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April 23, 1991
Fort St. Vrain
Unit No. 1
P-91139

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Attention: Mr. Seymour H. Weiss, Director
Non-Power Reactor, Decommissioning
and Environmental Project Directorate

Docket No. 50-267

SUBJECT: Natural Gas Collection Pipelines in the Vicinity of Fort St. Vrain - Contains Proprietary Information (Attachment 1)

REFERENCES: 1) PSC Letter, Crawford to Weiss, dated March 27, 1991 (P-91111)

2) PSC Letter, Crawford to Weiss, dated March 6, 1991 (P-91084)

Dear Mr. Weiss:

In a phone conversation on April 10, 1991, Mr. Steve Reynolds of the NRC staff informed PSC's Mr. M. H. Holmes that the NRC needs additional information to support PSC's submittal of March 27, 1991 (Reference 1), regarding analysis of postulated natural gas pipeline ruptures in the vicinity of Fort St. Vrain (FSV). The purpose of this letter is to provide the NRC with the requested information.

The NRC requested documentation of the inputs used to the INPUFF code, the INPUFF assumptions, and documentation of the INPUFF code outputs, for the two postulated pipeline rupture scenarios discussed in Reference 1. This information is included in Attachment 1, "Fort St. Vrain Gas Dispersion From a 4 and 6 Inch Line Breakage (5,551 lb. Detonation Case) Analysis Methods Summary." This information is considered to be proprietary by Westinghouse Electric Corporation, under the criteria set forth in 10 CFR 2.790. Attachment 2 is the non-proprietary version of this information. In accordance with the requirements of 10 CFR 2.790, the following documents are submitted with this letter:

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(1) One copy of an Application for Withholding Proprietary Information from Public Disclosure, Attachment 3.

(2) One copy of the Proprietary Information Notice, Attachment 4.

(3) One copy of an original affidavit, Attachment 5.

In addition to the information associated with the INPUFF code, the NRC requested that PSC identify the natural frequency of the FSV Reactor Building. The Turbine/Reactor Building Complex has a frequency for its first north-south translational mode of 1.70 cycles per second and a frequency for its first east-west translational mode of 2.07 cycles per second.

The NRC also requested information on the rise time at the FSV Reactor Building for a pressure wave produced by a postulated detonation of an unconfined cloud of natural gas, as analyzed in Reference 1. The rise time represents the time interval from the initial pressure rise, when the pressure wave from a detonation reaches the Reactor Building, until the maximum overpressure condition occurs at the Reactor Building. The ARCHIE code, which was used to model postulated detonations of natural gas clouds by the TNT equivalent method, does not compute a rise time.

The NRC informed PSC that, lacking information on the rise time, the NRC would assume an essentially instantaneous rise time and assume the overpressure condition at the Reactor Building is double that calculated by the TNT equivalent method.

In light of this position, PSC has decided to remove some of the conservatism from the analyses of a postulated detonation discussed in Reference 1. The analyses described in Reference 1 assumed that 8,392 lbs of gas detonates, for both Break 1 and Break 2 pipeline rupture scenarios. This mass of gas represents 100% of the natural gas which could leak out of the postulated ruptures in 10 minutes, conservatively assuming an initial pipeline pressure of 250 psig. 3,975 lbs of gas would be released due to the rapid pipeline depressurization, along with 4,417 lbs of gas flowing out over 10 minutes, based on the assumption of a 12 million scfd steady state release rate for 10 minutes.

10 minutes was selected as a very conservative time for accumulating natural gas involved in a postulated detonation since the 3,975 lbs of gas released in the rapid pipeline system depressurization, being dispersed by the wind at a horizontal velocity of 1 meter per second, would be far past the Reactor Building in 10 minutes (Note that the INPUFF code determined the natural gas concentration to be below the Lower Flammability Limit well before reaching the Reactor Building). Additionally, the amount of natural gas within a flammable concentration in the plume, formed by the continuous release rate of 12 million scfd, would have achieved steady state conditions within 10 minutes, so that times beyond 10 minutes would not increase the amount of natural gas in a flammable concentration.

The 12 million scfd steady state release rate, discussed in Reference 1, is based, in part, on 10 million scfd (at sonic velocity through the 1.5 inch line) feeding the postulated rupture through the 1.5 inch bypass line, which connects the 16 inch pipeline to the 6 inch pipeline. The 16 inch pipeline, which normally operates at a pressure of about 150 psig, is conservatively assumed to hold a constant pressure of 250 psig. An additional 2 million scfd contribution to the steady state release was assumed to be produced from several of the ten gas wells supplying this collection system, taking no credit for their automatic low pressure shut-in feature, as discussed in Reference 1.

The ARCHIE code, discussed in Reference 2, was used to model a steady state release of natural gas at 15 million scfd, which bounds the 12 million scfd steady state release rate that could conservatively continue after depressurization. The ARCHIE code, which assumes neutral buoyancy of the natural gas, determined that the steady state plume resulting from release of 15 million scfd, with a wind speed of 1 meter per second and Pasquill stability class F, contains 1,576 lbs of natural gas in the flammable concentration range (as opposed to the 4,417 lbs used in the previous analysis, assuming all the natural gas leaking out at the steady state rate of 12 million scfd is in the flammable concentration range). If it is conservatively assumed that all of the natural gas released in the pipeline depressurization (3,975 lbs) is in a flammable mixture with air, the total mass of gas which could be hypothesized to detonate is 3,975 lbs + 1,576 lbs = 5,551 lbs.

The ARCHIE code was used to model the effects of a postulated detonation of 5,551 lbs of natural gas at the Reactor Building using the TNT energy equivalent method, described in Attachment 1. As was done in the Reference 1 analyses, it was conservatively assumed that the equivalent TNT charge was positioned at the furthest horizontal distance from the rupture location where the natural gas concentration is at the lower flammability limit (LFL). However, this reanalysis assumes the postulated detonation is elevated (unlike the Reference 1 analysis which conservatively modelled a ground level detonation), since the portion of the plume where the LFL is closest to the Reactor Building was at a height above ground of 270 feet for the Break 1 scenario and 220 feet for the Break 2 scenario, as stated in Reference 1. The assumption of an elevated detonation vs. ground level detonation reduces the resulting overpressure. This is based on actual TNT field tests.

The result of this postulated detonation analysis, assuming 5,551 lbs of natural gas in the flammable concentration and modelling the equivalent TNT energy as an elevated detonation, is 0.30 psi at the Reactor Building from the Break 1 scenario, and 0.45 psi at the Reactor Building from the Break 2 scenario. These results, as well as a summary of the methods used in the calculations, are included in Attachment 1. A good deal of conservatism is associated with the amount of natural gas used in the calculation of these overpressure values, as identified in the preceeding paragraphs.

Since the FSV Reactor Building is designed to withstand a 300 mph horizontal wind, which corresponds to a design static positive pressure of 1.44 psi, it can easily withstand the overpressures calculated to be produced from a postulated detonation of the natural gas in a flammable mixture of the plume resulting from the Break 1 and Break 2 scenarios, even if these overpressures are doubled. PSC does not agree with the NRC's position on doubling the overpressures calculated by the TNT energy equivalent method. While this doubling may be applicable to an actual TNT detonation, which produces a shock wave travelling at sonic velocity, or faster, having a very steep wave front (step impulse), it does not seem reasonable for a deflagration of a large natural gas cloud, in which the flame propagation speed through the flammable portion of the cloud would not be expected to exceed about 300 feet per second (assuming turbulent conditions). The resulting pressure wave would be anticipated to have a frequency much lower than the natural response frequency of the Turbine/Reactor Building complex, due to the relatively long gas burn time, along with a relatively gradual buildup to the peak overpressure (related to the rise time). However, PSC concedes that we have been unable to compute a rise time for the postulated accident, an exercise characterized by several experts contacted by PSC as "extremely complex" for an unconfined cloud of natural gas due to the shape of the flammable portion of the plume and the fact that the combustion flame speed is dependent upon the natural gas concentration in the plume (which varies continuously), turbulence and temperature.

In conclusion, PSC considers that the Reactor Building structure will not be adversely impacted by ruptures of natural gas pipelines nearest the Reactor Building, even if the resulting gas plume is postulated to detonate. The postulated detonation of an unconfined cloud of natural gas, and its modelling as described above, are considered to be extremely conservative based upon natural gas vapor industry experience with actual ignitions of unconfined natural gas clouds.

PSC and Westinghouse Electric Corporation consider the treatment of natural gas buoyancy by the INPUFF code to be quite conservative, in that the initial natural gas temperature assigned to impart buoyancy to the natural gas quickly decreases to ambient. At PSC's request, Westinghouse Electric Corporation is assessing other models, which are able to account for the molecular weight of natural gas, that would achieve a more realistic modelling of dispersion following a postulated natural gas release. If other models are determined to be acceptable, they may be utilized in subsequent analyses of the final resolution of this issue. However, PSC considers that the conservative analyses of the "Interim Solution" (use of the 1.5 inch bypass line to connect the 16 inch line with the 6 inch line, per Reference 1) by means of the INPUFF and ARCHIE codes, clearly demonstrates that these natural gas pipelines in the vicinity of FSV do not pose a threat to nuclear safety while operating on the 1.5 inch bypass line.

Should you have any questions concerning this submittal, please contact Mr. M. H. Holmes at (303) 480-6960.

Very truly yours,

A. Clegg Crawford
Vice President
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ACC/JRJ:blt
Attachments

cc: Regional Administrator, Region IV

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