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 FIELDS, J.S.                      Pennsylvania Power & Light Co.  
 RECIP. NAME                      RECIPIENT AFFILIATION  
 DILAZARO, T.A.                      Pennsylvania, Commonwealth of

SUBJECT: Forwards opacity analysis plan re possible methods to reduce visible emissions during start-up tests, in accordance w/ Condition 5 of Air Quality Program Operating Permit 40-306-004.

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# Pennsylvania Power & Light Company

Two North Ninth Street • Allentown, PA 18101-1179 • 215/774-5151

January 31, 1994

Mr. Thomas A. DiLazaro, Program Manager  
Air Quality Program  
Pennsylvania Department of Environmental Resources  
Northeast Regional Office  
Cross Valley Centre  
667 North River Street  
Plains, PA 18705-1099

SUSQUEHANNA STEAM ELECTRIC STATION  
OPACITY ANALYSIS PLAN  
PERMIT NO. 40-306-004  
CCN 741326                      FILE R9-8B  
PLE- 17539

Dear Mr. DiLazaro:

The Pennsylvania Power & Light Company (PP&L), in accordance with Condition No. 5 of the Air Quality Program Operating Permit No. 40-306-004 for a 6948 horsepower emergency diesel generator located at the Susquehanna Steam Electric Station, Luzerne County, is submitting an Opacity Analysis Plan concerning possible methods to reduce visible emissions during start-up tests. After reviewing possible corrective measures to eliminate visible emissions such as diesel modifications, changes in fuel type, or use of chemical additives, PP&L determined that 1) visible emissions during these tests would not be eliminated and 2) station safety could be compromised during emergencies. PP&L has also evaluated Pennsylvania Department of Environmental Resources (PaDER) opacity regulations for obtaining alternative opacity limits for this diesel generator and is submitting this Opacity Analysis Plan for your review.

The attached plan analyzes the potential effectiveness of options to address opacity concerns for this emergency E-Diesel Generator during a testing start-up period of approximately 45 minutes per test, or 18 hours annually. Discussions with Cooper-Bessemer (C-B), the manufacturer, and other utilities using this diesel indicate that there are no established "technical fixes" available that could guarantee the control of visible emissions during this start-up period.

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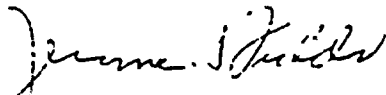
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PLE- 17539  
To: Mr. Thomas A. DiLazaro

Therefore, PP&L requests alternative opacity limits for this emergency diesel generator, Permit No. 40-306-004. PP&L would like to meet with the Pennsylvania Department of Environmental Resources (PaDER) to discuss alternative opacity limits listed in Title 25, Sections 123.45 and 123.11. Please contact me at (215) 774-7889 to set up a meeting to review this request.

Sincerely,



Jerome S. Fields  
Sr. Environmental Scientist-Nuclear

Enclosure

Copy to:

Mr. M. M. Cebula, PaDER

NRC Document Control Desk

NRC Region 1

Mr. R. J. Clark, NRC Sr. Project Manager

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## OPACITY ANALYSIS PLAN

### I. SUMMARY

The purpose of the Emergency Diesel Generators at the Susquehanna Steam Electric Station (SSES), a two unit nuclear generating station, is to provide a highly reliable, independent source of power for the electrical loads required for shutdown of both reactors in the event of a design bases Loss of Coolant Accident with a subsequent Loss of Offsite Power. Pennsylvania Power & Light Company (PP&L) tests the emergency E-Diesel Generator (Permit No. 40-306-004) at the Susquehanna SES one to two times per month to meet United States Nuclear Regulatory Commission (NRC) start-up test requirements. The station's original NRC Technical Specifications required the station diesels to meet emergency start-up requirements. They were to start-up within 10 seconds and load to 4,000 kw within 90 seconds for operation during emergencies. The diesel was designed and tested under these conditions and opacity was not a concern. However, due to experienced damage to the diesel cylinders and pistons, the manufacturer Cooper-Bessemer (C-B) recommended that all nuclear stations take a longer time period to add load to their diesels during required periodic testing. The NRC concurred, and PP&L and other utilities revised their technical specifications to add load over a longer period. The specific problem is "tin transfer," which initiates accelerated wear of the pistons and cylinders and causes severe damage to the diesel generator. Changing back to the original 90 second start-up for test purposes is not a viable .. option.

PP&L, based on C-B recommendations and NRC requirements to protect the E-diesel during tests, has increased the time for start-up. Starting up the diesel slowly, loading 1,000 kw approximately every 15 minutes up to full load or 4,000 kw, takes between 45 minutes and one hour. At approximately 45 minutes visible emissions (opacity) dissipates to 5% or less. PP&L evaluated the available options to resolve the opacity concern including using alternative fuels, using chemical additives, intake air temperature changes, installing a new turbocharger, and changing the cam-timing. None of these options have been tested by the manufacturer or approved by the NRC.

Results of this investigation indicate that there is no guarantee that 1) these options will correct the visible emissions during test start-up and 2) these modifications will meet emergency requirements. Accordingly, pursuant to the Pennsylvania Department of Environmental Resources (PaDER) Regulations at 25 Pa Code §123.45, PP&L respectfully requests alternative opacity limits for the E-Diesel Generator Permit No. 40-306-004, at the Susquehanna SES. The alternative limits are required only for a period of about 45 minutes per test (each test lasts four hours) or 18 hours per year during start-up testing of the diesel generator.

## II. BACKGROUND

The NRC requires emergency diesel generators like the E-Diesel (Permit No. 40-306-004) at the Susquehanna SES and other nuclear stations to safely shut down nuclear reactors during a loss of offsite power. The NRC's regulations and station technical specifications contain very specific details for design, testing, and operation of emergency diesel generators. During emergencies, diesels are required to start up within 10 seconds and load to 4,000 kw load within about 90 seconds. The C-B 20 cylinder diesels like the E-Diesel throughout the industry have experienced problems with the pistons and cylinders during rapid loading, which caused the emergency diesels to fail monthly start-up tests. These problems would be severe if they resulted in diesel failures during emergencies.

Utilities and the NRC were concerned about the diesel failure problems and several studies were conducted to find out the cause of the problem. PP&L's test results showed that the cause of these failures was due to the synergistic effect of all of the following:

- High compression pressure that occurs during start-up and or rapid loading of the engines
- Load carrying capabilities of the local lubrication conditions
- Design of the pistons' upper skirt

An independent expert confirmed PP&L's assessment of the problems. This diesel problem is now called "tin transfer or tin smearing." The NRC, the manufacturer, other utilities that own this diesel, and PP&L concur that tin transfer can occur during rapid start-up and load of the diesels. Therefore, PP&L has taken several corrective measures to assure that all Susquehanna SES emergency diesels will be available for possible emergencies, including installing a modification to control intake air temperature, installing pistons without end caps and lowering oil control rings, changing the rate of load in monthly tests, and inspecting the pistons and liners after every 200 hours of operation. Additional opacity has occurred because of the recommended start-up rate of adding 1,000 kw approximately every 15 minutes for approximately 45 to 60 minutes instead of the original 90-second loading. This start-up change causes approximately 18 hours per year of visible emissions, but protects the diesel from possible failure during an emergency.

### III. OPERATION

During emergencies involving station loss of offsite power, the E-Diesel Generator is required to start-up within 10 seconds and load to 4,000 kw within 90 seconds. When tests were conducted at this rate, there were no visible emissions except a short puff of smoke. Due to damage sustained by emergency diesels during rapid loading, monthly tests (one to two times) now are conducted with a longer loading period. Visible emissions occur on the E-Diesel for approximately 45 minutes during the load acquisition period (warm-up) for the monthly four-hour tests and the annual 24-hour test. PP&L is following NRC requirements and industry and manufacturer recommendations by performing the warm-up to make certain the diesel is available during an emergency.

### IV. CONTROL ALTERNATIVES TO REDUCE VISIBLE EMISSIONS

The following control alternatives have been reviewed or conducted in an attempt to eliminate visible emissions during start-up of the E-Diesel:

- The diesel air inlet temperature was raised from 105° to 135°F without any impact on visible emissions.
- Alternative fuels and a combination of #2 diesel fuel (present fuel source) and gas were reviewed. Initially, it was unclear if alternative fuels would work to reduce visible emissions. The estimated costs for diesel modifications to accommodate these fuels would cost well over \$2,000,000. These modifications would require NRC approval. The manufacturer has since indicated that there is no equipment available to support a dual fuel diesel and therefore the manufacturer does not recommend this modification for reducing opacity.
- PP&L reviewed the use of chemical additives such as Magnesium Carboxylate or Methylcyclopentadienyl Manganese Tricarbonyl to minimize emissions. These chemicals have been used in combustion turbines but according to one additive manufacturer they have not been used in diesel generators. Once again, NRC approval would be required, as well as further study by the diesel manufacturer.
- C-B analyzed replacing the turbocharger. Increased airflow potentially would increase the air in the fuel mixture, which possibly could reduce the visible emissions at low loads. It also would increase the pressure drops through the air intake and exhaust systems, and through the intercoolers prior to maximum load conditions could possibly reduce the visible emissions. However, this modification has never been performed before, and it would be considered a research and development project. C-B

cannot guarantee this redesigned turbocharger would meet applicable PaDER opacity requirements. This modification would cost a minimum of \$1,000,000 for the redesign and installation of the turbocharger. The NRC would have to approve this modification because it is on a safety system.

- Adjustment of cam-timing

C-B reviewed the potential for the effects of injection timing changes on the light load exhaust opacity of 20 cylinder engines. C-B engineers could not agree on the direction to change the timing, or on the probable effect of such a change. Thus, any changes to the timing would be in the nature of a research project, and the potential effect of these changes on start-up load opacity as well as on full-load operation, would have to be evaluated experimentally and would require NRC approval.

## V. ALTERNATIVE OPACITY LIMITS

After reviewing all potential options to correct the visible emissions, PP&L respectfully submits that the environmental impact over 18-hours per year does not result in emissions in a manner or concentration that is or may be inimical to public health, safety or welfare, nor does it unreasonably interfere with the comfortable enjoyment of life or property. Accordingly, PP&L believes that the 18 annual hours of opacity exceedances do not result in air pollution as defined by the Air Pollution Control Act, 35 P.S. §4003, particularly in view of the lack of satisfactory measures to abate the opacity concerns. PP&L respectfully requests that the PaDER provide the Susquehanna SES emergency E-Diesel Generator, Permit No. 40-306-004 with an alternative opacity limit (during start-up) as determined by Section 123.11, of the regulations.

Particulate matter emissions calculations based on Section 123.11 requirements allow for 18.2 lbs/hour of particulates to be emitted from this diesel.

### CALCULATION

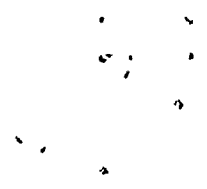
$$0.4 \text{ lbs of particulates/1,000,000 BTUs} \times 45,540,000 \text{ BTUs/hour} \\ (330 \text{ gal/hour} \times 138,000 \text{ BTUs/gal \#2 diesel fuel oil}) = 18.2 \text{ lbs/hour}$$

Using the US Environmental Protection Agency, Compilation of Air Pollution & Emission Factors, AP-42, Supplement E, Tables 3.3-1, October 1992, specifically for the E-Diesel, the amount of particulates emitted is 15.30 lbs/hour, within the PaDER opacity alternative limit criteria of Section 123.11.

### CALCULATION

$$1.0 \text{ g/hphr} \times 6948 \text{ hp} \times 1/454 \text{ lb/g} = 15.30 \text{ lb/hour}$$





## **VI. CONCLUSION**

Visible emissions are the result of a longer 45-minute start-up period for adding load to the diesel to avoid damage to the pistons and cylinders, thereby assuring availability of the diesel during emergencies. In view of the foregoing, PP&L respectively requests that the Department grant an Alternative Emission Limit pursuant to 25 Pa. Code §123.11 and 123.45.

PP&L has reviewed all potential alternatives to address visible emissions during start-up of the E-Diesel Generator, including the use of alternative fuels and chemical additives, modification of the turbocharger, and changing cam-timing. Moreover, these alternative measures are not likely to fully cure the opacity concerns, and accordingly these measures are not in the public interest. Therefore, PP&L requests alternative opacity limits during monthly start-up tests for the reasons set forth above.

