APR 26 1971

Mr. Edward J. Bauser
Executive Director
Joint Committee on Atomic Energy
Congress of the United States

Dear Mr. Bauser:

Recent discussions between representatives of the AEC regulatory staff and the Department of Defense have developed additional information on low-level military training flights. This information concerns events following the recent B-52 crash near the Big Rock Point nuclear power station in northern Michigan both with respect to the Bayshore training route near the Big Rock Point plant and the more general possibility of low-level military flights near nuclear installations throughout the country.

Subsequent to the crash of a B-52 bomber about six miles from Big Rock Point a series of meetings with DOD representatives was initiated through the office of the Military Liaison Committee to explore the question of low-level flights by military aircraft near nuclear installations. A letter to Chairman Seaborg dated March 1, 1971, from Mr. Ralph Nader and Chairman Seaborg's reply dated March 22, 1971, with respect to this matter and with respect to the proximity of commercial airports to nuclear power plant sites were previously transmitted to you by letter dated April 1, 1971. As noted in our reply to Mr. Nader, the proximity of the Air Force's Bayshore bomb scoring site to the Big Rock Point plant near Charlevoix, Michigan, and the associated use of the

plant in connection with training flights, came to the attention of the AEC in 1963. At that time it was the AEC's understanding that the plant was being used as a practice target and the AEC requested the Air Force to remove the plant from their practice target list. Our Division of Military Applications determined from the Air Force that the plant would not be used for this purpose. We were subsequently informed by DOD that the use of the plant as a practice target had been discontinued in 1963 but that low-level flights near the plant continued with the targets for these runs being in Lake Michigan, several miles offshore.

Subsequent to the January 7, 1971 crash, low-level training flights on the Bayshore route were suspended and SAC formally closed the route to low-level training missions on January 15, 1971.

The regulatory staff met with DOD representatives on February 3, 1971, and April 6, 1971, and in the latter meeting Air Force representatives proposed, for AEC and Consumers Power Company concurrence, an alternate flight path in the Bayshore area that would route low-level flights along a centerline about 5-1/2 miles east of the plant, with a return path to the entrance of the bomb-scoring run passing about 12 miles west of the plant. (The centerline of the previous route was 3000 feet west of the plant with the planes at an altitude of about 1750 feet as they left the off-shore scoring area.) The proposed flight path zone would be 8 miles wide (4 miles on either side of the centerline); therefore planes could approach to within 1-1/2 miles of the Big Rock Point

plant. However, we understand that the Air Force proposes to abort and redirect any training flights approaching the zone boundary in the Bayshore target area.

We have asked the Air Force representatives for a letter which would provide information on this alternate route, including statistics on the deviation of aircraft from the nominal flight path during such training missions. On the basis of this information we hope to be in a position to agree with the Air Force that the probability of a crash at the Big Rock Point plant as a result of low-level training flights on this alternate route would be negligible.

We understand that because of a loss of target flexibility associated with the alternate route that this change of route would be only an interim measure and that a new scoring area more than 10 miles west of the plant would be required to restore adequate target flexibility. This long-range proposal requires clearance from the FAA and would entail movement of radar tracking facilities from the present Bayshore location.

With regard to the general problem of low-level military flights, the staff has provided Air Force representatives with a list of site coordinates for licensed nuclear power plants and test reactors. We have received DOD Flip Low Altitude High Speed Training Route Charts for the contiguous States and Puerto Rico. On the basis of a preliminary

examination of these charts, it appears that only one other nuclear facility site, Arkansas Nuclear One in northwestern Arkansas, is near a low-level bomber training route similar to the Bayshore route. This facility is more than 5 miles from the nearest edge of the flight zone and should therefore not be subject to regular overflights.

The DOD charts also indicate about 250 other low-level military training flight paths for aircraft in the United States. Our preliminary examination of these routes indicates that about one-third of the nuclear power reactor sites are within about 10 miles of one or more of these routes. After receiving statistical information from the Air Force on the deviation of aircraft from the nominal flight path on these routes, the frequency of use of these routes, and relevant crash statistics, we will be in a better position to evaluate changes, if any, which may be desirable in current military training routes. (A simple instruction from DOD to all flying commands to instruct air crews to avoid the locations of nuclear power plant sites may be sufficient action in this matter.) The DOD has indicated that if formal route changes are required, the FAA will necessarily have to be consulted.

We plan later to notify all power and test reactor licensees of the ultimate results of these efforts and ask that they notify us of any unusual overflight conditions that arise in the future at their plants.

Of course military overflights are not the sole consideration in evaluating potential aircraft hazards. Commercial and general aviation overflights and the proximity of airports are also of concern.

In the course of our past evaluations of nuclear power facilities we have not considered that the hazards from these aircraft overflights warrant special measures when the facilities are not in the immediate vicinity of airports since statistics available on civilian and general aviation crashes indicated a very low probability of striking any given point near air corridors. We have concluded, however, that the area immediately around airports has a significantly higher crash probability, especially within the first two miles, and have had under development for some time explicit criteria concerning the design and location of nuclear power plants in relation to nearby airports. A copy of these criteria will be sent to you before publication for comment. As noted in Chairman Seaborg's letter to Mr. Nader, the Commission will also consider holding public hearings on the criteria at the time they are ready for publication.

Sincerely,

Harold L. Price
Director of Regulation

Conc.
Dennis Boyd Morris Cole Price

AF/OA 26 April 1971

MEMORANDUM FOR COLONEL CLARK

SUBJECT: Bayshore "Temporary Route" B-52/FB-111 Risk Analysis

1. Reference your request for an analysis of the proposed "temporary route" at the Bayshore RBS site with respect to the chance of endangering the Big Rock Point Nuclear Plant. Major points of relevance and calculations are provided below in a step by step sequence. Our understanding is that the temporary track will be located about 5.5 miles from the plant at the closest point. Further, there will be an 8-mile corridor (4 miles on each side of the desired track) with the corridor edge tangent to a one-and-one-half mile circle about the plant. Aircraft will approach the corridor limits only if they are having difficulty locating the target(s) which are on or very near the center of the corridor. If this should happen, the "lost" aircraft will be directed back toward the center by the RBS site. Only in the case of a communications failure would the RBS site fail to order a "lost" aircraft back to the center of the corridor, and a communication redundancy of three radios exists at both the RBS site and on each aircraft.

2. The analysis will proceed along the following lines:

Step 1. Scoring data from Bayshore low level bomb runs for the year 1970 will be examined to determine the frequency of gross errors which could require a redirection by the RBS site. The data will be examined to see if it is reasonable to expect all aircraft with good communications to be kept within the new corridor limits.

Step 2. Since off-track errors could be simultaneously accompanied by a communication breakdown which would prevent redirection of aircraft back to the center of the corridor, data on communications failure will be examined to determine a probability of communications outage.

Step 3. Data on navigation errors will next be examined to determine the probability of a navigation error of such a magnitude to cause "overflight" of a one-and-one-half mile circle about the nuclear plant.

Atch 1

Step 4. The probability that both a communications error and a navigation overflight error will occur on the same flight will then be computed by combining the probabilities of Step 2 and Step 3.

Step 5. Data on all crashes on similar low level missions will be examined and the probability of a crash on any low level bomb run will be computed.

Step 6. Next the probability that a crash will occur in any mile of a low level bomb run will be computed.

Step 7. The probability that any individual bomb run will end in a crash in the circle of concern will next be computed.

Step 8. Finally, the risk of a crash in the circle sometime during the next year's operation will be computed using an estimated number of bomb runs of 2200 at the Bayshore RBS.

3. The analysis follows:

Step 1. Based on 1654 scored bomb runs at Bayshore during the period 1 January 1970 to 31 December 1970, the circular errors scored by radar indicate that the average off-track distance, that is the distance from the desired bomb track to the actual aircraft track, was far less than one-half mile. (The precise figure, while it was used in the analysis, is classified because it indicates SAC's bombing accuracy.) There were no bombing errors outside of the buffer zone, set at nine miles on the right of the track and four miles to the left during 1970. Only three bomb scores showed a circular error greater than five miles, none were beyond six-and-one-half miles. Although actual off-track distances for these gross error bomb scores were not recorded, since both range and deflection errors are normally assumed equal, we can estimate that no off-track distances were greater than four-and-one-half miles.

Bombers are directed back toward the desired track and are given an "abort" score whenever they approach the corridor limits. There were 13 such aborts during 1970 at Bayshore.

Although the smaller, four miles on both sides, corridor may result in a slight increase in aborts it is reasonable, based on the above data, to assume that no overflights of the one-and-one-half mile circle will occur so long as bomber/RBS communications are intact.

Step 2. During 1970 with a total of 1834 sorties, we experienced 1 communication outage of the type which could have resulted in a bomber being outside the buffer zone had navigation also been faulty. In general, this situation would be corrected because if the communication outage were discovered early enough, as it most likely would be, the bomber would break off the run and not make the attack. However, assuming no such breakoff, the probability of a communication outage is computed from the above:

$$P_1 = \frac{1}{1834} = .0005556 = 5.556 \times 10^{-4}$$

Step 3. In the case of a communications failure, even if the B-52 did not break off, climb and leave the area, the probability of a navigational error of such a magnitude as to cause overflight of the one-and-one half mile circle is small. Navigational errors are assumed to be normally distributed about the desired bomb track. Although navigational data, as such, are not recorded for Bayshore missions, applicable data from Operational Readiness Inspections (ORIs) are available. On these inspections it is the usual practice to check aircrews over unfamiliar terrain and against unfamiliar RBS sites. (Bayshore flights have a large repeatability factor and hence navigation should be better). On 498 ORIs with flight profiles similar to those at Bayshore, two flights recorded navigational errors of over four miles. This suggests a normal distribution, $N(X,\sigma) = \frac{1}{\sigma\sqrt{2\pi}} e - \frac{(X-5.5)^2}{2\sigma^2}$, with $\sigma = 1.399$. Using this distribution to represent off-course navigation errors at Bayshore, the chance, P_2, that an aircraft will overfly the circle, given a communication outage, is given by:

$$P_2 = \int_{-1.5}^{+1.5} N(X,\sigma)dx$$

or

$$P_2 = .00212 = 2.12 \times 10^{-3}$$

Step 4. Thus, with the new buffer zone of four miles and operational procedures already established, the probability of overflight, P_3, is given by:

$$P_3 = P_1 \times P_2$$

or

$$P_3 = (5.56 \times 10^{-4}) \times (2.12 \times 10^{-3})$$
$$= 1.18 \times 10^{-6}$$

That is to say that the chance of an overflight for any bomb run at Bayshore will be about one in a million.

Step 5. Assuming a communication outage and a navigational error of such magnitude that an overflight of the one-and-one-half mile circle surrounding the power plant does in fact occur it is possible to examine the chances that on that flight a crash in the circle will occur. Based on historical data of low level crashes for flights of this type, we compute first the probability that a crash will occur while on a low level bomb run.

The probability of a crash, P_4, is computed simply by taking the ratio of the number of crashes on all low level bomb runs over several years to the total number of bomb runs of the type being considered here. There have been six crashes

including the recent unfortunate accident in Lake Michigan. There have been a total of 426,078 bomb runs giving a value of

$$P_4 = \frac{6}{426,078} = 1.4 \times 10^{-5}$$

That is, there are only about 14 chances out of one million that any low level bomb run will in fact end in a crash.

Step 6. The average range for this type of flight is 430 NM per low level run. Hence the probability, P_5, that a crash will occur in any given mile is

$$P_5 = \frac{P_4}{430} = 3.275 \times 10^{-8}$$

Step 7. Assuming independence between navigation errors and probability of crash, the probability, P_6, that, given no warning mechanism for redirection within the corridor, a crash will occur within the circle is

$$P_6 = \frac{2 \times 3.275 \times 10^{-8}}{\sigma \sqrt{2\pi}} \int_{-1.5}^{1.5} \int_{0}^{\sqrt{2.25 - x^2}} \exp\left[-\frac{(x - 5.5)^2}{2\sigma^2}\right] dx\, dy$$

$$= 1.8678 \times 10^{-8} \int_{-1.5}^{1.5} \sqrt{2.25 - x^2}\, \exp\left[-\frac{(x-5.5)^2}{3.9144}\right]$$

The integral in the above expression was evaluated by a graphical method giving the result:

$$P_6 = 1.225 \times 10^{-10}$$

The total probability, P_7, that any aircraft will crash in the circle is given then by,

$$P_7 = P_1 \times P_6$$

$$= (5.556 \times 10^{-4}) \times (1.225 \times 10^{-10})$$

$$= 6.68 \times 10^{-14}$$

This calculation neglects the fact that many crashes could occur in the circle and not cause damage to the plant. In addition, it is a conservative number since crews in trouble can be expected to take some evasive action to avoid built-up areas or buildings. Using these conservative numbers we can predict that there is less than one chance in ten trillion that any particular aircraft will crash in the circle.

Step 8. Since we estimate 2200 low level runs at Bayshore using the temporary route in the next year we can compute the total risk:

$$\text{Risk} = (6.68 \times 10^{-14}) \times (2.2 \times 10^{3}) = 1.47 \times 10^{-10}$$

3. Summary.

a. Based on data for the year 1970, the Air Force can assure that flights with communications intact will not approach closer to the power plant than one-and-one-half miles.

b. Based on historical communication outages and navigational experience, the chance of an overflight is conservatively estimated to be about 1.18×10^{-6} or about one chance in one million.

c. For any given Bayshore low level bomb run the chance of crash in the one-and-one-half mile circle surrounding the power plant is much less than one in ten trillion ($.668 \times 10^{-13}$).

d. The risk for an entire year's operation should be no more than about one-and-one-half in ten billion (1.47×10^{-10}).

4. Although the data base from which these calculations are made is not large, there is sufficient confidence in their accuracy to observe that even with the "temporary route" the chance for damage to the nuclear plant from SAC low level training flights is extremely low.

Richard J Camp

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