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REGION I

Report Nos. 50-220/88-22
50-410/88-23

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50-410

License No. DPR-63
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Licensee: Niagara Mohawk Power Corporation
301 Plainfield Road
Syracuse, New York 13212

Facility Name: Nine Mile Point Nuclear Station, Unit 1 and 2

Inspection At: Scriba, New York

Inspection Conducted: June 20-24, 1988

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Inspection Summary: Inspection on June 20-24, 1988 (Report Nos. 50-220/88-22 and 50-410/88-23

Areas Inspected: Unit 1 - Special announced inspection of the Emergency Operating Procedures (EOPs) to include a comparison of the EOPs with the BWR Owners Group Emergency Procedure Guidelines and the Plant Specific Technical Guidelines for technical adequacy, reviews of the EOPs through control room and plant walkdowns, evaluation of the EOPs on the plant simulator, human factors analysis of the EOPs, on-going evaluation program for EOPs, QA measures, EOP training activities, and an evaluation of the containment venting provisions. Unit 2 - Evaluation of an operating crew on the plant - referenced simulator.

Results: See Executive Summary in report.

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DETAILS

1.0 Executive Summary

1.1 Background

Following the Three Mile Island (TMI) accident, the Office of Nuclear Reactor Regulation developed the "TMI Action Plan" (NUREG-0660 and NUREG-0737) which required licensees of operating reactors to reanalyze transients and accidents and to upgrade emergency operating procedures (EOPs) (Item I.C.1). The plan also required the NRC staff to develop a long-term plan that integrated and expanded efforts in the writing, reviewing, and monitoring the plant procedures (Item I.C.9). NUREG-0899, "Guidelines for the Preparation of Emergency Operating Procedures," represents the NRC staff's long-term program for upgrading EOPs, and describes the use of a "Procedures Generation Package" (PGP) to prepare EOPs. The licensees formed four vendor type owner groups corresponding to the four major reactor types in the United States; Westinghouse, General Electric, Babcock & Wilcox, and Combustion Engineering. Working with the vendor company and the NRC, these owner groups developed Generic Technical Guidelines (GTGs) which are generic procedures that set forth the desired accident mitigation strategy. These GTGs were to be used by the licensee in developing their PGP. Submittal of the PGP was made a requirement by Confirmatory Order dated June 12, 1984. Generic Letter 82-33, "Supplement 1 to NUREG-0737 - Requirements for Emergency Response Capability" requires each licensee to submit to the NRC a PGP which includes:

(i) Plant-specific technical guidelines with justification for differences from the GTG

(ii) A writer's guide

(iii) A description of the program to be used for the validation of EOPs

(iv) A description of the training program for the upgraded EOPs.

From this PGP, plant specific EOPs were to have been developed that would provide the operator with directions to mitigate the consequences of a broad range of accidents and multiple equipment failures.

Due to various circumstances, there were long delays in achieving NRC approval of many of the PGPs. Nevertheless, the licensees have implemented their EOPs. To determine the success of the implementation, a series of NRC inspections are being performed to examine the final product of the program, the EOPs.

On June 20-24, 1988 an NRC team of inspectors consisting of two reactor inspectors, a reactor system consultant, an operating licensing examiner/inspector, two human factor specialists, and the resident inspector conducted an inspection of the Emergency Operating Procedures at the Nine Mile Point Unit 1 facility. Nine Mile Point Unit 1 is BWR-2 with a Mark 1 containment. The objectives of the team were to determine if: The EOPs are technically correct, the EOPs can be physically carried-out in the plant, and that the EOPs can be performed by the plant staff.

The objectives would be considered to be met if review of the following areas were found to be adequate: comparison of the EOPs with the plant specific technical guidelines (PSTG) and the BWR owners group emergency procedure guidelines (EPG), review of the technical adequacy of the deviations from the EPG, control room and plant walkdowns of the EOPs, real time evaluation of the EOPs on the plant simulator, evaluation of the licensee program on continuing improvement of the EOPs and performance of human factor analysis of the EOPs. The inspection focused on the adequacy of the product and did not depend on the review of the process to develop the EOPs. If any of the areas were not found to be acceptable the inspection would assess other areas as necessary to understand the basis for the deficiencies.

In this inspection the walkdowns of the procedures and the EOP usage in the simulator were found to be deficient therefore a review of the validation and verification activities, a review of the training activities associated with EOPs, as well as an assessment of the Unit 2 operators use of the EOPs was done. In addition, containment venting provisions were specifically reviewed. Containment venting provisions for all BWRs with Mark 1 containments are being performed across the country as an NRC inspection initiative.

At Nine Mile Point-1 the facility is in the final stages of converting the existing approved and implemented text version EOPs into flow charts. The current version of EOPs are based on revision 4ac of the BWR Owners Group Emergency Procedure Guidelines (EPGs). The facility is using the same version of the EPGs for the flow charts. This inspection focused much of the resources into the flowcharts since the facility plans to implement the flowcharts in the near future. Operators have been training on the flowcharts exclusively for about one year. Text procedures were assessed during the technical adequacy determination as well as during the simulator assessment.

1.2 Conclusions

Section 4 of the inspection report addresses the technical adequacy determination of the NMP-1 EOPs. The team concluded that the EOPs were generally technically adequate. There are a few items that have to be resolved by the licensee for assurance that the procedures are

consistent with the technical guidelines. The principal item of concern in this area is the number of procedures referenced in the EOPs that do not carry out the actions listed in the EOPs, that no longer exist or that include values which do not agree with those values in the EOPs. Followup of this item indicates that the facility does not have adequate administrative controls to assure that procedures referenced in the EOPs are not revised without first assessing the impact on the EOPs. (Unresolved item 50-220/88-22-01)

The control room and plant walkdowns are discussed in Section 5. The team concluded that the facility had not done an adequate job in pre-planning those activities necessary to carry out the EOP actions, had not done a formal plant walkdown of the procedures and had not assured that the tools, material and equipment are available to carry out the EOP required tasks. Therefore, an assurance does not exist that the EOP required actions in the plant can be carried out. In addition, the lack of distinct labeling for EOP equipment hampered facility personnel for some EOP related tasks. The facility indicated that the detailed control room design review should address the other inconsistencies noted in the plant labeling but a item by item comparison was not done. (Unresolved item 50-220/88-22-02)

The simulator portion of the inspection is discussed in Section 6. The team concluded, without reservation, that the operating staff was unable to use the flow charts or the text version of the EOPs. The team observed deficiencies in three areas: an apparent misunderstanding regarding emergency operating concepts; procedure adherence; and use of the procedures. The team concluded that licensed operators were deficient in the following areas: a fundamental understanding of the EOPs; a fundamental understanding of accident mitigation strategies; and an ability to implement the EOPs. In addition, while not part of the EOP assessment, teamwork and communication skills needed to be improved as well as the recognition of emergency system status and degraded plant conditions. Because of the widespread observations, the inspectors did not consider the observations to be of an individual nature but reflected a programatic deficiency. Additional information which describes the training effectiveness evaluation is discussed in the quality measures assessment in Section 9 and in the training assessment in Section 12 of this report. (Unresolved items 50-220/88-22-06, 50-220/88-22-08)

The human factors assessment of the flow chart version of the EOPs is discussed in Section 7. This assessment concluded that in general the EOPs are high quality procedures with an appropriate level of detail and a clearly designed format. However, in spite of the high quality, the EOPs do contain a number of weaknesses in areas that have a strong relationship to potential human error. The items are relatively few in number and easily corrected. (Unresolved item 50-220/88-22-03)

In Section 8 the team concluded that the on-going evaluation program for EOPs was weak and unstructured to ensure quality EOPs are maintained and modified as necessary based on plant experience and use, training, and plant modifications. (Unresolved item 50-220/88-22-04)

A deficiency in the EOP program was a lack of quality assurance involvement. This is discussed in Section 9 of the report and is based,in part, on the facility administrative procedure which excludes QA involvement in EOPs. (Unresolved item 50-220/88-22-05) The quality assurance section also describes a recent QA identified issue which questions the quality of the training provided to both the Unit 1 and 2 operators based on the lack of quality requirements included in the purchase of the training services. This QA finding warrants facility management immediate attention. (Unresolved item 50-220/88-22-06)

The containment venting requirements in the EOPs are discussed in Section 10. The draft procedure reviewed appeared to adequately describe the steps needed to vent the containment under emergency conditions. However, numerous comments and errors were identified that require resolution before it is issued.

The inspectors reviewed the licensee actions during the EOP validation and verification process. The validation and verification within the control room appeared to be adequate and fairly complete. However the verification and validation activities did not adequately use a multidisciplined team approach, the validation did not include non-control room actions in the EOPs and the verification did not address the correspondence of plant hardware with procedures as was indicated to be a part of the program. This is further discussed in Section 11. (Unresolved item 50-220/88-22-07)

Section 12 of the report discusses the findings of an assessment of the operator training on EOPs. The lesson plans appear to be complete and adequate. However the deficiecies in the knowledge and use of the EOPs suggest weakness in one or more of the following areas: instructor qualification, frequency and duration of EOP training or implementation of the lesson plans. (Unresolved item 50-220/88-22-08)

An assessment of the ability of a Unit-2 operating crew to use the Unit-2 EOPs was performed using the plant-referenced simulator. The current day shift operating crew was utilized at the end of their day shift to perform the assessment. The scenarios chosen by the team were essentially identical to those used at Unit-1, only substituting plant specific equipment. No fundamental weaknesses were observed regarding the Unit-2 operators.

2.0 Persons Contacted

Niagara Mohawk Company and Contractors

+R. Abbott, Unit 2 Station Superintendent
*S. Agarwal, Lead Engineer, Site Licensing
*H. Barrett, Assistant Operations Superintendent
K. Belvin, Assistant Senior Shift Supervisor
+M. Coulumb, Unit 2 Senior Shift Supervisor
*W. Drews, Technical Superintendent
D. Lilly, Senior Shift Supervisor
*C. Mangan, Senior Vice President
*J. Parrish, Senior Shift Superintendent
*J. Perry, Vice President, Quality Assurance
*N. Rademacher, Director Regulatory Compliance
*R. Randall, Operations Superintendent, Unit 1
*T. Roman, Unit 1 Station Superintendent
*K. Ross, Project Manager, OEI
*S. Sheahar, EOP Engineer
J. Siegler, Assistant Senior Shift Supervisor
+R. Smith, Unit 2 Operations Superintendent
*K. Thomas, Corporate Licensing
*P. Wilde, Quality Assurance Surveillance Supervisor
+*J. Willis, General Superintendent
*K. Zollitsh, Training Superintendent
*A. Zollnick, Assistant to Senior Vice President

New York State

*P. Eddy, Public Service Commission

U. S. Nuclear Regulatory Commission

*R. Gallo, Chief Operations Branch, Region I
*D. Lange, Chief BWR Section, Region I

*Denotes those present at the exit interview conducted on June 24, 1988
+Denotes those present at Unit 2 simulator session briefing.

The inspectors also contacted other members of the licensee operation and technical staff.

3.0 Basic EOP/BWR Owners Group EPG Comparison

A comparison of the facility EOPs and the BWR Owners Group Emergency Procedure Guidelines (EPGs) Revision 4ac was conducted to ensure that the licensee has developed the procedures indicated in the EPGs. The EOPs reviewed are listed in Attachment A of this report. This facility EOPs are in agreement with the EPGs on the type of procedures required to respond to symptoms which result in entry into these procedures.

4.0 Independent Technical Adequacy Review of the Emergency Operating Procedures

The Nine Mile Point 1 EOPs in Attachment A were reviewed to assure that the procedures are technically adequate and accurately incorporate the BWR Owner's Group EPGs. A comparison of the Plant Specific Technical Guidelines (PSTG) to the EPG and EOPs was also performed. Differences between the EPG and PSTG were assessed for adequate technical justification. Selected specific values from the procedures were reviewed to determine that the values were correct.

Findings:

4.1 Technical Basis for Parameters Used in EOPs

The PSTG Primary Containment Pressure Control section, step PC/P-2 states, "If torus pressure exceeds 18 psig (Torus Spray Initiation Pressure) but only if drywell temperature and pressure are within the Containment Spray Initiation Limits (Figure 5), shut down recirculation pumps and drywell cooling fans and initiate containment sprays." In step 6.2 of the flow chart and text procedures, the licensee has substituted a drywell pressure of 18 psig for the torus pressure which is the parameter of concern: The licensee stated that the change from torus to drywell was accomplished because the torus pressure gage only reads to 4 psig. The licensee was unable to provide adequate calculations and rationale in its technical basis document for the selection of a drywell pressure of 18 psig.

In the PSTG Primary Containment Torus Water Level Control section, step SP/L-2 (minimum torus water level LCO) calls for the maintenance of torus water level above the Heat Capacity Level Limit Curve (Figure 8). The licensee's EOPs have eliminated the use of this curve and substituted a fixed level limit of 7 feet. The justification for the elimination of the Heat Capacity Level Limit curve and the substituted methodology does not appear in the licensee's technical basis document.

4.2 Procedures Referenced in EOPs

The licensee's EOP 4 flow chart directs the operator to take action in several referenced procedures. Three of these procedures were found to be incorrect. In procedure OP-14, step 6.3 (flow chart step 7) no longer exists. The proper reference should be OP-14, step G.3. In procedure OP-2, (also step 7), step H.21.d is referenced. The latest revision of OP-2 does not contain this step and during a prior revision, the action which the operator is directed to accomplish (add water to the torus) was eliminated (from OP-2). Procedure PSP 13 is referenced in the Hydrogen and Oxygen monitoring and control section of EOP 4. This procedure was superseded in August of 1986 by procedure N1-CSP-13A, "Sample and Analysis of Reactor Water and Containment Gas Using the PASS," which is now in its third revision.

Procedure N1-CSP-13A requires that the Control Room open four valves upon request of the chemist who will take the PASS sample. This step cannot be accomplished by Control Room operators. There is a single valve operator which opens 8 valves in System 11 (which is being lined up in accordance with the procedure). Only two of these valves are included among the valves requested to be opened. The other two valves could not be identified by the Control Room operators. It was apparent to the inspector and to the operators that this portion of procedure N1-CSP-13A had not been validated by a walkdown.

Based on findings for procedure inconsistencies and other findings identified during the walkthrough, the inspector inquired if procedures referenced or interfacing with the EOPs are assessed against the EOPs before being modified. A review of AP-2 "Production and Control of Procedures" did not identify sufficient controls to assure procedures referenced by EOPs are not changed without assessing the EOPs for possible impact. Facility actions are needed to assure adequate administrative control. Facility actions to resolve technical adequacy concerns will be tracked as unresolved item 220/88-22-01.

5.0 <u>Control Room and Plant Walkdowns</u>

The inspectors walked down the EOPs and procedures referenced therein to confirm that the procedures can be implemented. The purpose of the walkdowns was to verify that instruments and controls contained or required to be used to implement the procedures are consistent with the installed plant equipment, insure that the indicators, controls, annunciators referenced in the procedures are available to the operator, and ensure that the task can be accomplished. Detailed comments identified are also noted in Attachment B. General comments, observations and conclusions from the detailed comments are discussed below.

The walkdowns identified a general inconsistency in the plant labeling. There were differences with the procedure names and plant labels. Gages were not always labeled. Sometimes the plant label referred to a name and sometimes referred to a number. The facility indicated that actions resulting from the detailed control room design review would respond to many of these observations.

The team observed a general lack of distinct labeling for EOP related instruments and equipment. There was no clear distinction between instruments that relate to the EOPs and those that do not.

The facility did not have any pre-staged storage of equipment, tools, or jumpers necessary to accomplish EOP required tasks but only planned on using tools that are generally available on site. The facility walkdown of EOPs and procedures referenced in the EOPs had not been done to assure that the procedures can be accomplished, as evidenced by: the lack of adequate boron on site to accomplish alternate boron injection, the lack of physical methods to add the boron to the tank, the lack of the controls

necessary to accomplish the containment sampling activities, the inaccessibility of plant equipment in the overhead, the difficulty in locating some EOP related electrical equipment, and the lack of information to indicate some of the EOP entry conditions in Secondary Containment Control.

The team concluded that because of the general lack of adequate preplanning to carry out the EOPs, the facility could not demonstrate that the EOPs could be carried out in the plant. Facility actions to resolve items generated during the walkdown will be tracked as unresolved item 220/88-22-02.

6.0 Simulator

Six scenarios were conducted on the plant specific simulator using a normal shift crew. The simulator scenarios provided information on real time activities. The purposes of this exercise were to determine that the EOPs provide operators with sufficient guidance such that their responsibilities and required actions during the emergencies both individually and as a team are clearly outlined; verify that the procedures do not cause operators to physically interfere with each other while performing the EOPs and verify that the procedures did not duplicate operator actions unless required (i.e. independent verification). In addition, when a transition from one EOP to another EOP or other procedure is required, precautions are taken to ensure that all necessary steps, prerequisites, and initial conditions, are met or completed and that the operators are knowledgeable about where to enter and exit the procedure.

The scenarios were consistent with those used during previous EOP inspections, and were designed to evaluate the EOPs. This evaluation includes operator knowledge of the EOP concepts and the usability of the procedures by the operators, not an evaluation of individual Reactor Operator (RO) and Senior Reactor Operator (SRO) performance.

From observations during the scenarios, and detailed discussions with the operating staff following each scenario, the team identified fundamental deficiencies in three areas. An apparent misunderstanding regarding emergency operating concepts, procedure adherence, and a misunderstanding regarding the use of the flowchart and text EOPs.

1. Regarding emergency operating concepts, the NRC team identified a lack of understanding by the operating crew in the following specific areas:

   The band to control RPV pressure, and the meaning of (ERV) Electromatic Relief Valve cycling.

   The need to sequence single ERVs when multiple single ERV operation is required.

Understanding the basis of waiting until RPV level is at top of active fuel prior to emergency depresurization.

Understanding containment control importance, especially during an ATWS.

Need for alternate water injection systems only when required.

When RPV water level can or cannot be determined.

2. Regarding procedure adherence, the NRC team identified a lack of understanding by the operating crew in the following specific areas:

Verification of the status of safety-related equipment.

Locking out of Core Spray pumps not required to assure adequate core cooling.

What to do if a step cannot be accomplished.

Use of the Level/Power control procedure.

Concurrent use of more than one procedure.

Concurrent execution of all legs within a procedure.

3. Regarding the use of flowcharts and text procedures, the NRC team observed performance deficiencies by the operating crew in the following specific areas;

Unfamiliarity with the text procedures.

Decision steps were being used as action steps.

Steps in the procedures were missed.

Steps required to be executed concurrently were not completed.

Placekeeping techniques were not used during implementation of the EOPs.

Transitions from one EOP to another were missed.

Unfamiliarity on when to enter and exit the EOPs.

Procedures required to be executed concurrently were not accomplished.

The team concluded that the operating crew was unable to use the flowchart EOPs or the existing text EOPs. This conclusion was reached by the NRC team from observations made, and detailed discussions held with the operating crew following each scenario. The NRC team determined that:

1. A fundamental understanding of the EOPs was lacking.

2. A fundamental understanding of accident mitigation strategies was lacking.

3. The ability to implement the EOPs was lacking.

4. Teamwork and communciations, while not an assessment criteria was not evident.

5. The ability to recognize emergency systems status was deficient.

6. The ability to recognize degraded plant conditions was deficient.

7.0 Human Factors Review of the NMP-1 Emergency Operting Procedures

As a result of the human factors review of the Nine Mile Point Nuclear Station Unit 1 EOPs, a list of concerns has been generated (see Attachment C). An initial desktop review of the EOPs was conducted prior to the on-site inspection. Observation of simulator exercises, interviews with NMP-1 staff, and plant walkdowns were used to both corroborate those items noted during the desktop review and to identify additional concerns. Because NMP-1 expects to have final approval on the flowchart version of the EOPs in the near future the following comments are based on the flowchart EOPs. In cases where comments refer to the NMP-1 text EOPs, explicit reference to the text version is made.

In general, the NMP-1 EOPs are high quality procedures with an appropriate level of detail and a clearly designed format. They should provide operators with easily understandable, highly useable support in performance of their duties during mitigation of the consequences of a range of accidents and equipment failures. However, despite their general high quality, a number of weaknesses have been identified in the NMP-1 EOPs. These weaknesses are of particular concern because they fall into categories with a strong relationship to potential human error. Identification of weaknesses in these categories suggests a less than adequate application of human factors principles in the development of the procedures. A summary of concerns in each of these categories follows. Attachment C contains the detailed concerns.

1. Transitions

Movement within and between procedures is often required of an operator during the execution of EOPs. An operator may be directed to concurrently perform more than one flow path, or more than one procedure, or to completely exit the procedure being executed and move to a different EOP. An operator may also be required to reference tables, charts, supplemental information, or non-EOP procedures. Movement within and between EOPs can be disruptive, confusing, and cause unnecessary delays and error. Therefore, it is particularly important that these transitions be minimized. When movement cannot be avoided, it is important that the transition directions to the operator be clearly and consistently structured.

Within the NMP-1 flowcharts and text procedures transition directions to the operator are indicated in multiple, inconsistent, and sometimes unclear methods. The presentation of transitions in the NMP-1 EOPs make the procedures more difficult to use and hold potential for confusion and error.

2. Decisions

When individuals are subjected to emotional or environmental stressors, such as those which may be present during the use of EOPs, difficulties may be experienced in a number of cognitive areas. For example, information drawn from long term memory may be incomplete or inaccurate, short term memory capacity may be reduced, and the ability to accurately assess the importance of details may be degraded. Any or all of these problems will lead to difficulty in decision-making. Because decisions are extremely important to the execution of EOPs, it is critical that they be clearly, consistently, and appropriately used.

In the NMP-1 EOPs, numerous types of decisions are required. Because many of these decisions are inconsistently and sometimes unclearly structured, they can be difficult for operators to use in emergency situations and thus hold a potential for error.

3. Cautions and Notes

Cautions are used to describe hazardous conditions that can cause injury or equipment damage and should describe the consequence of the hazard. Notes are intended to provide supplemental information to the operator. Neither cautions nor notes should contain directions to the operator. Because of the critical nature of the information contained in cautions, it is particularly important that cautions be emphasized in a way that distinguishes them from notes and that they be located where operators will not overlook them.

The human factors review revealed problems related to format, location, and content of cautions and notes in the NMP-1 EOPs. These deficiencies in the treatment of both critical and supplemental information could lead to delay or operator error.

4. Miscellaneous

A number of other miscellaneous concerns in the NMP-1 EOPs were identified through the human factors analysis. For example, "hybrid" steps combining override steps and actions steps were found in the procedures, though they were not defined in the writer's guide; symbol size was inconsistently applied throughout the flowcharts; and action steps were structured in a manner that conflicted with writer's guide directions, both in content and format.

The facility actions to resolve these itmes will be tracked as unresolved item 220/88-22-03.

8.0 On-going Evaluation of EOPs

The inspectors reviewed the long-term evaluation program for EOPs as recommended in Section 6.2.3 of NUREG-0899. The review was conducted to determine if the program evaluates the technical adequacy of the EOPs in light of operational experience and use, training experience, simulator exercises, control room walkthroughs and plant modifications.

The NRC team inspected the ongoing evaluation program for EOPs. This program consists of a two year review, in accordance with AP 2.0 Production and Control of Procedures, Section 13.0, Periodic Review of Procedures. Comments on any procedures are documented in accordance with S-SUP-4 Procedure Evaluation Requests. An informal log of instructor generated comments during simulator training sessions is maintained at the simulator. The NRC team determined that the on-going evaluation program of the EOPs was unstructured to ensure quality EOPs are maintained and modified as necessary from plant operational experience and use, training, control room walkthroughs and plant modifications. Facility actions to resolve this item will be tracked as unresolved item 50-220/88-22-04).

9.0 QA Measures

The NRC team inspected the QA organization involvement in the programmatic approach of the EOP program. The inspection focused on those policies, procedures and instructions necessary to provide a planned and periodic audit of the EOP development and implementation process.

Discussions were held with the QA Surveillance Supervisor. From these discussions and documents reviewed including Surveillance Report 88-10292, dated 6/20/88, the team concluded that until most recently the QA organization was functionally excluded from auditing and reviewing the EOPs and the EOP development process. Based on the facility administrative procedure, Administrative Procedure AP-2.0 Rev. 9 figure

2.0-1 "Procedure Type/Approval Matrix" Unit 1 or 2 EOPs do not require QA review. QA personnel have performed informal comparisons of the text and flowchart EOPs on a sample basis on NMP-1, and none of NMP-2 EOPs.

Lack of QA involvement in the EOP development program and review of EOPs is considered to be a facility management deficiency. This is considered an unresolved item. (50-220/88-22-05)

During the recent QA review of EOP activities (surceillance report 88-10292 dated 6/20/88), the QA organization noted that the procurement of consultant services for RO/SRO training was procured as non-safety related. QA submitted a Determination Of Appendix B Quality Requirements to NMPC Licensing. This request was for a determination if consultants procured for licensed operator instruction must meet the requirements of 10 CFR 50 Appendix B. NMPC Licensing determined that Appendix B Quality Requirements apply to consultants procured for RO/SRO instruction.

Based on this determination, NMPC-Nuclear Quality Assurance-Operations prepared a Corrective Action Request (CAR) to be acted upon by the Nuclear Training organization.

This CAR contains two concerns:

1. SRO Certified Training Instructors have been contracted from General Physics Corporation and General Electric. These contractors provide services which include the design, modification, development and implementation of RO/SRO training at NMP-1 and NMP-2. These services were procured as non-safety related. The contractor summary for these contractors does not include evaluation of training services or certification at the SRO level to meet the quality requirements of 10 CFR 50 Appendix B.

2. There is presently a lack of definition as to what elements of the Training Program are to be considered safety related.

This CAR was still under management review at the time of the NRC team inspection. This item represents a potential problem with the quality of training provided to NMP-1 and NMP-2 operation staff that warrants immediate senior management attention to resolve. This item is considered unresolved (50-220/88-22-06)

10. <u>Containment Vent</u>

Emergency venting of the primary containment at NMP-1 is required by the Emergency Procedure Guidelines (EPG), Revision 4ac, to control drywell pressure and hydrogen concentrations. To control drywell pressure, guidance is provided by EPG step PC/P-5:

"If suppression chamber pressure exceeds (the Primary Containment Pressure Limit), then irrespective of the offsite radioactive release rate, vent the primary containment, defeating isolation interlocks if necessary, to reduce and maintain pressure below (the Primary Containment Pressure Limit)..."

To control hydrogen concentrations, guidance is provided by EPG steps PC/H-1 and PC/H-4:

"When drywell or suppression chamber hydrogen concentration reaches 0.5% (minimum detectable hydrogen concentration), but only if the site radioactivity release rate is expected to remain below the site release rate, vent and purge the primary containment, defeating isolation interlocks if necessary, to restore and maintain drywell and suppression chamber hydrogen concentrations below 0.5%..."

"When drywell or suppression chamber hydrogen concentration reaches 6% and drywell or suppression chamber oxygen concentration is above 5% ... irrespective of the offsite radioactivity release rate, vent and purge the primary containment, defeating isolation interlocks if necessary, to restore and maintain drywell and suppression chamber hydrogen concentrations below 6% or drywell and suppression chamber oxygen concentrations below 5%..."

Instructions on how to vent the NMP-1 containment are provided in procedure N1-EOP-4.1, Primary Containment Venting. A draft copy of N1-EOP-4.1, Revision 0, was reviewed since the procedure had not been approved. A detailed description of the containment venting system, components and procedures was provided in an NRC memo dated March 16, 1988, and is available in the Public Document Room. The subject title of the NRC memo is "Trip Report RE: Containment Venting at Nine Mile Point 1 and Susquehanna 1&2." Detailed walkdown comments on N1-EOP-4.1 are provided in Attachment B of this report.

Entry to procedure N1-EOP-4.1 will be required when primary containment venting or purging is called for by steps in N1-EOP-4, Primary Containment Control. The method of venting the primary containment drywell and/or torus depends on several variables: drywell pressure, torus water level, torus or drywell hydrogen concentrations, and torus or drywell oxygen concentrations.

If drywell pressure exceeds the Drywell Pressure Limit (as given by a graph of drywell pressure versus torus/drywell water level, N1-EOP-4 Figure 4.4), the drywell is vented through one of two purge paths until the drywell pressure is reduced and maintained below the Drywell Pressure Limit. Regardless of the vent path used, containment isolation signals are bypassed, and venting is performed irrespective of the radioactive release rates. The discharge path used depends on torus water level. On adequate/low torus water levels, the drywell is vented through the torus

nitrogen vent and purge path, in an attempt to scrub radioactive particles from the vent flow prior to release to the environment. On high torus water level, the drywell is vented through the drywell nitrogen vent and purge path.

If drywell or torus hydrogen concentrations reaches or exceeds 0.5% or 6%, depending on offsite radioactivity release rates, one of four vent paths is used. After the primary containment isolation signals are bypassed, the vent path used depends on torus water level (high or normal/low) the drywell pressure (above or below Emergency Ventilation System (EVS) pressure rating. The preferred path, from either the drywell or torus is through EVS. The EVS provides a method of filtration of the vent flow. If drywell or torus pressure is less than 3.0 psig, the vent flow is routed to the EVS system. If drywell or torus pressure is above 3.0 psig, the vent flow is routed to the suction of the Drywell and Torus Vent and Purge Fan, which discharges directly to the plant stack. During high torus water level conditions, the containment is vented through the drywell. During normal or low torus water level conditions, the containment is vented through the torus.

After normal venting of Primary Containment, Procedure N1-EOP-4.1 also provides instructions on how to restore and maintain drywell and torus hydrogen (0.5% or 6%, depending on offsite release rate or oxygen (5%) concentration below undesirable values. The vent and purge paths described in N1-EOP-4.1 to restore hydrogen or oxygen concentrations include:

- Purging the drywell with nitrogen and venting through the torus during low torus water level conditions.

- Air purging the drywell and torus during low torus water level conditions.

- Purging the drywell with nitrogen and venting through the drywell vent during normal torus water level conditions..

- Air purging the drywell during normal torus water level conditions.

- Air purging the drywell during high containment (torus or drywell) water level conditions.

The Primary Containment Venting procedure, N1-EOP-4.1, appears to adequately describe the steps needed to vent under emergency conditions. Both procedures N1-EOP-4, Primary Containment Control, and N1-EOP-4.1, Primary Containment Venting, meet the intent of EPG steps PC/P-5, PC/H- and PC/H-4. However, numerous comments were identified relative to the draft copy of the procedure reviewed. The N1-EOP-4.1 walkdown comments are provided in Attachment B of this report.

11. Verification and Validation

Verification of the NMP-1 text EOPs was conducted from February to April, 1985, by a contractor to Niagara Mohawk. Verification activities were designed to assess compatibility of the EOPs with control room hardware and instrumentation, conformance with the NMP-1 PSTG, and compliance with the NMP-1 EOP Writer's Guide.

Initial validation of the NMP-1 text EOPs was conducted during August, 1985. The validation effort was designed and directed by a contractor to Niagara Mohawk. Validation activities included the participation of the NMP-1 Assistant Operations Superintendent and one regular operating crew. The validation process was designed to confirm appropriate level of detail, understandability of information presented, and compability of the procedures with plant hardware, plant responses, operator capabilities, other procedures, and shift staffing levels. These elements were evaluated through simulator exercises and talkthroughs.

As a result of findings from the verification and validation, the procedures were revised. The procedures were also substantially revised based on adoption of Revision 4ac of the EPGs in November, 1985. The NMP-1 PSTG was also revised at this time. In January, 1986, and June, 1986, additional verification was conducted on the revised procedures. Additional validation was deemed unnecessary.

The first draft of the flowchart version of the NMP-1 EOPs was developed in December, 1986. Verification of the flowcharts was conducted in February, 1987, and validation was conducted in April, 1987, by the same contractor who had designed and directed previous NMP-1 EOP validation and verification. Both verification and validation of the flowcharts excluded actions outside of the control room. Validation activities focused on major decision points, and did not validate every step in the flowcharts.

The NMP-1 text version EOPs (with the exception of EOP 4.1) were implemented as Rev 0 on July 1, 1986. Flowchart versions of the EOPs were completed in May, 1987, however, have not yet been officially approved for use at NMP-1.

Several concerns have been generated by a review of the NMP-1 EOP verification and validation process. They are:

1. Compatibility with plant hardware and instrumentation outside of the control room was not evaluated during the verification process.

2. The validation process did not include physical walkthrough of actions required outside of the control room, and steps that could not be exercised on the simulator were not necessarily walked through in the control room.

3. The validation and verification process did not utilize an adequate multidisciplinary team approach. For example, one contractor was represented as fulfilling the roles of technical writer, human factors specialist, engineer, and validation and verification director. The licensee actions to resolve these concerns will be included as unresolved item (50-220/88-22-07)

12. <u>EOP Training</u>

Because of the findings observed during the simulator exercises using the EOPs, a brief assessment of the EOP training provided to the operators was conducted. This was accomplished by review of training records, lesson plans and in discussions with training personnel.

Pre-implementation training on the NMP-1 EOPs was conducted from April to June, 1986, by a contractor to Niagara Mohawk in conjunction with the NMP-1 training staff. The training included both classroom and simulator hours. Since that time, EOP training has been integrated into the regular five-week training cycle at NMP-1. In addition to the regular EOP training, pre-implementation training on the use of EOP 4.1 was conducted in May 1988.

Several concerns have been generated by the initial review of the NMP-1 EOP training program. They are:

1. The number of hours per individual operator of pre-implementation EOP training ranged from 32 to 88 hours. No clear explanation of this variance was available.

2. The only documented EOP training since the pre-implementation training in mid-1986 totalled 14 hours per individual. This total does not include 8 hours of pre-implementation training on EOP 4.1 during 1988.

3. Although text EOPs are still the only approved EOPs at NMP-1, all training within the last year (both classroom and simulator) is reported to have used the flowchart version of the EOPs.

4. Documentation of EOP training prior to March 1988 did not necessarily distinguish between simulator and classroom hours.

5. Documentation of EOP training does not distinguish between text and flowchart format.

6. During pre-implementation EOP training, steps not able to be exercised on the simulator were talked through and thus not necessarily walked through or physically exercised by operators.

7. Training records did not allow easy access to documentation requested by the inspection team. Reconstruction of the information was required and resulted in an incomplete and sometimes unclear description about the training provided.

8. Records of pre-implementation training suggest that some training department instructors had not fully completed their own EOP training prior to instructing NMP-1 operators on use of the EOPs.

9. Training did not include local EOP operations.

No conclusion on the adequacy of the EOP training could be reached as a result of this brief review. However, it does suggest that the facility training program on EOPs is at least a part of the reason that the operating crew experienced difficulty during the simulator portion of this inspection. This will considered to be an unresolved item (50-220/88-22-08)

13. NMP-2 Simulator Exercises

Two simulator scenario's were run on the Unit-2 simulator on June 24, 1988. The purpose of which was to determine if the concerns identified during the simulator evaluations of the Unit-1 EOPs existed at NMP-2. The NRC team was the same that performed the evaluation of Unit-1. The operating staff chosen to operate the Unit-2 simulator was the operating crew that was on duty during the day-shift. This crew was requested to extend their work day into the evening hours to assist the NRC team. The facility was requested to provide an independent evaluation of the operating crew's performance and ability to implement and utilize the EOPs. Various staff memebers were present as observers.

The scenarios chosen by the NRC team were essentially identical to those used at Unit-1, only substituting the plant specific equipment of Unit-2. Following each scenario, detailed discussions were held with the operating crew.

A discussion was held with the facility representatives following the scenarios to determine the facility evaluation of the operating crew's performance and use of the EOPs. The NRC team met separately following each scenario to discuss findings and conclusions. The NRC team concluded that the facility evaluation of the operating crew was in agreement with the NRC evaluation.

The NRC team concluded the concerns raised at Unit-1 did not exist at Unit-2 based on the findings of:

1. The crew demonstrated a fundamental understanding of the EOPs.

2. The crew demonstrated a fundamental understanding of accident mitigation stategies.

3. The crew demonstrated the ability to implement, use and adhere to the EOPs.

4. The operating crew demonstrated adequate communications and teamwork.

5. The operating crew demonstrated the ability to recognize emergency systems status and degraded plant conditions.

6. The operating crew appeared to be adequately trained in the use of the EOPs.

14. <u>Unresolved Items</u>

Unresolved items are matters about which more information is required to ascertain whether they are acceptable items, items of noncompliance or deviations. Unresolved items identified during the inspection are discussed in sections 1, 4, 5, 7, 8, 9, 11 and 12.

15. <u>Exit Interview</u>

At the conlusion of the inspection on June 24, 1988 an exit meeting was conducted with those persons indicated in paragraph 2. The inspection scope and findings were summarized. The licensee did not identify as proprietary any of the materials provided to or reviewed by the inspectors during the inspection. At the exit meeting, the licensee was requested to discuss the corrective action to be taken as a result of the inspection findings. The facility responded that a comprehensive plan would be developed to address the findings in an integrated manner.

ATTACHMENT A

DOCUMENTS REVIEWED

Text EOPs

N1-EOP-1	Cautions & General Instructions	Revision 01
N1-EOP-2	RPV Control	Revision 02
N1-EOP-3	Failure to Scram	Revision 02
N1-EOP-4	Primary Containment Control	Revision 02
N1-EOP-5	Secondary Containment Control	Revision 01
N1-EOP-6	Radioactivity Release Control	Revision 00
N1-EOP-7	RPV Flooding	Revision 02
N1-EOP-8	Emergency RPV Depressurization	Revision 02
N1-EOP-9	Steam Cooling	Revision 01
N1-EOP-10	Drywell Flooding	Revision 01
N1-EOP-4.1	Primary Containment Venting	Draft

Flowchart EOPs

N1-EOP-1	Cautions & General Instructions	Draft
N1-EOP-2	RPV Control	Draft
N1-EOP-3	Failure to Scram	Draft
N1-EOP-4	Primary Containment Control	Draft
N1-EOP-5	Secondary Containment Control	Draft
N1-EOP-6	Radioactivity Release Control	Draft
N1-EOP-7	RPV Flooding	Draft
N1-EOP-8	Emergency RPV Depressurization	Draft
N1-EOP-9	Steam Cooling	Draft
N1-EOP-10	Drywell Flooding	Draft

Other Documents and Procedures

N1-OP-2	Core Spray System, Revision 17 effective 3/19/88 with changes through 5/18/88
N1-OP-14	Containment Spray System Nos. 80 & 93, Revision 27 effective 6/16/86 with changes through 9/8/87
N1-OP-9	Nitrogen Inerting and H2-O2 Monitoring Systems for the Primary Containment and Pressure Suppression System, Revision 15 effective 6/10/86
N1-OSI-3	Production and Control NMI1 Emergency Operating Procedure Revisions, Revision 0 effective 6/6/88
AP-2.0	Production and Control of Procedures, Revision 9 effective 3/4/88
N1-SOP-1	Reactor Scram Revision 0 dated 6/1/86
N1-SOP-3	Alternate Control Rod Insertion, draft dated June 88

N1-OP-5	Control Rod Drive System, Revision 23 (Section G.26)
N1-OP-12	Liquid Poison System, Revision 16 (Section H.4)
N1-OP-21	Fire Protection System, Revision 12 (Section G.6.a)

Letter T. Lempges to D. Vassallo, "NMP-1 Procedure Generation Package" dated 3/1/84

Letter C. Mangan to J. Zwolinski "NMP-1 Revised Writers Guide, Plant Specific Technical Guidelines and Revision 1 of the Training Description" dated 4/18/86

Letter C. Mangan to USNRC "NMP-1 EOP Verification Program Plan and Validation Program Plan" dated 3/3/87

ATTACHMENT B

Detailed Walkdown Comments

N1-EOP-2, RPV Control

1. A general inconsistency was noted with the valve labeling in the NMP-1 control room. Some, but not all, valves have valve number labels to go with the valve title labels. Most valve number labels were located above the associated valve status lights, but some were noted to be located below the valve control switches.

2. Figure 2.1, Core Spray Pump NPSH Limit, is a graph of torus temperature (°F) versus core spray pump flow (lbm/hr). The torus water temperature meter in the control room ranges up to 230°F. Torus temperature on Figure 2.1 curves up to 250°F. The control room meter cannot measure temperature over 230°F. The value to read for "torus overpressure" was not clear to operators. Different areas of the graph are shaded in Figure 2.1 in the flowcharts and text procedures. On the graph, the pump flow engineering units are lbm/hr, the control room meter is labeled lb/hr.

3. Step 4.1 asks, "Is any ERV cycling?" The referenced valves are labeled "Power Operated Relief Valve (Electromatic)," not ERV's.

4. Step 3.3.1 states, "Place the ADS inhibit Switch in Bypass." The bypass switches are not labeled in the control room.

5. In step 3.2 (and other places), the procedure section numbers were not listed in OP-2 and OP-12.

N1-EOP-3, Failure to Scram

1. EPG step RC/Q-5 (similar to step 6.3 of EOP-3) states, "If ARI has not initiated, initiate ARI." This step is repeated in EPG step RC/Q-2. The licensee step 6.3 is in a different logic location than would be required by the EPG.

2. EPG step RC/Q-1 states, "Confirm or place the reactor mode switch in shutdown." N1-SOP-1, Reactor Scram Procedure, instructs the operator to place the reactor mode switch in refuel position. EOP-3 does not agree with SOP-1.

EOP-4, Primary Containment Control

1. Step 4.4 calls for the operator to verify that 3 ERVs are open. The Relief valves are actually labeled "Power Operated Relief Valves (Electromotive)" on the panel.

2. Step 5.2 has a statement requiring the operator to take action before drywell temperature reaches 300 °F. There are several possible methods to read this temperature. The proper methodology to be used to obtain the reading should be indicated to the operator.

3. Table 4.1 indicates terminal blocks which must be jumpered to bypass containment isolation. These terminal connections are not identified in any special manner to indicate that they are EOP related (color coded, tagged, etc.). The jumpers which are to be used to perform this function are also not controlled for exclusive EOP use. When additional jumpering requirements are considered, the four jumpers sighted in the control room are not sufficient for EOP use.

4. In N1-OP-14, Containment Spray System, a procedure referenced in EOP-4, valve BV-93-65, which must be operated in the plant, is located in an inaccessible location about 12 ft. above the floor. A means to operate the valve when required during the execution of the EOPs should be provided.

5. N1-OP-9, Special Procedure, Venting Primary Containment through Reactor Building Emergency Ventilation System During Normal Operating Conditions is a procedure referenced in EOP-4. It was noted that most valves which were called out in the procedure are labeled differently in the control room, and some valves have no numbers on the panel at all (step G.I.a.3) and 4). In step G.I.a.5) the local station near valve SSI#2 has two pressure gages. The procedure does not identify which is to be read. The method of communication between this station and the control room is not specified nor is it apparent.

<u>EOP-5, Secondary Containment Control</u>

1. The entry condition for differential pressure is to be "at or above 0 in. of water". The gage installed for this purpose can not be read <u>above</u> 0 in. as "0" is a pegged position on the gage. The gage is not labeled as to function or that it reads negative pressure.

2. In Table 5.1, the area temperature in the EC Condensate Return Valve Area for ISOL VALVE 39-06 is given as 168 °F. In OP-13, which contains the annunciator response procedure, it is given as 174 °F.

3. In Table 5.2, the set points listed do not correspond in all cases with the actual set points of the instruments as determined from the labels on the indicators. As an example, the area radiation level for containment spray HX area is listed as 5 mr/hr in table 5.2 and as 20 mr/hr on the meter.

4. A review of procedure N1-OP-53, which is the procedure in which the annunciator alarm responses for the sump alarms in EOP Table 5.3 are located, indicated a lack of locations of the alarmed points. The locations are, however, indicated in the EOP. Sump #12 (SW corner area) had at least 3" of water in it at the time of this inspection. The alarm set point is 3". Sump #11 (NW corner area) is covered with a bolted plate which does not allow sump level to be visually inspected.

5. In all tables in EOP-5, which specify annunicator location, a review of the annunciator response procedures reveal that none of the annunciator response procedures cross reference the EOPs. The licensee explained that these references are being added when the annunicator response procedures (actually contained as a portion of the related system's OP) comes up for review. This review occurs every two years. All annunciator response procedures referenced in the EOPs require up-dating.

6. In Table 5.4, the maximum safe operating water levels (which are not annunciated points) are not indicated in any manner in the Pump Compartments. This could be easily identified with a painted level line on the Compartment wall. During visual inspection, it appeared to the inspector that the max safe operating water levels of 6' and 7' are too high. The pump motors would appear to be grounded out at a lower water level.

N1-EOP-7, RPV Flooding

1. Steps 2.4 and 3.3 states, "Place the Motor Feedwater Pump High Level Trip Bypass Switch on Panel F in Bypass." Two switches have to be placed in bypass (for pumps 11 and 12), not one, as implied by the wording of the steps.

2. The words "Reactor Head Vent" should be "Reactor Vessel Vent Valves" to agree with nameplate engraving and number of valves, in steps 2.1.4.2 and 3.1.3.2. Also "EC Vent to Torus" should be "EC Vent to Torus Valves" to agree with the number of valves to be repositioned. This comment also applies to step 1.4 in N1-EOP-8.

N1-EOP-8, Emergency RPV Depressurization

1. Step 1.4 states, "Is RPV pressure greater than 50 psi above torus pressure?" The torus pressure meter range is 0-4 psig. The use of the torus pressure meter may not be acceptable under certain conditions (>4 psig torus pressure) to answer the question.

2. Step 1.1 asks, "Is drywell pressure at or above 3.5 psig?" The drywell pressure meter in the control room is labeled in engineering units of psi, not psig.

N1-EOP-10, Drywell Flooding

1. Numerous discrepancies between valve nameplate labels in the control room and EOP-10 wording were noted (steps 1.1, 1.2 and 3).

N1-EOP-4.1, Primary Containment Venting, Draft Revision

1. Sketches of major components and flow paths are included as figures in procedure N1-EOP-4.1. A review of the figures resulted in several findings. Nine figures showed the wrong flow paths. Six figures did not have titles and/or figure numbers. The figures were noted to be

incorrectly drawn (locations of piping connections) when compared to the system piping diagrams. The licensee stated the figures were to be corrected by the time the procedure is approved.

2. The NRC inspector noted that the flow path figures do not provide the level of detail needed during the performance of the procedure and were making the procedure more voluminous. For example, more valves are operated than are shown on the figures. The licensee believes that the figures are operator aids, intended to show major flow paths only.

3. The words "Good" and "Bad" should be added to figure shown on page 12, to agree with figure N1-EOP-4.4 shown on N1-EOP-4.

4. Numerous steps reference a pressure meter that has engineering units of psi, when the procedure requests readings in units of psig.

5. Verification of automatic valve repositioning should be added to steps 2.4.2 and 4.4.2. Certain valves automatically close when the fan is manually stopped.

6. The performance of steps 6.0.b and c appears unnecessary for the procedure section (drywell and torus air purge).

7. Steps 6.3.2 and 8.2.2 are similar in intent, but are worded different to steps 5.1.16.2 and 5.1.16.3.

8. Other items noted during review of N1-EOP-4.1 include typographical errors, control room switch positions worn off the switches, and component/control room labeling inconsistencies.

<u>N1-OP-5, Control Rod Drive System, Revision 23 (Section G.26, Alternate Boron Injection)</u>

1. Step 26.e directs operators to add 2770 lbs of borax and 2695 lbs of boric acid to the demineralized water storage tank. Following an inspection of the NMP-1 and 2 warehouses, it was determined the licensee did not have the proper amount of borax and boric acid in stock. The Unit 1 warehouse did not have any in stock, the Unit 2 warehouse had 900 lbs of boric acid and 1000 lbx of borax in stock, and an offsite warehouse (Lakeshore) had approximately 450 lbs each in stock. The licensee had approximately half the boric acid and borax needed to perform step 26.e.

2. Specific instructions on physically how to add the borax and boric acid to the demineralized water storage tank were not provided in N1-OP-5.

3. In step 26.g, two valves (CS-47, CS-50) are listed with the wrong plant nomenclature.

4. The licensee should reconsider the method used for alternate boron injection. The use of RWCU or HPCI, and not CRD pumps, to inject boron should be considered. This will allow the operators to continue to use the CRD system to insert any rod not full in during an ATWS.

N1-OP-12, Liquid Poison System, Revision 16

1. System shutdown or restoration instructions should be provided in section H.4. The step re-aligns the liquid poison pump suction to the demineralized water storage tank. Instructions on when to stop the pump and how to re-align the system to the poison tank are not provided.

ATTACHMENT C

HUMAN FACTORS REVIEW EXAMPLES

The following examples are provided to clarify the types of problems identified in the areas of human factors concerns described in section 7 of this report. These examples are not intended to be viewed as an inclusive list of all such problems found in the NMP-1 EOPs, but rather as limited examples of the types of inadequacies identified through the human factors analysis.

1) Transitions

Because of the potential for confusion and delay inherent in transitions, it is particularly important that transitions be minimized. The NMP-1 EOP Writer's Guide identifies seven acceptable forms of transition directions including two forms of "cross-referencing." The distinction between cross-referencing and a procedural reference is not clearly described within the writer's guide, and the other methods provided are not necessarily required for clear transition direction. For example, "continue in this procedure at ..." and "return to..." could both easily be directed under the term "go to." In addition to the multiple forms approved in the writer's guide, the procedures also include a number of non-approved terms, for example: execute (EOP 3, steps 6.5 and 6.4.6; execute concurrently (EOP 3, step 6.3); refer to (EOP 3, 4.2.1, 4.5.3, 4.5.4); in step ___ (EOP 3, 4.3). In addition, the qualifier "of this procedure" called for in the writer's guide is not consistently used within the procedures (EOP 3).

Critical to easy transitioning in EOPs is a clear and consistent step numbering system. Due to the attempt to match EOP steps in both text and flowchart formats, the flowcharts include several unnumbered or multi-numbered steps. This system makes transitions difficult and can lead to confusion and error. For example, steps that are referenced cannot be clearly identified when lacking a step number. Evidence was found of references to an incorrect step because the correct step lacked a number (EOP 2, flowpath B, reference to step 3.3.4 should be to the step following 3.3.4). In addition, the lack of step numbers led to the identification of several flowpaths in EOP 2 by letters ("A," "B," and "C"). This system deviates from writer's guide directions.

Placekeeping methods play an important role in preventing error and delay during the execution of EOPs. While use of a grease pencil down the flowpath is an effective way to keep track of movement through the procedures, the EOPs lack spaces for placekeeping marks with lists in the flowcharts and with each step in the text procedures.

The symbols used in flowcharts provide a useful method for conveying information graphically, that is, the meaning identifed with the shape of each symbol. The NMP-1 flowcharts fail to take advantage of a specific transition symbol, instead embedding transitions in symbols used for action steps and override steps.

2) Decisions

Because of the difficult nature of decision making during emergencies, it is important the decisions be clearly identified and simply structured. In flowcharts, decisions are designated through use of decision symbols and decision tables. However, in the NMP-1 flowcharts, a number of decisions are

embedded within other steps, such as action steps, leading to a potential for confusion and error (e.g., EOP 3, 5.2 and 6.4.5; EOP 2, 3.2).

The format of decision tables can serve to clearly identify a required decision to the operator. In the NMP-1 flowcharts, decision tables requiring "IF, AND, THEN" logic are formatted identically to decision tables requiring "BEFORE, IF, THEN" logic. Especially when these tables are placed contiguously in flowpaths, the potential for error and delay is increased.

Related to the problem of "BEFORE, IF, THEN" decision tables, is the identification of non-logic terms as logic terms in the NMP-1 writer's guide. "BEFORE," "UNTIL," and "EXCEPT" are not formal logic terms, yet are defined and used as such in the NMP-1 writer's guide and EOPs. This misuse increases the complexity of decision steps and could lead to error. Steps including these terms should be rewritten to utilize actual logic terms (use of "WHEN,THEN" in place of "UNTIL") or to add a note when providing qualified supplemental pinformation ("EXCEPT" introduces a qualifier).

Decision tables can increase the ease with which decisions are made or, when incorrectly formatted, can disrupt flow of information. In the NMP-1 EOPs, some decision tables are formatted in extreme widths. This format style causes difficultly in tracking the information flow within the table and can lead to confusion and error (EOP 2; EOP 3).

3) Cautions and Notes

Because of the critical nature of information contained in cautions, it is particularly important that they be (1) properly emphasized to catch the operators attention, and (2) distinguished from the non-critical information contained in notes. In the NMP-1 EOPs, cautions and notes in the flowcharts are emphasized in exactly the same manner. It is also not clear that all cautions state the potential consequence of the identified hazard.

Some cautions and notes are located within action steps or following the step to which they apply. In all cases, cautions and notes must precede the step to which they apply. EOP-1, General Instructions consists of some cautionary and supplemental information that is more appropriately placed in the flowpath prior to the step to which it applies. Placement of such important information on a separate chart increases the number of transitions required in the procedures and can cause the operator to miss critical information.

4) Miscellaneous

A number of miscellaneous inadequacies were identified in the NMP-1 EOP system. Some are:

a) A number of steps are "hybrids," combining two different types of symbols, for example, combination caution, action step and decision table (EOP 3, step 4.3-4.4 and 4.5.2-4.5.4) or combination override step and decision table (EOP 4, step 6.2-6.4). This method of combining symbols can lead to operator error and diminishes the meaning conveyed by each type of symbol.

b) The size of each type of symbol is inconsistent across procedures. In addition, type size varies from procedure to procedure. Not only does this lack of restrictiveness.have the potential for operator confusion and delay, but a lack of control over type and symbol size could lead to unreadable procedures. In addition, the smaller type size found on several flowcharts (e.g., EOP 4, and EOP 6) appears to be below minimum human factors engineering standards.

c) The writer's guide states that general functions will be presented as steps, with more detailed instructions prescribing specific actions through which a step is accomplished presented as substeps (section 4.3, step 4). However, a number of action steps in the flowcharts combine a general function step with its substeps in a complex direction, rather than using the short, simple forms called for in the writer's guide section 4.3., steps 3 and 5 (e.g., EOP 3, steps 4.2.2, 4.5.3, and 4.5.4).

d) The writer's guide provides a table of standard nomenclature and definitions for use in the procedures. This table is not applied consistently throughout the procedures. For example, the table identifies the verbs "start" and "execute" to direct performance of an action or step. However, the EOPs also use the verbs "initiate" and "commence" (EOP 3).

e) Yes/no exits from decision symbols on the flowcharts were inconsistently placed.

f) The format for entry conditions defined in the writer's guide is not applied in the flowcharts.

g) The writer's guide states that a horizontal line will be used to separate related action steps within one action step symbol. The use of the horizonal lines is inconsistently applied throughout the EOPs.

h) The use of dotted lines in the flowcharts is not defined in the writer's guide and appears to be inconsistently used within the EOPs.

i) The intersection of both dotted and solid lines in the flowcharts can lead to error.

j) Graphics quality is variable within the flowcharts. The word "no" is difficult to read in a number of different locations.