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Experience With the Shift Technical Advisor Position

Interviews With Personnel from Nine Plants

Prepared by B. D. Melber, J. Olson, R. E. Schreiber, L. Winges

Pacific Northwest Laboratory
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U.S. Nuclear Regulatory Commission

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Prepared by
B. D. Melber, J. Olson, R. E. Schreiber, L. Winges

Pacific Northwest Laboratory
Richland, WA 99352

Prepared for
Division of Human Factors Safety
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
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ABSTRACT

The provision of engineering expertise on shift at commercial nuclear power plants has mainly taken the form of the Shift Technical Advisor (STA). This person, acting in a capacity that is part engineer and part operator, is expected to advise the operations crew in the event of an emergency and review plant operating experience during normal circumstances. The position was mandated by the Nuclear Regulatory Commission following the incident at Three Mile Island. This report expands on a growing body of knowledge regarding the effectiveness of the STA. The new data presented here come from interviews with plant personnel and utility officials from nine sites. Researchers from the Pacific Northwest Laboratory (PNL) interviewed plant personnel, including the STA and immediate management, the shift supervisor and management, the training department, and ancillary staff, all of whom affect the intended performance of the STA. The conclusions of the report are that the design of the STA position results in limited contribution during emergencies; more comprehensive ways should be sought to provide the variety and specificity of engineering expertise needed during such times.

EXECUTIVE SUMMARY

Engineering expertise on shift at commercial nuclear power plants has mainly been provided by the Shift Technical Advisor (STA). This person, acting in a capacity that is part engineer and part operator, is expected to fill the gap seen during the incident at Three Mile Island. This is a gap between skilled operator response to a severe transient and skilled engineering response when things do not go according to plan.

The structure and function of the STA position has been spelled out in NUREG-0578 (1) and succeeding documents. In the main, the STA is an engineer present at all times, and an advisor to Operations during times of crisis at a nuclear plant.

DATA SOURCES

This report expands on a growing body of knowledge regarding the effectiveness of the STA. The new data presented here come from interviews with plant personnel and utility officials from nine sites. This sample represents one-eighth of all operating nuclear plants and more than one-sixth of all utilities with operating nuclear plants in the United States.

Researchers from the Pacific Northwest Laboratory (PNL) interviewed plant personnel, including the STA and immediate management, the shift supervisor and management, the training department, and ancillary staff, all of whom impact the intended performance of the STA. The utility officials interviewed are responsible for policy implementation and recruiting. Thus, we sampled the expectations and observations of those participating in the inception, integration, and growth of the STA position.

CONCLUSIONS

- The design of the STA position results in limited contributions of STAs in emergency situations. Several types of specialized engineering knowledge may be needed in an emergency. The reliance on a single engineer to diagnose and resolve such unexpected events creates a performance expectation that cannot adequately be met.

- The operations staff and their immediate management seem reluctant to use the STA in an emergency; this appears to be due largely to use of inexperienced engineers to fill the STA position. This lack of acceptance has caused less than optimal use of STAs during emergencies (e.g., they have been assigned to read procedures).

- More comprehensive approaches should be sought to provide the variety and specificity of engineering expertise needed by the operations staff during emergencies. These other sources have at their command a full range of analytical tools, as well as a detailed knowledge of the plant.

RECOMMENDATIONS

- We recommend that engineering expertise be available on shift. There are a number of ways of providing this:

  1. upgrading the engineering knowledge of operations personnel, including reactor operators (ROs) and senior reactor operators (SROs), shift supervisors, and higher-level operations management

  2. maintaining a specific engineering position on shift.

Criteria for upgrading operations personnel should be established, and utilities should be allowed to select either upgrading the operations personnel or continuing to use the engineer position on shift.

Given the problems we have found with the current STA requirement, some modifications in the design of the engineer position on shift are recommended, where use of this position is continued:

1. Greater emphasis should be placed on mandated job functions for normal operations than on accident assessment alone. Emphasis on accident recovery creates a position of infrequent use and places an unrealistic burden on one position. Focus on normal operation emphasizes preventive action as opposed to reaction and encourages the continuous involvement in plant operations that is necessary preparation for accident recovery.

2. The experience level required should be increased. Lack of operations experience has been a major impediment to appropriate use of the engineer position.

- We recommend reduced reliance on a single individual and increased reliance on engineering staff, covering many engineering specialties, for resolution of emergency situations.

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INTRODUCTION

The purpose of this report is to describe utility experience in staffing and utilizing the Shift Technical Advisor (STA) position,[a] and to make appropriate recommendations regarding its continuation. Based on interviews with nuclear power plant personnel, this report focuses on utility experience during the first two years of the STA position requirement. A companion report (4), based primarily on documentation provided by utilities to the NRC in response to NUREG-0737 (3), describes utility practices at the initial stage of implementing the STA position. The objective of both reports is to provide a basis for the development of recommendations concerning the use of engineering expertise on shift in nuclear power plants.

BACKGROUND

In their assessment of potential responses to the Three Mile Island Unit-2 (TMI-2) accident, the "Lessons Learned Task Force" (NUREG-0585)(2) suggested the provision of engineering expertise at nuclear power plants during all periods of operation (i.e., on a 24-hour basis) as one way to enhance plant safety. The STA position was introduced by the NRC as an interim measure to provide "additional technical and analytical capability" to the operating staff for response to off-normal events (NUREG-0578) (1). The STA requirement represents one approach to providing on-shift engineering expertise. The main elements of this requirement are described in the appendix of the report on initial implementation of the STA position.

Utility discretion in implementing the STA requirement has been allowed by the NRC in five major areas:

- Education: A bachelor's degree <u>or the equivalent</u> in a science or engineering discipline is required.
- Experience: There is no specific requirement. One year's nuclear power plant experience is recommmended, with at least six months of that time spent onsite.
- Licensure: This area is left to utility discretion; no preference is stated.
- Dual vs. split functions: NRC prefers combined functions of accident and operating assessment and review, but no requirement is imposed.

(a) Throughout this report, the acronym "STA" is used to refer to the position responsible for STA functions, although actual titles in use vary across different plants.

- Location in organization: Independence from operations in carrying out functions is specified, but assignment to the operations (or any other division) is not proscribed.

As described in PNL's earlier report (4), some utilities created a full-time STA position in either the operations or engineering department. Other utilities added STA responsibilities and job functions to an existing position, either to engineering positions or to a senior reactor operator position. We chose to describe the various utility approaches to defining the STA position by the term "implementation mode." In this report, we present more detailed information about the effects of various implementation modes on STA utilization and performance.

The work described in this report is one element of a larger project to develop final recommendations concerning the provision of engineering expertise on shift. Other elements include the report on documentation of industry response in the initial period of implementation (4), a review of foreign practices and experience (5), and consideration of alternative approaches to providing engineering expertise to the operations shift crew (forthcoming report). This project is part of the Safety Technology Program of the Division of Human Factors Safety of the NRC.

METHODOLOGY

Key personnel from nine nuclear power plants were selected for onsite interviews to provide data on implementation of the STA position. The nine plants represent four different modes of implementing the STA requirement. Plants 1, 2, and 3 created a separate STA position in the operations department. Plants 4, 5, and 6 created a separate STA position in the engineering department. Plant 7 has a senior reactor operator (SRO) in the operations department who is responsible for STA job functions in addition to his regular work. Plants 8 and 9 have staff in engineering who take on STA responsibilities as a collateral (additional) job function.

Staff interviewed at the plants included the Vice President of Nuclear Operations and/or the personnel manager at corporate offices, the plant manager, the training manager, the operations superintendent, the shift supervisor, the STA, and an instrument and control engineer. At a few plants, some additional staff were interviewed who utility or plant personnel thought could provide additional useful information. These included an assistant to the Vice President for Nuclear Operations, a manpower planner, a corporate training director, and a reactor engineer.

The number of interviews that yielded STA information is shown in Table 1 by STA-implementation approach, job position, and plant. The site visits at two plants were limited due to plant work requirements during the period of data collection. At these plants, interviews were conducted with one or two key management personnel. In both of these plants, the STA job is a collateral job function of engineering staff.

TABLE 1. Number of Interviewees by Job Positions, Plant, and Implementation Mode

	Implementation Mode									
	Separate - Operations			Separate - Engineering			Collateral-Operations	Collateral-Engineering		
Job Position	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Plant 6	Plant 7	Plant 8	Plant 9	Total
Corporate		2	1		1					4
Plant Manager		1	1	1	1	1			1	6
Training Manager	1	1		1	1	1	1			6
Personnel					1	1	1	1		4
Operations Superintendent	1	1	1	1	1	1	1			7
Shift Supervisor	1	1	1	1	1	1	1			7
Reactor Engineer					1					1
STA	1	1	1	1	1	1	1	1		8
Instrument and Control Engineer	1				1	1	1			4
Total	5	7	5	5	9	7	6	2	1	47

Questions about the STA position covered the following topics:

1. Experience with the STA during transients
2. Role of the STA during normal operations
3. The need for engineering expertise in the control room
4. The STA's relationship with the operations crew
5. Contributions and problems of the STA position
6. Recruiting practices for STAs.

CONCLUSIONS AND RECOMMENDATIONS

The major empirical results of this study are presented below, followed by conclusions and specific recommendations concerning the provision of engineering expertise on shift. These recommendations are based on analysis of the information obtained in the site visit study and on consideration of approaches other than the use of the STA position that potentially may provide a mechanism for enhancing the quality of engineering expertise available to the operations shift crew.

EMPIRICAL RESULTS

The major empirical findings are presented below based on the case studies discussed in this report. While the nine plants visited cover a wide range of approaches to and experiences with the STA position, it is important to recognize the limitations to our drawing conclusions based on a small number of site visits.

STA PERFORMANCE

- STA effectiveness has been limited under off-normal conditions. There were only a few cases of significant contribution to resolving a transient situation. The reasons for limited contribution are as follows:
  - Reported off-normal situations that needed assistance beyond the operating shift crew were few in number.
  - In some plants, inexperience of the STAs resulted in a lack of their ability to contribute.
  - The expectation that one individual would possess all the skills needed to resolve off-normal situations was seen as unrealistic.
- STA effectiveness under normal conditions was primarily in terms of providing an additional safety review role, extra manpower, and an engineering perspective. This was seen as beneficial, but not crucial to plant safety.

NEED FOR ENGINEERING EXPERTISE ON SHIFT

- There is considerable variation in the perceived need for engineering expertise on shift. Most STAs recommend an engineering position on shift (onsite), while the plant managers and shift supervisors are divided, with approximately half recommending such a position and half recommending either a specific on-call engineer position (offsite) or use of the pre-STA call system. Only one operations superintendent recommended an on-shift engineer position.

- Of those supporting an on-shift position, the STAs and shift supervisors all recommended that a senior reactor operator (SRO) license be a qualifications requirement, while only one of the four plant managers specified a bachelor's degree as a qualifications requirement. None of the shift supervisors specifically recommended for or against such a requirement for an engineer position on shift.

IMPLEMENTATION ISSUES

- The lack of a labor supply of individuals with both a degree in engineering and nuclear operations experience has led to the recruitment of relatively inexperienced staff at some plants. This has limited the effectiveness of the STA position in terms of providing assistance and expertise to the operations shift crew.

- During the implementation period of this new position, some plants reported underutilization of the staff responsible for STA functions. There is evidence of improvement of these situations, over time, through expanded job responsibilities and in some cases redesign of the STA position.

- The creation of the STA position is seen as limiting the career prospects for licensed operators because STAs at many plants can compete for supervisory positions on shift that formerly were available primarily to operators. This is a significant issue because of potential impacts on shift crew performance, specifically negative effects on morale and possible increased operator turnover.

CONCLUSIONS

- The design of the STA position results in limited contribution of STAs in emergency situations. Several types of specialized engineering knowledge may be needed in an emergency. The reliance on a single engineer to diagnose and resolve such unexpected events creates a performance expectation that cannot adequately be met.

- The operations staff and their immediate management seem reluctant to use the STA in an emergency; this appears to be largely due to use of inexperienced engineers to fill the STA position. This lack of acceptance has caused less than optimal use of STAs during emergencies; e.g., they have been assigned to read procedures.

- More comprehensive approaches should be sought to provide the variety and specificity of engineering expertise needed by the operations staff during emergencies. These other sources have at their command a full range of analytical tools, as well as a detailed knowledge of the plant.

RECOMMENDATIONS

- We recommend that engineering expertise be available on shift. There are at least two means of providing this:

    1. upgrading the engineering knowledge of operations personnel, including ROs/SROs, shift supervisors, and higher-level operations management

    2. maintaining a specific engineering position on shift.

Criteria for upgrading operations personnel should be established, and utilities should be allowed to select either upgrading the operations personnel or continuing to use the engineer position on shift.

Given the problems we have found with the current STA requirement, some modifications in the design of the engineer position on shift are recommended, where use of this position is continued:

1. Greater emphasis should be placed on mandated job functions for normal operations than accident assessment only. Emphasis on accident recovery creates a position of infrequent use and places an unrealistic burden on one position. Focus on normal operation emphasizes preventive action, as opposed to reaction, and encourages the continuous involvement in plant operations that is necessary preparation for accident recovery.

2. The experience level required should be increased. Lack of operations experience has been a major impediment to appropriate use of the engineer position.

- We recommend reduced reliance on a single individual and increased reliance on engineering staff, covering many engineering specialties, for resolution of emergency situations.

EFFECTIVENESS OF THE STA POSITION

EXPERIENCE WITH STA PERFORMANCE UNDER TRANSIENT CONDITIONS

Shift supervisors and STAs were asked to describe the STA's activities during transients and to comment on the STA's usefulness in transient situations. Activities of the STA during transients included diagnostic evaluations, arranging meetings, checking logic diagrams, performing calculations, interpreting technical specifications, reading procedures and checking instrument readings. At two plants, reading procedures and checking instrument readings were activities listed as being inappropriate for the STA, while at four other plants, they were mentioned as appropriate activities.

The evaluation of the STA's usefulness during transients varied considerably across plants. To some extent, this was due to differences in the number and type of transients experienced by the interviewee since the STA position had been established. Three shift supervisors and one STA had never experienced a transient where the STA was needed. A few interviewees, especially at the operations superintendent level, indicated that the STA was on the staff because mandated, not because this position was useful or necessary.

This expression of low confidence in the STA was not universal, however. Half of the STAs and almost half of the shift supervisors reported a specific instance in which the STA had provided significant assistance. Four STAs and three shift supervisors provided examples of cases where the STA had helped resolve a transient through diagnosis, providing a different perspective or conducting necessary evaluations. Three of the four STAs provided examples of instances when the STA was not needed to resolve problems, as well as cases where a major contribution had been made. It is important to note that both the shift supervisors and STAs from the same three plants reported effective performance under off-normal conditions.

Two STAs and one shift supervisor indicated that the presence of the STA had been beneficial, though not crucial to resolution of transient situations. One STA had purely negative comments about another's performance during a transient. The failing was seen as due to lack of experience in logical analysis.

Thus, reported performance by STAs under off-normal conditions has been mixed. At some plants there have been specific instances of significant contributions by STAs, while at other plants there has been very limited assistance or simply no experience to report.

Among those interviewed who had direct knowledge of the STA's performance during transients, the majority thought that the STA was useful, at least for some transients. It is difficult to extract conclusions from such a moderate endorsement. It is entirely possible that the interviewees complimentary to the STA offered what they thought was the politically "right" thing to say. Possibly, too, the positive reactions to STAs were the result of good staff and high morale. It is interesting to note that those respondents who spoke negatively of the STA tended to be negative toward the whole interview.

ROLE OF THE STA DURING NORMAL OPERATION

At each plant, interviewees were asked to specify areas where STAs had made contributions to effective operations, crew performance, and plant safety. Responses included experiences with the full set of STA job responsibilities, and thus covered performance during normal conditions, which is the usual situation under which the STA is working.

Several different types of contributions of the STA position were mentioned:

- providing an engineering perspective
- ability to look at the "big picture"
- carrying out specific engineering-related tasks
- providing additional manpower
- serving as an organizational link between the operations and engineering departments.

Providing an engineering perspective means adding theoretical and conceptual knowledge to the practical experience of the operations crew. Ability to look at the "big picture" refers to the ability to consider trends and the relationships between systems, as well as providing an independent assessment. Examples of specific engineering tasks include interpreting Technical Specifications, performing calculations, reviewing procedures, and finding equipment problems. There were two different types of manpower advantages mentioned, an additional reviewer who doublechecks operations activities and an extra person available to handle the work load. Serving as an organizational link was mentioned both in terms of linking the operations and technical services departments and in terms of ultimately filling management positions with staff who have greater operations experience. Engineering perspective and additional manpower are relevant both to normal and off-normal conditions, while the "big picture" focus applies primarily to transient situations, and engineering tasks and organizational linkage generally refer to normal operations.

The most frequent areas mentioned referred to engineering perspective and tasks and additional manpower. The "big picture" role and organizational link were mentioned only by a few respondents. Six interviewees said that there were no advantages of the STA position.

There are some differences in the contributions emphasized by position of the interviewee. Operations superintendents most often referred to the advantage of additional manpower provided by the STA position; shift supervisors were most likely to mention the provision of a general engineering perspective as useful, while the STAs referred both to this general perspective and to specific engineering tasks carried out as the major areas of contribution. The "big picture" role was mentioned primarily by individuals outside of operations, such as training managers and instrumentation and control (I&C) engineers. Management personnel were the only respondents to mention better shift crew performance (see Appendix for specific examples). There was no pattern regarding those who saw no advantages to the STA position; the six who commented thus were spread across six different positions.

Few systematic patterns were found in contributions reported by plant or implementation mode. Four of the six interviewees who said that there were no advantages to the STA position came from a single plant, suggesting a problem with the STA position at this particular plant. The STA position was generally perceived by respondents as making some contributions to shift crew operations. In particular, the additional review role of the STA often was seen as enhancing effective operations and, to some extent, plant safety. Exposure to an accessibility of an engineering perspective also was seen as an advantage by several shift supervisors.

Interviewees also were asked to indicate specific problems or disadvantages of the STA position. Areas mentioned included the following:

- inexperience of STAs
- underutilization of their engineering backgrounds
- some negative effects on operator morale
- high cost of the position.

As in the case of specific contributions, the types of problems mentioned seem to be related to the interviewee's job position, but not related to implementation mode. Most plants reported experiencing similar types of problems.

Inexperience (mainly unfamiliarity with the plant) was the most common problem mentioned; comments from seven of the nine plants referred to this issue. It was cited most frequently by the plant managers and the STAs themselves. In general, the inexperience referred to use of recent engineering graduates as STAs, but there also were a few comments concerning lack of operations and control room experience among more senior engineers.

Underutilization was mentioned by respondents at six of the nine plants. It was primarily a management concern, particularly of plant managers and personnel managers.

The high cost of the position, relative to the perceived contributions, was mentioned by management personnel at four plants.

Operator morale was another problem mentioned primarily by management, particularly training and personnel managers. Interviewees from six of the nine plants referred to this as a concern. The major issue was career competition. The STAs have greater likelihood of promotion in such operations positions as assistant shift supervisor and shift supervisor; thus, they block the career mobility of nondegreed licensed operators.

Other issues, cited by only one or two interviewees each, concerned the implied downgrading of the capabilities of the shift supervisor by requiring the STA on shift, feelings of inequity due to high pay STAs received in some plants and, in some instances, resentment of the STA's role as a critic.

IMPACT OF THE STA POSITION

In general, the opinion of those interviewed is that the STA position is inadequate. The primary problems appear to be that the concept of the STA does not match the reality, that the operators do not trust the STA, and that utilities are generally unable to provide necessary on-the-job experience for the position.

PERCEIVED NEED FOR ENGINEERING EXPERTISE ON SHIFT

Most of the interviewees were involved in the nuclear industry prior to the establishment of the STA requirement, and thus had some experience with nuclear power plant operations both with and without an STA present on shift. They were asked to describe conditions under which engineering expertise should be provided to the shift crew, and to recommend ways of making that expertise available. The responses accented a contrast between the ideal concept of the STA as engineering support and the actual presence in the control room.

Major differences in judgments regarding the need for engineering expertise on shift were found by position at the plant (see Table 2). The STAs as a group were most likely to indicate a need for engineering expertise on shift. Only two of eight STAs did not see this as necessary. One thought that the plant engineering staff on call for emergency response would be sufficient to handle any problems. The second STA thought that a single on-call engineering

TABLE 2. Conditions Under Which Operations Shift Crews Need Engineering Expertise

	When Needed		
Job Position	Almost Never	Off-Normal Only	Normal and Off-Normal
Plant Manager	3	2	2
Training Manager	1	2	1
Personnel Manager	0	1	1
Operations Superintendent	4	2	0
Shift Supervisor	3	2	2
STA	1	4	3
I & C Engineer	2	1	0
Total	14	14	9

position, rather than an on-shift position, would be sufficient. The remaining six STAs specifically mentioned the need for having an engineer on shift. Three of the six specified that the person should report to the engineering department--e.g., "should not be part of operations because of operations mind set." Two specified that the STA should be assigned to the operations department, and one did not specify a departmental assignment. All six STAs stressed the need for experience as well as a degree, and five of the six said that an SRO license should be required. According to the basis of the interviews with the STAs, the preferred means of supplying engineering expertise is by an engineer who has an SRO License and who reports on shift. No particular pattern of responses on the basis of implementation mode emerged, although interviewees tended to think that the STA should report to the operations department or the engineering department depending on what was consistent with the practice at the plant.

In contrast to the comments from the STAs, the shift supervisors were less likely to see a need for engineering expertise as a specific advantage of the STA position. When asked for the best way of providing engineering expertise to the shift crew, three of the seven shift supervisors thought that an engineer should be on shift. All three preferred that the engineer have an SRO license and report to the operations department. Two shift supervisors thought that the existing Technical Support Center provided sufficient coverage. One shift supervisor recommended an on-call position, and one recommended a requirement for one SRO-licensed engineer per unit.

The operations superintendents typically did not see a need for an on-shift position. Of six who specifically discussed the issue, only one thought an engineer should be on shift. Two operations superintendents recommended on-call positions. The remaining four thought no specific position was needed; the existing engineering support system was considered sufficient without the STA's presence.

In contrast to the operations superintendents, over half of the plant managers (four of seven) recommended an on-shift engineering position. One plant manager suggested an on-call position, and the remaining two plant managers thought that the existing call structure and use of the Technical Support Center was sufficient.

Two of the plant managers who supported the on-shift position thought that engineering expertise is needed at all times, while the other two thought it would be needed only during transient situations.

The plant managers who saw no need for a special position, either on call or on shift, indicated that engineering support is needed at times, but is best provided by having specific support (such as maintenance, engineering, duty manager staff) on call and available as needed.

To summarize, most STAs, approximately half of the plant managers, almost half of the shift supervisors, but almost no operations superintendents recommended an engineering position on shift. The remaining interviewees recommended either a special on-call position or reliance on the existing on-call structure and Technical Support Center.

Of those supporting an on-shift position, the STAs and shift supervisors all recommended that an SRO license be a qualifications requirement, while only one of the four plant managers took this position (two plant managers specified operations training; one did not comment on this area). All STAs and three of the four plant managers specified a bachelor's degree as a qualifications requirement, while none of the shift supervisors specifically recommended for or against such a requirement.

Among those who recommended the availability of engineering expertise, there was some recognition that no one engineer was likely to meet all needs. The resource of engineering is not limited to one person, nor is it necessary to have one or more engineers constantly in the control room in order to have their expertise available in an emergency.

IMPLEMENTATION OF THE STA POSITION

The STA requirement has been implemented in different ways at various plants. Variations occur in the type of position created, its location in the organization, qualifications beyond those required by the NRC, work schedules, and job functions.

POSITION DESIGN AND DESCRIPTION

In the present sample there are four basic approaches to defining a position responsible for STA functions: 1) a separate STA position in the operations department, 2) a separate STA position in the engineering or technical services department, 3) a modified existing SRO position including STA functions as a collateral responsibility, and 4) a modified engineering position including STA functions as a collateral responsibility. We call these "implementation modes."

The qualifications required for the STA position vary in terms of licensing and prior nuclear power experience, but are similar with respect to education across the nine plants (see Table 3). Seven of the nine plants require a bachelor's degree; two have some substitution arrangements for non-degreed recruits. However, all eight of the STAs interviewed, each from a different plant, did have bachelor's degrees (see Table 4).

Experience requirements at the time of hiring were specified at 18 months by two plants and at 24 months by two plants. The remaining plants either did not have a specific minimum experience level or hired individuals without prior experience and provided nuclear power experience during the training period, prior to the individuals' assuming STA responsibilities. The actual experience levels of the STAs interviewed ranged from 1 to 13 years. The STA who served in a collateral engineering role had the greatest number of years experience; STAs in operations departments, whether as a separate or collateral position, had approximately 5 years of experience. STAs in a separate position in engineering averaged 3 years of experience, ranging from 1 to 6 years. In most cases the STAs had obtained all their experience working for their current utility and had worked only in the area of nuclear power generation.

Two plants require an SRO license. At three plants, it is expected that an SRO license will be obtained eventually, but it is not required. Three plants do not require a license, and one requires a license only if the STA does not have a bachelor's degree. There appears to be a relationship between the position implementation mode and the use of an SRO license requirement. Of the four plants that have located the position in the operations department, two currently require an SRO license and a third will require an SRO license when a new position description is implemented. None of the five plants where the STA is located in the engineering department requires an SRO license, although two of the plants provide SRO licensing training to STAs, and it is expected that, at these two plants, many STAs will obtain a license.

TABLE 3. STA Implementation Approaches

Position	Number of Plants
Separate/Operations	3
Separate/Engineering	3
Collateral/Operations	1
Collateral/Engineering	2
SRO License Requirement	
Not required	3
Acquired on the job	3
Required if not degreed	1
Required	2
Experience (at time of hiring)	
None	2
18 months	2
24 months	2
Not specified	3
Education	
B.S. degree required	7
Substitution allowed	2
Shift Schedule	
8-hour	3
12-hour	1
24-hour	5

TABLE 4. STA Background

	Implementation Approach								
	Separate Operations			Separate Engineering			Collateral Operations	Collateral Engineering	
Experience	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Plant 6	Plant 7	Plant 8	Plant 9
Time in Current Position	3 Years	$1\frac{1}{2}$ Years	2 Years	$1\frac{1}{2}$ Years	$2\frac{1}{2}$ Years	3 Years	10 Months	1 Year	--
Previous Job	QA	Interim STA	Supv. H.P.	School	School	Project Engineer	Rad. Waste	Maint. Supv.	--
Next Most Recent Job	School	Ass't STA	Rad. Control Engineer	--	--	--	--	Start-up Engineer	--
Time with Utility	5 Years	4 Years	5 Years	$1\frac{1}{2}$ Years	$2\frac{1}{2}$ Years	6 Years	6 Years	10 Years	--
Time in Commercial Nuclear	5 Years	4 Years	5 Years	$1\frac{1}{2}$ Years	$2\frac{1}{2}$ Years	6 Years	$4\frac{1}{2}$ Years	13 Years	--
Time in Nuclear Navy	0	0	6 Years	0	0	0	0	0	--
Other Electrical Production	0	$2\frac{1}{2}$ Years	0	0	0	3 Months	--	3 Years	--
Formal Education	BSNE	BSME	B.S. Physics	B.S. Physics	B.S.	BSEE	BSME	B.S. Marine Engineering	--

There are three different types of work schedules for the STAs. At three plants, STAs work 8-hour rotating shifts; at five plants, STAs work a 24-hour shift; and one plant uses a 12-hour shift. Thus, at six of the nine plants, STAs have a distinct schedule from that of the shift crews, and overlap the shift turnover period. Use of an 8-hour schedule is more common among plants where the STA position is located in the operations department.

Some overtime work (work hours beyond 8 hours a day) is common to STAs at all plants. In the six plants currently using 24-hour or 12- hour shifts, overtime work is a required part of the routine schedule.

STAs and shift supervisors were asked to describe the job functions of the STA under both normal and off-normal conditions. Their responses indicate the salient features of the STA position from the perspectives of these two different positions.

Tables 5 and 6 indicate categories of functions mentioned by STAs (Xs) and shift supervisors (Os) for normal and off-normal conditions, respectively.

Under normal conditions, the most common STA functions reported by STAs were review of operations experience, review of LERs and incident reports and monitoring of plant parameters. Other duties mentioned at two or three plants were reviewing procedures and technical specifications, involvement in equipment testing and outage reports, reviewing safety systems, reviewing operations logs, and training. The dominance of a reviewer role in monitoring plant operations and systems is common across the plants, although there is considerable diversity in the specific systems under review mentioned by the STAs.

There is generally greater overlap in perceptions of the shift supervisors and STAs when the STAs are located in the operations department than when they are located in the engineering department (see Table 5). The degree of overlap varies widely, from a low of 25% (separate engineering position) to a high of 80% (collateral operations position).

At plants where the STA was located in the engineering department, the shift supervisors were likely to mention engineering duties and special projects as STA functions under normal conditions. The STAs did not mention these responsibilities in describing their major duties; instead, they reported specific safety review functions.

The job functions mentioned under off-normal conditions are fewer in number and more similar across plants for both STAs and shift supervisors. This probably reflects a major emphasis of the the NRC-mandated function of the STA to observe, assist and advise the shift supervisor during onset of and recovery from transients.

RECRUITMENT OF STAS

This section discusses the nature of the recruitment experiences of the plants in filling the STA position. Four of the nine plants reported

TABLE 5. STA Functions--Normal Operations

Functions	Plant 1	2	3	4	5	6	7	8[(a)]	9[(b)]
Review Equipment Status								X	
Conduct Equipment Testing	X						XO		
Write Equipment Outage Reports	XO						X		
Review Plant Safety Systems		X			X				
Review Plant Procedures/ Tech. Specs	XO	X	X	O					
Interpret Plant Procedure/ Tech. Specs					O				
Ensure Compliance to Procedures/Tech. Specs					X	X			
Review Operations Logs			X					X	
Review Ops. Surveillance Tests/Evaluate Operations Experience	XO	X		XO	XO	XO	XO		
Check Control Board Settings				XO					
Monitor Plant Parameters		X		X		X	XO		
Maintain Awareness of Plant Status			X			X			
Computer Output Analysis									
Review LERs and Incident Reports	X	XO	XO	X	X				
Write LERs and Incident Reports	X								
Special Projects			X	O	O				
Training		X	X						
Engineering Duties		XO	O		O				
Supervise Operations							XO		
Advise SS[(c)]	XO		O	O					
Assist SS			X						
Observe/Maintain "Overview"									
Identify Problems			O				O		
Authority (X)	None	None	None	None	None	None	Supervisory		
Authority (O)	None	None	None	None		None	Supervisory		
Implementation Mode		Separate Operations			Separate Engineering		Collateral Operations	Collateral Engineering	

(a) No SS interview.
(b) No SS or STA interview.
(c) Shift Supervisor.

TABLE 6. STA Functions--Off-Normal Operations

Functions	Plant 1	2	3	4	5	6	7	8[a]	9[b]
Review Equipment Status									
Conduct Equipment Testing									
Write Equipment Outage Reports									
Review Plant Safety Systems									
Review Plant Procedures/ Tech. Specs									
Interpret Plant Procedure Tech. Specs			X						
Ensure Compliance to Procedures/Tech. Specs				0			X		
Review Operations Logs									
Review Ops. Surveillance Tests/Evaluate Operations Experience									
Check Control Board Settings									
Monitor Plant Parameters			0	0			0		
Maintain Awareness of Plant Status					0				
Computer Output Analysis					0				
Review LERs and Incident Reports									
Write LERs and Incident Reports	X			X	XO				
Special Projects									
Training									
Engineering Duties									
Supervise Operations									
Advise SS[c]	XO	XO	XO	XO		0	XO	X	
Assist SS as Required	XO		XO			X			
Observe/Maintain "Overview"	X	X	X		XO	X			
Identify Problems	0			X		XO	0		
Communications	X		0			X			
Authority (X)	None	None	None	None	None	None	None		
Authority (0)	None	None	None	None		None	None		
Implementation Mode		Separate Operations			Separate Engineering		Collateral Operations	Collateral Engineering	

(a) No SS interview.
(b) No SS or STA interview.
(c) Shift Supervisor.

significant recruitment problems. Three reported having minor or no recruitment problems, and two plants did not provide adequate information concerning recruitment experience.

A number of reasons for recruitment problems were given by the interviewees. The reason most often cited (six interviewees among five plants) was that the available labor supply did not provide enough candidates with adequate qualifications, in particular, degreed engineers with operations experience. One training manager summarized the problem: "We want more experience as well as a degree--but if a person has both, he wouldn't want to be an STA."

Shift work was also judged as a reason for recruitment problems at three plants. Degreed engineers were seen as unwilling to accept working off hours. Plants where respondents cited recruitment as a problem had either an 8-hour rotating shift or a 24-hour shift schedule. The shift schedule was seen as an advantage in recruitment at two plants, one with a 24-hour, and one with a 12-hour STA shift; the benefit lay in additional days off because of the long hours on shift.

Both the length of training and the process of becoming licensed were mentioned as impediments to recruiting. Though the stated formal training time varies widely among the plants (depending primarily on whether the training period includes licensing), the typical training program takes something over a year to complete.

Three other explanations for recruitment problems were mentioned in one plant each: 1) potential recruits do not see adequate engineering challenge in the STA position, 2) low salaries keep the recruits away, and 3) some potential recruits see work in the nuclear industry as socially unacceptable.

In-plant recruiting, both from operations and engineering staff, was mentioned by interviewees in six of the plants. In-house recruiting is followed in importance by within-utility recruiting and off-the-street recruiting. College recruiting and the recruiting of Navy personnel were reported in four plants each. Only one plant, which reported severe recruitment problems, recruited from other utilities and used employment agency services.

A pattern typical of a number of plants is to use in-house staff to fill the STA position until a longer-term plan for entry and training of new recruits was established. In these instances, there has been a change from the initial in-house source to a greater emphasis on recruiting direct from school to fill entry level positions. This change creates a need for considerable training prior to the recruit's taking on STA responsibilites.

Three plants have changed recruitment sources since initiation of the program. In all three cases, existing in-house staff were initially used to fill STA positions. In two cases, engineering staff were used on an interim basis while a longer-term program for training entry-level engineers was developed. As new college graduates are recruited into STA positions, the initial group returns to engineering positions. Each of these two plants has a separate full-time STA position (one in engineering and one in operations).

There were indications that in-house plant engineers were not interested in staying in the STA position on a long-term basis. In the third case, some non-degreed SROs were used to fill STA positions initially. However, this practice was discontinued because the NRC required the plant to use degreed engineers for the STA position.

In the face of past and present STA recruitment problems, respondents from a number of plants mentioned the development of new policies designed to improve the plant's ability to fill STA positions. Three patterns were noted. First was the use of financial incentives. Respondents in three plants mentioned this kind of incentive. The specific incentives included an accelerated salary schedule and mortgage and relocation assistance. The second approach was to provide a clear and attractive career path. Respondents in three plants identified this as an aide in recruiting. A final adaptation noted was the creation of an assistant STA position. Because fully qualified STAs could not be found, an assistant STA position was created that would allow the company to hire engineers without any prior experience and prepare them through on-the-job training for movement into the STA position. This approach is analogous to the route to reactor operator in some plants, where recruits generally begin in auxiliary or assistant operator positions, and through lengthy training and on-the-job experience move to the full reactor operator position.

TURNOVER

It is difficult to judge the degree and impact of STA turnover experienced by these plants. Since the STA programs are relatively new, reliable estimates of turnover are difficult to make. Only one respondent mentioned serious turnover problems to date. In a majority of plants, no turnover at all had been experienced. However, this does not mean that turnover is not, or will not become an issue, since respondents in two of the plants with no turnover reported that part of the reason for the lack of turnover was the existence of company policy not allowing promotion and transfers of STAs until replacements were available. In fact, some STAs had been waiting to move to other positions (usually a return to engineering positions). Given the significant recruitment problems facing several of the plants, any unplanned turnover in the STA program could result in serious staffing problems.

Finally, it should be mentioned that some of the plants have plans for rotating STA staff out of the position after a relatively short period (one to two years). Interviewees indicated that by designing the position in this way they would be in a better position to attract degreed engineers. These recruits would see an advantage in gaining operations experience as a step in career development, but would not be interested in a long-term shift work position. This policy, however, assures a relatively high level of turnover in the STA position.

IMPACTS OF IMPLEMENTATION PROBLEMS ON STA EFFECTIVENESS

The implementation problems faced by utilities operating nuclear power plants in recruitment and design of the STA position have resulted in some significant limitations to the current effectiveness of the STA position within the utilities sampled. The most notable problem has been the lack of an adequate labor supply of individuals with both a degree in engineering and nuclear operations experience. This constraint has led a number of utilities to recruit and train recent engineering graduates or entry-level engineers already in the employ of the utility as their main source of STAs. The short-term consequence of this strategy has been to fill the STA position with relatively inexperienced staff. This staff, who are learning operations on the job, can provide only limited assistance to the shift crew, especially in accident situations.

The definition of the position itself also has been problematic. As a new position, the place of the STA in the organization and the potential career progression of this position have been unclear (see appendix for fuller discussion). In addition, while position definitions have been evolving to make better use of the STAs, initial responsibilities were frequently so limited as to cause underutilization of the staff. These conditions, coupled with the shift work nature of the position, further contribute to difficulties in attracting highly-qualified staff.

Thus, while a major intent of the STA requirement was to provide seasoned expertise that would readily enhance crew response in accident situations, the typical implementation of the requirement has been use of the STA position as a training ground for junior engineers entering the nuclear industry. This result appears to have evolved from the labor shortage problem experienced by utilities in attempting to fill these positions; utilities generally were unable to find engineers with considerable operations experience.

While there appear to be short-term limitations on STA contributions from this approach, some long-term advantages are likely to be gained. In particular, the STA requirement has led to the development of a cadre of young engineers in the nuclear industry with significant operations experience, including a considerable number who have (or soon will have) SRO licenses. The current scarcity of, and demand for, this combination of expertise was widely noted. In the long run, an increased level of operations experience among management and engineering staff might be expected to enhance plant operations and safety.

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APPENDIX

METHODS

Sample Description

Key personnel from nine nuclear power plants were selected for on-site interviews to provide data on staffing problems and practices, implementation of the STA position, and staffing issues related to plant safety. Plants were selected to ensure that a variety of approaches to implementing the STA position requirement were included. Furthermore, size, type, and location of the plant, as well as size and nuclear experience of the utility, were considered so as to include a broad range of plants and utilities. Thus, the sample was purposely (as opposed to randomly) selected.

In Table A-1 the plant sample and the entire population of nuclear power plants are compared in terms of location, type, and size of the plant and size and nuclear experience of the utility. The sample includes plants from all regional locations: five from the Midwest, two from the Northeast, and one each from the South and West regions. Both PWR (seven) and BWR (two) plant types are represented. Two plants generate less than 600 MWe, three generate from 600 to 900 MWe, and four generate over 900 MWe. The sample includes single-unit plants (four), single units with additional units under construction (two), and multiple-unit plants (three). One plant has been operational less than five years, five plants have been operational from five to ten years, and three plants have been in operation over ten years. Three utilities have no plants under construction, three have one or two plants under construction, and two have three or more plants under construction. Experience of the utilities ranges from 6 to 88 reactor-years.

As shown in Table A-1, the sample does capture the wide range of variation found in plant and utility characteristics, with only one exception. The sample does not include plants owned by utilities that have 46% or more of their total generating capacity represented by nuclear plants. This category includes 11% of the total plant population.

Staff interviewed included the Vice President of Nuclear Operations and/or the personnel manager at corporate offices, and the plant manager, training manager, operations superintendent, shift supervisor (SS), the STA and an instrument and control (I & C) engineer at the plant level. At a few plants, some additional staff were interviewed who utility or plant personnel thought could provide additional useful information. These included an assistant to the Vice President for Nuclear Operations, a manpower planner, a corporate training director and a reactor engineer.

The educational background of the interviewees is shown in Table A-2. All eight STAs, the plant managers, and the vice presidents have at least a bachelor's degree. None of the SSs and only one of the plant training managers has a bachelor's or higher-level degree.

TABLE A.1. Population and Sample Plant Characteristics

Plant Characteristics	Plant Population N = 73	Plant Sample N = 9
Regional Location		
Northeast	22	2
Midwest	22	5
South	23	1
West	6	1
Type of Plant		
PWR	44	7
BWR	26	2
Other	4	0
Net MWe of Plant		
900 or more	18	4
600-900	35	3
600 or less	19	2
Number of Units		
Single	24	4
Single, with additional under construction	8	2
Multiple	41	3
Number of Operating Nuclear Power Plants of Utility		
1	27	2
2	22	5
3 or more	24	2
Number of Plants Under Construction by Utility		
0	31	3
1	11	2
2	9	2
3 or more	22	2
Reactor-Years Experience of Utility		
10 or less	12	2
11-23	34	1
24 or more	27	6

TABLE A.2. Frequency Distribution of Interviewees' Educational Levels

Interviewee's Job Position	Highest Level of Education: High School	2 Years College	Bachelor's Degree	Master's Degree	Missing Cases
VP Nuclear	0	0	2	0	2
Plant Manager	0	0	3	2	1
Training Manager	3	3	0	1	0
Personnel Manager	1	0	1	2	0
Operations Superintendent	2	1	3	1	0
Shift Supervisor	4	2	0	0	1
STA	0	0	8	0	0
Instrument and Control Engineer	1	0	1	1	1
Total	11	6	18	7	5

The average job experience of the interviewees is shown in Table A-3. The STAs average two years at their current job, five years in the commercial nuclear power component of the utility, and one year in other modes of electricity production. The STAs are less experienced in the field of commercial nuclear power than all other interviewees.

TABLE A.3. Average Job Experience of Interviewees (Years)

Interviewee's Job Position	N	Current Job	Job with Current Utility	Commercial Nuclear	Other Electricity Production	Missing Cases
VP Nuclear	2	2	16	16	9	2
Plant Manager	5	3	5	13	5	1
Training Manager	7	2	13	10	2	0
Personnel Manager	4	1	14	12	9	0
Operations Superintendent	7	4	10	16	2	0
Shift Supervisor	6	3	13	11	3	1
STA	8	2	5	5	1	0
Instrument and Control Engineer	3	2	7	7	2	1

As shown in Table A-4, only one of the eight STAs, compared to about half of all the other interviewees, has had nuclear Navy experience.

TABLE A.4. Nuclear Navy Experience of Interviewees

Interviewee's Job Position	Number Without Navy Experience	Number With Navy Experience (Years Experience)
VP Nuclear	2	0
Plant Manager	3	1 (9)
Training Manager	3	3 (6;6;12)
Personnel Manager	2	1 (6)
Operations Superintendent	3	4 (6)
Shift Supervisor	4	2 (6;6)
STA	7	1 (6)
Instrument and Control Engineer	1	1 (6)
Total	25	13 (mean = 7)

Interview Questions

In order to allow interviewees to generate their own answers rather than being forced to choose an answer supplied by the researcher, the questions were "open-ended." However, a detailed response format and probes for the interviewer were provided to enhance consistency across interviews. Such "open-ended" questions are useful in a preliminary investigation because they provide a broad range of opinions and answers. However, because of the unrestricted nature of the responses and the limited number of interviews that can be conducted using the in-depth interview format, the data are at times difficult to aggregate and categorize.

Questions about the STA position covered the following topics: recruiting practices, training, job turnover and mobility, job responsibilites, the STA's relationship with the operations crew, experience with plant transients, advantages and disadvantages of the STA position, and need for engineering expertise in the control room. In Table A-5 is a list of STA topics and the job positions of the interviewees who were asked questions about those topics.

IMPLEMENTATION OF THE STA POSITION

Work Schedules

Some overtime work (work hours beyond eight hours a day) is common to STAs at all plants. In the six plants currently using 24-hour or 12-hour shifts,

TABLE A.5. STA Topic Areas and Job Positions of Interviewees

	VP Nuclear and Personnel Manager	Plant Manager	Operations Superintendent	Training Manager	STA	SS	I & C Engineer
Recruitment	X			X			
Training				X			
Job Turnover and Mobility	X	X		X			
Job Responsibilities			X		X	X	X
Relationship with Operations Crew		X	X	X	X	X	X
Transient Experience					X	X	X
Advantages/Disadvantages of the STA Position	X	X	X	X	X	X	X
Need for Engineering Expertise	X	X	X	X	X	X	X

overtime work is a required part of the routine schedule. In four of these plants, all overtime is paid at an overtime rate; in one case, overtime pay is provided for the weekly expected overtime, and compensation time is used for additional overtime hours needed; and in one case, compensation time is used for the weekly expected overtime, with straight pay for additional hours as necessary. Of the three plants using an 8-hour shift schedule, only one has regularly required overtime, which is for training. Two of these plants provide compensation time for overtime hours rather than pay, and one allows a choice between compensation time or overtime pay.

It is interesting to note that, of the four plants that pay overtime rates for all overtime worked, the two that have a separate position in operations are in the process of changing from a 24-hour shift to an 8-hour rotation, which should reduce the overtime costs. The other two plants, which have a collateral position in engineering, are continuing with their arrangements.

The attitudes toward work schedule and overtime differed between those on a 12-hour or 24-hour schedule and those on an 8-hour schedule. Four of the five STAs on a 12- or 24-hour rotation said they liked the schedule; two specifically referred to the overtime pay as an attraction, although one mentioned that his wife found his work schedule problematic. The one STA who did not like the rotation schedule (because it interferred with engineering projects and with his home schedule) was the only one of the five who did not receive overtime rate pay for overtime hours. Two of the three STAs on an 8-hour rotation mentioned problems with shift schedule in terms of family life and doing project work. In both cases, these STAs also referred to overtime as a problem because of the use of compensation time rather than overtime pay for extra hours worked.

Recruitment

Four of the nine plants reported significant recruitment problems. Three reported having no or minor recruitment problems, and two plants did not provide adequate information to determine whether recruitment problems existed. Statements such as: "[the STA] is the hardest to get," "Interviewed 60-70 engineers for STA--one hire," and "Constantly looking for STAs--can't find them," came from respondents in plants experiencing difficulty in filling the STA position. Still other respondents complained of the quality of potential STA recruits.

At three plants which reported filling positions within three to four months, recruitment was seen as a significant issue; at another plant, where recruitment took over a year, it was not. Thus, shorter recruitment time did not always indicate lack of a problem.

Several explanations are possible for this apparent contradiction. First, it is possible that respondents at different plants employed different criteria for determining whether or not a recruitment problem existed. Secondly, and perhaps more likely, the belief that a recruitment problem existed could be as much a function of a lack of satisfaction with the background (primarily lack of experience) of those recruited as with an inability to fill the position at all. Finally, the different plants faced different amounts of urgency in recruiting. At the extremes were one plant with a surplus of STAs and one plant where the incumbent STAs were being kept in their positions beyond the length of tenure planned. This difference in urgency makes it difficult to assess the extent of recruitment problems solely on the basis of the length of time to fill the position. No clear pattern emerged when we compared implementation mode to the degree of recruitment problems.

As Table A-6 indicates, there are a number of sources used in recruiting STAs and, further, there is considerable variation across plants in the particular sources used. Recruiting in-plant, both from operations and engineering staff, was mentioned by respondents in six of the plants. An important consideration here is that within several plants, recruiting in-house was the initial response to the new requirement and has since been supplanted in importance by other recruitment strategies. In-house recruiting is followed in importance by within-utility recruiting and off-the-street recruiting. College recruiting and the recruiting of Navy personnel were reported in four plants each. Only one plant, which reported severe recruitment problems, recruited from other utilities and used employment agency services.

TABLE A.6. Recruitment Sources

	Plant									
	1	2	3	4	5	6	7	8	9	Total
Colleges	X	X		X	X					4
Navy	X	X			X	X				4
Off the Street		X		X	X	X				4
In-Plant		X		X		X	X	X	X	6
In-Utility	X	X	X		X		X			5
Other Utilities	X	X	X							3
Employment Agencies		X								1
Severity of Recruitment Problems	Low	High	Low	Med	Low	High	High	N.A.	N.A.	
Implementation Mode	Separate Operations			Separate Engineering			Collateral Operations	Collateral Engineering		

Career Mobility

As reflected in the recruitment and staffing problems experienced in these plants, the STA position is generally viewed as a temporary position for engineers. In general, the STA position is established by the utility as one to be filled by those early in their career paths. The nature of these paths, both before and after the STA position, is of interest because it reflects on the orientation of the STAs toward the program, management's view of the worth of STA personnel, and the evaluation of other staff of the usefulness of STA skills.

As noted earlier, the STAs interviewed are all college educated. They very considerably in their work experience. For some, the STA position was their first job. Others have had several jobs with the utility prior to the STA position. Actual operations experience prior to taking on the STA position is not common. This means that the STA position constitutes a major work change for most of the incumbents.

Because the STA position is new, most of the plants have not developed clear patterns in promotion and job transfers of STAs. Consequently, there is little concrete data concerning actual patterns of mobility. One plant did not provide any usable information relative to mobility. Four other plants have experienced no STA mobility. Interviewees at the remaining four plants, where only a small number of STAs have left the STA position, mentioned the following as jobs taken by STAs after leaving the STA position (the number of plants mentioning each is in parentheses):

(a) plant engineering (3)
(b) shift supervisor or assistant shift supervisor (2)
(c) corporate licensing (2)
(d) maintenance superintendent (1)
(e) left utility (1).

While the STA position may be a difficult one to staff and implement, the typical respondent sees it as a valuable base for movement into a range of other jobs. In this section we present options (destinations) that appear to be available to the STAs. We also indicate how these options vary among the plants and whether the perceptions of the opportunites seem to vary according to the position of the respondent. While a large number of specific job titles have been mentioned, we have consolidated them into more general categories for analytical purposes. In establishing these categories, we have retained information on the following:

(1) whether the position is primarily supervisory

(2) whether it is a plant or corporate position

(3) to which major organizational unit (operations, engineering, maintenance, other) it belongs.

The responses are contained in Table A-7. Several cautions are in order in interpreting these data. First, the potential career paths cited by interviewees may not reflect what actually will develop in the future. These are opinions of interviewees, not utility policies. Secondly, the number of perceived career alternatives is in part a function of the number of interviewees who provided information about career paths of STAs at their plant.

TABLE A.7. Potential Mobility: Career Destinations from the STA Position

	Plant									
Destination	1	2	3	4	5	6	7	8	9	Total
Operations:										
Supervisory	X	X	X		X	X	X			6
Staff		X	X	X						3
Maintenance:										
Supervisory	X					X				2
Staff		X		X		X				3
Engineering/ Technical										
Supervisory	X					X	X		X	4
Staff		X	X	X	X	X	X		X	7
Plant (Other)										
Management	X				X	X	X			4
Staff[(a)]		X		X	X	X				4
Corporate										
Engineering		X			X		X			3
Other[(b)]		X				X	X			3
Total Number of Different Destinations	4	7	3	4	5	8	6	NA	2	

(a) Includes such positions as QA, data services, human resources, load planning, and testing.
(b) Includes licensing and safety.

Not surprisingly, since STAs are typically engineers, the category reflecting the attitudes of respondents from the largest number of plants is in-plant engineering. A number of other positions are also considered possible; positions in the operations, maintenance, and other plant departments, as well as positions at the corporate office, were all mentioned in at least three plants. Furthermore, the STA position was seen by interviewees in most of the plants as a base for movement into supervisory positions.

Crew Relationships

This section presents information concerning crew acceptance of the STA in more detail than was presented in the section titled "Problems Experienced with the STA Position."

Only those interviewees whose work puts them in a favorable position to accurately judge the quality of crew-STA relations are included. These are the

STA, shift supervisor, operations superintendent, plant manager, training manager, and in-plant personnel manager. Of the 39 respondents in this category, 35 provided useful information relative to crew relationships. All nine plants are represented, though with varying numbers of respondents.

Tables A-8 and A-9 summarize the perceived seriousness of STA-crew relationship problems by position and plant. Most interviewees saw the relationships as relatively good, but then pointed out some sources of strain. Table A-8 demonstrates that perception of good or bad relationships does not appear to be a function of job position. With the exception of the plant manager position, the within-job-position distribution of responses seems to parallel the overall distribution of responses. The plant manager category appears to emphasize both extremes to a somewhat greater extent than the overall distribution. This suggests that there is general agreement over the extent of problems when they exist, since perception does not appear to be biased by position.

TABLE A.8. Perceptions of STA/Crew Relationship by Job Position

	Job Position					
Type of Relationship	STA	Shift Supervisor	Operations Superintendent	Plant Manager	Training Manager	Total
Good, No Problems	2	1	1	2	0	6
No Problems Now, Initial Problems	1	0	1	1	2	5
Pretty Good, but Some Problems	4	3	3	0	3	13
Fair, a Number of Problems	1	1	1	2	1	6
Poor	0	0	1	1	0	2

This perspective is reinforced by the data in Table A-9. Here, there is fairly good agreement within specific plants on the nature of STA-crew relationships. In general, the responses tend to cluster. Only in one plant, Plant 4, some interviewees reported that there are few problems while others said that many problems exist. The extent of perceived problems does not appear to be related to the STA implementation mode.

Reasons for Strain

The most frequently cited reason for STA-operations crew strain revolves around the issue of experience. Twelve of the thirty-five respondents, representing six of the nine plants, mentioned this as a problem. Specifically, the

TABLE A.9. Perceptions of STA/Crew Relationships by Plant

	Plant									
	1	2	3	4	5	6	7	8	9	Total
Good, No Problems	0	0	4	1	0	0	0	0	1	6
No Problems Now, Initial Problems	1	0	0	1	3	0	0	0	0	5
Pretty Good, but Some Problems	2	1	0	1	2	3	3	1	0	13
Fair, a Number of Problems	0	3	0	2	0	1	0	0	0	6
Poor	0	1	0	0	0	0	1	0	0	2
Implementation Mode	Separate Operations			Separate Engineering			Collateral Operations	Collateral Engineering		

STA is seen as having too little operations experience to be really useful. The operations crew frequently feels that it has the knowledge and skill and that the STA position creates a burden and interference. The following quotations are examples:

"Operators with lots of experience may resent supervision by STA with much less experience." (SS)

"ROs don't want to be asked dumb questions by the STA." (STA)

Second in frequency to the STA's lack of experience as a cause of strain is the issue of promotion and job competition. Seven respondents across four plants mentioned this concern. The STA is seen by some as blocking the career paths of the non-degreed operators. Before implementation of the STA/position, the operators' career paths were relatively clear and certain. Because only they had operations experience, they could become shift supervisors, perhaps to even higher positions. By gaining some degree of operations experience, the degreed STAs become serious threats to the operators' and, in some cases, shift supervisors' career paths. Typical comments include the following:

"[The STA] is seen as a threat to the operators. The operators feel that the STA will take the Assistant Shift Supervisor and Shift Supervisor positions." (training manager)

"[The STA] is a bottleneck to the promotion of non-degreed individuals with no supervisory experience." (operations superintendent)

Two reasons for poor crew-STA relationships were cited by five respondents. The first of these concerns the crew's perception that the STA is a spy or a watchdog. Some characteristics of the typical STA's job would reinforce this perception. For example, the STA is frequently assigned the responsibility of checking logs, reviewing tests, and checking the control board, to see if there are any problems. The connotation of a few of the responses is that the focus of the STA's duties is discovering operator mistakes. In addition, the main function of the STA is to step in during transient situations to provide diagnosis and advice, which can be seen as questioning the competence of the shift crew.

It is also important to remember that neither all respondents nor all plants reported significant STA-crew relationship problems. In this regard, it should be mentioned that several respondents cited reasons for good relationships. For example, a plant manager stated that STAs at his plant were experienced in operations and thus were well respected, and an STA indicated that good crew relationships exist when the STA uses his engineering background but does not try to compete with operators in matters of system knowledge.

EXPERIENCE WITH STA PERFORMANCE UNDER TRANSIENT AND NORMAL CONDITIONS

Transients

The evaluation of the STA's usefulness during transients varied considerably across plants. To some extent, this was due to differences in the number and type of transients experienced by the interviewee since the STA position had been established. Three shift supervisors and one STA had never experienced a transient where the STA was needed.

> "Never had a transient operators couldn't take care of. Most over quickly." (SS)

> "No firsthand knowledge (of STA's usefulness) ... hearsay only." (SS)

> "No transients have required STA to transfer to advisory function." (SS)

> "None required STA to become advisor. Had several trips, no needs other than to get out procedures. Not really needed except as SRO." (STA)

While these comments could be interpreted as meaning that the opportunity for the STA to perform during a transient had not occurred, they might also imply that the STA was not called in because he was not perceived as someone capable of offering help.

Half of the STAs and almost half of the shift supervisors reported a specific instance in which the STA had provided significant assistance.

> "All over control room, not just in a corner. Very useful." (SS)

In the first situation, "STA only read procedures--considered a waste since it did not involve an independent STA review of the situation." In the second situation, "STA conducted a number of evaluations considered very useful." (STA)

"Pretty useful, glad to have around. Twice in last year pretty freaky transient. Nice to have someone around to compare notes with. Alarm panel looked like a pinball machine." (SS)

"Trips--no problems--not called on for advice. Contributed more in non-trip." For example, at 3 a.m. called in to work with Assistant SS in diagnosing problem. "Arranged conference with managers and manufacturer to determine how to deal with problem till morning. Joint effort, worthwhile interaction. No antagonisms then when STA needed. Only in TMI-like situation will STAs make a major contribution." (STA)

"Check instrument readings, suggest action to SS. Leak checks; ... looked at diagrams and gave different perspective. Very useful." (SS)

"In response to leakage, verified leak calculation, let it run for one hour, checked change in VCT level ... resolved problem." (STA)

During SCRAM (loss of second recirculating pump), "By the time the STA got to control room, everything was over." During loss of DC event and turbine destruction, "STA helped isolate cause." (STA)

Two STAs and one shift supervisor indicated that the presence of the STA had been beneficial, though not crucial.

"Procedures, notifications; generally beneficial." (SS)

"Monitor primary conditions. Trips: assisted SS to help determine the cause of the trip. Check SS interpretations of Tech. Specs. Desirable but not required." (STA)

"Look up logic diagrams, ... core reactivity calculations, follow procedures and ensure correct execution ... . Helpful but not vital--could have gotten along without STAs." (STA)

Only one interviewee, an STA, had purely negative comments about the STA's usefulness during a transient:

Level change problem never resolved; STA not helpful in that instance. Logical analysis did not happen. STA lacked experience."

Thus, of the fifteen interviewees, four could not comment on the STA's performance during transients, ten interviewees thought that the STA was useful, at least for some of the transients, and one thought that the STA was not useful at all.

Normal Conditions--Contributions

Contributions of the STA position were categorized as follows: providing an engineering perspective, having ability to look at the "big picture," carrying out specific engineering related tasks, providing additional manpower, or serving as an organizational link between the operations and engineering departments. The lack of contributions and contributions that do not fall under the previously mentioned categories were also tallied. Table A-10 presents the number of interviewees who mentioned the various types of contributions. The "N" refers to the number of interviewees who responded to the question. The number of contributions mentioned is greater than the number of interviewees because each interviewee could mention more than one contribution. Thus, the three Nuclear Vice Presidents mentioned a total of four types of contributions. Similarly, of the five plant managers, two mentioned engineering tasks as the contribution, three mentioned other contributions and one said the STA makes no contribution. The most frequent areas mentioned referred to engineering perspective and tasks and additional manpower. The "big picture" role and organizational link were mentioned only by a few respondents. Six interviewees said there were no advantages of the STA position.

Comments regarding the provision of an engineering perspective include the following:

"Adds new theoretical perspective, two perspectives, experience and academic." (operations superintendent)

"Degree and knowledge help response to the big transient if they ever happen." (STA)

"Engineer right there--extra perceptions and assessment." (training manager)

"Conceptual understanding of design." (manpower planner)

"Another level of expertise." (training manager)

Specific engineering tasks mentioned as contributions include the following:

"Procedures improvement, discovered problems." (operations superintendent)

"Research and check data, interpret Tech. Specs. Find equipment problems." (SS)

"Calculations to help out operators--correction factors (verify and support); using engineering background has worked out a few times." (STA)

TABLE A.10. Number of Interviewees Mentioning Contributions of the STA Position by Interviewee's Job Position

Job Position	N	Contributions Mentioned: Big Picture	Engineering Perspective and Knowledge	Additional Manpower	Engineering Tasks	Organizational Link	Other	None
VP Nuclear	3	0	0	1	1	1	1	0
Plant Manager	5	0	0	0	2	0	3	1
Training Manager	7	2	3	3	1	0	3	1
Personnel Manager	3	0	1	2	1	1	1	1
Operations Superintendent	7	0	2	4	2	1	0	1
Shift Supervisor	6	0	3	2	2	1	2	1
Reactor Engineer	1	0	1	0	1	0	0	0
STA	8	1	4	1	5	2	2	0
Instrument and Control Engineer	4	3	1	2	1	0	0	1
Total	44	6	15	15	16	6	12	6

"Good review of procedures." (2 operations superintendents)

"Tech. Spec. and surveillance review." (STA)

There were two different types of manpower advantages mentioned: an additional reviewer of operations activities that provides a doublecheck and simply an extra person available to handle the work load. Examples of the reviewer role, which provides a direct safety-related function, include the following:

"Can spot things otherwise overlooked. Surveillance tests otherwise missed. Spot problems on informal tours." (STA)

"Problems solved that might have been postponed. Another set of eyes in control room and plant tour." (STA)

"Slight advantage picking up mistakes, preventative action once in awhile." (plant manager)

"Extra person to find problems, review computer printouts and write reports." (operations superintendent)

Comments regarding additional manpower, in a more general sense, manpower that presumably could be provided by non-STA staff, are listed below.

"Probably one more person is always a plus." (personnel manager)

"Gives additional manpower." (SS)

"Takes workload off shift supervisor." (operations superintendent)

"Extra person to do paperwork (although it's not STA's job)." (operations superintendent)

"An extra hand is available." (I & C engineer)

The "big picture" perspective was noted by a few respondents:

"Long term, not tied to daily operations, can consider trends." (I & C engineer)

"Cool head, able to sit back." (I & C engineer)

"Have someone in a transient situation to make an <u>independent</u> assessment." (STA)

"Big picture concept helpful and important." (training manager)

"Someone to look at problem in more depth than shift supervisor when problem is occurring." (training manager)

Enhancing organizational coordination was mentioned in two ways: improving the linkages between operations and technical services departments and ultimately filling management positions with staff with greater operations experience. For example:

"Technical services department appreciates STA interface with operations department." (STA)

"STA improves communication between crew and engineering group." (corporate)

"Management people there 24 hours a day enhances management response time and coordination." (STA)

"Good experience for potential managerial staff." (operations superintendent)

Examples of "other" contributions include the responses of four interviewees who indicated that the presence of the STA enhances shift crew performance. For example:

"Makes everyone work harder to prove STA not needed." (training manager)

"Management man in control room helps professional conduct of operators." (training manager)

"Keep non-degreed on their toes." (VP Nuclear Operations)

Also, two interviewees mentioned the enhancement of the engineer's expertise, and these responses were also categorized as "other."

"Individual is upgraded, keeps the individual current." (STA)

"STA position has broadened the engineer himself--more challenge." (plant manager)

The remainder of the "other" contributions were too varied and, in some cases, too uninterpretable to analyze meaningfully.

Normal Conditions--Problems

Specific problems or disadvantages of the STA position mentioned by interviewees included inexperience of STAs, underutilization of their engineering background, some negative effects on operator morale, and, to a lesser extent, the high cost of the position (see Table A.11). As in the case of specific contributions, there is some evidence of patterns in problems of concern by position at the plant, but little indication of systematic differences by implementation mode. Most plants reported experiencing similar types of problems.

TABLE A.11. Number of Interviewees Mentioning Disadvantages of the STA Position by Interviewee's Job Position

Job Position	N	Problems Mentioned: Inexperience	Underutilization	Operator Morale	Cost	Other	None
VP Nuclear	3	0	1	0	1	1	1
Plant Manager	5	3	3	1	1	1	0
Training Manager	7	3	2	3	2	3	0
Personnel Manager	3	1	2	3	0	1	0
Operations Superintendent	7	2	3	0	1	3	1
Shift Supervisor	6	2	1	2	0	3	0
Reactor Engineer	1	0	0	1	0	1	0
STA	8	4	1	2	0	5	0
Instrument and Control Engineer	4	2	0	0	0	1	2
Total	44	17	13	13	5	19	4

Inexperience was the most common problem mentioned; comments from seven of the nine plants referred to this issue. It was cited most frequently by the plant managers and the STAs themselves. In general, the inexperience referred to use of recent engineering graduates as STAs, but there also were a few comments concerning lack of operations and control room experience among more senior engineers. Examples include:

> "College grads with 3 months training don't know the plant, can't be effective in independent monitoring." (operations superintendent)

> "Low experience of 'off-street' hires; operators and shift supervisors are disgusted." (I & C engineer)

> "Lack of practical experience, but experience and quality improving with time." (SS)

> "Need more experience with job." (plant manager)

> "Inexperienced--hard to help!" (training manager)

> "Lack of experience hinders relative to having experienced foremen who came up through the ranks." (STA)

> "Rookie engineer is thorn in operators' backs." (STA)

> "Shift supervisor knows what's going on better than STA, more experience in control room." (personnel manager)

Underutilization was mentioned by respondents at six of the nine plants. It was primarily a management concern, particularly of plant managers and personnel managers. For example:

> "Paid higher than can perform--underutilized, underchallenged, no definite work." (plant manager)

> "Can do without, don't need on day shift; could perform useful work elsewhere." (SS)

> "Not being fully utilized. Need to challenge." (STA)

> "Not using engineering background--just plant knowledge. Hard to utilize education." (operations superintendent)

The high cost of the position, relative to the perceived contributions, was mentioned by management personnel at four plants. For example:

> "Don't see how utilities can continue to carry those high-priced people without getting full benefit." (training manager)

> "Not sure contribution warrants that manpower." (VP Nuclear Operations)

Operator morale was another problem mentioned primarily by management, particularly training and personnel managers. Respondents from six of the nine plants referred to this as a concern. The major issue was career competition. The STAs had greater likelihood of promotion in such operations positions as assistant shift supervisor and shift supervisor, thus blocking the mobility prospects of non-degreed licensed operators. Other issues concerned the implied downgrading of the capabilities of the shift supervisor by requiring the STA on shift, feelings of inequity due to high pay STAs received in some plants, and (in two instances) resentment of a negative use of the STA's reviewer role. Typical comments are presented below.

"Operators seem insecure in relation to STAs because STAs will be promoted first." (STA)

"Operators feel STA will take Asst. SS and SS positions, career progression. Speculation on future career potential and uncertainty hurts crew." (training manager)

"Blocks career path of nondegreed operators." (SS)

"Career impediment to operators is still a problem." (reactor engineer)

"Bottleneck to promotion for nondegreed operators." (operations superintendent)

"Small percentage of operators feel insulted by being forced to have someone assist." (training manager)

"Non-licensed person sleeping in trailer getting $20 an hour--animosity between SS and STA." (personnel manager)

"STA viewed as a spy." (STA)

"STA as squealer, emphasize finding faults rather than bringing problems to everyone's attention." (operations superintendent)

NEED FOR ENGINEERING EXPERTISE ON SHIFT

We asked interviewees under what conditions that engineering expertise would be needed in the control room and how to make that expertise available. It is important to remember that the emphasis was on necessity rather than the potential for contribution.

Examples of situations when STAs thought that engineering expertise is needed are listed below.

> Engineering expertise is needed "during recovery from a transient, but not for immediate use in accident," and for "procedural changes to go with new equipment."

> Engineering expertise not needed for normal conditions, "extra hands needed, not necessarily engineer;" needed for planned evolution, planning not necessarily execution;" and for transient diagnosis and recovery.

> Should not rely on technical support center because it's too remote from control room, needed for "normal operations to help understand engineering problems, for recovery from a transient."

> Not needed under normal conditions, "may help for planned evolutions but not vital, needed at beginning of big incident and for recovery from a transient."

Three of the seven shift supervisors thought that an engineer should be on shift. All three preferred that the engineer have an SRO license and report to the operations department.

> "For normal conditions and planned evolutions there is little or no need for engineering experience. For off-normal conditions and during recovery from a transient, engineering expertise would always be needed. Best way to assure availability of engineering expertise when needed is the STA/shift engineer on shift (need expertise as soon as possible for transient)."

> Engineering expertise needed "during normal conditions for plant engineering. If licensed, might be helpful at beginning of an incident. STA should be licensed at SRO level, more for diagnosis than for operations functions. STA should be on shift."

> Engineering expertise not needed for normal conditions or planned evolutions. For off-normal conditions, "50-50 proposition. Possibly very helpful in recovery." The best way to make engineering expertise available is to make it an "additional function of an experienced SRO, on shift, in operations."

Two shift supervisors thought the existing technical support center[a] provided sufficient coverage.

(a) The onsite technical support center (TSC) was mandated for all reactor power plants as a result of the TMI-2 incident. It is a special facility, near the control room, which is activated when there is a plant alert or higher emergency. The TSC contains instruments that monitor plant conditions, and it provides a technical liaison between the plant and outside authority. Furthermore, it reduces congestion in the control room.

"Not needed under normal conditions, planned evolutions, off-normal or recovery from a transient. Rather have engineering staff available on daylight to look into problems; have them now but takes a couple of weeks. Use existing Technical Support Center, plant engineer available for crises to support operations supervisor."

"Have never needed it in control room. Best way to supply engineering expertise is to use the existing technical support center."

One shift supervisor recommended an on-call position, and one recommended a requirement for one SRO-licensed engineer per unit.

Two operations superintendents recommended on-call positions. The remaining four thought that no specific position was needed; the existing engineering support system was considered sufficient without the STA's presence.

Engineering expertise in the control room is "never needed. College training dwells on theoretical. Plant requires actual performance."

Engineering expertise in the control room is "never needed. Used for calculations but they're pretty cookbook. STAs more efficient at reports, but that doesn't affect safety. Existing structure is sufficient. Have duty manager, technical service and maintenance people on call. No need for them to be on shift."

Engineering expertise in the control room is "never needed in this plant. Don't need an engineer in the control room. Use existing Technical Support Center."

Two of the plant managers supportive of the on-shift position thought engineering expertise is needed at all times, while the other two thought that it was needed during transient situations.

"Engineer on shift is necessary at all times (not necessarily in the Control Room and not exclusively to cope with accidents but to contribute effectively to the prevention of accidents). Shift Engineer at middle management level under operations superintendent is best approach (can relate well with Engineering/Maintenance Departments and Technical Services Department at that level)."

"Engineering expertise should always be around (not necessarily in) the control room to suppplement the skills of the shift supervisor and operators with basic understanding and engineer knowledge. A collateral engineering position is the best way to do it."

The plant managers who saw no need for a special position on shift indicated that engineering support is needed at times but is best provided by having specific support (such as maintenance, engineering, duty manager staff) on call and available as needed.

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B. D. Melber (10)
J. Olson (5)
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16. ABSTRACT (200 words or less)

The provision of engineering expertise on shift at commercial nuclear power plants has mainly taken the form of the Shift Technical Advisor (STA). This person, acting in a capacity that is part engineer and part operator, is expected to advise the operations crew in the event of an emergency and review plant operating experience during normal circumstances. The position was mandated by the Nuclear Regulatory Commission following the incident at Three Mile Island. This report expands on a growing body of knowledge regarding the effectiveness of the STA. The new data presented here come from interviews with plant personnel and utility officials from nine sites. Researchers from the Pacific Northwest Laboratory (PNL) interviewed plant personnel, including the STA and immediate management, the shift supervisor and management, the training department, and ancillary staff, all of whom affect the intended performance of the STA. The conclusions of the report are that the design of the STA position results in limited contribution during an emergency; more comprehensive ways should be sought to provide the variety and specificity of engineering expertise needed during such times.

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