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Author(s): H. A. Hahn, Florence Kay Houghton

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IMPACT OF STAFFING PARAMETERS ON OPERATIONAL RELIABILITY

Heidi Ann Hahn
Los Alamos National Laboratory
P. O. Box 1663 MS F684
Los Alamos, NM 87545
(505) 665-4606

F. Kay Houghton
Los Alamos National Laboratory
P. O. Box 1663 MS F684
Los Alamos, NM 87545
(505) 665-2047

ABSTRACT

This paper reports on a project related to human resource management of the Department of Energy's (DOE's) High-Level Waste (HLW) Tank program. Safety and reliability of waste tank operations is impacted by several issues, including not only the design of the tanks themselves, but also how operations and operational personnel are managed. As demonstrated by management assessments performed by the Tiger Teams, DOE believes that the effective use of human resources impacts environment, safety, and health concerns. For the purposes of the current paper, human resource management activities are identified as "Staffing" and include the process of developing the functional responsibilities and qualifications of technical and administrative personnel. This paper discusses the importance of staff plans and management in the overall view of safety and reliability, the work activities and procedures associated with the project, a review of the results of these activities, including a summary of the literature and a preliminary analysis of the data. We conclude that, although identification of staffing issues and the development of staffing plans contributes to the overall reliability and safety of the HLW tanks, the relationship is not well understood and is in need of further development.

INTRODUCTION

This paper reports on a project related to human resource management in the Department of Energy's (DOE's) High-Level Waste (HLW) Tank program. This project is one of several related activities funded as part of the HLW Tank Workshop Program, the primary objective of which is the systematic identification, prioritization, evaluation, and resolution of safety issues related to tank farm operations and equipment. The ultimate goal is the safe operation of tank storage within a valid safety envelope.

Safety of waste tanks and waste tank operations is impacted by several issues, including not only the design of the tanks themselves, but also how operations are managed. Human resource management, defined as the recruitment, selection, development, and utilization of, and accommodation to, human resources by organizations,[1] is one facet of overall operations management that may affect safety of tank operations. In turn, because accidents, injuries, and/or unsafe operations may cause work stoppages or slow-downs while causes are determined and corrective actions are taken, operations management, including human resource management, can be linked to operational reliability.

Inclusion of human resource management in the management assessments performed by the Tiger Teams reflects the belief of the DOE that the effective use of human resources impacts Environment, Safety, and Health concerns. In a report summarizing the results of the first sixteen Tiger Team assessments (which included three of the four DOE waste tank sites), it was noted that 80% of the facilities assessed do not have contractors that identify, prioritize, and/or develop plans to ensure that human resource requirements, including staffing needs and development, optimal utilization of existing resources, and maintenance of effective labor relations, are met; 33% of the facilities do not have a site wide program for contractor staff recruitment; and 93% of the facilities do not have effective contractor programs for staff development, training, and certification to ensure that qualified personnel are available[2]. These findings provide a clue as to the expected state of human resource management at the tank sites of interest in the current project.

In the Workshops Program, human resources management activities have been called out under the name "Staffing." Staffing has been defined as the process of developing the functional responsibilities and qualifications of technical and administrative personnel required to effectively operate the HLW tank storage systems.[3] (Note that a detailed study of training programs has been specifically omitted from this scope, as another entire workshop will been devoted to that topic. Training issues will be considered only insofar as they impact other staffing parameters.) On the surface, this definition is fairly straight forward, asking only "What functions must be performed?" and "What skills and/or education are necessary to perform them?" In this situation, a simple staffing model like that shown in Figure 1 could be proposed. Here, demand factors, like the functions to be performed, and supply factors, like the people and skills available to perform them, are balanced to create a manpower plan. This plan is based on the simple mathematical balance of supply and demand.

Figure 1. Simple Manpower Planning Model.

As Figure 2 shows, however, manpower planning does not occur in isolation. Rather, staff planning activities provide both direction and scope to subsequent staffing and development efforts. Together, manpower planning and staff development determine organizational performance, reflected in operational reliability and other operating results. Subsequent appraisal and analysis of results provides closed loop feedback to the rest of the system.[4] In looking at the human resource management activities of an organization, then, one must be concerned with a broader range of questions, such as:

- How is human resource planning conducted? Who is responsible for the acquisition and development of staff? What systematic methods exist or should exist to ensure that staffing needs are known and met, that existing resources are used optimally, and that staff relations are maintained in a manner that promotes safe and reliable operations?

- What staff recruitment programs exist or should exist, both for internal and external recruitment, to ensure the availability of qualified staff? Is recruitment competitive? How is the staff recruitment program monitored and evaluated for effectiveness?

- What programs exist or should exist for staff development, training, and certification, to ensure that only fully qualified staff are assigned to safety critical operations? What are the qualification criteria for the operating crews and how are those criteria developed?

- What assessment measures exist or should exist for staffing? Do the assessment measures include safety or operational performance indicators? How are performance measures used to project future staffing needs? Does management oversight incorporate assessment and feedback of operational experience?

Obviously, these questions go beyond a simple assessment of the individuals performing tank operations, and require consideration of broad management issues related to staffing. These issues, while predominantly the responsibility of the contractors operating waste tanks, also may be impacted by DOE's management of its contractors, especially at the field office level. Thus, both contractor and field office management activities are of interest in this study.

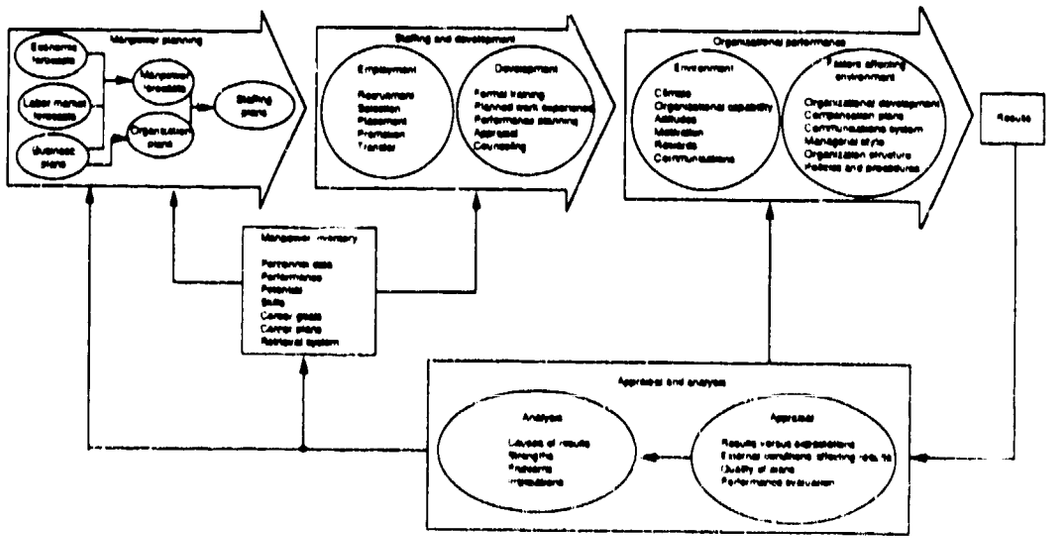

Figure 2. Model of Human Resource Management (from Cascio, 1978).

WORK ACTIVITIES AND PROCEDURES

The work activities of the staffing project can be broken down into three tasks:

1. Research the DOE Orders, guides, and regulations applicable to staffing of HLW tank storage operations. Use the general personnel management literature to provide foundations for the rationale for including staffing parameters in safety and operational considerations and for processes needed to develop and implement staff planning functions.

2. Promote the exchange of information among sites on organization and staffing requirements, both in terms of existing practices and identified needs.

3. Provide guidance for the development of staffing plans, including the development of functional responsibilities and qualifications, for the HLW tank storage program.

Task 1 was conducted in the fashion of a usual literature search, but involved both the specialized data sources comprised by the existing set of DOE Orders, procedures, and guidelines and the general literature on human resource management. The output of this activity is a database of: (a) requirements for staffing imposed by the DOE; and (b) literature abstracts describing relationships between staffing parameters and operational safety and reliability (most of which deal with staffing policies, such as the use and implementation of shift work, overtime, etc.). Results of this activity are summarized below.

Task 2 involves two steps: (a) conducting interviews at each site with contractor and field office personnel who are assigned to tank programs and who have responsibility for or knowledge of issues related to staffing; and (b) conducting working group sessions to promote information exchange among the sites. To date, interviews have been conducted at two of the four tank sites. The results of these interviews are summarized below. No working group sessions have been conducted yet.

The main purpose of the interviews is to gather information about how staff planning functions are performed at each site and to identify perceived site needs in the area of staffing in a non-threatening environment (i.e., without disclosing specific "deficiencies" of a particular site). As mentioned above, interviewees are being selected from among contractor and field office personnel at each site who are assigned to tank programs and who have responsibility for or knowledge of issues related to staffing. Referrals from site personnel are used to identify appropriate interviewees. Prior to visiting a site to conduct the interviews, the site is contacted by phone, an explanation of the workshops program is given, and agreement is reached that the site will provide knowledgeable contractor and field office personnel (at least one person from each organizational entity) both as interviewees and subsequent workshop participants.

All interviews are being conducted by the authors of this paper, both of whom are staff level.

Interviews are based on an *a priori* list of questions, containing items deemed important as a result of the literature search conducted as Task 1. These questions can be characterized as more specific versions of the set of questions regarding human resource management posed in the introduction to this paper. In all interviews conducted to date, although we were sure to gather all required information, interviews were rather free-form; interviewees were allowed to pursue their thoughts without lock-step regimentation to an ordered series of interview items.

In arranging for and conducting the interviews, each interviewee is assured that his or her identity, either by name or site, will be protected. Interviews are tape-recorded, but, after the tapes are transcribed, they are being destroyed. Tape transcriptions will not contain identifying information about the interviewees.

Transcripts serve as the data source for subsequent analysis. Analysis is being conducted as a four step process involving identification of passages (segments, extracts) in the transcripts that are regarded as significant, coding of those passages to indicate key content, data basing the key codes and passages, and extracting data in a meaningful form (i.e., for the identification of patterns, trends, and or inconsistencies across sites).

Once data extraction is completed, the information will be synthesized into a list of issues to be addressed. This issue list will serve as the starting point for the group meetings to be conducted as part of Task 2. The objectives of the working group meetings are three-fold: (a) to promote understanding about staffing parameters and their relationship to operational safety and reliability at the sites; (b) to gain consensus on the staffing issues that must be addressed by the sites if they are to be in compliance with DOE requirements; and (c) to collectively determine approaches to staffing that both meet DOE requirements and build upon existing practices at the sites. These approaches will then be documented in the staffing guidance document to be produced in Task 3.

RESULTS

Review of Orders and Other Literature

Over 40 DOE Orders, guidelines, and related documents were reviewed. Most of these direct the site management to provide adequate qualified personnel and resources to ensure safe operations, but leave implementation to the discretion of site management. Field offices are directed to oversee these activities.

Site management is responsible to determine both the qualifications requirements to ensure safe and reliable operations and the number of persons required. Qualification requirements are tied to education, experience, training and any special knowledge, skills and abilities required to perform the job. Where the orders do not delineate the qualification requirements (only one of the orders makes such specifications), it is mandated that the site management to perform a needs and job

analysis to determine qualifications. No specifications are given in the orders for how the required number of staff should be determined.

While staffing plans and related documentation are mandated by the orders, then, little guidance is provided regarding what staffing plans should accomplish and how staffing plans should be developed. Thus, our hypothesis going into the interview process is that it is unlikely that sites will have a common understanding of what is required in planning for staffing or a common staff development process.

The open literature provides numerous staffing assessment techniques, ranging from highly quantitative models to models that are indicative of the integrated nature of human resource management activities (i.e., that shown in Figure 2). Because of our expectation that staff planning activities are not well developed at the sites, we have opted to make use of the more conceptual models in the hope that they will promote better understanding of how staffing relates to operational safety and reliability at the sites.

Literature calling out defined links between staffing parameters and either operational safety or reliability is sparse. Most of that which does exist describes relationships between staff deployment tactics, specifically shift work and overtime, and performance. However, these relationships are not at all clear-cut, involving many potential mediating factors. For example, Gould[5] concludes that in nuclear facilities the use of 12 hour shifts has not resulted in a decrease in job performance or an increase in error rate. But, in scheduling shift work, several factors must be considered, including characteristics of the employee such as "morningness" or "eveningness" and circadian rhythms, and the characteristics of the task such as challenge and interest.[6] (DOE Order 5480.20 allows shifts to be as long as 16 hours, but acknowledges the task characteristics as a mediating factor by indicating that tasks be selected carefully for shifts longer than 12 hours.) This dearth of simple relationships between staffing parameters and safety and reliability complicates the development of programs to evaluate human resource management activities in an operational context.

Preliminary Analysis of Interview Data

Staffing issues identified in the interviews that may affect safety and reliability fall into three categories: human resource planning, including staff development and qualification; personnel flow; and staffing policies and procedures, specifically overtime and shift work policies. The relationship between staffing issues and HLW tank operational safety and reliability is not clearly understood. The interviews indicate that operational safety and reliability and staffing are considered as two distinct entities with very little overlap.

Human Resource Planning. At both sites where interviews were conducted, human resource planning is based on a staffing plan developed by the line management. While the actual acquisition of staff is performed by the personnel office, the line manager is responsible for setting the criteria for staff acquisition. The criteria include the number and type of personnel required and are defined in the staffing plans. The staffing plans are based on a simple model that includes the number of people needed and the qualification and skills requirements for each position (i.e., like that shown in Figure 1 in the Introduction).

Data from previous years and anticipated workload changes are used to project the personnel requirements. As the size of the operations changes, the line manager projects new workloads and either increases or decreases the number of personnel appropriately. If the scope of the project is modified to include new job functions, the workload estimates are revised to reflect the job task analysis (JTA) for the new functions. While resources are not unlimited, the basic attitude is that adequate resources will be available, therefore, staffing projections are based almost exclusively on need and are not particularly constrained by the availability of money.

While the staffing forecasts are based on an task analysis, it is not clear that the jobs are adequately defined by the identified tasks at either site. For example, personnel perform many "non-production" tasks such as participating in audits and conducting site tours. The time devoted to non-production tasks is not adequately factored into the assessment.

The question of non-production tasks leads to the question of adequate allocation of time for training, in particular continuing-training. One site uses a rotating shift with one shift dedicated to training. The other site is performing a feasibility study to determine if a dedicated training shift will meet the needs of the site.

Qualification and skills requirements are established by the JTA performed for each position. Both sites have a centralized training facility that is responsible for the tracking of employee qualification as well as the development and implementation of the training requirements.

At both sites, the line manager is ultimately responsible for ensuring that staffing needs are known and met, that existing resource are used optimally, and the staff relations are maintained in a manner that promotes safe and reliable operations. It appears that the line manager relates the staffing issues to safety and reliability in a subjective manner, based primarily on experience. While there is no written analysis, line managers do understand that the number of personnel is critical not only to perform the tasks required during normal operations but also to identify and perform off normal operations.

Staff Development and Qualification. At both sites the qualification requirements are established and monitored by a centralized training facility (that serves the entire site, not just the tank operations). The qualification programs are well defined and based on JTAs. To ensure that only qualified staff are assigned to safety-critical jobs, the qualification and requalification programs contain provisions for remediation of employees who fail the training. Furthermore, operators who fail the training are not allowed to perform tasks that require qualification unless they are directly supervised by a qualified operator.

An important aspect of the qualification programs is the qualification of the instructors providing the training. DOE

5480.20 requires that instructors conducting qualification programs be qualified as instructors and be technically qualified in the area of instruction. At one site, the instructors are primarily recruited from operations. Thus, they enter the training arena with appropriate technical qualifications and are trained in the instructional activities. At the other site, personnel with a training background are recruited and then trained to become technically qualified.

Because staff development is often implemented through internal recruiting as vacancies occur, the results of the staff development efforts can be seen in the flow of personnel from one position to another.

Personnel Flow. Both sites have an active recruitment program. One site is making an effort to hire personnel with Navy experience. At both sites, although the jobs are specialized, much of the external recruitment is from the immediate vicinity. Therefore, it is very difficult to hire personnel that do not require intensive training. It is estimated that it takes about a year before a new operator is useful to the plant. Internal recruitment at both sites is based on vacancies. However, there are very basic differences in the flow of operators from one job category to another at the two sites.

At one site, operators are given basic training and then become "Operator-1" qualified. They then are eligible to purse one of two "Operator-2" qualification tracks. When there is a vacancy, an Operator-1 may move into an Operator-2 position. The tasks performed by an Operator-2 are more difficult and require higher skill levels than those of an Operator-1. This forms an almost direct relationship between job experience and the difficulty of the job performed.

At the other site, there is a different flow of personnel. Openings in various positions are first filled by internal applicants. The operators are members of a union, and the process to fill jobs is controlled by the union contract. Thus, members are moved from one job function to another based on a bid process with an emphasis on seniority. The "more desirable" jobs are filled with senior persons. In this case, the "more desirable" jobs are actually those comprised of less difficult tasks. Thus, there is an inverse relationship between seniority and the difficulty in the job performed. Although at this time we have no hard data with which to prove this, we feel that such a policy could have negative impacts on plants safety and reliability. We are in the process of trying the validate this association.

Staff Policy and Procedures. Shift work and overtime are two staffing issues that may directly relate to the safety and reliability of the HLW tank operations.

Both sites use shift work and overtime as an integral part of operations. Both facilities use 12 hour shifts and report that there is no decrease in job performance or increase in error rate during different shifts. We are in the process of independently validating the relationship between shifts and reported occurrences at the sites. Both sites use a simple rotation to schedule shifts. The characteristics that have been shown to relate to the successful use of shifts, such as "morningness" or "eveningness", circadian rhythms, and age are not considered during scheduling.

At one site, overtime is regularly scheduled. Management reports a positive response by the employees to the use of overtime. Employees view overtime as a benefit, as it increases earning potential. Approximately 3% of the operations time is overtime. There has been no reported increase in the occurrence rate due to overtime.

CONCLUSIONS

Effective High-Level Radioactive Waste Management depends upon both innovative technology development and responsible operational management. Human resource management is one of the critical components of overall operations management, and may have profound effects on operational reliability and safety. Identification of staffing issues and the development of a cogent staffing plan for HLW tank operations lays a foundation from which effective technology utilization is possible, and contributes to overall reliability and safety of one of the engineered systems involved in High-Level Radioactive Waste Management.

One of the difficulties observed at the two HLW tank sites we visited is that the specific relationships between staffing parameters and operational safety and reliability are not well understood. Further, many of the parameters that are monitored (such as overtime hours worked) seem to have been selected out of convenience rather than because they can be demonstrated to form a cohesive picture of staffing impacts on safety and reliability. Indeed, in at least one case, there is no attempt to relate measured staffing parameters to operational factors. Therefore, additional work is needed to define reasonable performance indicators for staffing at the sites. Here, reasonableness will be determined by the utility gained by relating staffing and safety or reliability in terms of making improved human resource management decisions.

Another issue that will impact the development of guidance for human resource management is the current state of staff planning at the sites. As noted above, JTAs are available at the sites. Although they may not be comprehensive enough for adequate forecasts in their current instantiations, these JTAs should be used as a starting point for staff planning, as the JTA methodology is well understood and accepted at the sites. More top-down, macroeconomic approaches are unlikely to be accepted by site personnel. This conclusion is supported by a report on complex-wide manpower needs for DOE Environmental and Waste Management organizations.[7]

Finally, differences in the approaches taken to human resource planning at the tank sites and site-specific constraints (like union influences) make site dialogue, relative evaluation of the sites, and development of guidance problematic. Although the complex-wide study[7] advocates the coordination of manpower planning activities across sites, and indicates the need for a consistent taxonomy of job titles and related characterization of the knowledge, skills, abilities, and training required across the complex, a highly integrated system may not be feasible in the short term. Using a consensus based approach

to the development of staff planning guidance will no doubt result in a document that is more generic than specific, allowing some latitude on issues such as the development of job taxonomies, but will also likely be better accepted than a document mandating wide-spread changes in existing systems.

REFERENCES

1. W. L. FRENCH, The Personnel Management Process, Houghton Mifflin, Boston (1974).

2. U. S. DEPARTMENT OF ENERGY, Analysis of Findings from the First Sixteen Tiger Team Assessments, DOE/EH-0191, U. S. Department of Energy (1991).

3. U. S. DEPARTMENT OF ENERGY, Headquarters Management Plan for the High-Level Waste Tanks Workshops Program. March 10, 1992.

4. W. F. CASCIO, Applied Psychology in Personnel Management, Reston Publishing Co., Reston, VA (1978).

5. S. GOULD, "Safety Considerations Relating to 12-Hour Shift Schedules", Nuclear Safety, Vol. 30 Issue 1 (1989).

6. K. DAHLGREN, "Shiftwork, Work Scheduling, and Their Impact upon Operators in Nuclear Power Plants", Proceedings of the Fourth Institute of Electrical and Electronics Engineers Conference on Human Factors and Power Plants, (1988).

7. C. W. HOLMES, R. E. LEWIS, S. T. HUNT, and M. G. FINN, Environmental Restoration and Waste Management Manpower Needs Assessment: U. S. Department of Energy Complex, PNL-8171, Pacific Northwest Laboratory, Richland, Washington (1992).