U. S. NUCLEAR REGULATORY COMMISSION
REGION I

NINE MILE POINT UNIT 1 READINESS ASSESSMENT TEAM INSPECTION

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Licensee: Niagara Mohawk Power Corporation

Facility: Nine Mile Point Unit 1

Location: Scriba, New York

Dates: April 30 - May 11, 1990

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EXECUTIVE SUMMARY

The staff of the U. S. Nuclear Regulatory Commission (NRC) conducted a Readiness Assessment Team Inspection (RATI) at Nine Mile Point (NMP) Unit 1, April 30 through May 11, 1990. The inspection team evaluated the quality of Niagara Mohawk's efforts in the performance of tests, surveillances and other startup preparation activities during the inspection. The focus of the team was to make performance-based assessments of activities performed by Niagara Mohawk to determine whether sufficient progress had been made in the resolution of previously identified Underlying Root Causes of management deficiencies to support the restart of the unit. The team assessed the effectiveness of Niagara Mohawk's performance in five functional areas: (1) plant operations; (2) radiological controls; (3) maintenance and surveillance; (4) engineering and technical support; and (5) safety assessment and quality verification. The team also evaluated the material condition of the plant and overall management readiness to support restart and operation of the unit.

The team determined that Niagara Mohawk has made adequate progress in the resolution of the two Underlying Root Cause areas in which performance was previously determined to be weak by an Integrated Assessment Team Inspection (IATI) in October 1989. Specifically, the URC areas in need of improvement were URC No. 2 - Problem Solving and URC No. 4 - Standards of Performance and Self-Assessment. The team also determined that Niagara Mohawk has sustained its level of performance in the other three URC areas, namely, Planning and Goal Setting (URC No. 1), Organizational Culture (URC No. 3), and Teamwork (URC No. 5).

With regard to URC No. 2 (Problem Solving), effective use of engineering support for this purpose was noted throughout the inspection. A notable area of improvement has been the integration of the system engineering function into daily plant activities. The system engineers were knowledgeable with regard to their assigned systems and appeared to have accepted an increased accountability for system operational condition. Corporate engineering efforts to resolve the Reactor Building Closed Loop Cooling (RBCLC) heat exchanger tube vibration issue were comprehensive and effective. The use of contract engineering support was noted to be effective. Root cause analyses developed by both Niagara Mohawk and contract engineering personnel were generally good. The evolution of the work control center (WCC) provided an appropriate framework of work control and improvement of work efficiency. While work documentation packages were more informative, work efficiency was low in some cases. A "command center" approach to the 225 foot elevation of the radwaste building cleanup effort provided a controlled, deliberate and effective method of addressing problems encountered.

The team noted an overall attitude change in line with the standards of performance which have been developed by Niagara Mohawk. Positive acceptance of these standards of performance was noted in all the functional areas evaluated by the team. Specifically, improvement in the standards of performance were noted in the areas of procedural adherence, procedure quality, work control package quality, plant housekeeping, attention to industrial and radiation safety practices, communications and teamwork. Individuals interviewed by the team were generally aware of their position requirements and of the training required to support those requirements.

The team also concluded that Niagara Mohawk has continued to improve its performance in each of the functional areas evaluated during the inspection and

particularly in those functional areas which were rated Category 3 in the most recent SALP period which ended in February 1990. Acceptance and implementation of Niagara Mohawk's standards of performance has effected noticeable improvements in the operations, maintenance and surveillance, and safety assessment and quality verification areas. Operators were attentive and professional, and demonstrated their knowledge of plant status and their ability to identify plant problems. In the maintenance and surveillance area, improvement continued in the areas of procedures and procedural adherence, work control, work practices, and teamwork. The improving trend noted in the SALP assessment of the safety assessment and quality verification area has also been sustained. The team concluded that Niagara Mohawk's approach to controlling operations, maintenance, testing, and engineering activities was sound and reflected the systematic approach established in the Niagara Mohawk standards of performance.

In summary, the team concluded that an overall positive attitude change has been adopted consistent with the standards of performance described in Niagara Mohawk's Restart Action Plan. Acceptable performance was noted in all of the URC areas identified in the RAP and improved performance was noted in those functional areas rated Category 3 during the last SALP period. The team found the plant to be in an acceptable condition to support plant operation. With the exception of currently scheduled testing and startup preparation activities, the team found no impediments to the restart of Nine Mile Point Unit 1.

1.0 INTRODUCTION

1.1 Background

In December 1987, Nine Mile Point Unit 1 was shut down because of excessive vibration in the feedwater system. During the shutdown to repair damaged feedwater system pumps, valves, and pipe supports, NRC inspectors identified significant programmatic deficiencies in the inservice inspection program. In addition, after reviewing the methods used by Niagara Mohawk Power Corporation (Niagara Mohawk) to control the requalification training program for licensed operators at Unit 1, the staff issued a confirmatory action letter (CAL 88-13) on March 28, 1988. Subsequently, the NRC team reviewed licensed operator knowledge of emergency operating procedures (EOPs), and both the NRC staff and Niagara Mohawk identified additional technical and programmatic deficiencies. As a result of this review, the staff issued CAL 88-17 on July 24, 1988.

CAL 88-17 superseded CAL 88-13 and required Niagara Mohawk to determine and document its determination of the root causes for line management's ineffectiveness in recognizing and resolving problems. In addition, CAL 88-17 required Niagara Mohawk to develop and implement a Restart Action Plan and submit this plan to the NRC staff for review and approval. Also, CAL 88-17 required Niagara Mohawk to provide the NRC staff a written report of its readiness to restart NMP Unit 1 following a self-assessment of its progress.

Niagara Mohawk formed a special task force to prepare a comprehensive restart plan. The Restart Action Plan (RAP) was submitted to the NRC in accordance with CAL 88-17 on December 22, 1988. The plan identified five (5) underlying root causes (URCs) for management's lack of effectiveness and 18 specific technical issues. The URCs for previously identified management deficiencies, as defined in Section I.2 of Niagara Mohawk's Restart Action Plan are as follows:

URC No. 1 Planning and Goal Setting

"The management tasks of planning and goal setting have not kept pace with the changing needs of the Nuclear Division and with changes within the nuclear industry."

URC No. 2 Problem Solving

"The process of identifying and resolving issues before they become regulatory concerns was less than adequate in that there was not an integrated or consistent process used to identify, analyze, correct and assess problems in a timely way."

URC No. 3 Organizational Culture

"Management's technical focus has created organizational culture that diverts attention away from the needs and effective use of employees."

URC No. 4 Standards of Performance and Self-Assessment

"Standards of Performance have not been defined or described sufficiently for

effective assessment, and self-assessments have not been consistent or effective."

URC No. 5 Teamwork

"Lack of effective teamwork within the Nuclear Division and with support organizations is evidenced by lack of coordination, cooperation, and communication in carrying out responsibilities."

The RAP described the problems, their root causes, and the actions Niagara Mohawk planned to take to correct the problems. After consultation with the NRC staff, and two major revisions to the plan, Niagara Mohawk produced its RAP that the NRC staff approved in September 1989.

In August 1989, an NRC Augmented Inspection Team (AIT) evaluated the facts and safety implications associated with Niagara Mohawk's decision in July 1981 to use the radwaste building sub-basement (225 foot evaluation) as a liquid waste retention facility. This action had resulted in the inadvertent spilling of numerous radioactive waste storage barrels and caused widespread contamination with high dose rates. Attempts to decontaminate the sub-basement in 1981 and 1985 were discontinued due to the complexity and high potential for personnel exposure. In 1990, decontamination began using a specially developed robotic system.

On September 8, 1989, Niagara Mohawk submitted its Readiness for Restart Report (RRR) to the NRC. This report culminated Niagara Mohawk's extensive assessment of its Nuclear Division to determine the effectiveness of the implementation of the corrective actions outlined in the RAP. An NRC team reviewed the adequacy of this self-assessment during the week of September 25, 1989, and concluded that the self-assessment process was acceptable. Niagara Mohawk met with the NRC staff in the NRC Region I office on October 3, 1989, to discuss the readiness for restart. As a result of this meeting and the assessment team's findings, and in consultation with the Regional Administrator, William Russell, William Kane, Director, Division of Reactor Projects directed an NRC integrated assessment team to inspect NMP Unit 1.

An Integrated Assessment Team Inspection (IATI) was conducted October 4 through 6 and 10 through 20, 1989. While the team detected no fundamental flaws that would have indicated an inadequacy in the RAP, Niagara Mohawk's performance in the areas of problem solving (URC No. 2) and standards of performance and self-assessment (URC No. 4) was determined to be weak. Resident and region-based inspections since the October 1989 time frame have been focused on Niagara Mohawk's efforts to improve in these areas.

A Readiness Assessment Team Inspection was conducted April 30 through May 11, 1990. The focus of this team inspection was a performance-based evaluation of Niagara Mohawk efforts in the performance of tests, surveillances, and other startup preparation activities to determine the progress in resolving the remaining URC issues and overall readiness for restart. The team consisted of two inspectors during the week of April 30 - May 4, 1990 and seven inspectors during the week of May 7 - May 11, 1990.

1.2 Scope

The results of the IATI indicated that Niagara Mohawk was making progress in the resolution of the URCs of management deficiencies identified in the RAP but that the level of progress was not consistent in all areas. The scope of the RATI was to determine if Niagara Mohawk had improved its performance in the two URC areas which were determined to be weak by the IATI and also to determine if acceptable performance in the other URC areas had been sustained. Specifically, the URC areas in need of improvement were URC No. 2 - Problem Solving and URC No. 4 - Standards of Performance and Self-Assessment. The team assessed the effectiveness of Niagara Mohawk's performance in five functional areas: (1) plant operations; (2) radiological controls; (3) maintenance and surveillance; (4) engineering and technical support; and (5) safety assessment and quality verification. The team also evaluated the material condition of the plant and overall management readiness to support restart and operation of the unit.

1.3 Methodology

The focus of the inspection team was to determine the status of Niagara Mohawk's performance in the areas noted in Section 1.2 above through performance-based evaluations of day-to-day plant activities. The team assessed the performance of tests, surveillances, repairs and other startup preparation activities. As part of the observation of these activities, the team evaluated adherence to procedures and administrative controls, communications within and between departments, the quality of procedures and associated documentation used, the ability to identify and correct problems, attention to radiological and industrial safety, professionalism, and teamwork. Some backshift inspections were performed in order to assess pertinent activities. Also, the team interviewed a sample of employees representing all levels within the organization to assess the manner in which the plant organization operates as well as to assess each individual's knowledge of his/her responsibilities within the organization.

The team also evaluated trends in performance since the IATI in October 1989 and since the completion of the most recent Systematic Assessment of Licensee Performance (SALP) assessment period in February 1990.

2.0 SUMMARY OF RESULTS

2.1 Plant Operations

The team observed operator use of procedures and evaluated operator actions during several plant evolutions to assess the level and quality of procedural adherence, and the effectiveness with which operations department activities were controlled and operational problems were resolved.

The team determined operator performance during the inspection to be effective and professional. Operators demonstrated their ability to comply with established procedures and recognize problems. Operators were also knowledgeable of recent plant modifications and the effect of these changes on plant operation. The quality of communications and teamwork with other departments in the accomplishment of operations-related activities was good. Management oversight

of operations department activities was evident.

Although not solely an operations concern, the team identified a concern with regard to the control of instrument root valves. The team was concerned that the weak control of root valves could permit a root valve to be incorrectly positioned and to adversely affect the operation of a system. Niagara Mohawk agreed that root valves should be properly controlled and committed to review instrument drawings and to walk down instrumentation (other than local indication gauges) on safety-related systems to ensure that the root valves are properly positioned prior to restart. Niagara Mohawk stated that long-term corrective actions would be established to change P&IDs, valve lineup lists, and surveillance procedures, to label the root valves, and to address root valves not covered in the effort prior to restart.

2.2 Radiological Controls

The team observed ongoing radiation protection department activities during the inspection to obtain a status of the resolution of the URCs identified by the RAP and to assess department readiness to support startup and power operation. The most significant activity observed was the ongoing cleanup of the 225 foot elevation of the radwaste building. The cleanup effort was being accomplished cautiously and deliberately. An effective command center work concept was used to promote teamwork, planning and anticipation of problems.

The radiation protection department continually reinforced the need for procedural compliance and adherence to established radiation safety practices. The effectiveness of these efforts to improve performance have manifested themselves in a significant reduction of personnel contamination events.

2.3 Maintenance and Surveillance

The team observed the performance of surveillance tests, inservice tests, corrective maintenance, preventive maintenance and predictive maintenance on various plant systems and components in preparation for startup. The team also evaluated work control practices.

The team determined that Niagara Mohawk's performance in the maintenance and surveillance area has continued to improve since the IATI in October 1989 and since the end of the most recent SALP period in February 1990. The number of upgraded procedures has increased, and the overall quality and level of detail of the procedures has improved. A recently formed maintenance support group for the development of procedures has contributed to this improvement. Appropriate procedural precautions have been included to ensure that work will be stopped if the technician does not understand the procedure or feels that the procedure provides incorrect instructions. These procedural precautions were strictly adhered to by those technicians observed during the RATI.

The evolution of the work control center (WCC) concept for the planning and scheduling of work has contributed to the efficiency and effectiveness of maintenance work. Work package quality and work control have improved as a result.

2.4 Engineering and Technical Support

The team assessed the area of Engineering and Technical Support through the evaluation of both site and corporate engineering efforts in response to events which had occurred or activities which were already in progress at the time of the inspection.

The implementation of the onsite system engineering function has effected noticeable improvement in the quality of engineering support to site activities. This function has provided a convenient channel through which engineering support for site activities can be funneled. Niagara Mohawk has recognized the positive acceptance of the system engineering function and is undertaking efforts to ensure more effective and efficient use of corporate engineering functions to support the system engineers.
The team noted that the support provided by both onsite and corporate engineering for operational concerns was timely and effective. In particular, the team concluded that Niagara Mohawk had performed a comprehensive evaluation of the cause of failure of the Reactor Building Closed Loop Cooling (RBCLC) system heat exchanger tubes based on design analysis, vibration testing and root cause evaluation. Niagara Mohawk demonstrated appropriate use of consultant engineering help.

2.5 Safety Assessment and Quality Verification

The team concluded that the improving trend noted in safety assessment/quality verification functional area in the SALP report issued May 7, 1990, had continued.

The team perceived that Niagara Mohawk personnel demonstrated the ability to learn from experience. It appeared that their self-evaluations were sufficiently accurate to enable good corrective actions. The team judged that to further improve the assurance of quality of the work, Niagara Mohawk must demonstrate better ability to do the work correctly the first time. In some instances, Niagara Mohawk demonstrated the ability to identify problems but not the thoroughness to identify means to anticipate or prevent them.

2.6 Underlying Root Causes (URCs)

URC No. 1 Planning and Goal Setting
URC No. 3 Organizational Culture
URC No. 5 Teamwork

The IATI concluded that Niagara Mohawk had demonstrated satisfactory progress in these URCs. During the RATI, the team observed continued improvement in these URCs. Many positive observations by the team supported the continued improvement in these URCs, and there were no observations which contradicted this progress. For example, the team noted that better staffing in the work control center aided planning and goal setting, the more effective use of employees demonstrated an improved organizational culture, and the cooperation which existed between operations personnel, system engineers, and maintenance personnel demonstrated good teamwork.

URC No. 2 Problem Solving

The team concluded that Niagara Mohawk demonstrated satisfactory progress in URC 2 - Problem Solving. Engineering input to procedures and troubleshooting plans have effected improvements in these areas. Progress was noted in the effectiveness of system engineers, the appropriate use of outside help, and good root cause evaluations.

The system engineers were effective in enabling good identification and resolution of problems. The system engineers became involved in problems early in the process by being referred to personnel with technical issues via problem reports, following up on potential system interactions involving corrective maintenance on various components, or being summoned by operations or maintenance personnel to aid in ongoing problems. The system engineers facilitated better coordination of problems solving resources by interfacing between field personnel from different plant departments and other engineering groups. In addition, the use of troubleshooting plans, coordinated by system engineers, provided a more organized, better thought-out approach to problem solving.

Niagara Mohawk demonstrated appropriate use of contract engineering support. When in-house engineering expertise was available, plant personnel utilized corporate engineering resources to help resolve problems such as the battery charger MG set control problem. Corporate engineering personnel utilized an outside contractor for specialized hydraulic expertise on the RBCLC heat exchangers, and plant personnel utilized vendor representatives to resolve rod worth minimizer problems. In each of the examples, the team judged these approaches to be acceptable, in that the responsible Niagara Mohawk personnel retained responsibility for the problem and utilized the assistance of others to address that problem.

Niagara Mohawk demonstrated good root cause evaluation. The problem resolutions were technically conservative, and initial solutions were frequently correct. When initial solutions were implemented, thorough testing was used to establish whether the problem was resolved and if not resolved, additional solutions were evaluated. This was demonstrated in the evaluation of the RBCLC heat exchangers, drywell to torus leak rate test, control of instrument root valves, cleanup of radwaste building 225 foot elevation, the containment integrated leak rate test (CILRT) technical issues, and the reactor water cleanup (RWCU) system isolation.

URC No. 4 Standards of Performance and Self-Assessment

The team concluded that Niagara Mohawk demonstrated satisfactory progress in URC 4 - Standards of Performance/Self-assessment. This progress was most apparent regarding procedural adherence, oversight of field activities by supervision and management, more thorough approaches to maintenance and modifications, and emphasis on hearing protection.

The team found clear improvement in procedural adherence. The overall effort to upgrade the quality of procedures was evident, in that recently revised procedures were numerous, the revised procedures enabled better control of activities, and a procedure writer's guide was being used effectively. During interviews and work activities, workers demonstrated a good understanding of the

expectations that work will be controlled by procedures and that the procedures will be adhered to or corrected. The workers demonstrated good ability to self-assess whether the procedures met the expected standard. The numerous temporary change notices in the procedures provided evidence of corrections that had been made to the procedures during prior use to enable the procedures to be correct.

The team observed good oversight of field activities by supervision and management. This oversight provided the immediate reinforcement of the standards of performance, the resolution of any concerns, and better self-assessment of the work.

A more thorough approach to the control of maintenance and modifications was apparent. Specifically, the work in progress (WIP) form had been recently implemented to provide a better plant impact assessment of maintenance and testing activities, and planned post-maintenance testing prior to releasing the work to begin. Also, an improved approach to close out modifications, in terms of changes to drawings, procedures, and training, had been initiated.

The team noted good implementation of industrial safety practices, particularly hearing protection. It was apparent that Niagara Mohawk had emphasized the expectations for proper hearing protection for plant personnel and that the personnel had understood and complied with these expectations.

2.7 Concerns

The team noted the following concerns which did not necessarily correlate with either the functional area or URC evaluations. The team noted slow schedule progress on some activities. This appeared to result in part from the conservative, "do it right the first time" approach instilled by the Restart Action Plan (RAP), and as such it represented good evidence of Niagara Mohawk's revised approach to assuring the quality of activities. However, the slow progress also appeared to result from weak coordination of schedules and resources, such as field activities limited by insufficient operators to perform tagging and problems with parts availability. The team judged that Niagara Mohawk could benefit from a reassessment of coordination problems.

The team concluded that it was important for Niagara Mohawk to reduce the need for temporary changes to procedures. The team noted that field activities were disrupted by procedure changes to correct procedural errors and to better account for existing plant conditions. These disruptions not only interrupted the personnel needed to review the changes, but also prolonged and distorted plant conditions established for maintenance and testing. The team judged that Niagara Mohawk could do a better job of providing quality procedures for field use.

3.0 DETAILS OF INSPECTION

3.1 Plant Operations

During the inspection, the team observed operator use of procedures and evaluated operator actions during several plant evolutions. The emphasis of the inspection in this functional area was to assess the level and quality of procedural adherence and the effectiveness with which operations department activities were

performed and operational problems were resolved. In addition, the team performed several system walkdowns to determine operational status and assessed the process for notifying the operations department of plant modifications and operator knowledge of the status of selected modifications.

The team observed and evaluated the hydrostatic testing of the core spray system and found the testing to be acceptable. Initially, manpower restraints hindered the performance of the activity due to delays in the tagging of equipment. Once tagging was completed, the test was performed effectively, safely, and in compliance with procedures.

The team reviewed the followup to an incident on May 8, 1990 which involved an isolation of the reactor water cleanup (RWCU) system. System isolation occurred when non-regenerative heat exchanger inlet temperature reached 131 degrees F. Existing operating procedures indicated that an isolation of this nature would occur at 140 degrees F. The control room operators were initially puzzled with regard to the reason for the system isolation because of the temperature difference between the isolation setpoint given in the operating procedure for the RWCU system (less than 140 degrees F) and the temperature of the reactor coolant at the time of the isolation (131 degrees F). The system engineer responsible for the RWCU system reported to the control room within minutes of the isolation. Within approximately 8 hours, system engineering had submitted a package to the operations department which clarified the reason for the temperature difference between the actual reactor coolant temperature and the isolation setpoint and proposed a resolution to the problem. The RWCU system engineer determined the isolation temperature specification to be 133 degrees F $\pm$ 2 degrees F. The proposed resolution package included a comprehensive list of documents which would need to be revised in order to reflect the appropriate value for the isolation setpoint. The team concluded that the proposed revisions represented a good example of problem solving capability. While this non-routine incident had low safety significance, it provided positive indication of Niagara Mohawk's ability to recognize a problem and coordinate various administrative and technical support groups to resolve a problem for licensed operators in the control room.

While verifying the operability of the rod worth minimizer (RWM) in accordance with procedure N1-ST-V3, RWM Operability Test, the operations staff identified a computer program deficiency. The RWM program deficiency involved the undesirable insertion of rod blocks while the RWM was performing miscellaneous functions (i.e. typer print commands). A modification to the RWM had been accomplished in 1988 (Modification N1-86-57) to provide annunciation in the control room as well as control rod insert/withdrawal blocks when a RWM program failure occurs. Because of plant conditions, the post-modification testing for this change had just recently been accomplished, but was not designed to detect the type of program deficiency identified by procedure N1-ST-V3.

Having identified the RWM problem, the computer department initiated a Work Request (WR #181487) to troubleshoot and correct the program deficiency. The team reviewed and observed the execution of the troubleshooting plan after discussions with the Unit 1 computer/maintenance supervisor. Computer engineers and technicians followed the troubleshooting plan closely and demonstrated good overall procedural adherence during verification testing. Some additional RWM

hardware deficiencies were identified while completing the necessary program change verification testing and were appropriately resolved by the computer staff. The inspectors noted good supervisory oversight and good cooperation between the operations and computer department personnel.

The team walked down portions of the containment spray system, the liquid poison system, and the diesel generator cooling water system using valve lineup lists in the operating procedures and the piping and instrument drawings (P&IDs). The team concluded that these systems were in good condition and the valves were correctly positioned. The team found no inaccuracies on the P&IDs. The team had the following concerns with regard to the system walkdowns.

1. The root valves for instrumentation (the first valve on the instrument line from the process piping) were not controlled. In some cases, the root valves were shown on the P&ID, labelled, and listed on the lineup list. However, in other instances the valves were not shown, labeled, or listed. Based on discussions with operations and I&C department management, it was apparent that there was no consistent policy on the control of root valves. Some root valves were controlled by operations, some root valves were controlled by I&C, and other root valves were not controlled at all.

   The team found no instances of root valves being improperly positioned. Nonetheless, the team was concerned that the weak control of root valves could permit a root valve to be incorrectly positioned and to adversely affect the operation of a system. Niagara Mohawk agreed that root valves should be controlled and committed to review instrument drawings and to walk down instrumentation (other than local indication gauges) on safety-related systems to ensure that the root valves are properly positioned prior to restart. Niagara Mohawk stated that long-term corrective actions would be established to change P&IDs, valve lineup lists, and surveillance procedures, to label the root valves, and to address root valves not covered in the effort prior to restart. This is an unresolved item (50-220/90-80-01).

2. The valve lineup list for the containment spray system contained numerous, obvious errors due to a recent revision of the lineup list. Specifically, the team used a lineup list that had been approved days before and had not been used in the field by Niagara Mohawk personnel. The normal position listed for some valves had obvious errors, such as a check valve listed as locked closed, a vent valve listed as locked open, and a drain valve without an indicated position. All valves affected by such errors were correctly positioned. Niagara Mohawk stated that the lineup list had been retyped during the previous revision to enable a vertical alignment on the page and that the errors had not been found during procedure review. Niagara Mohawk stated that in recent months some valve lineup lists had been retyped and committed to review all such retyped revisions to ensure no other such errors existed. The team judged this corrective action to be appropriate.

   During the walkdown of the liquid poison system, the team noted that three obvious errors had existed in the lineup list due to similar retyping, and that the errors had been identified when a valve lineup was performed on

March 25, 1990 and had been corrected by a temporary change notice (TCN). Based on this the team concluded that the operators performing the valve lineup had capably identified the problem and had used the appropriate method to correct the problem. However, the team concluded that Niagara Mohawk should have done a better job of proofreading the procedure revisions during the review process to prevent issuing procedures with errors.

The team also audited several recent plant modifications for adherence to established procedural and administrative controls in their implementation and documentation. The results of this review revealed that acceptable procedures are in place for control of the plant modification process and provisions have been made for timely training of the licensed operator staff with regard to the effect of implemented modifications.

Specifically, during the containment spray system walkdown, the team noted that Modification M00813 had been made within the previous month to open two valves and remove their operators on a test line, interconnecting the primary and secondary spray loops. The team noted that the revised valve positions were correct on the lineup list. Further, in the control room, the modified configuration was properly shown on a red-lined P&ID, the disconnected controls were tagged, and the shift supervisor knew of the modification and its operational impact based on training. The team verified that all five shifts of licensed operators had received or would soon receive training on potential operational changes that resulted from the modification. The team concluded that the followup on this modification was good.

During inspection tours of the reactor and turbine buildings, the team noted very good implementation of industrial safety, particularly hearing protection. The team observed that the workers in these areas consistently used hearing protection in designated areas and that hearing protection signs were numerous and prominently displayed. It was apparent to the team that Niagara Mohawk had emphasized the expectations for proper hearing protection for all plant personnel and that the personnel understood and complied with these expectations.

Overall, the team determined operator performance during the inspection to be effective and professional. The quality of communications and teamwork with other departments in the accomplishment of operations-related activities was good. Management oversight of operations department activities was evident.

Underlying Root Causes

(1) Planning and Goal Setting
(3) Organizational Culture
(5) Teamwork

Performance in these URC areas has been sustained since the IATI in October 1989 in the operations area. The appointment of a permanent operations planner (this was formerly a rotational position filled by Senior Shift Supervisors) has contributed to the effectiveness of the Nine Mile Point 1 work planning process. Also, an assistant supervisor has been assigned as a training liaison to assure that operations department training requirements are maintained.

Teamwork was noted within the operations department and in the communications with other departments during the inspection. The operations staff clearly retained overall responsibility for plant equipment but cooperated with other plant department personnel to support maintenance and testing activities.

(2) Problem Solving

The team concluded from the activities observed during the inspection that the control room operators were cognizant of current plant conditions and capable of determining when conditions become off-normal. Operator response to the RWCU isolation incident was indicative of a quick response to an off-normal plant condition. System engineering was quickly brought in to support the resolution of the problem, and the problem was resolved in a timely manner.

The control room operators quickly recognized an off-normal condition related to the rod worth minimizer and were provided with effective assistance from computer/maintenance department staff.

(4) Standards of Performance and Self-Assessment

Operations department personnel were familiar with the recently adopted Niagara Mohawk standards of performance and appeared to have generally adopted them as part of day-to-day operations. Operators were aware of training requirements and the standards used to evaluate their performance.

3.2 Radiological Controls

The team observed ongoing radiation protection department activities during the inspection to obtain a status of the resolution of the URCs identified by the RAP and to assess department readiness to support startup and power operation. The most significant activity observed was the ongoing cleanup of the 225 foot elevation of the radwaste building.

Both the performance-based evaluations done during this inspection and the results of recent inspections of the NMP Unit 1 radiation protection program have indicated an overall improving trend in performance. It was noted in a recent inspection that formally scheduled plant tours and records reviews by all levels within the radiation protection organization have contributed to thorough and aggressive identification of problems. Additional trending and root cause analysis of problems identified during these reviews is facilitating effective corrective action. Other proposed actions, such as introduction of computerized records for personnel exposures and routine radiation survey data, new in-plant continuous air monitors (CAM), and a surrogate plant tour system using laser disc technology are planned for completion later in 1990.

The cleanup and recovery of the 225 foot elevation (sub-basement) of the radwaste building was in progress. As discussed in Section 1.1, the contamination had occurred in 1981 when numerous waste storage barrels spilled due to the use of the sub-basement as a liquid waste retention facility. This project presented significant radiological challenges due to very high dose rates and contamination levels. Niagara Mohawk's approach to the project was conservative, and the effective implementation of program controls has maintained an adequate level

of progress. Daily start-of-job meetings were used to discuss problems such as air line failures, current job status, personnel exposure status, and the work plan for the day. A "command center" approach was used to control the work. All personnel, including supervisors, technicians and workers wore communications headsets at all times. The supervisors directed and coordinated work from the command center while monitoring the area via six closed circuit television cameras. As work progressed, the team noted constructive exchanges of ideas between workers and supervisors on ways to approach upcoming portions of the cleanup. Personnel exposures for the job were at about one-third of the initial projections, due in part to the effective command and control of activities.

The team also noted Niagara Mohawk's recent identification of an adverse trend in personnel contamination events. The radiation protection department focused attention in this area through increased plant decontamination efforts and emphasis on adherence to established work practices. These efforts effected a significant reduction in contamination events.

The team noted that all radiation protection procedures were being reviewed and revised as necessary to improve their clarity, effectiveness, and application. This effort was scheduled for completion in 1991. For those procedures which have already been revised, radiation protection department management has insisted on verbatim compliance by all personnel in line with Niagara Mohawk's prescribed standards of performance.

Prior to the replacement of an Intermediate Range Monitor (IRM) by I&C personnel, an excellent job preparatory meeting was held. The meeting was attended by supervisors and technicians from both the radiation protection and I&C departments. Coordination of activities was discussed in detail. The team noted that the I&C procedure for this job had been recently rewritten to relocate personnel during the cable pulling phase to a location other than the CRD bridge as an exposure reduction measure. In addition, steps were added to the procedure to notify the reactor physics department of the movement of the IRM since it is classified as special nuclear material. These efforts were indicative of good teamwork between radiation protection and other plant departments.

In the planning area, the team noted the adoption by the radiation protection department of a special startup radiation survey program. This program was developed in anticipation of plant startup after the current outage and the potential radiological changes which may result from plant modifications which have been made. This program was based on the techniques and lessons learned during shielding verification on NMP Unit 2 during startup. The original NMP Unit 1 startup data from many years ago, although not as detailed, will be used to detect changes. Radiation protection technicians will be briefed on the techniques prior to NMP Unit 1 startup.

However, the team noted some difficulties in the planning area during the IRM replacement. Because of potential problems with other reactor protective system testing, the I&C technicians were told to delay the start of the IRM replacement. This information was not relayed to the radiation protection personnel involved, who proceeded with their work preparations in accordance with the original work schedule. As a consequence, the radiation protection technician who covered the job waited in the controlled area of the drywell for the job to begin, causing

unnecessary, however minimal radiation exposure.

Overall, the team noted improvement in the radiation protection area as a result of the RAP initiatives. Progress in the radwaste building 225 foot elevation cleanup effort has been very good.

Underlying Root Causes

(1) Planning and Goal Setting
(3) Organizational Culture
(5) Teamwork

Radiation protection department performance in these URC areas has been sustained at an acceptable level since the IATI in October 1989. A special startup radiation survey program was adopted which is intended to preclude problems which may be encountered as a result of the potential radiological changes from plant modifications. The command center approach to cleanup work in the 225 foot elevation of the radwaste building provided a vehicle for effective planning of upcoming cleanup efforts.

Except for an isolated instance of miscommunication during the replacement of an IRM, teamwork and communications within the radiation protection department, and between radiation protection and other plant departments were good.

(2) Problem Solving

The formal scheduling of plant radiation protection tours and enhanced trending and root cause analysis efforts were indicative of improvements in the problem solving area. The command center approach to the radwaste building cleanup effort provided a controlled, deliberate and effective method of addressing problems encountered.

(4) Standards of Performance and Self-Assessment

Overall, the Niagara Mohawk standards of performance appeared to have been accepted by the radiation protection department staff and were being routinely applied. The attention of other plant personnel to radiation safety practices was also indicative of the successful implementation of the standards of performance.

Improvement was particularly noteworthy in the area of procedural adherence. Adherence to radiation protection procedures and established work practices improved the effectiveness and efficiency of work performed and significantly reduced the number of personnel contamination events. All radiation protection procedures are currently being reviewed and revised as necessary to improve their clarity, effectiveness, and application.

3.3 Maintenance and Surveillance

The team observed the performance of surveillance tests, inservice tests, corrective maintenance, preventive maintenance and predictive maintenance on various plant systems and components in preparation for startup. The team

analyzed Niagara Mohawk's effectiveness in developing work packages, planning and scheduling work, performing the activity, and documenting activity results. The team reviewed the documentation related to the scheduling, performance, and recording of activity results for quality and compliance with station administrative guidelines and Technical Specifications. The team also interviewed several employees at all levels from each of the three maintenance department groups (mechanical maintenance, electrical maintenance, and instrumentation and controls (I&C) maintenance) to determine their knowledge and acceptance of changes made in response to the RAP.

Overall, the team determined that Niagara Mohawk's performance in the maintenance and surveillance area has continued to improve since the IATI in October 1989 and since the end of the most recent SALP period in February 1990. The number of revised procedures has increased, and the quality and level of detail of the procedures has improved. A recently formed maintenance support group for the development of procedures has contributed to this improvement. Appropriate procedural precautions have been included to ensure that work will be stopped if the technician does not understand the procedure or feels that the procedure provides incorrect instructions. These procedural precautions were strictly adhered to by those technicians observed during the RATI.

The team determined the work practices observed to be proper. The technicians performed the work cautiously and methodically, verifying their understanding of each procedural step before proceeding. Appropriate steps were taken to effect temporary procedure changes when difficulties were encountered. In one instance, the team noted that the torus level functional test was suspended when the technicians judged that the procedure steps could not be adhered to. Specifically, the procedure was written with the assumption that the torus level was within the normal range. However, when the test was begun, the actual torus level was slightly above the normal range due to a high water inventory within the plant, and the high level alarm was actuated. Accordingly, the technicians demonstrated the appropriate action when confronted with the problem. As the test method involved inserting a level signal into the channel, it appeared to the team that the procedure could have been written such that the actual torus level did not impact the test. Based on this, the team concluded that Niagara Mohawk's standards of performance for procedural adherence had been effectively communicated to personnel and that the personnel understood and accepted these standards. In addition, testing personnel appeared to be doing a good job of assessing their own work and the guidance provided to them with which to do it. However, based on the numerous previous TCNs and the suspended torus level test, the team concluded that Niagara Mohawk needed to do a better job of revising procedures to prevent unnecessary challenges to the testing process.

Good teamwork was noted within the work crews as well as between the work crews and other departments (operations, engineering, radiological protection, quality assurance). In particular, maintenance support for activities which were overseen by engineering such as the containment integrated leak rate test (see Section 3.4.3 for details), and the drywell to torus leak rate test (see Section 3.4.4 for details) was good. The control of disassembled equipment parts during maintenance activities was also noted to be good. This was attributed to the recent adoption of a formalized "bag and tag" parts control process.

Management personnel were observed providing oversight of field activities and contributing to the resolution of any testing or equipment concerns. The recently developed standards of performance were verbally reinforced by management both in the field and in daily meetings with the technicians. Daily meetings were noted to be constructive and professional with constructive criticism being freely solicited by management.

The evolution of the work control center (WCC) concept for the planning and scheduling of work has contributed to the efficiency and effectiveness of maintenance work. The WCC is a centralized planning group whose staff is composed of individuals from all disciplines that accomplish work within the plant. There are WCC staff groups which represent each of the three maintenance department groups. The members of these WCC staff groups are in continuous contact with their respective maintenance department group. The centralized nature of the WCC promotes communication between plant departments at all stages of the planning process and provides an opportunity to eliminate work scheduling and technical conflicts early in the process, i.e., before these conflicts are encountered in the field.

The WCC initially generates a work package which contains documentation pertinent to the scheduled activity. These work packages have become more informative in the recent past. The work packages included some or all of the following documents: work request, copy of field deficiency tag, work in progress data sheet, radiation work permit, system and/or component drawing, equipment location drawing, material issue sheet (parts request), staging checklist (needed parts, references, support (security, fire protection,...)), markup request (equipment tagging), troubleshooting plan, and plant impact statements (provided by operations). After generation of the initial work package, the requested markups (tags) must be verified and hung by operations prior to the commencement of work.

While the development of the WCC appeared to have provided an acceptable process for the planning and scheduling of work, the team observed that work performed during the week of the inspection was not accomplished as efficiently as it could have been. Some of the delays were attributed to the increased number of new and revised procedures, and the cautious and methodical manner in which procedures are being implemented during startup preparations. However, some of the delays were due to less than effective coordination of certain portions of the activity preparation process. Potential weaknesses were the coordination of planned activities with the availability of personnel for tagging efforts, parts availability, and turnaround time of Design Change Request (DCR) packages from engineering. Niagara Mohawk acknowledged that the planning process was still developing and the improvement of efficiency was needed. Recently, a permanent staff position for operations planning (formerly, this had been a rotational assignment for Senior Shift Supervisors) was assigned and generation specialists (for scheduling of surveillances, preventive maintenance, and other special work) were added to the staffs of the individual maintenance planning disciplines in an effort to improve efficiency. This appeared to be an appropriate response to resolve the problem.

The team interviewed both management and working level personnel to determine their participation in and knowledge of department training requirements. Structured, progressive training was offered to support upward movement within

the maintenance organization. Training courses were offered beyond the courses required for full technician certification to provide for continuing training in pertinent technical and administrative areas. The maintenance department staff members who were interviewed complimented the training program, primarily due to the large amount of hands-on activities which are included. Maintenance supervision is responsible for ensuring that work crews have received the appropriate training to perform a particular job and that staff members are provided with the opportunity to receive training which will permit them to perform additional tasks as well as to progress through the technician certification process.

Attention to procedural adherence contributed to the effective performance of surveillances. The matrix for tracking and scheduling Technical Specification required surveillances had been completed. The development of this matrix was a RAP commitment. Also, final evaluation of the results of Niagara Mohawk's review of all surveillance procedures was near completion (this was a part of the Technical Specification surveillance matrix commitment). In response to a recently noted SALP concern, Niagara Mohawk committed to ensure acceptable calibration for all safety-related and Technical Specification required instrumentation prior to startup.

Underlying Root Causes

(1) Planning and Goal Setting
(3) Organizational Culture
(5) Teamwork

Performance in these URC areas continued to improve. While improvements in planning and scheduling efficiency could still be accomplished, the planning process has developed to a point where an appropriate framework has been provided to promote improvements in efficiency. In the area of organizational culture, the team noted an obvious attitude change throughout the maintenance department in line with the newly implemented standards of performance. Maintenance department supervision continued to verbally reinforce the standards of performance.

Good teamwork was noted in field activities, intradepartmental discussions, and interdepartmental communications.

(2) Problem Solving

The more informative nature of work packages provided work crews with more reference information to address problems encountered during field work.

The maintenance department developed preventive maintenance programs as a result of assessments of work performed in the past few years. Preventive maintenance for the control rod drive hydraulic control units, the reactor building and turbine building supply and exhaust fans, diesel generator air compressors, and the screenhouse revolving screens are some of the programs which have resulted from these assessments.

Also, inspection team assessments of the physical condition of the plant

indicated that maintenance, as well as other plant departments responsible for plant physical condition, have accepted a higher standard of equipment condition and that overall plant upkeep has improved from the past. Recent efforts to improve system and valve labeling have contributed to work effectiveness.

(4) Standards of Performance and Self-Assessment

Maintenance department personnel were aware of the Niagara Mohawk standards of performance and appeared to have accepted them as part of daily activities. The enhanced awareness of procedural adherence contributed to personnel performance in many of the specifically noted standards (i.e, communications, teamwork, accountability, problem identification and resolution, plant and industrial safety, and quality). The administrative procedures for maintenance programs as well as the maintenance instructions which describe the programs have improved.

Awareness of procedural adherence has significantly increased and a questioning attitude has been fostered. Technicians were knowledgeable of the temporary change notice (TCN) process for resolving procedural deficiencies and used the process appropriately to resolve procedural concerns during the inspection.

Communications within the maintenance department were good as were communications between maintenance and other plant departments. Interviews with working level personnel indicated management's reinforcement of the standards of performance had contributed to the acceptance of stated goals and objectives.

The evolution of the work control center planning process has relieved maintenance line supervisors of a significant amount of work that had previously been their exclusive responsibility (work request evaluation and initial work staging efforts). This allowed more time for self-assessment efforts and on-the-job evaluations (OJE) of staff performance.

3.4 Engineering and Technical Support

The team assessed the area of Engineering and Technical Support through the evaluation of both site and corporate engineering efforts in response to events which had occurred or activities which were already in progress at the time of the inspection. In particular, the following activities was evaluated:

1. Reactor building closed loop cooling (RBCLC) heat exchangers.

2. Battery charger motor generator control problems.

3. Containment integrated leak rate test.

4. Drywell to torus leak rate test.

5. Power ascension testing program procedures.

An assessment of the contribution of the onsite system engineering group was also performed.

3.4.1 RBCLC Heat Exchangers

Niagara Mohawk had experienced significant flow induced vibration and failures of tubes in the RBCLC heat exchangers. Since the heat exchangers are an important feature providing cooling for major components in the NMP Unit 1 reactor, turbine, and waste disposal buildings, the team examined the engineering resources and procedures applied to resolve the tube failures. Particular attention was given to evaluating Niagara Mohawk engineering staff performance in the areas of problem solving and self-assessment of engineering efforts.

The RBCLC system provides demineralized water to cool auxiliary equipment in the reactor, turbine, and waste disposal buildings. The closed loop permits isolation of systems containing radioactive liquids from the service water system. The system includes three horizontal centrifugal pumps rated at 4500 gpm and 65 psi each, and three counterflow shell and tube heat exchangers with a total heat removal capability of 126 million Btu/hr with a flow of 8500 gpm. The heat exchangers are constructed of stainless steel tubes and tubesheets within a carbon steel shell and headers. The tube side is provided with cooling water from the service water system (lake water). The shell side RBCLC coolant is provided with makeup from a 2000 gallon tank.

On February 7, 1990, during the performance of an RBCLC pump and valve operability test, RBCLC pump No. 12 was inadvertently started while RBCLC pump No. 13 and RBCLC heat exchanger No. 13 were in operation. This resulted in a flow through RBCLC heat exchanger No. 13 of approximately 8000 gpm. Initial evaluation of this incident revealed tube failures in heat exchanger No. 13. The apparent cause of the failure was flow induced vibration.

Initial evaluation of the damaged heat exchanger No. 13 was conducted in March, 1990. Eddy current testing and visual inspection revealed several damaged tubes and extensive internal tube support damage. Several tubes had fractures at the tube sheet at the heat exchanger discharge side and several others had significant bending deformation in the direction of the outlet flow. Nineteen (19) tubes showed evidence of wall thinning, and 2 internal tube supports were found to be damaged.

Examination of heat exchanger No. 12 showed signs of problems similar to those of heat exchanger No. 13. Eddy current testing revealed 19 tubes near the discharge nozzle with 61% to 80% wall thinning. Visual examination revealed damage to the first three inadequately supported tubes which were plugged and the unit was returned to service at reduced shell side flows. Subsequent eddy current testing on heat exchanger No. 11 revealed similar damage to that of heat exchanger No. 12, but to a lesser degree.

The present heat exchangers were replacements of the original heat exchangers for the RBCLC system. The original heat exchangers were of shell and tube sheet design with carbon steel shells and Admiralty Metal tubes and tube sheets. Cracking of the bimetallic welds between the steel shells and Admiralty Metal tube sheets necessitated replacement. The replacement units are similar in heat transfer design except that the shell material is carbon steel, and the tube and tubesheet material is stainless steel. The tube supports are an egg crate design, providing reduced pressure drop through the shell side in comparison with

that of the original design which had an articulated, conventional tube support plate system. The new tube support design utilized a grid design (tweeners) that allowed parallel shell side flow for most of the length of the tubes by passing through the tube support grids. Water flows through a ninety degree turn upon entering the tube region (the inlet) and a ninety degree turn at the discharge. Thus there is a crossflow in the shell side inlet and discharge nozzle regions.

Niagara Mohawk's actions in dealing with the RBCLC heat exchangers took place in two phases. The first phase dealt with the replacement of the previous heat exchangers from 1986 to 1988. The second phase dealt with response to the current tube degradations. The first phase occurred prior to the implementation of any aspects of the RAP, whereas the second phase occurred in an environment influenced by the RAP initiatives.

Discussions with personnel involved in the initial design process prior to 1988 indicated that selection of the design considered input from multiple sources, such as mechanical and structural engineering, modifications engineering and maintenance representatives. The tube vibration issue was addressed by Niagara Mohawk and documented by the heat exchanger designer. Niagara Mohawk verified that industry accepted standards were used by the designer. In addition, an independent group within Niagara Mohawk performed a design verification. Niagara Mohawk personnel indicated that the design verification effort did result in improvements in such areas as the maintenance of the temperature control valve linkage. At the completion of design verification, it was Niagara Mohawk's understanding that the heat exchanger was capable of flows from 8000 to 9000 gpm without tube vibration problems. Although the design/design verification process probed the tube vibration characteristics of the heat exchangers in several aspects, it did not appear to have involved independent outside expertise, independent calculation and analysis, or confirmatory testing. In retrospect, due to an apparent design deficiency by the contracted design organization, the heat exchangers needed to have flow restricted to the 3000 gpm range or lower in order to avoid tube vibration problems at the shell inlet and discharge regions. Without recognition of this limitation, action was not taken to modify the system operating procedure to reduce flow rates accordingly. These events involving the design and implementation of the heat exchangers were completed prior to the implementation of the RAP.

Niagara Mohawk's actions upon recognition of the tube failure in February 1990 were prompt and broad based. The onsite system engineering group appears to have interfaced well with the corporate nuclear engineering and licensing department (NELD) mechanical engineering group. The fabricator and the designer for the heat exchanger was brought in, and NELD personnel visited the site for direct examination of the heat exchangers. Niagara Mohawk concluded that certain required analytical expertise was not available within the company and arranged to provide this expertise. The results of the independent analysis determined that the critical flow velocities for flow induced tube vibration in the heat exchangers would be much lower than previously recognized (in the 2500-3000 gpm range).

Corrective actions were documented on nonconformance reports (NCRs) and work requests. Niagara Mohawk modified the NCRs as needed to reflect evolving corrective action plans. The corrective actions on heat exchanger No. 13

observed by the team were eddy current testing and visual examinations, removal and cutting back to an intact tube support grid of all damaged or unsupported tubes, plugging of the tubesheet as required, and verification testing by accelerometer measurement of tube vibration during a flow test and by hydrostatic test. These corrective actions appeared to be appropriately developed and implemented. Niagara Mohawk was continuing with further modification and verification activities on the other heat exchangers at the conclusion of the inspection.

The team evaluated the root cause assessment activities related to this issue. A consultant had been engaged by NELD to perform analysis of the minimum flow requirements with regard to the potential for flow induced vibration of tubes. A portion of this effort which was to include loose parts analyses had not been completed at the time of the inspection. The team determined these root cause analysis efforts to be appropriate and in accordance with established procedures.

The onsite system engineering group performed a root cause analysis on the human performance aspects of site group actions on the tube failures. The team found this analysis, although still in draft form, to provide a good assessment of the contributing technical factors to the tube failures and the interrelationships of these factors. The primary factors were the lower than recognized design flow capability of the heat exchanger, a two pump-one heat exchanger alignment mode of operation and the pinning of the temperature control valve in a fixed position such that it directed all flow to the heat exchanger and none to bypass. This root cause analysis was sufficiently thorough and technically detailed but did not examine the process by which system design limits are communicated to the site and reflected in appropriate site documents for operating equipment. Niagara Mohawk should evaluate whether this process needs to be strengthened. As related to the RBCLC heat exchangers, system engineering has addressed this with a modification to operating procedure N1-OP-11 to require a minimum of one heat exchanger for each RBCLC pump in operation.

The inspectors met with the Vice President of Nuclear Engineering and Licensing and discussed the lessons learned from the circumstances surrounding the RBCLC tube failures. It was stated that NELD recognized that there needed to be more engineering design involvement in the early stages of tasks such as the design and replacement of the heat exchangers and that issue ownership needed to be better defined. The Vice President - NELD issued a document which recognizes this problem. The document provided guidance for improving the understanding of the respective roles of NELD and the corporate nuclear generation department (provides project engineering functions) and proposed the development of a task force to improve the understanding of the ownership of problems. The team regarded this as a positive contribution to self-assessment capability.

The team inquired as to the ability of current resources to provide for effective engineering performance. The Vice President - NELD responded that the present engineering staff is somewhat overburdened. However, the VP-NELD also stated that he believed that the current workload situation was temporary and was primarily a result of the volume of startup preparation activities. The current workload of engineering issues is being prioritized by Niagara Mohawk and consultant engineering personnel are being used as necessary for support.

The team concluded that Niagara Mohawk performed a comprehensive evaluation of the cause of failure of the RBCLC system heat exchanger tubes based on design analysis, vibration testing and root cause evaluation. The failure was determined to be the result of a design calculation error which led to an insufficiently rigid tube support system. This caused destructive fluidelastic vibration of the tubes at shell side flows within the operating flow range of the heat exchangers. The utilization of an experienced consulting firm to provide analytic, testing and root cause analysis of the heat exchanger failure was seen as an effective way to resolve the design deficiencies. The team determined the problem solving approach to be expeditious, well coordinated, and founded on adequate technical knowledge. The available root cause analysis information was detailed with regard to the specifics of the RBCLC heat exchanger issue but could have provided more insight into changes which could be made to the design change implementation process to preclude future similar occurrences.

At the end of the inspection, Niagara Mohawk and its consultants were considering near and long-term solutions to repair the damaged heat exchangers and specify operational procedures for the RBCLC system such that future operation of the system will not result in tube vibratory failure.

The team found procedures in place which provided for engineering design review with regard to a wide range of operational activities, including procurement of new equipment and modification of old equipment.

Corporate management began active implementation of policies and programs to promote continued development of an effective engineering organization which will result in improved problem solving capabilities and additional engineering expertise.

3.4.2 Battery Charger Motor Generator Problems

Earlier in 1990, emergency core cooling system actuation logic testing identified voltage oscillations when battery charger motor generator (MG) set 171 was supplying battery board No. 12, particularly when operated in parallel with other MG sets. Initial troubleshooting identified what appeared to be minor voltage regulator adjustment problems. Subsequent post-maintenance testing confirmed adequate resolution of all MG set voltage regulator concerns except MG set 171, which continued to demonstrate erratic behavior.

Because of the age of the motor generator sets and their previous non-safety related status (addressed in the Niagara Mohawk Unit 1 Restart Action Plan, Specific Issue 12), non-safety-related replacement DC speed/voltage regulators had to be purchased and then dedicated for safety-related use. A replacement voltage regulator and transfer kit circuit board were purchased and installed on MG set 171 under the governing troubleshooting work request (WR #179702).

The team witnessed the post-installation testing and initial run-in of these components conducted in accordance with the work request troubleshooting plan and the applicable motor generator set operating procedure N1-OP-48. The team discussed the MG set concerns, troubleshooting and long-term replacement schedule with the system engineer and responsible corporate engineers.

The team concluded that the approach to resolving the MG set 171 voltage regulator problem was methodical and carefully executed. The process of systematically eliminating potentially faulty components and following a detailed troubleshooting plan appeared to be a sound approach to problem identification and resolution for this issue. The system engineer was knowledgeable and thorough. He received good cooperation from the operations and maintenance staff in coordinating testing and monitoring the MG set performance. Discussions with the responsible corporate engineer identified a detailed plan for continued monitoring and evaluation to enhance MG set availability and reliability, and for the eventual replacement of the MG sets with inverters and uninterrupible power supplies.

3.4.3 Containment Integrated Leak Rate Test

Niagara Mohawk performed a successful Containment Integrated Leak Rate Test (CILRT) during the inspection. This is a large-scale test which calls for the coordination and cooperation of several different site departments. The test was performed efficiently and competently. Some delays were noted however, in the alignment and tagging of containment penetration configurations for the test and post-test return of those penetrations to normal service. Details of the test performance are provided below.

A CILRT of the Nine Mile Point Unit 1 containment was performed from May 3 through May 5, 1990 in accordance with Procedure N1-TSP201-001, Rev. 01, Integrated Leak Rate Test of Primary Containment. The team reviewed the test procedure and related test documentation and observed preparations for and performance of the test to determine if the test was being performed appropriately and in compliance with the Technical Specifications and 10 CFR 50, Appendix J. The test was performed at a reduced test pressure of 22 psig or greater (actual test pressure was 23.1 psig) in accordance with 10 CFR 50, Appendix J, Section III.A.5. The total time test method was used for a test duration of 8 hours. This method has been endorsed by 10 CFR 50, Appendix J, Section III.A.3.

The team independently verified, on a sampling basis, the pretest positioning of valves associated with the containment penetrations. The valve configurations were found to be correct. The results of Niagara Mohawk's inspection of the accessible interior and exterior surfaces of containment was also acceptable. The team suggested however, that more instruction could be provided for performance of this inspection than a single step in the procedure. Niagara Mohawk agreed to consider providing more detailed instructions for those who are to conduct this pretest inspection during subsequent CILRTs.

The calibration records for the resistance temperature detectors (RTDs), dew cells, pressure detectors, and flowmeter used for the test were reviewed. The instrument calibrations met appropriate accuracy requirements and were traceable to the National Bureau of Standards. A total of 17 RTDs, 4 dew cells, 2 pressure sensors and 1 flowmeter (with a backup) were used for the test. The volume fraction calculations and sensor failure analyses for these test instruments were reviewed. From this review, the team noted that two of the RTDs in the drywell, at the 237 foot elevation, were each assigned a volume fraction of 12%. While 10 CFR 50, Appendix J and the NMP Unit 1 Technical Specifications provide no

specific limits on represented containment volume fraction for a single RTD, industry guidance (ANSI/ANS 56.8 - 1987) indicates that no single drybulb temperature detector should be greater than 10%, regardless of whether other specified instrument selection criteria are met. Since Niagara Mohawk's program guide for containment leakage testing refers significantly to ANSI/ANS 56.8 guidelines, the team inquired as to whether there was a need to explain the acceptability of the existing configuration. The site technical department addressed the problem by generating an evaluation which stated why the existing configuration was acceptable. The evaluation discussed the effect of open grating in the drywell on measured temperature differences, compliance with applicable requirements (10 CFR 50, Appendix J, ANSI N45.4-1972), and other reasons which support the existing configuration. The team found the evaluation acceptable.

The team toured the external containment boundary before and during the test to assure that test activities were being conducted in accordance with the test procedure and in accordance with regulatory requirements. During these tours, test boundaries were surveyed for evidence of leakage and valve position. The team interviewed test supervisors to verify that test personnel were designated, their responsibilities were clearly defined, the test procedure was being followed satisfactorily, deviations from the procedure, if any, were administratively controlled and did not result in violation of applicable requirements, and systems required to maintain the plant in a safe shutdown condition were operable.

During a walkdown of the test boundary, the team identified a leak at the flanged capped end of piping for torus level transmitter LT-58-04. The pipe was through Penetration XS-347. The team notified test personnel who quickly inspected the leak and determined that it would not cause the test results to exceed the test acceptance criteria. The test personnel chose to continue the test and take corrective actions afterwards. The team found this acceptable and in accordance with 10 CFR 50, Appendix J, Section III.A.1.a. The leak was continually checked during the test to assure that it posed no safety problems and that no actions or containment boundary manipulations outside the scope of the procedure were taken.

The team observed that some electrical penetrations were kept under a nitrogen overpressure (approximately 6 psi) during the test. Niagara Mohawk indicated that this overpressure is provided continuously and that they would expect it to be available post-accident. The purpose of this overpressure is to prevent moisture intrusion as well as to provide a type of continuous leakage monitoring function for these penetrations. Since the nitrogen supply lines to these penetrations were not seismically qualified, the team questioned whether they should be disconnected for the performance of the CILRT. Onsite engineering personnel addressed this question by the generation of another technical evaluation. This evaluation stated that in keeping with the strictest interpretation of 10 CFR 50, Appendix J, these lines should be vented so that the penetrations are exposed to the full test differential pressure. Niagara Mohawk agreed to add the most recent local leak rate test (LLRT) measurements for these penetrations to the test result. A decision will be made in the future as to whether the lines will be disconnected for future tests. In any case, Niagara Mohawk stated that they would either disconnect the lines or add the most

recent LLRT results to the CILRT result. The team found this evaluation to be acceptable.

The results of the CILRT were successful. Preliminary calculations using the total time analysis method determined the "As Left" leakage rate at the 95 % upper confidence limit (95% UCL) to be 0.426 weight percent per day (wt%/day). The acceptance criterion of $0.75L_a$ is 0.826 wt%/day. Test result additions and corrections (including addition of the electrical penetration LLRT results) were minor and did not effect the success of the test. The "As Found" leakage rate at the 95% UCL was calculated to be 0.85 wt%/day compared to the acceptance criterion (L_t) of 1.101 wt%/day.

In summary, the CILRT was performed successfully and in accordance with procedural guidelines. Test personnel were knowledgeable and competent and resolution of encountered problems was timely and effective. Also, Operations department shift supervision was noted to be fully aware of ongoing testing activities.

Onsite engineering has developed an internal program guideline for containment leak rate testing performed at NMP Unit 1. This guide was developed from an overall assessment of leakage testing experiences at NMP Unit 1 in combination with the incorporation of general leak testing program guidelines derived from Niagara Mohawk's participation in the BWR Owners Group Subcommittee on Containment Leakage Testing. The team found this guide to be quite informative and a good example of Niagara Mohawk's commitment to increased standards of performance and self-assessment.

3.4.4 Drywell to Torus Leak Rate Test

Following completion of the containment integrated leak rate test on May 5, 1990, Niagara Mohawk performed N1-ST-R10, Drywell to Torus Leak Rate Test. The test failed due an excessive drywell pressure decay rate, indicating either vacuum relief valve seat leakage, potential leakage paths through interconnected containment spray system piping or incorrect test acceptance criteria. The test was reperformed, with the same results, four times by the same shift crew to ensure the test was correctly followed and the test methodology produced repeatable results (the test procedure had been revised since it was last performed in 1986).

With unsatisfactory results confirmed, the shift crew initiated Problem Report (PR) #1909 describing the test failure and requesting engineering evaluation and recommendations. The inspector determined that members of the station technical staff and site engineering had conducted some preliminary assessment of the test failure, but station management made a decision to postpone any further manpower expenditure on the problem until the responsible system engineer was available on May 9, 1990.

After the responsible system engineer had been briefed on the problem and had conducted some preliminary independent investigation, he determined that the test acceptance criteria (pressure decay curve) had been validated in 1989 (in response to PR #1375) concurrent with the test procedure revision. Further,

the probability of the vacuum relief valve seat leakage was low due to recently performed maintenance. Accordingly, the system engineer suspected the interconnecting containment spray system piping as the most likely leakage path, and he formulated a troubleshooting plan to investigate these potential leakage paths.

The drywell to torus leakage path was still unidentified at the conclusion of the team inspection. Subsequent to this inspection, a boroscopic inspection of a containment spray check valve (80-38) identified a small poly bottle wedged between the valve clapper and seating surface, confirming the system engineer's hypothesis.

The team judged Niagara Mohawk's effort to be a systematic and logical resolution of this concern. The system engineer was knowledgeable of the system and associated testing and carefully developed and executed a sound troubleshooting plan. Coordinated support for this problem resolution was evident. The decision to postpone further investigation of the problem until the system engineer was available was discussed with station management. They expressed that the reasoning was two-fold; (1) the system engineers were being held more accountable for their systems and (2) the system engineers were being used as the focal point for these types of investigations and system problem resolutions. The inspector considered this approach appropriate and consistent with the Niagara Mohawk standards of performance.

3.4.5 Power Ascension Test Program (PATP)

The team discussed the progress made in the preparation, review and approval of PATP test procedures with the power ascension manager (PAM) and other members of the PATP staff. As of May 4, 1990, nine of the 22 procedures required for the restart PATP had been formally issued. All other test procedures were in final draft form. The PAM informed the team that he had requested, and that SORC had approved, additional technical review of all PATP procedures under Site Administrative Procedure AP-3.4.3, Technical Review. This final, formal technical review will be in addition to other reviews (by site and corporate engineering, the independent safety engineering group and the quality assurance (QA) organization) performed during test procedure development.

The team reviewed several power ascension test procedures to ensure conformance with the NMP Unit 1 Technical Specifications and applicable Regulatory Guides and industry standards to verify the following attributes:

- Appropriate management reviews and approvals were accomplished.
- Appropriate committee reviews were accomplished.
- Test procedures were in the proper format.
- Test objectives were clearly stated.
- Appropriate references were listed.
- Appropriate prerequisites and precautions were included.
- Initial test conditions were specified.
- Acceptance criteria were clearly stated.
- Provisions were made to identify test equipment to be used.
- Provisions were made to identify personnel performing the test.
- The test procedure was technically adequate and workable.

- Temporary jumpers, installations and lifted leads will be properly restored by the procedure.
- Provisions were made for recording, evaluating and approving test data.
- Provisions were made to identify test deficiencies and exceptions and to document their resolutions.

The test procedures reviewed were all in final draft form awaiting final technical and SORC review. The team determined that, except for these final reviews, the test procedures conformed with applicable requirements and possessed the attributes listed above. Formal review and approval of these test procedures will be verified during augmented startup inspection coverage.

The team reviewed over 20 restart Technical Specification surveillance procedures to ensure that the condition of the plant during restart would be monitored by technically adequate, approved procedures that have been revised to reflect changes made to the facility and that the procedures are in conformance with Technical Specification requirements. The surveillance procedures were selected based on the safety significance of the associated systems and included surveillances of nuclear instrumentation, reactor physics, radiation safety, emergency core cooling and emergency power.

The team determined that the surveillance procedures were technically adequate and in conformance with Technical Specification requirements. During the review of six nuclear instrumentation surveillance procedures, the team noted a significant increase in overall quality (clarity, ease of use and communications to operational personnel of plant impact) in recently issued procedures. Discussions with Niagara Mohawk management determined that the use of a procedure writer's guide had recently been instituted and it was being used to revise procedures during normal periodic review.

The team determined that the operations and special operations procedures reviewed were technically adequate. The team reviewed several operations and special (off-normal) operations procedures to ensure that they were technically adequate and had been revised to reflect changes made to the facility. The operations and special operations procedures were selected based on their use in the performance of power ascension tests and surveillance tests discussed above.

3.4.6 NMP Unit 1 System Engineering

In early 1989, the NMP system engineering program was implemented. During the inspection, it was noted that this program is nearing full staffing with 46 system engineers for both units (20 for NMP Unit 1 and 26 for NMP Unit 2, with each engineer being responsible for approximately 4 systems). The team noted that the contributions of the system engineering staff have been accepted by the other technical plant departments as an acceptable, useful resource for the resolution of problems.

During inspection tours of the reactor building by the team, some concerns were identified regarding equipment and design, e.g., orientation of containment isolation butterfly valves, holddown hardware on containment spray and core spray strainers, and seismic support of air supply lines to valve operators. In each

case, after the team raised the concerns with plant personnel, the concerns were conveyed by plant personnel to the appropriate system engineer, who resolved the concern. In one case the resolution was not immediately apparent, and a problem report was initiated to enable additional engineering review. Subsequent Niagara Mohawk evaluation determined that an existing design evaluation provided a basis for resolution, and the problem report was closed out. Based on these examples, the team concluded that the system engineers demonstrated good problem resolution and that plant personnel demonstrated good understanding of the system engineers' function.

Underlying Root Causes

(1) Planning and Goal Setting
(3) Organizational Culture
(5) Teamwork

The team noted that the system engineering function has become an integral part of daily plant operations and has positively contributed to work effectiveness. The system engineers are looked upon by other plant departments as an instantaneously available source of engineering support. This is in contrast to the former organizational structure (before the system engineering function was developed) in which delays in the provision of engineering support to site issues were expected due to location and other administrative obstacles. Niagara Mohawk has recognized the value of the contributions being made through the system engineering function and is undertaking efforts to promote the effectiveness of engineering support by coordination of company-wide engineering functions. Clarification of issue ownership among onsite engineering, corporate engineering specialists and corporate project engineering was to be a primary concern of this effort.

The team noted good teamwork and communication between onsite engineering personnel and corporate engineering personnel and between the onsite system engineers and other plant personnel.

(2) Problem Solving

The integration of the system engineering function has promoted expedited engineering support for the resolution of operational problems. Effective use of system engineering support was noted throughout the inspection. The system engineers were knowledgeable with regard to their assigned systems and appeared to have accepted an increased amount of accountability for the operational condition of those systems. This increased sense of accountability appears to have evolved as the system engineering program continued to develop and the system engineers were used more as focal points for problem investigation and resolution. Troubleshooting and other problem resolution efforts by the system engineers were noted to be logically developed and effectively implemented.

The corporate engineering efforts to resolve the RBCLC heat exchanger tube vibration issue were comprehensive and effective. The use of contractors was effective and the root cause analyses were generally good.

(4) Standards of Performance and Self-Assessment

The standards of performance have been accepted by both onsite and corporate engineering and are being implemented. The evolution of the system engineering function has effected noticeable improvement in a number of the standards. Specifically, the timeliness of response to operational problems has improved. Efforts to resolve operational problems have improved due to the technical knowledge of the system engineers, their location onsite, and the evolution of the system engineering function as the focal point for the resolution of system problems. An increased sense of accountability for system operational condition has developed as the system engineering function has evolved. The successful performance of a major plant effort such as the CILRT demonstrated the effective use of procedures and the ability of onsite engineering to effect the cooperation of several plant departments in the accomplishment of a large-scale activity.

Niagara Mohawk has recognized the need to coordinate the sources of engineering support both within and outside the company. Efforts are in progress to evaluate this coordination and to clarify the responsibilities for and ownership of engineering issues.

3.5 Safety Assessment and Quality Verification

As the team emphasized review of field activities and resolution of identified problems, broad based evaluations of licensing, quality assurance, and corrective action programs were not practical. Nonetheless, the team evaluated Niagara Mohawk's approach to assuring the quality of work based on the activities observed. In general, the team concluded that Niagara Mohawk's approach to controlling operations, maintenance, testing, and engineering activities was sound and reflected the systematic approach established in their standards of performance. Although problems were encountered in the performance of some activities, no significant weaknesses in the quality of performance were identified. Several of the problems encountered could be attributed to the limited experience of personnel working in new positions, and the use of new and revised administrative controls and implementing procedures.

It was noteworthy that the number of NRC-identified concerns was limited and these concerns were relatively minor in nature. The identified concerns were adequately resolved by Niagara Mohawk by the end of the inspection. For example, although the team identified CILRT concerns with regard to the distribution of temperature detectors within the drywell and the leakage effects of the electrical penetration purge system, Niagara Mohawk resolved the concerns and the overall acceptability of the CILRT was not affected. Also, while there was a concern with regard to the control of instrument root valves, there were no instrument root valves found out of position, and Niagara Mohawk committed to ensure that all important root valves are confirmed to be correctly positioned prior to restart and to address long-term control of root valves. Further, the procedure errors found by the team were in a procedure which had not been used, and Niagara Mohawk committed to rereview applicable procedure revisions to ensure any other errors were corrected.

The team noted that Niagara Mohawk had identified numerous problems, but in all cases, the various departments were cooperating to establish an appropriate

corrective action plan and to resolve the problem. Examples of the coordinated and systematic resolution of such problems were observed in work performed on the RBCLC heat exchangers, the drywell to torus leak rate test, and battery charger motor-generator set 171.

The team judged that to further improve the assurance of quality of the work, Niagara Mohawk must demonstrate better ability to do the work correctly the first time. In some instances, Niagara Mohawk demonstrated the ability to identify problems but not the thoroughness to identify means to anticipate or prevent them. For example, some valve lineups were retyped to enable vertical alignment on the page and to include a remarks section at the bottom of the page. An appropriate review should have included proofreading for obvious errors between the original version and the revised version. Apparently, this proofreading was not adequately done, as the initial person to use a revised lineup found errors, and the team found errors in another lineup. It is important that such foreseeable procedure errors be found prior to their use in the field so that disruptions, both from schedule and technical standpoints, are minimized.

The team perceived that Niagara Mohawk personnel demonstrated the ability to learn from experience. It appeared that their self-evaluations were sufficiently accurate to enable good corrective actions. The team noted that review of corrective maintenance experience had been utilized to upgrade the preventive maintenance program, operating procedure revisions were proposed to address a better understanding of RWCU high temperature isolations, the staffing of the work control center was revised to provide a permanent position for operations planning, and that there was increased emphasis of the ownership of major procurement projects by engineering personnel.

Based on the above, the team concluded that the improving trend noted in safety assessment/quality verification functional area in the SALP report issued May 7, 1990, had continued.

As the above evaluation utilizes the observations from the other functional areas as bases and those functional areas were evaluated regarding the URCs, the evaluation regarding URCs has not been duplicated here. The overall summary regarding each URC is presented in Section 2.6.

4.0 MANAGEMENT MEETINGS

On May 11, 1990, the RATI team conducted an exit meeting to discuss the team's findings with Niagara Mohawk management representatives. Also present at the meeting was Thomas T. Martin, NRC Region I Regional Administrator. Partial exit meetings were conducted by individual inspectors on May 4, 1990 with regard to the containment integrated leak rate test and the power ascension test program.