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FACIL:50-387 Susquehanna Steam Electric Station, Unit 1, Pennsylva 05000387

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SUBJECT: LER 93-007-00:on 930611,identified need to address impact that corrosion products may have on ECCS suction strainer plugging.Caused by impact of rust & fibrous insulation on strainers.ECCS suction strainers modified.W/930702 ltr.

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TITLE: 50.73/50.9 Licensee Event Report (LER), Incident Rpt, etc.

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July 2, 1993

U.S. Nuclear Regulatory Commission
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Washington, DC 20555

SUSQUEHANNA STEAM ELECTRIC STATION
LICENSEE EVENT REPORT 93-007-00
FILE R41-2
PLAS - 570

Docket No. 50-387
License No. NPF-14

Attached is Licensee Event Report 93-007-00. Although it was determined that this condition is not reportable, this voluntary report is being submitted to provide the Commission with information concerning potential blocking of ECCS suction strainers due to containment debris.

H.G. Stanley
VP - Nuclear Operations

HL/mkf

cc: Mr. T. T. Martin
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NRC FORM 366 (6-89)

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMB NO. 3150-0104
EXPIRES: 4/30/92

ESTIMATED BURDEN PER RESPONSE TO COMPLY WTH 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.

# LICENSEE EVENT REPORT (LER)

| FACILITY NAME (1) | DOCKET NUMBER (2) | PAGE (3) |
|---|---|---|
| SUSQUEHANNA STEAM ELECTRIC STATION - UNIT 1 | 0 5 0 0 0 3 8 7 | 1 OF 0 6 |

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 0 | 0 7 | 0 2 | 9 3 | 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)* |
| ☐ | 20.405(a)(1)(iii) | ☐ | 50.73(a)(2)(i) | ☐ | 50.73(a)(2)(viii)(A) | | Voluntary |
| ☐ | 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 (AREA CODE) |
|---|---|
| Harrison Lloyd, Jr. - Power Production Engineer | 7 1 7 5 4 2 - 3 9 1 7 |

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 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | | | | | | | | | |

SUPPLEMENTAL REPORT EXPECTED (14)

X YES *(If yes, complete EXPECTED SUBMISSION DATE)* 6/01/94 ☐ NO

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

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


PP&L is currently engaged in assessing the impact on ECCS suction strainers of debris and corrosion products adhering to fibrous materials that may become dislodged as a result of a pipe break in containment. This evaluation is being performed under our Engineering Deficiency Report Program. Various sources of debris (fibrous insulation, coating material, corrosion products) exist in containment and could be drawn to the suction strainers of the ECCS pumps during inventory make-up and containment cooling functions. Many uncertainties exist in the assumptions which are made 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. A final determination of reportability could not be made at this time. However, it is clear that the issue has potentially significant industry safety ramifications due to its common mode effects and thus a voluntary LER is being submitted to provide to NRC the results of PP&L's analysis to date. Actions identified to date include: containment walkdowns to quantify amounts of potential debris; consideration for addition of metal jacketing on fibrous insulation and/or modification of suction strainers; qualification of coatings; and reducing amount of corrosion products in the wetwell. We are also developing procedures for backflushing suction strainers to provide additional assurance that long-term cooling will be maintained until permanent corrective actions are taken.

DESCRIPTION OF CONDITION

PP&L is currently engaged in assessing the impact on ECCS suction strainers of debris and corrosion products adhering to 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 are known to exist within the SSES containment which could potentially result in ECCS suction strainer plugging. These sources include: fibrous insulation material (primarily Nukon); unqualified paint/coatings; and corrosion products. The fibrous insulation material is located on pipe supports within the drywell. At these locations, reflective mirror insulation was not practical to install. The unqualified paint/coatings is located on walls, piping, components and under insulation within the containment. The corrosion products are located on un-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 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 stainers, 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 generation, 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 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 will likely consist of a mixture of individual fibers, small clumps and large sheets. A portion of these materials will reach the suppression pool during the blowdown phase, a portion will wash down the downcomers during the flooding phase and the remainder will stay in the drywell. The corrosion products are introduced directly into the suppression pool during the blowdown phase. Once in the pool, a portion is transported to the ECCS suction strainers due to the velocities generated by pump operation. If sufficient debris accumulates 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 evaluation (main steam, feedwater, reactor recirculation) indicate that long-term operation of ECCS pumps could be threatened. The following assumptions are 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 is 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 is assumed to be dislodged by the fluid jet. This assumption is consistent with regulatory guidance and industry testing. If it can be demonstrated that a smaller cone size is more realistic, then the amount of insulation debris assumed may 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 will become lodged on grating, platform steel, piping, cable trays, drywell coolers and other equipment. Once on the diaphram slab elevation, the material must wash into the downcomers to reach the suppression pool and could 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 will sink to the bottom as they become saturated, while smaller pieces will 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 migrates to the strainers, either flow blockage or an increased pressure drop across the strainer will be experienced. Flow blockage will 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 indicate that a large amount is not necessary. Prior to the onset of blockage, small fibers of insulation and other debris will 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 is a key factor in this report. Without this other material, complete blockage of flow is not expected. SSES contains a significant amount of unqualified coating in the containment; eighty percent of which is 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 will 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 will 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 is assumed that sufficient quantities of this material are available to become trapped by insulation at the strainers if the transport mechanism is 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 is 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 modelling indicates that sufficient transport velocities exist within the pool to enable debris to be drawn onto the suction

| FACILITY NAME (1) | DOCKET NUMBER (2) | LER NUMBER (6) YEAR | SEQUENTIAL NUMBER | REVISION NUMBER | PAGE (3) |
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| SUSQUEHANNA STEAM ELECTRIC STATION - UNIT 1 | 0 5 0 0 0 3 8 7 | 9 3 | — 0 0 7 — | 0 0 | 0 5 OF 0 6 |

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

strainers. Sufficient amounts of debris are contained within the area influenced by each strainer to allow for complete strainer coating.

CAUSE OF CONDITION

Based on recent industry events and the 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 have not been evaluated with regard to the amount of Nukon insulation generated in combination with other debris.

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

REPORTABILITY/ANALYSIS

This report is being made as a voluntary report. Our evaluation of this condition revealed a number of uncertainties in our current ability to ascertain 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 cannot be made at this time. However, it is clear that the issue has significant potential safety ramifications that are generic in nature.

The corrective actions discussed below will provide additional data which will be used to further assess this condition. Should any reportability assessment change, this information will be provided via an update to this report.

The operability of short-term ECCS function is assured based on timing of the event, and operability of long-term ECCS function is assured based on our judgment 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 short-term and long-term corrective actions to provide additional margin of safety. Efforts of the team identified to date include the following:

1. Evaluate modifications to the ECCS suction strainers.

2. Outage walkdowns in both Units' containment in the two upcoming refueling outages to quantify amounts of debris.

3. Installation of metal jacketing to existing fibrous insulation or replacement with non-fibrous material on areas affected by high energy line breaks.

4. Evaluation of coatings in the containment for the possibility of "qualifying" the coatings to provide assurance that the coatings will remain intact following a DBA.

5. Determine amount of corrosion products in the wetwell structural steel and determine actions to take to reduce the amount of corrosion products.

To provide additional assurance that long-term cooling will be maintained until permanent design features can be installed, we are developing procedures which will enable ECCS suction strainers to be backflushed upon detection of a plugged condition. These procedures are in the process of engineering evaluation for determining the most effective way of accomplishing the strainer backflush.

## ADDITIONAL INFORMATION

Failed Component Identification: Not applicable.

Previous Similar Events: None.