# LICENSEE EVENT REPORT (LER)

| FACILITY NAME (1) | DOCKET NUMBER (2) | PAGE (3) |
|---|---|---|
| Washington Nuclear Plant - Unit 2 | 50-397 | 1 OF 5 |

TITLE (4) Reactor SCRAM and Plant Transient Due to Failed Closed Main Steam Isolation Valve

| EVENT DATE (5) | | | LER NUMBER (6) | | | REPORT DATE (7) | | | OTHER FACILITIES INVOLVED (8) | |
|---|---|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YEAR | YEAR | SEQUENTIAL NUMBER | REV. NUMBER | MONTH | DAY | YEAR | FACILITY NAME | DOCKET NUMBER |
| 03 | 11 | 98 | 98 | 002 | 00 | 04 | 09 | 98 | FACILITY NAME N/A | DOCKET NUMBER |

| OPERATING MODE | | THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 20.402(b) | | 20.405(c) | X | 50.73(a)(2)(iv) | | 73.71(b) | |
| POWER | | | 20.405(a)(1)(i) | | 50.36(c)(1) | | 50.73(a)(2)(v) | | 73.71(c) | |
| | 100 | | 20.405(a)(1)(ii) | | 50.36(c)(2) | | 50.73(a)(2)(vii) | | OTHER | |
| | | | 20.405(a)(1)(iii) | | 50.73(a)(2)(i) | | 50.73(a)(2)(viii)(A) | | | |
| | | | 20.405(a)(1)(iv) | | 50.73(a)(2)(ii) | | 50.73(a)(2)(viii)(B) | | | |
| | | | 20.405(a)(1)(v) | | 50.73(a)(2)(iii) | | 50.73(a)(2)(x) | | | |

LICENSEE CONTACT FOR THIS LER (12)

| NAME | TELEPHONE NUMBER (Include Area Code) |
|---|---|
| Bill Pfitzer, Licensing Engineer | 509-377-2419 |

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

| CAUSE | SYSTEM | COMPONENT | MANUFACTURER | REPORTABLE TO EPIX | | CAUSE | SYSTEM | COMPONENT | MANUFACTURER | REPORTABLE TO EPIX |
|---|---|---|---|---|---|---|---|---|---|---|
| B | LD | TBG | unknown | Y | | | | | | |
| | | | | | | | | | | |

| SUPPLEMENTAL REPORT EXPECTED (14) | | | EXPECTED | MONTH | DAY | YEAR |
|---|---|---|---|---|---|---|
| | YES (If yes, completed EXPECTED SUBMISSION DATE). | NO | | | | |


ABSTRACT: At 0516 on March 11, 1998, with the plant operating at 100% power in Mode 1, WNP-2 experienced a plant transient and SCRAM initiated by closure of a single inboard main steam isolation valve (MSIV), MS-V-22D.

Immediately after closure of the single MSIV, a reactor SCRAM occured due to instantaneous high neutron flux, and steam flow was diverted to the remaining three steam lines, causing a high steam line flow condition of 140% flow, and automatic isolation of all MSIVs. Reactor Pressure Vessel (RPV) pressure immediately peaked and was limited to approximately 1090 psig by automatic lifting of two main steam safety relief valves (MSRVs). Due to the pressure peak, sensed vessel level decreased to Level 2 which caused initiation of the Reactor Core Isolation Cooling (RCIC) and High Pressure Core Spray (HPCS) systems. Approximately 60 seconds after the SCRAM, reactor level recovered to above Level 8 causing automatic curtailment of RCIC and HPCS injection. When level subsequently dropped to below the high level trip setpoint, RCIC was manually restarted for RPV level control, and pressure was being controlled by manual MSRV operation. Due to loss of drywell cooling, drywell pressure peaked at about 1.60 psig approximately 11 minutes into the event. The drywell pressure peak caused automatic starting of the emergency diesel generators, and partial makeup of low pressure Emergency Core Cooling System (ECCS) start logic (nominal setpoint at 1.68 psig). At approximately 50 minutes into the event, a second reactor SCRAM occurred due to RPV low level at +13 inches. This second SCRAM is the subject of LER 98-003.

The cause of the closure of MS-V-22D was loss of pneumatic actuating supply pressure due to a cyclic fatigue failure of the supply line tubing. The tubing was reworked to a configuration less susceptible to cyclic fatigue, and other MSIV supply tubing configurations were inspected. The safety consequences of this event were minimal.

| FACILITY NAME (1) | DOCKET NUMBER (2) | LER NUMBER (6) | | | PAGE (3) |
|---|---|---|---|---|---|
| | | YEAR | SEQUENTIAL NUMBER | REVISION NUMBER | |
| Washington Nuclear Plant - Unit 2 | 50-397 | 98 | 002 | 00 | 2 OF 5 |

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

Event Description

At 0516 on March 11, 1998, with the plant operating at 100% power in Mode 1, WNP-2 experienced a plant transient and SCRAM initiated by closure of a single inboard main steam isolation valve MS-V-22D [ISV].

Immediately after closure of the single MSIV, the resulting RPV pressure increase caused collapse of reactor coolant voids, causing in turn, a reactor SCRAM due to instantaneous high neutron flux of ≥118%. Concurrent with the SCRAM, and also owing to closure of the single MSIV, steam flow was diverted to the remaining three steam lines, causing a high steam line flow condition of >140% flow, and automatic isolation of all MSIVs. Upon closure of the MSIVs, RPV pressure immediately peaked and was limited to approximately 1090 psig by automatic lifting of two MSRVs [RV]. Due to the pressure peak, further pressure-induced steam void collapse occurred, and sensed vessel level decreased to Level 2 (-50") which caused initiation and injection of the RCIC [BN] and HPCS [BG] systems. The Level 2 condition also caused tripping of the Reactor Recirculation (RRC)[AD] pumps and the Reactor Closed Cooling (RCC)[CE] pumps which provide cooling to the drywell atmosphere, and the expected containment isolations, including isolation of the Reactor Water Cleanup (RWCU)[CE] system. At this time the operating crew had entered emergency operating procedures for low RPV level.

Approximately 60 seconds after the SCRAM, with the HPCS and RCIC systems injecting, reactor level recovered to above Level 8 (+54") causing the RCIC steam supply valve and HPCS injection valve to automatically close, and the Reactor Feedwater pumps to trip. When level subsequently dropped to below the high level trip setpoint, RCIC was manually restarted for RPV level control. Also at this time, RPV pressure was being controlled by manual MSRV operation. Additionally, one loop of Residual Heat Removal (RHR)[BO] suppression pool cooling was placed in service by the operating crew to limit heat up of the suppression pool water due to MSRV operation. At this time the emergency operating procedure entry condition for high wetwell level of +2 inches was met.

Due to heatup of the drywell atmosphere, drywell pressure peaked at about 1.60 psig approximately 11 minutes into the event, and then began to decrease after the operating crew re-established RCC to the drywell. The drywell pressure peak caused an automatic start of the emergency diesel generators [DG], realignment of RHR system valves for anticipated injection, and partial makeup of low pressure ECCS start logic (nominal setpoint at 1.68 psig). However, because actual drywell pressure peaked just below the ECCS actuation pressure switch setpoint, some elements in the low pressure ECCS pump start logic remained unsatisfied, and therefore no low pressure ECCS pumps started during the event. Also, at about 30 minutes into the event, the emergency operating procedure entry condition for high suppression pool temperature of ≥90 °F was met.

| FACILITY NAME (1) | DOCKET NUMBER (2) | LER NUMBER (6) | | | PAGE (3) |
|---|---|---|---|---|---|
| | | YEAR | SEQUENTIAL NUMBER | REVISION NUMBER | |
| Washington Nuclear Plant - Unit 2 | 50-397 | 98 | 002 | 00 | 3 OF 5 |

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

At approximately 40 minutes into the event, the initial SCRAM was reset to minimize temperature stratification in the lower RPV head area. Approximately 10 minutes later, during manual operation of MSRVs for RPV pressure control and manual operation of RCIC for level control, a second reactor SCRAM occurred due to RPV low level at +13 inches. This second SCRAM is the subject of LER 98-003.

The second SCRAM was subsequently reset, emergency operating procedures were exited when entry parameters were restored to normal and conditions were stable, and the RPV was depressurized per normal plant operating procedures using main condenser turbine by-pass valves. During the activity of re-opening MSIVs to allow depressurization to the main condenser it was recognized by the operations crew that MS-V-22D would not re-open.

10CFR50.72 reports were made addressing the initial SCRAM and MSIV isolation, the Engineered Safety Feature (ESF) actuations that occurred due to low RPV level, the ESF actuations that occurred due to high drywell pressure, and the second RPV low level SCRAM.

Immediate Corrective Action

A Problem Evaluation Request (PER) was written for the failure of MS-V-22D.

Plant Management initiated an investigation to determine the exact details of the event. Additional PERs were initiated for the problems found.

Further Evaluation

Although the cause of the SCRAM was not initially known, investigation revealed the cause to be inadvertent closure of MS-V-22D due to a failed Containment Instrument Air (CIA)[LD] tube supplying actuating nitrogen to the valve actuator. The ESF actuations that occurred due to low RPV level and high drywell pressure, which are also reportable per 10CFR50.73, were a direct and expected result of the initial SCRAM.

A detailed review of the Final Safety Analysis Report (FSAR) and related documentation was performed to verify the observed plant power level response, RPV pressure and level response, and containment pressure response were as predicted by analysis. Given the differences in plant operations and the analysis assumptions, the plant response to the event was consistent with the analyses.

A scenario very similar to the actual event was run on the WNP-2 simulator. With full MSIV closure, the RPV level decreased to approximately -27 inches during the simulation, versus approximately -50 inches experienced during the event. Changes in simulator modeling of pressure-induced RPV level effects are planned and are further detailed in LER 98-003.

| FACILITY NAME (1) | DOCKET NUMBER (2) | LER NUMBER (6) | | | PAGE (3) |
|---|---|---|---|---|---|
| | | YEAR | SEQUENTIAL NUMBER | REVISION NUMBER | |
| Washington Nuclear Plant - Unit 2 | 50-397 | 98 | 002 | 00 | 4 OF 5 |

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

Investigation revealed that the partial actuation of the low pressure ECCS pump start logic was as expected and in accordance with plant design. Drywell pressure peaked at just under the nominal trip setpoint for the pressure switches associated with the pump start logic, such that some switches actuated and others did not. An insufficient number of switches actuated in the start logic train to initiate automatic starting of any low pressure ECCS pump. Subsequent testing confirmed the proper operation of the drywell pressure switches associated with the low pressure ECCS pump start logic which did not actuate during the event. Plant Technical Specifications allow this logic actuation setpoint to be as high as 1.88 psig.

Cause of Event

The root cause of the SCRAM was the unplanned closure of MS-V-22D, which was in turn caused by loss of actuating medium, i.e., Containment Instrument Air, to the valve actuator. The 3/8 inch diameter CIA tubing supplying MS-V-22D experienced a circumferential failure due to cyclic fatigue. Inspection of the failed tubing configuration showed that the tubing forms an inverted "U" configuration, with a small vent valve mounted at the top. The cantilever length of the tube leg from the connection at the air operator to the top of the "U" was approximately 9 inches. The tubing was unsupported for a span of about 5 feet. The tubing configuration was in full compliance with plant design processes. In retrospect, it can be surmised that the vibration of the length of the cantilevered tube leg of the "U" with the vent valve on top was most likely near the vibration frequency of the MSIV to which it was connected, causing the cyclic fatigue cracking of the tube close to the rigid fitting connection. Further review revealed that the WNP-2 design process requires consideration of hydrodynamic and seismic loads, but does not explicitly require analysis of piping vibration. In accordance with WNP-2 design codes (ASME), this tubing is designed and analyzed for hydrodynamic and siesmic loads, and does not require vibration analysis.

Further Corrective Action

The CIA tubing supplying MS-V-22D was re-worked to shorten the cantilever length.

The CIA tubing configurations supplying the remainder of the MSIVs were inspected. All were found to have much shorter cantilever lengths and were judged less susceptible to cycling fatigue. Additionally, all fittings were checked for leaks.

Stress evaluations were performed for the CIA tubing configurations supplying all MSIVs.

| FACILITY NAME (1) | DOCKET NUMBER (2) | LER NUMBER (6) | | | PAGE (3) |
|---|---|---|---|---|---|
| | | YEAR | SEQUENTIAL NUMBER | REVISION NUMBER | |
| Washington Nuclear Plant - Unit 2 | 50-397 | 98 | 002 | 00 | 5 OF 5 |

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

Assessment of Safety Consequences

After the SCRAM and MSIV isolation the operations crew correctly implemented the emergency operating procedures to shutdown, stabilize, and maintain the plant in a safe condition. This event was within the bounds of the WNP-2 safety analysis. Accordingly, this event posed no threat to the safety of plant personnel or the public.

Similar Events

One recent previous event involved a plant SCRAM while at power accompanied by an MSIV isolation. LER 93-027 reported an event where a single MSIV closed due to problems encountered during surveillance testing. The isolation of the single MSIV resulted in 140% flow to be sensed in the remaining lines, causing full MSIV isolation and a plant SCRAM.