NRC FORM 366 (6-89)

U.S. NUCLEAR REGULATORY COMMISSION

# LICENSEE EVENT REPORT (LER)

APPROVED OMB NO. 3150-0104
EXPIRES: 4/30/92
ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE RECORDS AND REPORTS MANAGEMENT BRANCH (P-530), U7.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1): Susquehanna Steam Electric Station - Unit 1

DOCKET NUMBER (2): 0 5 0 0 0 3 8 7

PAGE (3): 1 OF 0 7

TITLE (4): Potential Plugging Of ECCS Suction Strainers By Containment Debris.

| EVENT DATE (5) | | | LER NUMBER (6) | | | REPORT DATE (7) | | | OTHER FACILITIES INVOLVED (8) | |
|---|---|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YEAR | YEAR | SEQUENTIAL NUMBER | REVISION NUMBER | MONTH | DAY | YEAR | FACILITY NAMES | DOCKET NUMBER(S) |
| 0 6 | 1 1 | 9 3 | 9 3 | — 0 0 7 — | 0 1 | 0 9 | 1 1 | 9 5 | SSES - Unit 2 | 0 5 0 0 0 3 8 8 |
| | | | | | | | | | | 0 5 0 0 0 |

OPERATING MODE (9): 1

POWER LEVEL (10): 1 0 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: *(Check one or more of the following)* (11)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20.402(b) | | 20.405(c) | | 50.73(a)(2)(iv) | | 73.71(b) |
| | 20.405(a)(1)(i) | | 50.36(c)(1) | | 50.73(a)(2)(v) | | 73.71(c) |
| | 20.405(a)(1)(ii) | | 50.36(c)(2) | | 50.73(a)(2)(vii) | X | OTHER *(Specify in Abstract below and in Text, NRC Form 366A)* Voluntary |
| | 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(1)(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: Robert Kichline - Project Licensing Specialist

TELEPHONE NUMBER: AREA CODE 7 1 7 — 5 4 2 - 3 2 8 9

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

| CAUSE | SYSTEM | COMPONENT | MANUFAC-TURER | REPORTABLE TO NPRDS | CAUSE | SYSTEM | COMPONENT | MANUFAC-TURER | REPORTABLE TO NPRDS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
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SUPPLEMENTAL REPORT EXPECTED (14)

☐ YES *(If yes, complete EXPECTED SUBMISSION DATE)* ☒ NO

EXPECTED SUBMISSION DATE (15): MONTH | DAY | YEAR

ABSTRACT *(Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines)* (16)


A voluntary LER was initially submitted to provide the NRC with preliminary results of PP&L actions upon identification of the ECCS suction strainer issue. This supplement addresses PP&L's corrective actions to the concern. PP&L has assessed the impact on ECCS suction strainers of debris, corrosion products and fibrous materials that may become dislodged as a result of a pipe break in containment, and has confirmed the operability of the ECCS systems. This evaluation was performed under our Engineering Deficiency Report Program. Various sources of debris (fibrous insulation, coating material, corrosion products) existed in containment and could be drawn to the suction strainers of the ECCS pumps during inventory make-up and containment cooling functions. Many uncertainties were evaluated to assess this condition including: 1) pipe break cone of influence; 2) amount of insulation damage; 3) transport of material to wetwell; 4) insulation effects on strainer flow; and amount of other foreign material in the containment. Actions to address this concern included: removal of fibrous insulation from HELB areas, testing to characterize the debris threat to strainer blockage, reduction in the amount of unqualified paint in containment, quantification of corrosion products on the structural steel in the wetwell, and establishment of a comprehensive analysis of containment debris effects. Additionally, containment installation and coating procedures now contain requirements reducing the potential of ECCS suction strainer blockage.

| NRC FORM 366a (6-89) U.S. NUCLEAR REGULATORY COMMISSION<br>LICENSEE EVENT REPORT (LER) TEXT CONTINUATION | APPROVED OMB NO. 3159-0104 EXPIRES: 4/30/92<br>ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE RECORDS AND REPORTS MANAGEMENT BRANCH (P-530), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503. |
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| FACILITY NAME (1) | DOCKET NUMBER (2) | LER NUMBER (6) YEAR | SEQUENTIAL NUMBER | REVISION NUMBER | PAGE (3) |
|---|---|---|---|---|---|
| Unit 1<br>Susquehanna Steam Electric Station | 0 5 0 0 0 3 8 7 | 9 3 | — 0 0 7 | — 0 1 | 2 OF 7 |

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

## DESCRIPTION OF CONDITION

PP&L has assessed the impact on ECCS suction strainers of debris, corrosion products and permanently installed fibrous materials (e.g., insulation) that may become dislodged as a result of a pipe break. Prior to the issuance of NRC Bulletin No. 93-02, a PP&L Engineering Deficiency Report (EDR) was issued identifying the need to address the impact that corrosion products may have on existing calculations for ECCS suction strainer plugging. This EDR resulted in the generation of an evaluation of the ECCS suction strainer plugging issue. A summary of this evaluation is presented below.

Various sources of debris were known to exist within the SSES containment which could potentially result in ECCS suction strainer plugging. These sources included: fibrous insulation material (primarily Nukon); unqualified paint / coatings; and corrosion products. The fibrous insulation material was located on piping and pipe supports within the drywell. The unqualified paint / coatings was found to be located on walls, piping, components and under insulation within the containment. The corrosion products were found to be located on coated surfaces of structural steel and piping found in the upper elevations of the wetwell. Following a large pipe break, significant amounts of this debris could potentially become dislodged and transported to the suppression pool. The ECCS pumps, while performing the inventory makeup and containment cooling functions, could draw this debris onto the suction strainers and could potentially affect those functions.

The intent of these strainers, as identified in the original GE system design specifications, is to trap relatively large particles of general debris which were assumed to be suspended in the suppression pool inventory. The holes are sized to prevent this debris from plugging the drywell / wetwell spray and vessel Core Spray sparger nozzles. The strainers were originally designed to accommodate a 50% blockage condition and provide adequate NPSH for the ECCS pumps. However, this blockage was not based on a calculated amount of debris generations, but was done under the expectation that strainer blockage could be possible.

Subsequent evaluations were performed to quantify the amount of debris generated and its impact on ECCS suction strainer plugging. These evaluations considered that during a large pipe break condition, debris from the drywell and wetwell could be introduced to the suppression pool. However, these initial evaluations did not fully consider the manner in which the debris is generated or the presence of corrosion products. The insulation that is blown off the pipe supports would likely consist of a mixture of individual fibers, small clumps and large sheets. A portion of these materials could reach the suppression pool during the blowdown phase, a portion could.wash down the downcomers during the flooding phase while the remainder would stay in the drywell. The corrosion products could be introduced directly into the suppression pool during the blowdown phase. Once in the pool, a portion could be transported to the ECCS suction strainers due to the velocities generated by pump operation. If sufficient debris accumulated on the strainers, plugging could result. This, in turn, could cause the flow area and available net positive suction head (NPSHA) for the ECCS pumps to fall below required values. Under worst case scenarios, this condition could lead to pump cavitation and severely restricted pump flow.

The various potential line breaks considered in the initial evaluation (main stream, feedwater, reactor recirculation) indicated that long-term operation of ECCS pumps could be threatened. The following assumptions were key factors in assessing the likelihood for the generation and transportation of fibrous insulation and other debris to the suction strainers:

1. Pipe Break Cone of Influence

   The amount of insulation debris generated was directly dependent upon the size of the pipe break cone of influence assumed. For this evaluation it is assumed that the insulation material within seven (7) pipe diameters of the break location would be dislodged by the fluid jet. This assumption was consistent with regulatory guidance and industry testing. If it could be demonstrated that a smaller cone size was more realistic, then the amount of insulation debris assumed would probably be less.

2. Amount of Insulation Material

   It is assumed that all insulation within the cone of influence is blown off the piping and hangers. Some of this material is disintegrated, while portions shielded from the direct jet may be of larger sizes. Larger pieces are more likely to become caught and remain in the drywell. Previous testing of insulation indicates that total failure of the Nukon Pillows should be assumed for any jet targets up to seven pipe diameters away from a high energy line break. Item 4 below addresses the quantity transported to the wetwell.

3. Time Duration of Jet

   The insulation material is expected to be dislodged almost instantaneously following a break. As the vessel blowdown proceeds, the consequence of the jet will continue to diminish.

4. Transport of Material

Once the insulation material is introduced to the drywell, it must be carried over to the suppression pool in order for the suction strainer blockage to begin. Depending on break location in the drywell, a significantly "torturous" path exists for the material to make its way into the suppression pool. It is expected that some quantities would become lodged on grating, platform steel, piping, cable trays, drywell coolers and other equipment. Once on the diaphragm slab elevation, the material must wash into the downcomers to reach the suppression pool and could possibly cause strainer blockage. The downcomers are designed with 18-inch high lips to prevent material from entering the pool.

Once in the pool, some of the larger pieces of insulation would sink to the bottom as they become saturated, while smaller pieces would remain suspended for some period of time. Previous testing to determine the minimum velocity required to keep the insulation suspended was only conducted on large pieces of insulation. Velocities of around 0.3 ft/sec were measured. Based on conversations with the manufacturer, this testing was not representative of the behavior of individual insulation fibers. Velocities on the order of 0.1 ft/sec or less could be expected to keep individual fibers in suspension. Depending on the size of insulation in the pool and water velocities that exist, insulation will fall out of suspension to the bottom of the pool since the specific gravity of the material is greater than 1.0.

5. Insulation Effects on Strainer Flow

Depending on the quantity of insulation which could migrate to the strainers, either flow blockage or an increased pressure drop across the strainer would be experienced. Flow blockage could occur as a result of the other debris (paint, rust, dirt, etc.) becoming trapped in the layer of insulation. Uncertainty exists regarding the amount of insulation required to trap material; however, testing performed by utilities and data from industry events indicated that a large amount is not necessary. Prior to the onset of blockage, small fibers of insulation and other debris would flow through the strainer and not be of concern.

The head loss testing conducted to date was performed on fragments of insulation at low strainer face velocities. This testing may underestimate the head losses experienced when individual fibers are deposited on the strainers at elevated velocities.

6. Other Material

The quantity of "other material" or debris was a key factor in this report. Without this other material, complete blockage of flow is not expected. SSES contained a significant amount of unqualified coating in the containment; eighty percent of which was believed to be 'qualifiable'. The majority of the qualifiable coatings should survive a DBA environment. Of the coatings not expected to survive, some would fail as a powder, while the rest would fail as flakes. This debris could be transported to the suppression pool by washing down the downcomers. Once in the pool, this material can be held in suspension allowing it to be deposited onto the insulation accumulated on the strainer.

As a result of the blowdown and the hydrodynamic loading, debris in the form of rust would be introduced into the wetwell. The generation of this debris is expected to occur concurrent with the transportation of fibrous material from the drywell. It was assumed that sufficient quantities of this material would be available to become trapped by insulation at the strainers if the transport mechanism was sufficient to deposit it onto the strainers.

7. Transport Velocities in Wetwell

As noted under #4 above, a range of velocities from 0.1 to 0.3 ft/sec was conservatively assumed to provide sufficient motive force to transport insulation within the suppression pool. Depending on the number of pumps assumed to be in operation, suppression pool flow modeling indicated that sufficient transport velocities existed within the pool to enable debris to be drawn onto the suction strainers. Sufficient amounts of debris could be contained within the area influenced by each strainer to allow for complete strainer coating.

CAUSE OF CONDITION

Based on recent industry events and issues identified by our EDR, a review was conducted of the evaluations associated with ECCS suction strainer plugging. This resulted in the following concerns:

1. The combined impact of rust, paint and fibrous insulation on strainers was not fully evaluated in light of the rapid reduction in strainer performance observed at other plants.

2. All break locations had not been evaluated with regard to the amount of Nukon insulation generated in combination with other debris.

3. Modeling to account for transport of insulation and debris from the drywell and wetwell to the suction strainers may not have been performed properly and was subject to considerable uncertainty.

## REPORTABILITY/ANALYSIS

The initial LER was made as a voluntary report because our initial evaluation of this condition revealed a number of uncertainties of the effects of containment debris on ECCS suction strainers following a design basis accident. The areas of uncertainty include qualification of sources of debris within containment, amount of debris which would become dislodged, and transport of debris from their source to the suction strainers. For these reasons, a clear determination of reportability could not be made. However, it was clear that the issue had significant potential safety ramifications that were generic in nature.

The corrective actions discussed below provided additional data which was used to further assess this condition.

The operability of the ECCS function is assured based on our evaluation of the uncertainties involved and compensatory measures described below.

## CORRECTIVE ACTION

In addition to the EDR generated to address this condition, a major project was initiated to establish corrective actions to provide an additional margin of safety. These corrective actions included the following:

- Removal of Nukon insulation from all areas inside Unit 1 and Unit 2 containments within seven (7) pipe diameters of any postulated high energy line breaks.
- Testing of insulation to determine the concentrations required to plug the ECCS suction strainers. The results of the testing supported the decision to proceed with the replacement of fibrous insulation material (see above) with a reflective-metallic insulation system.
- LOCA qualification testing of inorganic zinc paint inside containment. This testing resulted in a substantial reduction in the amount of unqualified paint in the containment of both Units.

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- Testing to quantify the corrosion products (rust) on the structural steel in the wetwell. This testing determined that the vast majority of rust from the structural steel in the wetwell could not be maintained in suspension and did not contribute to flow blockage.

- Enhanced containment housekeeping and inventory controls will ensure that unacticipated debris does not adversely impact the performance of the suction strainers under design basis conditions.

- An evaluation of LOCA-generated debris effects consistent with the guidance in Regulatory Guide 1.82, Rev. 1, utilizing the information from the evaluations noted above, was performed to determine if the identified debris would cause unacceptable ECCS suction strainer blockage. The result of this calculation concluded that ECCS suction strainer blockage is bounded by existing analysis.

- Insulation specification, Specification M-1517, requires that future fibrous insulation installations inside containment are controlled, and evaluated for their impact on ECCS strainer plugging, and

- Coating specification, Specification C-1051, requires that only qualified coatings are used inside containment.

Any additional actions, if necessary, will be taken in response to further NRC generic communication on this issue.

## ADDITIONAL INFORMATION

Failed Component Identification : Not applicable.

Previous Similar Events: None