Engineering Management
Field Project

Knowledge Retention: Developing a Knowledge Transfer Plan for the Engineering Department at Wolf Creek Nuclear Operating Corporation

By

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Executive Summary

The concept of knowledge must be set apart from data and information, because it is much deeper and richer than these two terms. Knowledge can be separated into two areas in order to better determine a capture method: tacit and explicit. Because the engineering field is highly steeped in knowledge, it is imperative that tacit and explicit knowledge is retained and transferred in order to develop an effective and efficient organization. When individuals leave the company, they leave with more than what they know. They also depart with relationships and contacts that are vital to performing work efficiently. As the baby boomer generation nears retirement, it is vital that this critical knowledge is transferred to other employees. The large repositories of codified data and information, popularized in the late 1990's to early 2000's, have proven to be an inefficient means of transferring knowledge due to the difficulties locating, interpreting or validating the information. The most effective method of capturing knowledge is to identify critical knowledge skills, determine the risk associated with losing this critical knowledge, and develop and implement a knowledge retention plan. The Tennessee Valley Authority has developed a method of capturing critical knowledge that will be tailored to Wolf Creek Nuclear Operating Corporation. This four step process assesses knowledge areas, determines a capture approach, develops and implements the retention/transfer plan and evaluates the process for continued improvement. To assist in determining the critical knowledge areas at Wolf Creek a survey was administered and subsequent interviews were scheduled to identify and assess the critical knowledge areas. Only three critical knowledge areas identified by the survey and interviews will be evaluated using the four step process due to the extensive time commitment needed to assess and disposition all knowledge areas in the engineering department. These critical knowledge areas were then evaluated to determine the

most appropriate method of capture and transfer. A plan was developed with actions and target dates to facilitate timely transfer of critical knowledge. This type of knowledge retention and transfer approach ensures the critical knowledge is identified up-front before it is lost due to attrition.

Table of Contents

Table of Figures

Chapter 1 – Introduction

The Introduction will provide a basis for why knowledge retention and transfer is an important issue that needs to be addressed at Wolf Creek. This chapter will also describe the purpose and expected outcomes of the research.

1.1 Topic and Significance

A challenge that many companies have faced, are currently facing or will be facing is retaining the knowledge of well-seasoned employees before they leave the company or eventually retire. Because the field of engineering is a knowledge-based profession, it is important that companies institute a knowledge retention and transfer program or risk losing vital information with the inevitable loss of knowledgeable individuals. Especially as the employees of the baby boomer generation begin to leave the workforce, an effective means of retaining even a portion of their experience and lessons learned will be extremely valuable. This knowledge is extremely vital in the workplace today considering more and more companies are adopting a "do more with less" philosophy, and employees are expected to perform to a higher standard. As such, the amount of information expected to be known by the employee has increased and the time allotted to formally train an individual has decreased.

Wolf Creek Nuclear Operating Corporation is no exception to these trends. Not unlike many other companies, Wolf Creek has recognized that knowledge retention is a problematic issue and a plan should be implemented to transfer the knowledge of the experienced engineers to the new hires. Unfortunately, even after a vast number of well-seasoned employees have either retired or left the company a formal knowledge retention plan has yet to be developed.

1.2 Purpose and Expected Outcomes

The purpose of this field project is to research and fully understand the importance of knowledge retention in order to develop a plan for Wolf Creek. To accomplish this, research into the subject of knowledge retention will be focused around two areas: Theory and Practice.

The Theory section will develop a basic understanding of knowledge retention, provide a basis for why it is important and explore how other companies have implemented a knowledge retention process. Knowledge retention is not a new concept and many companies have been successful in implementing knowledge retention programs. A wealth of information regarding knowledge capture already exists in the industry and will be exploited to prevent encountering the same mistakes of the past. A review of case studies will be performed in order to determine which methods of knowledge capture were successful and which methods were not. Survey questions will be developed based on the research and will be submitted to the employees within the engineering department at Wolf Creek. This will obtain data specific to Wolf Creek, which will provide an input in the customized knowledge retention and transfer plan for Wolf Creek.

The Practice section will outline the steps required to develop a robust knowledge retention and transfer plan based on the information described in the Theory section. This is done to provide a template that may be applied to other companies and industries even though the information will be specific to Wolf Creek.

Chapter 2 – Literature Review

The Literature Review will seek to understand why retaining knowledge is vital to an organization, as well as explore how other companies have attempted to capture critical knowledge.

2.1 What is knowledge?

The word "knowledge" is often used interchangeably with "data" and "information". However, the concept of knowledge is much broader, deeper and richer and should be set apart from data and information. Data is defined as a set of discrete, objective facts about events, and alone cannot transfer experience, expertise or wisdom. Data is transformed into information when the creator adds meaning. One of the most widely influential thinkers and writers on the subject of management theory and practice, Peter Drucker, once said that information is "data endowed with relevance and purpose (Davenport, 2000, 2-3)." Information is meant to change the way the receiver perceives something, to have an impact on his/her judgment and behavior. Knowledge, as defined by Davenport and Prusak is, "a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms (Davenport, 2000, 5)." Knowledge exists within people and because of this knowledge assets are much harder to recognize and appreciate. A better understanding of knowledge can be achieved by separating knowledge into two types: explicit and tacit.

Explicit knowledge is technical or academic in nature and can be easily communicated and shared through manuals, procedures or instructions (Smith, 2001, 315). Tacit knowledge is developed and internalized by the individual over a long period of time and is almost impossible to reproduce in a document or database (Davenport, 2000, 70). The first to articulate the concept of tacit versus explicit knowledge was the Hungarian philosopher Michael Polanyi. In his work, Polanyi shows that "tacit knowledge" cannot be easily formalized and put into exact words and has a sweeping presence in the world (Polanyi, 1966, X). Polanyi simply states, "we can know more than we can tell (Polanyi, 1966, X)." This is why tacit knowledge is so difficult to capture in written documents.

2.2 Why is knowledge important?

Engineering is a knowledge profession because engineers draw upon accumulated knowledge and expertise to perform a task. Knowledge workers draw on a huge store of tacit knowledge, built through years of experience. Individuals with these "deep smarts" maintain the ability to make swift decisions on the basis of pattern recognition, to extrapolate from the known to the possible and to make subtle distinctions that are invisible to a novice. They are able to predict interactions and interdependencies in complex systems, products and environments (Hammer, 2004, 17). Retaining and transferring this ability is instrumental to the long term success of the organization.

Up until the last few decades, knowledge was only obtained though many years of personal experience and often though trial and error. Now organizations are looking at processes that transfer the experience of the well-seasoned employee to the inexperienced. The quicker an

individual can be trained to be a productive and proficient member of the department, the better the company, the coworkers and the individual are served. Unfortunately, organizations lack good information about where their knowledge is and therefore have difficulty getting it and making use of it (Davenport, 2000, 40). Three factors often cause knowledge markets to operate inefficiently in organizations: the incompleteness of information about the knowledge market, the asymmetry of knowledge, and the localness of knowledge. The necessary knowledge is usually available in the organization; however, the lack of maps to guide a knowledge "buyer" to a "seller" is a fundamental problem. There is often an abundant supply of knowledge on a subject in one department of an organization and a shortage somewhere else. Knowledge seekers usually acquire knowledge from their organization neighbors, which means they are usually settling for information that is "good enough" and will not go to considerable lengths to get the best possible knowledge. All of these factors can be satisfied by identifying who holds the knowledge and documenting this information in an easily accessible place.

2.3 Who holds this knowledge?

The holders of knowledge can be classified into three different categories: central connectors, brokers and peripheral players. Central connectors are the hubs of a division, and people regularly seek them out for information. Central connectors have a high number of direct information relationships and have "deep smarts" based on experience and judgment. Brokers are those who have ties across subgroups and thus serve to integrate the entire organization. Brokers act as bridges across divisions and are vital to the day-to-day operations. Peripheral players are those who reside on the boundaries of a network, only infrequently seeking information from coworkers (Parise, 2006, p. 33). As to be expected, the knowledge loss

consequence is different with the departure of each type of knowledge holder. When central connectors leave, their technical expertise and their organizational relationships that can help others get information or resources to do their work disappear. When brokers leave, the ability to mobilize and coordinate efforts across departments is adversely impacted. When peripheral players leave, their specialized expertise and their knowledge of external relationships leave with them. Many of the people whose knowledge makes an organization work are not often identified or officially responsible for the results that they achieve (Davenport, 2000, 55). Identifying the different types of knowledge holders will help the organization assess the importance of the knowledge in order to determine which critical knowledge areas to retain and transfer first.

2.4 How can this knowledge be retained/transferred?

In the late 1990's and early 2000's, the response to capturing knowledge within a company was to develop large repositories of data and information; however, this method is inefficient. Considerable effort must go into searching and retrieving the information contained in these databases. A large man-hour effort is wasted populating the database just to be underutilized or be unaware to the masses. By recognizing the different types of knowledge, an appropriate method of capturing the knowledge can be developed.

Tacit knowledge is best transferred using a tacit method (tacit-tacit) such as mentoring. Capturing and transferring explicit knowledge (explicit-explicit) can be done utilizing best practices/lessons learned databases. Retaining tacit knowledge by capturing it in documents (tacit-explicit) is difficult but can be accomplished by developing desktop instructions, procedures and guidelines. Capturing and transferring explicit knowledge (explicit-tacit) is best

done though on-the-job and classroom training (Smith, 2001, 316). Pairing up new-hires and well-seasoned employees through mentoring is the most effective way to transfer the long term organizational experience and knowledge.

It may seem that the two explicit capture measures are one in the same. However, the difference between the best practices/lessons learned database (explicit-explicit) and the desktop instructions, procedures, guidelines (tacit-explicit) is that the best practices and lessons learned have been incorporated into the work process instead of being independent of the work activity. On-the-job and classroom training is effective in identifying the expectations, objectives and requirements of a task or process. This important information is not always conveyed during mentoring or emphasized in procedures or guidelines. A customized response to each type of knowledge must be developed for effective retention and transfer.

2.5 When and where should this knowledge be retained/transferred?

Because centralized knowledge management systems produce mixed results, many companies have moved away from the information repositories that were popular in the late 1990s and early 2000s. This outdated approach entails capturing and storing what a departing person knows by codifying electronic files and reports, conducting subject matter interviews and capturing lessons learned or best practices from projects in which the employee played a lead role. This method of capture is ineffective in two ways.

First, just because knowledge has been captured and stored in a database or a process manual does not mean it will ever be found, interpreted in the right way or given enough credibility to be

used. One of the key problems with this retention approach is that it only captures a small fragment of what made an individual successful and knowledgeable (Parise, 2006, 32). This shortcoming was realized at an audit and consulting firm that spent more than two years codifying best practices to place in a knowledge management system. Unfortunately, after the system was made available to more than 1,500 consultants, only 130 of them reported that they could find useful content (Benbya, 2010, 2).

Second, retention approaches often focus on a person's knowledge independent of the network of relationships critical to getting work done. As work has become more complex and interdependent, individuals rarely accomplish anything of substance on their own; they rely on both coworkers and external parties. There are few knowledge retention approaches that acknowledge this relational or network-based aspect of work. These systems that are isolated from the actual work process of an organization only capture a portion of the knowledge that made a person successful (Parise, 2006, 32).

In order to be competitive in the marketplace, organizations must develop and execute a strategic plan of action to retain and build on the great body of knowledge represented by their workforce that does not involve amassing large quantities of data just to be stored in an electronic repository. This more effective approach to knowledge retention is to identify the critical knowledge that is at the greatest risk of loss. Once identified, a plan can be developed to capture and institutionalize the knowledge (Boath, 2004, 1). By identifying the critical knowledge and developing an inventory, the organization will be able to ascertain the knowledge gaps and plan to "fill" those gaps (Dewhurst, 2013).

Rarely do organizations utilize a method to systematically identify the specific knowledge of individuals. This is troubling because companies may not even be aware of the valuable roles employees fulfill, because they are rarely described in formal job descriptions or organizational charts. Unfortunately, even fewer companies attempt to capture the knowledge of outgoing employees. Failure to capture this departing knowledge will result in frustration and confusion in the remaining workers that are left to accomplish the unfamiliar task (Lesser, 2001, 101).

The Tennessee Valley Authority (TVA) has developed a method to capture undocumented knowledge of the employees nearing retirement. TVA has recognized that the replacement of a departing employee is greatly influenced by the long lead time required for training new employees. Many power operation jobs require two to four years of training before an employee is fully qualified. TVA addresses this by implementing a three-step process of identifying critical knowledge skills, determining the risk associated with losing this critical knowledge and developing and implementing a knowledge retention plan ("Knowledge", 1999, 3). First, TVA identifies critical knowledge by answering questions specific to the individual's position. Second, TVA's response to a potential knowledge loss situation is different based on the importance of the knowledge, the immediacy of the knowledge loss, the cost and feasibility of recovering the lost knowledge, and how difficult it is to transfer the knowledge. The final step is to choose the most effective tactic for preserving the knowledge and then implement the plan.

Chapter 3 – Research Procedure

The Research Procedure will include the information on how the research is structured and conducted. Rudyard Kipling's "Six Honest Serving Men" will be used as a starting point for conducting research on preserving critical knowledge. The research will seek to answer the following questions: what is knowledge, why is knowledge important, who holds this knowledge, how can this knowledge be retained and transferred, and when and where should this knowledge be retained and transferred? Answering these six questions will ensure the concept of knowledge is fully understood in order to build a strong basis and justification for a knowledge retention and transfer plan at Wolf Creek. Pertinent research material will be collected by utilizing website search engines available on university and business databases (e.g. Harvard Business Review, MIT Sloan Management Review, KU libraries, etc.). Articles and volumes authored by individuals whom have advanced the practice of knowledge management will be reviewed and studied in order to develop a knowledge retention and transfer plan. This will ensure both the academic and practical aspects of knowledge retention and transfer are addressed.

Chapter 4 – Results

The Results chapter outlines the four-step knowledge retention and transfer plan and implements the plan on a small scale based on the results of the survey and interviews.

4.1 Four Step Knowledge Retention and Transfer Plan

As identified in the Literature Review section, capturing and utilizing explicit and tacit knowledge is essential for individuals in a knowledge profession to efficiently produce a quality product. The method outlined by TVA shown in Figure 1, will be used as a basis for developing the knowledge transfer initiative but will be adapted to Wolf Creek's engineering department. This method was used because it incorporates a qualitative, systematic approach to knowledge retention and transfer. Knowledge areas are identified and assessed, critical knowledge is dispositioned to determine an appropriate capture method, and critical knowledge is prioritized based on the risk of loss.

Figure 1: Four Step Plan

Step 1: Assess Knowledge Identify critical knowledge and determine the risk in losing this knowledge	**Step 2: Determine Approach** Assign the appropriate method of capturing critical knowledge
Step 3: Develop and Implement Plan Prioritize and schedule the transfer of critical knowledge	**Step 4: Evaluate** Check and adjust as necessary and review plan every three years

4.1.1 Step 1: Assess Knowledge

The first step to creating a knowledge retention initiative is to identify where the critical knowledge exists and assess the effect of losing the critical knowledge. Identifying this critical knowledge is accomplished in two ways: 1) A survey will be administered to the entire engineering department and 2) interviews will be conducted with selected individuals within the engineering department.

A survey will be administered to the engineering department at Wolf Creek. Due to the size of the engineering department (approximately 140 individuals), it would be extremely difficult and time consuming for one individual to identify the potential knowledge areas in danger of being lost. The purpose of the survey is to take an overarching look at the engineering department in order to determine the knowledge profile of the engineering department. In addition to collecting information on the breadth of knowledge in the engineering department, the survey will gather the department-wide perception of knowledge transfer methods (e.g. desktop instructions, guidelines, mentoring, training, etc.). This information will assist in determining which capture methods to employ, because if a certain capture method is unpopular, it should not be utilized. The survey will also identify knowledge that may be prevalent in one department but lacking in another. The survey questions to be administered to the engineering department are available in Appendix A.

Once the potential knowledge areas are identified, the owners of the knowledge areas will be interviewed. The purpose of the interviews is to take a deep look into the knowledge of the more experienced employees. Four categories of questions will be asked during the interview in order

to gain a full understanding of the knowledge areas associated with the position. These categories include general questions, questions about tasks, questions about facts or information and questions about pattern recognition knowledge. Examples of these questions are also available in Appendix A. In addition to identifying potential knowledge areas, the interview will also help identify individuals who represent a knowledge loss risk if they retire or depart from Wolf Creek. Interviewing the owner of the knowledge area is also beneficial because he/she will be able to recommend an appropriate capture method.

Criticality and attrition scores will be used to determine if the identified knowledge is critical to the organization and if there is a risk of losing the knowledge. By assigning numerical values to the knowledge areas, it allows one to prioritize which knowledge areas to address first.

4.1.1.1 Criticality Score

The criticality score will determine what knowledge areas are vital to engineering's core business, which is to ensure the plant is maintained and operated within the design and licensing basis as specified in the Updated Safety Analysis Report. The three factors that comprise the criticality score are the importance, rarity and recovery difficulty of the knowledge. The following will be considered when determining the significance of each factor.

At Wolf Creek, there is knowledge that may negatively impact the safe, reliable and efficient operation of the plant if lost. If the knowledge area was lost, it would have an impact over the entire engineering department versus just a localized group. If there are alternative methods to achieve the same result, the knowledge may not be vital.

There are highly specialized tasks that can only be performed by a few individuals. If the knowledge is only specific to a few individuals in the engineering department, then the knowledge is considered rare. However, it may not be practical to retain the knowledge within the organization if it available through industry experts at a low cost. The knowledge may not be rare if new hires are privy to the knowledge. If the loss of the knowledge area is slow over time, standard hiring will be sufficient to replenish the lost knowledge.

There is a wealth of operational history that is undocumented and could be unrecoverable if lost. If the knowledge is well-documented in desktop instructions, procedures or guidelines, the loss of knowledge would not have a detrimental effect. Knowledge would be considered critical if the lead time needed to document or transfer exceeds the individuals remaining time at Wolf Creek.

Each factor will be assigned either a value of 1 for Low, 3 for Moderate or 5 for High. The three values will be summed in order to obtain a total Criticality Score. The risk of losing the knowledge should not influence this ranking because assessing the risk of loss from a departing employee will be determined by the Attrition Score.

4.1.1.2 Attrition Score

The Attrition Score will establish the risk of losing critical knowledge by quantifying and weighing the probability (Loss Factor) and consequence (Position Factor). The TVA method of assessing knowledge loss risk is specific to individuals retiring and does not address the

individuals that may leave the company. Additional descriptions have been added to include individuals who have expressed interest in leaving the company or exhibit behavior that would indicate the individual may depart. Because the time between the notification of departure and the date of departure is typically shorter than a planned retirement, the loss factor was weighted heavier for individuals potentially leaving the company.

Loss Factor (Probability)

- 5 - Projected retirement date within 1 year / Individual may depart within 1 month
- 4 - Projected retirement date within 1 to 2 years / Individual may depart within 6 months
- 3 - Projected retirement date within 2 to 3 years / Individual may depart within the year
- 2 - Projected retirement date within 3 to 5 years / No departure threat
- 1 - Projected retirement date is greater than 5 years / No departure threat

The Position Factor is a function of the Criticality Score but with an increased focus on the employee and not just the critical knowledge area. The overall Criticality Score range was divided into five sections and provided below in brackets beside each Position Factor value as a guide. Strict compliance with the Criticality Score ranking is not required; however, deviation from the guide could undermine the validity of the Attrition Score.

Position Factor (Consequence)

- 5 [15-13] - Critical and unique knowledge or skills. Mission-critical knowledge or skills with the potential for significant reliability or safety impacts. Wolf Creek-specific

knowledge. Knowledge undocumented. Requires 3-5 years of training and experience. No ready replacements available.

- 4 [12-11] - Critical knowledge and skills. Mission-critical knowledge/skills. Some limited duplication exists in other positions and/or some documentation exists. Requires 2-4 years of focused training and experience.
- 3 [10-8] - Important, systematized knowledge and skills. Documentation exists and/or other personnel onsite possess the knowledge/skills. Recruits generally available and can be trained in 1 to 2 years.
- 2 [7-4]- Proceduralized or non-mission-critical knowledge and skills. Clear, up-to-date procedures exist. Training programs are current and effective and can be completed in less than one year.
- 1 [3-1] - Common knowledge and skills. External hires possessing the knowledge/skills are readily available and require little additional training.

The total Attrition Score will identify the level of effort necessary to effectively manage attrition. The Loss and Position Factors will be multiplied together to obtain the total Attrition Score.

<u>Attrition Score</u>

- 25-21: High Priority. Immediate action needed. Specific replacement action plans with due dates will be developed to include: method of replacement, knowledge management assessment, specific training required, on-the-job training/shadowing with incumbent.
- 20-16: Priority. Staffing plans should be established to address method and timing of replacement, recruitment efforts, training, shadowing with current incumbent.

- 15-10: High Importance. Look ahead on how the position will be filled/ work be accomplished. College recruiting, training programs, process improvements, reinvestment.
- 9-1: Important. Recognize the functions of the position and determine the replacement need.

Both the Criticality and Attrition Scores will help to evaluate the risk of losing the critical knowledge and determine the priority of the response. The Analysis Form for Assessing Knowledge, and The Knowledge Loss Risk Assessment spreadsheet, were developed to facilitate the assessment process. Examples of the completed form and spreadsheet are available in Appendix B and C, respectively.

4.1.2 Step 2: Determine Approach

Once the knowledge is identified and assessed, an approach to capturing the critical knowledge must be developed. The knowledge capture approach will be different depending on if the knowledge is explicit or tacit.

Explicit knowledge can be used to solve similar problems or accomplish routine tasks. In every knowledge profession, there are always administrative tasks that must be performed. Outlining the performance of these administrative tasks is an example of capturing explicit knowledge. Explicit knowledge can best be captured by embedding the information into desktop instructions, guidelines or procedures.

Tacit knowledge is demonstrated when a specific body of knowledge is mastered. It is automatic and instinctual based on years of learning and experience. In the engineering profession it is often referred to as "engineering judgment". This type of knowledge cannot be captured by typical academic means (i.e. manuals, guidelines or procedures). It can only be transferred by observation and hands-on learning. Tacit knowledge is best captured by mentoring, on-the-job training or shadowing.

The capture approach should only be dependent upon the type of knowledge not on the risk of losing the knowledge. For example, it is determined that a critical knowledge area can be best retained through mentoring/shadowing (tacit), but due to the time constraint of the individual departing the company, the retention method of documenting the knowledge into procedures (explicit) is chosen. A large portion of the critical knowledge will be lost translating tacit knowledge into an explicit document. Because the capture approach does not fit the nature of the knowledge, the exercise will result in wasting the time of the departing individual and the replacement will not be able to effectively utilize the incomplete knowledge. It can be difficult to determine if the knowledge can be captured using a tacit or explicit method. Usually the incumbent can provide a recommendation on whether a capture approach should be tacit or explicit.

The different capture approaches identified on the Knowledge Disposition worksheet have been labeled with a "T" or "E" to assist in determining if a capture approach is tacit or explicit (Appendix D). The preferred and most effective method of transferring knowledge is mentoring. However, the amount of resources this method would consume if utilized across the entire

organization is not feasible; nor is it economically competitive. As such, both explicit and tacit methods of retaining and transferring knowledge must be employed.

4.1.3 Step 3: Develop and Implement Plan

After a best way to capture the critical knowledge has been identified, a specific retention plan will be developed and implemented. The retention/transfer response of critical knowledge should be commensurate with the risk of loss (i.e. a high risk knowledge loss should be addressed expeditiously). The priority will be assigned based on the Attrition Score. At a minimum, the retention and transfer plan will contain actions to develop and implement the knowledge capture method (e.g. lesson plans, guidelines, mentor plans, etc.) and evaluate the progress and/or results. Target due dates will be assigned to the actions to ensure they are completed in a timely manner.

<u>High Priority</u>

Knowledge areas identified as High Priority will be addressed immediately by the supervisor developing a knowledge transfer schedule with finite due dates within one month. The incumbent Subject Matter Expert (SME) will play the lead role in developing any training lesson plans or guidelines for face-to-face turnover. The routine daily work will be shifted to other individuals to ensure there is sufficient time to transfer the critical knowledge.

<u>Priority</u>

For critical knowledge identified as Priority, a plan to transfer knowledge will be developed within three months. The SME will work with his/her supervisor to develop training lesson

plans, guidelines or a mentoring plan. It is not necessary to shift all responsibilities of the SME since more time is available.

High Importance

A retention approach will be developed within six months, because sufficient time exists between identification and loss for knowledge areas identified as High Importance. The supervisor and the training department will assist the SME in developing any training lesson plans.

Important

A knowledge retention plan will be developed within a year for areas identified as Important. Since the knowledge is considered "non-mission critical", the SME will develop training lesson plans and guidelines when time allows.

4.1.4 Step 4: Evaluate

When new knowledge areas are identified, this should be assessed and evaluated. The interim evaluation is to be performed by the group supervisor. A self-assessment should be performed every three years to evaluate the effectiveness of the plan. This three-year evaluation will be led by a member of management and will consist of a team of supervisors or an experienced individual from each group in the engineering department. It is essential that each engineering group is represented during the self-assessment to prevent overlooking potential critical knowledge areas. The existing critical knowledge areas should be reviewed to determine if the

current position or loss factor is still applicable. Also, the capture method should be evaluated to determine if the current method is appropriate or if a better one exists.

4.2 Critical Knowledge Identified and Assessed

Knowledge areas at Wolf Creek can be divided into two separate categories. 1) Non-position and 2) position-specific knowledge areas. Non-position specific knowledge areas are specialized areas of expertise within each engineering discipline (e.g. pipe stress and structural analysis, hydraulic and thermodynamic flow, safety analysis, instrumentation logic, etc.). These types are found in Nuclear and Design engineering departments. The position-specific knowledge areas are associated with the operating history of systems, structures and components. These types are found in System and Program engineering departments.

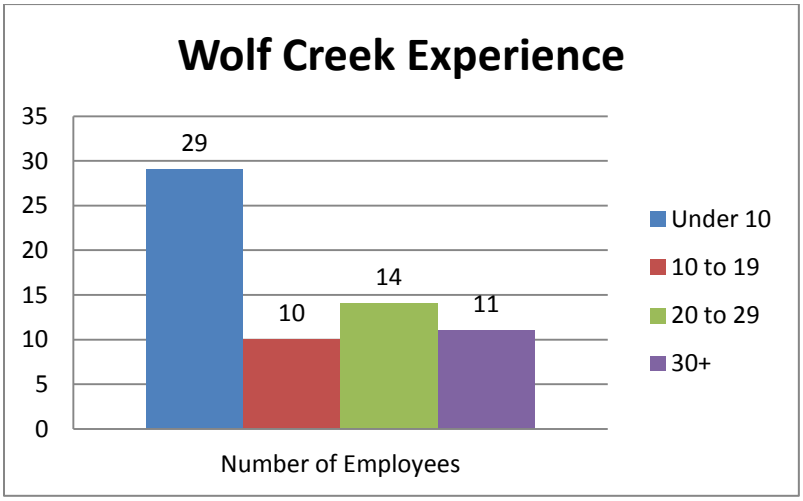
4.2.1 Survey Analysis

The responses from the survey provided a good representation from the four different divisions within the engineering department. At least a third of each division responded to the survey. A total of 64 responses were received out of a possible 140. The Overall and Wolf Creek years of experience were divided into four groups (less than 10 years, 10 to 19 years, 20 to 30 years and 30 years plus) and plotted to examine the experience demographic. The Overall Experience (Figure 2) demographic is skewed towards the most and least experienced, and the shape would be described as an inverted bell curve.

Figure 2: Overall Work Experience of Survey Respondents

When the data is rearranged to display Wolf Creek Experience (Figure 3), it shows a large portion of the employees have less than 10 years of Wolf Creek experience (29), which is 45 percent of the sample population. The majority of this group has less than five years of experience (22), which is 34 percent of the sample population.

Figure 3: Wolf Creek Specific Experience of Survey Respondents



To the outside observer, it appears that the engineering department is set up for success with a large number of inexperienced individuals able to learn from the large number of experienced; however, this is not the case. The large number of inexperienced individuals have recently been hired to fill positions that were already left vacant by employees departing the company. The trend from both graphs is indicative of a reactive response to employee attrition. With a large portion of individuals nearing retirement, it is imperative that a knowledge transfer plan be developed and implemented or risk losing critical knowledge.

The majority of the individuals who responded to the survey preferred the mentoring and on-the-job training method to transfer knowledge. This method provides the replacement engineer with the chance to ask questions that guidelines, desktop instruction or other methods of delivery just cannot cover. The ability to ask the departing individual questions about the history and the justification behind the decision made in the past is extremely valuable. The response to the question regarding how long it takes for an engineer to become proficient in their position ranged from six months to 10 years. The length of time varies depending on the individual's experience level, if they are new to the nuclear industry and/or the position they are occupying. All things considered, the general consensus is three to four years to become proficient in their position at Wolf Creek. Based on the preferred transfer method and the time it takes to become proficient, the long term staffing plan should be adjusted to reflect a more mentoring/apprenticeship program in order to facilitate effective knowledge transfer.

4.2.2 Critical Knowledge

Due to the size of the engineering department and the time it would take to identify and disposition all critical knowledge areas, only three examples were carried out through completion. It will be the responsibility of the supervisors to identify the specific critical knowledge areas of their group since they should have firsthand information of their subordinates.

The following critical knowledge areas were identified based on the results of the survey. First, there are only two individuals in the entire engineering department who performs pipe stress and structural analysis. There is a high risk of knowledge loss due to the fact that these two individuals are less than five years away from retirement. Second, there is only one individual responsible for the Gas Intrusion Program. Even though the individual is greater than five years away from retirement, there is an increased risk of loss due to the knowledge being confined to just one individual. Last, the Chief Engineer has identified that he will be retiring at the end of the April. There is a very high risk of loss since this individual is responsible for maintaining the Professional Oversight program and the Engineering Standards Team, with no identified backup. The holders of these critical knowledge areas were interviewed in order to gain a better understanding of how best to capture their knowledge.

4.3 Determine Approach

The interview with the responsible individuals revealed the best capture methods to retain and transfer the critical knowledge.

4.3.1 Gas intrusion

The most effective way to capture knowledge pertaining to system restorations following maintenance is through templates, guidelines and desktop instructions. Only minimal training is required to effectively perform this task. Because there is no backup individual assigned to the Gas Intrusion Program, the history and Wolf Creek specific knowledge pertaining to gas intrusion/voiding may be lost. The backup position can be filled by an existing individual in the engineering department. The methodology and calculations used to determine gas voiding criteria can be complex and confusing. As such, developing training material to transfer this knowledge is not feasible. This knowledge would be best transferred by mentoring.

4.3.2 Pipe stress/support analysis

The software used to perform pipe stress and pipe support analysis was developed by the Architect Engineer (Bechtel) over 30 years ago. As a result, any guidelines, desktop instructions or procedures are not available to assist the user in navigating the program. Having the SMEs develop step-by-step procedures would not be beneficial due to the limited number of individuals who have access to the software. Additionally, pipe stress analysis at Wolf Creek is very specialized with different components requiring different analysis techniques. The best method to transfer this knowledge is through mentoring and on-the-job training. Due to the possibility of both individuals leaving the company, an existing employee should be identified as the replacement and a new-hire should fill the backup position.

4.3.3 Chief Engineer

Due to the extremely short duration the current Chief Engineer will be at Wolf Creek, it is imperative that the individual be directly involved and driving the transfer of this knowledge.

Fortunately, the intricacies of the Professional Oversight program and the digital signature policy is well-documented, but a high risk of loss remains because a error in the digital signature software program could result in an immediate stoppage in work requiring engineering oversight. Because the knowledge is documented, the best way to transfer this knowledge is through on-the-job training. The owner of the Engineering Quality database and the chairman of the Engineering Standards Team (EST) responsibility will be transferred to another individual who is currently sitting on the EST.

4.4 Implementation Plan

As described above, the Implementation plan will be balanced with the risk of loss. All three knowledge areas were deemed critical based on the Criticality Score, but it was the Attrition Score that determined the priority of each knowledge area. Because the gas intrusion/voiding was determined to be a High Importance knowledge area, the retention and transfer plan was established within a six-month timeframe. The pipe stress and support analysis was designated as a Priority knowledge area. Thus, the plan to identify a replacement and develop a mentoring regiment must be completed within three months. Due to the High Priority ranking of the Chief Engineer knowledge area, the plan to identify a replacement, develop and complete on-the-job training, and evaluate the process must be condensed into a month's timeframe.

The retention plan for the three critical knowledge areas, complete with actions and target dates, is available in Appendix E.

Chapter 5 – Suggestions for Additional Work

The Suggestions for Additional Work chapter will explore applications of the knowledge retention and transfer plan that are outside the scope of this field project. The work put into identifying the critical knowledge areas can be put to use in developing a long term staffing plan. Since the actual or projected retirement dates will be known, determining when to hire in order to prevent any critical knowledge loss in the engineering department should be straight forward. Once the critical knowledge areas are identified for the entire engineering department, these can be identified on each employee's Individual Training Plan (ITP). Since completion of ITPs are closely monitored by leadership, it will ensure the critical knowledge areas are tracked to prevent any shortages in the future. Once all the critical knowledge areas in the engineering department are identified, they can be documented in a "knowledge map" and made available to all employees for their awareness. The knowledge retention and transfer plan does not have to be specific to the engineering department at Wolf Creek. The plan can also be utilized to identify the knowledge, skills and abilities in Operations and Maintenance departments.

References

Benbya, Hind and Marshall Van Alstyne. 2010. "How to Find Answers Within Your Company". MIT Sloan Management Review.

Boath, David and David Y. Smith. 2004. When Your Best People Leave, Will Their Knowledge Leave, Too? Harvard Business School Press.

Davenport, Thomas H. and Laurence Prusak. 2000. Working Knowledge: How Organization Manage What They Know. Harvard Business School Press.

Dewhurst, Martin, Bryan Hancock and Diana Ellsworth. 2013. "Redesigning Knowledge Work". Harvard Business School Press.

Hammer, Michael, Dorothy Leonard and Thomas Davenport. 2004. "Why Don't We Know More About Knowledge". MIT Sloan Management Review. Vol. 45 No. 4. 14-18

"Knowledge Retention: Preventing Knowledge From Walking Out the Door". 1999. Tennessee Valley Authority. Available at http://www.tva.gov/knowledgeretention

Lesser, Eric and Laurence Prusak. 2001. "Preserving Knowledge in an Uncertain World". MIT Sloan Management Review. Vol. 43 No. 1. 101-102.

Parise, Salvatore, Rob Cross and Thomas H. Davenport. 2006. "Strategies for Preventing a Knowledge-Loss Crisis". MIT Sloan Management Review. Vol. 47 No. 4. 31-38

Polanyi, Michael. 1966. The Tacit Dimension. Foreword provided by Amartya Sen. 2009. The University of Chicago Press. vii-xvi

Smith, Elizabeth A. 2001. "The role of tacit and explicit knowledge in the workplace". Journal of Knowledge Management. Vol. 5 No. 4. 311-321

Appendix A: Survey and Interview Questions

Survey Questions

1) Department
    a. Systems
    b. Design
    c. Programs
    d. Nuclear

2) Total years of experience in your professional career and years of experience at Wolf Creek.

3) Based on your knowledge, is there information that is in danger of being lost if an individual retires/quits? If desired, please provide examples.

4) Are you aware of any routine or infrequently performed tasks within your group that would benefit from incorporating best practices (e.g. Excess Torquing Guidelines, Scaffolding Evaluations, System Restoration Evaluations, etc.)? Please provide examples.

5) How can this information be best transferred from our experienced individuals to our new hires?
    a. Desktop Instructions/Lessons Learned/Guidelines
    b. Mentoring
    c. Training
    d. Other (please explain)_____

6) If you are given a task that you are unsure how to accomplish or even proceed, what is your first default action?
    a. Search for a desktop instruction/lesson learned/guideline that can provide guidance on the subject
    b. Talk to an individual that is knowledgeable on how to complete the task
    c. Discuss how to complete the task with my supervisor
    d. Other (please explain)_____

7) If information contained in desktop instructions/lesson learned/guidelines were easily searchable and retrievable, do you think it would be utilized more effectively?

8) Do you believe department specific task training would be effective in producing a quality document?

9) Is there a benefit to bringing in a replacement/backup engineer prior to an individual retiring?

10) How many years do you believe it takes to become a proficient* individual in your position?

*When given a task, a proficient individual is capable of identifying the appropriate procedures, industry standards, instructions, etc. required to complete the task in a timely manner without needing assistance from a coworker. A proficient individual is not considered an expert.

Interview Questions

Name: _____

General questions like 'What knowledge will Wolf Creek miss most when you leave?" The answers identify higher-order kinds of knowledge such as complex problem solving or deep understanding of the idiosyncrasies of a piece of equipment.
Task questions such as how to conduct specific tests or operate certain pieces of equipment.
Fact or information questions focus on what the employee knows and generate lists of contacts, maps, manuals, and other information.
Pattern recognition questions ask about lessons learned and insights about what's likely to go wrong and how to fix it.

1) What knowledge will Wolf Creek miss most when/if you leave?

2) Are there any tasks/activities that only you have performed in the past or only you have the skills or knowledge to perform?

3) Who do you rely on in different departments (e.g. maintenance, operations, chemistry, etc.) when you need information?

4) What type of lessons-learned could you provide that might help avoid the repeat of a major error in the future?

Appendix B: Analysis Form for Assessing Knowledge

Position: System Engineer Incumbent: John Harris

Position Description: Gas Intrusion Program Owner

Factors to Consider	Importance	Rarity of Knowledge	Recovery Difficulty
	-Impact on safe, reliable and efficient operations -Localized v. department-wide impact -Existence of alternative methods	-Redundancy of knowledge within the engineering department -Wolf Creek specific knowledge -Existence and cost of outside resources -New hires with this knowledge available -Loss gradual or abrupt	-Documentation or records exist -Lead time needed to document or transfer
Scale	1 = Low	3 = Moderate	5 = High

At-Risk Knowledge/Skill	**Importance**		**Rarity of Knowledge**		**Recovery Difficulty**		**Criticality Score**
Safety system gas voiding	5	+	5	+	3	=	13
System restorations		+		+		=	
Acceptance criteria determination		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	

Comments:
-Gas Voiding has the potential to have an immediate impact on operability
-John has been the only individual involved with determining acceptable void size via calculations. Experts outside of WC exist; however, availability of resources during emergent work could be a challenge
-Documentation exists, but it is not easily retrievable

Prepared by: Grant Bussard Date: 01/20/2013

Position: Design Engineer Incumbent: GM

Position Description: Mechanical/Civil Engineering (pipe stress/structural analysis)

Factors to Consider	Importance	Rarity of Knowledge	Recovery Difficulty
	-Impact on safe, reliable and efficient operations -Localized v. department-wide impact -Existence of alternative methods	-Redundancy of knowledge within the engineering department -Wolf Creek specific knowledge -Existence and cost of outside resources -New hires with this knowledge available -Loss gradual or abrupt	-Documentation or records exist -Lead time needed to document or transfer
Scale	1 = Low	3 = Moderate	5 = High

At-Risk Knowledge/Skill	**Importance**		**Rarity of Knowledge**		**Recovery Difficulty**		**Criticality Score**
ME101 software	3	+	5	+	5	=	13
Pipe stress analysis		+		+		=	
Structural/support analysis		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	

Comments:
- Maintenance (e.g. misaligned flanges, pipe strain, etc.) and system modifications (i.e. piping configuration changes) would be greatly impacted
- Understanding of the ME101 is very limited in the organization (i.e. 2 individuals that are close to retirement).
-Software user's guides and documentation is limited. Long-term working knowledge is used to perform calculations/analysis.

Prepared by: Grant Bussard Date: 01/25/2013

Position: Chief Engineer Incumbent: Frank Laflin

Position Description: Chief Engineer

Factors to Consider	Importance	Rarity of Knowledge	Recovery Difficulty
	-Impact on safe, reliable and efficient operations -Localized v. department-wide impact -Existence of alternative methods	-Redundancy of knowledge within the engineering department -Wolf Creek specific knowledge -Existence and cost of outside resources -New hires with this knowledge available -Loss gradual or abrupt	-Documentation or records exist -Lead time needed to document or transfer
Scale	1 = Low	3 = Moderate	5 = High

At-Risk Knowledge/Skill	**Importance**		**Rarity of Knowledge**		**Recovery Difficulty**		**Criticality Score**
Chief Engineer function	3	+	5	+	5	=	13
Professional Engineering Oversight SME		+		+		=	
Engineering Standards Team (Chair)		+		+		=	
Product quality database owner		+		+		=	
Digital signature/stamp		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	
		+		+		=	

Comments:
-The immediate impact on plant operation would not be felt; however, loss of PE stamping would result in a dramatic and sudden stoppage of engineering work requiring technical oversight.
-Frank is the only individual onsite that controls the digital signature policy and the owner of the guidelines that govern technical oversight
-Documentation exists, but time remaining at Wolf Creek is very limited

Prepared by: Grant Bussard Date: 03/1/2013

Appendix C: Knowledge Loss Assessment Spreadsheet

Department	Group	Incumbent	Level	Anticipated Departure Date	Source (Employee or Estimated)	Loss Factor		Position Factor		Attrition Score
System Eng.	NSSS	John Harris	ENG V	>5 years	Estimated	2	X	5	=	10
Design Eng.	Mech/Civil	GM	ENG IV	2015	Employee	4	X	5	=	20
Nuclear Eng.	Chief Eng	Frank Laflin	PRIN ENG	4/30/13	Employee	5	X	5	=	25
							X		=	
							X		=	

Appendix D: Knowledge Disposition Worksheet

Critical Knowledge: Safety system gas voiding

Description: Determine appropriate system restoration processes, review fill and vent procedures for accuracy and establish gas void volume acceptance criteria.

Recommended Response (Select all that apply):

☐ Identify and Develop Replacement (T)
- ☐ New Hire or Transfer
- ☐ Current employee to assume responsibilities

☐ Formal Training (T)
- ☐ Classroom instruction
- ☐ Dynamic Learning Activity
- ☐ Demonstration of skill in lab setting

X On-the-Job / Just-in-Time training (T)
- ☐ Self-study using lesson plans
- X Mentor / coach assigned
- ☐ Targeted work assignments
- ☐ Demonstration of skill with supervisor's sign-off indicating mastery

☐ Computer Based Training (E)
- ☐ Self-study using computer-based or video materials and lesson plans
- ☐ Testing and certification of mastery
- ☐ Demonstration of skill with supervisor's sign-off indicating mastery

X Rely on Alternative Resources (T)
- ☐ Establish a designated Subject Matter Expert
- X Shared duty responsibilities
- ☐ Contractor / Outside experts

☐ Eliminate/Reduce the need for the know-how
- ☐ Replace equipment with devices that are easier to operate or maintain
- ☐ Replace rare or non-standard equipment with standardized designs
- ☐ Eliminate task

X Documentation & Codification (E)
- ☐ Document knowledge for use by incumbent or annotate current procedures
- ☐ Establish or revise formal procedures and processes
- X Establish design guides or desktop instructions
- ☐ Establish a process to periodically gather and distribute new information

☐ Other Disposition

Additional Details or Recommendations:

-An official back-up individual must be identified for John. This will provide redundancy in the position and it will alleviate some of the workload.

-Training on establishing void criteria can best be accomplished through mentoring. Industry contacts and established metrics can be best transferred in this way.

-Templates, guidelines or DTI can best capture how to appropriately perform a system restoration evaluation and review fill and vent procedures for adequacy.

Prepared by: Grant Bussard Date: 1/25/2013

Critical Knowledge: Pipe Stress Analysis

Description: Analyze pipe and support stresses from modifications and maintenance activities using ME101 software.

Recommended Response (Select all that apply):

X Identify and Develop Replacement (T)
- X New Hire or Transfer
- ☐ Current employee to assume responsibilities

☐ Formal Training (T)
- ☐ Classroom instruction
- ☐ Dynamic Learning Activity
- ☐ Demonstration of skill in lab setting

X On-the-Job / Just-in-Time training (T)
- ☐ Self-study using lesson plans
- X Mentor / coach assigned
- ☐ Targeted work assignments
- ☐ Demonstration of skill with supervisor's sign-off indicating mastery

☐ Computer Based Training (E)
- ☐ Self-study using computer-based or video materials and lesson plans
- ☐ Testing and certification of mastery
- ☐ Demonstration of skill with supervisor's sign-off indicating mastery

☐ Rely on Alternative Resources (T)
- ☐ Establish a designated Subject Matter Expert
- ☐ Shared duty responsibilities
- ☐ Contractor / Outside experts

☐ Eliminate/Reduce the need for the know-how
- ☐ Replace equipment with devices that are easier to operate or maintain
- ☐ Replace rare or non-standard equipment with standardized designs
- ☐ Eliminate task

☐ Documentation & Codification (E)
- ☐ Document knowledge for use by incumbent or annotate current procedures
- ☐ Establish or revise formal procedures and processes
- ☐ Establish design guides or desktop instructions
- ☐ Establish a process to periodically gather and distribute new information

☐ Other Disposition

Additional Details or Recommendations:
- GM and Carlos are the only two individuals proficient in ME101. Since they are both nearing retirement (<3 years), a new hire replacement should be utilized to turnover knowledge.
-Because the ME101 software is owned by Bechtel, creating step-by-step instructions or developing training would be arduous and difficult. Learning should be one-on-one in a mentor setting.

Prepared by: Grant Bussard Date: 1/25/2013

Critical Knowledge: Chief Engineer

Description: Professional oversight SME, digital signature policy owner, Engineering Standards Team chairman and Product Quality database owner

Recommended Response (Select all that apply):

☐ Identify and Develop Replacement (T)

- ☐ New Hire or Transfer
- ☐ Current employee to assume responsibilities

☐ Formal Training (T)

- ☐ Classroom instruction
- ☐ Dynamic Learning Activity
- ☐ Demonstration of skill in lab setting

X On-the-Job / Just-in-Time training (T)

- ☐ Self-study using lesson plans
- X Mentor / coach assigned
- ☐ Targeted work assignments
- ☐ Demonstration of skill with supervisor's sign-off indicating mastery

☐ Computer Based Training (E)

- ☐ Self-study using computer-based or video materials and lesson plans
- ☐ Testing and certification of mastery
- ☐ Demonstration of skill with supervisor's sign-off indicating mastery

X Rely on Alternative Resources (T)

- X Establish a designated Subject Matter Expert
- ☐ Shared duty responsibilities
- ☐ Contractor / Outside experts

☐ Eliminate/Reduce the need for the know-how

- ☐ Replace equipment with devices that are easier to operate or maintain
- ☐ Replace rare or non-standard equipment with standardized designs
- ☐ Eliminate task

☐ Documentation & Codification (E)

- ☐ Document knowledge for use by incumbent or annotate current procedures
- ☐ Establish or revise formal procedures and processes
- ☐ Establish design guides or desktop instructions
- ☐ Establish a process to periodically gather and distribute new information

☐ Other Disposition

Additional Details or Recommendations:
-A replacement individual must be identified for Frank.
-OJT will be sufficient to bring an individual up to speed on the Professional oversight and the digital signature policy due to the existence of desktop instructions and guidelines.
-A member of the EST will take over as the EST chair and the owner of the product quality database

Prepared by: Grant Bussard Date: 3/1/2013

Appendix E: Retention Plan

Group: Engineering

Prepared by: Grant Bussard Date: 2/10/13

Safety System Gas Voiding (John Harris)	10 (High Importance)	1) Identify backup individual 2)Develop desktop instructions for system restoration reviews 3) Develop OJT lesson plans for gas void acceptance criteria 4) Complete training 4) Evaluate progress	2/15/13 5/17/13 6/27/13 7/19/13 8/9/13	Complete In Process In Process Pending Pending
Pipe Stress/Support Analysis (GM)	20 (Priority)	1) Identify replacement within the department 2) Develop mentoring plan for ME101 software 3) Evaluate progress	2/15/13 3/30/13 5/12/13	Complete In Process Pending
Chief Engineer (Frank Laflin)	25 (High Priority)	1) Identify replacement individual 3) Complete face-to-face turnover for administrative duties 4) Complete face-to-face turnover for Chief Engineer duties 5) Evaluate progress	3/7/13 3/29/13 3/29/13 4/5/13	Complete In Process In Process Pending