Public Service

Public Service
Company of Colorado
P.O. Box 840
Denver CO 80201-0840

A. Clegg Crawford
Vice President
Nuclear Operations

2420 W. 26th Avenue, Suite 100-D, Denver, Colorado 80211

March 6, 1991
Fort St. Vrain
Unit No. 1
P-91084

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 Wells in the Vicinity of Fort St. Vrain - Contains Proprietary Information (Attachment 2)

REFERENCE: PSC Letter, Crawford to Weiss, dated February 22, 1991 (P-91079)

Dear Mr. Weiss:

The referenced letter discussed natural gas wells in the vicinity of Fort St. Vrain and provided preliminary results of analyses of postulated natural gas leaks and subsequent explosions from FSV Well No. 11, the well closest to the Reactor Building. These analyses, four in all, were performed by Westinghouse Electric Corporation, and have been completed. The purpose of this letter is to document the results of these analyses.

As discussed in the referenced letter, an initial flow rate of 1 million cubic feet per day (this is standard cubic feet per day - scfd) was considered to represent a conservative upper limit for the Producer pipe rupture. The first analysis assumed a continuous natural gas flow rate of 1 million scfd from the FSV Well No. 11 wellhead, a wind speed of 5 mph in the direction of the Reactor Building, and Pasquill Class F atmospheric stability. It was assumed that 100% of the natural gas consisted of methane and that methane has the same density as air (neutrally buoyant). This is an extremely conservative assumption, given that methane has a specific gravity of 0.55, and rises rapidly in air. The first analysis modeled the steady state methane plume resulting from the conditions stipulated above, and concluded that the lower flammability limit of methane gas (4% methane in air) occurs at 108 feet from the gas flow source (wellhead), in the direction of the Reactor Building. The distance from the wellhead to one-half the lower flammability limit, in the direction of the Reactor Building, was determined to be 154 feet.

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The distance from the FSV Well No. 11 wellhead to the nearest corner of the Reactor Building (southeast corner) is 1184 feet (survey measurement). It is approximately 1060 feet from this wellhead to the southeast corner of the Turbine Building, and approximately 930 feet from this wellhead to the nearest switchyard equipment item.

The first analysis also postulated that this cloud of methane gas detonated, with ignition occurring at a point on the outer edge of the lower flammability limit nearest the Reactor Building. An overpressure of 0.1 psi was computed to occur at the Reactor Building as a result of the postulated detonation, in the form of a shock wave travelling at the speed of sound. This overpressure would not affect the structural integrity of the Reactor Building. The Reactor Building is designed to withstand a 300 mph horizontal wind velocity (corresponding to a positive static pressure of 1.44 psi) and maintain its structural integrity. Attachment 1 to this letter identifies damage which would be expected to result from shock waves from blasts which produce various dynamic overpressures.

A second analysis was performed, also based on the assumptions described above, with the exception of wind speed which was conservatively assumed to be 1 mile per hour in the direction of the Reactor Building. The use of a 1 mile per hour wind speed, with Pasquill stability Class F, represents a more conservative assumption than the 1 meter per second (2.24 mile per hour) wind speed, again with Pasquill stability Class F, that the NRC typically uses for dispersion analyses. This second analysis concluded that the greatest distance from the flow source to the lower flammability limit was 248 feet, and 359 feet to one-half the lower flammability limit. Postulated detonation of the steady state methane plume in this second analysis produced an overpressure condition of 0.3 psi at the Reactor Building, again assuming the ignition source was located at the point in the plume at the lower flammability limit which was nearest the Reactor Building. This 0.3 psi overpressure would have no effect on the structural integrity of the Reactor Building.

A third analysis was performed in which it was assumed that 100% methane flowed out of a postulated pipe rupture, at the location of the FSV No. 11 wellhead, at 1 million scfd under stagnant atmospheric conditions, with no dispersion. The methane was again assumed to have neutral buoyancy in air. Following one hour of leakage at this flow rate, detonation of the resulting gas cloud was assumed to occur, with ignition of all the methane that escaped. The resultant overpressure at the Reactor Building was computed to be 0.6 psi. This overpressure is sufficient to shatter windows, as identified in Attachment 1, but would not affect the Reactor Building structural integrity.

These calculations were performed using the Automated Resource for Chemical Hazard Incident Evaluation (ARCHIE), Version 1.00. This IBM PC code was developed by the Environmental Protection Agency (EPA), and the Federal Emergency Management Agency (FEMA). This code is capable of performing a multitude of analyses for the release of potentially hazardous, i.e. toxic or flammable, chemicals. For this analysis, ARCHIE was used to estimate the atmospheric dispersion of the natural gas released and the potential effects from a vapor cloud explosion. Since this code has not undergone internal Westinghouse review for application to nuclear analysis, the code calculations were checked in the following manner.

The dispersion of methane gas for the first analysis, assuming a 1 million scfd gas release rate with a 5 mph wind, was repeated using the EPA SCREEN, Version 1.0, code. The results indicated slightly less conservative results than the ARCHIE analysis; the flammability zone extended to approximately 90 feet, versus 108 feet for ARCHIE. The blast effect calculations were checked by performing the "worst case" calculations by hand, according to the methods described in "The SFPE Handbook of Fire Protection Engineering," Society of Fire Protection Engineers, National Fire Protection Association, First Edition, April 1990.

Since the release was treated as 100% methane (methane actually comprises approximately 80% of the natural gas from FSV Well No. 11), an evaluation was performed to assess potential effects from the 10% ethane in the flow stream, due to its higher density and lower flammability. It was determined that the presence of ethane would not extend the distance from the wellhead to the lower limit of flammability in the dispersion analyses, and the assumption of 100% methane release is considered to be conservative.

Westinghouse Electric Corporation has completed a fourth analysis involving a postulated explosion of natural gas inside the measuring station, located approximately 300 feet to the west of the FSV Well No. 11 wellhead. A stoichiometric mixture of methane in air was assumed to be present in a 512 cubic feet structure (the measuring station actually has a volume less than 200 cubic feet, and is vented to prevent such an explosion), which was then detonated. The pre-fab structure would collapse before pressures could reach 10 psig. At 10 psig, a missile, such as a plank or a portion of the measuring station siding, could not be propelled to the FSV Security fence, a distance of about 250 feet. The resultant overpressure at the Reactor Building was calculated to be less than 0.2 psi. Therefore, an explosion-driven missile and the resulting blast wave, from postulated explosion of the measuring station, would not affect the FSV Reactor Building.

Attachment 2 to this letter is the Westinghouse Electric Corporation Analysis Methods Summary documenting the results of the computer runs and calculations for the analyses described above. Information contained in Attachment 2a is considered to be proprietary by Westinghouse Electric Corporation, under the criteria set forth in 10 CFR 2.790. In accordance with the requirements of 10 CFR 2.790, the following documents are submitted with this letter:

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

(2) One copy of the proprietary information and notice, Attachment 4.

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

Calculation of the blast effects at various distances are estimates, and factors such as terrain, cloud shape, and detonation location can affect actual consequences but are difficult to quantify with existing technology. The analyses described above have incorporated much conservatism, by the assumptions of neutrally buoyant gases, extremely stable meteorological conditions, and detonation locations nearest the Reactor Building. Based on the results of the analyses described above, PSC considers that postulated accidents involving releases of natural gas from FSV Well No. 11, the gas well nearest the FSV Reactor Building, would not pose a threat to nuclear safety.

In recent phone conversations, the NRC has noted a concern regarding injection of large volumes of high pressure fluids into the natural gas wells in the vicinity of FSV. Except for occasional hydrofracing associated with possible recompletion of the gas wells near FSV, large volumes of high pressure fluids will not be injected into these wells for the purpose of enhancing oil or gas recovery.

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

Very truly yours,

A. Clegg Crawford

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Vice President
Nuclear Operations

ACC/JRJ:dh
Attachments

cc: Regional Administrator, Region IV

Mr. J.B. Baird
Senior Resident Inspector
Fort St. Vrain

Mr. Robert M. Quillin, Director
Radiation Control Division
Colorado Department of Health
4210 East 11th Avenue
Denver, CO 80220

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Reviewed by: James [signature] 3/5/91

Explosion Overpressure Damage Estimates

Overpressure* (psig)	Expected Damage
0.03	Occasional breaking of large windows already under stress.
0.04	Loud noise (143 dB); sonic boom glass failures.
0.10	Breakage of small windows under strain.
0.15	Typical pressure for glass failure.
0.30	Some damage to house ceilings; 10% window glass breakage.
0.40	Limited minor structural damage.
0.50 - 1.0	Windows usually shattered; some window frame damage.
0.7	Minor damage to house structures.
1.0	Partial Demolition of houses; made uninhabitable.
1.0 - 2.0	Corrugated metal panels fail and buckle. Housing wood panels blown in.
1.0 - 8.0	Range for slight to serious injuries due to skin lacerations from flying glass and other missiles.
1.3	Steel frame of clad building slightly distorted.
2.0	Partial collapse of walls and roofs of houses.
2.0 - 3.0	Non-reinforced concrete or cinder block walls shattered.
2.3	Lower limit of serious structural damage.
2.4 - 12.2	Range for 1-90% eardrum rupture among exposed populations.
2.5	50% destruction of home brickwork.
3.0	Steel frame building distorted and pulled away from foundation.
3.0 - 4.0	Frameless steel panel building ruined.
4.0	Cladding of light industrial buildings ruptured.
5.0	Wooded utility poles snapped.
5.0 - 7.0	Nearly complete destruction of houses.
7.0	Loaded train wagons overturned.
7.0 - 8.0	8-12 in. thick non-reinforced brick fail by shearing of flexure.
9.0	Loaded train box cars demolished.
10.0	Probable total building destruction.
15.5 - 29.0	Range for 1-99% fatalities among exposed populations due to direct blast effects.

* These are the peak pressures formed in excess of normal atmospheric pressure by blast and shock waves.

Source: Lees, F.P, Loss Prevention in the Process Industries, Vol. 1, Butterworths, London and Boston, 1980.