the standardization of data collection forms and in manpower/resource planning. However, one higher level manager noted that the Navy needs to devise directives to establish NOHIMS forms as the standard. Eleven out of 12 (92%) of the respondents mentioned the usefulness of having timely and perpetual access to administrative data. Generating administrative reports and increasing standardization of reports were mentioned next most frequently (mentioned by 83% of the respondents). Five other administrative functions for which NOHIMS will be useful were mentioned by the respondents but to a lesser degree. These included reducing paperwork (67%), determining environmental pay decisions (58%), managing inspection requirements (50%), maintaining equipment lists (50%), and time and motion studies (17%). In addition, an NHRC NOHIMS developer thought that NOHIMS would be useful as a built-in alarm system to alert administrators to real or potential problem areas. A test site administrator mentioned the usefulness of NOHIMS in planning and conducting follow-up surveys. In another part of his interview, the Bremerton higher level manager who was not interviewed with this section on administrative functions reported using NOHIMS for producing management data at least monthly.

The question of whether NOHIMS was useful in determining environmental pay decisions revealed an obvious source of controversy. Three higher level managers and one NHRC NOHIMS developer felt that while NOHIMS could provide data for these decisions, it should not be used for this purpose. Specific comments by these four respondents included "it muddies the intent of NOHIMS [to use the system in this way]," "would like to see [these decisions] totally eliminated--[instead we should] make the environment safe," and "practically speaking you could use NOHIMS for these decisions, but people should not be in the hazardous environment at all."

Table 69 shows the kinds of data that the interviewees identified as being useful for administrative functions. Of the two kinds of data we listed in the questionnaire, 83 percent of those who responded to this question felt that manpower/resource utilization data were required for administrative functions and 67 percent of the respondents thought that service utilization data were needed. Eighty-three percent of the respondents also mentioned needing hazard exposure data, 17 percent mentioned medical monitoring data, and one person (8%) mentioned needing acute care data.

TABLE 68
Administrative Functions for Which NOHIMS Will Be Useful
(Number who mentioned function; multiple answers allowed)

	NHRC NOHIMS Developers	Higher Level Managers	Test Site Admin.	TOTAL	% of Total Who Answered
Increasing standardization of data collection forms	3	5	4	12	100
Manpower/resource planning	3	5	4	12	100
Timely and perpetual access to administrative data	3	4	4	11	92
Generating administrative reports	3	3	4	10	83
Increasing standardization of reports	3	3	4	10	83
Reducing paperwork	3	2	3	8	67
Determining environmental pay decisions	1	2	4	7	58
Managing inspection requirements	2	1	3	6	50
Maintaining equipment lists	1	2	3	6	50
Time and motion studies	1	0	1	2	17
Other: Built-in alarm system	1	0	0	1	8
Follow-up surveys	0	0	1	1	8
TOTAL WHO ANSWERED	3	5	4	12	100
No Comment	1	0	0	1	
TOTAL INTERVIEWED	4	5	4	13	

TABLE 69
Kinds of Data Required for Administrative Functions
(Number who mentioned kind of data; multiple answers allowed)

	NHRC NOHIMS Developers	Higher Level Managers	Test Site Admin.	TOTAL	% of Total Who Answered
Manpower/resource utilization data	2	4	4	10	83
Service utilization data	1	3	4	8	67
Other data:					
Hazard exposures	2	4	4	10	83
Medical monitoring	0	1	1	2	17
Acute care	0	0	1	1	8
TOTAL WHO ANSWERED	3	5	4	12	100
No Comment	1	0	0	1	
TOTAL INTERVIEWED	4	5	4	13	

Table 70 shows the features/capabilities of NOHIMS that the respondents felt would be useful in administrative functions. All of the respondents mentioned that the on-line look-up/Interactive Query function in the industrial component would be useful. Eighty-three percent of the respondents thought that NOHIMS' ad hoc report generation capabilities would be useful, and 75 percent thought that the standard report generation capabilities would be of use.

The respondents would like some additional capabilities to make NOHIMS more useful for administrative functions. One test site administrator requested the ability to test values of data items (such as a value greater than X) in the Interactive Query process and the ability to generate narrative reports with a word processor that would automatically extract survey data from the database. Another test site administrator would like to be able to generate tables and graphs and to have the ability to determine the report formats. A higher level manager would like a spreadsheet capability and an overall office management module, and to be able to track occupational health personnel on the system. Two other higher level managers stated that they need a statistics capability.

The respondents varied in their perception of how NOHIMS has affected the amount of required paperwork (see Table 71). The varied perceptions in the effect of NOHIMS on the amount of paperwork could not be attributed to whether the respondent was involved with the medical or industrial component of NOHIMS. The higher level managers were more divergent in their ratings than the test site administrators. Two of the respondents (25%) gave NOHIMS a rating of having greatly increased paperwork, two (25%) gave NOHIMS a rating of somewhat increased, two (25%) gave a rating of no effect, and two (25%) rated NOHIMS as somewhat decreasing the amount of required paperwork. No one said that NOHIMS had greatly decreased the amount of required paperwork, although one higher level manager who gave NOHIMS a rating of somewhat decreasing paperwork said that NOHIMS might greatly decrease paperwork in the future. One test site administrator who had said that NOHIMS had increased the amount of required paperwork explained that this was because "we are not jotting things down in our minds anymore." One manager who rated NOHIMS as increasing the amount of required paperwork commented that "[the increase] is not bad, we are just collecting more data that may help someone." Another manager thought that even if NOHIMS forms are accepted as the standard, there will be a slight increase in the amount of paperwork because the data collection forms are more comprehensive. He also felt that there is a great increase in paperwork for now, but when the forms are printed the amount of paperwork may decrease.

In response to a question about the effect of NOHIMS on the standardization of reports and forms, 89 percent of those interviewed thought that NOHIMS had a beneficial effect on standardization (see Table 72). One test site administrator believed that NOHIMS had had no effect yet on the standardization of reports and forms. A test site administrator felt that NOHIMS is also standardizing input terminology.

One hundred percent of the respondents thought that having timely and perpetual access to administrative data with NOHIMS is very useful (see Table 73). One test site administrator did not comment on the usefulness of timely and perpetual access to data because he felt that NOHIMS did not have this capability yet.

TABLE 70
Features/Capabilities of NOHIMS That Will Be Useful in Administrative Functions
(Number who mentioned feature/capability; multiple answers allowed)

	NHRC NOHIMS Developers	Higher Level Managers	Test Site Admin.	TOTAL	% of Total Who Answered
On-line look-up/ Interactive Query functions	3	5	4	12	100
Ad hoc report generation capabilities	3	3	4	10	83
Standard report generation capabilities	3	4	2	9	75
TOTAL WHO ANSWERED	3	5	4	12	100
No Comment	1	0	0	1	
TOTAL INTERVIEWED	4	5	4	13	

TABLE 71
Assessment of How NOHIMS Has Affected the Amount of Required Paperwork
(Number who mentioned rating)

	Higher Level Managers	Test Site Administrators	TOTAL	% of Total Who Answered
Greatly increased	2	0	2	25
Somewhat increased	0	2	2	25
No effect	0	2	2	25
Somewhat decreased	2	0	2	25
Greatly decreased	0	0	0	0
TOTAL WHO ANSWERED	4	4	8	100
No Comment	1	0	1	
TOTAL INTERVIEWED	5	4	9	

TABLE 72
Effect of NOHIMS on Standardizing Reports and Forms
(Number who mentioned effect)

	Higher Level Managers	Test Site Administrators	TOTAL	% of Total Interviewed
Beneficial effect	5	3	8	89
Somewhat beneficial effect	0	0	0	0
No effect	0	1	1	11
Somewhat detrimental effect	0	0	0	0
Detrimental effect	0	0	0	0
TOTAL INTERVIEWED	5	4	9	100

TABLE 73
Assessment of the Usefulness of Having Timely and Perpetual Access to Administrative Data with NOHIMS
(Number who mentioned rating)

	Higher Level Managers	Test Site Administrators	TOTAL	% of Total Interviewed
Useful	5	3	8	100
Somewhat useful	0	0	0	0
Somewhat not useful	0	0	0	0
Not useful	0	0	0	0
TOTAL WHO ANSWERED	5	3	8	100
No Comment	0	1	1	
TOTAL INTERVIEWED	5	4	9	

Summary

The respondents thought that NOHIMS would be useful for a variety of administrative functions. The five functions that were mentioned most frequently were increasing standardization of data collection forms (mentioned by 100% of the respondents), manpower/resource planning (100%), timely and perpetual access to administrative data (92%), generating administrative reports (83%), and increasing standardization of reports (83%). Several people mentioned that while NOHIMS could be used to provide data for environmental pay decisions, they did not feel this was an appropriate use for NOHIMS data. The major kinds of data that will be useful in administrative functions included manpower/resource utilization data, service utilization data, and hazard exposure data. All of the respondents felt that the on-line look-up/Interactive Query function in the industrial component will be useful in administrative functions. The respondents generally thought that the NOHIMS ad hoc report generation capabilities and the standard report generation capabilities would also be useful. The capabilities of NOHIMS could be enhanced to make NOHIMS more useful for administrative functions, however. Suggestions for enhancements included data manipulation functions such as spreadsheet, graphics, and statistics functions, and the ability to test values of data items in the Interactive Query. The respondents varied in their perception of whether NOHIMS had increased the amount of required paperwork. No one seemed to be especially alarmed by the amount of paperwork required by NOHIMS, however. Eighty-nine percent of the respondents felt that NOHIMS had a beneficial effect on the standardization of reports and forms. All of the respondents thought that having timely and perpetual access to administrative data with NOHIMS was useful.

SECTION VI
EVALUATION OF TRANSFERABILITY OF NOHIMS TO OTHER NAVY INDUSTRIAL SITES

In early specifications for the Navy Occupational Health Information Management System, the system designers placed heavy emphasis on achieving a wide range of applicability for NOHIMS as well as a high degree of transferability (Pugh & Beck, 1981; Beck & Pugh, 1982). The designers endeavored to make NOHIMS equally applicable to small industrial settings and to large industrial facilities. Furthermore, they felt that NOHIMS' extreme flexibility would allow the system to be quickly adapted to a variety of industrial settings and sites. To accomplish this end, the NOHIMS software was designed to be exportable and to be used with any computer hardware that can run ANSI standard MUMPS software.

In this section we present an evaluation of the transferability of NOHIMS to other Navy industrial sites. This evaluation is based on interviews with the NHRC NOHIMS developers, higher level Navy managers, test site administrators, and the system users in both San Diego, California and Bremerton, Washington as well as on a description of features that make NOHIMS flexible and easily adaptable. The evaluation of transferability is covered in the following six subsections: (1) applicability of NOHIMS to other Navy industrial sites, (2) description of features that make NOHIMS flexible and easily adaptable, (3) description of implementation process at the test sites, (4) assessment of how well NOHIMS adapted to the information processing needs at the test sites, (5) assessment of acceptability of NOHIMS, and (6) assessment of transferability of NOHIMS to other Navy industrial sites.

APPLICABILITY OF NOHIMS TO OTHER NAVY INDUSTRIAL SITES

The interview guide for evaluating the applicability of NOHIMS to other Navy industrial sites contained five questions. The exact wording of these questions may be found in Component 29 of Appendix A. Four NHRC NOHIMS developers and six higher level Navy managers were interviewed with this guide. (One other higher level manager was not given these questions.) An amalgamation of their responses to these five questions is presented below.

The first question probed for any differences in information processing needs between the two test sites and the other Navy industrial sites that will be receiving NOHIMS. In particular, the interviewees were asked if they thought the two test sites (a NARF and a shipyard) were representative of the other sites. The NHRC NOHIMS developers agreed that general Navy occupational health policies are the same at all industrial sites but that local information processing needs and policies may differ. The developers acknowledged that NOHIMS will need to be customized for other sites. Where worker populations are more mobile (for example, in shipyards) it may be more appropriate to determine hazardous exposure levels by process (e.g., lead worker) rather than by work area surveyed. One developer felt that the extensive capabilities of NOHIMS could apply to operational entities (ships, for example) as well as to Navy

industrial sites. It was noted that the appropriateness of NOHIMS for Marine sites has not been addressed.

The higher level Navy managers were in agreement also that the basic broad concepts and principles behind the use of NOHIMS applied equally well to all Navy industrial sites. The general needs and functions of all sites are the same, but there will be local differences depending on the nature of the industrial activity. Differences and similarities were reported as follows.

All six NARFs are closely related, but shipyards, weapons stations, and public work centers (PWCs) may operate differently. Public work centers may be harder to implement because workers travel to many different locations making the task of tracking workers through environments more difficult. Hazards may vary from Navy site to Navy site, requiring different tests to monitor the health of workers. For example, the hazards at the Naval Ocean Systems Center (NOSC) in San Diego, California exhibit greater variability than those at other Navy sites. One interviewee speculated that there may be a broader spectrum of agents there because it is an R&D facility and that there may be possible differences in data collection methods because of tighter security measures.

These site-specific differences will have an impact on the NOHIMS directories. Items specific to the information processing needs of each site will have to be added to the NOHIMS directories. However, there should be a common core of directory entries used by all NOHIMS sites. It is planned that adherence to this standardization will come under the watchful eye of the NOHIMS Configuration Control Board.

One manager saw NOHIMS as being applicable to shipboard monitoring. He viewed ships such as submarine tenders, destroyer tenders, and aircraft carriers as floating factories with hazardous environments. NOHIMS could be used to perform medical surveillance for personnel on these ships.

The second question asked if NOHIMS can be adapted to a variety of Navy industrial settings and sites such as air rework facilities, shipyards, and public work centers. As part of this same question interviewees were also asked if there are aspects of NOHIMS that would make it unsuitable for any of these various environments. All four NHRC NOHIMS developers concurred that NOHIMS can be adapted to a variety of Navy industrial settings and sites. However, they identified a number of potential problem areas that might arise. The initial loading of personnel data at different sites may present a problem in some cases. Only the NARFs have a Personnel Extract File (PEF) for tracking the location of workers. It may be difficult to obtain the necessary personnel information at Navy industrial sites other than NARFs. Another potential problem area mentioned was tracking workers in shipyards because they work in a variety of environments that can change rapidly. Another comment was that the NOHIMS directories would have to be modified for different sites, but the developer who mentioned this point did not consider it to be a major problem. One developer remarked that if a site found certain aspects of NOHIMS unsuitable for their application, they did not have to use those features.

In general, the higher level managers felt that NOHIMS can be adapted to a variety of Navy industrial settings and sites because of its modular structure. Obstacles to its successful adaptation could be lack of funding, commitment, and personnel. It was noted that occupational health officers do about the same

tasks wherever they are assigned. One manager commented that air rework facilities and shipyards should not encounter any problems since the workers at these sites with some exceptions are home-based. Personnel at public work centers, on the other hand, are constantly performing their work in a variety of locations which could make them more difficult to track. Another manager felt that NOHIMS certainly is applicable even to Naval Supply Centers because hazardous materials are stored at these facilities before being sent to Navy industrial sites and also because there are occupational health units at Naval Supply Centers. A minor concern was expressed by another manager about how NOHIMS would be able to adapt to the very unstructured environments where shipboard intermediate maintenance activities are performed, citing the new ship base in Everett, Washington as an example. He felt that these unstructured, dirty environments which afford ample opportunity for hazardous exposures did not fall on the same continuum as other Navy industrial sites.

The third question dealt with NOHIMS' applicability to Navy industrial settings of varying sizes. Interviewees were also asked what limitations or requirements NOHIMS may have that relate to the size of the application environment. All of the NHRC NOHIMS developers agreed that NOHIMS is applicable to Navy industrial settings of varying sizes. One developer pointed out that one of the great benefits of the NOHIMS design is that NOHIMS can grow to the size needed. If there are any limitations that relate to the size of the application environment, these pertain to the hardware requirements which are dependent on the size of the database and the number of system users. The NOHIMS software is not limited by size of the application environment. One developer felt that NOHIMS may not be cost effective at very small sites. However, small sites may be able to use a subset of the functions in NOHIMS. Another developer mentioned the potential for problems in a multi-industry NOHIMS implementation, a system configuration that has not yet been tested. The potential problems anticipated would be performance problems, not data integrity problems.

Half of the higher level managers answered categorically that NOHIMS is applicable to Navy industrial settings of varying sizes. Another manager was not aware of what problems varying sizes would present. Several of the managers mentioned that a site might not be large enough to justify the cost of installing NOHIMS. Questions raised by these managers were how small can a NOHIMS configuration be and what is the break-off point in size where NOHIMS becomes cost effective to install. The NOHIMS contracted developers report that the smallest NOHIMS configuration would be a single-user system. Such a configuration is suitable for certain aspects of system development but would not be appropriate for an operational system. It was suggested by one interviewee that a number of smaller users might share a NOHIMS system.

In the fourth question, interviewees were asked what organizational changes are required at a new site in order for NOHIMS to perform successfully. Specifically they were asked what changes to normal operating methods and procedures are required and what changes in terminology would be needed. Further, they were asked if these changes will present problems at other Navy industrial sites. The NHRC NOHIMS developers responded to this multi-part question with a variety of answers. One developer stressed the need to configure the NOHIMS hardware and software to adapt to the site, pointing out that the generality of NOHIMS allows it to be adapted. Another developer focused on the need for coordination of personnel transactions so that workers

may be properly tracked in their work environments. A third developer mentioned four areas of organizational change precipitated by the advent of NOHIMS: systematic passing on of personnel information to the system; massive training, education, and orientation; hiring of system support personnel such as site managers and data entry clerks; and securing the commitment of higher level management that the information required to operate the system will be available. The last developer interviewed concentrated his attention on staffing issues. To be completely viable, he felt that NOHIMS will need a dedicated staff. It will be necessary to identify and train individuals to work specifically on NOHIMS. Career paths will need to be developed with incentives. He also mentioned the requirement for quality control of data entry, possible through review by a higher level person.

Two of the higher level managers felt that the biggest organizational change would be in the area of identifying and securing personnel resources to manage and maintain NOHIMS. One of these managers remarked that there would be no resources in the beginning to run the system, especially personnel. Once these people are on board, they will need to be trained, and who will train them? The other of these two managers expressed the need to make someone responsible for the operation of the system, commenting that it will require some organizational allocation to place staff in responsible management positions. A third manager noted changes that have already occurred at the Occupational Health Unit at his test site such as changes in exam scheduling and notification. He then went on to predict future changes that can be expected. He felt the biggest problems to anticipate are people problems. One group of NOHIMS users may relate well to the system while another group of users may resist introduction of the system. Which way it will go may be unpredictable. In order for the implementation of NOHIMS to go well, this manager recommended that the technical supervision of NOHIMS should be closely connected with the head of occupational medicine and that the NOHIMS site managers should have adequate knowledge of occupational health and medicine practices. He felt that if a site does not already have a reasonably well-developed occupational medicine program, people will not understand what NOHIMS is intended to do which could lead to resistance. It is natural to resist change and/or to ignore the system. This manager concluded that people will just have to get used to doing things differently. Another manager focused on the industrial component of NOHIMS, predicting that NOHIMS would increase communication between NAVMED and NAVSEA industrial hygienist personnel and between NAVMED industrial sites and NEHC.

In the fifth question, interviewees were asked what changes in the patterns of information exchange and communication NOHIMS will cause at a new site and if these changes will present problems at other Navy industrial sites. One NHRC NOHIMS developer thought that physicians will have more specific information on workers' exposures and two felt that there will be more information exchange between physicians and industrial hygienists (e.g., where surveys need to be conducted). In addition, one developer noted there will be a routine exchange of personnel information. Another developer stressed the need for hardware compatibility. The NOHIMS hardware should be standardized to allow different sites to talk to one another and the NOHIMS Configuration Control Board should develop standards for NOHIMS to ensure cross-site compatibility.

One of the higher level managers anticipated that NOHIMS would provide a more efficient, organized method of industrial hygiene record keeping. As he

noted, "The look-up of hazards information will be centralized in the computer rather than having to leaf through 20 to 30 books." One potential problem he foresaw, however, was with the unions who had complained periodically that they did not have access to NOHIMS data. He suggested that a thorough briefing of the unions at a NOHIMS site on the functions and capabilities of NOHIMS may prevent potential problems in this area. The major change expected by another manager was less paper shuffling. The same manager who predicted that NOHIMS would increase communication in answer to question four reiterated his conviction in answer to question five that there would be increased communication between NAVMED and NAVSEA industrial hygienist personnel and between NAVMED industrial sites and NEHC.

Summary

The NHRC NOHIMS developers and higher level managers generally agreed that Navy occupational health policies are the same at all industrial sites but that local information processing needs and policies may differ. Generally, NOHIMS is suitable for other air rework facilities, shipyards, public work centers, weapons stations, and even ships and Naval Supply Centers. NOHIMS will need to be customized for these other sites, however. For example, the processes and criteria used to determine whether and when an employee is called up for a physical examination may be different at other sites, different examinations or types of tests may be used, and hazardous agents may vary from site to site. Another problem that may arise in transferring NOHIMS to other sites is in obtaining personnel data. Only the NARFs have a Personnel Extract File for tracking the location of workers. The worker population at other sites may be more dynamic than at the test sites. New mechanisms for gathering this information will need to be designed at non-NARF sites. The higher level managers identified lack of funding, commitment, and limited personnel resources as an obstacle to successful adaptation of NOHIMS to other sites.

Most of the interviewees agreed that NOHIMS is applicable to Navy industrial settings of varying sizes. They felt that any limitations that might exist would be hardware related, and not software dependent. A few of the developers and managers raised the issue of the cost effectiveness of installing NOHIMS at small sites, even though the software is suitable for a small setting. A developer pointed out that NOHIMS has not been tested in a multi-agency setting yet, although he felt that the potential problems would be performance problems, not data integrity problems.

The NHRC NOHIMS developers had a variety of comments about organizational changes in operating methods that are required at a new site in order for NOHIMS to perform successfully. They identified the need for coordination of personnel transactions; hiring of support personnel; securing commitment of higher level management; massive training, education, and orientation; dedicating staff to NOHIMS; and establishing quality control of data entry as issues to be addressed by a new site. Higher level managers' comments on organizational changes focused on the need to identify and secure personnel resources to manage and maintain NOHIMS, the need for adequate training of personnel, and designating responsible management staff. One manager focused his comments on the need for close connections between technical support and site managers and the head of occupational medicine to ensure acceptance of NOHIMS.

The NHRC NOHIMS developers and higher level managers generally foresaw positive changes to information exchange and communication at new sites. They expected increased communication between physicians and industrial hygienists and routine exchange of personnel information. One manager predicted that NOHIMS would increase communication between NAVMED and NAVSEA industrial hygiene personnel and between NAVMED industrial sites and NEHC. A developer stressed the need for hardware compatibility between sites to allow for inter-site communication. Only one interviewee noted a potential communication problem. He foresaw that the unions may feel concerned about not having access to data because it is stored in NOHIMS.

DESCRIPTION OF FEATURES THAT MAKE NOHIMS FLEXIBLE AND EASILY ADAPTABLE

Component 30 of Appendix A poses a list of questions that ask what features of the medical and industrial components of NOHIMS make it flexible and adaptable to the various needs at other Navy industrial sites. The features that make NOHIMS flexible and adaptable fall into seven categories. These are NOHIMS' omnibus cross-referencing feature, directory features, system set-up features, data entry methods, output features, user friendly features, and hardware independence features. The following discussion presents a description of these various features.

Cross-Referencing Feature

NOHIMS' omnibus cross-referencing feature is one of the main characteristics of the system that assures its maximum flexibility and adaptability. The NOHIMS file structure in both the industrial and medical components provides pointers from one type of data element to another within the component so that it is possible to track workers by social security number through their entire work history or medical encounters. Thus it is possible to retrieve all of the environments in which an employee has worked, the industrial activities employing the worker, the dates and time spent in each work environment, hazards existing in these various workplaces, protective gear issued to the worker, levels of exposure to hazardous substances and agents, medical surveillance required for the worker, plus medical history and the results of physical examinations and laboratory tests.

Because of the vast flexibility inherent in the design of NOHIMS and its extensive cross-referencing capability, it is possible to ask a virtually unlimited number of questions of the system. Some examples of the kinds of questions that NOHIMS is capable of answering are provided below.

- What hazards are contained in a particular environment?
- For a particular hazard, what environments contain this hazard?
- For a particular environment, have workers there been exposed to any hazards? If so, who was exposed? To which hazards? When? How much? Does the amount of the exposure exceed the Threshold Limit Value (TLV) for that substance?

- Which environments have experienced exposures of a particular hazardous substance? When? In which of these environments did the exposure exceed the TLV for that substance?

- In what environments has a particular employee worked? Did any of these environments contain hazards? If so, which hazards? Has the worker been exposed to any of these hazards at a level that exceeded the TLV? If so, when?

- For a particular environment, what employees work there?

- For a worker exposed to a hazardous substance, what are the values of a particular lab test over time used to monitor that worker's state of health?

- What workers have been exposed to, say, asbestos in the last year? In what environments were they working when exposed?

- What is the incidence of, say, dermatitis in a particular work-place environment over time (to be related to a list of contaminants or hazards present in that environment at different times)?

- What is the incidence of, say, respiratory ailments among all patients seen at a particular branch clinic during the past month compared to the incidence in the preceding 12 months (to be related to exposure data and to seasonal variations)?

The list of questions enumerated above certainly is not exhaustive, but it is illustrative of what inquiries could be posed to NOHIMS. Many additional queries are possible.

Directory Features

Both the medical and industrial components of NOHIMS are driven by codes stored in directories. Codes can be added or deleted from these directories through the Directory option in the System Maintenance module of the medical component and the Directory Maintenance option in the Maintenance module of the industrial component.

In the medical component, a variety of parameters for the directory codes can be set and/or changed. Each code must have a long name (e.g., Blood Pressure), but it also can have an abbreviated name (e.g., BP). Both of these names can be changed. In addition, codes can be assigned modifiers (e.g., to represent different kinds of chest X-rays). The modifier names will print in various positions in relation to the long name of the code depending on how the print position parameter is set in the directory, or printing of the modifier name can be suppressed. Both the modifier name and print position can be changed. A number of input and output conditions can be set for each code such as requiring text to be input with a code or signifying to the output programs that special output formatting is to be done with data associated with the code. Input and output conditions can be changed. Physical examination findings and the results of laboratory tests can be checked for valid format, acceptable

values, and normal ranges with an additional provision for specifying normal ranges according to sex and/or age. Result checking conditions can be changed. Help text may be associated with a code and invoked by entering a question mark when the data entry clerk is being prompted to enter results. The help text can be changed. Flowcharts can be triggered by the presence of a code in the patient's medical record. For example, if a patient has been given the diagnosis of Hypertension, NOHIMS can be triggered to produce a Hypertension flowchart whenever the patient's medical record is displayed or printed. The flowchart trigger can be deleted if it no longer is desired. Listcodes group together commonly ordered sets of laboratory tests such as a SMAC, a Complete Blood Count (CBC) with Differential, and Electrolytes. The order that the individual tests follow for each Listcode can be set up to match the order in which the test results appear on the lab chit in use, thus facilitating data entry. The order for individual tests in Listcodes can be changed. With the ability to add codes to the medical component directory and the inherent flexibility just described in setting the parameters associated with each code, the system manager can tailor the medical component to meet the specific needs of the operational site being served by NOHIMS.

The industrial component of NOHIMS contains a directory system similar in operation to that of the medical component in that all features described for the medical component directory also apply to the industrial component directory. The directory allows any number of synonymous names to be defined for a code as well as a primary name and an abbreviation. This design feature allows retrieval and identification of directory codes or elements using local or popular synonyms. For example, Methyl Ethyl Ketone can be identified by its popular acronym MEK and Acronitrile will also be found as Vinyl Cyanide.

The industrial component directory has ten distinct data types. This feature allows definition of codes that are names, results, modifiers, panel codes, free text documents, dates, and times. It also includes a variety of translated key to text or value data codes, a user-defined data classification code type, and a code type that permits definition of subdirectories of associated names such as chemical manufacturers, occupations, or safety equipment lists. The hazardous agent table of the industrial component is actually a one-code subdirectory within the main directory wherein each chemical agent is defined as a member or element of the "HAZARDOUS AGENT" subdirectory code. NOHIMS has complete definition, editing, deletion, filing, selection, and retrieval capabilities for both directory and subdirectory codes. The document type of code can be defined with both document length and line width parameters. The text for document type codes is entered and edited via the industrial component text editors. The classification type of code allows the user to devise and use a coding scheme to categorize data having a multitude of associated attributes. The directory also facilitates control of recurrent input of a data item where multiple response input or multiple subdirectory member selection is applicable.

Using the TABLES suboption, the system manager may add or delete codes from the system translation tables or change the textual name associated with a given code. These tables cover medical history examination codes, medical laboratory examination codes, medical physical examination codes, sample media codes, concentration scales and units, medical examination applicability flag codes, occupation codes, physical restrictions codes, body part and organ systems codes, and mandatory medical requirement codes.

System Set-Up Features

One of the initial tasks in implementing NOHIMS at a site is to identify the system users. Both the medical and industrial components of NOHIMS allow flexibility in setting up the identification files for the users. Each user may select a unique ID code of from three to five characters to be entered when logging onto the system. The first three characters of the ID code are also used to uniquely identify the user in the system. In the industrial component, the system manager may also select the system options to which the given user will have access. In the medical component, the system manager defines user classes such as system managers, providers, and data entry clerks and then specifies which options may be accessed by that class of user. Each individual user is assigned to a class of users and is thereby limited to the access options of that class of users. The ID file in the medical component is also used for alphabetic look-up of providers' names during encounter entry. In both components of NOHIMS, the system manager may edit the ID file at any time and may activate/de-activate/re-activate users as required for his/her site. There is no practical limit to the number of users that may be entered into the ID files.

The industrial component is also flexible in the definition of the agency structure. During system implementation, the structure of the agency to be served is defined. As many organizational levels (for example, departments and divisions) as required may be defined, regardless of how scattered geographically they may be or the size of the agency. Within these organizational levels, any number of units or groups may be defined. There are no limitations on how the organizational branches may be named. The Edit Organization option of the Agency Data module allows the system users to change names, acronyms, or codes for any of the groups within the organization once the system is operational. It also allows the user to add groups to or delete groups from the organization as necessary. Any alterations that are made are reflected throughout the applicable levels of the agency's hierarchical structure.

Data Entry Features

The medical component of NOHIMS does not come with a standard patient registration form because only three data elements must be collected during registration--the patient's name, sex, and date of birth. Each NOHIMS site can collect other registration data elements as needed. The System Maintenance module in the medical component tells NOHIMS which data elements are to be collected, in what order they are to be collected, and how the registration data are to be displayed on the CRT screen. These parameters may be changed at any time through the System Maintenance module. A patient must be registered in NOHIMS before encounter data can be entered in the patient's medical record.

Medical encounter entry has very few constraints. The encounter format contains two parts--the Header and the Body. The Header contains primarily administrative information that identifies the patient, the date and site of the encounter, the name of the care provider(s), and the nature of the visit and service provided. The order of data items in the Header of a medical encounter in NOHIMS is fixed. Entry of data items in the Body of the medical encounter

can be in any order; however, the order of data entry should follow the items on the medical encounter forms. Lab test codes can be entered at the time of the encounter; lab results can be added to the patient record when they are received. Single result tests can be added in any order. Listcode panels and multiple result tests must be entered in the sequence that they are set up in the medical component directory or entry routines. The sequence of the Listcode panels can be changed through the System Maintenance module. If any errors or omissions are noted in a patient's medical record, they can be corrected at any time through the Medical Edit option in the medical component of NOHIMS.

An already existing numbering scheme can be used for identifying patient records including social security number. This number becomes the unit number in the medical component of NOHIMS. Patients can be looked up by either name or social security (unit) number. In the medical component of NOHIMS, there is a choice as to how codes can be entered in order to balance ease of data entry with ease of use by care providers. Codes may be entered by using the long name, a subset of the long name, the short name, or the internal code of a particular data item. The San Diego test site generally uses the short name of the data item. A NOHIMS site can develop as many different medical encounter forms and laboratory results input documents as are needed to collect the required information for data entry.

Data other than directory codes, such as free text, can be entered in the data files of the medical component. Status codes that define the status of a diagnosis or problem such as History Of, Rule Out, Presumptive, Major, and Inactive can be included. Physical findings and laboratory test results can be entered in the patient record in any format. Processing of narrative data, however, increases both data entry time and disk storage requirements; therefore, discretion in using narrative data is essential. Also, it is difficult to summarize or analyze textual entries.

The maximum number of patients that can be registered in a single medical component of NOHIMS is 6,759,999. The maximum number of medical encounters that can be stored at one time for a single patient is 999. The maximum number of different directory codes (excluding code modifiers) allowable in the medical component is 121,670. These limits are so large that in practice they normally are never reached. A more likely limiting factor would be the amount of disk storage space that is available. However, when NOHIMS approaches a fully loaded disk state, inactive and/or older patient records can be archived to tape to free up disk space, disks can be reorganized, or additional disks can be purchased.

In the industrial component of NOHIMS, data entry sequences for survey data, hazardous agent information, environment data, and personnel data follow either a set of standardized input documents or a minimum required entry set. A set of standard input documents is used by the industrial hygienists to first collect data during a survey of an environment and then to enter or update the survey data in NOHIMS. When entering survey data in NOHIMS, the data entry person may enter as many Occupational Hazard Data Sheets and as much Material Inventory data as is required to complete the survey information. The hazardous agent information is also input from a standard data collection form while the other major data areas--personnel and environments--require the entry of only a basic set of identification data items.

Additional input capabilities are facilitated by associating user-designed input sequences with any of the existing entry options. The input sequences are created by selecting any number and order of the industrial component's directory codes to be entered. Any number of sequences may be defined and associated with any entry process. The same data item may be used in more than one input sequence for different purposes without conflict or confusion. For example, the directory code for an agent concentration measurement may appear in the survey data input sequence denoting the concentration value from a survey in an environment. The same directory code may also appear in the personnel input sequence and denote a concentration value to which an individual worker was exposed. These two data items, identical in name and description but not in value, will not be confused with one another in NOHIMS since one value is associated only with the personnel entry function and the other value is associated only with the survey entry function. The input sequence definition, edit, and association processes are all accessed through the Directory Maintenance options of the Maintenance module.

In addition to the flexibility in the input sequences, the industrial component provides flexibility in the definition of environments, worker assignments, survey indexes, and hazardous agents. The Environment Data module compiles a list of all environments contained in the agency. In general, an environment may be anything that can be surveyed so NOHIMS allows three different types of environments to be defined. These types are locations (a physical location such as BLDG 150, ROOM A, Painting Area), events (a unique or unusual occurrence with an environmental impact such as a spill or leak), and occupations or programs (such as corrosion control or the respirator fit program).

In the Personnel Data module, a variety of worker assignments can be managed by NOHIMS. A given worker may be assigned to any agency organizational level, to work environments associated with other agencies, and to multiple work environments. These relationships may be established, altered, and terminated at any time. The local site may identify user-specified recommendations or other local requirements to be considered in determining appropriate medical monitoring.

Flexibility is inherent in the Survey Data module in that survey data may be defined for any number or type of environments. Local conventions for indexing or referencing a survey may be used to identify a survey in NOHIMS.

Additional hazardous agents specific to a given site may be defined in NOHIMS using the Hazard Data Entry option in the Hazard Data module. All hazardous agents may be identified by as many synonymous names as needed. Hazardous agent concentrations and exposure limits for a variety of authorities and sampling scales may be maintained in NOHIMS. NOHIMS stores PEL, TLV, and NIOSH exposure limits, and TWA, ACTION LEVEL, STEL, and CEILING limits for agents, if applicable.

A worker in the industrial component can be identified by either name, social security number, local employee/pay number or, in some instances, the agency unit to which the worker is assigned. There are no intrinsic limits on the number of personnel, hazardous agents, environments, surveys, or the size or organizational structure of the industry.

Output Features

NOHIMS produces a number of standard reports whose format and content (types of information contained) cannot be changed without programming intervention. In the medical component these patient-specific hard-coded reports are the Encounter Report, the Status Report (a summary of the patient's medical record), and the Index Patient (an index to all of the sections of a patient's medical record). The industrial component also has several hard-coded reports, namely, the Industrial Hygiene Survey Report, the Physical Exam Notification Report, the Occupational Health Examination Roster, and the Individual Exposure Examination Report.

In addition to the standard, hard-coded reports in the medical component of NOHIMS, however, there are a number of patient-specific reports whose format and content can be specified and altered if necessary through the use of System Maintenance options. The registration display (which can be printed as a report) is set up and can be changed through the Registration Functions option. The content and format of the Patient Summary report is set up and can be changed through the Medical Data Functions option. Templates for standard flowcharts are created and can be edited through the Directory option. There is also an Interactive Flowchart function that allows a NOHIMS user to create an ad hoc flowchart for a patient. When a NOHIMS user wishes to produce reports involving more than one patient, the Report Generator in the medical component is invoked. This module allows the user to select subsets of patients or visits, and to list and/or cross-tabulate the data items retrieved. The data items to be included in Report Generator runs can be defined and edited by the report user. The general report format cannot be changed without programmer intervention, however. The NOHIMS medical component cannot create ad hoc reports in any format desired with any content desired nor does the medical component have an interactive query function.

The industrial component contains cross-referenced data retrieval options for normal displays for all of the general data areas. As an example, when displaying the organizational units of an agency, the user may also elect to include the work environments associated with each agency unit and a list of the personnel assigned to each agency unit in the display.

The Query/Report function can retrieve any or all of the current data within the industrial component in any user-selected order that is consistent with the cross-referencing paths of the five data areas. The construction of a query is a step-by-step menu selection process wherein the user is provided a menu of the data areas and data items that are internally linked to the previously selected data areas. The industrial component Query/Report module does not require system maintenance when new codes are added to or data items are changed in the system. The Query/Report will detect new or altered input sequences or directory codes and adjust itself to being capable of retrieving these data in appropriate ways. The display format is fixed.

User Friendly Features

The medical and industrial components of NOHIMS have several features that make NOHIMS easy to learn and, therefore, easily adaptable to new installations.

These are its menu-driven design, on-line help text, supporting user documentation, and job aids. In both the medical and industrial components, all system options are identified and invoked through menu selection processes. A user may easily move forward and backward through menu levels, usually with a single character keystroke. The user is allowed to enter a "?" character when in doubt of the proper response to any system prompt. NOHIMS will then provide the user with either an explanation of the proper response, a list of applicable responses, and/or instructions on how to obtain additional help. A Question Mark Response suboption in the Directory option of the medical component allows the system manager to create and edit help text for the medical component. A Response-to-? suboption in the Maintenance module of the industrial component allows the system manager to augment or edit responses to a user's "?" entry at industrial component system prompts.

User manuals/guides are available for both the medical and industrial components of NOHIMS. Several job aids were designed to aid data entry clerks in entering medical data into the system. These are contained in the system user's guide for the medical component. A system manager's manual also is available for each component. The Assessment of Operational Characteristics subsection in the Evaluation of NOHIMS System Design section of this report contains further information on NOHIMS' user friendly features.

Hardware Independence Features

A variety of hardware configurations can support NOHIMS. A number of minicomputers can be used to run NOHIMS including both the DEC PDP 11 series and the VAX series, Plessey, Harris, Tandem, Prime, Data General, and Convergent Technologies (and CT look-alikes). For smaller NOHIMS sites, the software will run on a variety of microprocessors including the IBM PC/AT (and its clones), COMPAQ, Motorola, NCR, Tandy, and Olivetti.

NOHIMS can accommodate a variety of terminal/cursor types including any hard copy device, Infoton standard or Vistar with number pad, dumb terminals, and smart terminals. NOHIMS at this point in time does not support terminals with split-screen features.

Summary

Both components of NOHIMS have features that make NOHIMS flexible and adaptable to needs at other Navy industrial sites. These are the omnibus cross-referencing ability of NOHIMS, directory features, system set-up features, data entry features, output features, user friendly features, and hardware independence features. The omnibus cross-referencing ability of both the industrial and medical components of NOHIMS assures maximum flexibility and adaptability to varying data retrieval needs. NOHIMS can retrieve correlated data items within a component, making it possible to follow workers through their work or medical history, or to ask an unlimited variety of questions such as what hazards are in a particular environment.

The directories of the medical and industrial components also provide flexibility and adaptability. A variety of data types can be defined and various parameters of the data items such as primary name and synonymous names

can be defined and modified through directory functions as required by an application site.

NOHIMS allows flexibility in the definition and maintenance of the system user identification file. User-specified ID codes and access options may be set and changed. The industrial component initial agency definition process allows definition of the agency structure according to local needs. The organizational structure and titles may be modified as required by the operational site.

Many of the data entry sequences in NOHIMS can be set up and altered by the system manager. In the medical component, the system manager can alter the registration sequence through System Maintenance functions. The data entry sequence for the Header of an encounter is fixed; however, the data entry sequence for the Body of an encounter is not. Data in the Body of the encounter may be entered in any order. The input parameters for each code are set and altered through the Directory Maintenance option in the Systems Maintenance module. An already existing numbering scheme may be used for identifying patient records, including the social security number. A variety of data types, codes, free text, test results, and statuses (such as abnormal or major) may be entered. There are no practical limits on the number of encounters and directory codes that can be entered into the system; disk storage space is usually the limiting factor.

In the industrial component, survey data and hazardous agent data items are entered in sequence from standard data collection forms. As many Occupational Hazard Data Sheets and as much Material Inventory data as required to complete the survey may be entered. The personnel and environment data options use a standard set of entry items. Ad hoc input sequences may be defined by the user and associated with any of the system entry functions. Data items may be used in more than one input sequence. Environments may be defined as either a location, an event, or an occupation or program. A variety of worker assignments can be managed by NOHIMS including multiple work environments and multiple-agency assignments. Local requirements may be used to define medical monitoring recommendations. Local conventions may also be used for naming environments, workplace locations, and for identifying surveys. Additional hazardous agents may be added to the Hazardous Agent Table. A variety of exposure limits and sampling scales may be maintained in NOHIMS.

The medical component produces several reports whose content and/or format can be altered or defined by the end user. These include the Patient Summary, Flowchart, Interactive Flowchart, and the COSTAR Report Generator. The industrial component contains cross-referenced data retrieval options in all system modules in addition to the standard display of the data of that module. The user may define the content of these displays within the parameters of the system module. The user may also define data retrieval tasks using the Query/Report module; however, the format of a query is fixed.

The medical and industrial components of NOHIMS have several features that make NOHIMS easy to learn and, therefore, easily adaptable to new installations. These are its menu-drive design, on-line help text, supporting user documentation, and job aids.

Finally, NOHIMS is flexible and adaptable because a variety of mini- and microcomputers can support NOHIMS. NOHIMS can also accommodate a variety of terminal/cursor types.

DESCRIPTION OF IMPLEMENTATION PROCESS AT THE TEST SITES

The implementation of NOHIMS at the two test sites was an involved process that required significant resources and efforts. In this section we have documented the personnel involved in the implementation process at the test sites, the steps involved in implementing NOHIMS, problems that were encountered in implementing NOHIMS, the effects of NOHIMS installation on staff morale, and current operational procedures at the two test sites. Component 31 of Appendix A contains the questions that we used to solicit this information. It is our hope that a thorough documentation of the implementation process at the test sites will give future NOHIMS implementors and personnel at installation sites an accurate assessment of the work that will be involved in implementing NOHIMS, the resources that will be required, and the problems that may be encountered in the process.

Of the two test sites, the implementation process in San Diego, California was more involved than that in Bremerton, Washington for several reasons. First, San Diego was the pilot test site where both the industrial and medical components of NOHIMS were developed. A variety of Navy personnel, civilian employees, and contractors all took part in the implementation process in San Diego. Only the industrial component of NOHIMS was implemented in Bremerton, involving fewer people and less system resources.

Individuals and Steps Involved in the Implementation Process in San Diego, California

Even before the implementation process was begun in San Diego, a comprehensive systems analysis of the record keeping and reporting requirements of the North Island Naval Air Rework Facility (NARF) was conducted to develop preliminary specifications for collecting, processing, and displaying medical and environmental data within a prototype occupational health information system (Pugh & Beck, 1981). As a result of the systems analysis, a semi-automated interim system (described in another section of this report) was implemented to test NOHIMS design concepts and to provide a temporary capability to produce certain basic reports needed for management of occupational health activities. In the ensuing year, functional specifications for a fully automated Navy Occupational Health Information Management System were developed (Beck & Pugh, 1982). Lawrence A. Hermansen and Michael J. Gorney of the Naval Health Research Center (NHRC) assisted Donald D. Beck and William M. Pugh in maintaining the interim system. Richard L. Cohen, M.D. provided much needed medical information during the design phase. Anne K. Burton was instrumental in the development of the Industrial Hygiene Survey Form, and Captain Charles W. Bollinger contributed to the industrial hygiene procedure methodology.

The systems analysis was conducted by staff from the Environmental Medicine Department of NHRC spearheaded by William Pugh and Donald Beck. Many individuals assisted NHRC in collecting the data needed for the systems

analysis, including Captain Thomas V. McManaman, Commander Chris Holmes, Andrew L. Bryson, Anne Burton, and other staff members of the Environmental Health Service, San Diego Regional Medical Center; Captain John Osborne, Lieutenant Tyrone Cormier, Alan M. Watanabe, and other staff members of the Environmental Health Service, Naval Regional Medical Clinic, Hawaii; Captain Richard Nelson, Dr. Glenn H. Randall, and other staff members of the Navy Environmental Health Center, Norfolk, Virginia; HMCM W. H. Anders and other staff members of the NRMC Branch Clinic, NAS, North Island, San Diego; and Matt Rosa, Safety and Health Manager, Naval Air Rework Facility, NAS, North Island, San Diego.

The functional specifications for the NOHIMS software led to adapting public domain COSTAR (Computer STored Ambulatory Record) as the medical component of NOHIMS and writing completely new MUMPS software to implement the industrial component. These technical and programming services were provided by R-K Research and System Design, Malibu, California and The MITRE Corporation, McLean, Virginia under contract to NHRC. Key contract personnel contributing to the development of NOHIMS were Donald D. Beck for the industrial component, and Diane M. Ramsey-Klee, Ph.D., Kathryn E. Guidera, MSPH, and Anton S. Roberts for the medical component.

The development of forms to capture data for input to NOHIMS was also a team effort. Anne Burton, Larry Brady, William Pugh, Lawrence Hermansen, and Donald Beck collaborated to develop methods for collecting industrial hygiene survey data. On the medical side of NOHIMS, patient registration and medical encounter forms were developed jointly by Richard Cohen, M.D., Diane Ramsey-Klee, and Kathryn Guidera with additional input from Merle Bundy, M.D., Lois Moody, R.N., Margie Acol, and Jenny Early. Medical history and occupational history forms were developed by Richard Cohen, M.D., James C. Helmkamp, Ph.D., Diane Ramsey-Klee, Kathryn Guidera, and Craig M. Bone.

NOHIMS hardware and software installation in San Diego was accomplished by William Pugh, Donald Beck, Lawrence Hermansen, and Michael Gorney. NOHIMS system testing was performed by Donald Beck, William Pugh, Diane Ramsey-Klee, Kathryn Guidera, Lawrence Hermansen, Anne Burton, and by the data entry clerks. Necessary software modifications were made by Anton Roberts, Kathryn Guidera, Donald Beck, Jack Frogue, Diana Hamilton, and Mark Lauterern.

NOHIMS documentation for system users and the system managers was prepared by Diane M. Ramsey-Klee, Kathryn Guidera, Donald Beck, and Lawrence Hermansen. Although NOHIMS training was not included in contract work statements, a minimal amount of training had to be conducted at the time that NOHIMS became operational at the two test sites. In San Diego training initially was provided by Kathryn Guidera, Diane Ramsey-Klee, and Donald Beck, and later by Lawrence Hermansen in his role as NOHIMS system manager.

A number of technical reports were published to document the design, development, installation, and implementation phases of NOHIMS. These reports were authored by William Pugh, Donald Beck, Diane Ramsey-Klee, Lawrence Hermansen, James Helmkamp, Richard Cohen, M.D., Kathryn Guidera, and Craig Bone.

The Functional Manager of the NOHIMS project for the Naval Medical Research and Development Command, Bethesda, Maryland has been Commander Patrick A. Truman. Commander James W. Allen, Navy Environmental Health Center, Norfolk, Virginia has been the NOHIMS Project Manager. Management of NOHIMS' design and

development for the Naval Health Resarch Center, San Diego, California has been the responsibility of William M. Pugh, Head, Medical Information Systems Program. Lawrence Hermansen serves as the NOHIMS system manager for the San Diego test site on a full-time basis with the assistance of Diana Hamilton.

Individuals and Steps Involved in the Implementation Process in Bremerton, Washington

In the design phase of NOHIMS, Captain Charles W. Bollinger [Director, Occupational and Environmental Health Services, located at the Puget Sound Naval Shipyard, under the Naval Hospital, Bremerton, Washington] became involved in early development of system design concepts and industrial hygiene procedure methodology. He was instrumental in persuading Navy management to select Bremerton as the second test site for NOHIMS.

It was decided to initially implement only the industrial component at Bremerton. Harvey Grasso, an industrial hygienist, defined the organizational structure of the Puget Sound Naval Shipyard for NOHIMS with the assistance of Todd Merrill from the University of Washington and Michael Jackson, another industrial hygienist. NOHIMS hardware and software installation in Bremerton was accomplished by William Pugh, Donald Beck, and Michael W. Congleton, Ph.D., M.D.

Initially the industrial hygienists entered their own survey data into NOHIMS, in particular Larry Kalcso and Pete Howard. Survey data currently are input to NOHIMS by a data entry clerk. Roger Beckett, Head of the Industrial Hygiene Division, located at the Puget Sound Naval Shipyard, under the Naval Hospital, Bremerton, Washington provided administrative support for the introduction of NOHIMS at the second test site, allowing staff the time needed to initialize NOHIMS and learn how to use the system.

As the industrial component of NOHIMS became operational in Bremerton, Michael Jackson assumed the role of NOHIMS system manager, a responsibility that now consumes 50 percent of his time. Other NOHIMS users spend ten to 20 percent of their time interacting with the system. Since NOHIMS was introduced at Bremerton, Michael Jackson has been involved in all aspects of system start-up and maintenance including the hardware configuration and set up, installation of the operating system, daily management and operation of the NOHIMS software for the industrial component, system back-up, troubleshooting, and training of in-house staff.

Problems Encountered During the Implementation of NOHIMS

Thirteen NOHIMS users consisting of six medical care providers, five industrial hygienists, and the two system managers were asked what problems were encountered during the implementation of NOHIMS from their individual perspectives. Table 74 presents the problems they reported in response to this question. Only four problems were mentioned by more than one respondent and these four were noted by only two interviewees each. These four problems were lack of user training, time delays in installing hardware and telephone lines, initial software bugs, and initial shortage of data entry personnel. A medical care provider identified problems with insufficient resources to allocate to the

TABLE 74
Description of Problems Encountered
During the Implementation of NOHIMS
(Number who mentioned problem; multiple answers allowed)

	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
Lack of user training	0	2	0	2	22
Time delays in installing hardware and telephone lines	0	0	2	2	22
Initial software bugs	0	0	2	2	22
Initial shortage of data entry personnel	1	1	0	2	22
Insufficient resources to allocate to implementation	1	0	0	1	11
Insufficient personnel/ staffing	1	0	0	1	11
Patient resistance to filling out NOHIMS forms	1	0	0	1	11
Occupational and medical history forms too long	1	0	0	1	11
Frustrated with increased paperwork at first	1	0	0	1	11
Personnel Extract File not accurate and/or current	0	1	0	1	11
Data entry backlog for industrial hygiene survey data	0	1	0	1	11
Initially no standardized industrial hygiene survey form	0	1	0	1	11
Interface with medical care providers	0	1	0	1	11
No documentation initially for the industrial component	0	1	0	1	11

(Continued)

Table 74 (CONT.)
Description of Problems Encountered
During the Implementation of NOHIMS
(Number who mentioned problem; multiple answers allowed)

	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
Industrial hygienists not exposed to computers before	0	1	0	1	11
Unstable work force	0	0	1	1	11
Initial hardware failures	0	0	1	1	11
Indecision as to what information was needed	0	0	1	1	11
Pressure to get NOHIMS operational prematurely	0	0	1	1	11
TOTAL WHO ANSWERED	4	3	2	9	100
No Comment	2	2	0	4	
TOTAL INTERVIEWED	6	5	2	13	

implementation process and insufficient personnel or staff. Another medical care provider expressed frustration with increased paperwork at first. A third medical care provider felt that the experimental occupational and medical history forms were too long and reported patient resistance to filling out the new forms required by NOHIMS.

The industrial hygienists reported a variety of problems. In San Diego, an industrial hygienist expressed concern that the Personnel Extract File (PEF) was not accurate and/or current, leading to confusion about what workers were in which shops. Other problems mentioned by a San Diego industrial hygienist were that initially there was no standardized industrial hygiene survey form and that there was a data entry backlog for survey data. One industrial hygienist felt that there was a problem in the beginning concerning the interface between industrial hygienists and medical care providers. Problems mentioned by an industrial hygienist in Bremerton were lack of documentation initially for the industrial component and that they had not been exposed to computers before.

Additional implementation problems noted by one of the system managers were initial hardware failures, an unstable work force, indecision or ambivalence on the part of users as to what information they needed (particularly in the forms design process), and pressure to bring NOHIMS to an operational status prematurely. The system manager in San Diego observed that NOHIMS was treated as a production system while it was still under development.

The thirteen NOHIMS users were also asked to comment on how these problems during the implementation process were resolved or handled. The majority of the problems encountered in the implementation of NOHIMS worked themselves out naturally as time evolved. Six of the problems encountered during implementation are still problems. These are lack of user training, insufficient personnel/staffing, lengthy occupational and medical history forms, inaccurate Personnel Extract File data, data entry backlog for industrial hygiene survey data, and an unstable work force. In addition, one medical care provider commented that she was annoyed at first with the repetitious paperwork but then realized it was necessary to capture the required information for data entry. An industrial hygienist felt that there had been a step-by-step resolution of the problems in an evolutionary process, much like problem solving by trial and error. Also a plan to cross-train secretaries to do data entry should help ease the survey data entry backlog. The system manager in Bremerton felt that any problems encountered were normal problems to be expected during implementation of a test site, all of which were resolved.

Effect of NOHIMS Installation on Staff Morale

The thirteen users were also asked if staff morale had been affected by the installation of NOHIMS, whether this effect was a positive or negative one, and if the effect was temporary. Table 75 summarizes their responses to this multi-part question. Of the nine individuals responding, 78 percent felt that the effect on staff morale initially was negative and 22 percent thought the effect was positive initially. The negative responses were generally a result of the problems encountered during implementation and because of the increased workload generated by the advent of NOHIMS. The medical care provider who thought that the initial effect was positive based her response on her perception that "things are clearer now," and that she was legally covered by NOHIMS back-up as

TABLE 75
How Staff Morale Was Affected by the Installation of NOHIMS
(Number who mentioned effect)

	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
The initial effect was					
Negative	3	3	1	7	78
Positive	1	0	1	2	22
TOTAL WHO ANSWERED	4	3	2	9	100
No Comment	2	2	0	4	
TOTAL INTERVIEWED	6	5	2	13	
The final effect was					
Positive	4	3	2	9	100
TOTAL WHO ANSWERED	4	3	2	9	100
No Comment	2	2	0	4	
TOTAL INTERVIEWED	6	5	2	13	

to why she was doing what. A medical care provider who felt that the initial effect on staff morale was negative explained his response this way. "The medical ancillaries have so much more work to do, however, people like to be a part of interesting new things." One hundred percent of the NOHIMS users responding to this multi-part question thought that the final effect of NOHIMS installation on staff morale was positive, some even added that the effect was very positive. Reasons given for this long-term positive effect on staff morale were the availability of more concise survey data collection forms liked by both industrial hygienists and data entry personnel and that "data now exist in black and white." An industrial hygienist in Bremerton commented that NOHIMS has forced them to get out to all workplaces to collect base-line survey data and has forced compliance with some requirements of the 5100.23B NAVOP instructions. As a result, they are better meeting the requirements of their job. The medical care providers felt that NOHIMS has generally ha[illegible] a positive long-term effect because medical surveillance is more appropri[illegible]w; less unnecessary tests and examinations are being performed and fewer peo[illegible]re slipping through the cracks [of medical surveillance]."

Operational Procedures at Test Sites

When NOHIMS was implemented at the North Island NARF in San Diego, California it was a completely new data collection and processing system that replaced an essentially manual system. The Systematic Arrangement For Examinations (SAFE) program was in place at North Island, but it used very limited automation. Thus, the advent of NOHIMS introduced automation of occupational health information on a scale never before experienced at the Industrial Hygiene Division of the Occupational and Preventive Medicine Department or the Occupational Health Unit (OHU). Implemention of the industrial component of NOHIMS at the Industrial Hygiene Division, Puget Sound Naval Shipyard in Bremerton, Washington also introduced a completely new data collection and processing system into that Navy industrial environment, replacing a previous manual system. This subsection describes the operational procedures that have evolved for data collection, data entry, data retrieval, and report generation/utilization as well as problems encountered in the day-to-day operation of NOHIMS at these two test sites.

Current Data Collection Procedures for NOHIMS

In San Diego, patient data for the medical component of NOHIMS are collected using a set of standard forms developed specifically for the pilot test site. A Patient Registration form that captures basic demographic data necessary for occupational health care is filled out by the patient the first time the patient is examined at the OHU. The patient also fills out the first page of the Physical Exam Data Sheet (PEDS) encounter form; this page collects encounter-specific administrative data and is completed each time a patient has a physical examination. An Occupational Health Technician completes the rest of the PEDS form which provides data on job certification, hazardous agent surveillance, protective equipment, laboratory tests, radiology, pulmonary function tests, electrocardiograms, audiometry, and eye examination. The Physical Examination Findings (PEX) form is completed by the physician and includes vital signs, a review of systems, a problem list, and disposition. The Navy Asbestos Medical Surveillance Program form (6260/5) is used by the

physician to record patient data collected specifically for the Navy Asbestos Medical Surveillance Program. Two additional forms were developed to collect occupational history and medical history data. When these experimental forms were tested at the Occupational Health Unit, they took too long to complete. Consequently, they are not in current use. In most cases laboratory test results are collected using the standard Navy laboratory chits, including the Hearing Conservation Program forms (DD 2215 and DD 2216). A results form for the electrocardiogram is completed by the physician. Pulmonary function test results are obtained directly from the patient's medical record. At data entry, physicians verify the medical data on the data collection forms only if there are any ambiguities, questions, or omissions.

At North Island, survey data for the industrial component of NOHIMS are collected by industrial hygienists and workplace monitors using the standard industrial hygiene survey data collection forms developed specifically for NOHIMS. These include the Industrial Hygiene Survey Form, the Occupational Hazard Data Sheet, and the Materials Inventory. These survey forms have been well received by other industrial hygienists and are in general use in the San Diego medical region. The survey data collected by the workplace monitors are verified by the industrial hygienists. A peer review process is used to review the survey data collected by the industrial hygienists themselves. About three surveys were being conducted per month at the time of our interviews. Each workplace is supposed to be surveyed annually. However, because of a lack of industrial hygienists, they cannot meet this schedule and are surveying every two to three years instead. The other source of data for the industrial component of NOHIMS in San Diego is the Personnel Extract File (PEF) that provides workplace information on a monthly basis for workers at the North Island NARF.

At Bremerton, Washington, survey data for the industrial component of NOHIMS are now collected by industrial hygiene personnel using the NOHIMS industrial hygiene survey forms. Base-line survey data were collected in the field with a portable Epson microcomputer using a standardized data collection format. This survey information then was passed over to the Plessey microcomputer for permanent NOHIMS storage. Printouts of survey data from the Plessey are used to conduct survey updates as required and annual walk-through inspections. Technical supervisors and/or the head industrial hygienist review and verify all survey data before they are entered in NOHIMS. No data on the workplace location of workers at the Puget Sound Naval Shipyard are yet available for entry into NOHIMS.

Current Data Entry Procedures for NOHIMS

A full-time data entry clerk enters the medical data into NOHIMS at the North Island Occupational Health Unit in San Diego. There usually is no backlog for medical data entry unless there are problems with the communication lines/equipment or NOHIMS is experiencing hardware downtime. Data entry is not routinely verified.

At the time of our interviews, survey data collected at North Island were entered into the industrial component of NOHIMS by one industrial hygienist (Anne Burton) and by Naval Health Research Center personnel (Diana Hamilton). The industrial hygienist wished that she had time to do more data entry because

she has access to relevant reference material and felt that she was more accurate. The industrial hygienist at the NARF Safety Office corroborated this assessment, noting that Anne Burton verifies the survey data as she enters it. At the time of our interviews, the data entry backlog for survey data was approximately one-half month of data entry work.

At Bremerton, Washington there is one data entry clerk who spends approximately half of her time entering survey data into the industrial component of NOHIMS. The industrial hygienists reported that there never is a data entry backlog because they cannot survey faster than data entry is accomplished.

Current Data Retrieval Procedures for NOHIMS

In San Diego, the data retrieval capabilities of NOHIMS are not fully utilized because of lack of time and training. The data retrieval capabilities of the industrial component were better understood at the time of our interviews than those of the medical component. When we asked who requests retrieval of data from NOHIMS, we were given a variety of examples. Physicians and nurses request data on individual exposures for unscheduled patients and occasionally they request survey data. At the time of our interviews, the Patient Summary and Encounter Reports were not being printed for scheduled patients although these reports of the patient's electronic medical record could provide a useful adjunct to the patient's paper chart, particularly if the paper chart is misplaced or lost. A remedy for this situation would be to automatically print a Patient Summary and Most Recent Encounter for each scheduled patient for placement in the patient's paper chart and to educate the care providers in the useful features of these medical reports.

Other examples of requests for retrieval of medical data from NOHIMS in San Diego were telephone calls from division clerks to find out the date a patient was seen and from work supervisors to learn whether a worker had been given a particular test in the last year. Work supervisors may also request data for personnel actions and environmental pay decisions. Data are requested to help substantiate or refute worker complaints and claims. The industrial hygienists request survey data, standards and exposure levels for walk-through inspections, and data to support compliance with specific OSHA standards (e.g., lead surveys). Management statistics have been requested by NEHC such as the number of workers exposed to particular hazardous substances. The industrial hygienist at the NARF Safety Office uses data retrieved from NOHIMS to answer queries from work center supervisors and others, to develop work plans for the workplace monitors, and to defend worker claims. This interviewee would like to see the NARF safety specialists using NOHIMS but he questioned who was going to train them. A final example of requests for retrieval of data from NOHIMS came from NHRC where epidemiologists have requested special data retrieval to conduct research studies.

At the North Island Occupational Health Unit, requests by care providers for medical or survey data are handled by one of the occupational health technicians who usually retrieves the desired information within minutes. How long it takes to obtain the requested information depends on how busy the staff is at the moment of the request, although most requests are answered the same day. More complex requests that involve NOHIMS Report Generator runs in the

medical component are handled by NHRC staff and response time could be as long as several days depending on the NHRC workload and the complexity of the request.

The industrial hygienists in San Diego can retrieve most data requested of them within minutes to a day. How long it takes is more a function of finding the time to do it. If the request involves an interactive query of the industrial component's database, NHRC staff typically set up the query, with the output retrieved by the end of the day. Occasionally the data entry clerk for the medical component retrieves requested data for the industrial hygienists.

In Bremerton, Washington any member of the Industrial Hygiene Division may request retrieval of data from NOHIMS and all industrial hygienists have access to the query mode where the parameters for commonly run reports are saved. All of the industrial hygienists were taught how to retrieve industrial data from NOHIMS by Michael Jackson, the system manager. If an industrial hygienist does not know how to retrieve desired data, he asks Mr. Jackson for help. One industrial hygienist commented that the query function is an extremely useful and easy-to-use tool which he uses to retrieve all survey data with one request rather than the slower method of retrieving desired data items one by one. How long it takes to retrieve survey data depends on which shipyard zone the survey falls in. According to the NOHIMS system manager in Bremerton, the longest search was taking about 15 minutes at the time of our interviews. Turn-around time for most searches was normally fast enough for what was being done.

Current Uses of Reports and Data Generated by NOHIMS

The medical care providers in San Diego reported the following uses of reports and data generated by NOHIMS: use of the Individual Exposure Examination Report (IEER) and sometimes the Patient Data Sheet (Patient Summary) or a hardcopy of a survey report to provide health care; day-to-day and month-to-month epidemiological analyses; and a way to monitor the "hot spots."

The following uses of reports and data generated by NOHIMS were mentioned by industrial hygienists in San Diego: workload scheduling of industrial hygiene tasks, preparation of workplace monitoring plans and sampling schedules, an inventory of shops in their jurisdiction, printout of data for a survey as an actual report, reporting everyone exposed to hazardous agent X, and retrieval of data for managing medical emergencies such as a spill. The industrial hygienists in Bremerton also use the data generated by NOHIMS to prepare workplace monitoring plans for survey updates.

All of the care providers with NOHIMS experience agreed that the medical data collection instruments developed for NOHIMS exist in addition to the previously used forms or records. The traditional paper chart is still the basic medical record used by care providers in San Diego. Two care providers viewed the computer-generated report as existing in addition to the paper medical record (hopefully temporarily as noted by one physician) while the occupational health technician who uses NOHIMS the most felt that the computer-generated report supports the paper medical record.

Since the data collection forms were designed around OHU procedures, only minor changes in operational procedures were required by NOHIMS. NOHIMS has

necessitated policy changes, however. Examples included different criteria for determining who receives an examination and different criteria for determining what kinds of examinations and/or tests will be done.

All of the industrial hygienists in both San Diego and Bremerton agreed that the standardized industrial hygiene survey forms have replaced previously used forms or records. One industrial hygeinist noted that the standard forms made data collection more concise and that not much change in previous standard operating procedures was required to utilize reports and data generated by NOHIMS. This same interviewee also observed that NEHC views the survey data collected with this form as replacing OPNAVINST 5100.23B. One of the industrial hygienists in Bremerton reported that a variance had been obtained to substitute NOHIMS computer output for the required OPNAV 5100/14 form--the Workplace Monitoring Plan.

All of the NOHIMS users in San Diego who responded to our questioning agreed that NOHIMS reports are being used to identify workers requiring physical examinations. In Bremerton, NOHIMS is lacking the personnel files needed to track workers as well as the medical module. However, we were told at the time of our interviews that within the previous four months it had become possible to make recommendations concerning appropriate physical examinations via the environment-exam requirement display.

When we asked the medical care providers in San Diego if NOHIMS reports were being used to monitor compliance with Navy standards, two interviewees responded "yes" and two other individuals responded "no" to this question. One physician who responded "no" commented that they were not yet using the system as it was designed. The industrial hygienists in San Diego who responded to this question replied in the affirmative. The industrial hygienist at the North Island NARF cited the generation of a "noise roster" as an example of compliance with Navy standards. One industrial hygienist and the system manager in Bremerton unequivocally agreed that NOHIMS reports are being used to monitor compliance with Navy standards. Another Bremerton industrial hygienist felt that in a sense NOHIMS reports were being used to monitor compliance with Navy standards in that deficiencies are now being identified.

When we asked interviewees if NOHIMS is being used to produce and/or collect data for management reports, almost everyone responding to this question replied "yes." One care provider thought that the current use was very primitive yet. One medical ancillary responded "no" to this question because she was unaware that NOHIMS produces report generator runs that tally frequency counts of data items in the medical component's database for inclusion in the semi-annual Report of Occupational Health Services (NAVMED 6260/1) prepared for each Navy branch clinic, with copies forwarded to BUMED. One industrial hygienist in Bremerton responded that he did not know if NOHIMS is used to produce/collect data for management reports.

Problems Encountered in the Day-to-Day Operation of NOHIMS

NOHIMS users were asked what problems they had encountered in the day-to-day operations of the system and how these problems were or are being handled or resolved. Of the medical care providers in San Diego, two physicians mentioned the duplication of paperwork because of the dual manual and automated system.

One of these physicians commented that as a result, the occupational health technicians are really overworked. He noted that it also takes the physician a little extra time to fill out the NOHIMS forms, but that was considered to be a minor problem. His main concern was that the OHU was not getting much back yet from NOHIMS for all the effort to collect the data. The other physician agreed that the input effort so far has exceeded the output from the system. He felt that NOHIMS could be more trouble than it is worth. He also expressed concern that they cannot rely exclusively on NOHIMS because of hardware downtime. A third physician also mentioned computer downtime as an operational problem along with slowness in being able to get on-line and a data entry backlog. (This data entry backlog had improved at the time of our interviews.) Two medical ancillaries mentioned patient resistance to filling out the NOHIMS forms or confusion over items on the forms that had to be clarified for them. One physician's assistant commented that if patients can see benefit from filling out the forms, then they do not complain. She again mentioned the problem of tests being scheduled when the worker's measured exposure did not exceed the Threshold Limit Value (TLV). This apparent discrepancy occurs when Navy policy dictates that all workers exposed to certain hazardous agents are to be monitored medically regardless of the level of their exposure.

Two industrial hygienists in San Diego mentioned problems with the telephone line and slow system response at times. One of these individuals complained about the long time lag at North Island to install a dedicated telephone line and the need for more dial-up ports than the single port currently available for getting on the system. Two industrial hygienists in San Diego noted that there were some program bugs or errors that now seem to be mostly resolved. One of these individuals reported that she could not find a certain chemical name in NOHIMS. She was advised to report this problem to the NOHIMS system manager for investigation and resolution.

The NOHIMS system manager in San Diego mentioned a number of operational problems that remain unresolved because NOHIMS is running in an R&D environment rather than on production hardware. The primary problem is that the DEC PDP 11/24 at NHRC is being used for other R&D projects in addition to NOHIMS development/production which slows down the operational performance of NOHIMS. There is a lack of user accessibility to the CPU because of a single dial-up port and the CPU is limited in capacity. There are still problems with communication lines and hardware downtime. These problems are handled as they arise.

The industrial hygienists in Bremerton mentioned two problems encountered in the day-to-day operations of NOHIMS. One individual commented that there used to be one problem a day with the system but that most bugs are worked out now. The other industrial hygienist emphasized that he does not know the full capabilities of NOHIMS because of a lack of training.

The NOHIMS system manager in Bremerton mentioned the following operational problems: lack of user documentation, the need for the Material Inventory function, and that the database was not large enough yet. The User's Guide for the industrial component of NOHIMS had just been received in the mail at the time of our interviews, and Donald Beck installed the Material Inventory function right after our interviews. A higher level Navy manager at Bremerton told us that the time to do a system back-up (which is done every other Friday afternoon) is increasing and no one can use NOHIMS during this time.

Summary

The implementation process at the test sites required the effort of a significant number of people and other resources. The installation process at the San Diego test site was more involved because San Diego was the pilot test site where both the industrial and medical components of NOHIMS were developed. Only the industrial component of NOHIMS was implemented in Bremerton. Each module had been fully tested at San Diego prior to implementation at Bremerton.

The implementation process involved eight steps. The first step in the development was a comprehensive systems analysis of the record keeping and reporting requirements of the NARF. As a result of the systems analysis, a semi-automated interim system was implemented to test NOHIMS design concepts. Functional specifications for a fully automated NOHIMS were then fully developed. Numerous people from the Naval Health Research Center, San Diego, California; the Occupational Health and Preventive Medicine Department, San Diego, California; the Occupational Health and Preventive Medicine Department, Bremerton, Washington; the Environmental Health Service, Navy Regional Medical Clinic, Hawaii; the Navy Environmental Health Center, Norfolk, Virginia; the NRMC Branch Clinic, NAS, North Island, San Diego, California; and the Naval Air Rework Facility, North Island, San Diego, California were involved in this development process.

Once specifications for the system had been determined, public domain COSTAR (Computer STored Ambulatory Record) was adapted for the medical component of NOHIMS and new MUMPS software was written to implement the industrial component. Data collection forms were designed, hardware and software were installed, and documentation was written. (Only minimal training was provided because training was not included in contract work statements.) These tasks were accomplished through the team efforts of R-K Research and System Design, Malibu, California; The MITRE Corporation, McLean, Virginia; the Department of Occupational and Preventive Medicine, San Diego, California; the Department of Occupational and Preventive Medicine, Bremerton, Washington; and the Naval Health Research Center, San Diego, California. The development process was overseen by the Naval Medical Research and Development Command, Bethesda, Maryland and the Naval Environmental Health Center, Norfolk, Virginia.

The most common problems encountered during the implementation of NOHIMS were lack of user training, time delays in installing hardware and telephone lines, initial software bugs, and initial shortage of data entry personnel. There was also some initial resistance to increased paperwork on the part of staff and workers. The majority of the problems encountered during implementation worked themselves out naturally as time evolved.

Seventy-eight percent of 13 system users felt that the implementation of NOHIMS had a negative effect on staff morale initially. The negative response to NOHIMS was generally a result of problems encountered during implementation and because of the increased workload generated by the advent of NOHIMS. All of the users thought that the final effect of NOHIMS on staff morale was positive or very positive.

NOHIMS was a completely new data collection and processing system that replaced an essentially manual system at both test sites. Very little changes in operational procedures were required by NOHIMS at the industrial test sites. While NOHIMS did not require drastic changes in operational procedures at the medical test sites, clinic personnel did have to accustom themselves to new policies such as new criteria for determining when and what kind of physical examinations and/or tests were required.

The medical component of NOHIMS introduced a variety of new data collection forms. These were the Patient Registration form, the Physical Exam Data Sheet, the Physical Examination Findings form, and an Electrocardiogram Results form. The system also utilizes data from existing laboratory chits, the Asbestos Medical Surveillance Program form (6260/5), and the Hearing Conservation Program forms (DD 2215 and DD 2216). Experimental occupational history and medical history forms were also developed but are not in current use. The industrial component requires the use of three new data collection forms, namely, the Industrial Hygiene Survey form, the Occupational Hazard Data Sheet, and the Materials Inventory form.

Currently, the San Diego test site has a full-time data entry clerk who enters data into the medical component of NOHIMS and occasionally retrieves data from the system. The industrial hygienists at the OHU and NARF Safety Office, with support from the Naval Health Research Center, enter the industrial hygiene data. Bremerton has a data entry clerk who devotes half of her time to entering industrial survey data.

Retrieval of medical data from NOHIMS is sporadic and varied in nature. Standard medical reports are not routinely produced for inclusion in the medical record or for use by physicians during examinations. The traditional paper chart is still the basic medical record used by care providers. The industrial hygienists retrieve data from NOHIMS frequently. These data are used to respond to requests, plan workloads and surveys, and provide data for reports.

NOHIMS is gradually being integrated into day-to-day procedures. NOHIMS is being used to identify workers requiring physical examinations. Since in Bremerton NOHIMS is lacking the personel file needed to track workers, this is accomplished by making recommendations concerning appropriate physical examinations via the environment-exam requirement display.

The medical care providers had varying opinions on whether NOHIMS was being used to monitor compliance with Navy standards. The industrial hygienists generally agreed that NOHIMS was now being used to monitor compliance with Navy standards. Almost everyone felt that NOHIMS was being utilized to produce and/or collect data for management reports although a few people were unaware that NOHIMS could do this or was doing it.

The medical care providers mentioned three problems encountered in day-to-day operation of NOHIMS. One problem was that NOHIMS necessitates much duplication in efforts because OHU staff are maintaining both NOHIMS and the previous manual system. Some interviewees expressed frustration that they were not getting enough out of the system for what was being put into it. Medical care providers also complained of system downtime, although this situation was improving. The medical ancillaries mentioned patient resistance to or confusion

over the data collection forms. Careful explanation of the purpose of NOHIMS usually overcame these problems.

The industrial hygienists in San Diego mentioned problems with telephone lines and slow response time. Some program bugs or errors experienced by industrial hygienists at both sites have been resolved. One industrial hygienist at Bremerton mentioned lack of NOHIMS training as a day-to-day problem of NOHIMS operation.

The San Diego NOHIMS system manager mentioned several operational problems that remain unresolved because NOHIMS is running in an R&D environment rather than on production hardware. This situation contributes to slow response time and lack of system accessibility, and is compounded by problems with communication lines and hardware downtime. The system manager at Bremerton mentioned problems with lack of user documentation, the need for the Materials Inventory function, and that the database is not large enough yet. The first two problems were resolved last November when Bremerton received system documentation and the Materials Inventory function. As the NOHIMS database becomes larger, another day-to-day problem at Bremerton is that users do not have access to the system a significant amount of time every other Friday when a system back-up is performed.

ASSESSMENT OF HOW WELL NOHIMS ADAPTED TO INFORMATION PROCESSING NEEDS AT TEST SITES

The last three questions in Component 31 of Appendix A were included to assess the adaptability of NOHIMS to the information processing needs at the test sites. Thirteen NOHIMS users consisting of six medical care providers, five industrial hygienists, and the two system managers were asked these three questions.

In the first question, the interviewees were asked how well they feel NOHIMS has been integrated into the day-to-day procedures of their test site. Table 76 summarizes their responses to this question. All 13 NOHIMS users agreed that the system has been integrated into the day-to-day procedures of their test site very well or somewhat well, with 77 percent choosing the rating of very well. There were some qualifications, however. One industrial hygienist in San Diego felt that as far as NOHIMS is being used it has been integrated very well, but also it has great potential for further utilization. Another San Diego industrial hygienist chose the very well rating, but added "although it needs polish." Medical care providers and industrial hygienists chose the very well rating about equally often. Both system managers thought that NOHIMS has been very well integrated into the day-to-day procedures of their test site.

The second question asked the 13 interviewees how well they feel that NOHIMS has responded to the particular needs of their test site. Their responses to this question are shown in Table 77. All 12 of those who answered this question agreed that NOHIMS has responded very well to somewhat well to the particular needs of their test site, with 50 percent choosing the rating of very well. A number of reasons were given why the respondents chose a rating of less than very well. One medical care provider felt that the NOHIMS design was "all

TABLE 76
How Well NOHIMS Has Been Integrated into the
Day-to-Day Procedures of the Test Sites
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Interviewed
Very well	4	4	2	10	77
Somewhat well	2	1	0	3	23
Somewhat poorly	0	0	0	0	0
Poorly	0	0	0	0	0
TOTAL INTERVIEWED	6	5	2	13	100

TABLE 77
How Well NOHIMS Has Responded to the
Particular Needs of the Test Sites
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
Very well	2	3	1	6	50
Pretty well/Well*	1	1	0	2	17
Somewhat well	2	1	1	4	33
Somewhat poorly	0	0	0	0	0
Poorly	0	0	0	0	0
TOTAL WHO ANSWERED	5	5	2	12	100
No Comment	1	0	0	1	
TOTAL INTERVIEWED	6	5	2	13	

* Category added by respondents

right," but that the data in the system were not being employed. An industrial hygienist in San Diego stated a reservation concerning if he would be able to extract information from NOHIMS in desired formats. The San Diego system manager remarked that NOHIMS' response to the particular needs of his test site could be upgraded to very well by implementing system improvements and enhancements such as improving system access and response time. Other comments of interest included one medical care provider's observation that procedures are more standardized which minimizes the judgment calls and legally this should be helpful. An industrial hygienist in Bremerton noted that NOHIMS has "gotten them out in the field to collect data and then to load it into the system." The Bremerton system manager felt that NOHIMS has responded very well to the particular needs of his test site and is continually improving. There was very little difference between medical care providers and industrial hygienists in how these two classes of NOHIMS users responded to this question.

In the third question, the interviewees were asked if there were needs specific to their test site that NOHIMS could not meet, and if so, what those needs were. Two medical care providers did not respond to this question and another medical care provider could not think of any needs that were not being met. The other three medical care providers identified some unmet needs. One physician noted that NOHIMS has not yet been implemented for clinical case management of injury and illness care. This enhancement of NOHIMS for the OHU in San Diego is under development by NHRC. This same physician plans to design and implement a clinical effects table with some method for indicating a high, moderate, minimal, or no effect. Another physician commented that he puts risk factors on a patient's problem list and suggested that common risks be added to the Physical Examination Findings (PEX) encounter form in a "risk factor section" that could be checked off. He emphasized the need for accurate information and noted that outcome analysis is not being done yet. He also mentioned that there is no statistical capability in NOHIMS for doing research. One medical ancillary called attention to the problem of tracking no shows for scheduled exams. Workers who do not show for a scheduled exam during their birth month need to be flagged and rescheduled. At present, no shows are "falling through the cracks."

Four industrial hygienists out of five did not identify any needs specific to their test site that NOHIMS could not meet. One of these individuals observed, however, that NOHIMS has made it possible to document that he was able to meet his work zone criterion, a beneficial effect in his view. A fifth industrial hygienist noted a desire for more query capability so that she could produce lists and create different combinations of lists.

The NOHIMS system manager in San Diego saw a need for more ports on the hardware to provide greater accessibility to the system for NOHIMS users and a need for faster response time. The Bremerton system manager noted a need to test the multi-agency definitions in NOHIMS so that other industrial activities could be added to the system other than just the shipyard.

Summary

All 13 NOHIMS users agreed that the system has been integrated into the day-to-day procedures of their test site very well (77%) or somewhat well (23%). Fifty percent of the respondents felt that NOHIMS has responded very well to the

particular needs of their test site, 17 percent thought pretty well or well, and 33 percent judged NOHIMS' response as somewhat well. The San Diego system manager felt that NOHIMS' response to the particular needs of his test site could be upgraded to very well by implementing system improvements and enhancements while the Bremerton system manager thought NOHIMS' response to the needs of his test site is continually improving. Needs that NOHIMS could not meet that were each mentioned by one of the interviewees included the collection of data for injury and illness care (currently under development by NHRC), a check list for risk factors on the PEX form, a statistical capability for doing research, flagging and rescheduling of no shows for scheduled exams, more query capability in the industrial component, more ports to provide San Diego users greater access to NOHIMS, a need for faster response time, and a need in Bremerton to test multi-agency definitions to permit other industrial activities to be added to NOHIMS besides the shipyard.

ASSESSMENT OF ACCEPTABILITY OF NOHIMS

The interview guide for assessing the acceptability of NOHIMS to system users contained 16 questions. The exact wording of these questions may be found in Component 32 of Appendix A. Twelve NOHIMS users consisting of six medical care providers and six industrial hygienists were asked these 16 questions. The NOHIMS system manager in Bremerton inadvertently also was asked these questions. Since his comments were relevant and he is also an industrial hygienist, he was included with the five other industrial hygienists in this analysis.

In the first question, the interviewees were asked in general how adequately they feel that NOHIMS performs the functions that are required in their work. Table 78 summarizes their responses to this question. All respondents agreed that NOHIMS adequately or somewhat adequately performs the functions required in their work, with 73 percent choosing the rating of adequately. Industrial hygienists rated NOHIMS higher on this question than the medical care providers, which may be a reflection of the fact that the industrial component has been in routine use in San Diego approximately a year longer than the medical component and possibly has been better integrated into daily work routines.

In the next question, interviewees were asked to rate how reliable they feel that NOHIMS is. All respondents felt that NOHIMS is reliable or somewhat reliable, with 70 percent choosing the rating of reliable (see Table 79). The industrial hygienists as a group felt that NOHIMS was more reliable than the medical care providers did. One medical care provider who rated NOHIMS as somewhat reliable again mentioned the need to double-check Threshold Limit Values (TLVs) for the appropriateness of tests that were recommended. This individual was unaware that Navy policy dictates that all workers exposed to certain hazardous agents are to be monitored medically regardless of their exposure level. One industrial hygienist commented that NOHIMS was reliable because they have back-ups of their database.

All respondents to question 3 felt that NOHIMS is both user friendly and easy to operate (see Table 80). Two medical care providers did not answer this question but all industrial hygienists did.

TABLE 78
Rating of How Adequately NOHIMS Performs the Functions Required in the User's Work
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Who Answered
Adequately	3	5	8	73
Somewhat adequately	2	1	3	27
Somewhat inadequately	0	0	0	0
Inadequately	0	0	0	0
TOTAL WHO ANSWERED	5	6	11	100
No Comment	1	0	1	
TOTAL INTERVIEWED	6	6	12	

TABLE 79
Rating of How Reliable NOHIMS Is
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Who Answered
Reliable	2	5	7	70
Somewhat reliable	2	1	3	30
Somewhat unreliable	0	0	0	0
Unreliable	0	0	0	0
TOTAL WHO ANSWERED	4	6	10	100
No Comment	2	0	2	
TOTAL INTERVIEWED	6	6	12	

TABLE 80
Rating of How User Friendly and Easy to Operate NOHIMS Is
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Who Answered
NOHIMS is	4	6	10	100
NOHIMS is somewhat	0	0	0	0
NOHIMS is somewhat not	0	0	0	0
NOHIMS is not	0	0	0	0
TOTAL WHO ANSWERED	4	6	10	100
No Comment	2	0	2	
TOTAL INTERVIEWED	6	6	12	

The NOHIMS data collection forms were rated equally acceptable by medical care providers and industrial hygienists, with 83 percent of both groups rating the forms as acceptable and 17 percent rating the forms as somewhat acceptable (see Table 81). One medical care provider thought that the Physical Examination Findings (PEX) form was the easiest to use although filling out the data collection forms for NOHIMS requires a duplication of effort. Another medical care provider was not certain of the length limits for textual comments in the patient's NOHIMS medical record. One industrial hygienist who thought the data collection forms were acceptable observed that the forms had the limitation of an 8-1/2 by 11 inch sheet of paper.

Only the six medical care providers were asked to rate the acceptability of NOHIMS data collection forms to the patient/worker. Two-thirds of the care providers felt that they were acceptable and one-third felt that they were somewhat acceptable (see Table 82). One of the medical care providers who chose the rating of somewhat acceptable commented that patients/workers are overwhelmed, confused, and intimidated by the NOHIMS forms and that some time is required to allay their fears.

In Table 83, the changes in procedures required by NOHIMS were rated as to their acceptability. All of the industrial hygienists and two-thirds of the medical care providers felt that the procedural changes were acceptable. One industrial hygienist commented that the procedural changes have moved in the direction of increased standardization and that the changes required have been beneficial. Another industrial hygienist felt that the procedural changes were both acceptable and desirable. The two medical care providers who rated the required procedural changes as less than acceptable provided the following reasons for their rating. The need to cut down on the duplication of effort prompted one medical care provider's rating of somewhat acceptable. The other medical care provider who chose the rating of somewhat acceptable commented that unfortunately the changes are really additions to the procedures.

All of the respondents felt that NOHIMS is an aid in the provision of care to the patient/worker (see Table 84). There was no difference between the medical care providers and industrial hygienists in their ratings. One industrial hygienist in San Diego expressed a desire to use NOHIMS more than she has been doing. A Bremerton industrial hygienist noted that NOHIMS allows much better worker monitoring.

Only the six medical care providers were asked to rate whether NOHIMS has disrupted traditional patterns of clinical thinking and/or patient management. One-third of the medical care providers felt that NOHIMS had not been disruptive and two-thirds felt that NOHIMS had been somewhat disruptive (see Table 85). The two medical care providers who felt that NOHIMS had not been disruptive added further comments. One physician thought NOHIMS had enhanced traditional patterns of clinical thinking and/or patient management. Another physician cautioned against relying on NOHIMS without knowing the system's limitations. Three of the four medical care providers who chose the somewhat disrupted rating qualified their choice as follows: (1) not in a bad way, (2) only in a positive sense, and (3) has changed for the good.

The medical care providers and industrial hygienists were also asked how NOHIMS has affected their workload. The ratings varied greatly. Forty-two percent of the respondents felt that NOHIMS has significantly increased their

TABLE 81
Rating of Acceptability of Data Collection Forms to NOHIMS Users
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Interviewed
Acceptable	5	5	10	83
Somewhat acceptable	1	1	2	17
Somewhat unacceptable	0	0	0	0
Unacceptable	0	0	0	0
TOTAL INTERVIEWED	6	6	12	100

TABLE 82
Acceptability of NOHIMS Data Collection Forms to the Patient/Worker
According to the Medical Care Providers
(Number who mentioned rating)

	TOTAL	% of Total Interviewed
Acceptable	4	67
Somewhat acceptable	2	33
Somewhat unacceptable	0	0
Unacceptable	0	0
TOTAL INTERVIEWED	6	100

TABLE 83
Rating of Acceptability of Changes in Procedures
Required by NOHIMS
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Interviewed
Acceptable	4	6	10	84
Somewhat acceptable	1	0	1	8
Somewhat unacceptable	1	0	1	8
Unacceptable	0	0	0	0
TOTAL INTERVIEWED	6	6	12	100

TABLE 84
Rating of How Well NOHIMS Facilitates the
Provision of Care to the Patient/Worker
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Who Answered
NOHIMS is an aid	5	5	10	100
NOHIMS is somewhat of an aid	0	0	0	0
NOHIMS has no effect	0	0	0	0
NOHIMS is somewhat of a hindrance	0	0	0	0
NOHIMS is a hindrance	0	0	0	0
TOTAL WHO ANSWERED	5	5	10	100
No Comment	1	1	2	
TOTAL INTERVIEWED	6	6	12	

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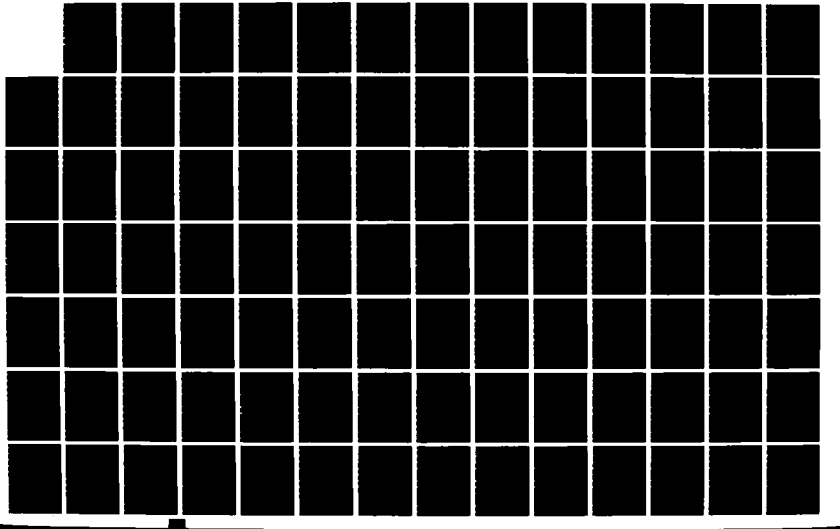

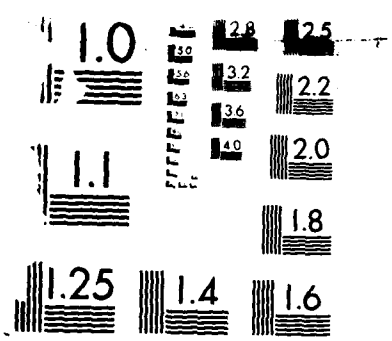

RESOLUTION TEST CHART

TABLE 85
Rating by Medical Care Providers Whether NOHIMS Has Disrupted Traditional Patterns of Clinical Thinking and/or Patient Management
(Number who mentioned rating)

	TOTAL	% of Total Interviewed
Not disrupted	2	33
Somewhat disrupted	4	67
Significantly disrupted	0	0
TOTAL INTERVIEWED	6	100

workload, 17 percent felt that their workload has been somewhat increased by NOHIMS, and 25 percent of the respondents judged that while NOHIMS has not significantly increased or decreased their workload, it has changed the nature of their workload (see Table 86). Of those respondents choosing the significantly increased rating, one physician commented that it is much harder to do a haphazard or less than complete job now. An industrial hygienist noted that his workload has been significantly increased because much more detailed data are being collected now. One industrial hygienist who stated that the nature of her workload had changed attributed this change to the fact that she was doing survey data entry that she did not think was part of her job. Table 86 also shows that one industrial hygienist thought her workload had been somewhat decreased, and one physician felt that there had been no net effect on his workload, that is, he felt that it took more time to collect the data but the quality of available data had improved.

Table 87 presents the features selected by the 12 NOHIMS users that have been incorporated into their everyday work procedures. Every one of the interviewees reported that the NOHIMS data collection forms are now a standard procedure. Two-thirds of both medical care providers and industrial hygienists use the on-line look-up, Query/Report module, and/or Interactive Flowcharts. One-third of NOHIMS users generate reports, primarily the industrial hygienists. Twenty-five percent of the interviewees use displays or printouts of standard reports, primarly the medical care providers. Three industrial hygienists (25% of the total interviewed) indicated that they were doing data entry. Of these three individuals, one was in San Diego and two were in Bremerton.

The interviewees were next asked whether they felt that NOHIMS' features have made their jobs easier or harder. Table 88 shows that 66 percent of those interviewed felt that these features have made their job much easier (41% of the total interviewed) or somewhat easier (25%). Four out of six industrial hygienists compared to one out of six medical care providers chose the rating of much easier. Two medical care providers (17%) felt that NOHIMS' features had had no effect on the difficulty of their job. Another 17 percent (one medical care provider and one industrial hygienist) thought that their job was somewhat harder as a result of NOHIMS' features. The industrial hygienist thought his job was somewhat harder because it is more time-consuming to gather comprehensive data.

With regard to productivity, 82 percent of the respondents felt that NOHIMS' features have made them more productive (see Table 89). All of the industrial hygienists chose this rating while only 60 percent of the medical care providers who responded chose this rating. Two of the three medical care providers (medical ancillaries) who chose the rating of more productive gave these reasons for their choice. One thought she was more productive in the sense that she has more to work with (e.g., recent reports) and knows exposure levels. The other thought she was more productive because she can see more patients in a day. Two other medical care providers felt that they were either about as productive or less productive.

Sixty-seven percent of the interviewees felt that they can perform their jobs more efficiently and effectively because of NOHIMS, with 50 percent of the medical care providers versus 83 percent of the industrial hygienists choosing this rating (see Table 90). Twenty-five percent of the interviewees felt that they were performing their jobs somewhat more efficiently and effectively (two

TABLE 86
Rating of How NOHIMS Has Affected Workload of Users
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Interviewed
Significantly increased workload	2	3	5	42
Somewhat increased workload	2	0	2	17
Somewhat decreased workload	0	1	1	8
Significantly decreased workload	0	0	0	0
Changed nature of workload	1	2	3	25
No effect on workload	1	0	1	8
TOTAL INTERVIEWED	6	6	12	100

TABLE 87
NOHIMS Features That Have Been Incorporated
into Everyday Work Procedures
(Number who mentioned feature; multiple answers allowed)

	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Interviewed
Data collection forms	6	6	12	100
On-line look-up, Query/Report module, Interactive Flowcharts	4	4	8	67
Report generation	1	3	4	33
Display of standard reports	2	1	3	25
Printed standard reports	2	1	3	25
Data entry	0	3	3	25
TOTAL INTERVIEWED	6	6	12	

TABLE 88
Rating of Whether NOHIMS' Features Have Made
a User's Job Easier or Harder
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Interviewed
Much easier	1	4	5	41
Somewhat easier	2	1	3	25
No effect	2	0	2	17
Somewhat harder	1	1	2	17
Much harder	0	0	0	0
TOTAL INTERVIEWED	6	6	12	100

TABLE 89
Rating of Whether NOHIMS' Features Have Made Users Less or More Productive
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Who Answered
More productive	3	6	9	82
About as productive	1	0	1	9
Less productive	1	0	1	9
TOTAL WHO ANSWERED	5	6	11	100
No Comment	1	0	1	
TOTAL INTERVIEWED	6	6	12	

TABLE 90
Rating of How Efficiently and Effectively System Users Can Perform Their Jobs Because of NOHIMS
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Interviewed
More efficiently and effectively	3	5	8	67
Somewhat more efficiently and effectively	2	1	3	25
To the same level of efficiency and effectiveness	0	0	0	0
Somewhat less efficiently and effectively	0	0	0	0
Less efficiently and effectively	1	0	1	8
TOTAL INTERVIEWED	6	6	12	100

medical care providers and one industrial hygienist) while one medical care provider thought he was performing his job less efficiently and effectively right now. He expressed concern that the staff was oriented toward getting caught up on NOHIMS data collection at the expense of other surveillance functions. This physician was newly arrived at the Occupational Health Unit (OHU) and perhaps did not have a full grasp of the system's potential for aiding in surveillance functions.

All of the respondents felt that in general people have adapted well (55% of the respondents) or somewhat well (45%) to NOHIMS (see Table 91). There was very little difference in the way that the medical care providers and industrial hygienists made this rating. Two of the three medical care providers who chose the rating of somewhat well offered some comments. One physician thought that the OHU needs someone to organize the NOHIMS application. Another medical care provider observed that both providers and workers seem somewhat befuddled by NOHIMS.

As a final question, the interviewees were asked to make an overall rating of NOHIMS' acceptability. Table 92 shows that all of the interviewees felt that NOHIMS overall is acceptable (83%) or somewhat acceptable (17%). There was no difference between the medical care providers' and industrial hygienists' ratings in response to this question. The physician who chose the rating of somewhat acceptable thought NOHIMS has a ways to go yet to be acceptable. A physician who chose the rating of acceptable also commented that NOHIMS must have further development, and if this were done, then the system would be very valuable to take care of large groups of workers systematically.

Summary

Twelve NOHIMS users (six medical care providers and six industrial hygienists) assessed the acceptability of NOHIMS along a number of different dimensions. All respondents agreed that NOHIMS adequately (73% of total respondents) or somewhat adequately (27%) performs the functions required in their work. Likewise, all respondents felt that NOHIMS is reliable (70%) or somewhat reliable (30%). The industrial hygienists felt that NOHIMS was more reliable than the medical care providers did. All respondents (100%) felt that NOHIMS is both user friendly and easy to operate.

NOHIMS data collection forms were rated as acceptable to NOHIMS users by 83 percent of the interviewees and as somewhat acceptable by 17 percent of the interviewees. There was no difference between the response of the medical care providers and the industrial hygienists for this rating. Only the medical care providers were asked to rate the acceptability of NOHIMS data collection forms to the patient/worker. Two-thirds of the medical care providers felt they were acceptable and one-third felt they were somewhat acceptable.

All of the industrial hygienists and two-thirds of the medical care providers felt that the changes in procedures required by NOHIMS were acceptable. All of the respondents (100%) thought that NOHIMS is an aid in the provision of care to the patient/worker. Only the medical care providers were asked to rate whether NOHIMS has disrupted traditional patterns of clinical thinking and/or patient management. One-third felt that NOHIMS had not been disruptive and two-thirds felt that NOHIMS had been somewhat disruptive.

TABLE 91
Assessment of How Well People Have
Adapted to NOHIMS
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Who Answered
Well	3	3	6	55
Somewhat well	3	2	5	45
Somewhat poorly	0	0	0	0
Poorly	0	0	0	0
TOTAL WHO ANSWERED	6	5	11	100
No Comment	0	1	1	
TOTAL INTERVIEWED	6	6	12	

TABLE 92
Overall Rating of NOHIMS' Acceptability
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	TOTAL	% of Total Interviewed
Acceptable	5	5	10	83
Somewhat acceptable	1	1	2	17
Somewhat unacceptable	0	0	0	0
Unacceptable	0	0	0	0
TOTAL INTERVIEWED	6	6	12	100

However, most of the medical care providers felt that the disruption in patterns of clinical thinking and/or patient management, if any, had been beneficial. Of the 12 interviewees, 42 percent felt that NOHIMS has significantly increased their workload, 17 percent felt their workload was somewhat increased, and 25 percent thought that NOHIMS had changed the nature of their workload. In addition, one respondent thought her workload had been somewhat decreased and another respondent felt that there had been no net effect on his workload.

With regard to NOHIMS features that have been incorporated into everyday work procedures, every one of the interviewees reported that NOHIMS data collection forms are now a standard procedure. Two-thirds of both medical care providers and industrial hygienists use the on-line look-up, Query/Report module, and/or Interactive Flowcharts. One-third of NOHIMS users generate reports, primarily industrial hygienists. One-fourth of the interviewees use displays or printouts of standard reports, primarily medical care providers, and one-fourth of the interviewees, all industrial hygienists, were doing data entry. Sixty-six percent of those interviewed felt that these features have made their job much easier (41%) or somewhat easier (25%). A much higher percentage of the industrial hygienists than the medical care providers chose the rating of much easier. Eighty-two percent of the respondents felt that NOHIMS' features have made them more productive. All of the industrial hygienists chose this rating while only half of the medical care providers did.

Ninety-two percent of the interviewees felt that they can perform their jobs more efficiently and effectively because of NOHIMS (67%) or somewhat more efficiently and effectively (25%). The industrial hygienists gave NOHIMS a higher rating than the medical care providers on how efficiently and effectively they can perform their jobs. All of the respondents felt that in general people have adapted well (55%) or somewhat well (45%) to NOHIMS. All of the interviewees felt that NOHIMS overall is acceptable (83%) or somewhat acceptable (17%).

ASSESSMENT OF TRANSFERABILITY OF NOHIMS TO OTHER NAVY INDUSTRIAL SITES

The interview guide for assessing the transferability of NOHIMS to other Navy industrial sites contained six questions. The exact wording of these questions may be found in Component 33 of Appendix A. The questions covered the suitability of NOHIMS to the information processing needs of other industrial sites, an assessment of the adequacy of the flexibility and adaptability of NOHIMS, areas in which NOHIMS needs to be more flexible, an assessment of the ease of transfer of NOHIMS to other Navy industrial sites, specific problems the interviewees foresee in transferring NOHIMS to other industrial sites, and an assessment of what the acceptability of NOHIMS among users at other Navy industrial sites will be.

Twenty-three individuals were asked these questions--three NHRC NOHIMS developers, seven higher level managers, six medical care providers, five industrial hygienists, and the two NOHIMS system managers. Although the NOHIMS system manager in San Diego was also one of the NHRC NOHIMS developers, he is included in this analysis as a NOHIMS system manager because that has been his more important role. In the succeeding discussion, the responses of the NHRC

NOHIMS developers and higher level managers are presented first followed by those of the medical care providers, industrial hygienists, and NOHIMS system managers.

NHRC NOHIMS Developers and Higher Level Managers

In the first question, the NHRC NOHIMS developers and higher level managers were asked to assess the suitability of NOHIMS to the information processing needs of other Navy industrial sites. All ten interviewees thought that NOHIMS was suitable to some degree, with 60 percent choosing the rating of very suitable, 20 percent choosing suitable, and 20 percent choosing somewhat suitable (see Table 93). Six of the seven higher level managers thought NOHIMS was very suitable to the information processing needs of other Navy industrial sites whereas none of the NHRC NOHIMS developers chose the very suitable rating, perhaps because the developers had a better appreciation of the work required to customize NOHIMS for other sites.

All of the NHRC NOHIMS developers and higher level managers agreed that NOHIMS is adequately or somewhat adequately flexible and adaptable, with 80 percent choosing the adequately flexible and adaptable rating (see Table 94). All of the developers and five of the seven higher level managers thought that NOHIMS was adequately flexible and adaptable.

The NHRC NOHIMS developers and higher level managers next were asked to report any areas in which NOHIMS needs to be more flexible and adaptable. Table 95 contains a summary of the areas mentioned. Only one area was mentioned by more than one respondent, namely, addition of Material Safety Data Sheet information, considered desirable by two higher level managers. Other areas mentioned by one of the higher level managers were inclusion of illness/injury data in NOHIMS (being implemented by NHRC), addition of a word processing capability, addition of a statistical package, and training in system usage. One higher level manager thought that there were no areas in which NOHIMS needs to be more flexible and adaptable. Two of the NHRC NOHIMS developers had no comments on this question. The third developer mentioned a need for an ability to re-assign groups of workers to new workplaces rather than just by individuals.

On the question of the ease of transfer of NOHIMS to other Navy industrial sites, the interviewees were divided in their ratings. Ten percent felt that the transfer process would be difficult, 40 percent felt it would be somewhat difficult, 30 percent felt it would be somewhat easy, and 20 percent felt the transfer process would be easy (see Table 96). The managers tended to feel that the transfer process will be more difficult than the developers did.

The NHRC NOHIMS developers and higher level managers next were asked what specific problems they foresaw in transferring NOHIMS to other Navy industrial sites. Table 97 enumerates the problems that were mentioned. The most frequently mentioned problem was committing billets to operate and manage NOHIMS, cited by 40 percent of the interviewees, all four of whom were higher level managers. The problem mentioned next most frequently by three interviewees (30%) was tracking worker personnel. Three problems were each mentioned by two of the interviewees (20%)--coordinating fiscal and personnel resources with the arrival of NOHIMS, dedication/cooperation of NOHIMS

TABLE 93
Rating of the Suitability of NOHIMS to the Information Processing Needs of Other Navy Industrial Sites by NHRC NOHIMS Developers and Higher Level Managers (Number who mentioned rating)

	NHRC NOHIMS Developers	Higher Level Managers	TOTAL	% of Total Interviewed
Very suitable	0	6	6	60
Suitable*	1	1	2	20
Somewhat suitable	2	0	2	20
Somewhat unsuitable	0	0	0	0
Very unsuitable	0	0	0	0
TOTAL INTERVIEWED	3	7	10	100

* Category added by respondent

TABLE 94
Rating of NOHIMS' Flexibility and Adaptability
by NHRC NOHIMS Developers and Higher Level Managers
(Number who mentioned rating)

	NHRC NOHIMS Developers	Higher Level Managers	TOTAL	% of Total Interviewed
Adequately flexible and adaptable	3	5	8	80
Somewhat adequately flexible and adaptable	0	2	2	20
Somewhat inadequately flexible and adaptable	0	0	0	0
Inadequately flexible and adaptable	0	0	0	0
TOTAL INTERVIEWED	3	7	10	100

TABLE 95
Areas in Which NOHIMS Needs To Be More
Flexible and Adaptable According to
NHRC NOHIMS Developers and Higher Level Managers
(Number who mentioned area; multiple answers allowed)

	NHRC NOHIMS Developers	Higher Level Managers	TOTAL	% of Total Who Answered
Addition of Material Safety Data Sheet information	0	2	2	29
Ability to re-assign groups of workers to new workplaces rather than just individuals	1	0	1	14
Inclusion of injury/ illness data in NOHIMS	0	1	1	14
Addition of a word processing capability	0	1	1	14
Addition of a statistical package	0	1	1	14
Training in system usage	0	1	1	14
None	0	1	1	14
TOTAL WHO ANSWERED	1	6	7	100
No Comment	2	1	3	
TOTAL INTERVIEWED	3	7	10	

TABLE 96
Rating of the Ease of Transfer of NOHIMS
to Other Navy Industrial Sites
by NHRC NOHIMS Developers and Higher Level Managers
(Number who mentioned rating)

	NHRC NOHIMS Developers	Higher Level Managers	TOTAL	% of Total Interviewed
Difficult	0	1	1	10
Somewhat difficult	1	3	4	40
Somewhat easy	2	1	3	30
Easy	0	2	2	20
TOTAL INTERVIEWED	3	7	10	100

TABLE 97
Problems Foreseen by NHRC NOHIMS Developers and Higher Level Managers in Transferring NOHIMS to Other Navy Industrial Sites
(Number who mentioned problem; multiple answers allowed)

	NHRC NOHIMS Developers	Higher Level Managers	TOTAL	% of Total Interviewed
Committing billets to operate and manage NOHIMS	0	4	4	40
Tracking worker personnel	1	2	3	30
Coordinating fiscal and personnel resources with arrival of NOHIMS	0	2	2	20
Dedication/cooperation of NOHIMS personnel	1	1	2	20
Training staff to operate NOHIMS	1	1	2	20
Standardizing industrial hygiene surveys	1	0	1	10
Adapting to site size/ number of workers served	1	0	1	10
Adapting to the variety of industrial processes performed	1	0	1	10
False expectations for NOHIMS	1	0	1	10
Gaining cooperation from the command	0	1	1	10
Resistance to standardizing medical recording procedures	0	1	1	10
Securing commitment to an automated medical information system	0	1	1	10
Initial loading of personnel data	0	1	1	10
Obtaining dedicated telephone line(s)	0	1	1	10
Allocating adequate floor space for hardware	0	1	1	10
TOTAL INTERVIEWED	3	7	10	100

personnel, and training staff to operate NOHIMS. All of the other problems listed in Table 97 were mentioned by only one individual each. Problems mentioned by one developer each were standardizing industrial hygiene surveys (seen as a benefit by NEHC), adapting to site size/number of workers served, adapting to the variety of industrial processes performed, and false expectations for NOHIMS (in that the system is directed at meeting OSHA requirements and not at answering all medical questions). Problems mentioned by one higher level manager each were gaining cooperation from the command, resistance to standardizing medical recording procedures, securing commitment to an automated medical information system, loading personnel data initially, obtaining dedicated telephone line(s), and allocating adequate floor space for hardware.

The last question asked of the NHRC NOHIMS developers and higher level managers dealt with the acceptability of NOHIMS among users at other Navy industrial sites. All ten interviewees thought that NOHIMS' acceptability would be high to some degree, with ten percent choosing the rating of very high, 70 percent choosing high, and 20 percent choosing somewhat high (see Table 98). The developers generally rated NOHIMS' acceptability higher than the managers did. The two higher level managers who rated NOHIMS' acceptability as only somewhat high offered reasons why they thought this would be the case. One industrial hygiene manager felt that NOHIMS users will resist the extra paperwork involved until system benefits are demonstrated and that NOHIMS' acceptability will depend on the manager's attitude toward the system and the availability of resources. A medical manager predicted resistance only initially followed by somewhat high or even high acceptance when individuals really get involved with using the system. Another manager, who rated NOHIMS' acceptability as high, commented that NOHIMS' acceptability to users may be dependent on a proper orientation to the need for and importance of NOHIMS and that some commands may be more responsive to occupational health and safety.

System Users and NOHIMS System Managers

Table 99 shows how suitable the medical care providers, industrial hygienists, and NOHIMS system managers thought NOHIMS is to the information processing needs of other Navy industrial sites. All eleven respondents (100%) thought NOHIMS is very suitable. One medical ancillary observed that the Occupational Health Unit (OHU) at the Ship Repair Facility on Guam where she had worked previously had identical needs to those of the North Island OHU. One industrial hygienist in San Diego pointed out that every industrial hygienist in the Southwest region is using the standard NOHIMS survey form and it was an easy switchover. The following types of industrial sites in the Southwest region are currently using this form: air station, hospital, submarine base, naval station, and naval training center. An industrial hygienist in Bremerton remarked that NOHIMS "fits very comfortably in the shipyard environment" and that their military industrial hygienist uses NOHIMS on ships. Another industrial hygienist felt that since NOHIMS handles the North Island Naval Air Rework Facility, it also should be able to handle other more stable industrial environments.

As shown in Table 100, all eleven respondents agreed that NOHIMS is adequately flexible and adaptable. One industrial hygienist in San Diego noted that the crucial first step to start up the system is obtaining personnel data.

TABLE 98
Rating of the Acceptability of NOHIMS Among Users
at Other Navy Industrial Sites
by NHRC NOHIMS Developers and Higher Level Managers
(Number who mentioned rating)

	NHRC NOHIMS Developers	Higher Level Managers	TOTAL	% of Total Interviewed
Very high	1	0	1	10
High	2	5	7	70
Somewhat high	0	2	2	20
Somewhat low	0	0	0	0
Low	0	0	0	0
Very low	0	0	0	0
TOTAL INTERVIEWED	3	7	10	100

TABLE 99
Rating of the Suitability of NOHIMS to the Information Processing Needs of Other Navy Industrial Sites by Medical Care Providers, Industrial Hygienists, and NOHIMS System Managers
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
Very suitable	4	5	2	11	100
Somewhat suitable	0	0	0	0	0
Somewhat unsuitable	0	0	0	0	0
Very unsuitable	0	0	0	0	0
TOTAL WHO ANSWERED	4	5	2	11	100
No Comment	2	0	0	2	
TOTAL INTERVIEWED	6	5	2	13	

TABLE 100
Rating of NOHIMS' Flexibility and Adaptability
by Medical Care Providers, Industrial Hygienists,
and NOHIMS System Managers
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
Adequately flexible and adaptable	5	4	2	11	100
Somewhat adequately flexible and adaptable	0	0	0	0	0
Somewhat inadequately flexible and adaptable	0	0	0	0	0
Inadequately flexible and adaptable	0	0	0	0	0
TOTAL WHO ANSWERED	5	4	2	11	100
No Comment	1	1	0	2	
TOTAL INTERVIEWED	6	5	2	13	

The NOHIMS system manager in Bremerton remarked that the adaptability of NOHIMS improves as one becomes familiar with the system. He noted that it seems rigid at first, but when one understands the system, it is flexible and adaptable.

In answer to the question asking for areas in which NOHIMS needs to be more flexible and adaptable, 75 percent of the respondents gave none (see Table 101). Both NOHIMS system managers, three industrial hygienists, and one medical care provider fell in this group of respondents. Two medical care providers each mentioned one area in which they felt NOHIMS needs to be more flexible and adaptable. One physician expressed a desire for automatic transfer of recommended lab tests by the industrial component to the medical component patient record. One medical ancillary wanted direct access to lab data without having to go through all of the other patient data (this individual had not been trained in the various ways to retrieve lab data selectively).

Like the NHRC NOHIMS developers and higher level managers, the system users and NOHIMS system managers were divided in their rating of the ease of transfer of NOHIMS to other Navy industrial sites. Ten percent felt that the transfer process would be difficult, 20 percent felt it would be somewhat difficult, 30 percent felt it would be somewhat easy, and 40 percent felt the transfer process would be easy (see Table 102). The NOHIMS system managers generally thought the transfer process would be more difficult than the system users did. One industrial hygienist in San Diego noted that the transfer process will be somewhat easy as long as there is access to personnel data. An industrial hygienist in Bremerton thought the transfer process would be easy because they had been able to adapt NOHIMS to all environments that exist in their jurisdiction. The NOHIMS system manager in San Diego thought the transfer process would be difficult and entail a great deal of work. The Bremerton system manager felt there were bound to be some problems introducing a new product and that users will need to become familiar with the system.

Table 103 lists the problems foreseen by the system users and the NOHIMS system managers in transferring NOHIMS to other Navy industrial sites. Three problems were mentioned by more than one respondent--obtaining billets needed (25%), training of NOHIMS personnel (25%), and initial resistance (17%). Twenty-five percent of those who answered this question foresaw no problems. All of the other problems listed in Table 103 were mentioned by only one individual each. Problems mentioned by one medical care provider each were adequate user training manuals, dedication/cooperation of NOHIMS personnel, management understanding of how to tailor NOHIMS for local needs, securing commitment to an automated medical information system, adaptation to different regulations/standards for each state, and a need to expand the job certification list. A problem mentioned by one industrial hygienist was access to accurate personnel data. The San Diego system manager foresaw the following problems: procuring, installing, and testing NOHIMS hardware; allocating adequate floor space for the hardware; modifications to NOHIMS software for specific sites; and adaptation of data collection forms and NOHIMS documentation. The Bremerton system manager foresaw a need for some standardization of terminology when NOHIMS is transferred to other Navy industrial sites.

All of the system users who responded to the last question and both NOHIMS system managers felt that the acceptability of NOHIMS among users at other Navy industrial sites would be very high (70%) or high (30%) (see Table 104). One physician remarked that "people are screaming for it--when, when, when?"

TABLE 101
Areas in Which NOHIMS Needs To Be More
Flexible and Adaptable According to
Medical Care Providers, Industrial Hygienists,
and NOHIMS System Managers
(Number who mentioned area; multiple answers allowed)

	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
None	1	3	2	6	75
Automatic transfer of lab tests recommended by the industrial component to the medical component patient record	1	0	0	1	12.5
Direct access to lab data without going through the other patient data	1	0	0	1	12.5
TOTAL WHO ANSWERED	3	3	2	8	100
No Comment	3	2	0	5	
TOTAL INTERVIEWED	6	5	2	13	

TABLE 102
Rating of the Ease of Transfer of NOHIMS
to Other Navy Industrial Sites
by Medical Care Providers, Industrial Hygienists,
and NOHIMS System Managers
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
Difficult	0	0	1	1	10
Somewhat difficult	1	0	1	2	20
Somewhat easy	1	2	0	3	30
Easy	2	2	0	4	40
TOTAL WHO ANSWERED	4	4	2	10	100
No Comment	2	1	0	3	
TOTAL INTERVIEWED	6	5	2	13	

TABLE 103
Problems Foreseen by Medical Care Providers,
Industrial Hygienists, and NOHIMS System Managers
in Transferring NOHIMS to Other Navy Industrial Sites
(Number who mentioned problem; multiple answers allowed)

	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
No problems foreseen	0	3	0	3	25
Obtaining billets needed	3	0	0	3	25
Training of NOHIMS personnel	2	0	1	3	25
Initial resistance	1	1	0	2	17
Adequate user training manuals	1	0	0	1	8
Dedication/cooperation of NOHIMS personnel	1	0	0	1	8
Management understanding of how to tailor NOHIMS for local needs	1	0	0	1	8
Securing commitment to an automated medical information system	1	0	0	1	8
Adaptation to different regulations/standards for each state	1	0	0	1	8
Need to expand job certification list	1	0	0	1	8
Access to accurate personnel data	0	1	0	1	8
Procuring, installing, and testing hardware	0	0	1	1	8
Allocating adequate floor space for hardware	0	0	1	1	8

(Continued)

TABLE 103 (CONT.)
Problems Foreseen by Medical Care Providers,
Industrial Hygienists, and NOHIMS System Managers
in Transferring NOHIMS to Other Navy Industrial Sites
(Number who mentioned problem; multiple answers allowed)

	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
Modifications to NOHIMS software for specific sites	0	0	1	1	8
Adaptation of data collection forms and NOHIMS documentation	0	0	1	1	8
Need for standardized terminology	0	0	1	1	8
TOTAL WHO ANSWERED	6	4	2	12	100
No Comment	0	1	0	1	
TOTAL INTERVIEWED	6	5	2	13	

TABLE 104
Rating of the Acceptability of NOHIMS Among Users
at Other Navy Industrial Sites
by Medical Care Providers, Industrial Hygienists,
and NOHIMS System Managers
(Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	System Managers	TOTAL	% of Total Who Answered
Very high	2	3	2	7	70
High	1	2	0	3	30
Somewhat high	0	0	0	0	0
Somewhat low	0	0	0	0	0
Low	0	0	0	0	0
Very low	0	0	0	0	0
TOTAL WHO ANSWERED	3	5	2	10	100
No Comment	3	0	0	3	
TOTAL INTERVIEWED	6	5	2	13	

Another care provider thought that "people will look to NOHIMS as a relief." One industrial hygienist in San Diego predicted some resistance at first but very high acceptance once they have used NOHIMS. One industrial hygienist in Bremerton felt that once users became accustomed to NOHIMS, they would be extremely pleased with the system. Another Bremerton industrial hygienist commented that at first there will be a great deal of work to enter the required information to initialize NOHIMS, but in the long run the system will be viewed as helpful. The San Diego system manager expected the acceptability of NOHIMS among users at other Navy industrial sites to start out somewhat low initially but to move up to very high. The Bremerton system manager thought that NOHMIS' acceptability among users would be very high when they became familiar with the system.

Summary

Twenty-three individuals were asked to assess the transferability of NOHIMS to other Navy industrial sites. Six of the seven higher level managers thought NOHIMS was very suitable to the information processing needs of other Navy industrial sites whereas the three NHRC NOHIMS developers felt that NOHIMS was suitable or somewhat suitable. All of the nine NOHIMS users who responded and the two NOHIMS system managers thought that NOHIMS was very suitable to the information processing needs of other Navy industrial sites.

NOHIMS was considered to be adequately flexible and adaptable by all of the NHRC NOHIMS developers, both NOHIMS system managers, all of the NOHIMS users who responded, and five of the seven higher level managers. The other two higher level managers thought that NOHIMS was somewhat adequately flexible and adaptable. Areas mentioned in which an interviewee felt that NOHIMS needs to be more flexible and adaptable included addition of Material Safety Data Sheet information (mentioned by two interviewees), inclusion of illness/injury data in NOHIMS (being implemented by NHRC), addition of a word processing capability and a statistical package, training in system usage, ability to re-assign groups of workers to new workplaces rather than just by individuals, and automatic transfer of lab tests recommended by the industrial component to the medical component patient record. Seven of the 15 respondents to this question (47%) thought that there were no areas in which NOHIMS needs to be more flexible and adaptable.

The interviewees were divided in their ratings of the ease of transfer of NOHIMS to other Navy industrial sites. Overall, ten percent felt that the transfer process would be difficult, 30 percent felt it would be somewhat difficult, 30 percent felt it would be somewhat easy, and 30 percent felt the transfer process would be easy. The NOHIMS system managers as a group thought the transfer of NOHIMS to other Navy industrial sites would be the most difficult followed by the higher level managers, NHRC NOHIMS developers, medical care providers, and lastly the industrial hygienists who thought the transfer process would be the easiest.

A variety of problems were foreseen in transferring NOHIMS to other Navy industrial sites. Overall, the most commonly foreseen problem (mentioned by four higher level managers and three medical care providers) was obtaining/ committing billets to operate and manage NOHIMS. Next most frequently cited as a problem was training staff to operate NOHIMS (mentioned by five respondents).

Problems mentioned by three respondents each were tracking worker personnel and dedication/cooperation of NOHIMS personnel. Two respondents each mentioned coordinating fiscal and personnel resources with the arrival of NOHIMS, initial resistance, securing commitment to an automated medical information system, and allocating adequate floor space for hardware. Seventeen additional problems were mentioned by only one respondent each. Several of these problems were related to ensuring that NOHIMS is adapted to varying needs at new sites such as different regulations and programs. No problems were foreseen by three respondents.

All 20 respondents thought that the acceptability of NOHIMS among users at other Navy industrial sites would be high to some degree, with 40 percent choosing the rating of very high, 50 percent choosing high, and 10 percent choosing somewhat high. The NOHIMS system managers as a group thought that NOHIMS' acceptability to users would be the highest followed by medical care providers, industrial hygienists, NHRC NOHIMS developers, and lastly higher level managers who thought user acceptability would be the least high. A number of respondents, including the two who gave NOHIMS the lowest ratings on acceptability, felt that NOHIMS' acceptability among users would increase as they became familiar with the system.

SECTION VII
BRIEF ECONOMIC ANALYSIS OF NOHIMS

BACKGROUND

A comprehensive economic analysis of the costs and benefits of NOHIMS was not performed in this test and evaluation of the system per direction of our sponsor, the Naval Medical Research and Development Command, because a thorough economic analysis had already been conducted by the Naval Medical Command. The findings from their economic analysis are reported in Appendix D of the NOHIMS System Decision Paper (SDP). The economic analysis concluded that continued development of NOHIMS would be more cost effective than procurement of a commercial occupational health information system if at least 30 systems were to be installed at Navy industrial sites. It was also concluded that procurement of a commercial system would require significant modifications to meet the Navy's requirements, adding further to the cost of a commercial system.

The economic analysis reported in the SDP also included a NOHIMS benefits analysis. Quantifiable benefits identified were (1) enhanced employee productivity due to "all at once" examination scheduling, (2) enhanced cohort identification for studies of occupational disease, and (3) improved clerical productivity. Nonquantifiable benefits recognized in the SDP were (1) improved quality of medical information, (2) improved quality of management information, (3) improved compliance with OSHA law, (4) availability of hazardous materials information, (5) improved employee protection, and (6) reduced claims compensation. These then were the benefits anticipated to result from NOHIMS at the time the SDP was written in June of 1984.

As part of our test and evaluation of NOHIMS, we realized that we had a special opportunity to poll individuals involved with NOHIMS regarding their perception of any benefits accruing from the introduction of NOHIMS at their test site. These individuals, we reasoned, could provide us with assessments of possible NOHIMS benefits that only people exposed to the system on a regular basis would be able to make. Consequently, we collected data on NOHIMS benefits as perceived by the only people currently exposed to NOHIMS in order to complement the benefits anticipated in the SDP. These people included six medical care providers, five industrial hygienists, and two test site administrators. We also polled the four NOHIMS developers at the Naval Health Research Center (NHRC) and seven higher level Navy managers to determine the benefits they perceived that had accrued as a result of introducing NOHIMS at the two test sites.

ANALYSIS OF THE PERCEIVED BENEFITS OF NOHIMS

We compiled an extensive hierarchical list of possible benefits that the advent of NOHIMS might provide to the Navy, higher level Navy managers, NOHIMS test site administrators, and the system users in both San Diego, California and

Bremerton, Washington. The hierarchy of potential benefits that we generated is shown below.

- Increased quality of care provided to the worker/patient through
  - fewer unnecessary tests and ancillary services
  - fewer unnecessary examinations/visits
  - appropriateness of tests performed
  - reduced waiting time
  - more accurate patient medical record
  - timely and perpetual access to data
  - earlier diagnosis of illnesses/conditions
  - earlier notification of abnormal test results/findings
  - base-line data on the health of an employee
- Increased compliance with monitoring programs
- Reduction in occupational exposures to hazardous agents
- Improved workplace monitoring
  - better identification of possible hazards
  - better identification of workers exposed
- Safer working conditions
- Improved job certification program
- Increased confidence of workers
- Improved communication between those concerned with the occupational health of the worker
- Increased productivity of staff/clinics
- Increased efficiency in the use of resources
- Savings in manpower
- Reduction in the cost of providing services
- Improved planning and budgeting
- More accurate administrative reports
- More accurate/available database for research efforts

Using this hierarchical list of potential benefits, we asked the NHRC NOHIMS developers, the higher level Navy managers, test site administrators, and the system users to identify which benefits they perceived were a result of the introduction of NOHIMS at the two test sites. We also encouraged them to mention any other health care, monitoring, and/or administrative benefits that they were aware of which were not on the list. We then asked them to select the most significant benefit of NOHIMS from those they had mentioned. Finally, we asked them to judge whether the costs of implementing and operating NOHIMS

outweigh the benefits or vice versa. The exact wording of the questions that we used for this portion of the interviews may be found in Component 34 of Appendix A. If an interviewee was requested to answer the questions about perceived benefits in two interviews, the answers were combined and included in only one category of the following tables. We based the category on what was the interviewee's main function with NOHIMS. The difference between higher level managers and test site administrators, as we defined them, is that the work location of the test site administrators is the test site and they presumably have more first-hand knowledge and/or experience with NOHIMS.

NHRC NOHIMS Developers and Higher Level Managers

At least three-quarters of the eleven NHRC NOHIMS developers and higher level managers mentioned the three benefits of improved workplace monitoring, increased compliance with monitoring programs, and more accurate administrative reports. Six additional benefits were mentioned by 73 percent of the interviewees (see Table 105). The other benefits on the hierarchical list were all mentioned by several of the developers/managers, but to a lesser degree than the first nine benefits. The developers/managers observed 15 other benefits than the ones on the hierarchical list. Four other health care benefits mentioned were the ability to interact with the system to retrieve desired information, double checks on abnormal lab tests, capability to avert accidents/illnesses by observing trends, and educational benefits from use of the system. Under other monitoring benefits, profits that were mentioned included the industrial hygiene monitoring plan and the value of data being readily available. Other administrative benefits were the ability to more effectively manage the workplace/employees, standardization of data and reports, and that management information falls out of having a database. In addition, six other general benefits were mentioned including improved morale of people who have access to NOHIMS, help in averting disasters, tracking data items in large populations, improvement in the knowledge of the medical community, information for the clinic physician director showing where his staff is being overworked, and education in computer tools.

The benefits noted by the NHRC NOHIMS developers and by the higher level managers differed, but not greatly. All of the developers mentioned fewer unnecessary tests and ancillary services, fewer unnecessary examinations/visits, and appropriateness of tests performed while less than half of the managers mentioned these three benefits. A much higher percentage of managers than developers mentioned increased productivity of staff/clinics, increased efficiency in the use of resources, safer working conditions, reduction in the cost of providing services, improved planning and budgeting, and improved job certification program. On the average, both groups mentioned about the same number of benefits per respondent. The NHRC NOHIMS developers mentioned 16.5 benefits per respondent and the higher level managers mentioned 16.9 benefits per respondent.

Three problems with how NOHIMS is being used that might compromise benefits surfaced in the interviews. One NOHIMS developer expressed concern that spills are not being recorded in the industrial component of NOHIMS. Emergency events of this nature can be stored in NOHIMS as a type of environment called an event. Industrial hygienists need to be trained as to how to use NOHIMS in this manner. One of the managers noted a problem with the count for how many workers are

TABLE 105
Perceived Benefits of NOHIMS
According to NHRC NOHIMS Developers and Higher Level Managers
(Number who mentioned benefit; multiple answers allowed)

	NHRC NOHIMS Developers	Higher Level Managers	TOTAL	% of Total Interviewed
Improved workplace monitoring	3	7	10	91
Increased compliance with monitoring programs	3	6	9	82
More accurate administrative reports	3	6	9	82
Increased quality of care provided to the worker/patient	3	5	8	73
Timely and perpetual access to data	4	4	8	73
Better identification of possible hazards	3	5	8	73
Better identification of workers exposed	3	5	8	73
Improved communication between those concerned with the occupational health of the worker	4	4	8	73
More accurate/available database for research efforts	3	5	8	73
Fewer unnecessary tests and ancillary services	4	3	7	64
Fewer unnecessary examinations/visits	4	3	7	64
Appropriateness of tests performed	4	3	7	64
Base-line data on the health of an employee	3	4	7	64
Reduction in occupational exposures to hazardous agents	3	4	7	64

(Continued)

TABLE 105 (CONT.)

	NHRC NOHIMS Developers	Higher Level Managers	TOTAL	% of Total Interviewed
Increased confidence of workers	2	4	6	54
Increased productivity of staff/clinics	1	5	6	54
Increased efficiency in the use of resources	1	5	6	54
Earlier diagnosis of illnesses/conditions	2	3	5	45
Earlier notification of abnormal test results/ findings	2	3	5	45
Safer working conditions	1	4	5	45
Reduction in the cost of providing services	1	4	5	45
Improved planning and budgeting	0	5	5	45
Reduced waiting time	1	3	4	36
More accurate patient medical record	1	3	4	36
Savings in manpower	1	3	4	36
Improved job certification program	0	3	3	27
Other health care benefits	2	2	4	36
Other monitoring benefits	1	1	2	18
Other administrative benefits	2	1	3	27
Other benefits	1	5	6	54
TOTAL INTERVIEWED	4	7	11	100
Average No. of Benefits Mentioned per Respondent	16.5	16.9		

using respirators, which should trigger an annual medical examination. The count has been wrong because respirator data have not been entered correctly into NOHIMS. Follow-up in April 1986 found that this problem had been resolved satisfactorily. Another manager felt that both medical care providers and industrial hygienists had not been trained as well as they should be to receive maximum benefit from use of the system. NOHIMS users agree that they have not received adequate training and do not fully understand all of the system features that could be of benefit to them.

When we asked the developers/managers to select the most significant benefit of NOHIMS from those they had mentioned, many of the interviewees could not limit themselves to selecting just one most significant benefit. As a result, Table 106 reflects more than eleven choices. In fact, 18 benefits were noted as most significant. Mentioned most frequently (four times) as being the most significant benefit of NOHIMS was increased quality of care provided to the worker/patient. Three benefits were mentioned next most frequently (two times each) as being the most significant, namely, better identification of occupational hazards and as a result decreased occupational exposures, improved communication between those concerned with the occupational health of the worker, and increased productivity of staff/clinics. All of the other most significant benefits included in Table 106 were mentioned only once. Four benfits mentioned by developers but not by managers were timely and perpetual access to data, improved workplace monitoring, giving workers the appropriate examinations, and the availability of a database for research and management needs. Managers mentioned five benefits that developers did not, namely, increased productivity of staff/clinics, increased compliance with monitoring programs, use of NOHIMS as a management tool, averting disasters because of the existence of a database, and standardized operation of Occupational Health Units.

Table 107 shows how NHRC NOHIMS developers and higher level managers rated the costs versus benefits of implementing and operating NOHIMS. Because interviewees had no real idea of what NOHIMS implementation and operational costs are other than their own involvement of time, their judgments are more subjective than objective. One individual thought the costs somewhat exceed or outweigh the benefits thus far. Seven individuals felt the benefits somewhat or clearly exceed or outweigh the costs. Two-thirds of those who felt they could weigh costs versus benefits thought that the benefits clearly exceed or outweigh the costs. One respondent thought NOHIMS will be cost effective in time and two individuals felt they could not make this rating. Of those who did respond, their additional comments provide some interesting insights into the value that higher level managers place on NOHIMS benefits. One manager concluded that "the cost of implementing and operating NOHIMS was necessary to be able to do the job." Other managers commented "worth whatever it cost" and "money should not hold this thing back." One manager even went as far as to say that he felt the system was shortchanged in its development and that not enough resources had been allocated.

System Users and Test Site Administrators

At least three-quarters of the 13 system users and test site administrators mentioned the four benefits of improved workplace monitoring, increased compliance with monitoring programs, better identification of possible hazards,

TABLE 106
The Most Significant of Those NOHIMS Benefits
Mentioned by NHRC NOHIMS Developers and Higher Level Managers
(Number who chose benefit as most significant;
multiple answers allowed)

	NHRC NOHIMS Developers	Higher Level Managers	TOTAL	% of Total Interviewed
Increased quality of care provided to the worker/patient	1	3	4	36
Better identification of occupational hazards and as a result, decreased occupational exposures	1	1	2	18
Improved communication between those concerned with the occupational health of the worker	1	1	2	18
Increased productivity of staff/clinics	0	2	2	18
Timely and perpetual access to data for everyone	1	0	1	9
Increased compliance with monitoring programs	0	1	1	9
Improved workplace monitoring	1	0	1	9
Giving workers the appropriate examinations	1	0	1	9
Use of NOHIMS as a management tool	0	1	1	9
Database for research and management needs	1	0	1	9
Averting disasters because of existence of database	0	1	1	9
Standardized operation of Occupational Health Units	0	1	1	9
TOTAL INTERVIEWED	4	7	11	100

TABLE 107
Rating of Costs Versus Benefits of Implementing and Operating NOHIMS
by NHRC NOHIMS Developers and Higher Level Managers
(Number who mentioned rating)

	NHRC NOHIMS Developers	Higher Level Managers	TOTAL	% of Total Who Answered
The costs of implementing and operating NOHIMS				
clearly exceed or outweigh the benefits	0	0	0	0
somewhat exceed or outweigh the benefits	0	1	1	11
equal the benefits	0	0	0	0
or the benefits				
somewhat exceed or outweigh the costs	1	0	1	11
clearly exceed or outweigh the costs	2	4	6	67
Will be cost effective*	0	1	1	11
TOTAL WHO ANSWERED	3	6	9	100
No Comment	1	1	2	
TOTAL INTERVIEWED	4	7	11	

* Category added by respondent

and more accurate/available database for research efforts. The first two benefits mentioned most frequently by system users and test site administrators were also the two benefits mentioned most frequently by NHRC NOHIMS developers and higher level managers. Five additional benefits were mentioned by more than 60 percent of the interviewees (see Table 108). The other benefits on the hierarchical list were all mentioned by some of the system users and test site administrators, but to a lesser degree than the first nine benefits. None of the five industrial hygienists mentioned the medical care benefits of appropriateness of tests performed, fewer unnecessary tests and ancillary services, base-line data on the health of an employee, improved job certification program, and earlier notification of abnormal test results/findings, suggesting that they have a narrower view of NOHIMS benefits. The only benefit that was not mentioned by medical care providers was savings in manpower. Under Other benefits, one test site administrator mentioned transfer of information between operational units and base stations.

The average number of benefits mentioned by the test site administrators was 16.5. This average is similar to the averages for the NHRC NOHIMS developers and the higher level managers. The average number of benefits mentioned by the medical care providers and by the industrial hygienists was approximately 11, another indication of their possibly narrower view of the benefits of NOHIMS.

Like the NHRC NOHIMS developers and higher level managers, the system users and test site administrators had difficulty limiting their selection to just one most significant benefit of NOHIMS. Table 109 shows that the 13 system users and test site administrators noted 20 benefits as most significant. Mentioned most frequently (two times each) as being the most significant benefit of NOHIMS were timely and perpetual access to data, better identification of possible hazards, and more accurate/available historical database. None of the medical care providers selected these three benefits as most significant. Better identification of occupational hazards was also mentioned two times by developers/managers as the most significant benefit of NOHIMS. All of the other most significant benefits included in Table 109 were mentioned only once. Medical care providers tended to pick patient care and surveillance benefits as most significant. Industrial hygienists focused more on hazard identification, exposure monitoring, and accessibility to an accurate historical database. Test site administrators noted as most significant some spin-off benefits and a benefit not previously mentioned, namely, that with NOHIMS patient examinations are based on their exposure history rather than on their occupation as was done in the past.

Table 110 shows how system users and test site administrators rated the costs versus benefits of implementing and operating NOHIMS. One medical care provider thought the costs somewhat exceed or outweigh the benefits now but that the potential is there to reverse this picture. He offered this interesting analogy as an explanation for his rating. "It's like building a freeway. There is only one lane open now. There's some pavement work to do yet, and then all lanes will be open." A test site administrator felt that the costs equal the benefits. Nine individuals or 82 percent felt that the benefits somewhat or clearly exceed or outweigh the costs, with 55 percent choosing the clearly exceed or outweigh the costs rating. Test site administrators most strongly rated benefits over costs followed by industrial hygienists, and then medical

TABLE 108
Perceived Benefits of NOHIMS According to Medical Care Providers, Industrial Hygienists, and Test Site Administrators
(Number who mentioned benefit; multiple answers allowed)

	Medical Care Providers	Industrial Hygienists	Test Site Admin.	TOTAL	% of Total Interviewed
Improved workplace monitoring	4	5	2	11	85
Increased compliance with monitoring programs	5	4	1	10	77
Better identification of possible hazards	3	5	2	10	77
More accurate/ available database for research efforts	4	5	1	10	77
Timely and perpetual access to data	4	3	2	9	69
Better identification of workers exposed	3	4	2	9	69
Improved communication between those concerned with the occupational health of the worker	2	5	2	9	69
Increased efficiency in the use of resources	3	4	2	9	69
Increased productivity of staff/clinics	3	3	2	8	62
Improved planning and budgeting	1	3	2	6	46
Increased quality of care provided to the worker/patient	3	2	0	5	38
Fewer unnecessary examinations/visits	3	1	1	5	38
Appropriateness of tests performed	4	0	1	5	38

(Continued)

TABLE 108 (CONT.)
Perceived Benefits of NOHIMS According to Medical Care Providers, Industrial Hygienists, and Test Site Administrators
(Number who mentioned benefit; multiple answers allowed)

	Medical Care Providers	Industrial Hygienists	Test Site Admin.	TOTAL	% of Total Interviewed
More accurate patient medical record	3	1	1	5	38
Earlier diagnosis of illnesses/conditions	2	2	1	5	38
Reduction in occupational exposures to hazardous agents	3	1	1	5	38
Savings in manpower	0	3	2	5	38
More accurate administrative reports	3	1	1	5	38
Fewer unnecessary tests and ancillary services	3	0	1	4	31
Safer working conditions	1	2	1	4	31
Increased confidence of workers	2	1	1	4	31
Reduction in the cost of providing services	1	1	2	4	31
Reduced waiting time for workers/patients	2	1	0	3	23
Base-line data on the health of an employee	3	0	0	3	23
Improved job certification program	2	0	1	3	23
Earlier notification of abnormal test results/findings	2	0	0	2	15
Other benefits	0	0	1	1	8
TOTAL INTERVIEWED	6	5	2	13	100
Average No. of Benefits Mentioned per Respondent	11.5	11.4	16.5		

TABLE 109
The Most Significant of Those NOHIMS Benefits Mentioned by Medical Care Providers, Industrial Hygienists, and Test Site Administrators
(Number who chose benefit as most significant; multiple answers allowed)

	Medical Care Providers	Industrial Hygienists	Test Site Admin.	TOTAL	% of Total Interviewed
Timely and perpetual access to data	0	1	1	2	15
Better identification of possible hazards	0	2	0	2	15
More accurate/available historical database	0	2	0	2	15
Increased quality of care provided to the worker/patient	1	0	0	1	8
Improved workplace monitoring	1	0	0	1	8
Better identification of workers exposed	1	0	0	1	8
Increased efficiency in use of resources	0	1	0	1	8
Standardization of care and monitoring	1	0	0	1	8
Improved patient follow-up/surveillance to hazards	1	0	0	1	8
Increased ability to do monitoring and reduce exposures	0	1	0	1	8
Industrial Exposure Report	1	0	0	1	8
Reliable information management system	1	0	0	1	8

(Continued)

TABLE 109 (CONT.)
The Most Significant of Those NOHIMS Benefits Mentioned by
Medical Care Providers, Industrial Hygienists,
and Test Site Administrators
(Number who chose benefit as most significant;
multiple answers allowed)

	Medical Care Providers	Industrial Hygienists	Test Site Admin.	TOTAL	% of Total Interviewed
Compliance with record keeping requirements	0	1	0	1	8
Testing by exposure history rather than by occupation	0	0	1	1	8
Teaching new physicians occupational history	0	0	1	1	8
Data extraction	0	0	1	1	8
Transfer of information	0	0	1	1	8
TOTAL INTERVIEWED	6	5	2	13	100

TABLE 110

Rating of Costs Versus Benefits of Implementing and Operating NOHIMS by Medical Care Providers, Industrial Hygienists, and Test Site Administrators (Number who mentioned rating)

	Medical Care Providers	Industrial Hygienists	Test Site Admin.	TOTAL	% of Total Who Answered
The costs of implementing and operating NOHIMS					
clearly exceed or outweigh the benefits	0	0	0	0	0
somewhat exceed or outweigh the benefits	1	0	0	1	9
equal the benefits	1	0	0	1	9
or the benefits					
somewhat exceed or outweigh the costs	1	2	0	3	27
clearly exceed or outweigh the costs	2	2	2	6	55
TOTAL WHO ANSWERED	5	4	2	11	100
No Comment	1	1	0	2	
TOTAL INTERVIEWED	6	5	2	13	

care providers. One medical care provider and one industrial hygienist felt they could not make this rating.

Summary

Table 111 shows the costs versus benefits of implementing and operating NOHIMS ratings for all interviewees combined. Eighty percent of all individuals who made this rating felt that the benefits of NOHIMS exceed or outweigh the costs, with 60 percent of those individuals making this rating indicating that the benefits clearly exceed or outweigh the costs. Three individuals (15%) thought that eventually the large developmental and start-up costs of NOHIMS would be exceeded by the system's benefits. These findings support the expectation of benefits from NOHIMS anticipated in the System Decision Paper of June 1984. What is of particular interest is that the benefits that were anticipated in 1984 do not coincide exactly with the benefits perceived by the developers, managers, and users of NOHIMS at the time of our interviews. For example, we were unable to document reduced claims compensation by NOHIMS at the time of our interviews because this benefit accrues from the ongoing construction of an accurate historical database. On the other hand, those individuals knowledgeable about NOHIMS at the time of our interviews identified additional system benefits that had not occurred to us when we compiled what we thought was a comprehensive list of possible NOHIMS benefits. The individuals we interviewed perceived many and varied ways that NOHIMS is benefiting or will benefit the Navy occupational health programs, corroborating earlier expectations of major benefits from NOHIMS.

TABLE 111
Rating of Costs Versus Benefits of Implementing and Operating NOHIMS
by All Individuals Interviewed
(Number who mentioned rating)

	TOTAL	% of Total Who Answered
The costs of implementing and operating NOHIMS		
clearly exceed or outweigh the benefits	0	0
somewhat exceed or outweigh the benefits	2	10
equal the benefits	1	5
or the benefits		
somewhat exceed or outweigh the costs	4	20
clearly exceed or outweigh the costs	12	60
Will be cost effective*	1	5
TOTAL WHO ANSWERED	20	100
No Comment	4	
TOTAL INTERVIEWED	24	

* Category added by respondent

SECTION VIII
BRIEF COMPARISON OF NOHIMS TO OTHER OCCUPATIONAL HEALTH INFORMATION SYSTEMS

This section presents a brief comparison of NOHIMS to other occupational health information systems. Specifically, NOHIMS is compared to government-owned occupational health systems, to commercially available occupational health systems, and to the interim Navy occupational health system.

COMPARISON OF NOHIMS TO GOVERNMENT-OWNED OCCUPATIONAL HEALTH INFORMATION SYSTEMS

Only one of the individuals we interviewed was familiar enough with government-owned occupational health information systems other than NOHIMS to make a comparison. This individual was a higher level Navy manager from the Navy Environmental Health Center (NEHC) where the NOHIMS System Decision Paper (SDP) was prepared in June of 1984. Alternative systems to NOHIMS in the government and commercial sectors were identified, described, and evaluated in the SDP. Five government-owned systems were included in the SDP, three from non-DOD government agencies and two from DOD agencies.

Non-DOD Government-Owned Occupational Health Systems

As reported in the SDP, a Naval Sea Systems Command (NAVSEA) occupational safety and health (OSH) working group conducted a search for government-owned OSH systems. Their search revealed that the Federal Occupational Safety and Health Administration (OSHA) did not have a record-keeping or reporting system that could be used by reporting agencies. The working group did find, however, that the Department of Transportation, the Coast Guard, and the Environmental Protection Agency each had an OSH-related information system or were in the process of investigating the development of one. The National Aeronautics and Space Administration (NASA) has also investigated the development of an OSH-related information system.

Department of Transportion VEIIRS

The Department of Transportation (DOT) has an accident/mishap central reporting system (no compensation function) for personal injuries and property damage. Although the system contains some environmental exposure elements, it is basically a safety-oriented system called the Voluntary Employee Injury/ Illness Reporting System (VEIIRS).

Coast Guard System

The Coast Guard Repair Station in Philadelphia is in need of an OHS system and at the time of the SDP had recently acquired contract services to study the problem.

Environmental Protection Agency

The Environmental Protection Agency (EPA) has only an Injury Reporting and Information System (IRIS) operating to support solid waste management. The EPA National Computer Center advised at the time of the SDP that software conversion efforts currently ongoing at their center could make one commercial OSH-oriented software application available to government users in the immediate future. However, further discussion with EPA representatives revealed that the potential application was not currently in use and had limited OSH functions.

National Aeronautics and Space Administration System

Not mentioned in the SDP was a study in the late 1970s for the National Aeronautics and Space Administration (NASA) of the information requirements of NASA's safety, environmental health, and occupational medicine programs leading to requirements for a consolidated information system and recommendations for a computerized information system (Whyte, 1978; OSHA medical surveillance requirements and NIOSH recommendations for employees exposed to toxic substances and other work hazards, 1980). At the time of the SDP, NASA had not implemented an OSH system.

DOD Occupational Health Systems

The NAVSEA working group identified two efforts within the DOD other than NOHIMS to develop an OSH system, one in the U.S. Army and the other in the U.S. Air Force.

U.S. Army System

At the time of the SDP, the Army did not have an OSH system but had initiated system development efforts. Safety Sciences of San Diego was contracted by the Army to develop the functional description and basic program logic. It was planned that the Army OSH system would be modularly designed and deployed.

U.S. Air Force System

At the time of the SDP, the Air Force (AF) Logistic Command had developed a standard OSH program (AF OSH STD 161-17), completed design of an automated system to support their manual program, and was currently awaiting funds for system development. The AF system will eventually consist of six modules with interactive capability: (1) Industrial Hygiene, (2) Occupational Medicine, (3) Manpower/Management, (4) Environmental Protection, (5) Coronary Artery Diseases, and (6) Environment Resident Response (chemicals). Detailed discussion with regard to proposed module functions revealed that the AF system will not contain all of the OSH functions required by the Navy. The AF anticipates operation on a distributive microcomputer configuration; however, system hardware evaluations had not been completed. The system was targeted to be operational in late 1985, although the AF was skeptical that funding would be provided to complete all six modules within this time frame. The AF Depot

Maintenance Facilities are currently using the Computerized Occupational Health and Environment Surveillance System (COHESS) acquired from Diamond Shamrock Corporation. The AF indicated that COHESS is a temporary system which has been plagued with problems and will be discarded when their Computerized Occupational Health Program (COHP) becomes fully operational (Computerized Occupational Health Program (COHP): Feasibility Study, 1982).

Suitability of Government-Owned Occupational Health Information Systems to Navy Needs

It was reported in the NOHIMS SDP that while government-owned occupational safety and health systems existed, analysis revealed that these systems would not meet Navy requirements. Therefore, procurement of an existing government-owned system was rejected as not a reasonable alternative. The lone interviewee familiar with these systems, a higher level Navy manager from NEHC, concurred in this assessment, adding further that none of the government-owned OSH systems equals the capabilities of NOHIMS.

COMPARISON OF NOHIMS TO COMMERCIALLY AVAILABLE OCCUPATIONAL HEALTH INFORMATION SYSTEMS

As part of the first phase of this test and evaluation, we conducted an extensive search of relevant literature for references to and descriptions of commercially available occupational health information systems that could be compared to NOHIMS.

Commercial Occupational Health Information Systems

One entire issue of the Journal of Occupational Medicine (Vol. 24, Issue 10, 1982) was devoted to a description of commercially used or marketed occupational health information systems. The following companies reported in this journal using and/or marketing an occupational health information system: Alcoa, Control Data Corporation, Diamond Shamrock Corporation, DuPont, Eli Lilly, Exxon, Ford Motor Company, General Foods, IBM, Monsanto, New York Telephone Company, Shell Oil, SmithKline, Standard Oil Company of California, Standard Oil Company of Indiana (AMOCO), Standard Oil Company of Ohio (SOHIO), and the Upjohn Company. Other commercial occupational health information systems reported in the literature are DEChealth (marketed by the Digital Equipment Corporation) (Reed & Solomon, 1982), ETHOS (provided by Stewart-Todd Associates) (Stewart, Allen, Bilella & O'Neill, 1982), FLOW GEMINI (marketed by Flow General) (Rappaport, 1983; Rappaport & Steen, 1981), and SunHealth (developed jointly by Sun Information Services Corporation and the Sun Oil Company) (Gavin, 1983).

Suitability of Commercially Available Occupational Health Information Systems to Navy Needs

Only two commercial occupational health information systems were compared to NOHIMS in the economic analysis of the June 1984 NOHIMS System Decision Paper (SDP). The two commercial systems considered to be the most viable

alternatives in the SDP were DEChealth and FLOW GEMINI. The NOHIMS project management team determined that procurement of a commercial system would require significant modifications to meet the Navy's requirements. It was also noted that no vendor-supplied systems are operational in such diverse industrial environments as exist in the Navy. The economic analysis concluded that continued development of NOHIMS would be more cost effective than procurement of a commercial occupational health information system if at least 30 systems were to be installed at Navy industrial sites. In addition, the significant modifications needed to meet the Navy's requirements would add further to the cost of a commercial system.

Of those individuals whom we interviewed, only the higher level Navy manager from NEHC was familiar enough with commercially available occupational health information systems to be able to compare them to NOHIMS. His assessment was that none of the commercial systems equals the capabilities of NOHIMS.

COMPARISON OF NOHIMS TO THE INTERIM NAVY OCCUPATIONAL HEALTH SYSTEM

A semi-automated interim Navy occupational health system preceded the development of the fully automated Navy Occupational Health Information Management System (NOHIMS). The interim system served two important functions (Pugh & Beck, 1981). First, the interim system was implemented to test design concepts for the fully automated NOHIMS. Second, the interim system provided useful occupational health information services that offered a preview of the expanded capabilities which NOHIMS was later to deliver.

Description of the Interim Navy Occupational Health System

The interim Navy occupational health system was developed and implemented at the North Island Naval Air Rework Facility (NARF) located at the Naval Air Station, San Diego. A medical encounter form was designed and used to capture data needed for management reporting from the dispensary. Information collected on this form included visit type; injuries, illnesses, and symptoms; adjunct services provided; causative agents for occupational medical conditions; and initial and final disposition. Trial testing at the NARF dispensary demonstrated that the specially designed encounter form could be used to complete the NAVMED 6300/1 (Medical Services and Outpatient Morbidity Report) and the NAVMED 6260/1 (Report of Occupational Health Services) report forms. Testing also showed that even a manual tally of the data recorded on the encounter form was better than the previous procedures for compiling the data for these reports.

The Naval Health Research Center (NHRC) staff trained personnel at the NARF dispensary in how to properly fill out the encounter forms. The data collected on the encounter forms were keypunched at NHRC. These punched cards then were fed into a series of computer programs written in FORTRAN to automatically compile the data for the NAVMED 6300/1 and NAVMED 6260/1 reports and to print the results on a monthly basis. This monthly batch operation involved a series of two dozen programs that had to be run in a particular sequence. The interim system was not an on-line, interactive system as NOHIMS was later to be. It was

dictionary-driven, limited in what functions it could perform, and too labor intensive for any long-term implementation.

The interim system also produced two monthly reports--the Industrial Hygiene Survey Report (IHSR) and the Excessive Exposure Report (EER)--in addition to the data for the NAVMED reports. Copies of these two reports were given to the industrial hygienists, the occupational health nurse, and the safety specialists. In order to generate these reports, it was necessary to have current personnel data on all employees including demographic items, work location, and work type. At the NARF, most of these data elements can be found in a computerized database called the Personnel Extract File (PEF). Also included in the PEF for each employee is a notation indicating whether a worker is to have a periodic physical examination, the month the examination is to take place, and a set of "operational categories" which indicate the clinical tests that should be performed. The interim system relied on the PEF for monthly updates of personnel data via a magnetic tape from the NARF. The interim system also included some environmental data pertaining to the presence of hazardous materials in the workplace and individual exposures. These two reports served as reference material for the industrial hygienists and safety specialists. The occupational health nurse used the IHSR when scheduling patients for periodic physical examinations to determine if any tests should be performed other than those which reflect the job processes that the employee engages in. The occupational health nurse used the EER to identify workers exposed to hazardous materials, and in the case of serious exposures, scheduled the employees for a physical examination. The nurse also received a copy of the PEF listing showing all of the employees due for a physical examination.

The interim system was designed to collect only the data needed to produce the four reports described above. It was not designed to be able to retrieve or manipulate data stored in the database. The interim system could produce counts of the number of physical examinations conducted, the number of laboratory tests done by type of test, and the number of procedures performed by type of procedure. However, any manipulation of the database to retrieve different information or information combined in different ways required additional programming and a great deal of effort. Therefore, that capability was deferred to NOHIMS.

Suitability of the Interim Navy Occupational Health System to Navy Needs

Four individuals who were involved with the design, development, and operation of the interim Navy occupational health system at NHRC were asked to assess the interim system's suitability to Navy needs. The four questions they were asked may be found in Component 37b of Appendix A.

With regard to the interim system's suitability to Navy information collection needs, the NHRC system developers felt that the system was suitable within the intended purpose of the interim system but unsuitable for the long-term system because data entry was cumbersome and the data collected were incomplete. Areas of additional data collection needed in the long-term system that were mentioned by the NHRC developers were more medical encounter data, results of lab tests, first aid information for acute exposures, hazard characteristics, medical history, and occupational history.

The interim system was regarded as suitable to Navy information retrieval needs for a developmental system to test design concepts but not for an ultimate system. One NHRC developer noted that the interim system was more suitable for retrieving occupational data than medical data in that the system could not retrieve data for an individual patient. The NHRC developers mentioned the need for a report generator and a query capability in the ultimate system.

The interim system was not considered suitable for Navy information manipulation needs by the NHRC developers because there was no way to query the database. The data were there, but data items were difficult to access and manipulate. The NHRC developers mentioned the need for a way to make ad hoc requests of the database and a statistical analysis capability in the ultimate system.

Overall, the NHRC system developers' assessment of the adequacy of the interim system for Navy information processing needs was that it was adequate for its intended interim purpose but that it was inadequate as a long-term operational system.

Benefits of the Interim Navy Occupational Health System

The NHRC system developers mentioned a number of benefits resulting from the interim Navy occupational health system that they regarded as most significant. One developer mentioned that the monthly reports produced by the interim system increased the acceptance of the NOHIMS concept. The administrative reports produced by the interim system were more accurate than the manually prepared reports they replaced. Two developers noted the benefit of considerable improvement in the appropriateness of examinations and tests performed resulting in increased efficiency in the use of resources.

An evaluation of the effectiveness and impact of the semi-automated interim system on operational procedures at the NARF dispensary was conducted by making a pre- and post-comparison of medical surveillance for workers at the North Island NARF. Data were collected and compiled for the month prior to the introduction of the interim system (February 1982) and for the four months after introduction of the interim system (March through June 1982) (NHRC, 1982).

The findings from this evaluation corroborate the benefits reported by the NHRC system developers. There were four principal findings.

1. Prior to the implementation of the interim system, few of the workers at the NARF exposed to four substances that require monitoring (acrylonitrile, asbestos, benzene, and lead) received the medical test(s) required because of their exposure.

2. After the implementation of the interim system, more workers received the required medical tests even though there was no increase in the total number of tests performed. In fact, there was a decrease in the total number of tests performed, from 323 in February 1982 to 208 in June 1982.

3. As a result of the interim system, proportionately more medical tests were being performed on workers with critical exposures.

4. As a result of the interim system, proportionately fewer medical tests were being performed on workers with no exposure to any hazards.

Summary

The alternative systems to NOHIMS in the government and commercial sectors that were identified, described, and evaluated in the June 1984 NOHIMS System Decision Paper prepared by the Navy Environmental Health Center were discussed. Additional systems that could be compared to NOHIMS were identified from a search of the relevant literature. Analysis of these systems revealed that none met Navy requirements and none equaled the capabilities of NOHIMS.

NOHIMS was also compared to a semi-automated interim Navy occupational health system that preceded it. The interim system was implemented to test design concepts for the fully automated NOHIMS and to provide useful occupational health information services for the North Island Naval Air Rework Facility. These services offered a preview of the expanded capabilities that NOHIMS was later to deliver.

Four administrative reports were produced in a batch operation on a monthly or semi-annual basis by the interim system. The system was designed to collect only the data needed to produce these four reports. It was not designed to be able to retrieve or manipulate data stored in the database. That capability was deferred to NOHIMS. The interim system was not an on-line, interactive system as NOHIMS was later to be. It was dictionary-driven, limited in what functions it could perform, and too labor intensive for any long-term implementation.

Overall, the Naval Health Research Center (NHRC) system developers who designed and developed both NOHIMS and the interim system felt that the interim system was adequate for its intended interim purpose but that it was inadequate as a long-term operational system. The NHRC system developers perceived a number of benefits resulting from the interim system. The administrative reports produced by the interim system were more accurate than the manually prepared reports they replaced and increased acceptance of the NOHIMS concept. They also perceived considerable improvement in the appropriateness of examinations and tests performed resulting in increased efficiency in the use of resources.

An evaluation of the effectiveness and impact of the semi-automated interim system on operational procedures at the Naval Air Rework Facility (NARF) dispensary was conducted by making a pre- and post-comparison of medical surveillance for workers at the North Island NARF. The findings from this evaluation corroborate the benefits perceived by the NHRC developers in that after the introduction of the interim system, more workers received the required medical tests even though there was no increase in the total number of tests performed, proportionately more medical tests were being performed on workers with critical exposures, and proportionately fewer medical tests were being performed on workers with no exposure to any hazards.

BIBLIOGRAPHY

Beck, D.D., & Pugh, W.M. Specifications for a Navy Occupational Health Information Monitoring System (NOHIMS): II. A functional overview. San Diego, CA: Naval Health Research Center, Report No. 82-6, 1982.

Comparison of medical surveillance at the North Island Naval Air Rework Facility before and after implementation of the interim Navy Occupational Health Information Monitoring System. San Diego, CA: Naval Health Research Center, 1982.

Computerized Occupational Health Program (COHP): Feasibility study. Brooks AFB, TX: USAF Occupational and Environmental Health Laboratory, June 1982.

Drexler, J.A., Jr., Jones, A.P., & Gunderson, E.K.E. (Eds.) Problems and Strategies of Implementing Navy Occupational Health and Safety Programs. Seattle, WA: Battelle Human Affairs Research Centers, and San Diego, CA: Naval Health Research Center, Contract N00014-78-C-0888, June 1979.

Gavin, J.H. SunHealth--A flexible IBM oriented system for both large and small organizations. In R.E. Dayhoff (Ed.), Proceedings of the Seventh Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1983. P. 393.

Journal of Occupational Medicine, Vol. 24(10), October 1982 (this entire issue is devoted to a description and comparison of occupational health information systems).

Navy Occupational Health Information Management System (NOHIMS) System Decision Paper I/II. Norfolk, VA: Navy Environmental Health Center, June 1984.

NOHIMS: Navy Occupational Health Information Management System Users Guide (Industrial Component), Version 1.0. Naval Health Research Center, San Diego, California, September, 1985.

NOHIMS OHS Component System Maintenance Manual, Version 1.0. Naval Health Research Center, San Diego, California, September, 1985.

NOHIMS System Managers' Manual (Medical Component), Version 1.0. Naval Health Research Center, San Diego, California, March 1985.

NOHIMS Users' Reference Manual (Medical Component), Version 1.0. Naval Health Research Center, San Diego, California, December 1984.

OSHA medical surveillance requirements and NIOSH recommendations for employees exposed to toxic substances and other work hazards (prepared for the NASA Occupational Health Office). Falls Church, VA: BioTechnology, Inc., January, 1980.

Pugh, W.M., & Beck, D.D. Preliminary specifications for a Navy Occupational Health Information Monitoring System (NOHIMS). San Diego, CA: Naval Health Research Center, Report No. 81-36, 1981.

Rappaport, W. FLOW GEMINI: A proven occupational health information system. In R.E. Dayhoff (Ed.), Proceedings of the Seventh Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1983. Pp. 391-392.

Rappaport, W., & Steen, C. FLOW GEMINI: An occupational health information system. In H.G. Heffernan (Ed.), Proceedings of the Fifth Annual Symposium on Computer Applications in Medical Care. Silver Springs, MD: IEEE Computer Society Press, 1981. Pp. 1061-1065.

Reed, L.J., & Solomon, M.E. DEChealth: A comprehensive occupational health information system. In B.I. Blum (Ed.), Proceedings of the Sixth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1982. Pp. 144-147.

Stewart, W.W., Allen, J.W., Bilella, J., & O'Neill, P. ETHOS, a health surveillance data base system. In B.I. Blum (Ed.), Proceedings of the Sixth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1982. Pp. 135-138.

Watson, B.L. Medical data and computer generated evidence. In R.E. Dayhoff (Ed.), Proceedings of the Seventh Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1983. Pp. 633-638.

Whyte, A.A. Information requirements of the National Aeronautics and Space Administration's safety, environmental health, and occupational medicine program. Falls Church, VA: BioTechnology, Inc., Contract NASW-3119, May 1978.

APPENDIX A

THE CONTENT OF STRUCTURED INTERVIEWS FOR TWELVE CLASSES OF INDIVIDUALS INVOLVED WITH NOHIMS, LISTING THE COMPONENTS CONTAINED IN EACH INTERVIEW GUIDE

Component 1	A-6	Component 20	A-72
Component 2	A-8	Component 21	A-74
Component 3	A-10	Component 22	A-78
Component 4	A-12	Component 23	A-79
Component 5	A-14	Component 24	A-84
Component 6	A-44	Component 25	A-86
Component 7	A-46	Component 26	A-88
Component 8	A-49	Component 27	A-89
Component 9	A-50	Component 28	A-90
Component 10	A-52	Component 29	A-91
Component 11	A-54	Component 30	A-92
Component 12	A-60	Component 31	A-94
Component 13	A-62	Component 32	A-97
Component 14	A-64	Component 33	A-100
Component 15	A-65	Component 34	A-101
Component 16	A-66	Component 35	A-102
Component 17	A-68	Component 36	A-106
Component 18	A-69	Component 37	A-110
Component 19	A-70		

CONTENT OF STRUCTURED INTERVIEWS

(NOTE: The numbers below correspond to the LIST OF COMPONENTS OF STRUCTURED INTERVIEWS)

STRUCTURED INTERVIEW FOR MEDICAL CARE PROVIDER USERS

2. Perceived goals for NOHIMS/Assessment of how well perceived goals for NOHIMS were met
7. Use and usefulness of information retrieval capabilities
10. Assessment of user friendliness of NOHIMS
13. Adequacy of security features
19. Suitability of NOHIMS to Navy information processing needs
20. Assessment of system performance
21. Attitude appraisal
23a. Medical monitoring and care goals/Assessment of how well medical monitoring and care goals are being met
23b. Assessment of increase in communication between departments
31. Implementation process at test sites
32. Acceptability of NOHIMS to users
33. Assessment of transferability of NOHIMS to other Navy industrial sites
34. Perceived benefits of NOHIMS

STRUCTURED INTERVIEW FOR INDUSTRIAL USERS

2. Perceived goals for NOHIMS/Assessment of how well perceived goals for NOHIMS were met
7. Use and usefulness of information retrieval capabilities
10. Assessment of user friendliness of NOHIMS
13. Adequacy of security features
19. Suitability of NOHIMS to Navy information processing needs
20. Assessment of system performance
21. Attitude appraisal
23b. Assessment of increase in communication between departments
31. Implementation process at test sites
32. Acceptability of NOHIMS to users
33. Assessment of transferability of NOHIMS to other Navy industrial sites
34. Perceived benefits of NOHIMS

STRUCTURED INTERVIEW FOR DATA ENTRY PERSONNEL

10. Assessment of user friendliness of NOHIMS
20. Assessment of system performance
21. Attitude appraisal

CONTENT OF STRUCTURED INTERVIEWS (CONT.)

STRUCTURED INTERVIEW FOR CONTRACTED NOHIMS DEVELOPERS

3. Programming structure and language used
4b. Minimum requirements for hardware
5. System description (options, features, and functions)
8. Software quality attributes
9. Operational characteristics
11. Information retrieval capabilities
12. Security features
14. Software support requirements
17. System scenarios to maintain the system
18. Organizational requirements
22. Appropriate scenarios for system testing
30. Features that make NOHIMS flexible and adaptable
34. Perceived benefits of NOHIMS

STRUCTURED INTERVIEW FOR NHRC NOHIMS DEVELOPERS

1. Stated Navy goals for NOHIMS/Assessment of how well Navy goals for NOHIMS were met
2. Perceived goals for NOHIMS/Assessment of how well perceived goals for NOHIMS were met
4a. Current hardware configuration
6. Description of system users
13. Adequacy of security features
15. Hardware support requirements
16. Available system support
17. System scenarios to maintain the system
18. Organizational requirements
19. Suitability of NOHIMS to Navy information processing needs
22. Appropriate scenarios for system testing
23a. Medical monitoring and care goals/Assessment of how well medical monitoring and care goals are being met
27. NOHIMS as an aid to epidemiologic research
28a. Uses in administrative functions
29. Applicability of NOHIMS to other Navy industrial sites
31. Implementation process at test sites
33. Assessment of transferability of NOHIMS to other Navy industrial sites
34. Perceived benefits of NOHIMS
35. Suitability of government-owned occupational health information systems to Navy needs
36. Suitability of commercially available occupational health information systems to Navy needs
37a. Description of Navy interim occupational health information system
37b. Suitability of Navy interim occupational health information system to Navy needs

CONTENT OF STRUCTURED INTERVIEWS (CONT.)

STRUCTURED INTERVIEW FOR NHRC INTERIM SYSTEM DEVELOPERS

1. Stated Navy goals for NOHIMS/Assessment of how well Navy goals for NOHIMS were met
2. Perceived goals for NOHIMS/Assessment of how well perceived goals for NOHIMS were met
19. Suitability of NOHIMS to Navy information processing needs
34. Perceived benefits of NOHIMS
37a. Description of Navy interim occupational health information system
37b. Suitability of Navy interim occupational health information system to Navy needs

STRUCTURED INTERVIEW FOR TEST SITE ADMINISTRATORS

2. Perceived goals for NOHIMS/Assessment of how well perceived goals for NOHIMS were met
6. Description of system users
7. Use and usefulness of information retrieval capabilities
10. Assessment of user friendliness of NOHIMS
13. Adequacy of security features
19. Suitability of NOHIMS to Navy information processing needs
20. Assessment of system performance
21. Attitude appraisal
28a. Uses in administrative functions
28b. Assessment of usefulness of NOHIMS in administrative functions
31. Implementation process at test sites
32. Acceptability of NOHIMS to users
33. Assessment of transferability of NOHIMS to other Navy industrial sites
34. Perceived benefits of NOHIMS

STRUCTURED INTERVIEW FOR SYSTEM MANAGERS

2. Perceived goals for NOHIMS/Assessment of how well perceived goals for NOHIMS were met
6. Description of system users
7. Use and usefulness of information retrieval capabilities
10. Assessment of user friendliness of NOHIMS
13. Adequacy of security features
17. System scenarios to maintain the system
20. Assessment of system performance
21. Attitude appraisal
22. Appropriate scenarios for system testing
31. Implementation process at test sites
33. Assessment of transferability of NOHIMS to other Navy industrial sites
34. Perceived benefits of NOHIMS

CONTENT OF STRUCTURED INTERVIEWS (CONT.)

STRUCTURED INTERVIEW FOR HIGHER LEVEL NAVY MANAGEMENT

1. Stated Navy goals for NOHIMS/Assessment of how well Navy goals for NOHIMS were met
2. Perceived goals for NOHIMS/Assessment of how well perceived goals for NOHIMS were met
13. Adequacy of security features
19. Suitability of NOHIMS to Navy information processing needs
28a. Uses in administrative functions
28b. Assessment of usefulness of NOHIMS in administrative functions
29. Applicability of NOHIMS to other Navy industrial sites
33. Assessment of transferability of NOHIMS to other Navy industrial sites
34. Perceived benefits of NOHIMS

STRUCTURED INTERVIEW FOR NEHC PROJECT MANAGEMENT TEAM

1. Stated Navy goals for NOHIMS/Assessment of how well Navy goals for NOHIMS were met
2. Perceived goals for NOHIMS/Assessment of how well perceived goals for NOHIMS were met
13. Adequacy of security features
19. Suitability of NOHIMS to Navy information processing needs
23a. Medical monitoring and care goals/Assessment of how well medical monitoring and care goals are being met
29. Applicability of NOHIMS to other Navy industrial sites
33. Assessment of transferability of NOHIMS to other Navy industrial sites
34. Perceived benefits of NOHIMS
35. Suitability of government-owned occupational health information systems to Navy needs
36. Suitability of commercially available occupational health information systems to Navy needs
37b. Suitability of Navy interim occupational health information system to Navy needs

STRUCTURED INTERVIEW FOR NAVY LEGAL COUNSEL

24. Information required for Navy legal purposes
25. Assessment of how well NOHIMS meets Navy legal needs
26. Appropriate scenarios for testing of legal interrogatories
34. Perceived benefits of NOHIMS

STRUCTURED INTERVIEW FOR NHRC/BREMERTON ADP PERSONNEL

4a. Current hardware configuration
15. Hardware support requirements
16. Available system support
17. System scenarios to maintain the system

LIST OF COMPONENTS OF STRUCTURED INTERVIEWS

1. Stated Navy goals for NOHIMS/Assessment of how well Navy goals for NOHIMS were met
2. Perceived goals for NOHIMS/Assessment of how well perceived goals for NOHIMS were met
3. Programming structure and language used
4a. Current hardware configuration
4b. Minimum requirements for hardware
5. System description (options, features, and functions)
6. Description of system users
7. Use and usefulness of information retrieval capabilities
8. Software quality attributes
9. Operational characteristics
10. Assessment of user friendliness of NOHIMS
11. Information retrieval capabilities
12. Security features
13. Adequacy of security features
14. Software support requirements
15. Hardware support requirements
16. Available system support
17. System scenarios to maintain the system
18. Organizational requirements
19. Suitability of NOHIMS to Navy information processing needs
20. Assessment of system performance
21. Attitude appraisal (a self-administered questionnaire; not part of structured interview)
22. Appropriate scenarios for system testing
23a. Medical monitoring and care goals/Assessment of how well medical monitoring and care goals are being met
23b. Assessment of increase in communication between departments
24. Information required for Navy legal purposes
25. Assessment of how well NOHIMS meets Navy legal needs
26. Appropriate scenarios for testing of legal interrogatories
27. NOHIMS as an aid to epidemiologic research
28a. Uses in administrative functions
28b. Assessment of usefulness of NOHIMS in administrative functions
29. Applicability of NOHIMS to other Navy industrial sites
30. Features that make NOHIMS flexible and adaptable
31. Implementation process at test sites
32. Acceptability of NOHIMS to users
33. Assessment of transferability of NOHIMS to other Navy industrial sites
34. Perceived benefits of NOHIMS
35. Suitability of government-owned occupational health information systems to Navy needs
36. Suitability of commercially available occupational health information systems to Navy needs
37a. Description of Navy interim occupational health information system
37b. Suitability of Navy interim occupational health information system to Navy needs

STATED NAVY GOALS FOR NOHIMS/ASSESSMENT OF HOW WELL NAVY GOALS FOR NOHIMS WERE MET

1. It is my understanding that the intended Navy primary goals for NOHIMS are/were to

   meet OSHA requirements/
   improve medical surveillance/
   improve workplace monitoring/
   provide data for epidemiologic analysis/
   improve patient care/
   improve coordination between departments/
   provide management data/
   improve access to care/
   improve manpower utilization/
   improve resources utilization/
   provide data for legal functions/
   other: _____
   _____
   _____.

2. The stated Navy goals came about in response to

   administrative direction/
   legal obligations/
   need felt by medical staff/
   need felt by medical research/
   public demand/
   political pressure/
   organized group pressure/
   worker demand/
   other: _____
   _____
   _____.

3. I consider NOHIMS in its present state to be meeting these Navy goals

   very well/
   somewhat well/
   somewhat not well/
   not well.

4. The specific goals that NOHIMS is not meeting very well are to

   meet OSHA requirements/
   improve medical surveillance/
   improve workplace monitoring/
   provide data for epidemiologic analysis/
   improve patient care/
   improve coordination between departments/
   provide management data/
   improve access to care/
   improve manpower utilization/
   improve resources utilization/
   provide data for legal functions/
   other: _____
   _____
   _____.

5. The reasons that NOHIMS is not meeting the goal(s) are

NOHIMS lacks essential function(s)
Specify: _____/
feature(s) are not implemented
Specify: _____/
feature(s) are not implemented well
Specify: _____/
other: _____
_____.

6. The goals that have been only partially achieved are to

meet OSHA requirements/
improve medical surveillance/
improve workplace monitoring/
provide data for epidemiologic analysis/
improve patient care/
improve coordination between departments/
provide management data/
improve access to care/
improve manpower utilization/
improve resources utilization/
provide data for legal functions/
other: _____
_____
_____.

7. The reasons that NOHIMS has only partially achieved these goals are

NOHIMS lacks essential function(s)
Specify: _____/
feature(s) are not implemented
Specify: _____/
feature(s) are not implemented well
Specify: _____/
other: _____
_____.

PERCEIVED GOALS FOR NOHIMS/ASSESSMENT OF HOW WELL PERCEIVED GOALS FOR NOHIMS WERE MET

1. My personal goals for NOHIMS are/were to

   meet OSHA requirements/
   improve medical surveillance/
   improve workplace monitoring/
   provide data for epidemiologic analysis/
   improve patient care/
   improve coordination between departments/
   provide management data/
   improve access to care/
   improve manpower utilization/
   improve resources utilization/
   provide data for legal functions/
   other: _____
   _____
   _____.

2. I consider NOHIMS in its present state to be meeting these goals

   very well/
   somewhat well/
   somewhat not well/
   not well.

3. The specific goals that NOHIMS is not meeting very well are to

   meet OSHA requirements/
   improve medical surveillance/
   improve workplace monitoring/
   provide data for epidemiologic analysis/
   improve patient care/
   improve coordination between departments/
   provide management data/
   improve access to care/
   improve manpower utilization/
   improve resources utilization/
   provide data for legal functions/
   other: _____
   _____
   _____.

4. The reasons that NOHIMS is not meeting the goal(s) are

   NOHIMS lacks essential function(s)
   Specify: _____/
   feature(s) are not implemented
   Specify: _____/
   feature(s) are not implemented well
   Specify: _____/
   other: _____
   _____.

5. The goals that have been only partially achieved are to

meet OSHA requirements/
improve medical surveillance/
improve workplace monitoring/
provide data for epidemiologic analysis/
improve patient care/
improve coordination between departments/
provide management data/
improve access to care/
improve manpower utilization/
improve resources utilization/
provide data for legal functions/
other: _____
_____
_____.

6. The reasons that NOHIMS has only partially achieved these goals are

NOHIMS lacks essential function(s)
Specify: _____/
feature(s) are not implemented
Specify: _____/
feature(s) are not implemented well
Specify: _____/
other: _____
_____.

PROGRAMMING STRUCTURE AND LANGUAGE USED

1. The system routines for the medical component of NOHIMS were written by

   a vendor/
   consultants/
   research personnel/
   clinical personnel/
   professional programmers.

2. The system routines for the industrial component of NOHIMS were written by

   a vendor/
   consultants/
   research personnel/
   clinical personnel/
   professional programmers.

3. Their operation was verified by

   the vendor/
   consultants/
   research personnel/
   clinical personnel/
   professional data processing staff.

   through

   a formal check-out procedure/
   pilot operation/
   routine operational use.

4. The principal programming language is

   Assembler/
   FORTRAN/
   COBOL/
   PL/1/
   MUMPS/
   Other: _____.

5. The programming structure is

   incremental/
   hierarchical/
   structured programming.

6. The routines were designed and written for

   this application/
   general medical purposes/
   general commercial purposes/
   general occupational health purposes.

7. The software is now being

   further developed/maintained/understood/ignored
   by the local staff/
   further developed/maintained/ignored by the
   authors.

8. The file system is characterized by

   sequential files/
   tabular files/
   indexed files/
   direct access (random files)/
   linked records/
   hierarchical direct access B-tree files.

9. The files are

   compressed/fixed length/variable length.

   File space is dynamically/pre-allocated.

10. NOHIMS uses

    foreground interactive processing/
    equal foreground/background processing/
    background/batch processing/

    for most of its processing.

CURRENT HARDWARE CONFIGURATION AND MINIMUM REQUIREMENTS FOR HARDWARE

4A Current Hardware Configuration

1. The processing capability is provided through the following computer(s)

No.	Manufacturer	Model	Size	Year Installed

2. The computing services are provided through a

   vendor: _____

   associated organization: _____

   in-house.

3. The equipment is rented/leased/purchased.

4. Maintenance is by vendor/in-house.

5. Approximately _____% of the processing capability is used for NOHIMS.

6. Approximately _____(% or actual) of the file capability is used for NOHIMS.

	No.	Type	Model
7a. The files are stored on			
b. Communication equipment includes			
c. Other important equipment is			
d. Archival storage is			

8. Hardcopy terminals are

No.	Type	Char./ line	U/L case	Speed	Mechanism	Reliability

9. Softcopy terminals are

No.	Type	Screen	Char./ line	U/L case	Speed	Lines/ screen	Relia- bility	Character resolution
_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____

10. Currently production occupies _____% of the machine,

and development _____%.

11. Of the production load

_____% is data entry,
_____% is file maintenance,
_____% is data analysis, and
_____% is report preparation.

12. The operating system was designed and written

for this application and/or institution/
for general medical purposes/
for general commercial purposes.

13. It is now being

further developed/maintained/understood/ignored
by the local staff/
further developed/maintained/ignored
by the original supplier.

↑
4A

4B Minimum Hardware Requirements

14. The minimum hardware configuration that could support NOHIMS is

Processor: _____

Terminals: _____

File Storage: _____

Communications Equipment: _____

SYSTEM DESCRIPTION (OPTIONS, FEATURES, AND FUNCTIONS)

1. What are the primary system options in the medical component of NOHIMS? What is the function of each of these options? What suboptions are available under each system option?

   Registration: _____

   Enter Medical Data: _____

   Display Medical Data: _____

   Print Medical Data: _____

   System Maintenance: _____

   COSTAR Report Generator: _____

   Mailbox: _____

   Occupational Health Information: _____

2. What are the main functions and features of each of the options in the medical component of NOHIMS?

   Registration: Patient Registration/Edit

   Can patients already entered in the database be adequately identified in order to avoid duplicate registrations?

   Can patients be identified with ambiguous entries?

   Are patient names searched by phonetics?

   Can a patient unit number be assigned by the system? by the clinic?

   Can the sequence of registration entry items be altered to add new items? delete items? require items? not require items? change the sequence of prompts? change the name of the prompts? provide range checking?

   Can the possible responses to the items in the registration sequence be changed?

   What are the limits on the number of items that can be entered for a patient during registration?

Are items that are not applicable skipped automatically?

Is there any limitation to the kinds of data that can be entered during registration?

Are there conventions which minimize the keystrokes required at each prompt?

Are the entries made displayed on the screen during data entry? Does the screen display during data entry duplicate the input documents?

Can the user redisplay the data entered to be certain that all entries are correct?

Can the display of registration items be formatted in any manner desired?

Are there any features that verify the entry of data?

What requirements are there for the input documents for registration?

What methods can be used to enter data such as keypunch, optical scanning, bar code reading, CRT entry, or direct machine interface?

Can data be kept historically for selected data items?

Can incorrect entries be edited before filing?

Can the user select the specific data item that needs editing?

Is the patient registration information filed in the background while registration proceeds?

Is there help text for the registration sequence?

Can help text for the registration sequence be changed?

Describe any additional features of this option.

Enter Medical Data: Encounter

What defines an encounter for NOHIMS?

Can more than one encounter be entered on a given day?

Can an encounter be entered if a patient has not been registered?

Can the prompt sequence for the header of the encounter be altered to change the sequence? add items? delete items? perform range checking? change prompt names? require items? not require items?

Does the patient record need to be identified for each encounter entered into the database?

Can possible responses to the items in the header sequence be changed?

Is there help text for the encounter header entry sequence?

Can help text for the encounter header entry sequence be changed?

Can the providers of care for the encounters be entered in a table that is referred to by the prompt sequence? Can changes be made to this table?

Is there any limitation to the types of data that can be entered during the header portion of the encounter?

Can the sequence for entering data during the body portion of the encounter be altered?

Is there any limitation to the types of data that can be entered during the body portion of the encounter?

Can the items to be entered during the body portion of the encounter be augmented to assign abnormal statuses? assign other statuses?

Can lab results be entered during encounter entry?

Can a panel of tests be specified? Can the individual tests be specified?

Is help text available for the entry of data in the body of the encounter?

Are the entry procedures the same for each class of data item?

What is the minimum amount of information required to enter data in the system? Is there more than one way to enter a particular item?

Are there any short-cut methods to enter the data?

Are there conventions that minimize the keystrokes required at each prompt?

Does a data item have to be predefined in NOHIMS before it can be entered?

Can free text be associated with codes?

Can additional codes be added to the directory?

Can features of these codes be changed at will?

Can NOHIMS be told to automatically prompt for text?

Can NOHIMS be told to require that a modifier be entered?

Can special input/output formats be specified for selected data items?

What restrictions are there on the short name of a code?

What restrictions are there on the long name of a code?

What is the significance of the COSTAR code? the COSTAR taxonomy?

What functions does the modifier play? How is it useful in the NOHIMS application?

Can codes be blocked from encounter entry?

What other input conditions can be set for codes entered during encounter entry?

Can flowcharts be triggered by the entry of a code in the patient's medical record?

Does NOHIMS perform range checking on results and findings? What criteria can be specified for range checking?

Are the entries made displayed on the screen during entry? Does the screen display during entry duplicate the input documents?

Can changes be made to the information already entered for a patient while in the encounter option?

What methods can be used to enter data such as keypunch, optical scanning, bar code reading, CRT entry, or direct machine interface?

What requirements are there for the input documents for encounter entry?

Are all codes to be entered into NOHIMS precoded on the data collection forms? Who codes data that are not precoded?

Are there any features that verify entry of the data? Does the COSTAR code have a check digit?

Is the information entered during encounter entry filed in the background/using transaction processing/batch processing? When are the input data reflected in the files?

Can another encounter be entered while data are being filed to a patient record?

Describe any additional features of this option.

Enter Medical Data: Medical Edit

Can the patient record to be edited be identified with an ambiguous entry?

Can the patient record to be edited be identified by name? by social security number? by unit number?

Is the patient record to be edited displayed before editing is done?

Can all data items be edited? be deleted?

Can the user select the specific item that needs editing?

What is the format for editing a data item?

Is editing done on-line or with a special batch program? When are changes reflected in the files?

Is an item which is deleted actually removed from the patient record?

Are old results and free text associated with codes that have been edited actually removed from the patient record?

Is an audit trail of all entry errors maintained?

Does editing an encounter affect the display of the encounter?

When a correction is made, are all previously derived reports/ fields automatically corrected or are changes entered in the file only?

Can an entire encounter be deleted?

Can a generic edit be accomplished such as deleting all laboratory codes?

Are the edits made displayed on the screen during editing?

Are there any features that verify the editing of data?

What requirements are there for the input documents for editing an encounter?

Describe any additional features of this option.

Enter Medical Data: Lab Results

Can the patient for whom lab results are to be entered be identified with an ambiguous entry?

Can the patient for whom lab results are to be entered be identified by name? by social security number? by unit number?

Does the patient record need to be identified for each lab result entered?

How is the proper lab test to be resulted identified?

Can lab results be entered for a date that does not have an encounter?

Can lab results be entered for a test that has not been recorded in the encounter?

Are there short cuts to entering lab results data?

Can panels of tests be resulted as a group? can individual tests be resulted?

Do all tests in a panel have to be resulted at the same time?

Are there any features that verify the entry of data? Is range checking performed on the lab results entry?

What limitations are there on the format for entering lab results data?

Can free text be entered with a lab result?

Can NOHIMS interpret lab results? What criteria are used to interpret the results? Can these criteria be changed easily?

Can lab results be edited once they are filed?

Is the filing of lab results done in the background?

Does NOHIMS keep track of the status of a lab test (ordered/ pending/resulted)?

Are there conventions that minimize the keystrokes required at each prompt?

Are the entries made displayed on the screen during entry? Does the screen display during entry duplicate the input documents?

Is there any limit to the number of lab tests that can be entered for a given patient on a given day?

Can more than one lab result be entered for a lab test on the same day (repeat tests)?

Can special input/output sequences be used for tests with several components such as urinalysis and pulmonary function tests?

Is there help text for the lab results entry? Is it specific for each lab test?

Can an incorrectly entered lab test be deleted in this option?

What requirements are there for the input documents for the laboratory results?

Can lab results be automatically entered from machines or other systems?

Can NOHIMS automatically generate orders for laboratory tests?

Describe any additional features of this option.

Display Medical Data*

Print Medical Data*

* Please see the Information Retrieval Capabilities section of the structured interviews for questions on these two system options.

System Maintenance

Please see the Security Features section of the structured interviews for questions on security functions. See the Software Quality Attributes and Operational Characteristics sections of the structured interviews for questions on error recovery procedures and error diagnostics.

Can the functions of the background filing job (Monitor) be controlled without programming intervention?

Does NOHIMS display information regarding the filing status of the data?

Can a variety of terminal types be used with NOHIMS?

Can the codes in the directory be printed and/or displayed for review?

Can the user select the directory codes to be printed/displayed by division? by other criteria?

Can the user specify the order in which the codes are printed/displayed?

What is the format of the directory print/display? Can this format be altered without programming intervention?

Can the specifications for a particular code be reviewed?

Can the specifications for a particular code be altered?

Can a code be added to the directory? deleted from the directory?

Can patient records be archived to tape? retrieved from tape? to and from other media?

What selection criteria may be used to define the patient records that are to be archived? retrieved from the archive?

Is there a zip code directory? Can the zip code directory be updated?

Can a 9-digit zip code be entered in the directory?

Can jobs run on the system be queued to run at a particular time of day on a particular date?

Can the job queue be altered without programming intervention? Can a job be deleted from the job queue?

Does the system provide a profile of current users of the system? What information is included in this profile?

Can a user be given the ability to review the specifications of a code without being given the ability to alter the directory?

Is there help text for the system maintenance procedures?

Describe any additional features of this module.

Mailbox

Can NOHIMS store messages for other users of the system?

Can a message be sent to all users? to a selected group of users?

Is there any limitation to the length of a message?

Can a message be edited before it is stored? after it is stored?

Does NOHIMS note the time and day that a message was sent?

Does NOHIMS tell you if you have mail?

Does NOHIMS keep track of whether you have read your mail?

Can NOHIMS tell you if others have read the mail you sent?

Can a hardcopy of a message be produced?

Can mail be selectively deleted? by the receiver? by the sender? by the system manager?

Is there any limitation to the number of messages that can be sent/stored at any one time?

Is there help text for the mailbox procedures?

Describe any additional features of this module.

Occupational Health Information

Can the data in the industrial component of NOHIMS be accessed from the medical component? by the user? by the system for reports?

Can restrictions be placed on the access to the industrial component?

Describe any additional features of this module.

3. What system interfaces/relationships does NOHIMS have with other Navy and/or non-Navy data systems?

   Does NOHIMS access and display information derived from intra- and extra-Navy databases such as demographic data from personnel databases, safety department databases, and hazard/toxic chemical databases?

   Does NOHIMS incorporate or replace existing central Asbestos Medical Surveillance Program (AMSP) and HEaring Conservation Management Information System (HECMIS) databases?

   Does NOHIMS utilize historic data contained in AMSP and HECMIS databases?

4. What are the primary options in the industrial component of NOHIMS? What is the function of each of these options? What suboptions are available under each system option?

   Agency: _____

   _____

   _____

   Personnel: _____

   _____

   _____

   Environments: _____

   _____

   _____

   Surveys: _____

   _____

   _____

   Hazardous Agent Table: _____

   _____

   _____

   System Maintenance: _____

   _____

   _____

5. What are the main functions and features of each of the options in the industrial component of NOHIMS?

INDUSTRIAL COMPONENT OF NOHIMS

PRIMARY INFORMATION TOPICS

The Industrial Component is concerned with the collection, control, coodination and manipulation of the five specific major topical areas of information as given below.

The design of this component specifically attempts to record, maintain and assess the inter-relationship of these data in order to provide automated capabilities that satisfy the industrial related information objectives of the NOHIMS system.

1. The Industrial organization (Agency).
2. The employees and other personnel within the organization (Personnel).
3. The work environments local to the organization (Environments).
4. The contents, concentration measurments, configuration and use of materials, agents and conditions of the work environments (Surveys).
5. The collection and application of information related to the monitoring, usage and health care aspects of chemical substances, biological elements and physical phenomena (Hazardous Agent Table).

The following interrogatory scenarios solicit and chronicle the pertinent technical, functional and methodological attributes and features that are incorporated in the Industrial component as they apply to:

1. Each of the above major topics.
   a. Purpose and usage.
   b. Identifier entry, edit, update, filing, availability, retrieval and display functions.
   c. Associated data item entry, edit, update, filing, availability, retrieval and display functions.
   d. Transaction handling.
   e. Inter-relation to other major topic data.
   f. Special features.

2. System objective specific functions.
   a. Objective description.
   b. Initiation, subject and/or data item identification and selection.
   c. Data or transaction entry, edit, update and filing.
   d. Retrieval, organization and display.
   e. Special features.

3. System Security Functions.

4. System Tables, Directory and Utility Maintenance.

5. System Error Recovery.

AGENCY FUNCTIONS and INFORMATION

PURPOSE: Describe the primary objectives that the system functions, as a whole, are designed to provide, achieve or support in this topic area.

IDENTIFIERS: Include explanations or comments as required.

Can a local or ad hoc organizational structure be defined for use?
Defined by whom? <general user/system manager/system implementor/ADP professional>

Can one or more geographical locations (sites) local to the industry be defined within the oganizational definition?
With user-specific identifiers?
With additional user-selected acronyms?

Can the hierarchical levels and associated titles of the organizational structure be defined?
With user-specific title identifiers?

Can the association between hierarchical level and work unit be defined?
Can it represent the true relationship of work units at each hierarchical level?
Can it represent the true relationship of work units at hierarchical levels above and below any specified level?

Can each individual work unit be defined?
With user-specific identifiers?
With additional acronyms or user-specific codes?
Is the site location of the work unit associated with it?
Can a work unit reside at more than one site?

ASSOCIATED DATA: Provide a list of data items that are intrinsically solicited relative to the AGENCY topic or identifiers. Include any necessary description.

UPDATE CAPABILITY:

Can the original organizational definition be altered, updated, expanded, deleted and generally manipulated?

Are alterations that are made reflected throughout the applicable elements of the hierarchical structure?

Is there an update capability for individual work unit name, acronym or code identifiers?
Historical retention of previous identifiers?

Additional work unit definition capability?
For all existing work units at any hierarchical level?
Historical retention of the previous configuration of the augmented work unit?

Can individual work units be deleted or de-activated?
Historical retention of the unit identifiers and their location within the organizational hierarchy?

Can the hierarchical structure levels be increased?
Historical retention of the previous configuration?

Can the hierarchical level title identifiers be changed?
Historical retention of the previous title identifiers?

Can a work unit be relocated in the hierarchical structure?
Historical retention of previous configuration?

By whom can the above tasks be done? <general user/system manager/system implementor/ADP professional>

Does the update, deletion or alteration of the agency structure or identifier configuration require any system software or hardware modifications?
Describe all necessary modification requirements and indicate by whom they are to be performed.

Can the associated intrinsic data items be entered, updated and generally manipulated by the user?
Is a historical record of <each/ some/ specific> altered data item retained?

Can additional user defined data items be included in topical data groups in an ad hoc manner?
Describe the item definition capability.
Does the user have the same general update capabilites with ad hoc data items as with intrinsic data items?

EDITING:

Are identifier entries and changes edited for content, construction and applicable omission or duplication restraints by <entry process/ a background process/ a batch process/ no process>?

Are data item entries and changes edited for content, construction and applicable omission or duplication restraints by <entry process/ a background process/ a batch process/ no process>?

Describe other pertinent edit processes or considerations that are applied to these data.

FILING:

Are identifier entries and alterations filed by a <foreground/ background/ batch> process?

Are data item or data groups filed by a <foreground/ background/ batch> process?

Describe any additional features of AGENCY entry, editing, update, deletion or general management of these functions.

RETRIEVAL & DISPLAY: Agency Identifiers/data items

Responses to the following questions are not to include the capabilities of general "Query", "Data Base" or "Report Generator" functions that may be present in the system. Only capabilities available in the "normal" entry, edit, update and display functions are solicited here.

Unless otherwise noted, it is assumed that data and groups of data that are retrievable in the manner indicated can also be displayed to the user in that manner or made available to any other applicable task concerned with the agency and agency data.

Can any work unit at all hierarchical levels be retrieved?
All work units under a specific unit at the next descendent hierarchical level?
All work units under a specific unit at all descending hierarchical levels in cascade order?
All work units within the organization in cascade order?
All work units at any specific hierarchical level?
A specific group of work units at the same hierarchical level?
A specific group of work units and their respective descendent work units?
A random user specified set of individual work units?

Can a specific site be selected for retrieval of work units?
Can sites be specified by acronym or ambiguous entry?

Can retrieval include work units at all applicable sites?

Can retrieval of work units be accomplished by ambiguous identifier entry?

Does the system construct a selection list of all possible subject candidates for an ambiguous identifier entry?
Is multiple selection from the candidate list allowed if applicable to the task?
Is selection of all entries of a candidate list allowed if applicable to the task?

Does the retrieval of agency elements intrinsically include pertinent names, acronyms, code, titles and site data?
List items included.

For applicable tasks, can retrieval optionally include pertinent identifiers and/or data items from other major topic data areas?
Provide a list of topics and data that can be included.
Identify the specific tasks or functions where this is allowed.

Can such retrieval include any desired "agency" associated data item or data group in an ad hoc manner?
Describe the means of data item selection if selection is allowed.
Identify the specific tasks or functions where this is allowed.

Describe any additional features of retrieval of AGENCY associated system elements.

The AGENCY data contains or directly references:

Work environments associated with an agency work unit?
Personnel assigned to an agency work unit?
Survey data associated with an agency work unit?

The AGENCY data contains or directly references what other primary or pertinent data areas within the system? Describe.

Example response to AGENCY usage:

<<<Ex. evaluation finding follows:

To provide a local reference for the placement, movement, termination and other transactions related to personnel and work environments.

To provide a local means of collective and individual identification and selection of personnel.

To identify and relate the local authority over work environments and personnel.

To provide an optimum intrinsic adaptation capability.>>>

PERSONNEL FUNCTIONS and INFORMATION

PURPOSE: Describe the primary objectives that the system functions, as a whole, are designed to provide, achieve or support in this topic area.

IDENTIFIERS: Include explanations or comments as required.

Is there an intrinsic limit to the number of personnel that may be defined?

Can each person be identified by actual name?
By social security number?
By a local employee or pay number?
By any user-defined ad hoc identifier scheme?

AGENCY UNIT AND ENVIRONMENT ASSIGNMENT:

Can each person be assigned to any agency unit?

Can each person be assigned to any work environment that is associated with the assigned agency unit?
Assigned to work environments associated with other agency units?
Assigned to multiple work enviroments?

Is duration or proportion of time a person is associated with each agency unit and work environment maintained?
In an historical fashion?

ASSOCIATED DATA: Provide a list of data items that are intrinsically solicited relative to the "PERSONNEL" topic or identifiers. Include any necessary description.

EXPOSURE AND MEDICAL MONITORING REQUIREMENTS DATA:

Does the system maintain the association between a person and the actual survey information for each applicable work environment?

Are all applicable hazardous agents, concentration measurement data and surveyed conditions considered in the summarization of personnel medical monitoring requirement and exposure information?
Are all applicable agent-specific mandatory requirements considered also?
Are user-specified recommendations or local requirements considered?
Are sex, age and previously established medical factors and conditions considered?

Is a list of specific medical requirements established for each person?
Listing of physical examination elements, laboratory testing and other medical procedures required?
Are relevant or applicable elements of medical, work and family history noted?
List any other applicable medically oriented information that is or may optionally be included.

Is a list of applicable hazardous agents and materials summarized?
Does it include measured concentration data for each agent?

Does the system provide a selection and report capability for the exposure data and medical requirements summary?
For an individual or a user-specified ah hoc selection of individuals?
For personnel associated with user-selected agency units and/or work environments?
For a given personnel data item criterion?
Can it be produced at any user-desired frequency?
Can it provide notification of requirements to both the applicable agency authority and the person?
Does it historically record medical action taken, results, cancellation and no-response dispositions for the medical requirements produced?

List any additional attributes, capabilities or elements of consideration that are applicable to the personnel exposure and medical requirements information area.

UPDATE CAPABILITY:

Can an original name, social security number, employee number or user-defined personnel identifier be updated?
Is the previous identifier historically maintained?

Can any associated intrinsic data items be entered, updated and generally manipulated by the user?
Is an historical record of <each/some/specific> altered data item retained?

Can the personnel to agency unit and work environment relationships be established, altered and terminated by the user at any time?
Historical retention of the previous relationship?

Can the induction, assignment, termination and within agency transfer transactions involving personnel be accomplished by both a manual foreground interactive process and a background transaction file processing task?

Are the effects of additional and updated environment, survey and exposure information that may be made throughout the system immediately reflected in the personnel medical information?

Are alterations that are made reflected throughout the applicable elements of associated functions?

By whom can the above tasks be done? <general user/system manager/system implementor/ADP professional>

Does the update, deletion or alteration of any personnel identifier configuration require any system software or hardware modifications?
Describe all necessary modification requirements and indicate by whom they are to be performed.

EDITING:

Are identifier entries and changes edited for content, construction and applicable omission or duplication restraints by <entry process/background process/batch process/no process>?

Are data item entries and changes edited for content, construction and applicable omission or duplication restraints by <entry process/background process/batch process/no process>?

Describe other pertinent edit processes or considerations that are applied to these data.

FILING:

Are identifier entries and alterations filed by a <foreground/background/batch> process?

Are data item or data groups filed by a <foreground/background/batch> process?

Describe any additional features of PERSONNEL entry, editing, update, deletion or general management of these functions.

RETRIEVAL & DISPLAY: Work environment identifiers/data items

Responses to the following questions are not to include the capabilities of general "Query", "Data Base" or "Report Generator" functions that may be present in the system. Only capabilities available in the "normal" entry, edit, update and display functions are solicited here.

Unless otherwise noted, it is assumed that data and groups of data that are retrievable in the manner indicated can also be displayed to the user in that manner or made available to any other applicable task concerned with the agency and agency data.

Can any individual be retrieved?
By name entry?
By social security number entry?
By employee number or other user-adopted identification scheme?
By the association of a person to an agency unit?
By the association of a person to a work environment?

Can retrieval of target personnel be accomplished by specific ageny unit, work environment or ambiguous name identifier entry?

Does the system construct a selection list of all possible subject candidates for an agency unit, work environment or ambiguous identifier entry?
Is multiple selection from the candidate list allowed if applicable to the task?
Is selection of all entries of a candidate list allowed if applicable to the task?

Can the retrieval of personnel rosters and data be done for any configuration of agency unit identification data?
For any configuration of environment descriptor data?

For applicable tasks, can retrieval optionally include exposure, medical requirements and disposition information?
Provide a list of other topics and data that can be included.
Identify the specific tasks or functions where this is allowed.

Describe any additional features of retrieval of PERSONNEL associated system elements.

The PERSONNEL data contains or directly references:

Agency units associated with a person?
Work environments assigned to a person?
Exposure data and medical health care requirements for a person?

The PERSONNEL data contains or directly references what other primary or pertinent data areas within the system? Describe.

WORK ENVIRONMENT FUNCTIONS and INFORMATION

PURPOSE: Describe the primary objectives that the system functions, as a whole, are designed to provide, achieve or support in this topic area.

IDENTIFIERS: Include explanations or comments as required.

Can local physical location and area descriptors be used in the definition of an environment?

Can an occupation be defined as an environment?

Can an event, episode, accident or ad hoc incident be defined as an environment?

Can a hierarchical description such as a specific area within a room within a building be defined as an environment?
To what hierarchical depth?
What restrictions apply?

Can multiple descriptors be used to define an environment?
How many?
Can each such descriptor be an ad hoc text?
What restrictions apply?

Is there an intrinsic limit to the number of environments that may be defined?

Can an environment be defined for and assigned to:
Any agency unit?
Any ad hoc selection of agency units?
Any individual person?
Any ad hoc selection of personnel?
All personnel within any agency unit?
Any ad hoc selection of personnel within an agency unit or units?
Personnel having a specific occupation?
Personnel working in more than one occupation?
Agency units and/or personnel involved in or associated with any specific event, accident, exposure episode or other ad hoc user-defined incidents?

ASSOCIATED DATA: Provide a list of data items that are intrinsically solicited relative to the WORK ENVIRONMENT topic or identifiers. Include any necessary description.

UPDATE CAPABILITY:

Can an original environment definition be altered, updated, expanded, deleted and generally manipulated?

Does the update, deletion or alteration of any environment identifier configuration require any system software or hardware modifications?
Describe all necessary modification requirements and indicate by whom they are to be performed.

Can any associated intrinsic data items be entered, updated and generally manipulated by the user?
Is a historical record of <each/ some/ specific> altered data item retained?

Can the environment to agency unit and/or personnel relationship be established, altered or terminated by the user at any time?
Historical retention of the previous relationship?

Are alterations that are made reflected throughout the applicable elements of associated functions?

By whom can the above tasks be done? <general user/system manager/system implementor/ADP professional>

EDITING:

Are identifier entries and changes edited for content, construction and applicable omission or duplication restraints by <entry process/background process/batch process/no process>?

Are data item entries and changes edited for content, construction and applicable omission or duplication restraints by <entry process/background process/batch process/no process>?

Describe other pertinent edit processes or considerations that are applied to these data.

FILING:

Are identifier entries and alterations filed by a <foreground/ background/batch> process?

Are data item or data groups filed by a <foreground/background/ batch> process?

Describe any additional features of WORK ENVIRONMENT entry, editing, update, deletion or general management of these functions.

RETRIEVAL & DISPLAY: Work environment identifiers/data items

Responses to the following questions are not to include the capabilities of general "Query", "Data Base" or "Report Generator" functions that may be present in the system. Only capabilities available in the "normal" entry, edit, update and display functions are solicited here.

Unless otherwise noted, it is assumed that data and groups of data that are retrievable in the manner indicated can also be displayed to the user in that manner or made available to any other applicable task concerned with the agency and agency data.

Can any environment be retrieved individually?
All environments used by a specific agency unit?
All environments assigned to a specific person?
All environments for a specific survey?
Can user-selection of individual environments be accomplished from the above group retrieval?

Can retrieval of environments be accomplished by ambiguous identifier entry?

Can retrieval of environments be accomplished for all environments containing an incomplete set of descriptors; such as, retrieval of all environments containing a specific building number where the building number may have been only one element of a description?
Can this type of retrieval be done using any number or combination of user-specified descriptors?

Does the system construct a selection list of all possible subject candidates for an incomplete or ambiguous identifier entry?
Is multiple selection from the candidate list allowed if applicable to the task?
Is selection of all entries of a candidate list allowed if applicable to the task?

Can environment retrieval include any associated agency unit identification data?
Can the identification data of persons within the agency unit and who are associated with the environment also be included?

For applicable tasks, can retrieval optionally include pertinent identifiers and/or data items from other major data areas?
Provide a list of topics and data that can be included.
Identify the specific tasks or functions where this is allowed.

Describe any additional features of retrieval of WORK ENVIROMENT associated system elements.

The WORK ENVIRONMENT data contains or directly references:

Agency units associated with an environment?
Personnel assigned to an environment?
Survey data associated with the environment?

The WORK ENVIRONMENT data contains or directly references what other primary or pertinent data areas within the system? Describe.

SURVEY FUNCTIONS and INFORMATION

PURPOSE: Describe the primary objectives that the system functions, as a whole, are designed to provide, achieve or support in this topic area.

IDENTIFIERS: Include explanations or comments as required.

Can local conventions for indexing or referencing be used to identify a survey?

List any constraints which affect the configuration of a survey reference.

Is there an intrinsic limit to the number of surveys that may be defined?

Can a survey be defined for and associated with:
Any environment?
Any number of environments?
Any type of environment?

ASSOCIATED DATA: Provide a list of data items that are intrinsically solicited relative to the SURVEY topic or identifiers. Include any necessary description.

UPDATE CAPABILITY:

Can an original survey data content be altered, updated, expanded, deleted and generally manipulated?

Does the update, deletion or alteration of any survey reference or content configuration require any system software or hardware modifications?
Describe all necessary modification requirements and indicate by whom they are to be performed.

Can any associated intrinsic data items be entered, updated and generally manipulated by the user?
Is a historical record of <each/ some/ specific> altered data item retained?

Can the survey-to-environment relationship be established, altered or terminated by the user at any time?
Historical retention of the previous relationship?

Are alterations that are made reflected throughout the applicable elements of associated functions?

By whom can the above tasks be done? <general user/system manager/system implementor/ADP professional>

EDITING:

Are identifier entries and changes edited for content, construction and applicable omission or duplication restraints by <entry process/background process/batch process/no process>?

Are data item entries and changes edited for content, construction and applicable omission or duplication restraints by <entry process/background process/batch process/no process>?

Describe other pertinent edit processes or considerations that are applied to these data.

FILING:

Are identifier entries and alterations filed by a <foreground/background/batch> process?

Are data item or data groups filed by a <foreground/background/batch> process?

Describe any additional features of SURVEY data entry, editing, update, deletion or general management of these functions.

RETRIEVAL & DISPLAY: Survey reference identifiers/data items.

Responses to the following questions are not to include the capabilities of general "Query", "Data Base" or "Report Generator" functions that may be present in the system. Only capabilities available in the "normal" entry, edit, update and display functions are solicited here.

Unless otherwise noted, it is assumed that data and groups of data that are retrievable in the manner indicated can also be displayed to the user in that manner or made available to any other applicable task concerned with the survey and survey data.

Can any survey be retrieved individually?
All surveys for a specific agency unit?
All surveys for an environment?
Can user-selection of individual surveys be accomplished from the above group retrieval?

Can all components of the survey, agent sample data, material inventory data or primary survey data be displayed selectively?

For applicable tasks, can retrieval optionally include pertinent identifiers and/or data items from other major data areas? Provide a list of topics and data that can be included.

Describe any additional features of retrieval of SURVEY associated system elements.

The SURVEY data contains or directly references:

Environments associated with a survey?
Hazardous agent identification associated with the survey?
Products containing hazardous agents associated with the survey?

The SURVEY data contains or directly references what other primary or pertinent data areas within the system? Describe.

HAZARDOUS AGENT TABLE and FUNCTIONS

PURPOSE: Describe the primary objectives that the system functions, as a whole, are designed to provide, achieve or support in this topic area.

IDENTIFIERS: Include explanations or comments as required.

Is there an intrinsic limit to the number of agents that may be defined?

Can each agent be identified by actual name?
By one or more synonmous names? How many are allowed?
By one or more agent number or code configurations?
By any user-defined ad hoc identifier scheme?

ASSOCIATED DATA: Provide a list of data items that are intrinsically solicited relative to the HAZARDOUS AGENT topic or identifiers. Include any necessary description.

EXPOSURE AND MEDICAL MONITORING REQUIREMENTS DATA:

Does the system maintain the association between an agent and the current medical examination requirements for personnel exposured to or association with the agent?

Does the system maintain other pertinent medical information for each agent?
List the other medical data that is maintained.

Are hazardous agent concentration and exposure limits maintained?
For more than one authority such as PEL, TLV, NIOSH etc.?
List the authorities included.
For more than one sampling scale?
For TWA, ACTION LEVEL, STEL and CEILING limits?
List all that are included.

Can agent sampling, handling and disposal procedures be maintained for each agent in the system?

List any additional attributes, capabilities or elements of consideration that are applicable to the agent exposure and medical requirements information.

UPDATE CAPABILITY:

Can the original agent name and/or synonyms be updated?

Can any associated intrinsic data items be entered, updated and generally manipulated by the user?
Is an historical record of <each/some/specific> altered data item retained?

Are alterations that are made reflected throughout the applicable elements of associated functions?

By whom can the above tasks be done? <general user/system manager/system implementor/ADP professional>

Does the update, deletion or alteration of any hazardous agent identifier configuration or data item require any system software or hardware modifications?
Describe all necessary modification requirements and indicate by whom they are to be performed.

EDITING:

Are agent identifier entries and changes edited for content, construction and applicable omission or duplication restraints by <entry process/background process/batch process/no process>?

Are data item entries and changes edited for content, construction and applicable omission or duplication restraints by <entry process/background process/batch process/no process>?

Describe other pertinent edit processes or considerations that are applied to these data.

FILING:

Are identifier entries and alterations filed by a <foreground/background/batch> process?

Are data item or data groups filed by a <foreground/background/batch> process?

Describe any additional features of HAZARDOUS AGENT entry, editing, update, deletion or general management of these functions.

RETRIEVAL & DISPLAY: Hazardous Agent identifiers/data items

Responses to the following questions are not to include the capabilities of general "Query", "Data Base" or "Report Generator" functions that may be present in the system. Only capabilities available in the "normal" entry, edit, update and display functions are solicited here.

Unless otherwise noted, it is assumed that data and groups of data that are retrievable in the manner indicated can also be displayed to the user in that manner or made available to any other applicable task concerned with the agent and agent data.

Can any individual agent be retrieved?
By name entry?
By entry of a synonym?
By entry of any applicable numeric or alphanumeric code configuration?

Can retrieval of target agent data be accomplished by ambiguous name or synonym identifier entry?

Does the system construct a selection list of all possible subject candidates for an ambiguous identifier entry?
Is multiple selection from the candidate list allowed if applicable to the task?
Is selection of all entries of a candidate list allowed if applicable to the task?

For applicable tasks, can retrieval optionally include exposure limit and medical requirement information?
Can a location or "in use by" list for each agent be included?
Provide a list of other topics and data that can be included. Identify the specific tasks or functions where this is allowed.

Describe any additional features of retrieval of HAZARDOUS AGENT associated system elements.

The HAZARDOUS AGENT data contains or directly references:

Work environments containing the agent?
Exposure data and medical health care requirements for the agent?

The HAZARDOUS AGENT data contains or directly references what other primary or pertinent data areas within the system? Describe.

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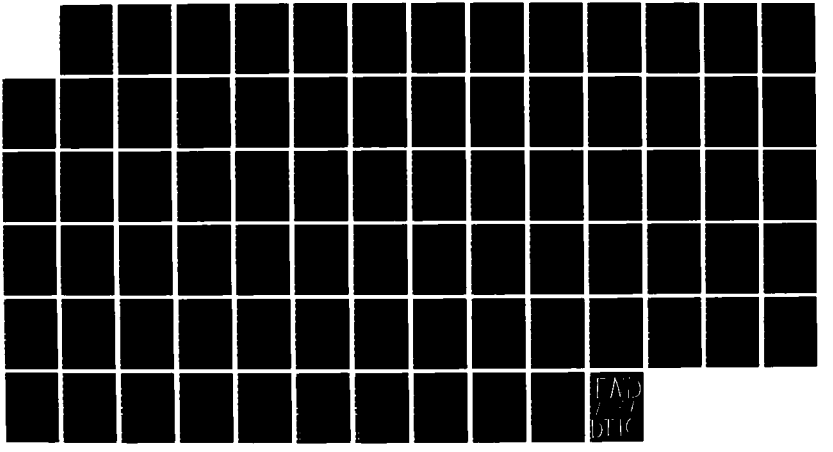

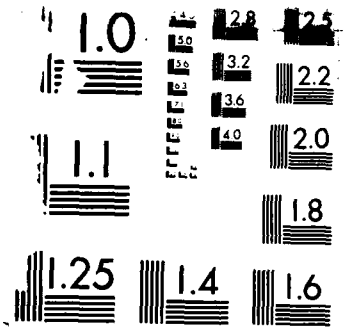

RESOLUTION TEST CHART

SYSTEM MAINTENANCE:

Are routines available to augment, edit and otherwise alter, as necessary, tables, data directories and other intrinsic system control or support schema?

Is there a method for verification of application data file pointers, counters, cross-referencing and other critical file attributes?
Describe the applicable files and extent of verification.
Can the verification be done at any time?
Is there a method for the automated correction of filing discrepancies available?

Is there an error log, trap or other recording of the occurrence of a software error?
Is the recording available at any time?

Is there a log or indicator of hardware failure occurrence during critical disc filing actions or other operations that have the potential to corrupt the system routine execution or data files?

Are maintenance functions available to archive or remove specified out-of-date or historical data from the data base?

Describe any additional features of SYSTEM MAINTENANCE associated operation.

INDUSTRIAL COMPONENT OF NOHIMS

GLOSSARY

Agency: Any organization as a whole.

Agent: Any chemical, compound, material, product, condition or physical phenomenon.

Ambiguous entry: Refers to a partial or incomplete user response to a system request for subject identification or selection information such that more than one subject may possess the entered configuration.

Directory: A general scheme by which either specific or ad hoc subject data and data item information may be introduced, named, defined, identified, retrieved and manipulated in the system by applicable tasks.

Environment: Any identifiable physical location, area, space, condition, circumstance, incident or episode that contains or represents a real or potential hazard or risk when inhabited by or associated with a worker.

Hazard: Any known or unknow real or potential risk to the general short or long term health of a worker.

Identifier: The information necessary to retrieve, select or make known a unique subject or data group.

Local: Actual "real world" or "as is now used" conventions, configurations, procedures or terminology.

Personnel: Any civilian or military employee, contractor, visitor or other person that is under the authority of or by circumstance is considered to be within an area of responsibility of an agency.

Retrieval: To identify, select and make available the desired subject information.

Subject: The intended person, place, object, topic, data item or task of current interest.

Table: A stored collection and arrangement of known information on one or more subject areas.

Unit: Any unique organizational element or work unit identifiable within an agency.

DESCRIPTION OF SYSTEM USERS

FOR EACH NOHIMS TEST SITE:

1. Who are the hands-on clerical users of NOHIMS? (Examples: receptionists, medical record room personnel, and data entry technicians.) Which NOHIMS options do they use?

Name	Job Title and Function	NOHIMS Options Used
a.		
b.		
c.		
d.		

2. Who are the hands-on medical/professional users of NOHIMS? (Examples: MDs, PAs, NPs, nurses, occupational health technicians.) Which NOHIMS options do they use?

Name	Job Title and Function	NOHIMS Options Used
a.		
b.		
c.		
d.		

3. Who are the hands-on industrial/professional users of NOHIMS? (Examples: industrial hygienists and safety specialists.) Which NOHIMS options do they use?

Name	Job Title and Function	NOHIMS Options Used
a.		
b.		
c.		
d.		

4. Who are the hands-on ancillary users of NOHIMS? (Examples: laboratory, radiology, and audiology technicians and corpsmen.) Which NOHIMS options do they use?

Name	Job Title and Function	NOHIMS Options Used
a.		
b.		
c.		
d.		

5. Who are the hands-on administrative users of NOHIMS? (Examples: clinic directors and department chiefs.) Which NOHIMS options do they use?

Name	Job Title and Function	NOHIMS Options Used
a.		
b.		
c.		
d.		

6. Who are the NOHIMS system manager(s)?

Name	Job Title and Function
a.	
b.	
c.	

7. Who are the other hands-on users of NOHIMS? (Examples: researchers.)

Name	Job Title and Function	NOHIMS Options Used
a.		
b.		
c.		

USE AND USEFULNESS OF INFORMATION RETRIEVAL CAPABILITIES

Standard Reports

1. The standard reports that NOHIMS produces which I receive/use regularly are

   Industrial Hygiene Survey Report/
   Report of Individual Exposures/
   Patient Data Sheet/
   Medical certification report/
   Monthly Compliance Report/
   Navy management reports:
      Report of Occupational Health Services (6260/1)/
      Medical Services and Outpatient Morbidity Report (6300/1)/
   Encounter Report/
   Patient Summary/
   Status Report/
   Flowcharts/
   other: _____/
   none (go to 9 if none).

2. These reports are used in my work to

   provide direct patient care/
   plan workloads/
   communicate with others/
   prepare required reports/
   other: _____/
   not used.

3. The reports are used

   daily/ quarterly/
   weekly/ semi-annually/
   semi-monthly/ annually/
   monthly/ never.

4. The information produced in these reports

   more than adequately meets my needs/
   adequately meets my needs/
   less than adequately meets my needs/
   is not relevant to my work.

5. The information produced in these reports is

   very useful/
   somewhat useful/
   not useful.

6. (Medical users only) Specifically, in the day-to-day provision of medical care, the standard medical reports are

   very useful/
   somewhat useful/
   not useful/
   not used.

7. (Medical users only) The effect of the standard medical reports on the quality of medical care has been

very beneficial/
somewhat beneficial/
no effect/
somewhat detrimental/
very detrimental.

8. Additional information/reports I would find helpful include:

User-defined Information Retrieval Capabilities

9. The user-defined information retrieval capabilities I have used are

Interactive Flowcharts/
Report Generator runs/
interactive query function in OHS/
on-line look-up/
other: _____/
none (go to next interview section if none).

10. I consider the ability to generate user-defined reports to be

very useful/
somewhat useful/
not useful.

11. I generate a special user-defined report

daily/
weekly/
semi-monthly/
monthly/
quarterly/
semi-annually/
annually/
never.

12. The information I usually retrieve using specially generated reports is used

in direct patient care/
for resource management/
to assess quality of care/
in research/
other: _____.

13. (Medical users only) In the day-to-day provision of medical care, the user-defined reports are

very useful/
somewhat useful/
not useful/
not used.

14. (Medical users only) The effect of the user-defined reports on the quality of patient care has been

very beneficial/
somewhat beneficial/
no effect/
somewhat detrimental/
very detrimental.

15. I do on-line look-up/interactive query of patient/worker data

often during the day/
daily/
several times during the week/
weekly/
several times during the month/
other: _____/
never.

16. I do on-line look-up/interactive query with the

medical component/
industrial component/
both components/
neither component.

17. I consider the ability to do on-line look-up/interactive query of patient/worker records to be

very useful/
somewhat useful/
not useful.

18. The information I usually retrieve using on-line look-up/interactive query is

review of previous patient encounters/
lab results/
patient-specific exposures/
shop-specific exposures/
survey-specific information/
verify or look up administrative information/
other: _____.

SOFTWARE QUALITY ATTRIBUTES

1. Does NOHIMS allow performance of all required tasks?

   What functions is NOHIMS required to perform?

   Does NOHIMS allow performance of identification tasks?

   Does NOHIMS allow performance of entry tasks?

   Does NOHIMS allow performance of review tasks?

   Does NOHIMS allow performance of editing tasks?

   Does NOHIMS allow performance of information retrieval tasks?

   Does NOHIMS allow performance of system maintenance tasks?

2. Is NOHIMS a reliable system?

   Is the data retrieval consistent?

   Can the user corrupt the database intentionally or unintentionally?

   Can the system resolve extraneous input?

3. What error recovery procedures does NOHIMS have?

   What system functions aid in recovering data if an error occurs or if the system crashes?

   What inherent abilities does NOHIMS have to insure the integrity of the database, such as Monitor in the medical component which does "housekeeping" chores before halting?

   What system features prevent program and data "crashes"?

4. What back-up procedures are required to prevent data loss?

   How often should the database be copied to disk?

   How often should the database be copied to magnetic tape?

   What procedures/functions are used to restore the database from a back-up?

   How easy is it to restore the database from a back-up?

5. What features make the source program code efficient?

   How much of the system memory does NOHIMS require to operate? What features minimize this requirement?

6. How portable and hardware independent is NOHIMS?

   Can NOHIMS be configured on a portable system?

   Is a particular hardware configuration required to operate NOHIMS?

7. How maintainable is the NOHIMS software?

   Does NOHIMS require ongoing software support?

   Is system support required to maintain the integrity of the database?

OPERATIONAL CHARACTERISTICS

User Friendly Features

1. How well does NOHIMS present its operational capabilities to the user?

   While selecting system options, is the screen display clear and helpful?

   Are the system prompts well worded and informative? Are they easy to understand?

   Are data displays and reports presented in easily readable and understood formats?

   Are there messages from NOHIMS that tell the user how the system interpreted the entries?

   Are there messages from NOHIMS that tell the user what the the system is doing, such as "Please wait while filing"?

2. Is NOHIMS "menu driven" at all selection levels?

   Are the option menu displays well organized and easy to read?

3. What user on-line assistance functions does NOHIMS have?

   Can the user ask for help text at system selection prompts?

   At what selection levels does NOHIMS have help text?

   Is it easy to ask the system for help text?

   Is there more than one level of detail of help text?

   Is the help text easily readable and understood? Is the help text concise?

   Does the help text contain examples?

   Is the help text specific to the NOHIMS application? Does it need to be specific to the NOHIMS application?

   Can the help text messages be changed without programming intervention?

   Are there other on-line assistance functions?

   Are there supporting job aids and operations manuals?

4. What error diagnostic features and debugging aids does NOHIMS have?

   Is there an error log, trap, or other recording of the occurrence of a software error?

   Is there an error log or other indicator of hardware failure occurrence during critical filing actions or other operations that could potentially corrupt the system routine execution or data files?

   What information is recorded in the error log(s)? How is the log organized?

How accessible is the information in the error log(s)? Is it available at any time? to any user?

How long is the error log maintained by NOHIMS? Can old or corrected errors be deleted from the log without programming intervention? Who can delete them?

Can a user document errors obtained while using NOHIMS in a file for later review by a system manager?

Can system functions be tested without affecting the live database?

5. What database manager utilities does NOHIMS have?

Data Manipulation Tasks

6. What is the average entry time per input form?

7. What are the add, save, change, and delete procedures?

8. Does NOHIMS have a search in context capability?

   What are the limitations on its ability to search in context?

   Can searches be performed on segments of a patient/worker name?

   Does the system have an alphabetic look-up function for directory items?

9. What are the general filing procedures for NOHIMS?

   Are they the same for both the medical and industrial components?

10. Can data and routines by downloaded to magnetic tape?

    How is this accomplished?

ASSESSMENT OF USER FRIENDLINESS

1. It was

   very easy/
   somewhat easy/
   somewhat difficult/
   very difficult/

   for me to learn to use NOHIMS.

   ☐ Have not learned to use NOHIMS (then go to next interview section).

2. I am

   very confident/
   somewhat confident/
   somewhat unsure/
   very unsure/

   of my ability to work with NOHIMS.

3. It is

   easier/
   somewhat easier/
   not different/
   somewhat more difficult/
   more difficult/

   to use NOHIMS than other automated systems I have used.

   ☐ Not used other systems.

4. Please rate the following features of NOHIMS in terms of their helpfulness in using NOHIMS.

	Very Helpful	Somewhat Helpful	Not Helpful
a. Screen displays	____	____	____
b. System prompts/menus	____	____	____
c. System messages	____	____	____
d. Help text/assistance functions	____	____	____
e. Report formats	____	____	____
f. Techniques for looking up an individual	____	____	____
g. Agency unit look-up	____	____	____
h. Environment look-up	____	____	____
i. Survey data look-up	____	____	____
j. Hazardous agent look-up	____	____	____
k. Directory item look-up	____	____	____

5. Improvements I would like to see to make NOHIMS easier to use include

_____

_____

_____

_____.

6. Overall, I feel that NOHIMS is

very user friendly/
somewhat user friendly/
somewhat user unfriendly/
very user unfriendly.

INFORMATION RETRIEVAL CAPABILITIES

1. What system options in the medical component of NOHIMS are involved with information retrieval?

   Display Registration Data/
   Display Medical Data/
   Print Medical Data/
   COSTAR Report Generator/
   ad hoc interactive query/
   other: _____

2. What are the main functions and features of each of the options involved with information retrieval in the medical component of NOHIMS?

   Registration: Display Registration

   Can the patient to be displayed be identified with an ambiguous entry?

   Can the patient be identified by name? by social security number? by unit number?

   Are patient names searched by phonetics?

   Can the display of registration items be formatted in any manner desired?

   Can changes be made to the registration record while in this option?

   Describe any additional features of this option.

   Display Medical Data

   Can patients for whom data are to be displayed be identified with ambiguous entries?

   Can patients for whom data are to be displayed be identified by name? by social security number? by unit number?

   Does the patient to be displayed need to be identified for each display request?

   Can all the data for a given encounter be retrieved in a report format?

   Does NOHIMS display a list of encounters entered for the patient?

   What is the format for the Encounter Report? Can this format be changed without programming intervention?

   What data elements are included in the Encounter Report? Which of their associated elements (results, statuses, text, etc.) are displayed?

   Can the user request the display of a single data item?

   Are the registration data displayed with the encounter data?

Can the user select to display an encounter on a particular date?

Can the user select to display the most recent encounter? the first encounter? the nth encounter? from any encounter, the previous encounter?

Can the user request the display of all encounters that contain a particular item?

Can the user request the display of more than one encounter with the same request (e.g., the last N encounters)?

Can the user select the encounters to be displayed by the type of encounter? site of the encounter? provider of care for the encounter? characteristics of patients? other nondate-related criteria?

Will the system produce reports that summarize data across encounters? Can the encounters to be summarized be specified?

What is the format of these summary reports? Can this format be altered without programming intervention?

What data elements are included in the summary reports? Which of the associated data (results, statuses, text, etc.) are also displayed?

Can a single data item or set of data items be displayed across encounters? Can the user select which data item or which set of data items?

Can the user choose to limit the associated data items that are displayed in the summary reports?

Can the ability to display reports be restricted to certain devices? to certain classes of users? to certain users?

Is there help text for the display medical data procedures?

Can the registration data display be reviewed while in this option?

Can the information in the displays be edited while in this option?

Can both hardcopy and softcopy reports be obtained?

Describe any additional features of this module.

Print Medical Data

Will NOHIMS automatically print reports for all patients scheduled to be seen on a given day? Which reports can be printed?

Can the user specify which reports for which patients are to be printed?

Can reports be printed for those patients that were entered in a particular batch? within the last N days? Which reports can be printed in this manner?

Can the user specify the order of print of the reports?

Can the printing of reports be interrupted? restarted?

Can the user indicate which device to print the reports on in order to free terminals?

Can the requests for report printouts be stored, to be used again at a later date?

Can the ability to print medical reports be restricted to certain devices? to certain classes of users? to certain users?

Is there help text for the print medical data procedures?

Describe any additional features of this module.

COSTAR Report Generator

Can listings of data items or the data associated with data items (results, statuses, text, etc.) be produced?

Can tabulations of data items or the data associated with data items (results, statuses, text, etc.) be produced?

Can reports be generated for every patient in the database? for every encounter in the database?

Can subsets of patients be selected for reports? Can patients be selected on patient characteristics? encounter characteristics? dates of encounters? other criteria?

Can subsets of encounters be selected for reports? Can encounters be selected on patient characteristics? encounter characteristics? dates of encounters? other criteria?

What is the format of the listings and tabulations generated by NOHIMS? Can this format be altered without programming intervention?

What does a user need to know about the directory codes in order to use the report generator?

Can the user define selection criteria for individual data items such as last, most recent, number of, etc.?

Are there any restrictions on the data items that can be listed at any one time? tabulated at any one time?

Will NOHIMS generate 2-way tables? 3-way tables? 4-way tables?

Can individual items be selected for reports? Can classes of items be selected for reports? Can items be selected by associated data such as status, presence/absence of free text, presence/absence of results?

Will NOHIMS compute percentages for the tabulation tables? Can the user specify the denominator? Can more than one denominator be defined?

Will NOHIMS compute deviations from the mean for the tabulation tables?

Will NOHIMS compute chi square values for the tabulation tables? calculate t statistics? perform analysis of variance?

Does NOHIMS compute actuarial statistics such as survival rates, morbidity rates, or mortality rates?

Does NOHIMS produce graphic representations of data produced in reports such as histograms and trend lines?

What time-saving features does the report generator have to shorten the search through the database?

Can data in reports be printed in patient name alphabetic order?

Can data in reports be printed in encounter date order?

Can the user create a set of report specifications?

Can the report specifications be stored for later use?

Can the report specifications be edited? Can these be saved under a new name?

Can the user select which report specification is to be altered or must each specification be edited or accepted?

Can report specifications be deleted?

Can a list of available report specifications be displayed?

Can a user select to run a report from the report specifications stored in NOHIMS?

Can a report specification file be renamed?

Are there any limits on what a report specification file can be named?

Does NOHIMS keep track of when changes were last made to a report specification file?

Does NOHIMS store data generated by the report runs for future printing/use?

Can files stored during report runs be deleted?

Can a user specify a particular time on a particular date to run a report?

Can more than one report be run at a time?

Can the report runs be linked to run one after the other?

Does running a report tie up any terminals/printers?

Can both hardcopy and softcopy output be produced?

Does NOHIMS have an interactive query capability?

Is there help text for the report generator procedures?

Can mailing labels be generated by the system? Can they be printed in zip code order? alphabetic order?

Can mailing labels be printed for a subset of patients?

Describe any additional features of this module.

3. What are the information retrieval functions in the industrial component of NOHIMS?

ad hoc interactive query/
report generation/
display of data/
printing of data/
other: _____

4. What are the main functions and features of the ad hoc interactive query function in the industrial component of NOHIMS?

Syntax

Does the query utilize a custom syntax to describe the desired sequence and topics to be retrieved?

Indicate the identifiers and data item areas that are accessible via the query syntax.

Agency identifiers?
Agency data items?
Personnel identifiers?
Personnel data items?
Environment identifiers?
Environment data items?
Hazardous Agent identifiers?
Hazardous Agent Table data items?
Survey identifiers?
IHS Survey and Occupational Hazard Data Sheet data items?

Identifiers (Include explanations or comments as required.)

Indicate which topic identifiers are directly selectable via the query syntax.

Agency units?
Environments?
Personnel?
Hazardous Agents?
Surveys?

Can as many topic identifiers as desired be specified in an ad hoc fashion?

Does the query have the full capability for identification and selection of each topic that is provided in the normal topic area functions?

Can the query assume an "all available" set of topic identifiers at any topic area identifier selection point?

Are there any topic area identifiers that cannot be specified via the query operation?

Data Items

Can the user select specific data items for each applicable topic area?

Can a data item be subjected to user-specified conditional testing?

Can testing include comparison to a given numeric value?
Can testing include comparison to a given numeric interval?
Can testing be done for the presence of a data item?
Can testing be done for the absence of a data item?
Can testing include comparison to a given literal value?
Can testing include a search of the data item content for a given single of multi-word literal?
Can testing include comparison to an associated table of values where applicable to the data item?

Process

Is the construction of a query syntax set an interactive process?

Can a query syntax set be filed and reused whenever required?

Is the execution of a query syntax set a foreground process?

Can the output information of a query task be directed to either a terminal screen or a printer as required?

Is the query operation available to the general user if permitted by the system security attributes for the user?

Describe any additional retrieval features of the QUERY function or operation.

5. Please see the interview section on System Description for questions on the industrial component's display and printing of data and generation of standard reports.

SECURITY FEATURES

1. What are the features of the medical component of NOHIMS that maintain the confidentiality of patient information?

   Are system users identified in some form by NOHIMS?

   Is there a user identification sequence to sign onto NOHIMS? Is the identification sequence echoed such that it is displayed or may be viewed at the sign-on device? Can the display of the identification sequence be masked or overstruck?

   Can access to various options be restricted by device? by class of user? by user?

   Can options and special functions be protected by a password?

   Does NOHIMS report security breaches? disconnect users who breach or attempt to breach security?

   Can users no longer qualified to access NOHIMS be deleted from the access list?

   Does NOHIMS have an automatic time out for unattended terminals?

   Are data fields masked? Are patient names kept separately from data files?

   Do data collection forms contain confidentiality warnings?

   Do reports generated by NOHIMS contain confidentiality warnings?

   Can occupational health information be accessed from the medical component of NOHIMS?

   Can medical data be accessed from the industrial component of NOHIMS?

   Who/what controls the security features?

2. What are the security features of the industrial component of NOHIMS?

   Terminal Device Security

   It is assumed that access to the computer system via a local or remote terminal device is controlled by the established conventions of the operating system. The following questions are directed only to the application-supported security functions that provide control over terminal device and personnel access to the application capabilities.

   Terminal Device Access

   Can a user's access to specific functions be determined and delimited by the particular terminal device or communication access line in use? Describe.

   Can the device access be altered as required?

   Can the associated function access for the device be altered as required? By whom?

Is there a unique identification sequence assigned to each individual user?

Does the user identification delimit access to specific functions? Describe.
Is the identification sequence echoed such that it is displayed or may be viewed at the sign-on device?
Can the identification sequence be altered as required?
Can the associated functional access be altered as required?

Is there an access control required to execute the system maintenance functions that define or alter the terminal and/or user identification access attributes?

Describe any additional features of SECURITY-associated system operation.

ADEQUACY OF SECURITY FEATURES

1. In my opinion, the sign on/off security procedures are

   very adequate/
   somewhat adequate/
   somewhat inadequate/
   very inadequate/

   to prevent unauthorized persons from accessing NOHIMS.

2. In my opinion, the various security levels (by device, by user classification, through passwords for specific options) are

   very adequate/
   somewhat adequate/
   somewhat inadequate/
   very inadequate/

   to prevent persons from accessing areas of NOHIMS for which they are not authorized.

3. In my opinion, the confidentiality warnings on input and output documents are

   very adequate/
   somewhat adequate/
   somewhat inadequate/
   very inadequate/

   to maintain the confidentiality of patient/worker data.

4. The security protection features provided by NOHIMS are

   fully utilized/
   loosely utilized/
   ignored/
   bypassed.

5. In general, the security protection provided by NOHIMS is

   insufficient/
   somewhat insufficient/
   somewhat sufficient/
   sufficient.

6. If insufficient or somewhat insufficient, the areas of protection which are lacking include:

7. In general, the security protection provided by NOHIMS is

   unnecessary/
   somewhat unnecessary/
   somewhat necessary/
   necessary.

8. If unnecessary or somewhat unnecessary, the areas which should be removed or changed include:

SOFTWARE SUPPORT REQUIREMENTS

1. What and how many support personnel are required to maintain the NOHIMS software?

   _____ ADP personnel:

   _____ managers/

   _____ operators/

   _____ programmers/

   _____ system analysts/

   _____ outside consultants/

   _____ vendors

2. What functions must be performed by the support personnel?

   system back-ups/
   investigating and correcting system errors/
   directory updates/
   software updates/
   archival of records to tape/
   changing report parameters

3. What is the estimated amount of support manhours required per month to maintain the system?

HARDWARE SUPPORT REQUIREMENTS

1. What and how many support personnel are required to maintain the NOHIMS hardware?

   _____ ADP personnel:

   _____ managers/

   _____ operators/

   _____ programmers/

   _____ system analysts/

   _____ outside consultants/

   _____ vendors

2. What functions must be performed by the support personnel?

   periodic maintenance/
   system back-ups/
   repack disks/
   repairs

3. What is the estimated amount of support manhours required per month to maintain the system?

AVAILABLE SYSTEM SUPPORT

1. What kind of system support is available for initial training of NOHIMS users?

   NOHIMS training module/
   outside consultants/
   on-site trainers/
   off-site trainers/
   system managers/
   audio-visual packages/
   outside training seminars/
   users groups/
   other: _____

2. What kind of system support is available for ongoing and update training of NOHIMS users?

   NOHIMS training module/
   outside consultants/
   on-site trainers/system managers/
   off-site trainers/
   audio-visual packages/
   outside training seminars/
   users groups/
   other: _____

3. What kind of system support is available for the NOHIMS hardware?

   outside consultants/
   in-house consultants/programmers/analysts/
   technical "hotline" to _____/
   on-site support/system managers/other _____/
   outside training seminars/
   users groups/
   other: _____

4. What kind of system support is available for the NOHIMS software?

   NOHIMS system maintenance module/
   outside consultants/
   in-house consultants/programmers/analysts/
   technical "hotline" to _____/
   on-site support/system managers/other _____/
   outside training seminars/
   users groups/
   other: _____

5. What kind of documentation and job aids are there that support system operation?

documentation for data entry
Specify: _____/

documentation for data retrieval
Specify: _____/

documentation for system maintenance
Specify: _____/

job aids that support documentation
Specify: _____/

other: _____

_____

SYSTEM SCENARIOS TO MAINTAIN THE SYSTEM

1. What prime time system maintenance functions must be performed during the day on a daily basis?

   be certain that Monitor is running in the background before entering data/
   review error logs/
   investigate common or new errors/
   other: _____

2. What system maintenance functions must be performed during the off-shift on a regular basis? How often must these tasks be performed?

   system back-ups on a daily/weekly/monthly basis/
   recreate alphabetic directory on a daily/weekly/monthly/as needed basis/
   other: _____

3. How often must patient files be archived to tape?

   monthly/
   quarterly/
   annually/
   as needed

ORGANIZATIONAL REQUIREMENTS

1. What requirements are there for users of NOHIMS to have MUMPS programming skills?

   none required/
   minimal amount of knowledge required/
   moderate amount of knowledge required/
   extensive knowledge required.

2. What requirements are there for system managers of NOHIMS to have programming skills?

   none required/
   minimal amount of knowledge required/
   moderate amount of knowledge required/
   extensive knowledge required.

3. What requirements are there for system managers of NOHIMS to comprehend NOHIMS source code?

   none required/
   minimal amount of comprehension required/
   moderate amount of knowledge required/
   extensive knowledge required.

4. Describe in full-time equivalents (FTEs) the staff required to operate a NOHIMS installation.

   _____ FTE(s) of data collection personnel

   _____ FTE(s) of data entry personnel

   _____ FTE(s) of system managers

   _____ FTE(s) of administrative personnel

   _____ FTE(s) of support personnel

5. Describe the requirements for the configuration of the installation area.

   What are the electrical/power source requirements?

   What are the lighting requirements?

   What are the communications requirements?

   What are the heating/cooling requirements?

   What are the space and room dimension requirements?

   What furniture/equipment is required (excluding system hardware) such as desks, chairs, and file cabinets?

SUITABILITY OF NOHIMS TO NAVY INFORMATION PROCESSING NEEDS

1. The features/capabilities of NOHIMS that make it especially suitable to Navy information processing needs are

   the required information is collected:
   - personnel data/
   - hazardous materials characteristics/
   - presence of hazardous materials/
   - data on health of workers:
     - illness and injuries/
     - sick leave/absenteeism/
     - routine examinations/
     - test and procedure results/
     - medical histories/
     - mortality data/
   - individual exposures/exposure history/
   - data on accidents/incidents/
   - occupational histories/
   - other: _____/

   data can be retrieved in the required formats:
   - tables of hazardous materials/
   - lists of workers with exposures/
   - lists of workers requiring physical examinations/
   - medical encounter reports/
   - medical summary reports/
   - management reports/
   - other: _____/

   data can be manipulated in required ways:
   - number of surveys conducted/
   - number of individuals exposed to hazard/
   - number of examinations conducted/
   - number of laboratory tests done/
   - number of radiographs done/
   - number of asbestos examinations conducted/
   - list of those with ordered but unresulted tests/
   - other: _____/

   other: _____.

2. My assessment of the suitability of NOHIMS to Navy information collection needs is that NOHIMS is

   very suitable/
   somewhat suitable/
   somewhat unsuitable/
   very unsuitable.

3. My assessment of the suitability of NOHIMS to Navy information retrieval needs is that NOHIMS is

   very suitable/
   somewhat suitable/
   somewhat unsuitable/
   very unsuitable.

4. My assessment of the suitability of NOHIMS to Navy information manipulation needs is that NOHIMS is

very suitable/
somewhat suitable/
somewhat unsuitable/
very unsuitable.

5. Areas in which NOHIMS could be changed to make it more suitable to Navy information processing needs include

collect additional information
Specify: _____/
improve/create new retrieval capabilities
Specify: _____/
improve/create new manipulation capabilities
Specify: _____/
other: _____
_____.

6. Overall, my assessment of the adequacy of NOHIMS for Navy information processing needs is that NOHIMS is

very adequate/
adequate/
somewhat adequate/
somewhat inadequate/
inadequate/
very inadequate.

ASSESSMENT OF SYSTEM PERFORMANCE

1. NOHIMS has given no/some/many problems in the area of

   reliability/
   downtime/
   communication lines/
   man-machine interface/
   other: _____.

2. A noticeable (to the user) failure happens about _____/ _____ and that number has been

   improving/
   steady/
   getting worse.

3. The number of failures/errors for NOHIMS is

   acceptable/
   somewhat acceptable/
   somewhat unacceptable/
   unacceptable.

4. When there is heavy usage of the computer system, then there will be

   a noticeable slowdown/
   an annoying slowdown/
   a terrible slowdown/
   no effect.

5. Data entry is

   never/
   rarely/
   occasionally/
   often/

   delayed by system response time.

6. The time required to obtain a display of data is usually

   fast/
   somewhat fast/
   somewhat slow/
   slow.

7. When a NOHIMS failure occurs, it affects the day-to-day provision of medical care because

   work procedures must be changed/
   reports usually used in care are not available/
   on-line look-ups cannot be done/
   medical charts are held up in data entry/
   survey data are held up in entry/
   other: _____/
   no effect.

8. When a NOHIMS failure occurs, it affects the administration of the occupational health unit because

   work procedures must be changed/
   reports usually used are not available/
   on-line look-ups cannot be done/
   medical charts are held up in data entry/
   survey data are held up in entry/
   data entry gets backlogged/
   other: _____/
   no effect.

9. NOHIMS has

   no/
   one or two/
   a few/
   several/
   many/

   major "bugs" in the software that affect system performance.

   These are: _____

   _____

   _____.

10. I have used or been exposed to NOHIMS for _____ months.

YOUR STRUCTURED APPRAISAL OF THE PERFORMANCE OF THE
NAVY OCCUPATIONAL HEALTH INFORMATION MANAGEMENT SYSTEM (NOHIMS)

Contained in the following pages are 22 statements reflecting possible attitudes or opinions that users of NOHIMS might hold. You are being asked to carefully read each of these statements and then to place an "X" in the blank that most nearly reflects your opinion of NOHIMS, indicating the extent to which you agree or disagree with each statement. PLEASE EXPRESS AN OPINION ON EACH STATEMENT EVEN IF YOU HAVE NEVER THOUGHT ABOUT THIS SUBJECT BEFORE IN JUST THIS WAY.

The intent of this short exercise is to systematically explore what your subjective attitudes and opinions are concerning the impact of NOHIMS on your department. Your responses will remain anonymous and will be used only in the aggregate to provide a composite picture of the benefits that have accrued from NOHIMS in your department. Thank you for your cooperation and valued assistance.

SITE:

APPRAISAL OF THE PERFORMANCE OF NOHIMS

	Strongly Agree	Agree	Neutral Opinion	Disagree	Strongly Disagree
1. Worker/patient-related information is more accessible and available more quickly with NOHIMS.					
2. As a result of NOHIMS, I am able to do a better job.					
3. The performance of NOHIMS falls short of what I expected.					
4. I could never go back to using the old manual record system now that I have been using NOHIMS.					
5. NOHIMS catches more human errors than the old manual system did.					
6. In my opinion, NOHIMS should not have been implemented at this activity.					
7. I rarely have to wait for necessary worker/patient information because the NOHIMS system is down.					
8. In general, NOHIMS is better than the old manual system of record keeping.					
9. NOHIMS has some major problems that need correction.					
10. If there were budget cuts at this activity, I would rather see other services that I need cut before I lost NOHIMS.					

	Strongly Agree	Agree	Neutral Opinion	Disagree	Strongly Disagree
11. NOHIMS has "goofed" up worker/patient records more times than I care to remember.					
12. I truly feel that the quality of care has been improved as a result of NOHIMS.					
13. From an administrative point of view, NOHIMS provides timely data for making management decisions that were not available with the previous manual system.					
14. Scheduling and staffing patterns have been improved since the advent of NOHIMS.					
15. NOHIMS does not benefit me much personally.					
16. Worker/patient satisfaction seems to be running higher since NOHIMS was introduced.					
17. I can see how NOHIMS can be a boon to other users.					
18. With NOHIMS, I am able to get more done in a day.					
19. The records produced by NOHIMS are more amenable to review and better meet Navy standards.					
20. The confidentiality of the worker's/patient's record is more vulnerable with NOHIMS than it was with the manual system.					

	Strongly Agree	Agree	Neutral Opinion	Disagree	Strongly Disagree
21. I don't care much what NOHIMS costs to operate, we need it to handle our workload efficiently.	____	____	____	____	____
22. If NOHIMS were to be taken out, I would be willing to make a reasonable effort to get it back in service.	____	____	____	____	____

The purpose of the following two questions is to provide classification information for the statistical analysis of responses to the questionnaire. Please mark all categories that apply to you.

23. I am a system developer ____

user ____

24. My function is clerical ____

medical:

professional ____

ancillary ____

industrial:

hygienist/safety specialist ____

work center supervisor ____

administrative ____

other: _____.

APPROPRIATE SCENARIOS FOR SYSTEM TESTING

1. Should NOHIMS features and functions be tested using the examples contained in the operational manuals, using contrived test data, live data, or some combination thereof?

2. What features and functions of NOHIMS should be operationally tested to be certain that NOHIMS can perform expected tasks?

   Should a hazardous agent table be created? What data are required in a hazardous agent table?

   Should data from an industrial survey(ies) be entered into NOHIMS? What data are gathered in an industrial survey?

   Should data from a physical examination(s) be entered into NOHIMS? What data are gathered in a physical examination?

   Should one/several of the following be generated by NOHIMS? What data are required in NOHIMS and what parameters must be known in order to generate these items?

   - Notification of individual exposures
   - List of patients requiring physical examinations
   - Patient Data Sheet
   - Patient Summary
   - Encounter Report
   - Flowcharts
   - Reports for the 6260/1 management report
   - Medical certification report

   Should one or more user-defined reports be generated by NOHIMS? What should be the content of these reports? What information is required to be in NOHIMS in order to generate these reports?

   Should one or more queries into the database be performed? What should be the content of the queries?

   What other features and functions should be operationally tested? What information is required in order to perform these tests?

3. How will the results of these tests be evaluated?

   What criteria will be used to evaluate the performance of NOHIMS?

   What level of performance will be considered satisfactory?

   How many times will a given test be performed? by how many different users?

MEDICAL MONITORING AND CARE GOALS/ASSESSMENT OF HOW WELL MEDICAL MONITORING AND CARE GOALS ARE BEING MET

23A 1. It is my understanding that the specific goals for NOHIMS in the area of medical monitoring and care are/were to improve

- quality of care:
  - patient management:
    - diagnostic tests/
    - database acquisition/
    - treatment planning/
    - problem identification/
    - feedback to physician regarding achievement of desired outcomes/
  - patient compliance with physician orders because of comprehensiveness/continuity of care/
  - quality of care review procedures/
  - research information collection/
  - training activities/
  - record accuracy/
  - earlier diagnosis of abnormal conditions/
  - earlier notification of patient abnormalities/
  - communication/
  - automated medical testing/
- access to care:
  - patient follow-up/
  - appointment scheduling/
  - record contents/
  - record availability/
  - visit registration/
  - medical reports/
- resource utilization:
  - health manpower utilization/availability:
    - medical - technical personnel/
    - clerical personnel/
    - use of paramedical personnel/
    - all personnel/
  - patient services:
    - fewer unnecessary visits/
    - fewer redundant laboratory tests/
    - better referral/
- management aspects of health care:
  - improve management and operations of the facility by:
    - provision of management with information and analytical tools for:
      - utilization review procedures/
      - manpower scheduling/
      - budgeting and planning/
      - long-range manpower planning/
      - long-range facility planning/
      - regional/Navy-wide health planning/
    - administrative reports/

(Continued)

23A ↓

compliance with monitoring programs/Navy set standards of care:
periodic physical examinations/
protective equipment/
asbestos surveillance program.

2. I consider NOHIMS in its present state to be meeting these medical monitoring and care goals

very well/
somewhat well/
somewhat not well/
not well.

3. The specific goals NOHIMS is not meeting very well are

improvement in the quality of care/
improvement in access to care/
improvement in resource utilization/
improvement in management and operations/
improvement in compliance with monitoring programs/
other: _____.

4. The reasons that NOHIMS is not meeting these goal(s) are

NOHIMS lacks essential function(s)
Specify: _____/
feature(s) are not implemented
Specify: _____/
feature(s) are not implemented well
Specify: _____/
other: _____
_____.

5. The goals that have been only partially achieved are

improvement in quality of care/
improvement in access to care/
improvement in resource utilization/
improvement in management and operations/
improvement in compliance and monitoring programs/
other: _____.

6. The reasons that NOHIMS has only partially achieved these goal(s) are

NOHIMS lacks essential function(s)
Specify: _____/
feature(s) are not implemented
Specify: _____/
feature(s) are not implemented well
Specify: _____/
other: _____
_____.

7. The effect of NOHIMS has been to

increase/maintain/decrease

the quality of care.

23A 8. The effect of NOHIMS has been to

increase/maintain/decrease

the access to care.

9. The effect of NOHIMS has been to

increase/maintain/decrease

resource utilization.

10. The effect of NOHIMS has been to

increase/maintain/decrease

compliance with monitoring programs.

11. The effects of NOHIMS generally have been because of

increased patient care services provided/
more appropriate services provided/
improved follow-up of patients with abnormal findings or tests/
improved communication between departments/
increased availability of the medical record/
more accurate medical records/
availability of patient-specific summary reports/
availability of on-line look-up of patient-specific data/
availability of user-defined reports/
improved manpower scheduling/
improved patient compliance/
improved quality of care review procedures/
earlier diagnosis and notification of problems/
improved appointment scheduling/
other: _____.

23B 12. Since NOHIMS was implemented, communication between industrial hygienists and medical personnel has

improved/
been maintained/
deteriorated.

23B 13. If communication has changed, this is generally because of

availability of reports generated by NOHIMS/
less need for direct communication/
more accurate or complete data/
other: _____.

23B 14. (Industrial users only) Since NOHIMS was implemented, communication between industrial hygienists/safety specialists and work center supervisors has

improved/
been maintained/
deteriorated.

23B 15. (Industrial users only) If communication has changed, this is generally because of

availability of reports generated by NOHIMS/
less need for direct communication/
more accurate or complete data/
other: _____.

23A 16. The effect of the availability of an accurate medical record on the quality of patient care has been

very beneficial/
somewhat beneficial/
no effect/
somewhat detrimental/
very detrimental.

17. The effect of the availability of an individual's exposure history at the time of the physical examination has been

very beneficial/
somewhat beneficial/
no effect/
somewhat detrimental/
very detrimental.

18. The effects of NOHIMS on medical monitoring and care have been evaluated through measurements which are

subjective judgment
Specify who: _____/
counting/
objective measures such as surveys and questionnaires/
other: _____/
no measurements done.

19. Evaluation measurement methods used include

examination of the medical record for accuracy and completeness/
examination of the medical record for appropriateness/
checking of the diagnostic test pattern/
assessment of patients' response to treatment/
assessment of patient compliance/
assessment of quality of care review/
evaluation of research contributions/
evaluation of missed appointments/
evaluation of timeliness of physical examinations/
evaluation of availability of medical record/
evaluation of manpower utilization/
evaluation of time taken for specific tasks/
checking appropriateness of laboratory tests done/
checking adequacy of protective equipment issued/
checking adequacy of follow-up on abnormal findings or tests/
other: _____.

23A 20. Results of measurements conducted are

_____

_____

_____

_____.

(NOTE: Questions on usefulness of reports are found in Component 7, "USE AND USEFULNESS OF INFORMATION RETRIEVAL CAPABILITIES.")

INFORMATION REQUIRED FOR NAVY LEGAL PURPOSES

1. The legal purposes for which data stored in NOHIMS could be used are

   workers' compensation determinations/
   tort claims actions/
   Veterans Administration disability procedures/
   Navy medical boards/
   other: _____.

2. The types of data required for the above legal purposes are

   protection used/
   hazardous exposures/
   physical examination data/
   job histories/
   medical histories/
   illness and injury data/
   mortality data/
   demographic data/
   other: _____.

3. Specific data elements required are

4. To be useful in Navy litigations, the data stored in NOHIMS must be supported by

   the industrial hygiene survey stored in _____/
   the paper medical record stored in the patient's chart/ elsewhere/
   the medical data entry document stored in the patient's chart/elsewhere/
   both the paper medical record and the data entry document stored in the patient's chart/elsewhere/
   a physician's signature on the paper medical record/ computer-generated report/data entry document/
   an industrial hygienist's signature on the industrial hygiene survey/computer-generated report/
   procedures of the ordinary course of business/
   other: _____.

5. To be useful in Navy litigations, the data stored in NOHIMS must be formatted

   in any manner/

   other: _____/

   other: _____.

6. The kinds of information about NOHIMS that are required to prove the legal foundation of NOHIMS include

   description of computer hardware/physical plant/
   description of data entry procedures/
   description of software:
      features that assure input accuracy/
      features that protect the integrity of the database/
      security features/
      other: _____/
   other: _____.

7. The accuracy of the medical record must be verified by

   dual entry/
   review of data entered/
   batch verification/
   internal check digits/controls/
   not required/
   other: _____.

8. Describe any additional requirements.

ASSESSMENT OF HOW WELL NOHIMS MEETS NAVY LEGAL NEEDS

1. What obligations does the Navy have to respond to discovery requests and subpoenas for NOHIMS-generated data? Is it more likely that the paper medical record will be requested or subpoenaed?

2. a. Could NOHIMS standard operating procedures be construed as meeting the requirements that records admissable as evidence in legal proceedings be made in the ordinary course of business?

   b. If not, why not?

3. a. Are there adequate witnesses who can provide legal foundation for computer-stored records (i.e., witnesses with relevant educational and occupational background who can testify to the type of computer used, the physical plant, procedures used, software integrity, and security features)?

   b. Who, specifically, could currently provide this function?

   c. Would their testimony on the characteristics of NOHIMS be adequate to prove legal foundation?

4. Would a sampling of the NOHIMS database be accepted as representative of the entire database?

5. What is your assessment of the effect of NOHIMS on the number of Navy legal claims, if any, and why?

   decrease, because of reduction in errors/improved patient care/improved compliance with Navy/OSHA standards/ proof of compliance with Navy/OSHA standards/

   other: _____/

   increase, because of easier access to records/proof of non-compliance with Navy/OSHA standards/highlighting of errors/

   other: _____/

   no effect/

   no opinion/cannot say

6. What is your overall assessment of the adequacy of NOHIMS for use as a legal database?

   very adequate/
   adequate/
   somewhat adequate/
   somewhat inadequate/
   inadequate/
   very inadequate

APPROPRIATE SCENARIOS FOR TESTING OF LEGAL INTERROGATORIES

1. Describe in detail some typical legal cases handled by the Navy legal department.

2. What specific information would be required from the NOHIMS database for these specific types of cases?

3. What specific time frame is usually required for obtaining data for these typical cases?

NOHIMS AS AN AID TO EPIDEMIOLOGIC RESEARCH

1. The epidemiologic research functions that I see NOHIMS being useful for include

   identifying populations at risk/cohorts/
   identifying workers exposed, exposure levels, and length of exposure/
   determining medical effects of exposures/
   detecting disease trends/outbreaks/
   identifying common risk factors among exposed workers/
   other: _____.

2. The kinds of data required for these investigations include

   demographic data/
   worker exposure histories, including type of hazard/ degree of severity/time of exposure/duration of exposure/
   worker occupational histories/
   worker medical histories/
   physical examination data:
      presenting complaints/symptoms/
      test results/
      diagnoses/
   mortality data/
   other: _____.

3. The features/capabilities of NOHIMS that will be useful in epidemiologic research include

   cross-referencing ability/
   ability to analyze data at varying levels (individual, selected groups, or population)/
   reference tables/
   ad hoc information retrieval capabilities/
   other: _____.

4. My assessment of the adequacy of NOHIMS for conducting epidemiologic research is that NOHIMS is

   very adequate/
   adequate/
   somewhat adequate/
   somewhat inadequate/
   inadequate/
   very inadequate.

5. If NOHIMS is not at least adequate, the limitations/problems that I see with NOHIMS are

   inability/limited ability to manipulate database
      Specify: _____/
   required data are not collected
      Specify: _____/
   data are collected improperly/not standardized
      Specify: _____/
   other: _____.

USES IN ADMINISTRATIVE FUNCTIONS/ASSESSMENT OF USEFULNESS OF NOHIMS IN ADMINISTRATIVE FUNCTIONS

28A 1. The administrative functions that I see NOHIMS being useful for include

determining environmental differential pay decisions/
increasing standardization of reports/
increasing standardization of data collection forms/
reducing paperwork/
generating administrative reports/
providing timely and perpetual access to administrative data/
manpower/resource planning/
time and motion studies/
maintaining equipment lists/
managing inspection requirements/
other: _____.

28A 2. The kinds of data required for these functions include

hazard exposures/
service utilization data/
manpower/resource utilization data/
other: _____.

28A 3. The features/capabilities of NOHIMS that will be useful in administrative functions include

standard report generation capabilities/
on-line look-up/interactive query functions/
ad hoc report generation capabilities/
other: _____.

28B 4. My assessment of how NOHIMS has affected the amount of required paperwork is that NOHIMS has

greatly increased the amount of paperwork/
somewhat increased the amount of paperwork/
no effect/
somewhat decreased the amount of paperwork/
greatly decreased the amount of paperwork.

28B 5. It is my opinion that in terms of standardizing reports and forms NOHIMS has had

a beneficial effect/
a somewhat beneficial effect/
no effect/
a somewhat detrimental effect/
a detrimental effect.

28B 6. My assessment of the usefulness of having timely and perpetual access to administrative data with NOHIMS is that it is

useful/
somewhat useful/
somewhat not useful/
not useful.

APPLICABILITY OF NOHIMS TO OTHER NAVY INDUSTRIAL SITES

1. How do the information processing needs of the other Navy industrial sites that will be receiving NOHIMS differ from the information processing needs of the test sites? Are the two test sites representative of the other sites?

   no difference/
   different data collection requirements
      Specify: _____/
   different reporting requirements
      Specify: _____/
   other difference(s)
      Specify: _____

2. Can NOHIMS be adapted to a variety of Navy industrial settings and sites such as air rework facilities, shipyards, and public works centers? Are there aspects of NOHIMS that would make it unsuitable for any of these various environments?

3. Is NOHIMS applicable to Navy industrial settings of varying sizes? What limitations/requirements does NOHIMS have that relate to the size of the application environment?

4. What organizational changes are required at a new site in order for NOHIMS to perform successfully? For example, what changes to normal operating methods and procedures are required? What changes in terminology? Will this present problems at other Navy industrial sites?

5. What changes in the patterns of information exchange and communication will NOHIMS cause at a new site? Will this present problems at other Navy industrial sites?

FEATURES THAT MAKE NOHIMS FLEXIBLE AND ADAPTABLE

1. What features of the medical component of NOHIMS make it flexible and adaptable to the various needs of other Navy industrial sites?

   Is NOHIMS directory driven? Can codes be added or deleted from the directory?

   Can parameters for the codes be set and/or changed? What parameters can be set? Which of these can be changed?

   Can data other than directory codes be entered in a patient record?

   Is there a limit to the kinds or amounts of information that can be coded/entered?

   Can registration entry, medical encounter entry, and lab results entry be done in any order? at the same time? at different times?

   Can the entry sequences for registration and for medical encounter entry be altered?

   Can an already existing numbering scheme be used for identifying patient records? Can the social security number be used as the unit number?

   Can a patient be looked up by either name, unit number, or social security number?

   Is there a choice as to how codes can be entered in order to balance ease of data entry with ease of use by providers?

   Can standard report formats and content be specified and/or altered?

   Can the user create ad hoc reports? in any format desired? with any content desired? Does the system have an interactive query function?

   Can the above choices or changes be made without requiring programming intervention? Are there system maintenance functions which perform these tasks?

   What requirements are there for encounter and laboratory results input documents?

   What features make the medical component easy to learn and use?

   Does NOHIMS have on-line assistance functions? Is it menu driven?

   What supporting documentation and job aids are there to help the user?

   What system support is required to maintain the system? Is this support readily available?

   Can a variety of hardware configurations support the system? Can NOHIMS accommodate a variety of terminal/cursor types?

2. What features of the industrial component of NOHIMS make it flexible and adaptable to the various needs of other Navy industrial sites?

   Is NOHIMS directory driven? Can codes be added or deleted from the directory?

   Can parameters for the codes be set and/or changed? What parameters can be set? Which of these can be changed?

   Can data other than directory codes be entered in a file?

   Can user-specific identifiers be defined and used?

   Can a worker be identified by either name, social security number, or local employee number/pay number?

   Can data other than directory codes be entered in a worker record?

   Is there a choice as to how codes can be entered in order to balance ease of data entry with ease of use by industrial hygienists?

   Is there a limit to the kinds or amounts of data that can be entered into the files?

   Can organizational structures be defined to suit the site?

   Can a variety of entities be defined as environments?

   Can local conventions for indexing or referencing be used to identify a survey?

   Can tables of hazards and medical care standards be defined/altered?

   Can standard report formats and content be specified and/or altered?

   Can the user create ad hoc reports? in any format desired? with any content desired? Does the system have an interactive query function?

   Can the above choices or changes be made without requiring programming intervention? Are there system maintenance functions which perform these tasks?

   What requirements are there for input documents?

   What features make the industrial component easy to learn and use?

   Does NOHIMS have on-line assistance functions? Is it menu driven?

   What supporting documentation and job aids are there to help the user?

   What system support is required to maintain the system? Is this support readily available?

   Can a variety of hardware configurations support the system? Can NOHIMS accommodate a variety of terminal/cursor types?

IMPLEMENTATION PROCESS AT TEST SITES

Implementation Process

1. (NHRC system developers and test site administrators only) Who was involved in the implementation of NOHIMS at the (your) test site(s)? What degree of involvement did each of these people have?

   a. e.

   b. f.

   c. g.

   d. h.

2. (NHRC system developers and test site administrators only) In what areas of the implementation were each of these people involved? What total amount of time did each of these people spend on the implementation of NOHIMS?

   a. e.

   b. f.

   c. g.

   d. h.

3. In what areas of the implementation were you directly involved? What total amount of time did you spend on the implementation of NOHIMS?

4. (NHRC system developers and test site administrators only) What steps were involved in implementing NOHIMS at the (your) test site(s)?

5. From your perspective, what problems were encountered during the implementation of NOHIMS? How were these problems resolved/handled?

6. Was staff morale affected by the installation of NOHIMS?

   Was this effect a positive or negative one?

   Was the effect temporary?

Operational Procedures

7. What are the current data collection procedures for NOHIMS? What changes were required in previous standard data collection procedures in order to accommodate NOHIMS?

   Who collects the data?

   Who verifies the data?

   At what points in the process are data collected?

8. What are the current data entry procedures for NOHIMS data?

   Who enters the data?

   What is the backlog for data entry?

9. What are the current data retrieval procedures?

   Who requests retrieval of data from NOHIMS?

   Who retrieves the data from NOHIMS?

   How long does it take to get the requested information?

10. What are the current uses of reports/data generated by NOHIMS? What changes were required in previous standard operating procedures in order to utilize the reports/data generated by NOHIMS?

    Are reports/computer-generated data available to the physician when he/she sees the patient?

    Do the data collection instruments support/replace/exist in addition to the previously used forms/records?

    Does the computer-generated report support/replace/exist in addition to the paper medical record?

    Are NOHIMS reports used to identify workers requiring physical examinations?

    Are NOHIMS reports used to monitor compliance with Navy standards?

    Is NOHIMS used to produce/collect data for management reports?

Operational Procedures (Cont.)

11. What is the hardware configuration at the (your) test site(s)?

    What type and how many terminals are there?

    What type and how many printers are there?

    What type of communications equipment is used?

    What type of processor is used?

    Where are these devices located?

    Are remote terminals and printers used on a regular basis?

12. What physical security features have been implemented at the (your) test site(s)?

    Are there cipher locks on doors?

    Is there a log book for people entering the computer room?

    Is there a record of batch programs?

13. (NHRC system developers and test site administrators only) Is NOHIMS a development of a previous automated system at the test site(s)? replacement of a previous automated system? supplement to an existing manual system? replacement of a manual system? a completely new data collection and processing system?

14. What problems do you encounter/are encountered in day-to-day operations of NOHIMS? How are/were these problems resolved/handled?

Assessment of Adaptability of NOHIMS to Needs of Test Site(s)

15. How well do you feel NOHIMS has been integrated into the day-to-day procedures of the (your) test site(s)?

    very well/
    somewhat well/
    somewhat poorly/
    poorly.

16. How well do you feel that NOHIMS has responded to the particular needs of the (your) test site(s)?

    very well/
    somewhat well/
    somewhat poorly/
    poorly.

17. Were there needs specific to the (your) test site(s) that NOHIMS could not meet? If so, what were those needs?

ACCEPTABILITY OF NOHIMS TO USERS

1. In general, I feel that NOHIMS

   adequately/
   somewhat adequately/
   somewhat inadequately/
   inadequately/

   performs the functions that are required in my work.

2. Generally, I feel that NOHIMS is

   reliable/
   somewhat reliable/
   somewhat unreliable/
   unreliable.

3. Generally, I feel that NOHIMS

   is/
   is somewhat/
   is somewhat not/
   is not/

   user friendly and easy to operate.

4. In general, the data collection forms are

   acceptable/
   somewhat acceptable/
   somewhat unacceptable/
   unacceptable/

   to me.

5. In general, I think that the data collection forms are

   acceptable/
   somewhat acceptable/
   somewhat unacceptable/
   unacceptable/

   to the patient/worker.

6. I feel that the changes in procedures required by NOHIMS are

   acceptable/
   somewhat acceptable/
   somewhat unacceptable/
   unacceptable.

7. I feel that NOHIMS

   is an aid in/
   is somewhat of an aid in/
   has no effect on/
   is somewhat of a hindrance in/
   is a hindrance in/

   the provision of care to the patient/worker.

8. (Medical users only) I feel that NOHIMS has

   significantly disrupted/
   somewhat disrupted/
   not disrupted/

   traditional patterns of clinical thinking and/or patient management.

9. NOHIMS has affected my workload by

   significantly increasing my workload/
   somewhat increasing my workload/
   somewhat decreasing my workload/
   significantly decreasing my workload/
   changing the nature of my workload/
   no effect on my workload.

10. NOHIMS features that have been incorporated into my everyday work procedures include

    data collection forms/
    data entry/
    on-line look-up/interactive query/interactive flowcharts/
    display of standard reports/
    printed standard reports/
    report generation/
    other: _____/
    none.

11. These features have made my job

    much easier/
    somewhat easier/
    no effect/
    somewhat harder/
    much harder.

12. These features have made me

    less productive/
    about as productive/
    more productive.

13. Generally, I feel that system users can perform their jobs

    more efficiently and effectively/
    somewhat more efficiently and effectively/
    to the same level of efficiency and effectiveness/
    somewhat less efficiently and effectively/
    less efficiently and effectively/

    because of NOHIMS.

14. In general, my assessment of how well people have adapted to NOHIMS is that they have adapted

    well/
    somewhat well/
    somewhat poorly/
    poorly.

15. Overall, NOHIMS is

acceptable/
somewhat acceptable/
somewhat unacceptable/
unacceptable.

16. If NOHIMS is unacceptable or somewhat unacceptable, what changes need to be made in order to make it acceptable?

less data have to be collected/
more data have to be collected/
data have to be collected at more points/
changes to data collection forms are required/
data have to be stored longer/
more hardware is required/
more communication gear is required/
more software is required/
changes to present software are required/
new report formats are required/
new reports are required/
inquiry capability is required/
more inquiry capability is required/
more system support is required/
more training is required/

other: _____/

other: _____/

other: _____

ASSESSMENT OF TRANSFERABILITY OF NOHIMS TO OTHER NAVY INDUSTRIAL SITES

1. My assessment of the suitability of NOHIMS to the information processing needs of other Navy industrial sites is that NOHIMS is

   very suitable/
   somewhat suitable/
   somewhat unsuitable/
   very unsuitable.

2. My opinion of the flexibility and adaptability of NOHIMS is that NOHIMS is

   adequately flexible and adaptable/
   somewhat adequately flexible and adaptable/
   somewhat inadequately flexible and adaptable/
   inadequately flexible and adaptable/

   to be transferred to other Navy industrial sites.

3. Areas in which NOHIMS needs to be more flexible and adaptable include:

4. My assessment of the ease of transfer of NOHIMS to other Navy industrial sites is that the process will be

   difficult/
   somewhat difficult/
   somewhat easy/
   easy.

5. The specific problems I foresee in transferring NOHIMS to other Navy industrial sites are that

6. It is my opinion that the acceptability of NOHIMS among users at other Navy industrial sites will be

   very high/
   high/
   somewhat high/
   somewhat low/
   low/
   very low.

PERCEIVED BENEFITS OF NOHIMS

1. In my opinion, the benefits of NOHIMS have been

   increased quality of care provided to the worker/patient through:
   - fewer unnecessary tests and ancillary services/
   - fewer unnecessary examinations/visits/
   - appropriateness of tests performed/
   - reduced waiting time/
   - more accurate patient medical record/
   - timely and perpetual access to data/
   - earlier diagnosis of illnesses/conditions/
   - earlier notification of abnormal test results/findings/
   - base-line data on the health of an employee/

   increased compliance with monitoring programs/
   reduction in occupational exposures to hazardous agents/
   improved workplace monitoring/
   - better identification of possible hazards/
   - better identification of workers exposed/

   safer working conditions/
   improved job certification program/
   increased confidence of workers/
   improved communication between those concerned with the occupational health of the worker/
   increased productivity of staff/clinics/
   increased efficiency in the use of resources/
   savings in manpower/
   reduction in the cost of providing services/
   improved planning and budgeting/
   more accurate administrative reports/
   more accurate/available database for research efforts/
   other health care benefits: _____
   _____
   other monitoring benefits: _____
   _____
   other administrative benefits: _____
   _____
   other benefits: _____
   _____

2. Of those mentioned, the most significant benefit of NOHIMS is

3. The costs of implementing and operating NOHIMS

   clearly exceed or outweigh the benefits/
   somewhat exceed or outweigh the benefits/
   equal the benefits/

   or the benefits

   somewhat exceed or outweigh the costs/
   clearly exceed or outweigh the costs.

SUITABILITY OF GOVERNMENT-OWNED OCCUPATIONAL HEALTH INFORMATION SYSTEMS TO NAVY NEEDS

1. What government-owned occupational health information systems exist? What is their current development status?

   Department of Transportation---Voluntary Employee Injury/ Illness Reporting System (VEIIRS)/
   Coast Guard---acquired contract services to study problem/
   Environmental Protection Agency---Injury Reporting and Information System (IRIS)/
   U.S. Army---has initiated system development efforts/
   U.S. Air Force---Computerized Occupational Health Program currently awaiting development funds/
   Other: _____.

2. For each system, check off the features/capabilities required by Navy information processing needs that the government-owned systems have.

	DOT VEIIRS	Coast Guard	EPA IRIS	U.S. Army	U.S. Air Force
Required information is collected:					
personnel data					
hazardous materials characteristics					
presence of *hazardous* materials					
data on health of workers:					
illness and injuries					
sick leave/absenteeism					
routine examinations					
test results					
procedures					
medical histories					
mortality data					
individual exposures/ exposure history					
data on accidents/incidents					
occupational histories					
other					

	DOT VEIIRS	Coast Guard	EPA IRIS	U.S. Army	U.S. Air Force
Data can be retrieved in required formats:					
tables of hazardous materials					
lists of workers with exposures					
lists of workers requiring physical examinations					
medical encounter reports					
medical summary reports					
management reports					
other					
Data can be manipulated in required ways:					
number of surveys conducted					
number of persons exposed to hazard					
number of examinations conducted					
number of laboratory tests done					
number of radiographs done					
number of asbestos examinations conducted					
list of those with ordered but unresulted tests					
other					
Other					
Not familiar with system					

3. My assessment of the suitability of each of the government-owned systems to Navy information collection needs is that they are

	DOT VEIIRS	Coast Guard	EPA IRIS	U.S. Army	U.S. Air Force
Very suitable					
Somewhat suitable					
Somewhat unsuitable					
Very unsuitable					

4. My assessment of the suitability of each of the government-owned systems to Navy information retrieval needs is that they are

	DOT VEIIRS	Coast Guard	EPA IRIS	U.S. Army	U.S. Air Force
Very suitable					
Somewhat suitable					
Somewhat unsuitable					
Very unsuitable					

5. My assessment of the suitability of each of the government-owned systems to Navy information manipulation needs is that they are

	DOT VEIIRS	Coast Guard	EPA IRIS	U.S. Army	U.S. Air Force
Very suitable					
Somewhat suitable					
Somewhat unsuitable					
Very unsuitable					

6. Overall, my assessment of the adequacy of each of the government-owned systems to Navy information processing needs is that they are

	DOT VEIIRS	Coast Guard	EPA IRIS	U.S. Army	U.S. Air Force
Very adequate					
Adequate					
Somewhat adequate					
Somewhat inadequate					
Inadequate					
Very inadequate					

SUITABILITY OF COMMERCIALLY AVAILABLE OCCUPATIONAL HEALTH INFORMATION SYSTEMS TO NAVY NEEDS

1. What commercial occupational health information systems are available?

   Computerized Occupational Health and Environmental Surveillance System (COHESS)/
   FLOW GEMINI [Flow GEneral's Medical Information Needs for Industry] (FG)/
   DEChealth (DEC)/
   Other: _____
   Other: _____.

2. For each system, check off the features/capabilities required by Navy information processing needs that the commercial systems have.

	COHESS	FG	DEC	Other	Other
Required information is collected:					
personnel data					
hazardous materials characteristics					
presence of hazardous materials					
data on health of workers:					
illness and injuries					
sick leave/absenteeism					
routine examinations					
test results					
procedures					
medical histories					
mortality data					
individual exposures/ exposure history					
data on accidents/incidents					
occupational histories					
other					

	COHESS	FG	DEC	Other	Other
Data can be retrieved in required formats:					
tables of hazardous materials					
lists of workers with exposures					
lists of workers requiring physical examinations					
medical encounter reports					
medical summary reports					
management reports					
other					
Data can be manipulated in required ways:					
number of surveys conducted					
number of persons exposed to hazard					
number of examinations conducted					
number of laboratory tests done					
number of radiographs done					
number of asbestos examinations conducted					
list of those with ordered but unresulted tests					
other					
Other					
Not familiar with system					

3. My assessment of the suitability of each of the commercial systems to Navy information collection needs is that they are

	COHESS	FG	DEC	Other	Other
Very suitable					
Somewhat suitable					
Somewhat unsuitable					
Very unsuitable					

4. My assessment of the suitability of each of the commercial systems to Navy information retrieval needs is that they are

	COHESS	FG	DEC	Other	Other
Very suitable					
Somewhat suitable					
Somewhat unsuitable					
Very unsuitable					

5. My assessment of the suitability of each of the commercial systems to Navy information manipulation needs is that they are

	COHESS	FG	DEC	Other	Other
Very suitable					
Somewhat suitable					
Somewhat unsuitable					
Very unsuitable					

6. Overall, my assessment of the adequacy of each of the commercial systems to Navy information processing needs is that they are

	COHESS	FG	DEC	Other	Other
Very adequate					
Adequate					
Somewhat adequate					
Somewhat inadequate					
Inadequate					
Very inadequate					

DESCRIPTION OF NAVY INTERIM OCCUPATIONAL HEALTH INFORMATION SYSTEM/SUITABILITY OF NAVY INTERIM OCCUPATIONAL HEALTH INFORMATION SYSTEM TO NAVY NEEDS

37A 1. Check off the features/capabilities required by Navy information processing needs that the Navy interim system has.

	Navy Interim System
Required information is collected:	
personnel data	
hazardous materials characteristics	
presence of hazardous materials	
data on health of workers:	
illness and injuries	
sick leave/absenteeism	
routine examinations	
test results	
procedures	
medical histories	
mortality data	
individual exposures/ exposure history	
data on accidents/incidents	
occupational histories	
other	

37A

	Navy Interim System
Data can be retrieved in required formats:	
tables of hazardous materials	
lists of workers with exposures	
lists of workers requiring physical examinations	
medical encounter reports	
medical summary reports	
management reports	
other	
Data can be manipulated in required ways:	
number of surveys conducted	
number of persons exposed to hazard	
number of examinations conducted	
number of laboratory tests done	
number of radiographs done	
number of asbestos examinations conducted	
list of those with ordered but unresulted tests	
other	
Other	
Not familiar with interim system*	

* If not familiar with the interim system, go to the next interview section.

37A 2. What are the software quality attributes of the interim system?

↓

Does the interim system allow performance of all required tasks?

identification tasks/
entry tasks/
review tasks/
editing tasks/
information retrieval tasks/
system maintenance tasks.

Is the interim system reliable?

What error recovery procedures does the interim system have?

What back-up procedures are required to prevent data loss?

What features make the source program code efficient?

How portable and hardware independent is the interim system?

How maintainable is the interim system software?

3. What are the operational characteristics of the interim system?

How well does the interim system present its operational capabilities to the user?

Is the interim system "menu driven" at all selection levels?

What user on-line assistance functions does the interim system have?

What error diagnostic features and debugging aids does the interim system have?

What database manager utilities does the interim system have?

What is the average entry time per input form?

What are the add, save, change, and delete procedures?

Does the interim system have a search in context capability?

What are the general filing procedures for the interim system?

Can data and routines be downloaded to magnetic tape?

4. What security features does the interim system have?

5. What are the software support requirements for the interim system?

What and how many support personnel are required to maintain the interim system software?

What functions must be performed by the support personnel?

What is the estimated amount of support manhours required per month to maintain the interim system?

37A 6. What system support is available for the interim system?

↓

What kind of support is available for the initial training of users?

What kind of support is available for ongoing and update training of users?

What kind of support is available for technical concerns?

What kind of documentation and job aids are there that support system operations?

7. What system scenarios are required to maintain the interim system?

What prime time maintenance functions must be performed during the day on a daily basis?

What system maintenance functions must be performed during the off-shift on a regular basis? How often must these tasks be performed?

How often must patient files be archived?

8. What are the organizational requirements of the interim system?

What requirements are there for users of the interim system to have programming skills? for system managers?

What requirements are there for system managers to understand source code?

What staff is required to operate an interim system installation?

What requirements are there for the installation area?

9. What is the minimum hardware configuration that could support the interim system?

37B 10. My assessment of the suitability of the Navy interim system to Navy information collection needs is that it is

very suitable/
somewhat suitable/
somewhat unsuitable/
very unsuitable.

37B 11. My assessment of the suitability of the Navy interim system to Navy information retrieval needs is that it is

very suitable/
somewhat suitable/
somewhat unsuitable/
very unsuitable.

37B 12. My assessment of the suitability of the Navy interim system to Navy information manipulation needs is that it is

very suitable/
somewhat suitable/
somewhat unsuitable/
very unsuitable.

37B 13. Overall, my assessment of the adequacy of the Navy interim system to Navy information processing needs is that it is

very adequate/
adequate/
somewhat adequate/
somewhat inadequate/
inadequate/
very inadequate.

APPENDIX B

INTERVIEWS CONDUCTED

APPENDIX B
INTERVIEWS CONDUCTED

Person Interviewed/Title/Location	Interview Guide Used
CDR. JAMES W. ALLEN NOHIMS Project Manager Navy Environmental Health Center Norfolk, Virginia	NEHC Project Management Team
MARGIE ACOL Occupational Health Technician Occupational Health Unit North Island, San Diego, California	Medical Care Provider User
DONALD D. BECK Consultant Paso Robles, California	NHRC Interim System Developer
ROGER BECKETT Head, Industrial Hygiene Division Naval Hospital Bremerton, Washington	Higher Level Navy Management
C. W. BOLLINGER, M.D. Director, Occupational and Environmental Health Services Naval Hospital Bremerton, Washington	Medical Care Provider User Test Site Administrator
LARRY BRADY Industrial Hygienist Naval Air Rework Facility North Island, San Diego, California	Navy Legal Counsel Industrial User (Hygienist)
PAT BROWNE Administrative Services Officer/ Assistant to Production Department Head Naval Air Rework Facility North Island, San Diego, California	Navy Legal Counsel
ANDREW BRYSON Head, Environmental Health Division Occupational Health and Preventive Medicine Department San Diego, California	Higher Level Navy Management

MERLE BUNDY, M.D. Head, Occupational Medicine Division Occupational Health and Preventive Medicine Department San Diego, California	Higher Level Navy Management Medical Care Provider User
ANNE BURTON Industrial Hygienist Occupational Health and Preventive Medicine Department, Industrial Hygiene Division North Island, San Diego, California	Test Site Administrator Industrial User (Hygienist)
RICHARD COHEN, M.D. Head Occupational Health Unit North Island, San Diego, California	Test Site Administrator Medical Care Provider User
JENNY EARLY Occupational Health Technician Occupational Health Unit North Island, San Diego, California	Medical Care Provider User
STEVE GRABOWSKI, M.D. Occupational Medical Officer Occupational Health Unit North Island, San Diego, California	Medical Care Provider User
E. K. ERIC GUNDERSON, Ph.D. Head, Environmental Medicine Dept Naval Health Research Center San Diego, California	NHRC Interim System Developer NHRC NOHIMS Developer
CAPT. C. W. HALVERSON Head, Occupational Health and Preventive Medicine Department San Diego, California	Higher Level Navy Management
BILL HAROLD Peripheral Equipment Operator Occupational Health Unit North Island, San Diego, California	Data Entry Personnel
JAMES C. HELMKAMP, M.D. Research Epidemiologist Naval Health Research Center San Diego, California	NHRC NOHIMS Developer

CAPT. TOM HENN Head, Occupational Health and Preventive Medicine Department Naval Hospital Bremerton, Washington	Free form interview
LARRY HERMANSEN Systems Analyst Naval Health Research Center San Diego, California	NHRC Interim System Developer NHRC NOHIMS Developer ADP Personnel NOHIMS System Manager
PETE HOWARD Industrial Hygienist Naval Hospital Bremerton, Washington	Industrial User (Hygienist)
MIKE JACKSON NOHIMS Site Manager/ Industrial Hygienist Naval Hospital Bremerton, Washington	NOHIMS System Manager/Test Site Administrator ADP Personnel
GERALD JOCHEM Administrator, Injury Compensation Program Naval Air Station/Naval Air Rework Facility North Island, San Diego, California	Navy Legal Counsel
LARRY KALCSO Industrial Hygienist Naval Hospital Bremerton, Washington	Industrial User (Hygienist)
ROY KENNON, M.D. Occupational Physician Occupational Health Unit North Island, San Diego, California	Medical Care Provider User
SUSAN LANCASTER Compensation Specialist Civilian Personnel Naval Hospital San Diego, California	Navy Legal Counsel
MICHAEL LEMM NOHIMS Site Manager Occupational Health and Preventive Medicine Department San Diego, California	Higher Level Navy Management

BONNIE NELSON, P.A. Physician's Assistant Occupational Health Unit North Island, San Diego, California	Medical Care Provider User
JAN PEARSON Clerk Typist Naval Hospital Bremerton, Washington	Data Entry Personnel
WILLIAM M. PUGH Head, Medical Information Systems Program Naval Health Research Center San Diego, California	NHRC Interim System Developer NHRC NOHIMS Developer ADP Personnel
LYNNE PUGSLEY Employee Relations Specialist Civilian Personnel San Diego, California	Naval Hospital Navy Legal Counsel
VERNA RAGER Adminstrative Services Officer Naval Air Rework Facility North Island, San Diego, California	Navy Legal Counsel
MATT ROSA Safety and Health Manager Naval Air Rework Facility North Island, San Diego, California	Navy Legal Counsel Higher Level Navy Management
BETTY WHITEAKER Industrial Hygienist Occupational Health and Preventive Medicine Department, Industrial Hygiene Division North Island, San Diego, California	Industrial User (Hygienist)

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