Commonwealth Edison
1400 Opus Place
Downers Grove, Illinois 60515

April 30, 1993

Dr. Thomas E. Murley, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attn: Document Control Desk

Subject: Dresden Station Units 2 and 3
Quad Cities Station Units 1 and 2
Additional Information Pertaining to
Combustible Gas Control (10 CFR 50.44)
NRC Docket Nos. 50-237/50-249 & 50-254/50-265

References: (a) J.L. Schrage to T.E. Murley letter dated April 16, 1993.

(b) Teleconference between CECo (J. Schrage) and NRR (J. Stang) on April 22, 1993.

Dear Dr. Murley:

In the Reference (a) letter, Commonwealth Edison (CECo) submitted information pertaining to a proposed methodology for demonstrating compliance with 10 CFR 50.44, including the associated General Design Criteria (DGC 41, 42, 43), at Dresden and Quad Cities stations. During the Reference (b) teleconference, the NRC requested CECo to submit the Regulatory Guide (RG) 1.7 analysis which supports the information provided in Reference (a). A summary of the analysis was provided to the NRC during a CECo/NRC meeting at Quad Cities Station on August 24 and 25, 1992. The RG 1.7 analysis for Dresden and Quad Cities Stations is provided in the Attachment to this letter.

If there are any questions or comments, please contact John L. Schrage at 708-663-7283.

Sincerely,

John L. Schrage
Nuclear Licensing Administrator

Attachment

cc: A. Bert Davis, Regional Administrator-RIII
J. Dyer, Project Director-NRR
J. Stang, Project Manager-NRR
C. Patel, Project Manager-NRR
T. Taylor, Senior Resident Inspector-Quad Cities
M. Leach, Senior Resident Inspector-Dresden
Office of Nuclear Safety-IDNS

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ATTACHMENT

Dresden and Quad Cities

Regulatory Guide 1.7 Analysis

GE Nuclear Energy

General Electric Company
2931 West 22nd St. Oak Brook, IL 60521
708 573-0329

EBO-91-596A

December 6, 1991

Mr. H. L. Massin
Commonwealth Edison Company
Executive Towers West III
1400 Opus Place, Ste. 500
Downers Grove, ILL 60515

SUBJECT: **NCAD ANALYSIS TRANSMITTAL DRESDEN AND QUAD CITIES NUCLEAR STATIONS**
REVISION 1

REFERENCE:
1) BUDGETARY ESTIMATE NO. 295-1B7D4-EBO
(GE LETTER EBO-91-316, JUNE 7, 1991)

2) GE Letter EBO-91-596, E.R. Cooper to H. L. Massin
November 18, 1991
Revision of the NCAD System Study

Dear Mr. Massin:

This letter is a revision to, and superceedes, Reference 2 with a minor correction as noted on Page 4, paragraph C.3. "Added H2" has been changed to "Added N2."

GE Nuclear Energy (GE) is pleased to submit this Nitrogen Containment Atmosphere Dilution (NCAD) System Study to Commonwealth Edison Company (CECo) for the Dresden and Quad Cities Nuclear Stations.

Nitrogen Containment Atmosphere Dilution (NCAD) System Study for CECO

I. Executive Summary

A study has been performed by GENE to determine the critical system parameters for the application of NCAD systems to Dresden 2 and 3 and Quad Cities 1 and 2. The study was based on NRC Reg. Guide 1.7 assumptions for radiolytic oxygen and hydrogen generation following a design basis Loss Of Coolant Accident (LOCA), and upon a conservatively determined initial oxygen and nitrogen content of the containment.

The following important findings are reported:

A. The Reg. Guide 1.7 flammability limit for oxygen of 5 vol% is reached about 15 hours into the event providing there is no specific intervention taken before that time. In order to prevent the oxygen from exceeding 5 vol% nitrogen must be added at a rate of about 29 Standard Cubic Feet per Minute (scfm) (standard conditions are $0^{o}C$ and 1 atmos absolute - $32^{o}F$ 14.7 psia)

Note: The standard review plan NUREG 0800, Rev. 2 sec 6.2.5 II4, states; "The proposed operation of the CAD systems will be acceptable if there is a margin of 1 v/o between the limiting hydrogen or oxygen concentration limit -- and the concentration at which the system would be activated." This could require a 4% O_2 limit which was not used in this analysis nor in any other analysis that GENE has made.

B. In order to assure that plants have the nitrogen needed on site to provide oxygen control, the NRC has required that a seven day supply be on hand unless it can be demonstrated that an outside supply is assuredly available in less time.

To meet the seven day requirement for either Dresden or Quad Cities, 135,700 std ft^3 must be available. This is equivalent to about 1,460 gallons of liquid nitrogen. At the 7-day time, the nitrogen must be supplied at a rate of about 10.6 scfm in order to keep the oxygen at 5 vol%.

C. If nitrogen is added to the containment at a rate that will just keep the oxygen at 5 vol%, the containment pressure would reach the 10CFR50.44 limit (1/2 the design pressure or 31 psig) in about 32 days using Reg. Guide 1.7 assumptions and assuming zero leakage.

At 32 days, nitrogen is being added at a rate of 5.2 scfm to maintain the O_2 at 5 vol% and the containment must be vented at a rate of 6.1 scfm to maintain the pressure equal to 31 psig.

Note: The above results are based on Reg. Guide 1.7 assumptions and zero containment leakage. A BWR Owners' Group supported a study published as GENE NEDO 22155 in 1982 based on conservative, but realistic and consistent, assumptions and concluded that no nitrogen would need to be added in 1,000 days to maintain $O_2 \leq 5$ vol%.

The NRC has not formally accepted this position.

II. Details of the analysis for quantity of nitrogen needed as a function of time and of the assumptions used in the analysis are presented in the attached letter from S. T. Lam to L. B. Nesbitt (SIL-91-12 10 Oct 91).

The specific results are:

A. The containment is calculated to reach 5 vol% C_2 at about 15 hours post-LOCA.

B. To maintain the O_2 at just 5 vol% up to 7 days after the LOCA 378 lb. moles of nitrogen (135,700 scf) would have to be added at a time dependent rate starting at 29 scfm at 15 hours and reducing to 10.6 scfm at 7 days and further reducing to 5.2 scfm at 32 days when the pressure is calculated to reach the regulatory limit of 31 psig.

At 32 days the calculations indicate that a total of 474,600 scf of N_2 must have been added.

C. The calculation that establishes that one-half the containment design pressure is reached at LOCA plus 32 days is as follows:

1. Assumed containment temperature is 125°F corresponding to a water vapor pressure of 1.943 psi.

2. The containment pressure is 31 psig (45.7 psia).

3. The non-condensable gases present at 32 days provide a pressure of 43.76 psig with the composition:

Initial O_2	26.32 lb-moles	(9,449 cf)
Initial N_2	526.38	(188,970 cf)
Metal water H_2	11.62	
1% of the outer 0.023" of active fuel clad)		(4.172 cf)
Radiolytic O_2	72.7	(26,099 cf)
Radiolytic H_2	145.4	(52,199 cf)
Added N_2	1100.0	(394,900 cf)

The estimated accuracy of the above is $\pm$ 0.5%.

III. Conclusion

The NCAD system can control the containment combustible gas composition without venting for at least 30 days if the conservative generation rates of Reg. Guide 1.7 are used. If more realistic rates are assumed, the NCAD will not be needed.

In order to comply with a 7-day supply of inerting nitrogen about 140,000 scf of N_2 must be available.

To minimize the amount of N_2 needed, accurate and continuous O_2 measurement is required.

NCAD calculations for Dresden 2-3 and Quad Cities 1-2

Given: The temperature in equilibrium in the containment at the time post LOCA when the total gauge pressure is equal to 1/2 of the design pressure is 125°F (374.7°K). 1/2 the design pressure is 31 psig. 1.942 psi of this is water vapor pressure. The residue, 29.06 psig (43.76 psia), comes from all of the non condensable gases (H_2 +O_2 + N_2). To determine the absolute amount of non condensable gas required to achieve this pressure, the pressure must be corrected to standard temperature (273°K). The result is a pressure of 36.7 psia.

The air volume of the containment is given in the UFSAR as 271.036 ft^3. At 273°K and 36.7 psia the containment will hold 676,668 std ft^3 of ideal gas (1884.9 lb moles) as derived in the attached paper.

The initial non condensable gases (4% O_2 + 96% N_2) amount to 552.7 lb moles.

To achieve the defined $P_{1/2}$ design with $P_{H_2O} = 1.94^2$, 1337.7 lb moles of ideal gas must be added.

The Reg. Guide 1.7 metal water H_2 reaction equal to 1% of the first 0.023" of the active fuel clad amounts to 11.62 lb moles of hydrogen for the GE fuel at Quad Cities. For non-GE fuel, the actual amounts must be calculated per 10CFR50.44 (d)1.

The inventory of non condensable gases at the time that the total non condensable gas pressure equals 43.76 psia is:

1.	Initial O_2	26.32 lb moles
2.	Initial N_2	526.38 lb moles
3.	Metal water H_2	11.62 lb moles
4.	O_2 from radiolysis	
5.	H_2 from radiolysis	
6.	N_2 added to maintain 5% O_2	

Where 1 + 2 total 552.7 lb moles. Leaving 1332.2 lb moles to be contributed by 3+4+5+6

At Quad cities, this is found to occur in about 32 days. The value for 3 above, is indeterminate for Dresden based on their use of non-GE fuel.

GE appreciates the opportunity to provide this analysis for CECo. If any questions arise concerning this study, please contact me at your convenience.

Sincerely,

E. R. Cooper

E. R. Cooper
Project Engineer
(708) 573-3997

ERC:LBN:mas
Attachment

cc: CECo
C. A. Moerke
E. J. Rowley
M. C. Strait
R. J. Walsh
B. M. K. Wong

GE
J. C. Elliott
P. F. Kachel
R. B. Gayley
M.W. Hansen
W. G. Myers
J. E. Nash
L. B. Nesbitt
M. A. Wrightsman
File: 4.Z41.0

Plant Analysis Services
San Jose, CA

STL-91-12

Oct 10, 1991

cc: L.S.Burns
DRF A00-05020

TO: L.B.Nesbitt

FROM: S.T.Lam, M/C 769, X55797

SUBJECT: **NCAD Analysis for Dresden and Quad Cities Nuclear Stations**

REFERENCES: (1) Letter, M.A.Wrightsman (GENE) to H.A.Massin (CECo), "NCAD Analysis - Dresden and Quad Cities Nuclear Stations", EBO-91-316, 6-7-1991.
(2) US NRC Standard Review Plan, Section 6.2.5, "Combustible Gas Control in Containment", NUREG-0800, Rev. 2, July 1981.
(3) US NRC Regulatory Guide 1.7, "Control of Combustible Gas Concentrations in Containment Following a Loss-of-Coolant Accident", Rev. 2, November 1978.

This letter transmits results of an analysis performed in accordance with the agreement with CECo (Reference 1) to determine the time following a LOCA for the containment oxygen gas concentration from radiolytic decomposition to reach the 5 v/o oxygen flammability limit, and the nitrogen makeup needed to maintain the combustible gas concentration at or below the limit for up to 7 days. The NCAD analysis results presented herein apply to both the Dresden and Quad Cities plants. The major analysis assumptions and methodology are consistent with the NRC combustible gas control SRP 6.2.5 (Reference 2) and RG 1.7 (Reference 3). In addition, the analysis applied the following assumptions:

(1) hydrogen generation from metal-water reaction and corrosion are negligible,
(2) good mixing is assumed in the containment,
(3) containment leakage is negligible, and
(4) the amount of water vapor in the inerted containment remains constant throughout the course of the accident.

Major containment parameters and initial conditions used in the NCAD analysis are summarized in Table 1:

TABLE 1

Major Containment Parameters and Initial Conditions

Core Thermal Power (102 % rated)		2578 MWt
Drywell	Free Volume	158236 ft^3
Wetwell	Free Volume	112800 ft^3
Drywell	Temperature	150 °F
	Pressure	15.7 psia
	Relative Humidity	0 %
	Oxygen Concentration	4 % vol
Wetwell	Temperature	95 °F
	Pressure	14.7 psia
	Relative Humidity	100 %
	Oxygen Concentration	4 % vol

It is noted that the amount of pre-accident gases in the containment increases with increasing initial containment pressure and decreases with increasing initial containment temperature. The containment initial conditions selected for the analysis and presented in Table 1 will minimize the calculated initial gas amount and the time to reach a flammable concentration and maximize the calculated nitrogen addition.

The rate of gas production from radiolysis depends upon the fission product decay and the amount of fission products released to the coolant. Using the power decay profile recommended in References 2 and 3, the calculated integrated oxygen generation as a function of time following a LOCA is shown in Figure 1, the respective contributions due to energies released by fission products remaining in the fuel and those dissolved in the coolant are also shown in the figure. Figure 2 shows the time to reach the 5 v/o flammability limit, calculated with the oxygen generation and the values listed in Table 1, to be about 5.4E4 seconds or 15 hours. The integrated nitrogen addition at 7 days (6.048E5 seconds) is found to be 378 lb-moles, as shown in Figure 3. Figure 3 can be used to estimate the total gas addition (hydrogen, oxygen, and nitrogen) to the containment at various times after a LOCA. For example, at 32 days (2.76E6 sec) the amount of oxygen and hydrogen gases plus the nitrogen addition would add up to about 1322 lb-moles. The corresponding rate of nitrogen addition at this time is estimated from the figure to be about 0.83 lb-mole/hr.

Verified by:

D. R. Rogers

D.R.Rogers
M/C 769, X51935

Reviewed by:

R Muralidharan 10/6/97

R.Muralidharan
M/C 769, X56963

FIGURE 1
INTEGRATED OXYGEN PRODUCTION VS. TIME

DRESDEN 2/3 AND QUAD CITIES 1/2

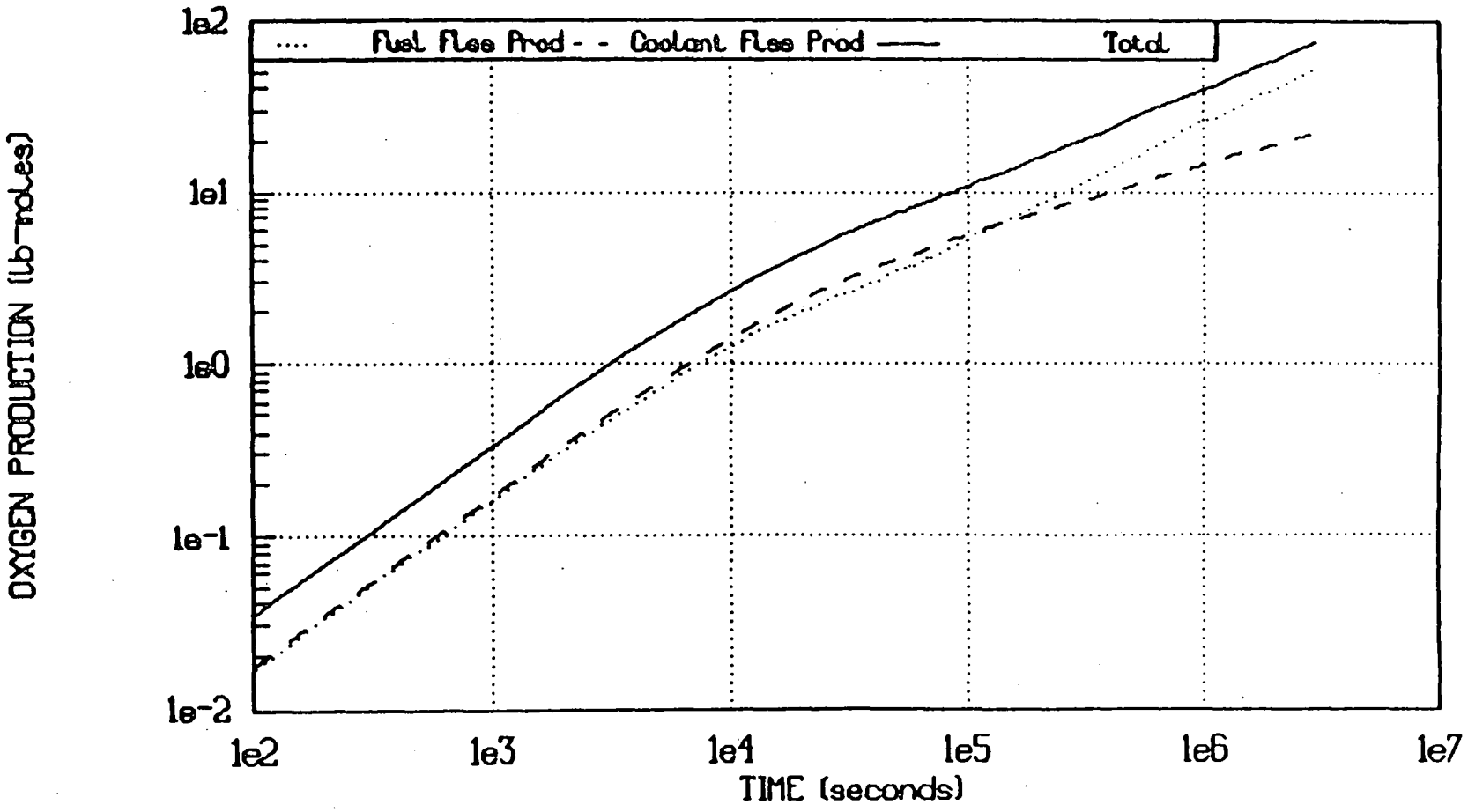

FIGURE 2
CONTAINMENT OXYGEN CONCENTRATION VS. TIME
DRESDEN 2/3 AND QUAD CITIES 1/2

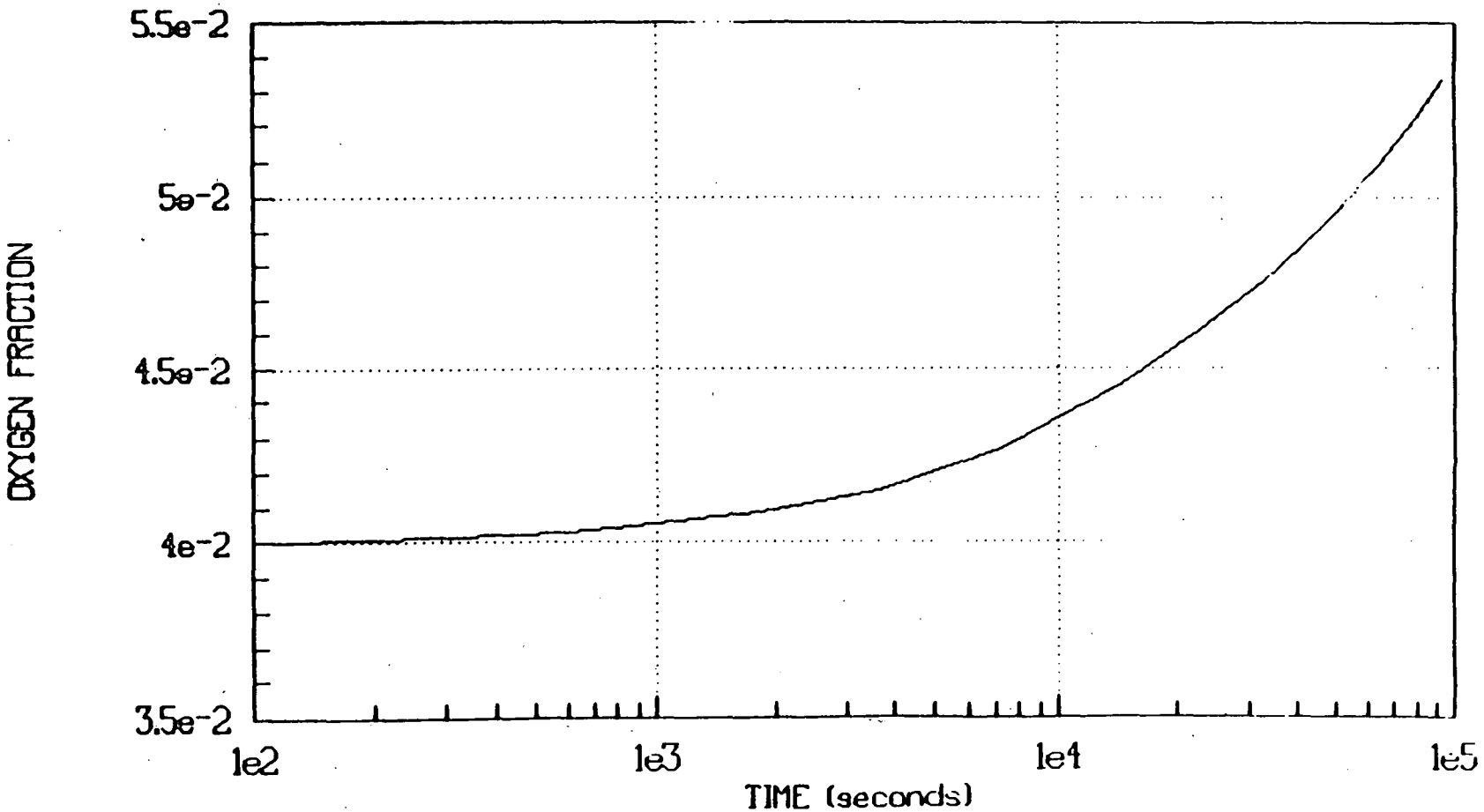

FIGURE 3
INTEGRATED GAS ADDITION VS. TIME
DRESDEN 2/3 AND QUAD CITIES 1/2
(OXYGEN 5 v/o)