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SUPPLEMENTAL CALCULATIONS OF MCA FOR BODEGA

At the request of Mr. Knuth of your branch the subject calculations were performed by Mr. Waterfield of this branch to study additional facets of the MCA for this reactor. The general nature of the events during the accident were given in the request, while a number of specific assumptions tabulated below were initiated in the process of making the calculations.

Case 1 and Case 2 deal with a situation following the standard TID 14844 meltdown in which the emergency ventilation system fails, leading to an unfiltered, ground-level release. It is also assumed that all the released material passes freely into the refueling building, although it is not clear to the writer just how this can happen. In Case 1, it is assumed that the driving force for leakage from the refueling building is a rapid decrease in barometric pressure. In Case 2, the leakage is caused by high winds which produce exfiltration from the building in the manner and rates postulated by Niagara Mohawk. Case 3 deals with a failure of the recirculating cooling system some twelve hours after the standard TID meltdown, so that activity is displaced from the primary containment by the incoming emergency cooling water, and is discharged through the emergency ventilation system, filters, and out the stack. More specific assumptions dealing with each case will be described below along with the resulting doses for each case.

For Case 1, experience with calculations for the NBS reactor was used to assume that the maximum probable rate of barometer change is 5% per day, accompanied by neutral diffusion conditions (Pasquil Type D), and wind velocity of three meters/sec. Values of uX/Q were obtained directly from ORO 545 for the distances of interest, and appropriate average values of the source strength for periods of two hours and thirty days were obtained from graphs used in all our hazards calculations. The final results are given below for these fractions of the entire core inventory present in the refueling building: 100% noble gases and 25% iodines.

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Distance Miles	Whole Body Doses Rem 2 hrs.	Whole Body Doses Rem 30 days	Thyroid Doses Rem 2 hrs.	Thyroid Doses Rem 30 days
0.6	6.4	120	1100	38,000
1.5	1.8	35	310	11,000
3.0	0.5	10	90	3,200
5.0	0.2	4	29	1,300

In preparing for Case 2, the calculations of the dependence of exfiltration rate on wind velocity presented by Niagara Mohawk in the recent supplement to their Preliminary Hazards Summary Report were studied carefully. It was found that the exfiltration rates they calculated are directly proportional to the velocity head for the wind, and that the magnitude is approximately that which would be obtained if 1/4 of the total area of the building were subjected to this pressure difference. It was found that for a period of two hours, while radioactive decay is relatively unimportant, the off-site dose increases as the wind velocity increases. However, for longer periods of time extending until all the material has decayed, there is a critical wind velocity which produces the largest dose (40 mph in this case). This dose does not vary rapidly with wind velocity near this maximum value, however, so that for the case studied if the velocity is half that which gives the maximum dose, the dose is reduced to only approximately 78% of the maximum. It was also found that the maximum dose is associated with the wind velocity which produces an exfiltration rate which is equal numerically to the radioactive decay rate. Also, the value of the maximum dose is inversely proportional to the wind velocity necessary to produce it. Therefore, while more rapid decay rates require larger wind velocities to produce the maximum dose, the value of this dose is less because of the higher wind velocities required.

The results tabulated below are for a wind speed of 20 mph under inversion conditions, which seemed to be as high as is credible at this site. Higher velocities occur under less stable conditions but the added diffusion more than compensates for the increased exfiltration which results, so that these doses are definitely maximum.

Distance Miles	Whole Body Doses 2 hrs.	Whole Body Doses 2 days	Thyroid Doses 2 hrs.	Thyroid Doses 2 days
0.6	36	335	6,200	85,000
1.5	9	85	1,600	22,000
3.0	3.2	29	550	7,700
5.0	1.5	14	260	3,600

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Case 3 assumes the standard TID 14844 meltdown and release has occurred, and that all the activity is contained within the dry well and suppression chamber. After a period of twelve hours, the recirculating cooling system for this containment fails, and it is necessary to start adding emergency cooling water from an external source, which displaces the airborne activity. This activity is then vented at the displacement rate through filters which remove 95% of the iodine, and up the stack. The total air space in the containment initially is 195,000 cubic feet, and the cooling water is added at the rate of 300 gpm. This displaces air at the rate of 40 cfm, or 2400 cubic feet per hour, or 30% of the contents per day. At this rate, all the material is displaced approximately four days after initiation of the accident. Decay during this period was accounted for over short-time intervals for greater accuracy of calculation. The table below gives the resulting doses during the first two hours after the beginning of venting, and for the entire period (infinite).

Distance	Whole Body Doses		Thyroid Doses	
Miles	2 hrs.	Infinite	2 hrs.	Infinite
0.6	0.7	11	193	5800
6.0	1.0	16	285	8500

The dose at 0.6 miles is the maximum that occurs at any distance under Pasquil Type D (neutral) conditions with a wind speed of three meters/sec., and is the maximum that can occur at the site boundary for any diffusion conditions with an elevated release. The dose at 6.0 miles is the maximum that occurs at any distance with the standard TID 14844 inversion conditions.

Without going to the same detail in the calculation as originally done, it appears that if the addition of water is begun at 36 hours, the whole body dose for the first two hours will be reduced to 40% of the values above, while the other doses will be approximately 70% of these values.

cc: D. Knuth, R&PRSB

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