EVALUATION OF OPERATOR AND TRAINING EFFECTIVENESS DURING THE SITE AREA EMERGENCY AT NINE MILE POINT UNIT 2 ON AUGUST 13, 1991

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ASSESSMENT OF OPERATOR RESPONSE

and

TRAINING EFFECTIVENESS

SUMMARY

A review of operator response to the event of August 13, 1991, which led to the declaration of a Site Area Emergency and the effectiveness of training to prepare operators for such an event has resulted in the following conclusions:

1) Operator response/actions during and following the event were appropriate.

2) All plant parameters were stabilized and controlled.

3) EOPs appropriately addressed control of station parameters. This event has demonstrated that symptom based procedures are the most effective way to handle large complicated events.

4) Operating procedures were generally useful however there were some identified instances where a given procedure was not specifically written for existing (unanticipated) plant conditions.

5) Procedures were appropriately used.

6) Training has been effective in preparing operators for events of this nature. Simulator training was identified as a significant strength. Some specific training recommendations have been identified.

DETAILED REVIEW

At approximately 0548 on August 13, 1991, NMP2 experienced a loss of Main Transformer Phase B Transformer and UPS-1A through D and G power supply. This resulted in loss of the majority of control room annunciators, plant essential lighting, communications systems and control rod position indications. Additionally, with the general exception of control room meters on P601 and P852 most control room meters and recorders failed.

APRM recorders failed as is due to the power loss. At the initiation of the event operators assessed plant conditions and noted the following:

- PAM recorders (running in fast speed) indicated approximately 175" RPV water level and 920 psig RPV pressure
- APRMs were indicating downscale on back panel meters (no power was lost to this indication)
- Feedwater pumps had tripped
- RCS pumps had downshifted
- ARI had initiated, and
- The RPS solenoid white power supply lights were extinguished

Within several seconds the reactor mode switch was taken to shutdown at the direction of the SSS. RPV water level was lowering and RCIC manually started. The RCIC system experienced oscillating flow, speed and pressure in automatic and was placed in manual. This stabilized the oscillations. Realizing that there was conflicting control room indications for reactor power and recognizing that RCS had downshifted and feedwater pumps had tripped, placing the reactor mode switch to shutdown was a conservative and appropriate action. Starting RCIC is authorized by N2-OP-101C for use.

RPV water level continued to lower to L3 at which time N2-EOP-RPV was entered. Recognizing that control rod position was unavailable the SSS immediately exited section RL of that procedure and entered N2-EOP-C5. These were the appropriate procedures to utilize. These procedures were then used to control RPV water level, pressure and power. RCIC was used to restore RPV water level above the scram setpoint after which it was placed in a full flow test lineup. RCIC use is authorized in N2-EOP-C5, and its use was therefore appropriate. As the scenario progressed, RPV pressure was slowly lowering. Main steam line drains (2MSS-AOV87A-D) were closed in order to stabilize the RPV pressure. This is consistent with N2-EOP-RPV section RP and N2-OP-101C Scram Procedure. 2RHS*P1A was placed in Suppression Pool Cooling mode by the operators shortly after RCIC was started in order to control suppression pool water temperature.

When N2-EOP-C5 was entered the ADS system was defeated utilizing the inhibit logic switches. For NMP2 these switches were specifically added for ATWS events. Their use is authorized by N2-EOP-C5 in order to prevent; 1) a severe thermal transient on the RPV, 2) complications involving RPV water level control and 3) the rapid uncontrolled injection of large amounts of relatively cold unborated water should RPV level fall to L1 during ATWS conditions. Therefore, this action was appropriate.

At 0600 the SSS declared a Site Area Emergency and activated the station emergency plan. Because the communications systems were unavailable at NMP2, control room operators requested the NMP1 control room to make the emergency announcements. Offsite notifications were made as required.

As RPV pressure continued to lower operators secured the running condensate booster pump to prevent its injection into the RPV (the feedwater level control valves (LV10s) had failed as is in the open position). RPV water level was slowly rising with normal CRD as the only injection source (RCIC was in full flow test) when RPV L8 was exceeded. Securing the condensate booster pump is authorized by N2-OP-101C in order to control RPV level and is consistent with N2-EOP-5 and RPV which specify a maximum RPV level of L8. Thus this action was appropriate.

When it was recognized that the UPS-1 power supplies were lost, operators were dispatched to identify the problems and restore power. Power was restored manually at each UPS. It was identified that the existing procedure (N2-OP-71) for restoring UPS power did not fully address the restoration of the UPSs in their current configuration, thus the operator was required to utilize his knowledge of UPSs in order to access and manually close in the maintenance power supply breaker. This is considered appropriate response under these emergency conditions in order restore control room alarm and instrumentation system. This is specifically authorized by AP-2.0 (Rev. 23) section 3.4.4 which states "In emergency situations not addressed by procedures, personnel may take action to avoid or minimize personnel injury or damage to the station". Additionally this action of manually operating a breaker is considered within an operators Skills of the Trade. N2-ODI-5.16 (Rev. 0) Skills of the Trade will be revised to add manual operation of breakers (other than 13.8 and 4.16 KV which have a separate procedure for operation).

At approximately 0615 hours RPV water level reached L8. The condensate booster pump was secured at or just prior to this point thus the only injection source into the RPV was CRD. RPV water level remained above L8 for approximately eight minutes after which it continued to slowly lower. Subsequent evaluation has determined that the RPV level did remain below the main steam lines. At this time the SSS directed RPV pressure be maintained 500-600 psig using turbine bypass valves and that Condensate Booster pump P2A be started to maintain RPV level 165-180 inches. UPS power had been restored at this point and the LV10s were able to be closed. RPV water level continued to slowly lower to approximately 124 inches before the condensate booster pump (using LV137) was able to turn the trend and restore RPV level. RPV water level of 124 inches is well within the specified control band of -14 to 202.3 inches in N2-EOP-C5. Additionally that procedure requires that RPV level recovery be performed deliberately slow.

Operators were unable to open the feed pump suction valves (2CNM-MOV84s) following the startup of the condensate booster pump due to the inability to access the turbine bldg. (to equalize around the MOV84s). Thus only the low press/low flow makeup valve (LV137) was available. Following restoration of UPS power the operators were able reset the rod drive control system and determine that the majority of control rods were fully inserted.

Several control rod positions were still unable to be determined. At this point the SSS was still utilizing N2-EOP-C5 for RPV water level control and had directed that alternate control rod insertion methods be attempted utilizing N2-EOP-6, Attachment 14. Utilizing N2-EOP-6, Attachment 14 the operators defeated RPS interlocks in able to permit resetting the scram signal in order to effect multiple scrams. Upon resetting the scram the operators were able to determine that all control rods were fully inserted thus further N2-EOP-6, Attachment 14 actions (additional scrams) were not required. The SSS then properly exited N2-EOP-C5 and returned to N2-EOP-RPV section RL for RPV water level control. Subsequent evaluation following the event has determined that all control rods were fully inserted. Those which had lost position indication had over traveled in. Restoration of defeated ADS and RPS interlocks were then accomplished later in the scenario following the clearing of all scram signals. Defeating of RPS interlocks is authorized by the EOPs for this particular scenario in order to provide the ability to reset the scram and perform multiple scrams. The premise is that the failure of all control rods to fully insert could be caused by a hydraulic problem, thus resetting the scram enables the scram discharge volume (SDV) to drain. In this scenario the operators using N2-EOP-6, Attachment 14 recognized that there was no pneumatic system problem and that the SDV was full and thus performed appropriate actions.

Approximately one half hour after determining that all control rods were fully inserted (0731) operators had restored RPV water level above L3. At this point in the scenario all control rods had been inserted, RPV water level was stable between L3 and L8 using condensate booster pump P2A and CRD, and RPV pressure was being controlled with turbine bypass valves to maintain RPV cooldown rate less than 100°F/hr. Throughout the morning many balance of plant (BOP) system manipulations were made. Among these system operations the following were included:

- Startup of Auxiliary Boiler B.
- Establishment of turbine sealing steam with the Auxiliary Boiler supplying steam to the clean steam reboilers.
- Startup of the condenser air removal pumps to maintain condenser vacuum.

- Placing the main turbine on the turning gear. (Some difficulty was encountered when performing this evolution requiring assistance of the system engineer), and

- Restoration of process and radwaste computers (following restoration of UPS power).

At approximately 1055 hours it was decided to startup the RWCU system in the full reject mode in order to facilitate RPV water level control (when SDC is placed in service) and to assist in reactor coolant chemistry control.

That system lineup is authorized by N2-OP-101C following a reactor scram. When the RWCU pump P1B was started the differential flow isolation logic was initiated causing a system isolation. NRC notification was made as required by 10CFR50.72 b.2.ii.

A root cause is currently in progress to determine the reason for the isolation. It was reported to the control room that loud noises (waterhammer) were heard in the RWCU heat exchanger room. The control room notified the TSC which initiated an engineering walkdown of the system. No problems were identified by the engineering walkdown which was completed early that evening. No further analysis was required.

RCIC was declared inoperable and 2ICS*MOV126 deactivated shut when it was recognized that 2ICS*AOV156 failed to indicate full closed. RCIC was not required at this point for RPV level or pressure control. These valves are containment isolation valves and these actions were taken to comply with Tech. Spec. 3/4.6.3.

At approximately 1000 hours it was determined that two SRVs (2MSS*PSV128 and 133) had lifted at the initiation of the event. N2-OSP-ISC-M@002 the Drywell Vacuum Breaker Operability Test was initiated and performed.

Primary containment parameters were monitored and trended throughout the event. Early in the event it was recognized that DW Cooling fans had tripped had been lost due to the BOP power loss. Operators attempted to restore DW Cooling using N2-OP-13 and 60. Use of the LOCA bypass switches for the fans was attempted however failed to be effective due to the power loss. Operators were able to restore DWUCs following restoration of UPS power. Use of the LOCA bypass switches during non-LOCA conditions is authorized by N2-OP-13 and 60. At one point during the morning it was noted that Division 2 Hydrogen concentration recorder had spiked indicating a high containment hydrogen concentration. Actual concentration as indicated on Division 1 H^2/O^2 remained normal (<1%) throughout the event. Operators found that the H^2/O^2 monitor sample pump tripped and restored the unit to service after which indicated hydrogen concentration returned to normal levels. At no time during the event were any Primary Containment EOP entry conditions met.

When the SDC high pressure isolation interlocks (approx. 1200 hours) cleared, operators secured 2RHS*P1A from suppression pool cooling, stroked 2RHS*MOV40A (a deferred PMT for WR work), completed the necessary paperwork and declared RHS Loop A operable for SDC. This was done in order to comply with a one hour TS requirement for SDC in Mode 3.

At approximately 1500 hours, 2RCS*P1B was shutdown and 2RHS*P1B placed in SDC using N2-OP-101C and 31. While in SDC RPV level control was with CRD injection into the RPV and RHS reject to Radwaste (RWCU was unavailable due to the previous trip). Difficulty in controlling RPV level was experienced when the normal reject throttle valve to Radwaste (2RHS*MOV142) failed.

This required operators to use 2RHS*MOV149 full stroke open and close to control level until Electricians were able to effect repairs to *MOV142. This resulted in RPV water level rising and falling above and below the L8 setpoint periodically until the valve was repaired. RPV water level remained well below the elevation of the Main Steam lines throughout the duration.

Plant Cooldown continued until Cold Shutdown was reached at 1846 and the MSIVs closed using N2-OSP-MSS-CS001. MSIV 6D indicated intermediate position following the test and was declared inoperable. The Site Area Emergency was then terminated at 1943.

An assessment regarding the ability of operators to perform required actions during the UPS power loss was completed. This was conducted by review of operator written statements, shift debriefing and operator interviews. The loss of lighting was determined not to impact operator actions. The only prolonged loss was essential lighting in stairways (Reactor Bldg. lighting went out initially but came back on within 30 seconds). Since the only lighting lost was stairway lighting and since flashlights are normally carried, operators felt that this did not impact plant operations. Communications systems were also lost while the UPS power supply was de-energized. This impacted the gaitronics and radio systems. This caused reports and directions to and from the control room to be delayed. Operators stated that had communications been available restoration of power may have taken place more quickly but also noted that they still were able to carry out required actions.

Instrumentation operability in the control room was reviewed to determine if EOP use was impacted. The results of this review indicate the following:

1) Control room instrumentation was operable which supports all entry level EOP parameters

2) Control room instrumentation necessary to support all remaining EOP parameters were operable with the exception of control rod position indication.

A review of the procedures has shown that they are structured to provide appropriate direction both with and without control rod position indication available. Operators did appropriately follow the actions of the procedures.

A review of applicable T.S. requirements has been made for the time period this event was in progress. It has revealed that all T.S. LCO requirements were adhered to with exceptions described as follows:

- T.S. 4.6.4.b.1

  This T.S. surveillance requirement specifies cycling the DW-SC vacuum breakers through one complete cycle of full travel within two hours following SRV actuation.

  It was not determined that SRVs had actuated until approximately four hours following event initiation. At that point the required surveillance was completed in the following two hours.

- T.S. 3.3.1 action b.

  This T.S. action requirement specifies placing at least one RPS trip system in a tripped condition within one hour. Using N2-EOP-6, Attachment 14 operators had defeated all RPS interlocks (except for manual) as directed by the EOPs for a period of approximately one and one half hours. This was required in order to permit resetting the scram signal to allow the SDV to drain down and subsequently perform additional scrams to effect control rod insertion. This action is directed by NMP2 EOPs consistent with the BWROG-EPG (Rev. 4) and is recognized in the Safety Evaluation for NMP2 EOPs (Rev. 4) (SER 90-145, Attachment 4, Event 15.8). Additionally EPG Appendix B specifically states the following "...This is not to imply that operation beyond the Technical Specification is recommended in any emergency. Rather, such operation is required and is now permitted under certain degraded conditions in order to safely mitigate the consequences of those degraded conditions...."

Since defeating RPS interlocks was believed to have been required (the operators were unable to determine multiple control rod positions) in order to insert control rods, and the basis for the procedures and safety evaluation recognize the potential for this condition the action taken by the operators and direction by the procedures was appropriate.

Assessment of radiological conditions was performed during this event. At the onset of the event operators verified that the Main Steamline Rod Monitors were downscale and that the reactor was shutdown. Additionally containment parameters were normal and RPV water level stabilized well above TAF, thus it was concluded that there were no immediate concerns relative to radiation levels or radiological releases. Shortly after power was restored to the UPSs it was reported by an operator that ARMs on TB 250 ft elevation were alarming. The SSS had everyone (operations damage control teams) who was previously sent out to the turbine building recalled (the SAE and Station Evacuation was in effect). Approximately one hour later Rad Protection authorized reentry for operators with the provision that minirads be carried. It was during this time period that the feed pump suction MOVs were closed to support condensate booster pump startup. It was subsequently determined by rad protection that turbine building radiological conditions were normal. Early in the event the stack GEMS recorder in the control room became inoperable. This necessitated that a chemistry technician monitor the data logger/display locally at the stack until it was restored (approximately two and one half hours). Stack GEMS (with the exception of the control room recorder and a short period (0757 - 0829) in order to reboot the computer system.) remained operable throughout the event including the time period during which the mechanical vacuum pump was operating.

Additional actions taken in order to assess radiological conditions included the following:

- Rad Protection surveys of the reactor, turbine, offgas and aux boiler buildings
- Sampling and analyzing the RX/RW Vent (Vent GEMS was inoperable prior to and during the event)
- Monitoring of the remote indicating controller (RIC) for the 1E monitors
- Restoration of the DRMS system
- RCS sample
- Service Water Sampling/Analysis (A and B lines)

A review of the NMP2 EOP (Rev. 4) Safety Evaluation (90-145) for analysis of USAR events 15.2.2 (Generator Load Reject) and 15.8 (ATWS) has been completed.

The only difference between actual operator performance and that described in the safety evaluation was that operators entered the EOPs based upon low RPV water level vice high RPV pressure assumed in the safety evaluation. This had no impact on procedure use or plant conditions.

An assessment of training effectiveness has been performed in regard to this event the purpose of which was to determine the following:

- Was operator training effective in preparing operators to handle this type of event?
- What particular training was useful or identified as a strength in preparing for this event?
- Was there any additional training or recommendations which could be used to better prepare for events of this nature?

The following strengths and recommendations/feedback were identified based upon operator response to interview questions and debriefings by Operations Management and Training.

STRENGTHS

1) EOP training in the simulator
   - used backup indications to assess plant conditions

2) SSSs command and control
   - several interviews perceived the SSS as calm, and very much in control of the situation
   - "his leadership made us feel very much at ease"

3) Teamwork
   - many instances of operators backing each other up

4) Non-licensed operator training in the simulator
   - made it easier for the NLOs to keep the "Big Picture" throughout the event
   - Helps them better understand their responsibilities

5) Newly qualified B operators were noted as being very well trained by several other more senior operators

6) Communications

7) Static simulator scenarios in the requal program enhanced operator skills. Oncoming crews found it easier to assess plant conditions as they walk in cold into the control room without having to disrupt the actions of the on shift crew.

TRAINING RECOMMENDATIONS/FEEDBACK:

1) Training on operation of the UPSs when the Units have tripped and restoration of power from maintenance power supply is required.

   a) Include an actual hands on JPM or training on UPS operations in addition to the existing classroom training.

2) Maintaining accountability during the event was very difficult. Personnel were unaware that they had to go through the OSC before moving to other areas of the plant.

3) Coordinating operations of the plant through the OSC were at times difficult.

4) Review operation of Reactor Water Cleanup system above saturated conditions. (N2-OP-37 Operations)

5) Locations for the remote indications
   - reactor pressure
   - reactor water level

6) Turnover of the SED function from the SSS to TSC should be reviewed in regard to how this is accomplished.

7) Scenario's which include losses of several annunciators.

8) Verify that the simulator modeling of drywell pressure rate of pressure rise per unit time is correct. During the event drywell unit coolers were lost for approximately 1/2 hour and no pressure rise had occurred in the drywell (Plant was 100% power before the scram).

9) Maintain the quality and quantity of simulator training for licensed and non-licensed personnel.

10) Use of static scenarios (not necessarily the exams) in training as exercises can be beneficial. The oncoming crew was able to access plant status without disrupting the crew combating the event.

11) If and when a UPS is replaced for upgrading, consider using the replaced UPS for training use as a mock-up.

Based upon the proceeding feedback from operators and recognition that the procedures used were properly implemented and the plant maintained in a safe configuration during the event it can be concluded that operator training has been effective in preparing operators for events of this nature.