July 20, 1981

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of §
§
HOUSTON LIGHTING & POWER COMPANY § Docket No. 50-466
§
(Allens Creek Nuclear Generating §
Station, Unit No. 1) §
§

TESTIMONY OF ROBERT C. IOTTI, ON BEHALF OF HOUSTON LIGHTING & POWER COMPANY ON BISHOP CONTENTION 6 And BOARD QUESTION 12 RELATING TO THE SHELL OIL CO. 6 INCH LIQUID PETROLEUM GAS PIPELINE

Q. Please state your name and business address and describe your educational and professional experience.

A. My name is Robert C. Iotti and my business address is Ebasco Services, Inc., 2 World Trade Center, New York, N. Y. I have previously discussed my position and background in connection with my testimony on Doherty Contention 47.

Q. Dr. Iotti, what is the purpose of your testimony?

A. The purpose of my testimony is to address Intervenor Bishop's Contention 6 which alleges that:

> The rupture of the six-inch liquid petroleum gas pipeline could cause a cloud of explosive gas to travel along depressions to the area of the plant before exploding with such force to damage the safety equipment at the plant and the

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workers at the plant. For this reason either the pipeline or the plant must be moved.

My testimony will also address Board Question 12, which asks the following:

> Has it been definitely established whether [the LPG] pipeline might carry potentially more dangerous materials such that, following a pipeline rupture, safe shutdown of the plant would be precluded?

Q. Dr. Iotti, briefly describe how far the six-inch liquid petroleum gas pipeline is located from the nearest ACNGS Category I structure?

A. At its closest point, the line is located approximately 8000 feet northeast of the nearest ACNGS Category I structure.

Q. What measures has Shell Oil Company taken to detect a possible leak in this pipeline?

A. Shell Oil Company is providing a leak detection system capable of detecting a leak of approximately 20 bbls/hr in 3 minutes after the leak occurs. Isolation valves in the line will be closed and the pump tripped by the operator after information is received that a leak has occurred. Completion of this isolation can be accomplished in 5 minutes following leak detection. The use of this leak detection system coupled with the ability to isolate makes it extremely unlikely that a rupture occurring

at the nearest point of ACNGS Category I structures could be accompanied by a release of a quantity of LP gas large enough to present a hazard to the plant safety related structures in the event of a detonation or deflagration.

Q. Dr. Iotti, although you state that it is extremely unlikely that a detonation of significant quantities of propane could occur from a rupture of the six-inch liquid petroleum gas pipeline, has the Applicant nonetheless performed an analysis of potential effects of a rupture of the line and the potential effects of detonation/ deflagration of the escaping LP gas?

A. Yes. Appendix 2.2-A of the PSAR contains analyses of the potential effects of a rupture of the liquified petroleum gas line and subsequent detonation and/or deflagration of the escaping gas. These analyses utilize several conservative assumptions and demonstrate conclusively that the plant's Category I structures will not suffer any adverse consequences from a line rupture and subsequent detonation and/or deflagration of the emitted LP gas.

Q. Would you briefly describe the gaseous transportation mechanisms for which these analyses are performed?

A. Separate analyses have been performed for each of the four modes in which a flammable cloud of LPG could be

generated and transported toward the plant. The four modes described briefly are:

1. Atmospheric dispersion toward the plant of the LP gas released from the postulated break.

2. Slumping of the heavier than air cloud formed by the mixing of the LP gas and the surrounding air at the postulated break location accompanied by further mixing with air at the cloud-to-air interface resulting in a fog-like cloud travelling toward the plant along the depression of Allens Creek.

3. Initial gravity flow of the LP gas/air cloud followed by atmospheric dispersion and vice versa.

4. Gravity flow of nearly pure LP gas/liquid with little mixing with the surrounding air. This results in essentially a pure LP gas stream in the Allens Creek depression, which is postulated to heat up, mix with air, and then be atmospherically dispersed toward the plant.

Q. What are the significant assumptions used in each LPG pipeline rupture analysis?

A. Those assumptions which have the greatest impact on the calculations performed are:

1. The rate of flow of LP gas out of the break, which influences the size of the cloud that can be created, is conservatively computed by assuming that a complete severance in the line occurs at the Allens Creek Crossing. (This assumption applies to the analyses performed for the modes numbered 2, 3 and 4 above).

2. Double ended rupture of the line occurs instantaneously and at the closest point to plant Category I structures (8000 feet). (This assumption applies to the analyses performed for mode number 1.)

3. The temperature of the atmosphere is assumed to be 72°F. Higher temperatures would lead to higher vaporization of escaping propane, but the flow rate would be less due to higher quality at the exit plane.

4. The LP gas is assumed to be propane because of its chemical and physical properties which render it a conservative choice for reasons explained later in my testimony.

5. Assumed meteorological conditions were characterized by a Pasquill F inversion with wind speed of 0.8 mps in the direction of the plant

structures. Such conditions occur at the ACNGS site only 5% of the time. (This assumption applies to the analyses performed for the modes numbered 1 and 3 above.)

6. A leak detection system is available which is capable of detecting a leak of approximately 20 bbls/hr (or about 5% of operating flow) in 3 minutes after the leak occurs. After detection, line shutdown and isolation will be taken in 5 minutes.

The break is conservatively calculated to initially discharge 568 lbs/sec for 480 seconds. Thereafter due to pipeline operator action in stopping the pipeline pumps and closing valves, flow is predicted at 70 lbs/sec for 515 seconds, then dropping to 30 lbs/sec for another 2750 seconds, at which time flow ceases.

To estimate the maximum credible size of an atmospherically dispersed cloud, an average constant conservative flow of 100 lbs/sec of propane is assumed to issue continuously from the postulated break.

Q. For each analysis that was performed, what were the calculated effects on the Allens Creek plant?

A. For the analysis concerned with the previously-described first mode of gaseous transportation, the calculated effects were:

The assumption of stable atmospheric conditions with low wind speeds led to the prediction of larger detonable/deflagrable clouds than would be predicted if realistic atmospheric conditions were assumed. The calculated maximum size of the detonable cloud has been determined to be 1.55×10^7 ft^3, while the maximum deflagrable size has been determined to be 1.96×10^7 ft^3.

After detonation, the analysis shows that a peak overpressure of only 0.6 psi would impact on the nearest Category I plant structure. Since all Category I plant structures are designed to withstand a peak overpressure of 2.3 psi, no damage would occur to the ACNGS Category I structures.

For the analysis concerned with the previously-described second mode of gaseous transportation, the calculated effects were:

For the analysis of the gravity flow along the Allens Creek depression with air mixing at the propane/air cloud and air interface, the analysis demonstrates that clouds of flammable concentration

will not extend further than 6,000 feet down the Allens Creek channel, a location which is approximately 1400 feet from the nearest Category I plant structure.

Assuming further that the entire cloud is a homogeneous flammable mixture of propane and air, its detonation has shown to produce a peak overpressure of only 1.0 psi. Again this detonation would pose no safety hazard to the plant.

For the remaining two analysis concerned with the previously described third and fourth modes of transportation the calculated effects were:

Detonation of these maximum sized clouds pose no safety hazard to the plant. Peak overpressures of less than .6 psi and 1.0 psi have been calculated to result from analyses concerned with the third and fourth previously described modes respectively.

Q. Does the PSAR analysis address the hazards resulting from cloud deflagrations instead of detonations?

A. Yes, it does. Using the same analyses that were applied to the detonable clouds, the conclusion reached is that deflagration would also pose no hazard to the plant Category I structures.

Q. Did the PSAR analysis also look at the effect of missiles generated by the assumed detonation?

A. Yes it did. The hazards presented by missiles have been assessed by computing the total mass of debris observed to be generated by surface explosions of equivalent amounts of TNT for the largest of the detonations postulated by the four analyses previously described. Then the total mass of debris that could strike a plant safety related structure was computed using the assumption that all of this mass would be concentrated in one missile travelling at the maximum air particle velocity.

This was done since the open area between the location of the hypothetical clouds and the plant is devoid of structures or objects capable of becoming severe missiles. Under these assumptions the energy of the missile has been computed to be insufficient to cause any damage to any plant safety-related structure.

Q. In the preceding analyses you have stated that the postulated rupture in the line is a complete severance of the line. Could smaller breaks occur and result in hazards to the plant which are possibly more severe than those caused by the very large break?

A. No, they could not. Smaller breaks have been examined and, under the same conservative assumptions made in the analyses of the large breaks, result in lower volumetric flow rates and ultimately in smaller, lesser-concentrated

clouds which, if detonated, would produce lower overpressures than those resulting from larger breaks.

Q. In reference to Board Question 12, propane has been used as the representative LP gas for performing the analysis. What is the reasoning behind this choice and could the LPG pipeline carry potentially more dangerous materials?

A. Propane gas was chosen because it represents the most conservative approach in the analysis for the following reasons:

1. The LP gas line currently carries batches of gasoline, isopentane, normal butane and isobutane, plus distillate. The only other hazardous products which could reasonably be assumed to be transported in the line are propane and possibly other liquid hydrocarbons. Pound for pound propane has effectively the same TNT mass equivalency of other flammable hydrocarbons such as butane, isobutane, ethylene, butadiene, propylene, etc. 1/

1/ T. V. Eichler, E. S. Napadensky, "Accidental Vapor Phase Explosions on Transportation Routes Near Nuclear Plants," NUREG/CR-0075, April 1977.

2. The flammable and detonable limits of propane are wider than those of the higher hydrocarbons, hence proportionately more propane can be contained in deflagrating or detonating clouds than other higher hydrocarbons. Thus for the same flow of LP gas out of the break, assuming propane as the LP gas maximizes the quantity of material which can detonate or deflagrate and hence maximizes the hazards to the plant.

3. For the same line pressure and temperature, the specific volume of the higher hydrocarbons is comparable or higher than that of propane, so that the same or more pounds of propane would be contained in any given segment of the line as other hydrocarbons. Thus again a larger quantity of flammable material can be postulated to escape from a hypothetical break in the line by assuming that the line carries propane rather than other higher hydrocarbons, leading again to maximizing the hazards to the plant.

4. The initial flow rates out of a break are comparable for propanes and butanes, but would be slower for the other heavier than air hydrocarbons. Hence, again the assumption of propane leads to maximizing the hazards to the plant.

5. The amount of energy needed to cause a detonation of a mixture of LP gas and air is lower for propane-air mixtures than for mixtures of air and other higher hydrocarbons. Assuming that the LP gas is pure propane increases the likelihood that there will be sources of sufficient energy to cause the hypothetical vapor cloud to ignite or detonate. The only known case of an open air detonation of a vapor cloud involved propane.

6. There are several instances of unconfirmed propane-air cloud deflagrations and at least one detonation, against which it was possible to compare results of the analyses.

In summary, propane was chosen since it would present the greatest hazard to the plant.

Q. What are your conclusions?

A. Analyses have been performed, utilizing conservative assumptions, that adequately demonstrate the plant Category I structures at Allens Creek will not suffer adverse consequences due to the postulated LP line rupture and subsequent detonation and/or deflagration of the emitted LP gas.