REPORT
OF THE
FUNDAMENTAL CAUSE
ASSESSMENT TEAM

JULY 12, 1996

PREPARED BY

MARIO V. BONACA - FCAT CHAIRMAN
NORTHEAST UTILITIES

GARY R. DOUGHTY - PRESIDENT
JANUS MANAGEMENT ASSOCIATES, INC.

RICHARD H. VOLLMER - PRINCIPAL
PRISM CONSULTING, INC.

9609100354 960904
PDR ADOCK 05000423
P PDR

TABLE OF CONTENTS

SECTION I EXECUTIVE SUMMARY 1

SECTION II INTRODUCTION 4

SECTION III METHODOLOGY 5

SECTION IV HISTORICAL SUMMARY 8

SECTION V FUNDAMENTAL CAUSE ANALYSIS OF NUCLEAR PERFORMANCE DECLINE 18

APPENDIX 31

SECTION I
EXECUTIVE SUMMARY

The Fundamental Cause Assessment Team (FCAT) has concluded its assessment of the causes of the decline in Northeast Utilities' (NU's) nuclear program performance. This assessment was based on review of relevant documents covering NU's nuclear performance since the mid 1980s and on confirmatory interviews. These documents included internal NU assessments, assessments by consultants and third parties, Nuclear Regulatory Commission (NRC) documents, and records and communications concerning particular events.

As a result of this assessment, the FCAT identified the following fundamental causes of the decline in performance in NU's nuclear program relative to the increasing demands placed on a well-performing nuclear program:

- The top levels of NU management did not consistently exercise effective leadership and articulate and implement appropriate vision and direction.
- The nuclear organization did not establish and maintain high standards and expectations.
- The nuclear organization's leadership, management, and interpersonal skills were weak.

These fundamental causes are interrelated. For example, executive management vision and direction affected the standards applied in the nuclear organization. Similarly, leadership and interpersonal skills affected the way in which directions and standards were implemented.

Leadership

The top levels of NU management did not consistently exercise effective leadership and articulate and implement appropriate vision and direction to keep pace with the increasing demands placed on a well-performing nuclear program. Three findings support this fundamental cause:

- Vision and direction were not consistently in conformance with the fundamental needs of a well-performing nuclear program. There was no "champion" to articulate and advocate the unique needs of nuclear power nor to consistently and forcefully convey the overarching need for excellence as fundamental to safe and reliable nuclear operation. Clear priority of long-term safe and reliable operation relative to production needs was not consistently communicated.
- Emphasis was often placed on justifying the *status quo* rather than resolving problems. This led to a narrow and legalistic interpretation of some requirements,

persistence of some degraded plant and design documentation conditions, and failure to aggressively respond to certain employee concerns.

- There was an ineffective response to mounting indications of serious performance and regulatory problems identified by NU assessments, employee concerns, operational events, and external observers. There appeared to be a strong belief by senior management that the nuclear program was fundamentally healthy and did not warrant significant criticism.

Standards

The NU nuclear organization did not establish and maintain high standards and expectations. Three findings support this fundamental cause:

- Standards and expectations set by management resulted in a tolerance of deficient conditions. Deficiencies in programs and processes, plant equipment and design basis documentation were often not recognized or acted upon due to a lack of understanding of requirements, a near term focus on cost control and production, and narrow and ineffective oversight. Corrective actions were often slow or overly narrow.
- Management and employee standards did not consistently ensure conservative decision making nor reinforce the need for conservatism in decisions affecting plant safety. Decisions which affected margins of safety were often made with an imbalance toward continued near term production.
- The prevailing attitude toward regulatory standards within NU was not consistent with nuclear excellence. The organization became isolated from rising standards and regulatory change. This resulted in operation-dominated decisions which gave insufficient weight to maintenance of safety margins and a conservative approach to regulatory standards.

Management Skills

NU nuclear leadership, management, and interpersonal skills were weak. Four findings support this fundamental cause:

- Communication and interpersonal skills of nuclear program did not foster trust, teamwork, or good morale. Lessons learned were not consistently communicated and implemented within the nuclear organization.
- Management was ineffective in responding to many employee concerns. An overly critical or adversarial approach toward employee allegations was sometimes taken.

- Resource allocation, plan implementation, and prioritization did not support overall performance improvement. Resources devoted to the nuclear program were not applied to certain areas where improvement was needed.
- Management did not always clearly or appropriately define organizational roles. Nuclear oversight organizations had a narrow focus and were ineffective.

SECTION II
INTRODUCTION

This Report describes the results of an analysis to determine the fundamental causes of the performance decline of the NU nuclear program with particular emphasis on the three units at Millstone station.

In May 1996, the Nuclear Committee of the Northeast Utilities (NU) Board of Trustees established a Nuclear Committee Advisory Team (NCAT) to assist the Nuclear Committee in evaluating the performance of NU's nuclear program. A portion of the NCAT's responsibilities is to assess whether NU management actions to address nuclear program performance problems are effective. The Fundamental Cause Assessment Team (FCAT) was established in May 1996 to assist the NCAT in determining the fundamental causes of the nuclear program's performance decline and regulatory problems so that the NCAT can evaluate whether management actions are effectively addressing those causes.

The FCAT is composed of a senior NU manager and two consultants with extensive experience in evaluating nuclear power plant performance and regulatory issues. Assistance was provided by NU staff and consultant support. The FCAT has been provided with free access to Company records and personnel and was given approximately two months to perform its review. Summaries of the qualifications and experience of the FCAT members are presented in the Appendix.

SECTION III
METHODOLOGY

The FCAT used the following method to identify and validate the fundamental causes of NU's nuclear program performance problems.

Review and Analysis of Records

Documentary records reflecting nuclear program performance primarily during the period 1986-1996 were assembled and organized. These records included:

- descriptions of NU nuclear programs and policies
- assessment reports prepared by NU
- assessment reports prepared by consultants
- NRC documents, including inspection reports, Notices of Violation, "watch list" letters, Systematic Assessment of Licensee Performance (SALP) reports, and other correspondence between NU and the NRC
- periodic Institute of Nuclear Power Operations (INPO) evaluations of NU plants and corporate functions
- organization charts
- objective performance measurement records
- previous improvement plans
- NU corporate annual reports
- NU budget information

Timelines and summaries of key events were developed, management and program changes were analyzed, and evaluations of specific areas were completed in order to facilitate a systematic review.

The FCAT reviewed the timelines and summaries on a year-by-year basis to identify key events and assessment results for each year. For each key event or assessment result, the FCAT identified the causal factor(s) that appeared to have led to its occurrence. Underlying documentary records were consulted as appropriate to ensure that events and their causes were fully understood. Statements in assessments and other reviewed documents were accorded weight based on the extent to which the document provided examples or facts supporting the statement or were corroborated by other documents or facts identified during the FCAT'S review. The FCAT considered not only information available to management at the time, but also subsequent assessments, findings, and results.

Following the identification of causal factors for key events in each year during 1987-1996, the FCAT reviewed the events, assessment results, and causal factors as a whole to identify those causal factors which were fundamental in that they were repeatedly involved in negative events or assessment results, persisted over time, and appeared to have had a significant impact on nuclear program performance. Key examples of the impact of each of these causes during the reviewed period were assembled. Fundamental causes were then further defined, validated, and supplemented through personnel interviews and historical analysis.

Personnel Interviews

The FCAT interviewed 16 people during the course of its review. The purpose of these interviews was to aid in validating and defining the fundamental causes identified through the document review and analysis process, and to determine whether any other fundamental causes might exist. Interviewees were selected based on their position(s) and scope of responsibility in the NU organization during the reviewed period and their knowledge of or involvement in key events and/or assessments. At his request, one former concernee was also interviewed.

Interviews typically lasted between one and four hours. Interviewees were asked about specific events or assessments within their knowledge or scope of responsibility, and were also requested to provide their overall opinions on the causes of current performance and regulatory problems. Specific statements made during interviews were relied upon only when corroborated by other interviewees or documentation.

The FCAT reviewed the interview results, grouped interview statements to identify common themes, and compared them to the fundamental causes identified during the review and analysis of documentary records. Insights gained through the interview process are reflected in the historical summary and fundamental cause analysis presented in sections IV and V.

Historical Summary

To provide further insight into the historical development of current nuclear program performance problems, the FCAT prepared a narrative summary of key actions and events from the early 1980s to 1996. The narrative is based on information obtained from the document reviews and interviews described above.

Management Verification

Solely for purposes of factual verification, copies of the final draft of this report were provided to senior NU nuclear program management for review. Comments received were independently dispositioned by the FCAT.

Scope

This analysis identified the fundamental causes for the overall decline in performance of NU's nuclear program. Because the analysis sought to determine the causes of that decline, heavy emphasis was placed on evaluation of negative events and assessment results, rather than positive accomplishments. Also, because that decline is most apparent at the Millstone Station (i.e., its placement on the NRC "watch list"), this analysis was primarily focused there. It was not done on a unit specific basis. As such, the performance of each unit was not individually assessed. The extent to which the identified fundamental causes affected the performance or operability of individual units was not assessed. Connecticut Yankee was analyzed to a lesser extent than Millstone, and the FCAT's analysis did not determine whether the fundamental causes and associated findings had an impact at Connecticut Yankee similar to that at Millstone. Seabrook's performance was not analyzed because it was not operated by NU until 1992 and, until recently, was managed as a separate entity.

SECTION IV
HISTORICAL SUMMARY

Preface

This historical summary provides an overview of a number of the more significant events, conditions, and decisions that accompanied the decline in performance of NU's nuclear program from its position of industry leadership in the mid-1980s. It provides general background on the timing and interrelationships of some of the key events and issues analyzed by the FCAT in determining the fundamental causes of decline presented in Section V of this report.

Performance During the Early to Mid 1980s

During the early to mid 1980s, NU was widely considered a leader in the nuclear industry. Operating history and NRC Systematic Assessment of Licensee Performance (SALP) scores were generally good. Plant capacity factors were usually above average. There were few NRC civil penalties and no significant "whistle-blower" issues.

In this time frame, NU embarked on several programmatic or industry initiatives that were recognized positively throughout the nuclear community. These included:

- Design basis reconstruction for Connecticut Yankee (later expanded to include the Millstone units) in response to the 1984 cavity seal failure at the plant
- Construction of a training center with four plant-specific simulators
- Initiation of an integrated configuration management program in 1985
- Designation to a lead role in many EPRI task forces, ASME / IEEE code committees, and AIF activities
- Assumption of a lead role in the use of Probabilistic Risk Assessment (PRA) beginning in early 1985, and use of PRA in negotiating a schedule of plant improvements with the NRC (Integrated Safety Assessment Program (ISAP) for Connecticut Yankee and Millstone 1)
- Assumption of a lead role in the establishment of INPO

A number of these programs, such as those involving design basis and configuration management, addressed areas of weakness that were prevalent in the industry at the time. NU was viewed as a leader in efforts to resolve those issues.

In addition, in 1986, NU completed and started up Millstone Unit 3. Although there was a substantial backlog of issues to be resolved at the time of initial startup, the construction completion and startup were generally considered to be successful. Accordingly, while there

were some problems that had to be addressed, the NU nuclear program in the early to mid 1980s was generally successful and recognized as such by the NRC and others in the industry.

Developments That Challenged NU in the Late 1980s and Early 1990s

Beginning in the mid 1980s and continuing into the early 1990s, several events took place that ultimately contributed to the decline in NU's program.

Management Changes

A number of the executive and management team members who had successfully guided NU's nuclear program retired or resigned during the mid 1980s. These included the Chairman and CEO, the President, the Executive Vice President of Engineering and Operations, the Senior Vice President of Nuclear Engineering and Operations, and two of the Millstone Unit Directors. Following these changes, upper management responsible for the nuclear program was largely composed of individuals promoted from within NU, particularly Millstone, who had not participated in major engineering or design basis efforts. These individuals gained experience and were promoted at a time when NU nuclear program budgets and activities were expanding, and the organization had limited experience in effecting cost reductions on nuclear program activities.

Shift in Focus from Construction to Sustained Operation

This period also encompassed a major shift in focus for the nuclear organization. Prior to 1987, the NU nuclear program had a strong focus on nuclear construction and plant modification activities. With the completion of Unit 3 in 1986, the workoff of Three Mile Island-related modifications, and the addition of the Seabrook Nuclear Station, the new challenge was to sustain successful multi-unit, multi-site nuclear plant operations with plants of varying vintage and design. This change entailed a shift from management approaches appropriate for near-term construction project completion (such as intense focus on immediate milestone completion, cost, and schedule for a single project) to approaches that would sustain successful operation over the long term (such as design control, conservative decision-making, consideration of potential consequences of nascent problems, allocation of resources among several sites, and personnel development). This change was rendered more complicated by the need to integrate Seabrook into the NU nuclear program, which along with the overall acquistion of Public Service Company of New Hampshire (PSNH), required substantial management attention.

Financial Conditions, Industry Cost Control Initiatives, and Emergence of Competition

During the late 1980s and early 1990s, NU was presented with financial challenges from three sources. First, the completion of Millstone 3 had required an extraordinary amount of resources. A portion of the cost of the unit was disallowed by the Connecticut and Massachusetts public utility commissions, and they directed that allowed costs be phased into rates over a several-year period. During the early 1990s, NU continued to receive intensive scrutiny of its costs (particularly costs incurred as a result of plant outages and shutdowns) by the state commissions.

In several cases, costs were disallowed. Second, evaluations by McKinsey & Company, Inc., NU internal groups, and line management led the Company to conclude that costs (of which nuclear program expenditures were the largest component) would have to be reduced if the Company were to be competitive against customer self generation and independent power producers, and in the deregulated electrical power production industry expected to develop during the 1990s. Third, New England suffered a severe economic recession during 1989-1993, reducing anticipated revenues. Non-nuclear portions of NU underwent significant budget and personnel reductions, and there was a corporate expectation that the nuclear program should bear its share of these reductions. The non-nuclear portions of NU held and communicated strong negative feelings about the amount of resources required by the nuclear group.

In addition to financial conditions specific to NU, during the late 1980s, the nuclear power industry as a whole began to focus on the need to control operations and maintenance (O&M) costs. These costs had risen steadily during the 1980s and in the early 1990s, the industry embraced a number of cost control initiatives, including interactions with the NRC (e.g., Cost Beneficial Licensing Actions) to mitigate this trend. Also during the early 1990s, the National Energy Policy Act was passed, which opened up wholesale power sales to competition and reinforced the need for control of O&M costs. Other nuclear utilities moved aggressively to control costs and reduce plant staffs. Industry data showed a correlation between well-run plants and low-cost producers.

NU anticipated these trends and initiated measures to ensure cost control. Senior nuclear program management received from executive management and transmitted to the nuclear organization strong direction that cost control efforts were essential. However, management communications did not consistently convey an appropriate balance of competing factors. At various times, senior nuclear management statements implying that "excellence is too expensive," and instances of tolerance of deficient conditions and non-conservative decisions to operate in the face of equipment problems, provided nuclear management personnel with inconsistent direction as to the relative priorities of safety, cost, production, and attitude towards regulatory standards. Nuclear cost control efforts included substantial cuts to budgets for the configuration management program (integral to maintaining design control and conformity to the FSAR) and reductions in nuclear program Engineering personnel. Other budget cuts focused on reducing travel and limiting participation in nuclear industry groups and programs, including some of the programs in which NU had been considered a leader in the early to mid 1980s. Although overall nuclear program budgets and numbers of personnel did not significantly decline, cost control efforts adversely impacted some key programs and decisions.

Rising Standards of Performance

Also during the late 1980s and early 1990s, NRC and industry standards governing nuclear plant operations underwent significant evolution. Standards and levels of performance that were relatively common in the early 1980s were no longer acceptable. For example, as the number of nuclear plants under construction diminished, the NRC began to focus more heavily on the safety and management of operating plants, and the number and types of NRC reviews of operating plants proliferated. At the same time, the NRC began moving strongly toward "performance-

based" evaluation, such as the Senior Management Meeting / "watch list" process; as a result, the agency began to find "weaknesses" in performance even when an adequate level of safety was being achieved. Similar rising standards were promulgated by INPO and reflected in INPO evaluations.

NRC expectations for design basis documentation evolved in a similar manner. NRC inspection processes developed in the mid-1980s, such as Safety System Functional Inspections and Safety System Outage Modification Inspections, focused heavily on design documentation and configuration control. Through Generic Letters and other NRC communications, more emphasis was placed on precise compliance of facilities to the design and licensing basis.

Industry wide employee concerns and "whistleblower" issues also began to receive substantial NRC attention. Prior to the 1990s, these issues had largely been addressed by the Department of Labor, and the NRC normally did not become extensively involved. But in the early 1990s, NRC involvement dramatically increased. NRC inspections, investigations, and enforcement actions relating to employee concerns and "whistleblower" issues increased in number and prominence, and focused heavily on potential harassment, intimidation, or discrimination, as opposed to any underlying nuclear safety concern. The NRC revised its enforcement policy and manual relating to discrimination against "whistleblowers", and revised its regulations to provide for criminal penalties. A new policy statement on employee concerns was drafted and issued. These developments required senior licensee management to become much more heavily involved in "whistleblower" situations than had previously been the case. Many nuclear utilities had not developed strong programs for successfully handling these situations.

In all of these areas, licensee performance levels needed to improve to meet the rising expectations of the NRC. The NRC encouraged licensees to benefit from "lessons learned" at other nuclear power plants, and supported industry efforts to raise performance standards. Performance levels considered acceptable or good during the early 1980s were considered weak by the mid 1990s.

In summary, during the late 1980s and early 1990s, NU underwent significant executive and nuclear program management changes and was required to shift its focus from construction projects to long-term multi-site nuclear operations. Substantial management attention was necessary to consummate the acquisition of PSNH. At the same time, cost pressures arose from completion of Millstone 3, close state rate commission scrutiny, economic recession, and the anticipated onset of competition in the electric industry. Efforts were made to reduce costs, including reductions in programs that previously had helped NU stay attuned to industry and regulatory developments and become recognized as an industry leader. These actions anticipated industry-wide cost control initiatives and competitive pressures that developed in the 1990s. Directions and actions by management did not communicate a consistent priority of safety and quality over cost and production. Also during this period, NRC expectations in such areas as plant operations, design and configuration control, and employee concerns and "whistleblower" protection were evolving, and previously accepted levels of performance would not necessarily continue to be satisfactory. These developments and rapidly changing conditions presented a significant challenge to NU.

Erosion of NU's Nuclear Program Performance

The strong performance that characterized NU's nuclear program began to erode in the late 1980s. At first, many of the problems appeared isolated, and NRC assessments generally indicated continuing strong performance. As time went on, however, problems became more numerous and severe. Performance decline emerged through operational events and equipment problems, internal and external assessment results, NRC evaluations and penalties, DPUC nuclear plant outage cost disallowances, weaknesses in design basis and configuration control, procedural non-compliance issues, and a number of employee concerns.

Operating Events and Equipment Problems

During the early to mid 1990s, there were several events that indicated both equipment problems and weaknesses in operating standards. Events included: the 1990 Millstone 1 traveling screen failure that resulted from the insufficiently evaluated removal of the automatic trip function from the traveling screens; the 1990-1991 failures of two Millstone 3 moisture separator drain lines and two Millstone 2 moisture separator reheater drain lines due to erosion/corrosion; the 1992 inadvertent draindown of the Millstone 2 spent fuel pool; the 1992 Millstone 3 repeated operability problems and ultimate shutdown due to design deficiencies in the Supplemental Leak Collection and Release System (SLCRS); the 1993 2-CH-442 valve event on Millstone 2 involving on-line repairs which presented personnel safety and significant operational risks; and the 1994 Connecticut Yankee service water pipe leaks due to microbiologically induced corrosion (MIC) that had been detected earlier but not corrected. Many of these events involved operating despite potential operability concerns, tolerance of deficient conditions, or failure to correct equipment or design deficiencies prior to equipment failure. Several events also indicated design or configuration management deficiencies. In some cases, events reflected a lack of teamwork and communication between unit organizations that may have been exacerbated by competition between NU units in meeting production goals.

Assessment Results and NRC Evaluations

Beginning in 1988, NU began to receive assessment results and NRC evaluations indicating increasing levels of concern with nuclear program performance. Initially, these assessment and evaluation results did not consistently show overall decline. But by the early 1990s this decline was being identified with increasing frequency. Among these assessments were:

- A 1988 Safety System Functional Inspection (SSFI) of Millstone Unit 1 by NU identified a "global observation" of inaccuracies in the Unit 1 Updated Final Safety Analysis Report (UFSAR).
- A 1989 report by LRS, Inc., consultants to NU, indicated (among other things) that shortcuts had been taken to meet production goals, that certain management and leadership skills were lacking, that safety and quality standards had not been effectively incorporated into all activities, and that employees' attitudes towards the nuclear organization and its future were negative. LRS noted that these symptoms

had been present at another nuclear plant that had once been a strong performer but was now (1989) considered a troubled plant. LRS reported that 90% of NU employees surveyed had not observed broad, effective teamwork from the three nuclear Vice Presidents.

- NRC Systematic Assessment of Licensee Performance (SALP) scores for the Millstone units underwent significant declines in 1990 and 1992. After 1992, Millstone SALP evaluations continued to be substantially lower than both industry averages and previous Millstone ratings. Connecticut Yankee SALP scores were excellent in 1990 (all category 1s), declined slightly in 1991, and declined further in 1993 and 1994 to a less-than-average level.

- A set of internal task force reports commissioned by nuclear program management in 1991 to review nuclear safety concerns, nuclear organization performance, operability and reportability issues, and procedure compliance were very critical and identified several problems involving: equipment marginalities; deficient programs and processes; a "production bias"; lack of a clear "excellence" goal; missing design information; lack of appreciation by NU leadership for the unique needs of a successful nuclear program; and degrading nuclear employee trust in management and morale problems.

- Since 1989, NRC Civil Penalties have been assessed against Connecticut Yankee and Millstone with more frequency than was previously the case. In each of the years 1990, 1991, 1993, and 1994, the Connecticut Yankee and Millstone units collectively received three or more proposed civil penalties.

- In May 1992, an NRC Millstone Assessment Panel, comprised of both Region I and Headquarters personnel, was formed in response to the decline in performance of the Millstone station. Normally, such panels are only formed in cases where the NRC has significant concern regarding plant performance.

- In March 1995, the NRC Executive Director for Operations, the Director of Nuclear Reactor Regulation, and the Region I Regional Administrator, met with the NU Board of Trustees to express the NRC's overall concern with NU nuclear program performance. Normally, such meetings are only held when the NRC has significant concern with licensee performance.

- The February 1996 report (Adverse Condition Report 7007) on causes of inaccuracies in the Millstone 1 USFAR identified deficiencies in design control, oversight, and management response.

- In January 1996, the NRC placed the Millstone units on its "watch list". In June 1996, the NRC classified Millstone as a Category 3 plant on the "watch list" which requires approval of the NRC Commissioners for restart.

Design Basis / Licensing Basis Problems

In the early 1980s, faced with the many post-TMI backfits to the operating units, NU determined that it needed to improve its design basis information to support the design change process. Problems were also identified with the accuracy of available licensing bases. In response to the 1984 Connecticut Yankee reactor cavity seal failure event, a design basis reconstruction effort was initiated for that plant, which was later expanded to all four Connecticut units. In 1985, this effort was integrated within a larger project to develop a system-wide electronic configuration management program.

In early 1987, this program was severely reduced in scope and components. The electronic configuration management program was eliminated. The design basis reconstruction efforts were drastically reduced. A project to complete the "current licensing basis" was never funded. The cuts scaled back programs for which NU had previously received positive recognition from the NRC and the industry. Although NU continued to vigorously address some major technical issues, generally the approach was to react to problems rather than proactively address them.

At about the time these cuts occurred, the team of consultants performing the design basis reconstruction program was removed from design engineering. Because the work was performed outside of engineering, design engineering never took ownership for the program and the resulting products. Program-identified discrepancies were evaluated for reportability and operability, but were not promptly dispositioned and continued to accumulate. Funding provided through the 1992 Performance Enhancement program (PEP) accelerated completion of the design basis program, but did not significantly expand its scope. In 1996, a team assembled to determine the scope and causes of design basis discrepancies determined that configuration management had not been fully implemented, and that cultural problems with ownership, attitude towards compliance, definition of organizational roles, and a production bias had contributed to problems in design basis, configuration management, and FSAR compliance (ACR 7007).

Employee Concerns

Beginning in 1988, the Millstone units became the subject of numerous employee concerns. During 1991-1995, the number of allegations received by the NRC from Millstone employees was among the highest for all U.S. nuclear power plants. In several cases, NU management was not successful in resolving the concerns promptly or in making concernees feel that their concerns were being properly addressed. In some cases NU utilized weak technical arguments and analyses to deny that the safety concerns were valid. Employee concerns problems have persisted into 1996, and have required NU to devote substantial senior management attention and resources. In several cases the NRC and / or the Department of Labor (DOL) have found that discrimination claims were without merit. However, since 1988, NU has received three NRC civil penalties based upon discrimination against personnel who raised safety concerns, and has been the subject of adverse DOL determinations. Internal assessments performed in 1991 and January 1996, concluded that response to employee concerns has not been effective and that a number of employees do not have confidence that their concerns would be appropriately resolved. The Nuclear Safety Concerns Program was substantially revised in 1990, and

subsequently upgraded, including a stronger effort to reach out and respond to concernees. However, employee concerns remain an issue at Millstone.

Procedural Non-Compliance

In the late 1980s, issues of procedural non-compliance began to surface at Millstone and were increasingly noted by the NRC as a significant problem. Contributing to this problem were the instances of procedural non-compliance identified by concernees and reported with increasing frequency to the NRC. In 1987, a Procedure Upgrade Program (PUP) was initiated in response to an evaluation which cited procedure quality as a major issue. By 1991, this concern prompted the assembly of two task groups to review this issue, assess its significance and recommend solutions. Both groups recognized the need for procedural improvements and for increased management expectations regarding procedural compliance. As a result of these findings, resources dedicated to the ongoing PUP were significantly increased. Notwithstanding these efforts, instances of procedural non-compliance continued to occur in succeeding years and this problem has persisted up to the present time.

Management Response to Identified Problems

Management took several steps to respond to the problems raised by the events, assessment results, and issues described above. For example, following the declining SALP scores, civil penalties, and adverse self-assessment results in 1990 and 1991, changes were made to the nuclear management structure, including the creation of an Executive Vice President position focused solely on nuclear matters. Several other changes in senior nuclear program management were also made. Additional operational and training resources, including a significant number of additional personnel, were provided to the nuclear program in 1991. The Nuclear Safety Concerns Program was substantially revised in 1990 to provide employees an alternate means of seeking resolution of safety concerns, and beginning in 1994, supervisory personnel were provided with Management Action Response Checklist (MARC) training to help them respond properly when concerns are raised. In addition, an extensive Performance Enhancement Program (PEP) was initiated in 1992 to address weaknesses that had been identified by NU and NRC assessments. Key features of the PEP included:

- a broad scope, including management practices, program and process improvements, and performance assessment. PEP also consolidated and integrated previously identified and funded improvement programs.
- specific action steps and assignments to achieve improvements
- schedules by which improvement actions were to occur
- budgeted resources for improvement actions

Substantial financial and personnel resources were devoted to the PEP.

The management changes and the PEP did not succeed in arresting the overall declining trend. This lack of success is attributed to undue focus on meeting specific PEP schedule and budget targets, as opposed to the scope and long-term effectiveness of the actions taken. Although the completion of specific actions was verified, formal assessments of the overall effectiveness of the PEP were not conducted.

Further rearrangements of the NU nuclear organization occurred in 1993-1995. In 1993, the Engineering Division was realigned along unit lines, and engineering management was consolidated under the Engineering Vice President. In 1994, the NU nuclear organization was consolidated under a newly-created Energy Resources Group, and a management team building program was implemented. A new Chief Nuclear Officer (CNO) was appointed in February 1996. In February 1996, as part of a "re-engineering" effort, a new organization was installed which established a team of officers over the five (5) NU nuclear plants. The management team included Vice Presidents of Nuclear Operations; Work Services; Nuclear Safety and Oversight; Nuclear Technical Services; and Re-Engineering Implementation.

In addition to the PEP, between 1992 and 1995 there were additional programs to achieve performance improvement. For example, in 1994, an Improving Station Performance (ISP) effort was initiated, but implementation has not been completed. Similarly, in 1995 and early 1996, efforts were made to improve performance and reduce costs through the re-engineering process. Substantial effort was put into developing a re-engineered organization during 1995. However, the re-engineering was premised on performance levels and cultural conditions better than had actually been achieved. The re-engineering process has been only partially implemented, leaving parts of the organization in a transitional mode in which some roles are not clearly defined.

There were also several significant actions taken which improved the condition of particular Millstone equipment or programs:

- The Millstone 2 steam generators were replaced.
- The NU erosion / corrosion program was substantially upgraded.
- The motor operated valve (MOV) maintenance and testing program was substantially upgraded.
- The most recent Millstone 2 refueling outage was extended to address problems that had adversely affected plant performance and to improve plant materiel conditions.

Substantial resources and attention were devoted to a number of these efforts. However, these initiatives were not coordinated into an overall program for improvement, and the overall declining trend was not arrested.

Ineffectiveness of Oversight

Contributing to management's ineffective response to mounting indications of serious problems was the fact that Oversight (Quality and Assessment Services, the Nuclear Review Boards, and the Plant Operations Review Committees) did not identify and bring about resolution of some key problem areas. Internal evaluations have been performed which indicate that, in general, the nuclear leadership expected the scope and depth of independent oversight to be limited to the minimum required by regulations. In part, because of this narrow focus, the oversight organization became compliance-oriented, focused on procedural steps and procedural accuracy, and failed to identify the larger issues and patterns from the aggregation of specific problems.

Current Status

Currently, the three Millstone units are shut down. NRC requests for information must be responded to and other substantial work completed prior to restart of the first unit (Unit 3). The Millstone units were placed on the NRC "watch list" in Category 2 in January 1996, and, following a downgrade to Category 3 in June 1996, must receive Commission approval prior to restart. A restart plan for Unit 3 and an overall Nuclear Excellence Plan are under development.

Summary

In summary, NU's nuclear program was generally considered strong in the early to mid 1980s. In the latter part of the 1980s, several challenges arose, including: management changes; a transition in focus from construction to operation; a need for cost reduction; the emergence of competition; and rising NRC and industry standards of performance. There were significant increases in the level of NRC scrutiny of plant operations, design and licensing basis issues, and employee concerns. Management vision and direction concerning relative priorities of safety, quality, cost, and attitude towards regulation were not always appropriate. Decisions were made to eliminate or cut programs which had helped NU earn recognition as an industry leader. Concurrent with and following these events, a declining trend in performance began, as evidenced by plant events, assessment and evaluation results, design and configuration control problems, procedural compliance problems, increased levels of employee concerns, NRC violations, and civil penalties. In many cases, these events and results reflected weak management standards and skills. NU management took action to address these issues through management changes, improvement plans, and re-engineering, but the declining trend has not been reversed.

SECTION V
FUNDAMENTAL CAUSE ANALYSIS OF NUCLEAR PERFORMANCE DECLINE

Based upon the reviews performed as described in Section III (Methodology) of this report, the FCAT identified three (3) fundamental causes for the decline in NU's nuclear program performance relative to the increasing demands placed on a well-performing nuclear program:

- The top levels of NU management did not consistently exercise effective leadership and articulate and implement appropriate vision and direction.
- The nuclear organization did not establish and maintain high standards and expectations.
- The nuclear organization's leadership, management, and interpersonal skills were weak.

These fundamental causes are interrelated. For example, executive management vision and direction affected the standards applied in the nuclear organization. Similarly, weaknesses in leadership and interpersonal skills affected the way in which directions and standards were implemented. All of these causes also occurred against a backdrop of external events and rising industry and regulatory standards, as described in Section IV.

Each of these fundamental causes is discussed in more detail below. Findings that form the basis for each fundamental cause are presented, along with the specific information that supports each finding.

FUNDAMENTAL CAUSES - LEADERSHIP, VISION, AND DIRECTION

I. THE TOP LEVELS OF NU MANAGEMENT DID NOT CONSISTENTLY EXERCISE EFFECTIVE LEADERSHIP AND ARTICULATE AND IMPLEMENT APPROPRIATE VISION AND DIRECTION.

A. Vision and direction were not consistently in conformance with the fundamental needs of a well-performing nuclear program.

The top levels of NU management did not forcefully and consistently convey the overarching need for excellence as fundamental to safe and reliable operation. Clear priority of long-term safe and reliable operation relative to immediate cost and production needs was not consistently established and communicated. Leadership did not include a "champion" of the nuclear power program who strongly advocated the unique needs of nuclear power generation and insisted on excellence.

Examples / Sources:

- Management statements on excellence versus cost and production sent mixed messages.
  - Starting in the late 1980s, there was a perception that excellence was too expensive.
  - The 1991 Task Group Report on Procedure Compliance stated that procedure compliance was not rigorously insisted upon when production was at issue.
  - The 1991 NE&O Performance Task Group Performance Report stated that personnel have been demoralized by lack of an "excellence in performance" goal and that excellence has been equated with cost control. Cost control had been communicated and received as an acceptance of lower, though adequate, level of performance.
  - Outage and program schedules were sometimes unrealistic (e.g., Millstone 2 1994 Refueling Outage, original goals for the Millstone 3 Restart from current 50.54(f) outage).
  - Management encouraged competition for capacity factor among plants, putting a strong focus on production.
- Key decisions were sometimes inconsistent with articulated standards (e.g., decisions on particular cost cuts; choosing to operate through equipment problems).
  - The backlog of unresolved items from the completion of Millstone 3 was accepted for several years.
  - Major budget cuts were made to design basis, licensing basis, and configuration management programs in 1987, and limited programs existed through 1995.
  - Plant management decided with senior nuclear management concurrence to operate Millstone 2 at full power and attempt to repair an unisolable reactor coolant system valve (2-CH-442) in 1993.

- Plant management decided not to resolve the Connecticut Yankee service water piping problem (microbiologically induced corrosion) during the 1994 outage in order to adhere to schedule.

- Interviews of several responsible senior nuclear managers indicated that:
  - Top NU management did not fully understand the demands of the nuclear environment.
  - A goal of "mid-level" performance was often articulated, resulting in a perception that less-than-excellent performance was acceptable to achieve cost control.
  - The nuclear organization did not have a strong champion.

FUNDAMENTAL CAUSES - LEADERSHIP, VISION, AND DIRECTION

B. Emphasis was often placed on justifying the *status quo* rather than resolving problems.

A number of significant events and long-standing issues were the result of decisions to justify the *status quo* rather than attack and resolve problems. This led to legalistic interpretations of some requirements, persistence of some degraded plant and design documentation conditions, and failure to aggressively respond to some employee concerns.

Examples / Sources:

- The 1987 decision to curtail design basis reconstruction efforts illustrated NU's tendency to defer rather than resolve an identified problem.
- The 1991 NE&O Performance Task Group stated that NE&O management needed to move beyond legalistic arguments with respect to regulatory compliance.
- The Millstone 1 full core offload issue demonstrated NU's resistance to evaluate and implement required changes which were identified by an employee concern.
- The 1996 Millstone Employee Concerns Assessment stated that NU management demonstrated an inability to prioritize and resolve issues and learn from past experience. It also cited the continuing existence of a technically arrogant style, and that management had a tendency to rely too heavily on a legalistic response to resolving issues.
- The 1996 NRC "watch list" meeting transcript and letter criticized NU for legalistic interpretations of regulatory issues.
- Interviewees indicated that NU viewed its nuclear program performance as strong, was defensive in response to criticism, and sometimes did not directly address problems.

FUNDAMENTAL CAUSES - LEADERSHIP, VISION, AND DIRECTION

C. NU did not effectively respond to mounting indications of serious problems.

Indications of serious performance and regulatory problems from NU assessments, employee concerns, operational events, and outside observers did not evoke an effective overall response. This appeared to be tied to a general belief by NU senior management that the nuclear program was strong and did not warrant significant criticism. As a result, changes to ways of doing business were not effectively implemented.

Examples / Sources:

- NRC penalties significantly increased from the period prior to 1987 to the present.
- The 1989 LRS Report noted deteriorating performance and several parallels between Millstone and another plant then on the "watch list".
- The 1990 Millstone 1 intake structure traveling screens collapse event was indicative of an inadequate design change control and safety review process.
- The 1990 - 1991 erosion / corrosion events illustrated some fundamental programmatic problems with corrective action and erosion / corrosion programs.
- NRC SALP scores for Millstone significantly declined during 1990 - 1992.
- The 1991 NU Task Group Assessments identified problems involving: equipment deficiencies, deficient programs and processes, a "production bias", lack of a clear excellence goal, missing design information, degrading employee trust and morale, and lack of appreciation by NU leadership for the unique needs of a successful nuclear program.
- PEP was pursued with an emphasis on tasks and sufficient focus was not placed on whether lasting improvement occurred (NRC OIG Report).
- The 1992 Millstone Perception Survey reflected a lack of respect, trust, and communication between management and employees.
- Management response to Millstone 2 valve 2-CH-442 event findings were not commensurate with seriousness of the scope of the findings.
- The re-engineering process was focused more on competitiveness and cost control than performance improvement in problem areas, and was premised on a level of performance and cultural conditions that had not been achieved.
- Significant procedural non-compliances were identified during the 1994 Millstone 1 outage, including previous over-tensioning of reactor vessel studs and operator actions resulting in reactor vessel draindown.
- Plant management was reluctant to recognize and promptly address reactor coolant pump oil collection/Appendix R issues at Millstone 2 in 1994 after identical problems were identified at Connecticut Yankee.
- There did not appear to be a strong effective response to the March 1995 NRC visit to Board of Trustees. Although certain significant management actions were taken, there was not formal follow-up on the effectiveness of these actions.

- Interviewees indicated that senior management did not react strongly enough to problems that ultimately led to Millstone's placement on the NRC "watch list". Management did not recognize the seriousness of problems and signs of performance decline.

FUNDAMENTAL CAUSES - STANDARDS

II. THE NUCLEAR ORGANIZATION DID NOT ESTABLISH AND MAINTAIN HIGH STANDARDS AND EXPECTATIONS.

A. Deficient conditions were often tolerated by being overlooked, not corrected, or corrected slowly or with a narrow focus.

Deficiencies in programs and processes, plant equipment and design basis documentation were often not recognized or not acted upon. This was due to a lack of a questioning attitude, an insufficient regard for excellence, a near term focus on cost control and keeping the plants on-line, and narrow and ineffective oversight. Corrective actions were in many cases slow or overly narrow.

Examples / Sources:

- Acceptance of the Millstone 3 construction completion backlog for several years.
- Budget reductions in 1987 to the design basis documentation, licensing basis, and configuration management programs and a minimal program thereafter resulted in plant design basis problems not being resolved.
- Lack of questioning attitude and aggressive response to certain technical issues (e.g., FWCI (1989), Rosemount transmitters (1989), Millstone 1 Full Core Offload (1993)) resulted in employee concerns and civil penalties.
- Marginalities in some plant equipment were not resolved for extended periods.
  - Single failure vulnerability (Millstone 2-ESAS 1992, Millstone 1-LNP circuitry 1995).
  - Faults in original design (Millstone 2 - ESAS, Millstone 1- LPCI heat exchangers, Millstone 3 - QSS / RSS).
- Instances in which plant operation was inconsistent with design limits / and safety analysis assumptions were sometimes not resolved for extended periods.
  - Millstone 1-TBSCCW heat exchanger high flow (1989).
  - LPCI heat exchanger high flow (1990).
- A number of corrective actions were ineffective.
  - Licensed operators requalification training (LORT) results / violations (1991-1994)
  - Equipment tagging repeat problems (self-assessments, NRC)
  - Delay in installing Connecticut Yankee auxiliary feed water automatic initiation
  - The poor material condition of the Millstone 1 Liquid Radwaste System was tolerated for an extended period.
- Interviewees noted several instances in which deficient conditions were allowed to persist. In some cases, "quick fixes" were performed rather than sustained corrective actions. Some actions and commitments were delayed for long periods of time.

FUNDAMENTAL CAUSES - STANDARDS

B. Management and personnel standards did not ensure conservative decisions.

There was not consistent reinforcement of the need for conservatism in decisions involving plant operations, maintenance and design. Decisions which reduced margin(s) or otherwise increased risk were often made with an emphasis on production and/or cost control. These decisions were both short term (acceptance of degraded equipment condition for remainder of the operating cycle delaying repair to the next outage) and long term (cuts to programs for configuration control/design basis maintenance). Some of these decisions were made without a full appreciation of the magnitude of the effect on safety.

Examples / Sources:

- Management delayed taking action to correct identified adverse conditions in the Feed Water Coolant Injection (FWCI) system in 1989.
- In 1991, service water temperature was raised above Plant Technical Specifications on several occasions to eliminate mussel infestation.
- The 1991 Operability, Reportability, and Communications Task Group Report cited reportability problems.
- The depth of reviews were not conservative with respect to the Millstone 2 Engineered Safeguards Actuation System (ESAS) issue.
- Millstone 2 plant management decided with senior nuclear management concurrence to operate at full power and attempted to repair an unisolable reactor coolant system valve (2-CH-442) from May to August 1993.
- Failures to address Millstone 2 CVCS Valve problems prior to 1993 did not demonstrate conservative decision making.
- Millstone 1 plant management permitted full discharge of fuel from the reactor to the spent fuel pool since early plant operations on a routine basis. When an employee safety concern about this practice was raised in 1993, management was slow to respond.
- In 1994, Millstone 2 operators failed to perform a reactor shutdown margin calculation associated with a stuck reactor vessel control rod and failed to report the event in accordance with the Emergency Plan.
- Interviewees indicated that there was strong encouragement to find solutions to problems that would keep the plants running. Although in some cases outages were extended to fix problems, in other cases, outage schedules were not realistic to address known problems. Several examples of "non-conservative" decisions concerning equipment and programs were provided.

FUNDAMENTAL CAUSES - STANDARDS

C. The prevailing attitude toward regulatory standards within NU's nuclear departments was not consistently appropriate for nuclear excellence.

Regulatory standards were not always met because the applicability or importance of certain requirements was not recognized and others were narrowly interpreted. In many instances the approach was to narrowly interpret requirements or rely on margins to defend a position that compliance was being achieved. The organization became isolated to rising standards and regulatory change in the industry. The desire for continued operation dominated decision making and the processes used for evaluation of regulatory constraints were ineffective.

Examples / Sources:

- The Millstone 1 UFSAR was inaccurate and there were insufficient design basis documentation, licensing basis and configuration management programs (1987-1996).
- Elements of cost control initiatives in the late 1980s and early 1990s (i.e., restrictions on travel and participation in industry groups) contributed to the isolation of NU.
- There were instances of legalistic defense of decisions and less-than-rigorous operability / reportability determinations.
  - Rosemount transmitters (1989)
  - FWCI (1989)
- During the Millstone 2 valve 2-CH-442 event in 1993, a safety evaluation was not performed before holes were drilled in the valve.
- Certain events reflected an attitude that some non-compliance issues were not significant.
  - Millstone 3 auxiliary feed water valves
  - Millstone 1 full core offload issues
- A 1995 independent evaluation of nuclear licensing indicated that management had not communicated higher standards beyond minimum conformance with regulatory requirements.
- Interviewees indicated that regulatory standards were often narrowly interpreted, and NU was viewed by the NRC as taking a "close line" on operability calls. NU was "technically arrogant" and did not keep pace with rising standards in the industry.

FUNDAMENTAL CAUSES - MANAGEMENT SKILLS

III. THE NUCLEAR ORGANIZATION'S LEADERSHIP, MANAGEMENT, AND INTERPERSONAL SKILLS WERE WEAK.

A. Communication and interpersonal skills of nuclear program management did not foster trust, teamwork, or good morale.

Communications among and within the various parts of the NU nuclear organization were often ineffective. Lessons learned by one NU nuclear unit were sometimes not communicated to or acted upon by other NU units. Communications to employees have often been untimely or unclear. Interpersonal skills of nuclear program management were often weak. This was reflected in the falling employee morale, lack of trust in management, and problems with teamwork.

Examples / Sources:

- The LRS report of 1988 observed teamwork problems and falling employee morale.
- Some employee disputes were permitted to escalate and were not expeditiously resolved.
- The 1989 LRS report cited lack of leadership and decision making by the Executive Vice President, Senior Vice President, and the three Vice Presidents as well as an absence of broad, effective teamwork from the three Vice Presidents. The report stated that the organization was, in effect, horizontally divided into three groups operating more or less independently.
- The 1991 Procedure Compliance Task Group cited ineffective communication across the organization.
- The Performance Enhancement Program (PEP) Phase I Report in 1992 cited management practices in communication, leadership, conflict resolution, and other areas as a root cause of problems.
- The 1994 Millstone Horizontal Self Assessment cited a lack of communication and inadequate evaluation of corrective actions.
- The 1994 Millstone 2 Startup Assessment Team identified unclear management expectations.
- The 1996 Millstone Employee Concerns Assessment Team cited a failure in employee / management relations and a need for improvement in consistency, openness and timeliness in communication by management.
- Interviewees indicated that people management skills of management were often weak; that there was not sufficient teamwork among the units and between the Vice Presidents (1991 time frame); and that management sometimes exhibited a "command and control" approach which stifled communications and discouraged differing opinions.

FUNDAMENTAL CAUSES - MANAGEMENT SKILLS

B. Management was ineffective in responding to many employee concerns.

An overly critical and adversarial approach toward employee allegations was sometimes taken. Weak interpersonal skills contributed to an inability to resolve difficult employee relations problems and weaknesses in responding to employee concerns.

Examples / Sources:

- Some employee disputes were permitted to escalate and were not expeditiously resolved.
- The Company was fined three (3) times for intimidation and harassment of individuals who raised safety concerns (FWCI, Rosemount transmitters, and radiation safety).
- Management was not effective in handling the employee concern regarding the Millstone 1 full core offload and spent fuel pool cooling issue.
- The 1996 Millstone Employee Concerns Assessment Team cited a failure in employee / management relations.
- During 1991 - 1995, the number of allegations filed with the NRC regarding Millstone was among the highest in the industry.
- Interviewees indicated that management was not skilled in handling employee concerns. In some cases the substantive issue was not handled well, and in other cases personal relations were not handled well. Trust in management was lost. In some cases, a confrontational approach prevented concern resolution from being a "win/win" situation.

FUNDAMENTAL CAUSES - MANAGEMENT SKILLS

C. Resource allocation, plan implementation, and prioritization did not support overall performance improvements.

Resources devoted to the nuclear program were not applied to certain areas where improvement was needed. Improvement plans were sometimes weak or not clearly coordinated with other organizational initiatives. Implementation of improvement efforts was often incomplete or did not include assessment of the effectiveness of improvement action.

Examples / Sources:

- In 1987, design basis, licensing basis, and configuration management program budgets were substantially cut.
- The 1991 NE&O Performance Task Group cited deficiencies in management skills and corporate support, lack of programmatic thinking and management.
- The 1991 Allegations Root Cause Task Group cited a lack of a management development plan and micro-management rather than strategic leadership.
- The 1992 PEP process did not include a formal evaluation of overall effectiveness.
- The 1994 Millstone Horizontal Self Assessment cited a lack of communication and inadequate evaluation of corrective actions.
- Interviewees indicated that there was a "production bias" in allocating resources, and that cost control was not well thought out in terms of impact on the needs of the nuclear program. Cost pressures adversely impacted configuration management and design basis programs.

FUNDAMENTAL CAUSES - MANAGEMENT SKILLS

D. Management did not always clearly or appropriately define organizational roles.

Organizational roles were not always clearly or appropriately defined. For example, the roles of Operations and Engineering in resolving operability and compliance issues were not clearly delineated. Oversight organizations had a narrow focus and were ineffective.

Examples / Sources:

- The 1989 LRS report cited lack of leadership and decision making by the Executive Vice President, Senior Vice President, and the three Vice Presidents as well as an absence of broad, effective teamwork from the three Vice Presidents. The organization was, in effect, horizontally divided into three groups operating more or less independently.
- Recognition of organizational issues or problems was reflected in significant organizational changes in 1991, 1993, and 1994, as well as the re-engineering effort in 1995.
- The 1996 report on the Effectiveness of the Oversight Organization noted that the update of the UFSAR was outside the Quality Assurance organization's scope and that management expected oversight to be limited to the minimum required by regulations.
- The 1995 - 1996 re-engineering effort was premised on performance levels and cultural conditions that have not been achieved. Consequently, the re-engineering effort has not been fully implemented leaving portions of the organization in a transitional mode in which roles are not clearly defined.
- Interviewees indicated that respective roles of Engineering and Operations were not well defined, and teamwork was often weak. Oversight was narrowly defined to focus on minimum literal compliance. Prior to 1991, there were too many layers of management in the nuclear organization.

APPENDIX

Background of FCAT Members

Mario V. Bonaca

Mario V. Bonaca is Executive Director of Nuclear Safety and Analysis for Northeast Utilities Company. He has 29 years in the nuclear power field in the areas of nuclear fuel, safety analysis, probabilistic risk assessment (PRA), radiological engineering, emergency planning, engineering programs and nuclear safety and oversight.

Mr. Bonaca's experience includes 12 years with Babcock & Wilcox and Combustion Engineering, designers and fabricators of nuclear reactor systems, and 17 years with Northeast Utilities in positions of increasing responsibility. His assignments have included leadership and participation in several assessments of nuclear plant performance, and he served as chairman of the Millstone Unit 3 Nuclear Review Board during 1983 - 1988.

Mr. Bonaca has also served on numerous national and international nuclear safety and standards committees. He received his Doctoral Degree in Physics from the University of Florence, Italy in 1964.

Gary R. Doughty

Gary R. Doughty is President of Janus Management Associates, Inc., a management consulting firm assisting utilities in the areas of operations management, plant effectiveness, rate case testimony and litigation support. He has over 25 years experience in the nuclear power industry. This experience includes prudence assessment, economic analysis, and expert testimony concerning the Pilgrim, Peach Bottom, Turkey Point, Calvert Cliffs, and Duane Arnold nuclear power plants.

Mr. Doughty's experience prior to forming Janus includes five years as a nuclear management consultant. He served as a Manager of Industry Relations with the Institute of Nuclear Power Operations (INPO). In 11 years with Northeast Utilities from 1975 to 1986, Mr. Doughty served in positions of increasing responsibility including startup engineer and manager of projects for Millstone 2, Millstone Unit 3 startup, and nuclear information manager.

In earlier experience, Mr. Doughty served five years in the U.S. Navy nuclear power program as a nuclear submarine officer.

Mr. Doughty holds a B.S. in Electrical Engineering from Vanderbilt University and a M.B.A. in Management and Finance from the University of New Haven.

Richard H. Vollmer

Richard H. Vollmer is a Principal of PRISM Consulting, a management and technical consulting firm assisting nuclear utilities. He has over 44 years experience in the nuclear field in the areas of reactor design and operational safety issues, regulation of nuclear plants under construction and in operation, and executive consulting in plant performance improvement, regulatory issues, and in rate case and litigation support.

Mr. Vollmer's experience includes five years as Senior Vice President with Tenera, a nuclear utility engineering and management consulting firm, and 22 years with the U.S. Nuclear Regulatory Commission. While with the USNRC, Mr. Vollmer served in positions of increasing responsibility including Deputy Director of the Offices of Nuclear Reactor Regulation (NRR) and Inspection, Director of the Division of Engineering, Deputy Director of the Office of Nuclear Regulatory Research, and Director of the Office of Policy Planning.

In prior experience, Mr. Vollmer was involved with nuclear power plant operations, testing, design, and operator training at the Argonne National Laboratory, the Savannah River Plant, Allis-Chalmers, and Atomics International (1952 - 1968).

Mr. Vollmer holds a B.S. in Physics from the University of Notre Dame.