**BEFORE THE**
**UNITED STATES NUCLEAR REGULATORY COMMISSION**

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In the Matter of :

Docket No. 50-387

PENNSYLVANIA POWER & :
LIGHT COMPANY

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**PROPOSED AMENDMENT No. 175**
**FACILITY OPERATING LICENSE NO. NPF-14**
**SUSQUEHANNA STEAM ELECTRIC STATION**
**UNIT NO. 1**

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Licensee, Pennsylvania Power & Light Company, hereby files proposed Amendment No. 175 to its Facility Operating License No. NPF-14 dated July 17, 1982.

This amendment contains a revision to the Susquehanna SES Unit 1 Technical Specifications.

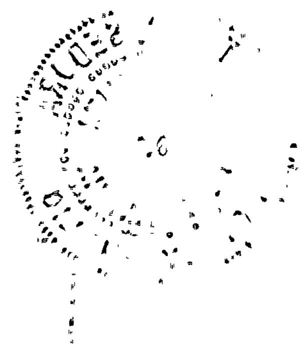
PENNSYLVANIA POWER & LIGHT COMPANY
BY:

R. G. Byram
Sr. Vice President - Nuclear

Sworn to and subscribed before me
this 11 of November, 1994.

Notary Public

Notarial Seal
Martha C. Sedora, Notary Public
Allentown, Lehigh County
My Commission Expires Jan. 15, 1998
Member, Pennsylvania Association of Notaries



**BEFORE THE**
**UNITED STATES NUCLEAR REGULATORY COMMISSION**

In the Matter of :

Docket No. 50-388

PENNSYLVANIA POWER & :
LIGHT COMPANY

**PROPOSED AMENDMENT No. 129**
**FACILITY OPERATING LICENSE NO. NPF-22**
**SUSQUEHANNA STEAM ELECTRIC STATION**
**UNIT NO. 2**

Licensee, Pennsylvania Power & Light Company, hereby files proposed Amendment No. 129 to its Facility Operating License No. NPF-22 dated March 23, 1984.

This amendment contains a revision to the Susquehanna SES Unit 2 Technical Specifications.

PENNSYLVANIA POWER & LIGHT COMPANY
BY:

R. G. Byram
Sr. Vice President - Nuclear

Sworn to and subscribed before me
this 1st of November, 1994.

Notary Public

Notarial Seal
Martha C. Sedora, Notary Public
Allentown, Lehigh County
My Commission Expires Jan. 15, 1998
Member, Pennsylvania Association of Notaries

# SAFETY ASSESSMENT

## *MAIN TURBINE VALVE SURVEILLANCE TEST INTERVAL*

## BACKGROUND

Susquehanna Technical Specification 3/4.3.8 (Turbine Overspeed Protection System) currently requires a surveillance test of all the Main Turbine Stop, Control, and Combined Intermediate Valves on a weekly basis. The surveillance test involves the cycling of each of the aforementioned valves from the running position and observing valve closure. Conformance with this surveillance requirement results in a weekly downpower (2%), and the increase in the probability of an automatic reactor scram during the test evolution. Extending the surveillance interval, in line with current vendor recommended test frequencies, will reduce plant mid-cycle losses, reduce manpower requirements for testing, and lower scram risk.

Extending the surveillance frequency for the Main Turbine Stop, Control, and Combined Intermediate Valves (Main Turbine Valves) is acceptable based on turbine vendor (General Electric) recommendations, the results of turbine failure analysis, industry operating experience, and Susquehanna specific operating experience.

General Electric has recommended a surveillance test interval for main stop, control, and combined intermediate valves not greater than three (3) months (TIL 969 Revision 1). This test interval limits the probability of excessive overspeed, due to a Main Turbine Valve fail-to-close event, to the level accepted for missile generation and is within the predictive capabilities of the overspeed analysis. Specifically, this recommendation permits a valve test interval of three months for 1) units having all monoblock (integral) turbine rotors, and 2) units that are not subject to NRC limits on calculated turbine missile probability regardless of whether they have all monoblock rotors or a combination of monoblock and keyway rotors.

Susquehanna replaced its original keyway turbine rotors with monoblock turbine rotors due to concerns over keyway cracking identified by the turbine vendor. The monoblock rotors installed at Susquehanna SES have an acceptably low probability of turbine missile damage to safety-related structures, systems, and components. The monoblock design eliminates the keyway crack initiation site, which is the area between the rotor and the turbine wheel that can fail and lead to turbine missiles.

The safety analysis provided here will show that the proposed change to turbine valve testing intervals can be safely applied at Susquehanna SES. The proposed change is a line item improvement to Technical Specifications as discussed in NUREG-1366, section 5.13.

DESCRIPTION OF CHANGE

The proposed Technical Specification change extends the current weekly steam valve surveillance test interval to an interval not to exceed 92 days. However, the LIMITING CONDITION FOR OPERATION, ACTION, and other SURVEILLANCE REQUIREMENTS associated with Technical Specification 3/4.3.8 will remain unchanged. The Technical Specification Basis section for 3/4.3.8 will be updated to reflect the proposed change.

A mark-up of Technical Specification sections affected by the proposed changes are attached to this analysis; Attachment 1.

SAFETY ANALYSIS

**Analysis**

The safety significance associated with the valve surveillance testing comes from the function of the Main Turbine Valves to close based on Electro-Hydraulic Control response to prevent an overspeed condition of the turbine. Turbine overspeed is a concern because of the potential that the overspeed condition may lead to turbine failure. Turbine failure may in turn lead to the generation of turbine missiles, with the potential to strike-and-damage safety-related structures, systems, and components. However, Main Turbine Valve failure is only one contributor to the potential for turbine missiles to impact safety-related SCCs. Turbine orientation, design, and condition also affect missile damage probability. In reviewing the safety consequences of the proposed Technical Specification change, only the interval of testing is being modified and thus the contribution to missile damage from all other factors is considered unchanged.

Main Turbine Valve testing is conducted at Susquehanna at intervals that meet, or are more conservative than, the turbine vendor recommendation. General Electric first revised its recommendations for nuclear turbine valve testing in 1984 (TIL 969 Rev. 0). Prior to the issuance of TIL 969 Rev. 0 (5/22/84), General Electric recommended Main Turbine Valve testing be performed at the frequencies that had been established for large steam fossil turbines. With the issuance of TIL 969 Rev. 0, General Electric acknowledged the considerably lower Main Turbine Valve fail-to-close rates associated with nuclear turbines from their fossil counterparts. Fossil turbines operate at significantly higher temperatures, which increases oxidation buildup on the stems and bushings of the fossil turbine valves and can lead to operational problems. In 1993, General Electric again updated its Main Turbine Valve test interval recommendations based on operating experience and safety analysis. A summary of Susquehanna's Main Turbine Valve testing intervals and General Electric's past and current recommendations for Main Turbine Valve testing at Susquehanna, with monoblock rotors installed, are provided below:

| VALVE | CURRENT SSES TEST FREQ. | TIL 969 R0 TEST FREQ. (1984) | TIL 969 R1 TEST FREQ.[1] (1993) |
|---|---|---|---|
| Main Stop | Weekly | Weekly | Quarterly |
| Main Control | Weekly | Monthly | Quarterly |
| CIV | Weekly | Weekly | Quarterly |

The proposed Technical Specification change extends the current weekly Main Turbine Valve surveillance test interval to an interval not to exceed three months. The safety basis for increasing the surveillance interval for the Main Turbine Valves is supported by four contributing factors:

1. Main Turbine Valve testing has the potential to result in automatic reactor scrams and pressure transients, and therefore testing rates should be optimized to balance the probability of turbine missile generation against the potential for plant transients.

2. The monoblock rotor design installed at Susquehanna has an acceptably low wheel burst probability, and probability of turbine missile damage.

3. Updated industry operating experience has shown a decrease in Main Turbine Valve fail-to-close events, resulting in a slightly lower turbine overspeed probability.

4. Susquehanna plant specific operating performance exceeds industry average performance - Susquehanna has never experienced an occurrence where the Main Turbine Valves would not have performed their design function to close for overspeed protection.

*Main Turbine Valve testing has the potential to result in automatic reactor scrams and pressure transients, and therefore testing rates should be optimized to balance the probability of turbine missile generation against the potential for plant transients.*

BWR operating experience indicates there have been several incidents of plant scram during periodic turbine valve tests. A plant scram causes rapid shutdown of the reactor and can challenge safety systems and operators based on changing from a steady state operation to a pressure transient condition. An increase in unnecessary plant scrams and pressure transients contributes to an increased core damage frequency as calculated in plant Probabilistic Safety Analyses. Susquehanna is continually looking for ways to identify causes and take actions to reduce the frequency of automatic reactor scrams.

[1] GE TIL 969 R1 recommends quarterly valve testing for units with all monoblock rotors and units not subject to NRC limits on calculated turbine missile probability.

A review of BWR turbine related scrams from 1985 through August 1992 indicates there have been a total of 104 turbine system related scrams from reactor operations (post startup). Of this total, 18 scrams occurred during periodic turbine valve surveillance tests. This represents approximately 0.1 scrams per plant-year that have occurred during valve testing. Decreasing the turbine valve test frequency can reduce this scram rate and have a positive effect on plant availability and safety by reducing the potential of unnecessary plant shutdowns and challenges to safety systems and plant operators. This effect from reduced valve testing was considered by the turbine vendor in developing revised Main Turbine Valve testing recommendations. The turbine vendor concluded that a decrease in the turbine valve test frequency will not significantly affect the turbine missile probability beyond the established acceptance criteria. This is based on the built-in conservatism and the very low absolute value of the NRC acceptance criteria (i.e., < 1E-04 /turbine-year for a favorable turbine orientation and < 1E-05 /turbine-year for an unfavorable turbine orientation).

*The monoblock rotor design installed at Susquehanna has an acceptably low wheel burst probability, and probability of turbine missile damage.*

The NRC requires that nuclear utilities consider the effects of turbine missiles that might affect the operation of nuclear power plants. Utilities commonly demonstrate protection against the effects of turbine missiles by the use of probability based analyses. The NRC has developed guidelines that limit the maximum annual probability for various hypothetical events. In the case of the Susquehanna units, the limit for the annual probability for generation of a turbine missile is 1E-05. Analyses by General Electric have shown that this probability limit can be exceeded for units that have the built-up rotor construction with separate wheels shrunk on a shaft and have axial keyways in the wheels. Experience has shown that stress corrosion cracks (SCC) can initiate and grow with time in the wheel axial keyways. If such cracking is allowed to continue, a wheel burst may occur presenting the potential for a wheel missile to exit the turbine. The monoblock rotor design installed at Susquehanna eliminates the keyway region.

For the Susquehanna units, the maximum attainable turbine speed is 215-218% if the full arc admission mode is used and 218-222% if the partial arc admission operating mode is used. The minimum speed capability of the monoblock rotors, assuming all buckets remain attached to the rotor, is 219-225%. This range is based on the minimum specification tensile strength value. Using a more typical tensile strength value, the speed capability is increased to 230-235%. A complete failure of the control system is required to achieve the above overspeeds. The annual probability of this complete failure is in the range of 1E-08, three orders of magnitude lower than the limit for the annual probability for generation of a turbine missile.

Susquehanna evaluated the probability of a postulated turbine missile damaging safety-related structures, systems, and components in the FSAR. The analysis was performed for keyway rotors, and the results of the analysis were extrapolated for the monoblock design. The keyway analysis was the bounding analysis. The turbine missile damage probability calculated in the FSAR varied from 1E-12 to 1E-14, the damage probability for monoblock rotors was concluded to be even lower. These damage probabilities are acceptably low (i.e. < 1E-07) based on NRC guidance for acceptable strike-and-damage probability as specified in NUREG-1048, section 3.5.1.3.

*Updated industry operating experience has shown a decrease in Main Turbine Valve fail-to-close events, resulting in a slightly lower turbine overspeed probability.*

The BWROG, with the participation of the turbine vendor (General Electric), initiated a survey to gather more current nuclear field data related to turbine valve failure rates. The primary purpose of the survey was to determine if current valve performance data warrants a modification to the valve test intervals. The survey received responses from 39 GE turbine units representing 30 BWRs and 9 PWRS. The data base represents 247.4 years of reactor/turbine operation.

An updated fail-to-close rate was calculated at the 50 % confidence level for each of the turbine valves. These updated rates are referred to as the "new rates" in this report and the previous rates referred to as "old rates". The ratios of the new rates to the old rates are as follows:

| Type of Valves | Percent Change (New Rate/Old Rate) X 100 |
|---|---|
| Main Stop Valves (SV) | 79 % |
| Main Control Valves (CV) | 74 % |
| Intermediate Stop Valves (ISV) | 52 % |
| Intercept Valves (IV) | 53 % |

In all cases the new rates are lower than the old rates.

The relative effect of the newly calculated fail-to-close rates on overall unit overspeed results in a slightly lower overspeed probability. These new rates were considered in the development of the recommendation for quarterly turbine valve test intervals. Attachment 2 contains the General Electric report and Susquehanna specific analysis.

*Susquehanna plant specific operating performance exceeds industry average performance - Susquehanna has never experienced an occurrence where the Main Turbine Valves would not have performed their design function to close for overspeed protection.*

A review of the performance history of Main Turbine Valve testing for the Stop, Control and Combined Intermediate Valves was performed by System Engineering. The review found that there have been a few instances where the test circuitry required maintenance, but there has never been an occurrence where the valve would not have performed its function of closing per design for turbine overspeed protection. Susquehanna's Main Turbine Valves have an excellent performance record, and are maintained on a regular basis during refueling outages.

Susquehanna's current Main Turbine Valve testing frequency is more conservative than the turbine vendor recommendations prior to revision. Prior to revision, the turbine vendor had recommended weekly testing on the Main Stop Valves, monthly testing of the Main Control Valves, and weekly testing of the Combined Intermediate Valves. Susquehanna performs all Main Turbine Valve testing on a weekly basis. As a result, Susquehanna has performed more individual valve tests than the industry average, and has done so without encountering any fail-to-close events.

## CONCLUSION

Extending the surveillance frequency for the Main Turbine Stop, Control, and Combined Intermediate Valves to quarterly is acceptable based on turbine vendor recommendations, the results of turbine failure analysis for monoblock rotors, industry operating experience, and Susquehanna specific operating experience. The safety basis for the proposed change shows that the probability of automatic plant scram, or pressure transient, can be reduced without increasing the potential for turbine overspeed and missile generation by adopting a quarterly interval for Main Turbine Valve testing. The proposed change; decreases the probability of an automatic plant scram, or pressure transient, does not introduce the potential for any new accidents, and increases the margin of overall plant safety. The proposed change is consistent with NUREG-1366, Improvements to Technical Specifications Surveillance Requirements.

## NO SIGNIFICANT HAZARDS CONSIDERATIONS

*I.* *This proposal does not involve a significant increase in the probability or consequences of an accident previously evaluated.*

The proposed Technical Specification change to a quarterly turbine inlet valve surveillance test interval is based on maintaining the turbine missile generation probability within the NRC criteria as stated in Table 3.1 of NUREG-1048. This, combined with the NRC acceptable strike-and-damage probability as specified in NUREG-1048, will keep the probability of unacceptable damage to safety-related structures, systems, and components from turbine missiles acceptably low (i.e., $<10^{-7}$) . Thus, the NRC acceptable risk rate of $<10^{-7}$/yr. is not changed and there is no increase in the probability of an accident previously evaluated.

The proposed Technical Specification change to the turbine inlet valve surveillance interval does not effect the sequence of events or the consequences of an accident previously evaluated. The surveillance interval does not affect the strike and damage scenario of an accident previously evaluated. Thus, the radiological consequences of an accident previously evaluated will not be increased.

*II.* *This proposal does not create the possibility of a new or different kind of accident from any accident previously evaluated.*

The proposed Technical Specification change to the turbine inlet valve surveillance interval does not affect the surveillance test characteristics. There are no new surveillance testing requirements. Surveillance testing of these valves does not create the possibility for a new or different kind of accident from any accident previously evaluated.

*III.* *This change does not involve a significant reduction in a margin of safety.*

The proposed Technical Specification change to the turbine inlet valve surveillance interval is based on maintaining the same margin of safety as previously determined by the NRC and does not reduce the margin of safety. In fact, the reduction in the testing rate will reduce the potential for testing related transients, which have been credited with causing 18 reactor scrams in the period 1985 through 1992.

## ENVIRONMENTAL CONSEQUENCES

An environmental assessment is not required for the proposed changes because the requested changes conform to the criteria for actions eligible for categorical exclusion as specified in 10 CFR 51.22(c)(9). The requested changes will have no impact on the environment. The proposed changes do not involve a significant hazards consideration as discussed in the preceding section.

The proposed changes do not involve a significant change in the types or significant increase in the amounts of any effluents that may be released offsite. In addition, the proposed changes do not involve a significant increase in individual or cumulative occupational radiation exposure.

## IMPLEMENTATION

It is requested that this change be approved as soon as possible but no later than April 15, 1995 with implementation within 30 days of the date of issuance.