STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

RHODE ISLAND ATOMIC ENERGY COMMISSION
Nuclear Science Center
South Ferry Road
Narragansett, R.I. 02882-1197

August 5, 1988

Director
Standardization and Non-Power Reactor
Project Directorate
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Attn: Mr. Theodore S. Michaels

License R-95
Docket 50-193

Dear Sir

It is hereby requested that the Technical Specifications for the Rhode Island Nuclear Science Center reactor be amended by substituting the enclosed page 3 for the original page 3. The changes are shown in bold type.

This amendment will essentially change the flow rate in the 115 feet high stack from approximately 4,000 cubic feet per minute (cfm) (the capacity of the reactor building ventilation exhaust blower) to approximately 14,000 cfm (the capacity of the reactor building exhaust blower plus the capacity of two additional blowers which provide exhaust for fume hoods). Note that there is no change in the ventilation rates of the reactor room exhaust blower or any other exhaust blower associated with the operation of the reactor.

This amendment is requested because the flow rate in the stack has been 14,000 cfm for many years and because the information presented with this transmittal of dose rates at a proposed nearby building, the Center for Atmospheric Chemistry Studies (CACS), created by the stack exhaust plume during normal operation has been calculated utilizing the 14,000 cfm exhaust rate.

Page 30 of the Technical Specifications presents dilution factors for the routine release of radioactive particulates and gases through the 115 foot stack. These diluting factors were based on calculations presented in a letter dated April 16, 1963 to the U. S. Atomic Energy Commission. A copy is

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attached for your convenience. The calculations in the April 16, 1963 letter were based on a stack flow rate of 4000 cfm. While a flow rate increase to 14,000 cfm will provide for larger dilution for the routine release of radioactive particulates and gases, we are not now requesting a change in the current dilution factors. This letter also contains the frequency of wind speed and direction used in the original calculations and the calculations which follow.

JUSTIFICATION FOR THE CHANGE

The exhaust rate in the stack has been about 14,000 cfm for many years. In addition, the reactor does not operate unless all the blowers are operating and this provides an approximate 14,000 cfm flow rate. This requirement comes about because the argon-41 containing exhaust enters the stack about mid-height. If there were no additional blowers, this exhaust would divide and some would blow up the stack and some would blow down the stack. That portion which would blow down could enter the reactor building through stack connections required for the emergency clean up system. To prevent this, two blowers providing exhaust air for hoods enter the stack at its bottom, and these air streams in the stack prevent the argon-41 containing air stream from coming down the stack.

Since the reactor does not operate unless all these blowers are operating, it is appropriate that the total flow of at least 14,000 cfm be the technical specification requirement and 14,000 cfm be used in the calculations which follow.

By the letter dated June 2, 1987 the Rhode Island Atomic Energy Commission informed the U. S. Nuclear Regulatory Commission that it intended to allow the University of Rhode Island to construct the CACS building on the three-acre reactor site. Many of the occupants of the CACS building utilize the reactor.

By letter dated April 12, 1988 the Rhode Island Atomic Energy Commission informed the U. S. Nuclear Regulatory Commisison of the design criteria being utilized to insure that the new building does not interfere with the operation of the reactor facility exhaust stack. This letter will present the results of calculations which show that the plume from the reactor building exhaust stack will create acceptable radiation levels in and on the CACS building.

The following parameters are used in the calculations:

Distance between CACS building and reactor stack	37 meters
Max height of CACS building	14.6 meters
Height of reactor building exhaust stack	35 meters
Diameter of exhaust stack	0.559 meters
Exhaust rate in stack (14,000 cfm)	6.61 $meters^3$/sec
Exhaust velocity from stack	26.95 meters/sec
Temperature of exhaust air	Ambient
A-41 exhaust rate from stack at 2 MW power level (measured)	0.12 mCi/sec

The doses and dose rates to occupants of the CACS is dependent on the effective height of the stack which is itself dependent on the wind velocity. The effective height of the stack is calculated using the techniques of Davidson-Bryant, Bosanquet and Holland as presented on page 191 of Reference 1.

From spreadsheets 1,2 and 3 it is seen that the Davidson-Bryant technique leads to the largest effective stack height while the Holland technique leads to the smallest effective stack height. Therefore all calculations have been performed using the effective stack height predicted by the Holland technique.

Consider first the gamma dose to a receptor standing on the roof of the CACS building from an overhead infinite line source created by a continuous series of 1 second puffs from the stack. Each puff will contain 0.12 mCi and the source strength will be dependent on the wind velocity. This infinite line source will exist at an altitude which is the effective stack height.

From page 462 of Reference 2, the flux ϕ in γ's/cm^2-sec from an infinite line source of S photons/cm-sec is given by

$$\phi = S/4x$$

where x is the distance between the line source and the receptor in cm. From page 439 of Reference 2 it is seen that it takes 400

γ's/cm^2-sec at 1.3 Mev to produce an exposure rate of 1 mR/hr. These calculations, shown in spreadsheet 4, predict a receptor dose rate of .00026 mR/hr when averaged over frequency of wind speed and direction. Assuming that the reactor operates 24 hours/day, 5 days/week, 50 weeks/year, the annual dose to a "full time" receptor is therefore 1.56 mR.

Consider next the gamma dose to a receptor standing on the roof of the CACS building from an overhead plume which exists at an altitude which is the effective stack height.

The dose rate from an overhead plume is discussed on page 339 of Reference 1. Figure 7.9 of the reference shows the coordinate system used in the calculation. The release point is always the effective height of the stack and the receptor is on the roof of the new building.

To perform the calculation, it is necessary to find values of σ_x, σ_y, and σ_z for a plume only about 40 meters from its source. Pages 102 and 103 of Reference 1 suggest that the σ_y and σ_z are less than 1.

Equation 7.42, page 340 of Reference 1 predicts the dose rate from an overhead plume to a receptor below for the finite cloud case: i.e. where the receptor is not in the plume. This equation requires graphical evaluations of two integrals whose solutions are presented on pages 341 and 342 of Reference 1. For these calculations we assume that $\sigma_x=\sigma_y=\sigma_z=\sigma_I=1$ and that s, the distance from the plume centerline to the receptor, is the effective stack height (a function of wind speed) minus the height of the building. Here again the region of interest for our calculation is at the low end of the x axis where the value of the integrals appears to be not strongly dependent on exact sigmas and where the curves appear to be flat. Therefore even for σ 's less than 1, this calculated result will not change. This calculation, presented in spreadsheet 5, predicts a dose rate of 0.00021 mR/hr when averaged over frequency of wind speed and direction. Assuming that the reactor operates 24 hours/day, 5 days/week, 50 weeks/year, the annual dose to a "full time" receptor is 1.26 mR.

Finally consider the dose to a receptor from immersion in the plume. For this to occur, the plume from the exhaust stack would have to reach at least the roof of the building. The dilution factor in this case is obtained from equation 3, page 404 of Reference 1. From this equation, by examining the term

$$\exp \left[-(z-h)^2/2\sigma_z^2 + \cdots\right]$$

where z = elevation of receptor (roof of new building)

h = effective stack height (minimum of 22 meters)

σ_z = about 1,

it is seen that $(z-h)^2 / 2\sigma_z^2$ is so large that the value of the exponent is effectively 0. This means that the plume does not reach the building.

It is, however, useful to perform a calculation of the maximum ground concentration where the ground plane is "moved up" to the roof of the new building. This will over-estimate the maximum concentration because the reflection of the ground plane is not fully developed in the actual situation. The nomogram solution for this situation is presented on page 410 of Reference 1 where $\chi u/Q$ is plotted as a function of effective stack height and Pasquill stability class. The highest concentrations are for Pasquill class A so class A is used in the calculation. The calculation is presented in spreadsheet 6. The concentration is converted to dose in an infinite cloud using the formula from page 568, Eq. 1.46, Reference 2.

Assuming that the reactor operates 24 hours/day, 5 days/week, 50 weeks/year, the annual dose to a "full time" receptor is therefore 4.2 mR.

The Emergency Plan for the Rhode Island Nuclear Science Center requires that the Emergency Coordinator "order the protective evacuation of members of the general public onsite". This requirement exists for all levels of emergencies. It is therefore not necessary to reevaluate site conditions following a reactor emergency since the occupants of the CACS building will be evacuated for all levels of emergency.

Thank you for your consideration.

Very truly yours,

A. Francis DiMeglio
Director

AFD:cd

cc: Rhode Island Atomic Energy Commission
Reactor Utilization Committee
Region 1

Subscribed and sworn to before me on this 5th day of August, 1988.

David G Johnson, Notary Public

My Commission expires on June 30, 1991.

References

1. Meteorology and Atomic Energy, 1968 USAEC, David H. Slade, Editor.

2. Introduction to Nuclear Engineering, 2nd Edition, John R. Lamarsh, Addison-Wesley, 1983