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NORRIS L. STAMPLEY
VICE PRESIDENT

August 14, 1973

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U.S. ATOMIC ENERGY COMMISSION
Regulatory
Mail Section

United States Atomic Energy Commission
Washington, D. C. 20545

Attention: Mr. A. Giambusso, Deputy Director
for Reactor Projects
Directorate of Licensing

SUBJECT: Grand Gulf Nuclear Station
Units 1 and 2
Docket Nos. 50-416/417
File 0272/L-952/11000
Advance Information Combustible
Gas Control & By-Pass Leakage
(MAEC-62)
AECM-63

Gentlemen:

Enclosed are five (5) copies of information requested by your July 19, 1973, letter concerning the combustible gas control system and bypass leakage.

This is advance information and will be identical in content to information filed later this month as part of Amendment 11 to the Grand Gulf Preliminary Safety Analysis Report.

Yours very truly,

J. P. McGaughy, Jr.

for N. L. Stampley
Vice President

Subscribed and sworn to before me this 14th day of August, 1973.

Robert C. Travis

Notary Public, in and for the County of Hinds, State of Mississippi

My Comm. Expires April 21, 1977

NLS/ls
Enclosures

cc: Mr. Troy B. Conner, Jr.
Mr. Robert C. Travis

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C-3/B/37

Item 6.2.39 Provide the results of an analysis of the plant's capability to allow initiation of the hydrogen recirculation system at 10 minutes following a loss-of-coolant accident. Define the spectrum of primary system break sizes for which this capability may exist and discuss the specific limitations which determine the unacceptable break ranges. As a minimum, the following possible limitations should be addressed:

a. containment spray heat capacity;

b. RHR system interlocks;

c. capability of the recirculation system to effectively mix the drywell and containment atmospheres considering the evolution rate of hydrogen due to metal-water reaction;

d. interlocks on the recirculation system valves; and

e. requirements for operator action.

RESPONSE: The following are the results of an analysis of the Grand Gulf Plant's capability to accommodate initiation of the hydrogen mixing system at 10 minutes following a loss-of-coolant accident. This is a theoretical analysis based on an arbitrary 10-minute start time because, as has been stated in PSAR Subsection 6.2.5.3.2.2 and shown in PSAR Figure 6.2.24a, this system will not be required until at least one hour following a LOCA.

Metal-water reaction is a function of primary system break size. It is a time-at-temperature phenomena, with the maximum temperature occurring for the DBA (reference Section 6.3 of the PSAR). The double-ended recirculation line break is, therefore, the worst-case break in relation to maximum metal-water reaction. All other spectra of pipe breaks would produce lesser amounts of metal-water reaction at a reduced rate of generation. The 10 minute start time capability has, therefore, been related only to this worst-case break.

a. As discussed in the response to question 6.2.41, the containment spray system is capable of maintaining containment pressures and temperatures within their design limits, assuming that the hydrogen recirculation system is initiated at 10 minutes or later after a LOCA. A very conservative end point calculation, assuming that the containment is at peak design conditions, indicates that the containment spray system is capable of condensing all the steam being produced in the reactor vessel at approximately 11.7 minutes after the LOCA. The results of this analysis are shown in Figure R6.2.39-1.

   The analysis did not assume transient effects which would allow the containment pressure to fluctuate between initial conditions at 10 minutes (5 psig) and design conditions (15 psig). The analysis assumed the pressure remained constant and calculated the time at which the system may be started without increasing the temperature of the containment. The initial containment conditions are such that approximately 20,000 lb of additional steam can be absorbed by the containment atmosphere prior to exceeding the design pressure. If the hydrogen mixing system is postulated to start at 10 minutes, it has been determined that less than 6,000 lb of additional steam is produced prior to the containment spray having the capability to condense all the steam produced. Therefore, adequate margin exists to enable a start time of 10 minutes.

b. Existing RHR system interlocks (See Subsection 7.3.1.1.5) apply to the initiation of the hydrogen recirculation system. None of these impose a limitation on the capability to start the system at 10 minutes following a LOCA.

c. The capability of the fans was discussed in the response to Item 6.2.30b. As noted therein, the recirculation fans provide one complete drywell air change every seven minutes.

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The flow rate, assuming that two of the four hydrogen recirculation fans are operating, is 40,000 cfm. Thus, whenever the recirculation system is started (and assuming a hydrogen concentration of 4 percent by volume) the hydrogen is removed from the drywell at the rate of 1600 cfm. It can be seen that this removal rate far exceeds the generation rate of 237 scfm at 10 minutes using the equation listed in the response to Item 6.2.28. It can also be shown that the recirculation system is capable of removing the hydrogen at the generation rate which would give 4 percent by volume concentration in the drywell in 10 minutes (as postulated by this question):

$$\text{generation rate} = \frac{1}{2}\left(\frac{33,800}{170}\right)\left(\frac{170}{10}\right)^{\frac{1}{2}}$$

$$= 410\ \frac{ft^3}{min}$$

The recirculation flow rate, therefore, is sufficient to remove hydrogen generated even in the postulated 10-minute time.

d. Two interlocks are provided to prevent the possible overpressurization of the containment due to the initiation of the recirculation system. These are:

1. A signal indicating initiation of the containment spray.

2. A hydrogen concentration indication permissive in the drywell in excess of approximately 4 volume percent.

The limitations on opening the containment spray valves are discussed in (b) above. In addition, the ΔP switches of the vacuum relief function will not initiate closing of the recirculation inlet valves once the system has been initiated following a LOCA.

During the hydrogen concentration lockout, no operator action can cause recirculation initiation (although automatic vacuum relief is possible); however, the operator can initiate the system if the hydrogen concentration approaches four volume percent.

e. Recirculation is manually initiated. The monitored parameters and operator actions based on those parameters are described in the response to Item 6.2.40. The containment sprays are also manually initiated. Spray actuation requires only the diverting of the LPCI flow to the spray headers.

FIGURE R6.2.39-1

CONTAINMENT SPRAY CONDENSING CAPABILITY AND REACTOR STEAMING RATE FOLLOWING RECIRCULATION LINE BREAK

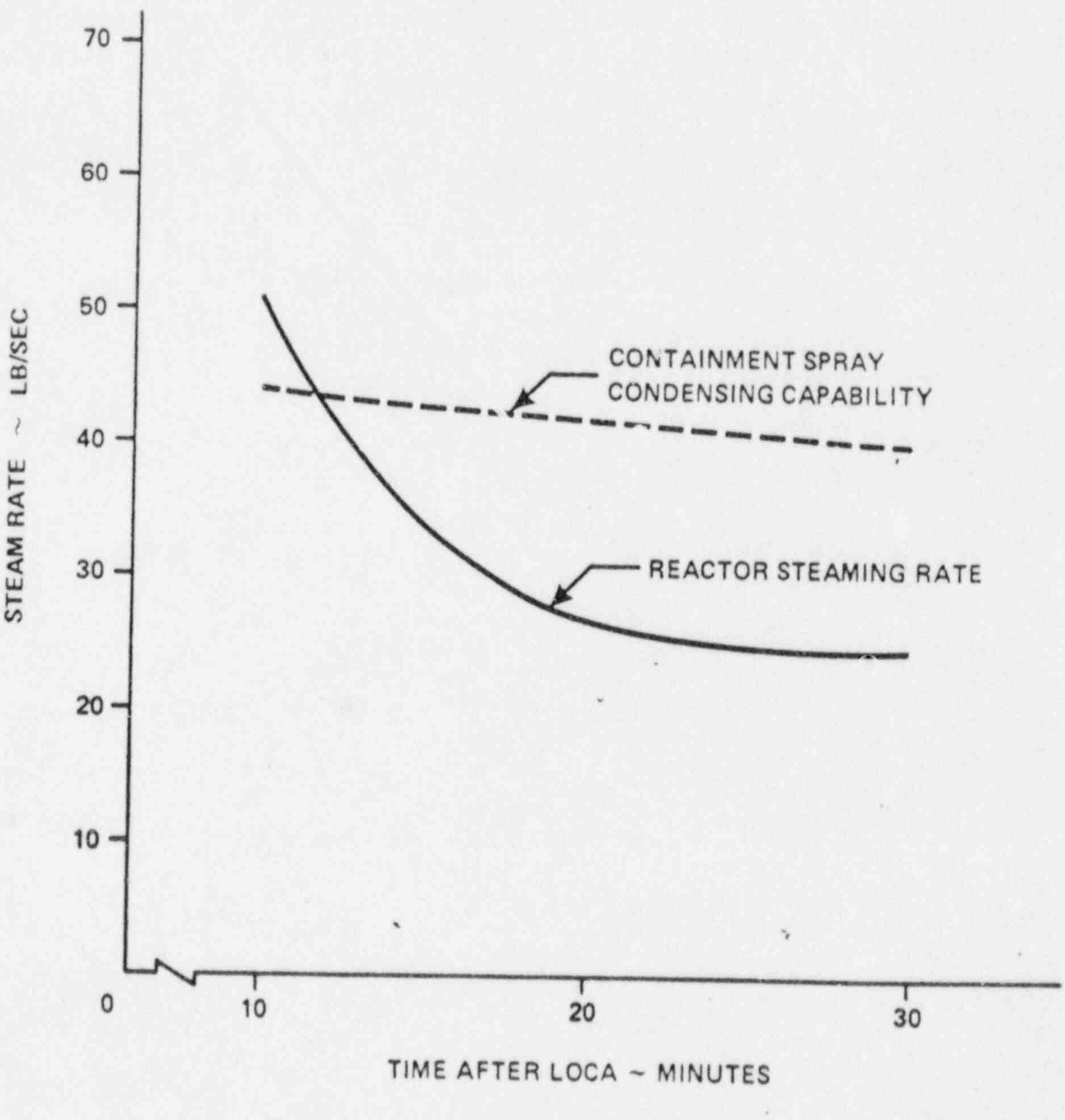
ASSUMPTIONS:

CONT. SPRAY

1 RHR PUMP, 5700 GPM
1 HX, KHX = 470
η = .75
P_c = 15 psig

REACTOR VESSEL

1 HPCS PUMP
P = 15 psig



Item 6.2.40 Discuss the process parameters which are monitored by and available to the operator and the general operating procedures which he will follow in making the decision to initiate the hydrogen recirculation system. Describe the manual actions which must be performed by the operator to start recirculation.

RESPONSE: The concentration of hydrogen gas in the drywell and containment is displayed in the control room by four indicators connected to separate analyzers. Two systems are used to monitor the drywell and two systems are used to monitor the containment. Alarms are operated from each analyzer to be activated on a high concentration of hydrogen.

When the concentration of hydrogen reaches 4 percent, the operator will place the hydrogen mixing system in service by manual operation of two pushbutton switches for system initiation or operation of individual switches for each component.

Item 6.2.41 Provide an analysis of the heat removal capability of the containment spray system. Discuss the assumptions and the justifications for the assumptions used in the analysis.

RESPONSE: The heat removal capability of the containment spray system for Grand Gulf is 44 lbm/sec bypass steam from the drywell. The containment could tolerate this flow rate of bypass steam from the drywell into the containment air space without having the design pressure (15 psig) being exceeded.

The key assumptions for the analysis are as follows:

a. The flow rate of the containment spray is 5700 gpm. This flow rate is conservatively interpolated from the rated flow rate 7400 gpm of the RHR pump by considering higher total discharge head required for the spray system.

b. Steam bypass begins at 10 minutes following a primary system break accident.

c. The suppression pool temperature at the time of the spray initiation is 142 F. Calculation of this temperature is based on the pool heatup by the primary system energy dumped.

d. The RHR heat exchanger capacity is 470 Btu/sec-F which is reduced from 540 Btu/sec-F at rated pump flow.

e. The spray efficiency was set at 75 percent. Spray efficiency is defined as:

$$\eta = \frac{T_f - T_c}{T_a - T_c}$$

where: T_f = temperature of drop after condensation, F
T_c = temperature of incoming spray water water, F
T_a = bulk temperature of containment atmosphere, F

Item 6.2.42 Provide sensitivity analyses which relate the allowable bypass capacity (Figure 6.2-26), for small primary system breaks, to the following means of mitigating or terminating bypass leakage:

a. containment sprays;

b. plant shutdown times;

c. containment heat sinks (specify the sources of the heat sinks and the manner by which heat sink effectiveness was determined); and

d. any other means for mitigating the effects of bypassing.

Considering the above analyses, summarize the containment capability to withstand the effects of direct bypass of the suppression pool.

RESPONSE: a. The answer to the question 6.2.39.a and 6.2.41 indicates that the containment of the Grand Gulf Station could tolerate a bypass rate of approximately 44 lbm/sec steam from the drywell. In comparison with the maximum allowable drywell leak rate 2.2 lbm/sec for a small line break, the containment spray system could increase the drywell leak rate by a factor of about 20. This clearly indicates that the containment spray can serve as a strong back-up system for increasing the containment capability to tolerate a higher drywell leak rate.

b. Plant Shutdown Times

The maximum allowable bypass capacity ($A/\sqrt{k}$ = .043 ft^2) is based on a normal reactor shutdown (depressurization and cooldown)over a six-hour period. If this time is decreased, the allowable bypass capacity will increase accordingly. The maximum time at which the reactor could be depressurized without exceeding a vessel cooldown rate of 100 F/hr is approximately three hours. This would result in an approximate doubling of the maximum allowable bypass capacity. Bypass capacity vs. time is shown in Figure R6.2.42-1.

c. Containment Heat Sinks

Some portion of any postulated steam bypass from the drywell to the containment will realistically be condensed on the relatively cool containment structures and internals. The fraction of leakage flow condensed depends largely on the size and break location, mixing process, and film coefficients.

A model assuming homogeneous mixing of the bypass steam with the air in the containment should logically include the total surface area of the containment structure and internals where considering condensation. Condensation rates in this case would be high and result in large, allowable bypass capacities.

A model assuming stratification of the steam leakage in the upper region of the containment would logically include only the upper surfaces bounding and included in the stratified layer for condensation considerations.

Both cases have been examined in some detail with regard to condensation and containment pressurization. It is concluded that the stratification model results in the most realistic and conservative assessment of the actual phenomena.

The maximum allowable leakage capacity calculated for the Grand Gulf containment is based on the stratified model and includes the effects of condensation. The condensation rate is based on heat transfer only to the upper part of the concrete containment scructure consistent with the stratification assumption. The heat transfer rate over the long term is relatively insensitive to the condensation film coefficient due to the heat conduction limitation of the concrete sinks. Over the six-hour shutdown period, approximately 1/3 of the bypass steam flow is condensed and has the effect of increasing $A/\sqrt{k}$ by approximately 1/3.

d. A conservative assessment of the maximum allowable drywell to wetwell bypass capacity results in an $A/\sqrt{k} = 0.043\ ft^2$. This value is predicted on the assumption of a normal shutdown period of six hours and includes a conservative assessment of leakage condensation.

The maximum bypass capacity is inversely proportional to the shutdown time; the shorter the shutdown time the larger the allowable leakage capacity. Maximum shutdown rate could approximately double the allowable leakage capacity.

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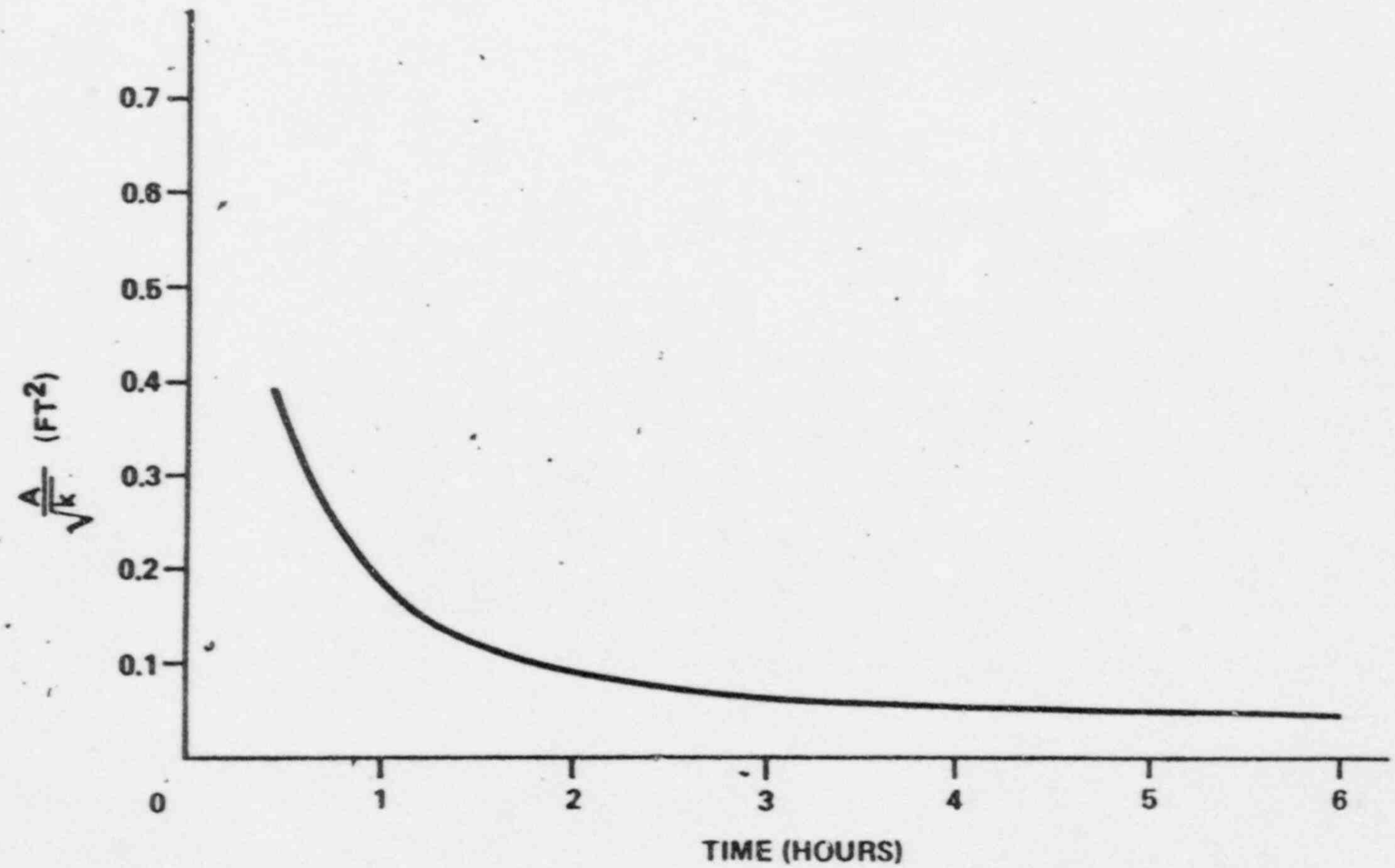
A conservative assessment of leakage condensation is included in the maximum allowable bypass capacity calculation. It is doubtful if a less conservative analysis would result in even doubling the allowable bypass capacity.

Containment sprays have a significant effect on the maximum allowable bypass leakage capacity. A conservative assessment of the use of sprays would increase the allowable leakage capacity by a factor of 20 for the small break accident case.

FIGURE R6.2.42-1

BYPASS CAPACITY VS. SHUTDOWN TIME
SMALL-BREAK ACCIDENT



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GENERAL ELECTRIC COMPANY REVIEW OF ATOMIC ENERGY COMMISSION REGULATORY GUIDE 1.7 - req AEC reconsider and modify the Guide to reflect hydrogen control requirements

REMARKS

Pls. include A. Summerour on distribution list for cy. of reply.

Morton-Action Coordinate with Levy - Pawlicki / [illegible] action

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Rogers f/action	8/2/73
ARLOTTO "	8/3/73
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IS NOTIFICATION TO THE JCAE RECOMMENDED? ____

Cys:

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DIRECTOR OF REGULATION COMMUNICATIONS CONTROL

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