SKI perspective

Background

SKI is currently involved in assessing the issues associated with decommissioning of nuclear power plants in Sweden. Of particular concern is any period of plant operation during which there is uncertainty relative to whether the pant will continue to operate.

Projects objective

The objective of this project was to support SKI in the preparation and presenting of a research paper on the consequences of uncertainty on organizational safety during decommissioning at the 16th Annual System Safety Society Conference.

Tasks

The work was organized into three tasks. Task 1 consisted of a review and assessment of available information on the effects of uncertainty on performance, preparing a draft paper and submitting the paper to the System Safety Society Session on Organizational Safety. Task 2 Based on feedback from SKI and from System Safety Society (SSS) reviewers, the paper was revised and prepared according to the SSS requirements and submitted to the SSS proceedings. Task 3 included preparation and presentation at the SSS Conference.

Result

The result of this project was a paper that discusses the potential consequences of uncertainty surrounding decommissioning nuclear power plants on safety performance. The paper was presented at the System Safety Society Conference in Seattle, Washington, during the period of September 14th to 19th, 1998.

Project information

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Projektnummer: 14.3-980871/98152

CONTENT

Summary

When organizations face significant change—reorganization, mergers, acquisitions, downsizing, plant closures or decommissioning—both the organizations and the workers in those organizations experience significant uncertainty about the future. This uncertainty affects the organization and the people working in the organization—adversely affecting morale, reducing concentration on safe operations, and resulting in the loss of key staff. Hence, organizations, particularly those using high risk technologies, which are facing significant change need to consider and plan for the effects of organizational uncertainty on safety—as well as planning for other consequences of change—technical, economic, emotional, and productivity related. This paper reviews some of what is known about the effects of uncertainty on organizations and individuals, discusses the potential consequences of uncertainty on organizational and individual behavior, and presents some of the implications for safety professionals.

Sammanfattning (Summary in Swedish)

När organisationer står inför genomgripande förändringar, t.ex. omorganisation, fusion, företagsförvärv, nedskärning, nedläggning eller avveckling, upplever både organisationen och de anställda stor säkerhet inför framtiden. Denna osäkerhet påverkar organisationen och de anställda och leder till försämrad arbetsmoral, minskad fokusering på säker drift, samt till att nyckelpersoner slutar. Detta leder till att organisationer som står inför omfattande förändringar, och speciellt de som arbetar inom branscher som innefattar högriskteknologi, behöver överväga och planera för påverkan på säkerheten när framtiden känns osäker. Samtidigt måste de också planera för andra följder av förändringarna, såsom tekniska, ekonomiska, känslomässiga och produktionsrelaterade konsekvenser. Denna rapport behandlar en del av det man vet om effekterna av osäkerhet för organisationer och enskilda anställda. Vidare går författarna igenom de potentiella konsekvenserna av osäkerhet på organisationernas och de enskilda anställdas beteende, samt en redovisning av några av konsekvenserna för de som arbetar specifikt med säkerhetsfrågor.

Introduction

While change seems to have become the norm rather than the exception in organizations — and while all changes create some uncertainty - major changes, especially those that threaten the primary goals or the existence of the organization, are less common and create greater uncertainty.

In Sweden the Nuclear power industry faces an uncertain future. In the middle of the 1970's nuclear power became the focus of major political controversies in Sweden. The Three Mile Island accident in the United States in 1979 triggered a referendum in 1980 on the future of the Swedish nuclear power program. After the passage of the referendum, parliament decided to eventually phase out the existing 12 nuclear power plants in Sweden. The schedule for starting the decommissioning of nuclear power plants in Sweden has changed several times. In the spring of 1997, the Swedish Parliament adopted a bill on the new energy policy entitled "A Sustainable Energy Supply". This proposal includes the closure of the boiling reactor Barsebäck unit 1 by July 1, 1998 and closure of Barsebäck unit 2 by July 1, 2001. The utility is currently challenging the proposed plant closures in court. The final decision regarding these plant closures is uncertain at this time; meanwhile, the plants continue to operate (ref. 1).

The Swedish Nuclear Power Inspectorate (SKI) has the mandate to oversee and to assure the safety of the entire life cycle of nuclear power activities in Sweden. Currently, SKI is preparing for the regulation of the shutdown and decommissioning of nuclear power plants. As a part of SKI's research program, SKI has recently conducted research on potential safety-related impacts of the major transition from operating to closing and decommissioning nuclear power plants. The research regarding decommissioning and organizational change is a part of SKI's preparation for effective regulation of the decommissioning process. While there has been substantial research and analysis regarding the technical requirements for shutdown and decommissioning, very little has been done to date on the organizational and human aspects of nuclear power plant closures.

This paper presents findings on issues regarding organizational and individual uncertainty relevant to the decommissioning of nuclear power plants. The paper reviews some of what is known, in general, about organizational and individual responses to high levels of uncertainty (such as those created by closing a power plant), and discusses how this uncertainty may affect safe operations.

The overall objective of this paper is to present a logic of how responses to high levels of uncertainty may create safety risks and to begin a dialogue about how recognizing the potential risks of uncertainty and taking responsive action may help avoid or mitigate negative safety consequences. The approach used in the paper is to discuss uncertainty, individual and organizational responses to uncertainty, and how uncertainty may affect safety.

Because addressing the issue of uncertainty is a very broad area, we have limited our discussion to some specific types of uncertainty. This paper only deals with uncertainties

associated with major disruptions—not more typical uncertainty that is part of day-to-day activities. That is, we address uncertainty about the continued existence of an organization itself or the continuation of an organization's primary mission, not uncertainty about more routine issues such as who will receive promotions next year or whether a customer will place an expected order. Also, only some of the effects of uncertainty on organizational and individual behavior will be covered. For example, we will discuss types of individual responses to uncertainty at a general level, but will not address how an individual's job position or personality characteristics is likely to affect specific reactions to uncertainty.

Defining uncertainty

For purposes of this paper we are discussing uncertainty as one end of a continuum that goes from certainty, through various levels of partial uncertainty, to total uncertainty. Under conditions of total uncertainty an individual does not have any information about, nor control over, what will happen in the future. Hence, under complete uncertainty individuals do not have any basis for making decisions. Under conditions of partial uncertainty, the individual has some knowledge and control over what will happen and can make a decision or choice based on that limited knowledge and control. Certainty is when the individual has complete information and control over outcomes. Conditions of absolute uncertainty or absolute certainty are rare (or nonexistent); so most decisions are made under various levels of uncertainty (ref. 2).

It is important to note that uncertainty arises from the perception of risk. For this reason, uncertainty often emerges before any actual change occurs — and therefore, the effects of uncertainty can affect the organization long before there is any material change to the organization. In the case of the nuclear industry in Sweden, uncertainty — along with its potential effects - has increased even though actual shutdown or decommissioning may not commence for a period of years.

Uncertainty and its effects on organizations and individuals

While the potential for change, as well as actual changes, always presents challenges to an organization and to the individuals working in an organization, these challenges are particularly difficult when the change is surrounded by very high levels of uncertainty about the fate of the organization itself. Below we discuss what areas of uncertainty this type of potential or actual change may create for individuals and organizations.

Individuals

Three areas of uncertainty affect people's decisions (ref.3).
First, there is uncertainty about whether the environment surrounding the individual or the organization will change — will there be a change?
Second, there is uncertainty about the effect of a particular change on an organization or individual what does this mean for me?
Finally, there is uncertainty about how to respond to a change how should I react? In the situation of a major change — such as the possible decommissioning of a nuclear power plant - all three of these types of uncertainty are created.
For example, the individual may not know whether the plant will continue to operate or be shut down, what the shut down will mean for him or her if it does occur, nor what options he or she will have to respond to a decision to close the plant. The situation creates individual uncertainty about:

- Whether there will still be an organization
- Whether he or she will still have a job
- What their job will be
- How they will do their job
- Whether there will be changes regarding rewards and remuneration—e.g., will there be changes in the contract between the organization and the employee?
- What resources will be available to do the work (including co-workers)

Uncertainty creates stress for individuals—which can lead to feelings of helplessness, lack of control, physical and mental health problems, and substance abuse (ref. 4). It also creates increased employee cynicism. Effects of increased cynicism include lower organizational commitment, lower job satisfaction, lower motivation to work hard, and lower perceived credibility for organizational leaders (ref. 5).

The organization

Changes that affect the basic survival or function of an organization create uncertainties about the goals of the organizations and/or about the means the organization will use to achieve these goals. Organizations usually are created to pursue a particular goal according to some prescribed means. The organizational goal is often thought of as being very clear and well understood (e.g., to make x number of widgets) and the means also well known (use the widget maker). In reality, even under the best of circumstances, organizational goals are less than perfectly clear (at a simple level—is the goal to make the most widgets, the best widgets or the most profit from widgets?). The means are also not always well known (while the process for making widgets may be straight forward, the means are far less certain for curing disease or maintaining safety in operations which use hazardous materials). Hence, changes in an organization's goal affect the fundamental basis of the organization's existence—the "why" of the organization. These changes also affect the means of the organization, the "how" the organization uses to achieve goals.

Like individuals in organizations, the organization also faces uncertainty about whether there will be a change, what that change will be, and how the organization can, and should, react. In particular, the organization faces uncertainty about:

- Whether the organization will continue to exist
- Whether the organization will continue to pursue the same goal (e.g., production of electricity) or a new goal (e.g., decommissioning)
- How the organization will achieve new goals, or achieve old goals under new circumstances
- Whether the organization will be able to maintain its resources — including staff
- How the organization can and should respond

Some responses to uncertainty and the implications for safe performance

The most pervasive response to uncertainty, a response to be expected at both the organizational and the individual level, is to try to decrease it (ref. 6). This reaction is not surprising since uncertainty has negative psychological and physical health effects on people and on the decision-making ability of organizations. Generally organizations and individuals attempt to reduce uncertainty in two ways, by increasing information and by increasing control over the outcome(s) of events.

Increasing information is an effective means of reducing uncertainty—both in the short term and in the long term. Information gathering is most effective if done purposefully (i.e., with some direction) and if it is finite (not waiting for "all" information). Information can be increased through search procedures (e.g., asking questions, reading, etc.) or though more active means (e.g., through research projects, data analysis etc). If there is useful information available, it can reduce uncertainty either by providing information on the probabilities of different possible outcomes, on the present situation, or on potential future situations. The desire for additional information may also have negative effects. For example, individuals faced with uncertainty spend a great deal of productive time searching for information to reduce their own uncertainty (ref. 7). This may distract workers from doing their jobs in a safe manner.

Increasing control, either over the current situation or possible future situations, is another approach to reducing uncertainty. Organizations may try to increase control over the current situation through legal, economic, or political means. For example, an organization can buy a competitor to reduce economic uncertainty. Control over the future can be achieved by increasing the options available once the situation becomes more certain—i.e., when an outcome is known. This can be done by preserving options (discussed below) or taking active measures to increase options. Good examples of this approach are emergency planning and emergency response training.

Below we discuss some strategies (both functional and dysfunctional) that may be used by organizations and individuals to decrease uncertainty. We then discuss some of the potential safety implications of each strategy.

"Jump ship"—abandon the uncertain situation

Organizations can leave an uncertain situation either physically (e.g., by moving to a new place), or by becoming a "different" organization (e.g., changing the product of an organization, or changing the means the organization uses to achieve its goals). Individuals can also leave (e.g., quitting a job or no longer contributing). Leaving can be a very effective means of reducing uncertainty, however, it also can have high costs for both the individual and the organization. For example, an individual may quickly decide to take a new, less desirable, job out of fear of losing his or her current position in the future, even though there is a very low probability that the person's job would, in fact, be eliminated.

In terms of safety implications of this response to uncertainty, the choice, or potential choice, of the organization to leave--or change what it does--can have significant effects. During the period of deciding whether or not to abandon the organization's current place or product, there may be an inattention to current operations—and the safety of those operations. In addition, the potential for the organization to leave or change is part of the uncertainty faced by workers. If workers feel the organization's actions may violate the psychological contract they have with the organization (that is, if they feel the organization will not keep or has not kept its stated or unstated promises), they are likely to lower their contribution to the organization (ref. 8) or leave. The choice of some people to leave or contribute less during a period of uncertainty creates problems for the organization and for the individuals who choose to remain. The organization may no longer have the resources to perform adequately. The people remaining active in the organization may be overworked. The loss of people and their experience can occur rapidly—and can occur before an actual change takes place (ref. 9). Loss of key personnel and experience also leads to the loss of "corporate memory" that can be essential for both safe operations and safe shut down of facilities (ref. 10).

"Business as usual" - Do nothing

There are a number of reasons why an organization or an individual may do nothing in response to the uncertainty created by a major organizational change. First, an organization or individual may deny that change is likely to occur (or, in some cases, deny that a change has occurred). Denial of the change may seem preferable to accepting the uncertainty created by the change. Since uncertainty is a perception, denial can be very effective—at least in reducing short-term anxiety about uncertainty. Second, the "business as usual" response may be caused by an inclination to "wait and see" what will actually happen. That is, to assume that the uncertainty will diminish with time. In the long term this approach is likely to leave the organization or the individual unprepared to respond effectively to the changes that ultimately are imposed (e.g. plant shut down or job loss), because they have not considered in advance alternative ways of dealing with these likely changes. Adverse

safety consequences may occur because of lack of planning. The organization is often left with only a short time frame and/or limited resources to react once the change occurs.

"Hoarding resources"—not investing in current operations:

This approach is reactive rather than proactive. The organization or the individual "puts things on hold"—that is, waits to carry out activities that can be delayed until the potential changes have been decided upon. This affects both human and material resources: e.g. putting off purchases, not conducting routine maintenance, delaying training of staff etc. This response is akin to an individual deciding not to replace worn tires on an automobile because she or he is considering selling the car in the near future. The potential negative safety consequences of this approach include both incidents that directly result from lack of investment (inadequate maintenance leading to equipment failures) and incidents due to a degradation of the safety culture at the facility. In this climate management is sending a clear message—by their actions if not their words—that safety is a low priority.

Planning for alternative futures

Another approach is to analyze and plan for alternative outcomes (e.g., scenario assessments). While this approach does not reduce the immediate uncertainty about what will happen, it increases control over the future by providing the basis for responding to various contingencies. For example, organizations facing uncertainty about the future availability of skilled workers have worked with local education and training institutions to create programs to increase the availability of needed skills. Policies to maintain resources during a period of uncertainty can also enhance organizational control and reduce uncertainty for employees. For example, during times of business downturns, some organizations choose to reduce the hours of all affected employees instead of terminating some workers completely as a way of responding to reduced demand for their products. This strategy allows a company to provide greater job security to its employees and to return to higher production levels when demand increases, without the time and expense needed to recruit new hires. By decreasing uncertainty for workers this approach can have a positive safety impact. These responses provide the individual or organization with the basis for responding to changes in a proactive way—and allow them to anticipate and prevent potential safety problems.

Acting in the face of uncertainty

In this response the organization or the individual moves on despite uncertainty. Acting in the face of uncertainty is routine and necessary in many common situations. For example, many medical diagnoses are made under conditions of too little information. A treatment is begun in order to maximize the potential for a cure if the diagnosis is correct. Not taking any action until there is certainty regarding a diagnosis may preclude a cure. While making decisions in spite of uncertainty is often both necessary and desirable, there are a number of potential pitfalls. For example, there is a general tendency to continue on a particular path once it is begun and to interpret new information within the assumptions of the original

decision. Subsequent decisions become more or less set—even when new information that was lacking when the original decision was made becomes available and suggests a different path. This is one reason why doctors are advised to "ignore all previous diagnoses, even your own" when assessing a patient. All information needs to be considered independent of decisions and analyses that were made when less information was available.

An organization's choice of action can affect short and long term uncertainty. A course of action may reduce one form of uncertainty, but create another. For example, organizations faced with reducing staff can take different approaches. One approach is voluntary reductions in force. These include strategies such as early retirement and incentives to quit. These strategies increase individuals' control over what happens to them and reduce (to some extent) uncertainty regarding job stability. However, these strategies also increase uncertainty in other areas. For example, the individuals who choose to remain at the organization do not know whether there will be enough voluntary reductions to make their position secure. They also do not know whether the types of skills and support services they need will be available or whether key staff with such expertise will be lost. An alternative approach is planning for needed skills and areas of expertise and providing incentives for people in those areas to stay—while communicating a schedule and plan for terminations in other areas. This approach reduces individual control for those laid off and may cause employees to feel that their psychological contract with the organization has been violated (as discussed above). However, this approach increases certainty about the availability of key staff resources for the organization and about job future for all staff--both those terminated and those retained (ref. 10).

Concentrate power in positions that deal with uncertainty

Another response by organizations to uncertainty is to concentrate power within the organization to fields of expertise, departments, etc. that effectively deal with current areas of uncertainty. In a study of the departmental backgrounds of chief executive officers (CEOs) in American manufacturing from the 1880's to 1979, Fligstien (ref. 11) found that the major area of uncertainty in the 1920's to the 1940's was production—and that the CEOs during these years came from manufacturing. In the 1940's to the 1960's uncertainty moved to distribution and CEOs came from sales. In the 1970's finance was the major source of uncertainty, and CEO's emerged from the ranks of financial officers. [It will be interesting to see if the background of the CEO's of major utilities change in the U.S. with the deregulation of energy production, as the sources of uncertainty shift from production and distribution to competitive sales.] While this approach may help the organization to more effectively deal with uncertainty, it has some potential safety consequences. For example, if the uncertainty facing an organization switches from operations and safety to political or legal issues, and legal staff take on top management positions, the people making decisions about organizational policies may not have an adequate understanding of the safety consequences of decisions they make.

Protect the technical core

One way that organizations attempt to deal with uncertainty is to create policies, practices, positions and departments to buffer, or protect the technical core of the organization from uncertainty (ref. 12). This allows the technical core to carry out its work without disruption or distraction. For example, in a manufacturing company, if the greatest source of uncertainty is the availability of raw materials, the organization may stockpile those materials. If the greatest source of uncertainty is government regulatory decisions, the organization may create departments to buffer the operations from the effects of the regulator. If the greatest source of uncertainty is the potential for catastrophic accidents, the organization will create departments to focus on prevention and mitigation of safety hazards. This approach does not necessarily reduce the overall uncertainty surrounding the organization—instead it protects the critical activities of the organization from some of the negative consequences of uncertainty.

Most organizations and individuals use several of the strategies described above to deal with uncertainty. It is common for organizations to respond on an ad hoc basis, without much consideration of options prior to reacting to uncertain situations. However, systematic analysis of and planning for uncertainty is possible and is likely to lead to more effective responses to emerging changes (ref. 2).

Summary and Conclusions

As noted in the introduction, this paper supports SKI's preparation for effective regulation of the decommissioning of nuclear power plants. It has presented some general findings regarding responses to organizational and individual uncertainty that are relevant to maintaining safety during the decommissioning process.

The nuclear industry deals with a technology and with operations that have the potential for creating major safety hazards or catastrophic accidents. It has sophisticated procedures and policies for maintaining safety and a history of careful planning and operations. For this type of organization, any situation that creates uncertainty—that is, that decreases the amount of knowledge and control available for decision making—requires re-evaluation of these processes, policies and procedures. As part of this evaluation, along with examining the technical aspects of shutdown and decommissioning—and how these may affect safety—the organizational and human aspects of decommissioning must also be considered. In fact, because uncertainty emerges before any changes in the material conditions of the operation, the effects of organizational uncertainty may create safety problems earlier than technical issues and may undermine the effectiveness of technical planning and control processes. It is therefore important to approach these issues in a systematic fashion and to consider the effects of uncertainty when identifying the pros and cons of different strategies.

Safety systems are by definition fraught with uncertainty and risk—these are the issues that safety professionals deal with in their work. Organizational uncertainty is somewhat outside

the usual scope considered by safety professionals, but many of the approaches to assuring system safety are relevant to responding to the safety issues surrounding organizational uncertainty. Just as risks from fire and earthquakes can be addressed through analysis and planning (e.g. stronger facility designs, emergency response training etc.), organizational uncertainty also creates safety hazards that can be systematically addressed. Some of the potential safety consequences of organizational uncertainty discussed in this paper were the loss of key personnel (and their knowledge and experience), delaying maintenance, and a loss of safety focus. As with other areas of safety analysis and response, anticipation and planning are necessary to prevent these potential negative safety consequences of organizational uncertainty.

While a significant amount of research has been conducted on individual and organizational responses to uncertainty, this research has not usually been applied to organizational safety. This paper has attempted to bring a large and disparate body of knowledge to bear on a situation in which there is a great deal of uncertainty--the future of the nuclear power industry in Sweden. It is intended to be a first step in assessing this issue. The authors hope that it may start a dialogue about how to better incorporate expertise on organizational and human behavior into analyses of system safety.

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