Supplement 2 to Dresden Station Special Report No. 14

Quad-Cities Station Special Report No. 7

"RESPONSE TO AEC QUESTIONS CONCERNING THE PROPOSED

CONTAINMENT ATMOSPHERIC DILUTION SYSTEM"

AEC Dockets
50-237
50-249
50-254
50-265

February

Commonwealth Edison Company

RETURN TO REGULATORY CENTRAL FILES
ROOM 016

Question 1

Discuss experience at Dresden and Quad-Cities Stations with respect to the concentration of oxygen you have been able to maintain in containment. In addition, discuss your capability to further reduce oxygen concentration.

RESPONSE

The response to this question will be submitted to the AEC about March 15, 1973.

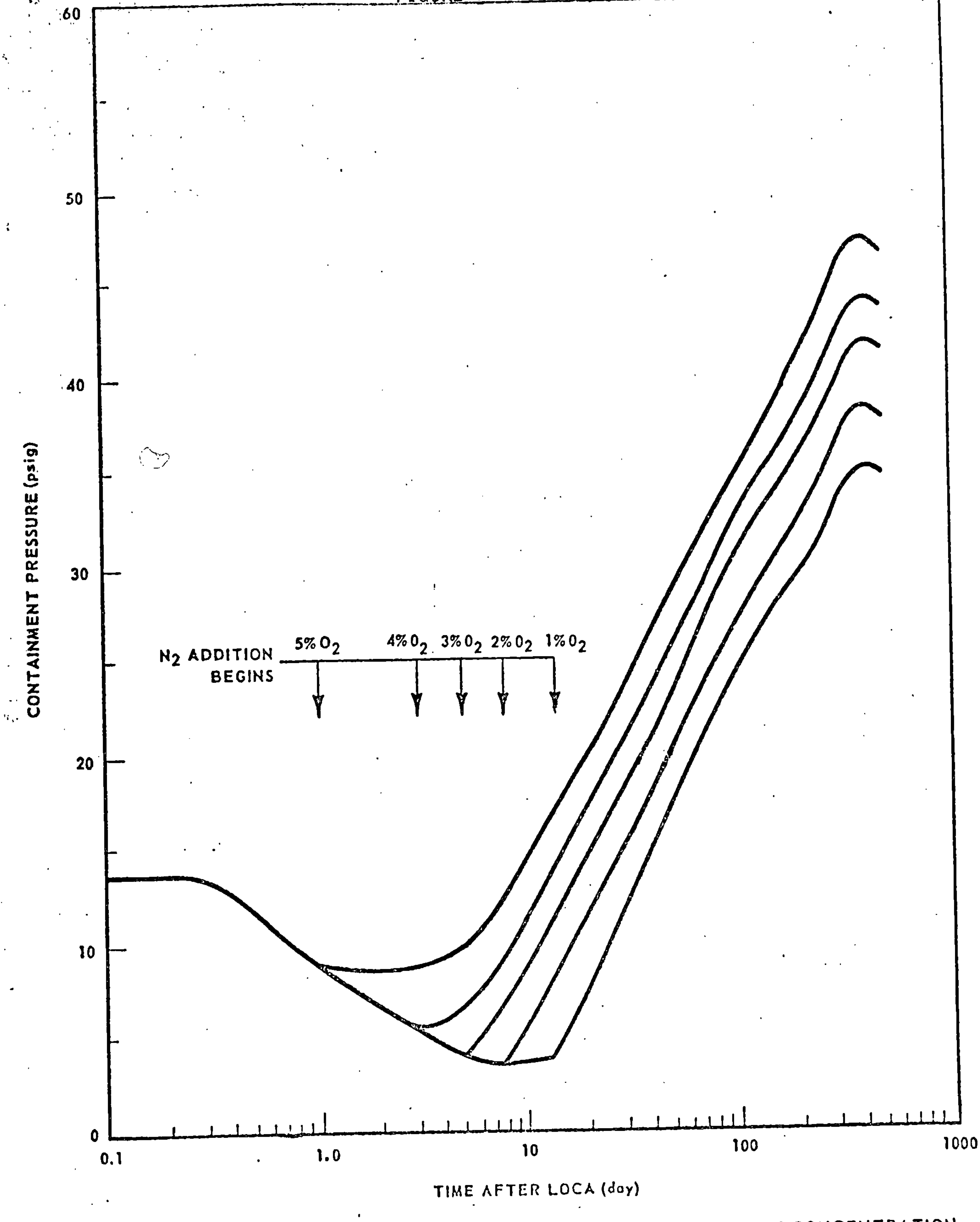
Question 2

Present an analysis of the time at which nitrogen addition must begin following a LOCA as a function of initial oxygen concentration.

RESPONSE

Figure No. 1 represents a generic function of containment pressure versus time (for different oxygen concentrations), Figures No. 2 and No. 3 demonstrate the somewhat higher pressures characteristic of Dresden and Quad-Cities (see Dresden Unit 3 Supplement to Special Report No. 14).

FIGURE 1



CONTAINMENT PRESSURE VERSUS TIME EFFECT OF INITIAL OXYGEN CONCENTRATION
(CONSTANT LEAK RATE = 0.5% V/day)
(SAFETY GUIDE 7 ASSUMPTIONS)

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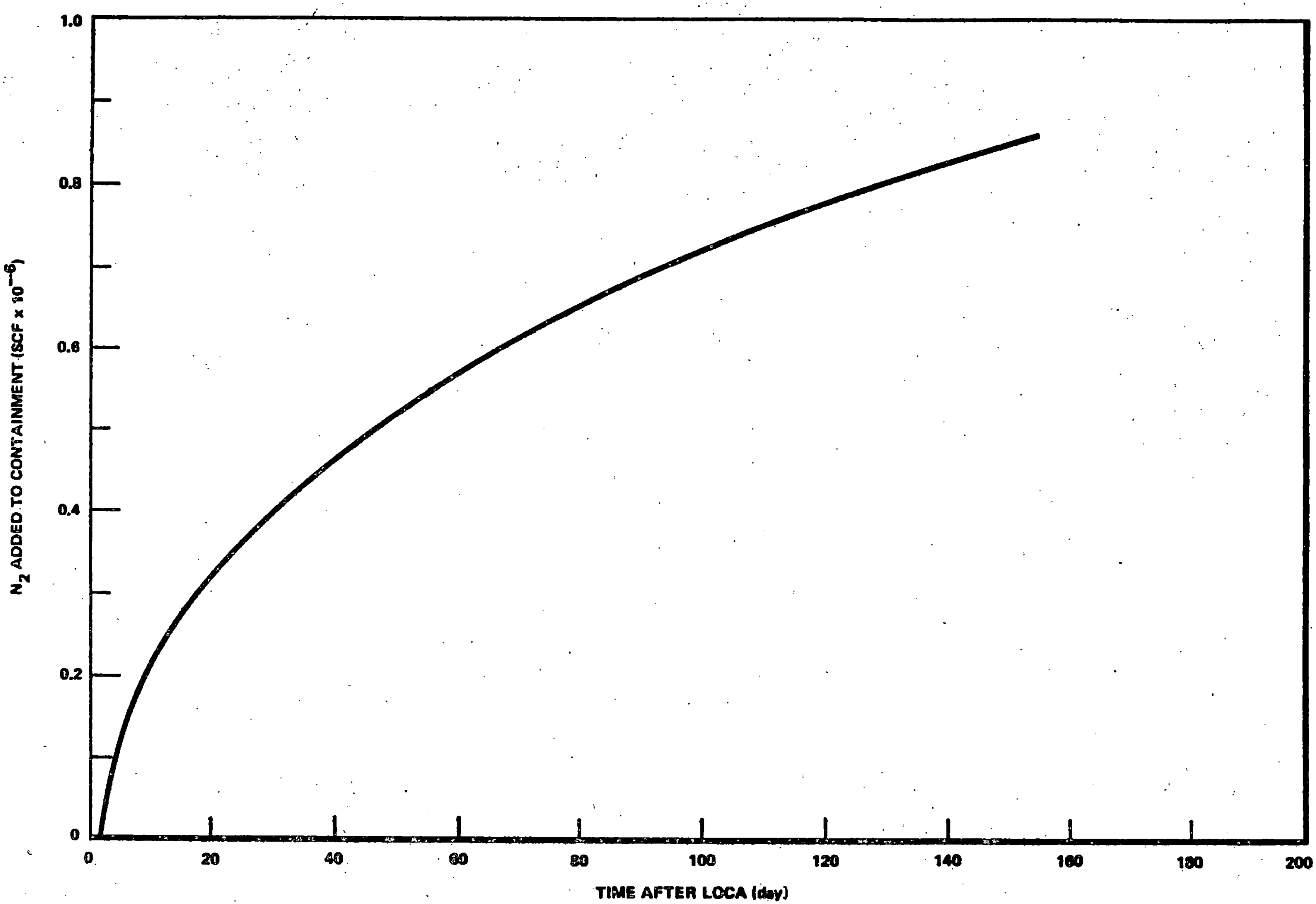

FIGURE 2. DRESDEN 2, 3 – MAXIMUM NITROGEN REQUIRED FOR DILUTION – AEC SAFETY GUIDE 7 ASSUMPTIONS; NO CONTAINMENT LEAKAGE

FIGURE 2

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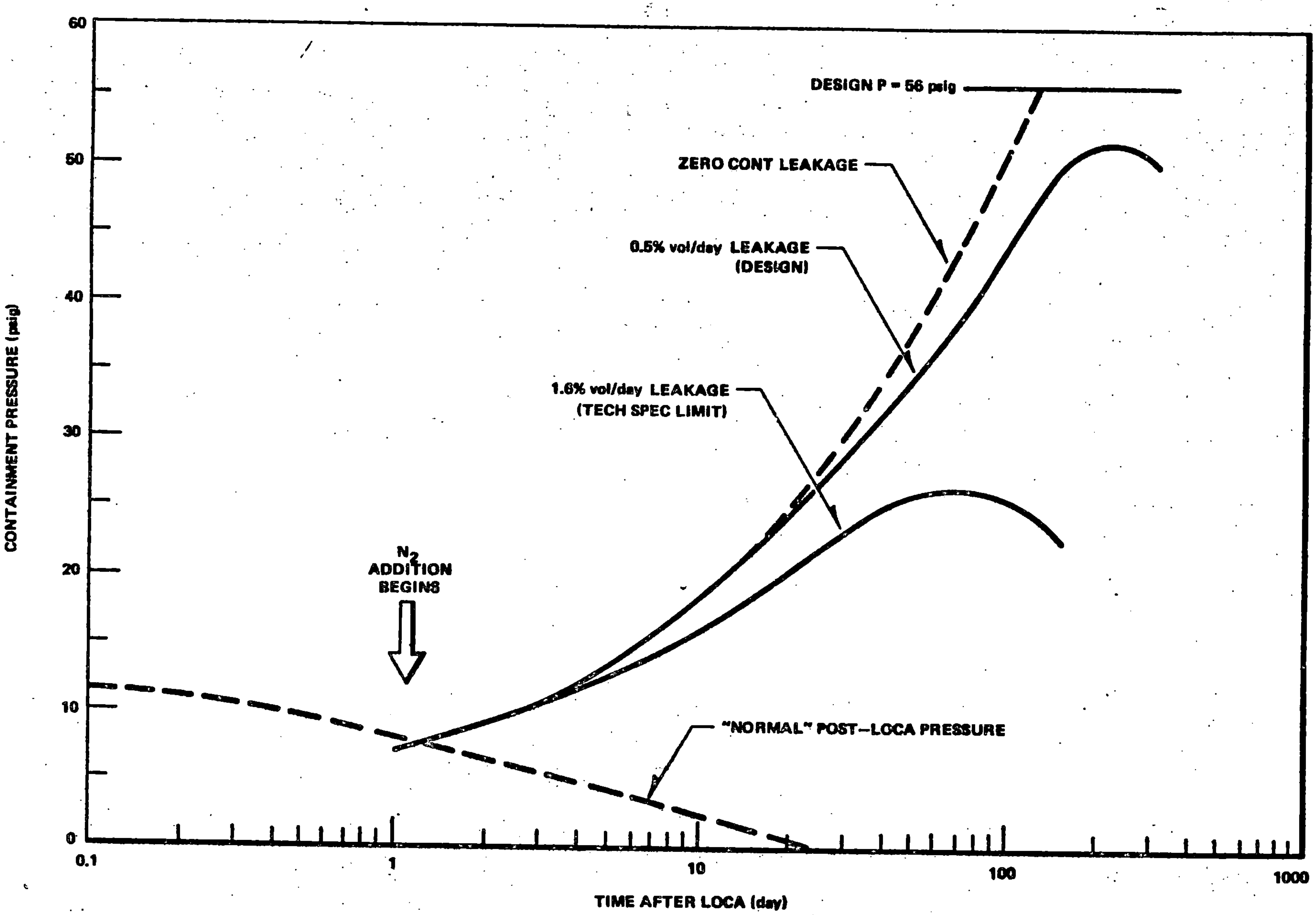

FIGURE 3. DRESDEN 2, 3 – CONTAINMENT PRESSURE AS A FUNCTION OF TIME FOLLOWING LOCA WITH DILUTION (MAXIMUM NITROGEN ADDED PER FIGURE 2)

FIGURE 3

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Question 3

Identify all potential post-LOCA oxygen sources within containment, excluding that oxygen attributable to radiolytic decomposition. Discuss the nature of these sources (e.g., oxygen entrained in coolant, leakage from air supply systems, etc.) and the potential for contributing to the total oxygen concentrations in containment.

RESPONSE

The only other sources of oxygen known at the present are the water and steam in the reactor itself, which will contain a small amount of dissolved and free oxygen, and a lesser amount of dissolved oxygen in the suppression chamber water. Following the LOCA, most of the water and steam in the reactor will be released to the primary containment. Some of the dissolved oxygen in the suppression chamber water would be released also. If it is conservatively assumed that all of the dissolved oxygen in the reactor water and about one-half of that in the suppression chamber would be released, there would be about 0.04 lb-moles of O_2 added to the primary containment. When this is compared to the 28 lb-moles of O_2 initially present (containment inerted to 4% O_2) or the 2.3 lb-moles of O_2 generated by radiolysis (Safety Guide 7 assumptions) in the first hour after the LOCA, it can be seen that the oxygen in the additional sources can be considered an insignificant amount.

All gaseous pneumatic systems in the Dresden and Quad-Cities containments use containment atmosphere as the working fluid. Therefore, any in-leakage from these systems does not alter the composition of the containment atmosphere.

Question 4

Provide a curve of the steam concentration versus time and a discussion of the long term containment pressure transient selected assuming the containment and core cooling systems are functional. Justify that the selected long term pressure transient is conservative from the viewpoint of (a) steam concentrations, and (b) nitrogen makeup requirements.

RESPONSE

A detailed response to this question was given in Amendment 2 to the Duane Arnold FSAR, Question G1.1 (f)*. While the specific data given in that response was not generated for Dresden and Quad-Cities, the following overall conclusions reached are applicable:**

1. The long term pressure transient is conservative because using the highest containment temperature from the FSAR results in the highest calculated pressures.

2. Between the two extremes of no water vapor and 100% relative humidity, there is only a small difference in cumulative nitrogen makeup requirements.

The lower the water vapor content the sooner nitrogen injection must begin. For example, if conditions which minimize containment water vapor content are assumed, (40°F cooling water, 70°F initial suppression pool temperature, and containment sprays operating), nitrogen injection into the suppression chamber would have to begin at about 2 hours if the initial oxygen content were 5.0 percent. Injection into the drywell would have to begin at about 12 hours. With an initial oxygen content of 4.0 percent and assuming no water vapor present, nitrogen addition to the containment would not be required until after about 12 hours.

* Reproduced and attached hereto.

** A curve of steam concentration vs. time is given in the response to Question No. 6.

2027.8

G1.1 QUESTION

With respect to operation of systems providing combustible gas control inside containment, additional information is needed as follows:

f. The analysis of combustible gas buildup assumes dilution by steam during the post-LOCA period. Provide tables or curves of steam concentration versus time assumed for your calculations. State the bases and assumptions used for long-term pressure transient calculations in each sub-volume. Justify that the long-term pressure transient calculations are conservative from the viewpoint of steam concentration and nitrogen makeup required.

RESPONSE

The concentration of steam at any time following the LOCA was calculated based on the reasonable asusmption that the drywell and suppression chamber gas spaces were at 100% relative humidity. Therefore, the concentration of steam was simply the ratio of the partial pressure of the water vapor to the total pressure of the containment.

The partial pressure of the water vapor was obtained from standard steam tables as a function of temperature. The temperature used was from the standard post-LOCA containment response analysis as presented in Subsection 14.6 of the FSAR.

The range of steam concentrations can vary from 100% in the drywell immediately following the blowdown down to practically zero. Choosing the zero leakage case for illustration, Figure 2-G.1-2 shows the steam concentration vs time in the drywell and suppression chamber following the LOCA.

Pressure in the containment, both short and long-term, was calculated using the ideal gas equation of state and the partial pressure of water:

$$P = \frac{nR_oT}{V} + P_{H_2O}/_T$$

where

n	=	moles of noncondensible gases
R_o	=	ideal gas constant
T	=	gas temperature
V	=	volume
$P_{H_2O}/_T$	=	partial pressure of water @ T

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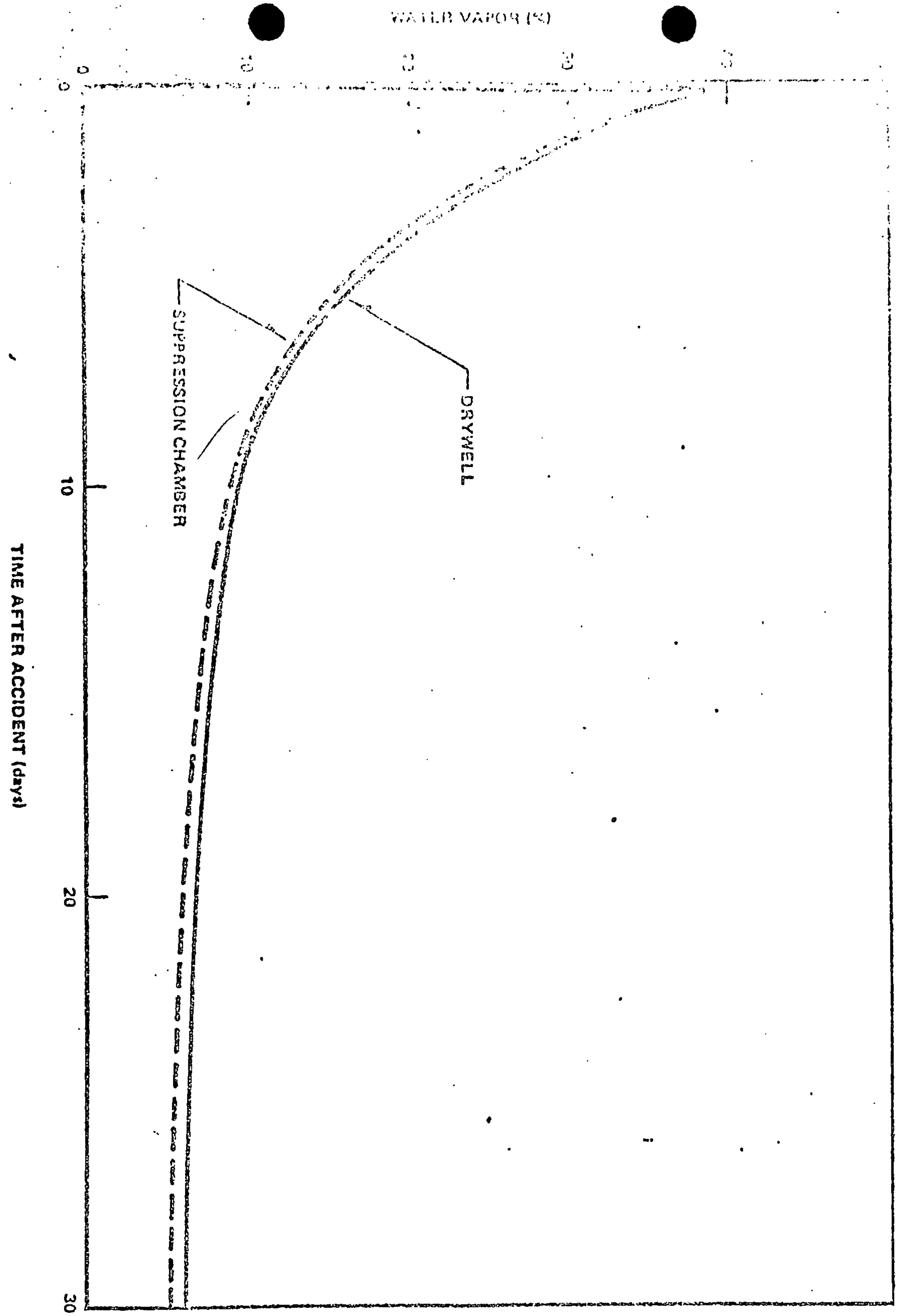
The temperatures and volumes (drywell and suppression chamber) are input values. The noncondensible gas inventory was continuously uprated accounting for leakage, nitrogen additions, radiolysis and metal-water reactions, and gas transfers between chambers.

The long-term pressure transient calculations were conservative because the use of the highest post-LOCA calculated temperature (i.e., minimum cooling, no sprays) from Section 14.0 of the FSAR results in a calculation of the peak containment pressure even after considering the additional amount of nitrogen that would be required at lower temperatures to compensate for the lower water vapor concentration. This is graphically illustrated in Figure 2-G.1-3 where it is shown that for a constant oxygen concentration of 5%, pressure continually increases with increasing temperature. Therefore, the use of the highest temperature is conservative from a pressure viewpoint. Secondly, if some condition other than 100% relative humidity were assumed at the same temperature, the same total pressure would still result for CAD operation. This is because any loss in water vapor would have to be made up by an equal amount (moles) of nitrogen. Thus, at a given temperature, the total number of moles, hence pressure, would remain the same.

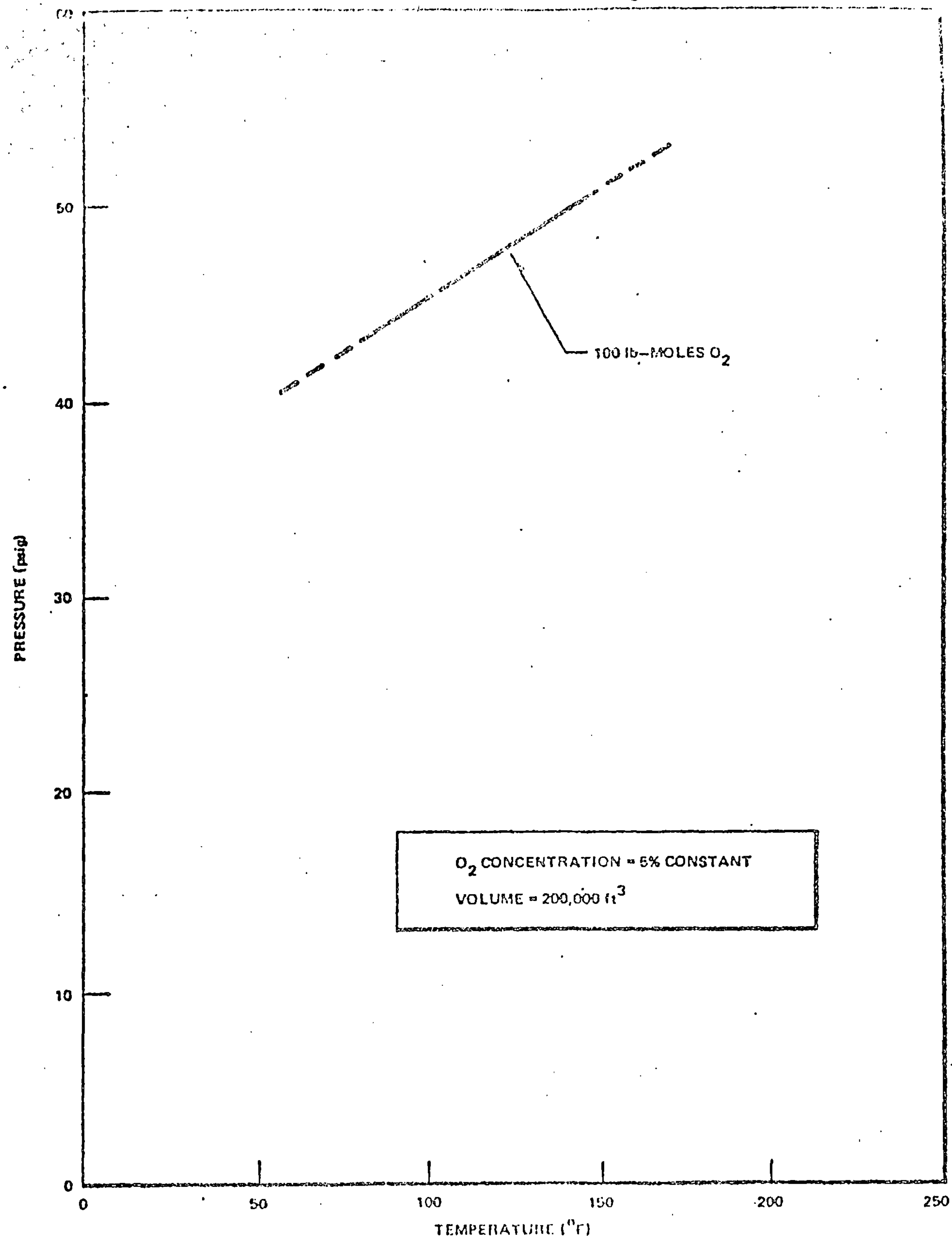
From the viewpoint of nitrogen makeup requirements, the long-term cumulative nitrogen makeup requirements are only slightly affected by variations in water vapor concentration. Figure 2-G.1-4 shows the relatively small effect of water vapor concentration on the total nitrogen requirements between the two extremes of 100% and 0% relative humidity. From a practical viewpoint, this means that total nitrogen supply requirements can be reasonably determined without too much concern about containment atmospheric conditions.



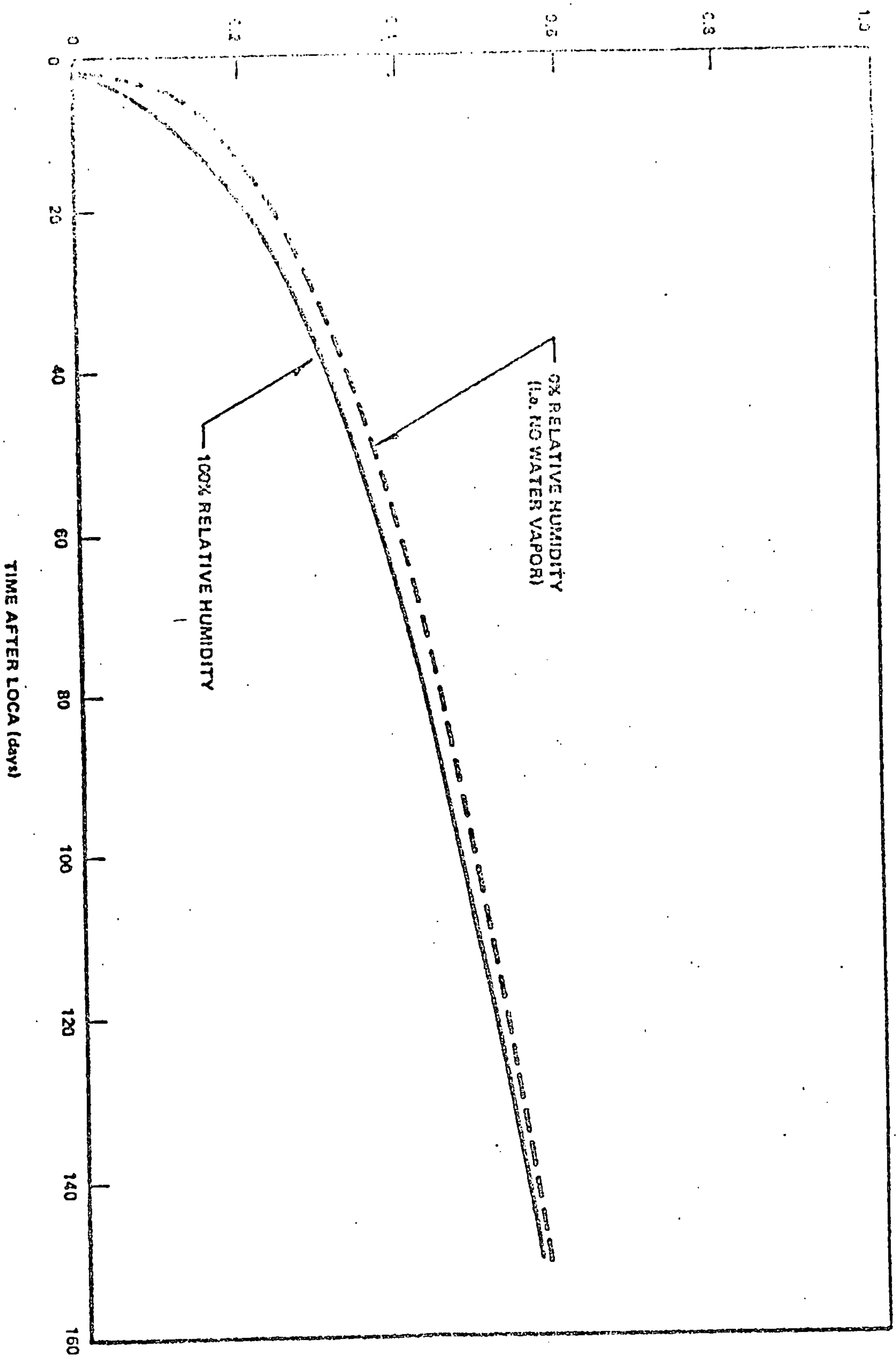
Percent Water Vapor Versus Time

0% Leakage - N_2 Injection

FIGURE 2-G.1-2



Containment Pressure Variation
With Temperature
100% Relative Humidity
FIGURE 2-G.1-3



Maximum Nitrogen
Required for Dilution
FIGURE 2-G.1-4

Question 5

Provide the analyses and diffusion calculations to support **the contention that no special mixing provisions (or systems)** are required. Describe and evaluate the containment atmosphere circulation patterns and paths between the drywell and suppression chamber that will develop which allows for homogeneity of the combustible gases. Reference experimental work to support this contention of mixing.

RESPONSE

The CAD concept is based on maintaining the oxygen concentration below the Safety Guide 7 limit of 5%, thus the only concern from a mixing viewpoint is the potential degree of non-uniformity in oxygen concentration that would occur in the containment. There are three mixing forces existing in the containment after a loss of coolant accident; they are diffusion, natural convection and forced convection. Forced convection is the most difficult mixing force to quantitatively evaluate and detailed calculations of its effects on concentration gradients have not been done. However, calculations have been done on the other two mixing forces, that is, diffusion and natural convection. The details of this analysis were presented in Amendment 2 of the Duane Arnold Energy Center FSAR in response to Question Gl.1(d)*. The referenced calculations showed that the maximum oxygen concentration deviation would be 2% from the average at the surface of the suppression pool using conservative assumptions relative to the natural convection driving force. Less conservative assumptions for natural convection would result in a maximum concentration deviation of only 0.3%. In other words, given an average oxygen concentration of 5%, the maximum concentration at the suppression pool surface would be 5.10%, or less conservatively, 5.015%. Based on the results of this analysis, it has been concluded that the assumption of a uniform oxygen concentration in the containment is reasonable for performing analysis related to the CAD operation.

*Reproduced and attached hereto.

2037.15

G1.1 QUESTION

With respect to operation of systems providing combustible gas control inside containment, additional information is needed as follows:

d. Provide the assumptions and the precise diffusion calculations describing atmospheric mixing in containment.

RESPONSE

Atmospheric mixing in the containment is a complex function of diffusion and natural and induced convection. Largely due to the complex geometry of the containment, detailed and rigorous calculations of convective flow paths are impractical. However, a number of solutions of the diffusion equation for specific geometries and boundary conditions are available in the literature. Furthermore, by noting the similarities between the phenomena and equations governing mass and heat transfer, experimental heat transfer data and their correlations can be used to predict the effect of convection on mass transfer.

This mass/heat transfer analogy was used to make a conservative prediction of the concentration gradients for oxygen and hydrogen in the suppression chamber. The results of this analysis are summarized in Figure 2-G.1-1. It shows a maximum oxygen concentration of 5.10% at the suppression pool surface for an average concentration of 5%. Because of its higher diffusivity, the concentration gradients for hydrogen are even less. Using less conservative assumptions with respect to natural convection, heat transfer coefficients would result in a maximum oxygen concentration of only 5.015% at the pool surface.

Concentration gradients in the drywell were not specifically calculated. However, the existence of strong convection inducing forces such as the high temperature differential between the reactor vessel and the drywell atmosphere, flow out of the broken pipe, and the drywell sprays would result in the calculation of smaller concentration gradients than were calculated for the relatively quiescent suppression chamber.

Given the conservatism of the Safety Guide 7 assumptions and the results of this analysis, the overall conclusion is that assumption of uniform concentration in the containment is reasonable for performing calculations related to the CAD operation.

Analysis:

The general diffusion equation (one dimension)

$$\frac{dv_1}{dt} = K \frac{\partial^2 v_1}{\partial x^2}$$

describes the transport of "v_1" as a function of a "concentration" gradient, $\frac{dv}{dt}$. In the heat conduction problem, v is temperature and $K = \frac{k}{pc}$, where k is the thermal conductivity. In the mass diffusion problem, v is the molecular density of the diffusing component and K is the coefficient of diffusion. Since the heat transfer problem is more generally encountered, a large number of solutions of the diffusion equation for various boundary and initial conditions can be found in many textbooks and reference manuals.

Two particularly useful solutions that can be applied to the problem of radiolysis in the suppression chamber can be

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found in Carslaw and Jaeger (Ref. 1) and in "Temperature Response Charts" by P. J. Schneider (Ref. 2). The Carslaw and Jaeger solution is for a slab with a constant flux at one surface, and is written as (for mass diffusion)

$$V = \frac{F_o t}{\ell} - \frac{F_o \ell}{K}\left[\frac{3x^2-\ell^2}{6\ell^2} - \frac{2}{\pi^2}\sum_{n=1}^{\infty}\frac{(-1)^n}{n^2}\cdot e^{-kn^2\pi^2 t/\ell^2}\cos\frac{n\pi X}{\ell}\right]$$

where F_o is the flux.

Carslaw and Jaeger plot the solutions of this equation for various values of X/ℓ (normalized distance) and the dimensionless ratio, $\frac{Kt}{\ell^2}$.

Schneider's solution is for essentially the same boundary conditions as Carslaw and Jaeger's except that flux is not a constant but linearly decreasing with time. The solution is also plotted as a function of $\frac{Kt}{\ell^2}$. Therefore, it can be seen that the problem is essentially one of evaluating the dimensionless ratio, $\frac{Kt}{\ell^2}$.

Previous analyses of the hydrogen problem have shown that no flammable condition exists until a number of days after

QUESTION G.1 REFERENCES

1. Carslaw and Jaeger, "Conduction of Heat in Solids", 2nd Edition, Oxford, 1959.

2. Schneider, P. J., "Temperature Response Charts", John Wiley & Sons, New York, 1963.

3. Kays, W. M., "Convective Heat and Mass Transfer", McGraw-Hill, New York, 1966.

4. Jeans, Sir James, "An Introduction to the Kinetic Theory of Gases", Cambridge, 1962.

5. Reid, R. C. and T. K. Sherwood, "The Properties of Gases and Liquids", McGraw-Hill, New York.

6. McAdams, W. H., "Heat Transmission", 3rd Edison, McGraw-Hill, New York, 1954.

the LOCA has occurred. Furthermore, the height of the top of the suppression chamber above the pool surface is on the order of 500 cm. Therefore, the ratio of t/ℓ^2 (in sec/cm^2) is on the order of unity.

The values of K used in the analysis were evaluated from the coefficients of diffusion for hydrogen and oxygen and analogy between heat and mass transfer coefficients. Kays (Ref. 3) discusses the analogy between heat and mass transfer. He states that experimental heat transfer data, expressed in terms of the Nusselt number, can be used to determine an equivalent mass transfer coefficient. Noting that the Nusselt number is the ratio of convective to conductive heat transfer and that pure molecular diffusion is equivalent to heat conduction, the following relationship for a mass transfer coefficient was developed.

$$K_{\text{convective mass transfer}} = Nu_{\text{heat transfer}} \; D$$

when Nu is the Nusselt number from experimental heat transfer data and D is the classical molecular coefficient of diffusion.

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Values for the coefficient of diffusion can be found in various sources (Ref. 4,5). The values selected for calculational purposes were $D = .76 \frac{cm^2}{sec}$ for hydrogen and $D = .2 \frac{cm^2}{sec}$ for oxygen.

Small variations in these values due to temperature and concentration changes are of second order importance when compared to the order of magnitude of the convective term or the Nusselt number.

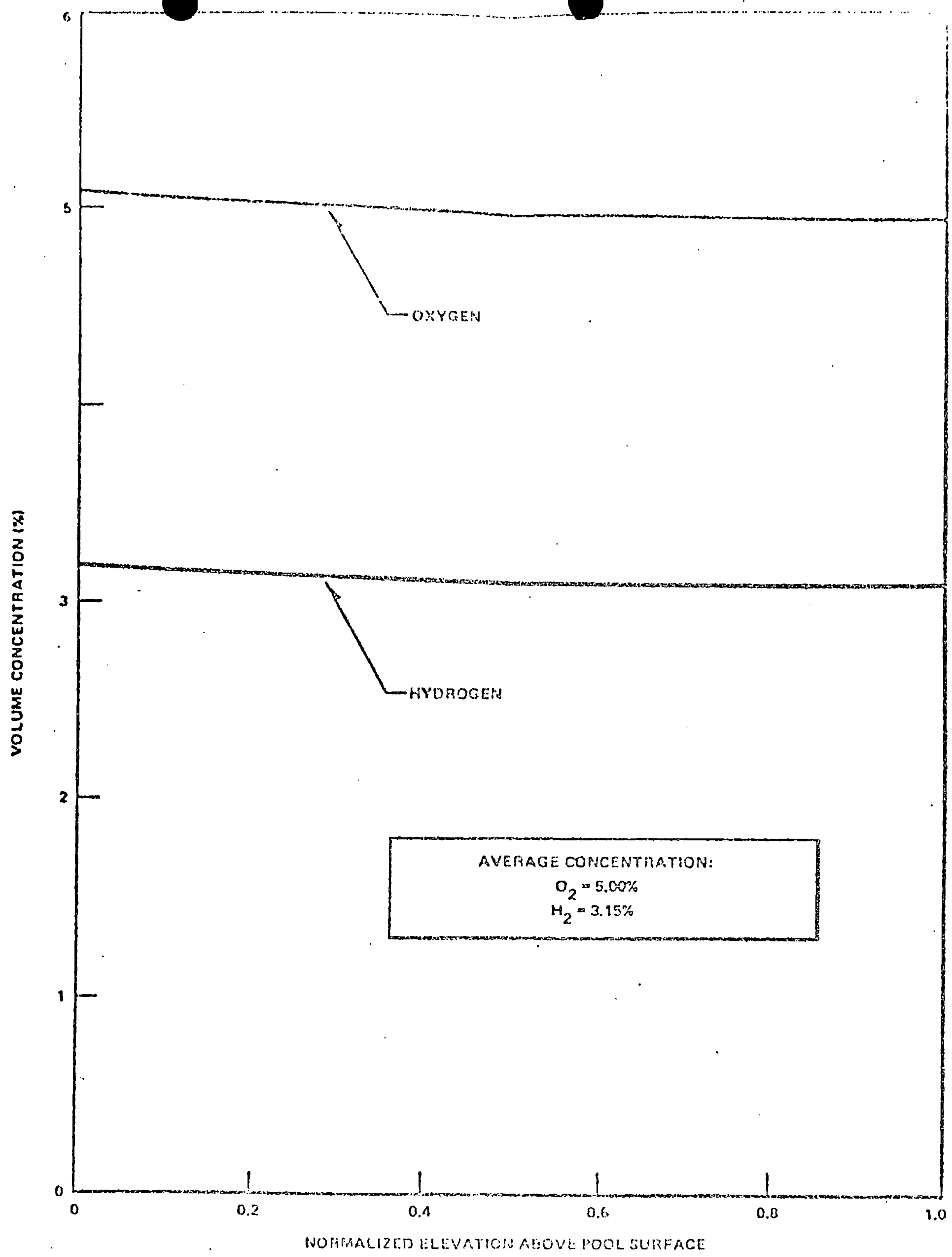
McAdams (Ref. 6) is the most general reference source for experimental heat transfer correlations. Using the correlations presented in the chapter on natural convection, Nusselt numbers from $25\Delta t^{1/4}$ to $150\Delta t^{1/4}$ (Δt is a temperature differential) can be calculated depending on what geometric assumptions are used. The temperature differential describes the buoyancy term which is the natural convection driving force. It can be seen that for even very small Δt's, the Nusselt number ranges from about 25 to 150.

Conservatively selecting the lowest Nusselt number of 25, the mass transfer coefficient, K, used in the calculations was thus 19 for hydrogen and 5 for oxygen. Selecting three days (the time at which oxygen concentration reaches 5%) after the LOCA as t, $\frac{Kt}{\ell^2}$ was 19.6 for hydrogen and 5.2 for oxygen.

Using these values for $\frac{Kt}{\ell^2}$ in the Carslaw and Jaeger solution (constant flux) resulted in the concentration gradients shown in Figure 2-G1.1-1. It should be noted here that only that portion of the total oxygen concentration which was due to radiolysis (about 30%) was subject to the gradient calculation. The remaining oxygen was part of the original inventory, hence it does not have a gradient associated with it. All of the hydrogen was assumed to be subject to the gradient, even though a small part of it was from the hydrogen due to the metal-water reaction.

The Schneider solution, for a linearly decreasing flux, results in even smaller gradients than the constant flux solution. The actual flux is not decreasing linearly, of course; however, the Schneider solution does show that the assumption of constant flux is conservative.

If a Nusselt number of 150 had been used, the Carslaw and Jaeger solution would have yielded a maximum oxygen concentration of only 5.015% at the pool surface. The Schneider solution would have resulted in an even lower concentration.



Maximum Hydrogen and Oxygen
Concentration Gradients
In Suppression Chamber
FIGURE 2-G.1-1

Question 6

Using Safety Guide No. 7 parameters, provide curves of the oxygen and hydrogen gas generation versus time for the suppression chamber and for the drywell. Provide the steam concentration for each location versus time and indicate the point in time when homogeneity of the gases occur. Distinguish between core and containment solution radiolysis.

RESPONSE

The BFNP curves of hydrogen, oxygen and steam concentration in the drywell and suppression chamber are attached as representative of Dresden and Quad-Cities. (Figures W5-1 through W5-3). No attempt is made to predict when homogeneity occurs. The maximum deviations in oxygen concentration were discussed in the response to Question No. 5 above and were found to be very small considering just diffusion and natural convection as the mixing forces. Therefore, for all practical purposes, homogeneity can be assumed at any point in time.

The model used to analyze the problem does distinguish between radiolysis in the core and suppression pool. The differences in the radiolytic generation rates between the core and the pool are part of the reason why there are differences in hydrogen and oxygen concentrations between the drywell and suppression chamber. Also, the drywell and suppression chamber are connected through the vents and vacuum breakers; therefore, the containment will eventually come to an equilibrium hydrogen concentration of about 10% with zero leakage from the containment. The drywell is initially higher because of the hydrogen generated from the metal-water reaction must pass through the downcomer with the steam to the suppression pool. (The drywell pressure must be greater than 2 psi higher than the suppression chamber for flow to occur.) Later on the vacuum breakers open frequently, to permit pressure equalization whenever the suppression chamber pressure is greater than the drywell pressure by 0.5 psi. Thus hydrogen equilibrium in the containment will be established in the long term by back flow through the vacuum breakers.

The curve showing water vapor content in the drywell and suppression chamber is based on maximizing the pressure in the containment (90°F cooling water, 90°F initial suppression pool temperature, and no containment sprays operating). The effects of cold containment conditions are discussed in the response to Question No. 4 above.

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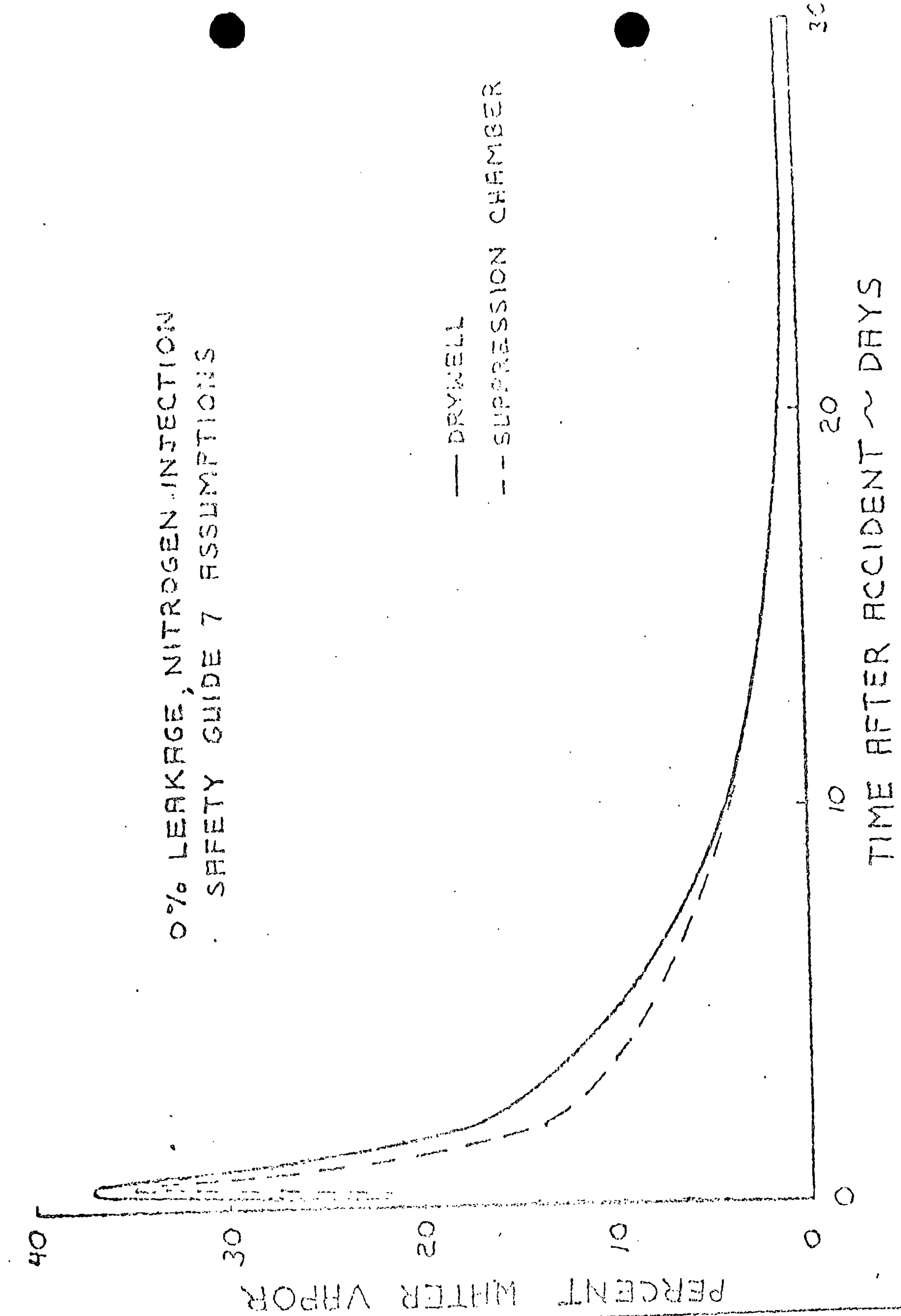
This point was also discussed in Amendment 2 to the Duane Arnold FSAR in response to Question G.1.1(h).*

*Reproduced and attached hereto.



BROWNS FERRY NUCLEAR PLANT
FINAL SAFETY ANALYSIS REPORT

Water Vapor Concentration

Figure W5-1

(Added by Amendment 41)

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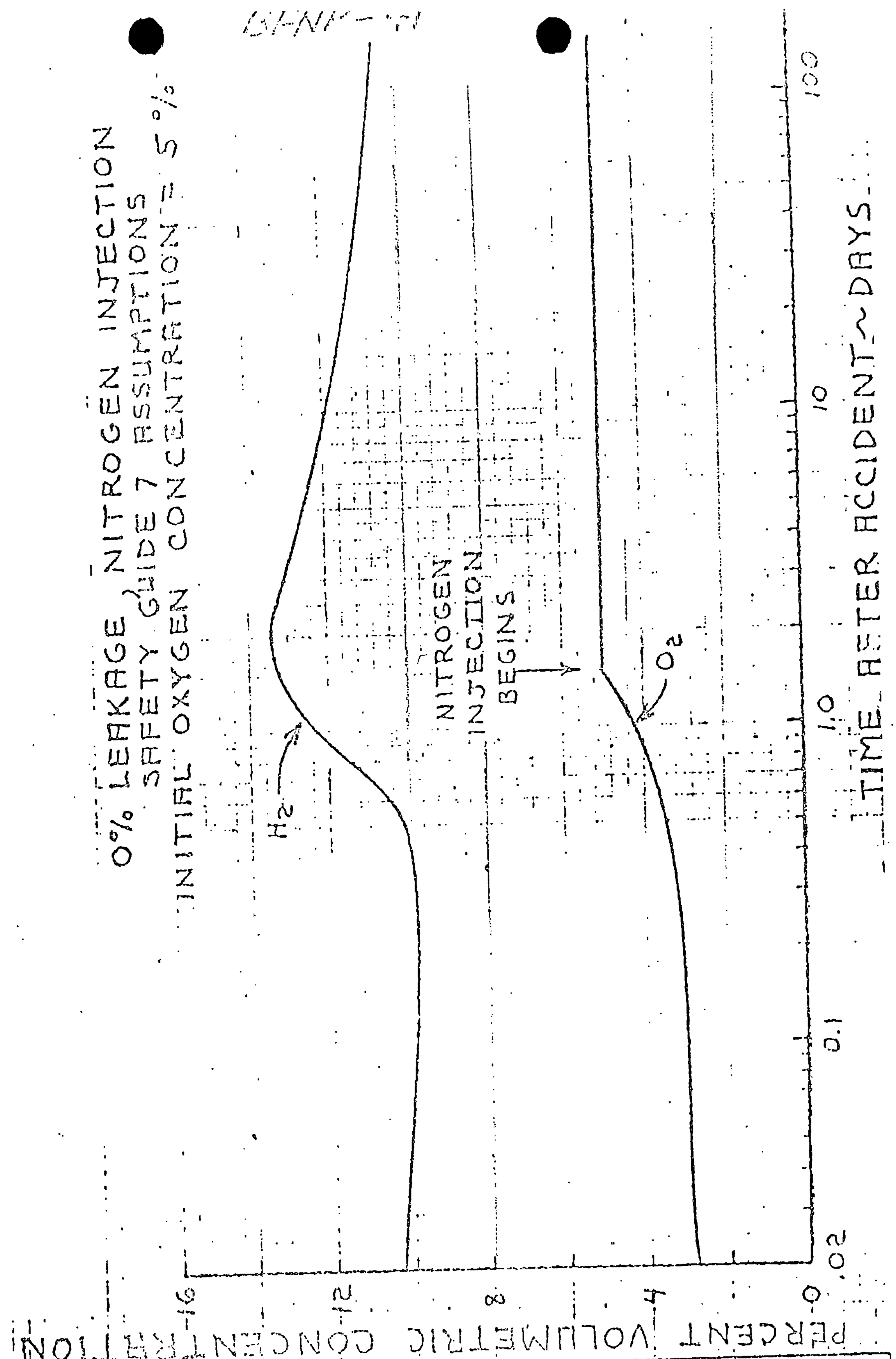

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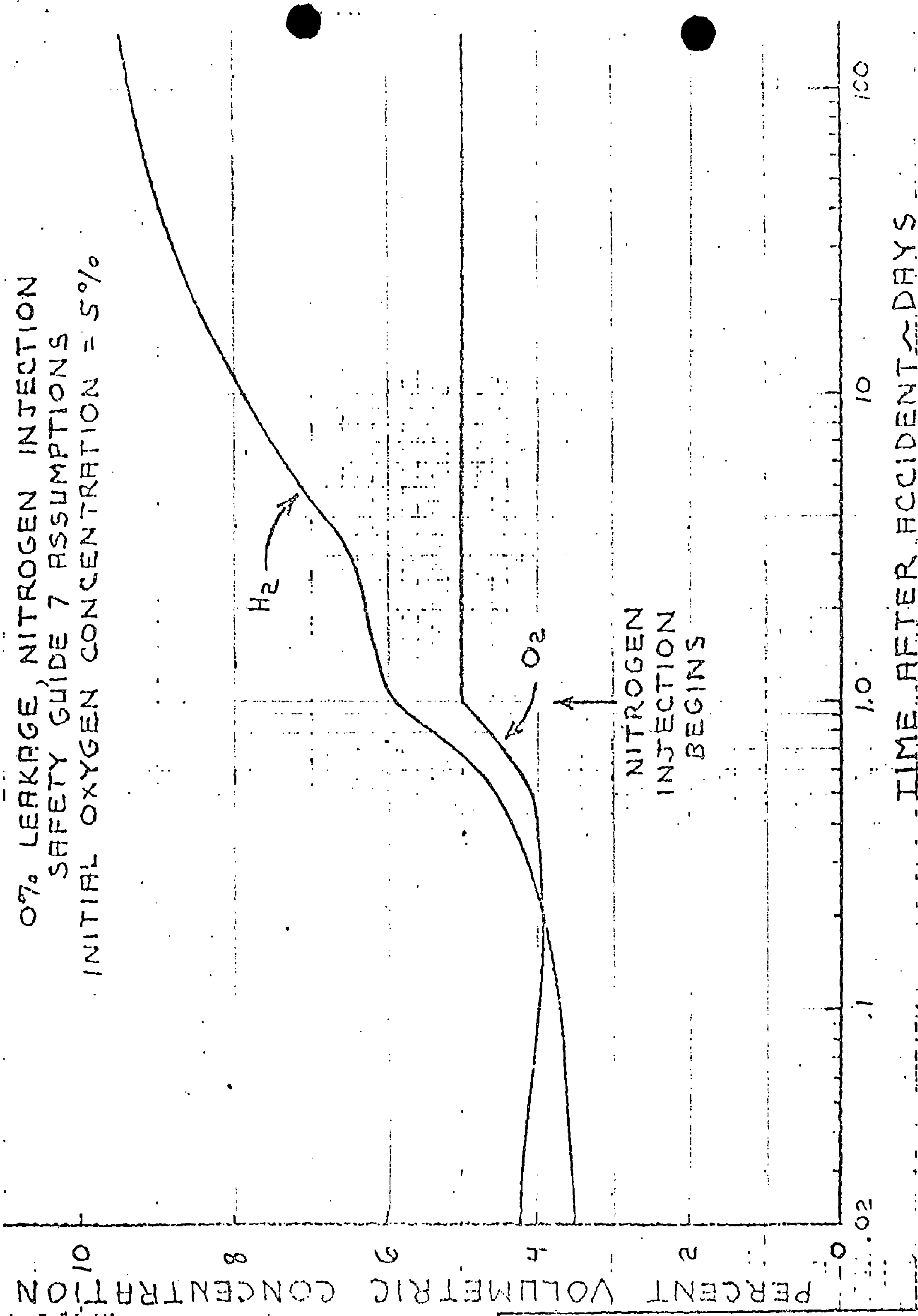
Concentrations in Drywell

Figure W5-2

(Added by Amendment 41)



BROWNS FERRY NUCLEAR PLANT
FINAL SAFETY ANALYSIS REPORT

Concentrations in Suppression Chamber

Figure W5-3

(Added by Amendment 41)

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G1.1 (Cont'd)

With respect to operation of systems providing combustible gas control inside containment, additional information is needed as follows:

h. The analyses of the hydrogen and oxygen evolution in the post-LOCA period should consider those gases resulting from entrained fission products as well as from the reactor core. Also, the analyses should be directed to examining the combustible gas concentrations that develop in the drywell and the suppression chamber as separate volumes and not as a single "lumped" volume.

RESPONSE

The analyses done for DAEC were in strict accordance with Safety Guide 7. Therefore, the "entrained fission products" are accounted for in the assumption that 50% of the core halogens and 1% of the solids are intimately mixed with the coolant water. The reactor core was treated as a separate radiolysis source. The radiolysis rates from each of these sources, i.e., entrained fission products and the reactor core region, were calculated per the recommended assumptions in Safety Guide 7.

The drywell and suppression chamber were treated as separate volumes in the analyses. Hydrogen and oxygen generation in the drywell was based on radiolysis in the core region. Generation in the suppression chamber was based on radiolysis due to the entrained fission products. Communication between the two chambers via the vents and vacuum breakers was also accounted for in the calculations.

Question 7

Provide an evaluation of the adequacy of the purge system and/or the standby gas treatment system to acceptably function as a backup system for the proposed nitrogen dilution system. Identify the system flow rates*, initiation time, initiation actions required, instrument information that is required to be available to alert operator of the need to initiate purge, the purge gas composition (including fission products, moisture levels, gas concentrations, etc.) and any system constraints (e.g., pressure, sampling time, moisture, combustible gas levels, fission products inventory, air infiltration, nitrogen makeup requirements, etc.) against earlier initiation. Provide an evaluation of the sizing bases for the system's components (e.g., filters, ducting, fans, etc.) and make a conclusion regarding the acceptability of these components to sustain the post-LOCA purge gas conditions and composition. If the CAD system is inoperable and purge is used at the proposed purge rate, provide a curve of containment atmosphere composition and pressure as a function of time.

RESPONSE

The CAD system, including its nitrogen dilution functions, is designed as an engineered safeguard system, meeting the redundancy and seismic requirements of such systems and also the requirements of IEEE-279. Therefore, a backup system is not necessary.

As noted in Dresden Unit 3 Supplement to Special Report No. 14, the existing nigrogen inerting system can be used for containment atmosphere dilution. This system is not of engineered safeguard quality. If it were available following an LOCA, and if the CAD system were not, the nitrogen inerting system would be utilized in a CAD mode rather than in the purge mode. It is capable of being used in the purge mode, but higher offsite doses would result.

*To perform necessary radiological dose calculations, the information provided should include purge rates in terms of equivalent containment leakage as a function of time following a LOCA.

Question 8

Provide detailed P&I diagrams showing all essential system elements and the detailed design arrangements for the proposed nitrogen dilution and purge backup systems. Include the appropriate sampling, mixing, and makeup system elements.

RESPONSE

The response to this question will be submitted to the AEC about March 15, 1973.

Question 9

Provide discussion and analyses in detail to support the adequacy of the design bases for the nitrogen dilution system and discuss how the system will be operated. The discussion should include, but not be limited to the following:

a. The sampling equipment, principles, design, operating procedures, equipment qualification for LOCA service, time to sample or monitor, location of sampling points in containment, location of measurement readout, sampling errors and stratification considerations.

b. The pre-operational checkout and evaluation of the sampling and nitrogen dilution systems.

c. The system testing procedures and frequency.

d. The design pressure limitations of components and piping.

e. The delivery capability of the nitrogen supply against the pressure head of containment under accident conditions.

f. The existing constraints which would prevent earlier than anticipated usage of the nitrogen dilution system, e.g.,

(1) makeup limitations due to inadequacy of onsite nitrogen inventory or time to obtain offsite makeup (specify),

(2) time required to sample and judge action requirements,

(3) time and actions required to override the isolation requirements, including all applicable valving required to be defeated to effect dilution operations.

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RESPONSE

9.a. Hydrogen and oxygen monitors will be provided in the form of redundant sensors located in the drywell and suppression chamber of each unit with readout in the main control rooms. The sensors measure the percentage of oxygen and hydrogen electronically within the drywell and suppression chamber. An electrical signal is transmitted to the recorders in each control room. Remote calibration capability is provided to allow for periodic testing and calibration during normal reactor operation.

As installed, one sensor with associated electronics forms a single analyzer unit. There will be 2 units each for H_2 and O_2 in both the drywell and suppression chamber. The volume percent of hydrogen and oxygen is recorded by a 2 channel strip recorder. Each channel will be powered from separate buses providing redundant and reliable analyzers.

Monitoring is continuous with a predicted accuracy of $\pm$ 1/2 of 1%. No special operating procedures are required once the systems are in operation. The sensors have been qualified for operation at 340°F, 62 psig, 100% RH and post LOCA fission product activity. Stratification is discussed in the response to Question No. 5 above.

9.b. Preoperational checkout of the sampling system will include checking the electronic circuits and calibrating the system using the built-in calibration gas sources for each sensor. During normal operation, each monitor will be calibrated weekly.

One of the two atmospheric nitrogen vaporizors will be tested in the manufacturer's shop to establish that it is capable of delivering the required flow at -20°F. Preoperational tests of the completed installation will be conducted to establish that individual components perform as required. Following interconnection with the individual units, each train of the nitrogen supply portion of the CAD system will be operated to supply nitrogen to the primary containment. This may be done during unit startup while the containment is being inerted. During inerting, each of the gas release paths will be tested by flowing air through the standby gas treatment system, using air supplied through the test connection. The gas supply and gas release tests will be repeated at each refueling outage.

During normal operation, the nitrogen-operated valves will be cycled periodically to ascertain that they are functioning correctly.

9.c. Refer to the response to Question 9.b.

9.d. It is highly unlikely that the CAD nitrogen supply system would be put in operation prematurely. Even if it were actuated at the time of a LOCA, however, the effect on containment pressure would be negligible. A flow restrictor in the nitrogen supply line limits flow to 100 scfm. In order to raise containment pressure by 1 psi, 19,000 ft^3 of gas must be added. The peak drywell pressure occurs at about 10 seconds; the CAD system could increase the pressure by no more than 0.0009 psi in that time. At the time of initiation of the containment cooling mode of RHR (10 minutes), the CAD system would have added only 0.053 psi to the containment pressure.

Release of gas from containment following a LOCA requires deliberate operator action to override the containment isolation valves. The modifications made for the CAD system do not increase the hazards of premature gas release.

The system is designed to prevent exposing the standby gas treatment system to excessive pressure. If a pressure control valve in the gas release line were to malfunction in such a way as to increase the gas release rate, the control valve would limit the maximum flow rate to 100 scfm. The remotely operable control valve is designed with mechanical stops to limit valve position.

The valves and supply piping downstream of the vaporizers are of stainless steel to avoid problems of brittle fracture that would be encountered with carbon steel.

9.3. The liquid nitrogen storage pressure of 100 psig can be maintained at temperatures as low as -20°F. This is adequate to ensure delivery of gaseous nitrogen at a rate of 100 scfm against a pressure of 40 psig in the containment.

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9.f. (1) Each of the CAD system nitrogen storage tanks has a capacity of 2500 gallons of liquid nitrogen. Using Safety Guide 7 assumptions, about 2260 gallons would be used in the first 7 days after a LOCA. During normal operation, the tank will be filled whenever the level drops to 2260 gallons.

(2) Oxygen and hydrogen are monitored continuously.

(3) Valves in the nitrogen supply portion of the CAD system are normally closed, and do not receive a containment isolation signal. Hence, it is not necessary to override an isolation signal in order to admit nitrogen.

Question 10

Identify the codes, standards, and classifications applied to the final design of the nitrogen dilution systems and components, including the supporting systems and equipment, i.e., makeup, sampling, purge system.

RESPONSE

The CAD system, including nitrogen storage tanks, vaporizers, piping and valves, is an engineered safeguards system, and is designed to meet seismic class I requirements. The system is designed in accordance with the following:

a. United States Atomic Energy Commission (USAEC) "Safety Guides for Water-Cooled Nuclear Power Plants," Revised 3/10/71. Safety Guide No. 7, "Control of Combustible Gas Concentration in Containment Following a Loss-of-Coolant Accident".

b. American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code

(1) ASME Section III, Nuclear Power Plant Components (1971)

(a) Subsection NE, Metal Containment Components
(b) Subsection NC, Class 2 Components

All components will be stamped in accordance with this reference. The installation will conform except for code stamps.

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(c) Institute of Electronic and Electrical Engineers (IEEE), IEEE 279, Nuclear Power Plant Protection Systems.

Question 11

It is our understanding that the nitrogen dilution, purge, and sampling systems originally were provided for normal operating functions and were not specifically considered as being required for post-accident safety functions. Describe in detail the design bases for and any design changes made or planned to these systems to upgrade them to the standards of an engineered safety system. Provide a failure mode analysis for these systems.

RESPONSE

The nitrogen inerting system is to serve as a containment atmosphere dilution system until the permanent CAD system is installed. No design changes are planned to have the nitrogen inerting system function as an engineered safeguard system.

Question 12

Describe all features, components, and functions in the containment atmosphere control system that will be shared between plant units and evaluate the acceptability of the proposed sharing.

RESPONSE

Two independent nitrogen supply systems serve the containments. Each containment has its own gas release system. Each nitrogen supply system can deliver nitrogen to either of the containments at a maximum rate of 100 scfm. Using Safety Guide 7 assumptions, the maximum nitrogen supply rate required is about 32 scfm.

Question 13

Describe the surveillance of the CAD system equipment and monitors and limiting condition of operation you would propose for incorporation into the Dresden Units 2 and 3 and Quad-Cities Units 1 and 2 Technical Specifications.

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RESPONSE

The Dresden and Quad-Cities Units will have a Limiting Condition for Operation and Surveillance Requirement similar to the sample supplied below:

3.5 LIMITING CONDITION FOR OPERATION	4.5 SURVEILLANCE REQUIREMENT
I. Nitrogen	I. Nitrogen
1. There shall be a minimum of 200,000 ft^3 of nitrogen on site. If this minimum volume of nitrogen requirement cannot be met, an orderly shutdown of the reactor shall be initiated.	1. Once a month the quantity of nitrogen available shall be logged. 2. Once each month the valves in the nitrogen makeup system shall be actuated.
Bases: 3.5	Bases: 4.5
I. The nitrogen supply of 200,000 ft^3 will supply the primary containment with nitrogen sufficient to dilute and control the containment oxygen concentration to less than 5% per volume in the unlikely event of a LOCA for a period of seven days. Additional nitrogen can be obtained and delivered to the site within a 24-hour period; thus, a seven-day supply provides adequate margin.	1. The nitrogen quantity must be checked to ensure continuous operation of the nitrogen makeup system over a period of seven days.

This suggestion was a part of Dresden Unit 3 Supplement to Special Report No. 14. Additional recommended surveillance was discussed in the answer to Question No. 9 above.

Question 14

Section 3.2, page 6 of the Supplement to Special Report No. 14, states that "the operator will have sufficient time available to establish some small leakage rate if the containment leakage rate proves to be too small." Clarification of this statement should be provided and should include discussion of:

a. The information readily available to the operator to facilitate his judgment on whether the leak rate is less than or greater than the allowable leak rate,

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b. The system used and actions that can be taken to control the leak rate,

c. A discussion on what constraints and system provisions will exist for the operator to limit the allowable leak rate within prescribed values, and

d. What disposition and processing provisions are provided for the discharged gases.

RESPONSE

The response to this question will be supplied about March 15, 1973.

Question 15

Discuss the potential for stratification of hydrogen leakage from the drywell into the reactor building or compartments. Discuss the need for positive mixing of the atmosphere in the reactor building or compartments to prevent the formation of localized combustible gas mixtures.

RESPONSE

The response to this question will be submitted about March 15, 1973.

Question 16

For the long-term period following the DBA, discuss the potential degradation of valve structure and penetrations within the primary containment in connection with the capability of the containment and containment systems to maintain (a) structural integrity and (b) required leak-tightness requirements needed during the long term following a loss-of-coolant accident.

The response to this question will be submitted about March 15, 1973.

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