STUDENT MANUAL

Site Day 5

Assume that you have worked on a draft inspection report with significant findings that will be used as a major input to the ROP. Your report covers a special inspection in which you reviewed repair activities to correct a body-to-bonnet leak on a letdown system isolation valve, RC-8085, that was not isolable from the reactor coolant system.

Your task is to complete the following action:

- Evaluate findings under the ROP:
- Provide bases for findings.
- Screen the findings for significance (minor, green, greater than green).
- Determine what, if any, enforcement actions should be proposed.
- Prepare notes for an NRC pre-exit meeting based on the observations to be contained in your report. Findings will be presented to the instructors playing the roles of licensee or NRC management (at the discretion of the instructor) in a simulated meeting. Expect to be questioned on specific regulatory requirements, safety significance, and apparent cause for any problems.

SEALANT INJECTION EVENT DRAFT INSPECTION REPORT

1.0 INTRODUCTION

A special inspection was performed into the circumstances regarding licensee repair activities for an unisolable reactor coolant leak from letdown system isolation valve RC 8085. Excessive leakage from this valve resulted in a forced shutdown of Trojan on August 5. The inspection consisted of observations of repair activities, interviews with licensee personnel, and review of documents, and focused on the following licensee activities:

- Implementation of the licensee's repair plan
- Adequacy of engineering and technical support
- Management oversight of repair activities
- Licensee oversight of vendor activities
- Quality Assurance Program performance

A detailed chronology of events is provided at the end of this report.

2.0 BACKGROUND

On August 5, in an ongoing attempt to stop reactor coolant system (RCS) leakage from the body-to-bonnet flange joint (split line) of letdown system isolation valve RC 8085, the licensee injected sealant into the valve gasket area. (The licensee repeatedly had been peening the split line area and injecting sealant into the gasket area since June. Leakage would stop for some period of time and then return as sealant was expelled from the split line area.) This injection was performed in preparation for welding a clamp across the split line of the valve in order to retain the sealant within the split line area. While injecting sealant and peening the flange area on August 5, the valve bonnet appeared to lift slightly from the valve body, significantly increasing the leakage rate and forcing abandonment of the repair. The licensee determined that the one gallon per minute limit for unidentified reactor coolant system leakage (Technical Specification 3.4.6.2) had been exceeded, and at 2:39 p.m., a reactor shutdown was commenced. The licensee declared an Unusual Event in accordance with its emergency plan and notified the NRC. The unit was placed in the cold shutdown condition (Mode 5) at 9:33 a.m., on August 6, reducing RCS leakage to less than one gallon per minute. The licensee terminated the Unusual Event at 9:52 a.m on August 6.

3.0 SYSTEM/COMPONENT DESCRIPTION

Valve RC 8085 is a 3-inch, normally open, manual gate valve used to isolate the letdown portion of the chemical volume and control system from RCS loop 3 for maintenance and for local leak rate testing of system containment isolation valves. It is the first valve downstream of the RCS penetration and is located in the containment building at an elevation approximately 4 inches below the centerline of the RCS hot leg. The valve is a Velan 1500, model M08-3543B-13MS, with design and operating pressure and temperature ratings of 2485 psig/650 degrees Fahrenheit (°F) and 2235 psig/550°F, respectively. The body and bonnet material is ASTM A-182 Type 316 stainless steel. The four, 3/4 inch-lO UNC-2A body-to-bonnet studs are ASTM A-461 Type 630, and the nuts are ASTM A-194 Grade 8M stainless steel.

Valve RC 8085 was disassembled for seat leakage repair in November last year. During reassembly, the bonnet was installed 180 degrees from its normal position on the valve body. While having no functional impact on valve performance, this error subsequently complicated the task of fabricating and installing a sealant injection clamp around the valve. On May 24, this

year, when the very small body-to-bonnet leak was identified by the licensee, the unit was in the hot standby condition (Mode 3) following a reactor trip during main condenser thermal backwashing. The inspector learned that the licensee had considered a plant cooldown to repair the leak at this time, but had decided to perform a temporary leak repair instead due, in part, to concerns regarding the effect of the cooldown on the performance of the mechanical seal on the "D" reactor coolant pump.

Plant startup commenced on May 25 and full power was achieved on May 27. The licensee planned to perform the temporary repair by injecting sealant directly into the valve gasket area through fittings drilled and threaded into the split line and installing an external sealant-retaining clamp. In the long term, the licensee planned to permanently repair or replace the valve during the next regularly scheduled outage. From June 4 to August 5 the valve was injected with sealant with varying degrees of success. Two leak repair vendors were involved in this activity under the direction of unit maintenance engineering. The valve was injected approximately 30 times using an estimated 0.63 gallons of sealant before the shutdown on August 5.

Valve RC 8085 was cut out of the system on August 8 and moved to the reactor building for disassembly and inspection under the direction of a licensee investigation team. The inspector witnessed portions of this activity, examined the disassembled valve, and reviewed the licensee's findings. The valve body and bonnet had been peened excessively. The entire body-to-bonnet split line of the valve had damaged metal. There was a chisel groove starting one-half inch below the split line at the southwest corner stud which extended approximately 1-1/2 inches across the south face of the body. The groove had been peened partially, and was 1/8 to 3/16 inches deep. Three of the four injection fittings adjacent to the studs on the east and west sides of the valve were drilled past the outer diameter of the bonnet gasket and well into the gasket area. Sealant had penetrated all four stud holes. The valve showed no signs of damage from steam cutting, or indication that sealant had been injected into the process flow areas (i.e., no mainlining). All four of the studs had thread damage from peening of the split line. The southwest corner stud also had been damaged slightly when an injection fitting was drilled too close to the stud hole. This stud had completely sheared in a brittle manner two threads below the surface of the body flange. The southeast corner stud also appeared to be bent slightly and had been damaged by drilling during the first attempt to install a valve clamp.

The licensee sent the valve and studs to an independent laboratory for detailed examination and failure analysis. Pending the results of this analysis, the stud failure mechanism is unresolved.

4.0 MAINTENANCE ACTIVITIES

The leak repairs on valve RC 8085 were performed under automated work orders (AWOs) issued on June 4 (M2-93-7225), June 10 (M2-93-07864), and June 11 (M2-93-07939). The repairs were to be implemented in accordance with instructions contained in nonconformance reports 293-090, 293-091 and 293-094, respectively. Each AWO package contained four documents providing guidance for the repair activities: a nonconformance report (NCR) disposition, Maintenance Procedure MP-2721M, "Leak Sealing Procedure," Station Form SF-365, "Checklist For 'Injection' Repair Engineering Evaluation," and engineering memoranda referenced by the preceding documents. The inspector reviewed the AWO packages to identify the quality attributes needed to ensure the valve's structural integrity and to prevent injecting sealant into the RCS. All of the AWOs included the following guidance:

- Injection fittings to be drilled between stud holes to ensure structural integrity of flange load carrying sections (two AWOs contained sketches showing load path areas to be avoided)

- Injection fittings to be drilled in non-pressure retaining section of the bonnet flange; i.e., do not drill past the outer gasket diameter

- Injected sealant volume to be limited to avoid mainlining into the RCS

- Injection pressure to be selected such that ASME Code allowable stress limits are not exceeded for the limiting valve component

- Peening of entire circumference of the valve is prohibited

The inspector noted that no limits were placed upon the number of times the valve could be injected; that no quantitative guidance was provided regarding proximity of the fittings to the valve studs; and that no caution or prohibition regarding peening of the valve near the studs existed. The inspector concluded that these deficiencies were contrary to Step 6.3.1 of Procedure ACP-QA-2.02C, "Work Orders," which requires that all procedures and forms referenced in AWO packages be reviewed to ensure that adequate guidance is provided for work to be performed. As a result, the valve was injected about 30 times; the fittings were installed very close to the studs, damaging one stud which ultimately sheared; and all four studs were damaged by peening. In addition, contrary to Procedure MP-2721M, the entire circumference of the valve was peened, and three out of four of the injection holes were drilled past the outer diameter of the gasket and into the pressure retaining section of the bonnet flange. The inspector also noted that the peening of valve surfaces was excessive and not controlled by licensee personnel as evidenced by their inability to determine when and how the chisel groove on the body surface occurred.

The inspector determined that from June 4 to July 23, the only quality control (QC) hold point listed in the inspection plans (Form SF-207) was to verify sealant injection pressure. The inspector reviewed licensee administrative procedures to determine requirements for QC hold points. Procedure ACP-QA-2.02C, Step 6.3.4, requires the identification of quality attributes from design documents, procedures, codes, specifications, and standards. Acceptance criteria against which success/failure of the inspection may be judged were also required. Procedure ACP-QA-3.33, "Performance of Reviews For The Use Of 'Epoxy/Rubber' and 'Injection' Type Repair Materials," Section 5.3, requires the job supervisor to ensure that special conditions specified in checklist SF-365 are implemented in the AWO inspection plan. Three of the five attributes listed above were contained in Form SF-365; however, they were not included in the AWO inspection plans.

The inspector concluded that instructions to ensure proper installation of the injection fittings and to prevent damage to the valve studs had been inadequate; that the procedure and instruction steps contained in the AWO packages necessary to ensure a quality repair of valve RC 8085 had not been implemented; and that the inspection plans did not contain sufficient hold points to ensure proper implementation of the repair activity. This is an apparent violation of licensee procedures.

The inspector determined through interviews that maintenance personnel knew on June 4 that one injection fitting had been drilled past the outer diameter of the gasket. This nonconforming condition was not formally documented. The inspector also found that on June 10, licensee

personnel identified that all four injection valves had been installed into the valve load transfer path contrary to the guidance contained in the AWO package. The nonconforming condition was resolved as acceptable per a three-way memorandum, dated June 10. Nonetheless, in both cases, failure to initiate an NCR when nonconforming conditions were identified during the performance of work is contrary to Step 6.6.1.10 of Procedure ACP-QA-2.02C and Step 6.1.1 of Procedure ACP-QA-5.01, "Nonconforming Materials and Parts."

On June 12, an attempt was made to install an injection clamp onto the valve. This activity was controlled by AWO M2-93-07940, which referenced the disposition to NCR 293-094, dated June 11. The clamp installation included drilling of two holes per valve stud to inject sealant into the stud holes. Two holes were drilled through the bonnet in the vicinity of the southeast stud before it was determined that the clamp did not fit the valve.

The inspector found that the drilling was not documented in the AWO, and that the maintenance engineer had not been aware that the holes had been drilled. In addition, the inspector learned that the AWO had not been authorized by the operations department prior to being performed.

Believing that no work actually had been performed under the AWO, the licensee canceled it. The licensee subsequently determined that the holes had been drilled too deeply, contrary to the NCR disposition, and that the southeast stud had been damaged by the drilling. Performance of work without authorization by operations and cancellation of an AWO under which work has been performed are counter to the direction provided in steps 6.5.8.2 and 6.18.1, respectively, of Procedure ACP-QA-2.02C, "Work Orders." The inspector concluded that this activity was symptomatic of a breakdown in the licensee program for control of work on quality components.

The inspector noted during review of AWOs and through discussions with licensee personnel that reconstruction of work performed on valve RC 8085 was difficult because the AWOs did not indicate clearly which fittings were injected (and how much sealant was used) on any given occasion. Also, when and by how much the valve split line had been peened was not always documented. In addition, the inspector noted several discrepancies regarding implementation of Procedure ACP-QA-2.02C:

- Purchase order and vendor names were not identified on two AWOs, contrary to Steps 6.2.5 and 6.16.2.1.

- The "Surveillance Requested" block on three AWOs was not completed for vendor services, contrary to Step 6.2.7.3.

- Light grinding, buffing, and a dye penetrant test were performed on the valve without an operations authorization signature, contrary to Step 6.5.8.2.

- Commercial grade sealant was dedicated for use on the valve using an NCR, contrary to Step 6.6.1.29.

- The department approval line of three AWOs was not signed by a vendor representative, contrary to Step 6.16.3.6.

The inspector concluded that while these items individually had little safety significance, they indicated a significant pattern of lack of attention to detail by licensee personnel.

On June 15, maintenance submitted a request to evaluate welding a sealant-retaining clamp onto the valve. Between June 18 and July 7, the valve did not leak. The valve was reinjected on July 8 and 9. On July 13, AWO M2-93-08812 was initiated to take dimensions on the valve and to fabricate the clamp. The AWO was assigned a priority of "3", which, per ACP-QA-2.02C, is routine work to improve unit performance, availability, and operability and should be scheduled and completed in a timely manner. The inspector noted that the sealant injection AWO's had been assigned a priority of "2" and judged that the lower priority assigned to the clamp work indicated the licensee concluded that the leakage was under control. The sealant-retaining clamp evaluation was received by the unit on July 28, and reflected in the disposition to NCR 293-113, dated August 3. The AWO to install the clamp was released on August 5. The inspector concluded that the licensee did not approach installation of the clamp with a sense of urgency commensurate with the consequences of a valve failure.

Through interviews with licensee personnel, the inspector determined that maintenance supervisors often deferred to the expertise of the vendors and did not exercise direct technical oversight of vendor activities at the job site. This resulted in the conditions adverse to quality listed above such that the integrity of the valve was degraded severely, forcing a plant shutdown. The inspector also noted that maintenance supervision and management failed to initiate NCRs for nonconformances that occurred due to the failure to follow procedures and instructions. The inspector acknowledged that a self-initiated investigation into the performance of the first vendor resulted in their removal from the job on June 11. However, a vendor NCR was not generated, and at the end of the inspection period the vendor remained conditionally approved to perform safety-related work at the plant.

The inspector also noted that maintenance management initiated a debriefing of the job in early July to determine whether the leak sealing activities could be enhanced. The recommendations focused primarily on radiological and industrial safety considerations, personnel protection, and comfort. The nuclear safety consequences of a nonisolable RCS leak were not addressed. Nevertheless, further injection of the valve continued, and a comprehensive reevaluation of the repair technique and the nuclear safety implications of the degrading condition of the valve was not performed.

The inspector noted that the Maintenance Manager did not inspect the valve directly in the containment until August 2, at which time he recommended shutdown of the unit. Although the degraded overall condition of the valve was noted, licensee response to the shutdown recommendation focused on the engineering evaluation of an apparent crack in the body of the valve near the errant chisel mark. Licensee attention then refocused on the repair activities, rather than the safety implications of the degraded condition of, and continuing leakage from, the unisolable valve. The inspector concluded that maintenance supervision and management were ineffective in overseeing repair activities and in considering the safety implications of continued sealant injection of an unisolable RCS boundary valve. Plant shutdown was not seriously considered.

5.0 ENGINEERING AND TECHNICAL SUPPORT

The inspector reviewed Form SF-365, the licensee checklist completed in accordance with Procedure ACP-QA-3.33 to ensure that evaluation of design considerations relevant to the performance of leak sealing activities was performed. The form considered the physical condition of the valve studs and nuts, chemical compatibility of sealant with system materials and the reactor coolant, valve stress analysis, system evaluation to limit volume of sealant injected,

seismic evaluation of the valve including weight of sealant and injection fittings, industrial and personnel safety concerns, radiation exposure, and retest requirements. However, the inspector noted that some of the conclusions reached in the evaluation were based on engineering judgement rather than rigorous analysis and were not well documented before the activity commenced. The inspector considered that this informality was not commensurate with the safety significance of a potential failure of this valve (small break loss of coolant accident) and severe injury or death of personnel. The inspector also identified the following weaknesses in the licensee's evaluation:

- No root cause evaluation of the body-to-bonnet leak was performed prior to performing the leak repair.
- Stress calculations did not consider effects of peening the split line or the thermal effects caused by repetitive isolation and restoration of letdown flow.
- No limits were established on the number of times the valve could be injected.

Detailed guidance for the implementation of on-line leak sealing at nuclear power plants was promulgated to the industry in July 1989 (EPRI NP-6523-D). This document provides specific details of leak sealing techniques and specifies precautions needed to ensure that leak sealing activities are performed safely. The inspector found that the licensee was not familiar with this document and that certain precautions listed were not incorporated in the licensee's leak sealing procedures. In particular, the fact that improper peening can result in excessive loading of flange bolts; that the leak sealing process constitutes a modification to the plant; that reinjections should be limited and carefully evaluated; and that clamp-type (enclosure) leak sealing requires careful assessment of the condition of the closure studs were not adequately covered in Procedures MP 2721M or ACP-QA-3.33.

The inspector also identified engineering performance weaknesses during the leak repair activities. Lack of engineering presence at the job site may have contributed to a lack of appreciation for the degrading condition of the valve as repair activities continued to be performed. The discrepancies, which resulted from the lack of control over the repair activities, required engineering resources to be focused on justification of the repair nonconformances rather than the accumulated effects of the repair activities and the continued appropriateness of further injections.

Poor communication/support between maintenance and engineering staffs occurred on several occasions. At site request, a calculation was performed which justified a significant increase in the maximum sealant injection pressure. The calculation assumed that the injection fittings would not be installed at certain areas of the split line near the studs. By the time the calculation was forwarded to the site, the four fittings had already been installed in the prohibited areas. Also, the fact that some of the injection fittings may have been drilled past the outer diameter of the gasket was not communicated to engineering. On June 15, the unit requested that engineering evaluate welding a sealant clamp onto the valve. Despite the fact that direct injection of the valve continued to be unsuccessful, engineering's formal response was not expedited and, therefore, not completed until late July.

The inspector questioned the licensee's position that the repair was a maintenance activity rather than a modification to the valve, despite the installation of injection fittings into the split line, the proposed addition of an external clamp, peening of the split line, drilling into the gasket area, and changes in stresses to the valve as a result of the leak sealing process. The inspector considered that the changes to the valve required a safety evaluation pursuant to 10 CFR 50.59.

The inspector concluded that lack of effective engineering involvement in field activities and inadequate scope of engineering evaluations of leak sealing activities contributed to an ongoing decrease in the margin of safety designed into valve RC 8085.

6.0 QUALITY VERIFICATION

The inspector reviewed the Quality Services Department's (QSD) role with respect to the valve RC 8085 repairs to assess program effectiveness. The inspector found that QSD involvement consisted of inspection and surveillance activities. Regarding inspections, Procedure ACP-QA-2.02C, Step 6.4, required quality control (QC) personnel to review and approve AWO packages per Procedure QSD-4.05, "Review of Work Orders. Section 6.4 of Procedure QSD-4.05 states that inspection plans are a place to document inspection attributes "agreed" to by QSD and the lead department head. The QSD reviewer is directed to consider where deviations from expected results may occur and, where independent verification would be desired to ensure that work performed on safety-related systems meets code, technical specification, procedure, or good workmanship practices. The step further indicates that hold points are negotiated by the parties involved in the activity to be inspected.

As noted in Section 4.0 of this report, the inspection plans associated with valve RC 8085 were very limited and failed to include several important quality attributes. Lack of critical technical review of the work activity was evident in the QSD reviewer's approval of the inspection plan. Based on interviews, the inspector determined that the ongoing poor maintenance practices were not focused on by the QC inspectors who attended these repairs. This occurred because the assigned coverage was limited in scope and because unit management had, in the past, discouraged inspectors from exceeding their assigned inspection scope. The NRC concluded that the QC inspectors complied with the requirements of the inspection plans and performed the tasks which they were expected to perform. But, in so doing, the QSD failed to function effectively in assuring a quality repair of the valve. The inspector also concluded that Procedure QSD-4.05 establishes a possible framework for loss of independence of the quality assurance function in its apparent emphasis on negotiation of hold points with the inspected department.

QSD surveillance of leak repair vendor services was required by Step 6.2.7.3 of Procedure ACP-QA-2.02C. In addition, the purchase orders applicable to both vendors required performance of surveillances to verify compliance with approved procedures. Procedure MP-2721M, "Leak Sealing Procedure," was listed explicitly in the purchase orders. The inspector reviewed the QSD surveillance reports associated with the valve work. Numerous examples of procedure and instruction noncompliances were identified by the NRC in Section 4.0 of these reports. The surveillance reports concluded, however, that no procedural or programmatic noncompliances were observed. Through discussions with QSD personnel the inspector found that the surveillances were limited to inspection plan hold point verification and general observation of radiological and industrial safety practices. Based on the limited scope of observed activities, the inspector questioned the broad conclusions contained in the surveillance reports, and was concerned that the reports could result in unconditional approval by the licensee of marginal vendors. Also, to the extent that the scope of the surveillances was driven by the AWO inspection plan developed by the lead department, the independence of this important quality assurance function was potentially degraded.

The inspector concluded that the QSD coverage of the work on valve RC 8085 was ineffective in preventing conditions adverse to quality. Based on the discussions with maintenance management and QSD personnel, the inspector concluded that the level of QSD involvement in

this repair had met the QA program expectations. Therefore, the inspector concluded that this event represented a potential breakdown in the licensee's quality assurance program in that the expectations were too low.

7.0 MANAGEMENT INVOLVEMENT

The body-to-bonnet leak from valve RC 8085 was discovered on May 24 while the plant was in the hot standby condition (Mode 3) following a reactor trip. Unit management considered cooling down to repair the valve but decided to start up on May 25 based on (1) concern to minimize perturbing the "D" reactor coolant pump seal and (2) the confidence that the sealant injection process had been used successfully at the unit in the past. The specific application of leak seal techniques to this nonisolable RCS penetration did not, however, receive appropriate management focus and oversight commensurate with the consequences of a valve failure. From discovery of the leak on May 24 until August 2, when a possible through-wall leak was discovered on the valve body, plant management relied primarily on the ability to fabricate and install a sealant injection clamp to stop the leak. The number of times that the valve was being injected and the deteriorating condition of the valve appeared not to be a significant safety concern. The inspector noted that management oversight and control of in-field activities were inadequate, and the Plant Review Board was not significantly engaged in this process. As evidenced by the period between June 15 and July 28, during which time the plant awaited engineering evaluation of welding the clamp to the valve body and bonnet, the inspector concluded that there was little sense of urgency regarding fabrication/ installation of the clamp. Not until a potential through-wall leak was discovered near the split line of the valve was fabrication of the clamp placed on an expedited schedule.

The inspector concluded that the engineering calculations demonstrated unwarranted margins of safety for the valve. Undermining the calculations was a lack of appreciation regarding the degraded physical condition of the valve. The inspector concluded that there was a lack of questioning attitude within the unit staff regarding the appropriateness of continuing with the leak repair activities. Site and corporate management showed an apparent willingness to tolerate the ongoing inability to stop the leak and the lack of urgency in implementing the clamp installation. In addition, senior managers were generally familiar with the ongoing difficulty in repairing this leak but did not cause the unit to appropriately reassess the safety significance of continuing the repair activities on this nonisolable RCS penetration. The inspector concluded that the licensee's management activities regarding this issue were not commensurate with the potential safety consequences of a valve failure.

Valve RC 8085 Event Chronology

May 24

- Reactor tripped during main condenser thermal backwashing
- Light wisp of steam identified at valve RC 8085 body-to-bonnet joint (split line)

May 25

- Reactor startup commenced
- Unit at full power

- Maintenance engineering contacted valve vendor (Velan) regarding availability of replacement valve

June 4

- Small steam wisps from valve split line at the east and west sides of the valve
- Automated work order (AWO) M2-93-07225 released to perform sealant injection repair - Leak Repair, Inc.
- Installed first injection fitting and injected valve at the northwest (NW) position - leak did not stop
- Installed second injection fitting and injected valve at the southeast (SE) position - leakage present at SE fitting

June 11

- AWO M2-93-07864 released to install additional fittings and to perform sealant injection
- Installed third and fourth injection fittings at the northeast (NE) and southwest (SW) positions and injected valve - leak not stopped
- Injected first two fitting - leak not stopped

June 12

- Injected valve - leak slowed
- Removed injection fittings to install injection clamp fabricated by Leak Repair, Inc. - clamp did not fit
- Two holes drilled through bonnet at southeast (SE) stud per AWO M2-93-07940.
- Reinstalled fittings, peened split line, and injected valve - leak not stopped
- Leak Repair, Inc. replaced by Furmanite, Inc.
- AWO M2-93-07939 released to perform leak repair of valve - Furmanite, Inc.
- Valve injected, but sealant extruded from split line
- Attempted to inject valve, but sealant would not travel - leak rate 0.63 gallons per minute
- Peened valve split line and injected - leak not stopped
- Injected valve - leak stopped
- Leak Repair, Inc. fitting at SE position fell out - leak restarted

June 13

- Installed adapter and new fitting, and injected valve - leak rate 1 to 2 drops per minute
- Injected valve - leak stopped

June 14

- Velan provided quotation for replacement valve - 24 week lead time
- Peened split line and injected valve - leak stopped
- Closed circuit television installed in control room to monitor valve leakage
- Engineering requested to perform evaluation of ASME Code and examine practicality of proposal to weld bar stock on two sides of valve for clamping strength, and to "seal weld" split line of remaining sides
- Work commenced on design/fabrication of injection clamp - day shift coverage

June 18

- Injected valve - leak not stopped
- Injected three fittings (NE, SE, SW positions) - leak stopped
- Leakage restarted two hours later at SE fitting

- Injected all four fittings - leak stopped

June 22
- Velan informed maintenance engineering that one-for-one replacement valve not available

June 24
- Maintenance engineering initiated inquiries with valve vendors regarding replacement valve

July 3
- Leak restarts

July 7
- Redrilled and injected four fittings - leak stopped

July 8
- Tapped and installed adapter and new fitting at SW position and injected valve - leak stopped
- Leak restarted three hours later
- Injected valve - leak stopped
- Leak restarted three hours later
- Injected valve - leak not stopped

July 9
- Reactor coolant system unidentified leakage 0.58 gallons per minute
- Peened and injected valve - leak stopped
- Conference call between licensee and NRC Region I regarding status of valve

July 13
- AWO M2-93-08812 released to obtain valve dimensions and fabricate injection clamp

July 23
- Maintenance engineering contacted Divesco for one-for-one replacement valve from "cancelled plant" spares - no valve available alternate valves considered
- Injected valve - leak stopped
- Leak restarted - reinjected valve - leak stopped

July 26
- Maintenance engineering contacted another valve vendor and obtained list of replacement valves available
- Licensee searched NPRDS for one-for-one spares at other utilities - no butt weld Velan valves available
- In-stock inventory searched - no QA Class 1 replacement valves available

August 1
- Peened and injected valve - leak stopped

August 2

- Injected valve - leak stopped, then restarted
- Injected valve - slight leakage
- Furmanite personnel observed apparent linear indication/surface defect and through-wall leakage below split line on south face of valve body Peened area and informed maintenance personnel
- Maintenance manager, engineering, and quality services personnel inspected valve and noted a chiseled groove (1 -1/2 inches long by 3/16 inch deep) on the valve body near the southwest body-to-bonnet stud, 1/2 inch below the split line - confirmed apparent through-wall leakage
- Maintenance manager contacted unit director and recommended shutdown of the unit
- Fabrication of valve injection clamp expedited -24-hour coverage

August 3

- Stress analysis and materials engineers arrive on-site to inspect and evaluate condition of valve - concluded that leakage originated from pressurized stud hole rather than through-wall leakage
- Started stress calculations to evaluate structural integrity of valve assuming failure of one body-to-bonnet stud
- Conference call conducted between licensee, NRC Office of Nuclear Reactor Regulation (NRR), and NRC Region I regarding condition of valve
- Peened and injected valve through fittings at SW and NW positions. Leak stopped momentarily, then restarted at the SE position
- Performed "informational" dye penetrant examination of suspect area of valve body - results inconclusive
- Second conference call conducted between licensee and NRC Region I regarding dye penetrant test results
- Stress analysis engineering completed reviews to allow installation of socket welded replacement valve

August 4

- Peened and injected valve- leakage stopped
- Furmanite maintained constant injection pressure on fitting at SW position to facilitate formal dye penetrant examination - after light grinding, examination showed no cracks in valve body
- Fitting at SW position developed steam plume
- Injected fittings at SW and NW positions
- Replacement valve vendor forwards quotation for new valve

August 5

- AWO M2-93-09431 released to weld injection clamp bar stock along north and south split lines of valve
- Peened and injected valve six times - Furmanite personnel observed valve bonnet lift slightly from body flange and sudden increase in valve leakage - repairs abandoned - reactor coolant system unidentified leakage greater than 1.0 gallons per minute
- Reactor shutdown commenced at 2:39 p.m.