U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN
OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 3.5.1.6 AIRCRAFT HAZARDS

REVIEW RESPONSIBILITIES

Primary - Accident Analysis Branch (AAB)

Secondary - Structural Engineering Branch (SEB)
Auxiliary and Power Conversion Systems Branch (APCSB)

I. AREAS OF REVIEW

The staff reviews the applicant's assessment of aircraft hazards to the plant. The purpose of the review is to assure that either aircraft hazards are eliminated as a design basis concern or appropriate design basis aircraft have been chosen and properly characterized as to impact and fire hazards. The review also involves a determination of adequate protection against fire hazards for design basis events. Some information relating to this review is contained in Section 2.2 of the applicant's safety analysis report (SAR), e.g., facility locations, projected traffic, and accident statistics.

The APCSB determines which structures and components are to be protected, and the SEB assures that adequate protection has been provided.

II. ACCEPTANCE CRITERIA

1. The plant is considered adequately designed against aircraft hazards if the probability of aircraft accidents resulting in radiological consequences greater than 10 CFR Part 100 exposure guidelines is less than about 10^{-7} per year (see Standard Review Plan 2.2.3).

2. The probability is generally considered acceptable by inspection if the level of aircraft activity near the site falls below the criteria given in Section 2.2.3 of Regulatory Guide 1.70 (Ref. 2) for analysis of hazards due to commercial, experimental, and general aviation aircraft. For military airspace, a minimum distance of five miles from the reactor is adequate for low level training routes except those associated with usage greater than 1000 flights per year or activities (such as practice bombing) where an unusual stress situation exists.

3. Aircraft accidents which could lead to radiological consequences in excess of the exposure guidelines of 10 CFR Part 100 with a probability of occurrence greater than about 10^{-7} per year should be considered in the design of the plant.

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4. The evaluation of fire hazards will be done on an individual case basis. Concrete structures are generally assumed to withstand fire, but protection must be provided to prevent fire, smoke, or flammable mixtures from entering safety-related ventilation intakes, such as those for the control room, areas housing shutdown equipment, and the diesel generators.

III. REVIEW PROCEDURES

The reviewer selects and emphasizes aspects of the areas covered by this review plan as may be appropriate for a particular case. The judgment on areas to be given attention and emphasis in the review is based on an inspection of the material presented to see whether it is similar to that recently reviewed on other plants and whether items of special safety significance are involved.

The staff's review of the aircraft hazard assessment consists of the following steps:

1. Data describing aviation uses in the airspace near the proposed site, including airports and their approach paths, federal airways, Federal Aviation Administration (FAA) restricted areas, and military uses is obtained from Section 2.2 of the SAR. For many cases, no detailed analysis need be made as the probability can be judged adequately low based on a comparison with analyses previously performed. In such cases the conclusion reached and a citation of the cases used for comparison should be transmitted by buck slip to the AAB site analyst for retention in the case workbook.

2. For situations where federal airways or aviation corridors pass through the vicinity of the site, the probability per year of an aircraft crashing into the plant (P_{FA}) should be estimated. This probability will depend on a number of factors such as the altitude and frequency of the flights, the width of the corridor, and the corresponding distribution of past accidents.

   One way of calculating P_{FA} is by using the following expression:

   $$P_{FA} = C \times N \times A / w$$

   where:

   C = inflight crash rate per mile for aircraft using airway,

   w = width of airway (plus twice the distance from the airway edge to the site when the site is outside the airway) in miles,

   N = number of flights per year along the airway, and

   A = effective area of plant in square miles.

   This gives a conservative upper bound on aircraft impact probability if care is taken in using values for the individual factors that are meaningful and conservative. For

commercial aircraft a value of $C = 3 \times 10^{-9}$ per aircraft mile has been used. For heavily traveled corridors (greater than 100 flights per day), a more detailed analysis may be required to obtain a proper value for this factor.

3. The probability of an aircraft crashing into the site should be estimated for cases where either of the following apply:

   a. An airport is located within five miles of the site.

   b. An airport with projected operations greater than 500 d^2 movements per year is located within ten miles of the site, or an airport with projected operations greater than 1000 d^2 movements per year is located beyond ten miles from the site, where "d" is the distance in miles from the site.

The probability per year of an aircraft crashing into the site for these cases (P_A) may be calculated by using the following expression:

$$P_A = \sum_{i=1}^{L} \sum_{j=1}^{M} C_j \; N_{ij} \; A_j$$

where:

M = number of different types of aircraft using the airport,

L = number of flight paths affecting the site,

C_j = probability per square mile of a crash per aircraft movement, for the jth aircraft,

N_{ij} = number (per year) of movements by the jth aircraft along the ith flight path, and

A_j = effective plant area (in square miles) for the jth aircraft.

As noted earlier, the choice of values for the parameters should be made judiciously in order to arrive at a meaningful result. The manner of interpreting the individual factors may vary on a case-by-case basis because of the specific conditions of each case or because of changes in aircraft accident statistics.

Values for C_j currently being used are taken from the data summarized in the following table:

Distance From End of Runway (miles)	Probability ($\times 10^8$) of a Fatal Crash per Square Mile for Aircraft Movements			
	U.S. Air Carrier[1]	General Aviation[2]	USN/USMC[1]	USAF[1]
0-1	16.7	84	8.3	5.7
1-2	4.0	15	1.1	2.3
2-3	0.96	6.2	0.33	1.1
3-4	0.68	3.8	0.31	0.42
4-5	0.27	1.2	0.20	0.40
5-6	0	NA[3]	NA	NA
6-7	0	NA	NA	NA
7-8	0	NA	NA	NA
8-9	0.14	NA	NA	NA
9-10	0.12	NA	NA	NA

[1] Reference 2.

[2] Reference 4.

[3] NA indicates that data was not available for this distance.

4. For military installations or any other airspace usages, a detailed quantitative modeling of all operations should be verified. The result of the model should be the total probability (C) of an aircraft crash per unit area and time in the vicinity of the proposed site.

   The probability per year of a potentially damaging crash at the site due to operations at the facility under consideration (P_M) is then given for this case by the following expression:

   $$P_M = C \times A$$

   where:

   C = total probability of an aircraft crash per square mile per year in the vicinity of the site, and

   A = effective area of the plant in square miles.

5. The total aircraft hazard probability at the site equals the sum of the individual probabilities obtained in the preceding steps.

6. The effective plant areas used in the calculations should include the following:

   a. A shadow area of the plant elevation upon the horizontal plane based on the assumed crash angle for the different kinds of aircraft and failure modes.

b. A skid area around the plant as determined by the characteristics of the aircraft under consideration. Artificial berms or any other man-made and natural barriers should be taken into account in calculating this area.

c. Areas of the plant susceptible to structural damage as a result of aircraft impact.

d. Areas of the plant susceptible to fire hazards resulting from aircrift accidents on the site.

For those classes of aircraft hazard having a probability of occurrence of causing radiological consequences in excess of 10 CFR Part 100 guidelines greater than about 10^{-7} per year, the reviewer should verify that the proper design basis events have been chosen and the aircraft properly characterized in terms of impact and fire parameters.

The capability of structures to withstand the postulated aircraft impacts will be reviewed by the SEB, and the vital target areas will be defined by the APCSB. In the past, external fire effects have been evaluated by the AAB with assistance from consultants (Ref. 3), but the APCSB will review this area for future applications.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and drafts an introductory paragraph for the evaluation findings indicating those facilities described in SAR Section 2.2 for which an aircraft hazards analysis was performed. A brief description of the methods used in the analysis should be provided, together with references to any sources of statistical data utilized.

The reviewer also verifies that the review and calculations support conclusions of the following type, to be included in the staff's safety evaluation report:

1. "The applicant's assessment of aircraft hazards at the site has been independently verified by the staff and results in a probability less than about 10^{-7} per year of an accident having radiological consequences worse than the exposure guidelines of 10 CFR Part 100. We conclude, therefore, that operation of the _____ plant in the vicinity of _____ does not present an undue risk to the health and safety of the public."

2. "Plant sites reviewed in the past which had equivalent aircraft traffic in equal or closer proximity were, after careful examination, found to present no undue risk to the safe operation of those plants. Based upon this experience, in the staff's judgment, no undue risk is present from aircraft hazard at the plant site now under consideration."

3. "The applicant's assessment of aircraft hazards at the site has been independently verified by the staff and we corroborate that if the plant (or appropriate parts of

the plant) is designed to withstand the aircraft selected as the design basis aircraft, the probability of an aircraft strike causing radiological consequences in excess of the exposure guidelines of 10 CFR Part 100 is less than about 10^{-7} per year. We conclude, therefore, that the operation of the _____ plant in the vicinity of _____ does not present an undue risk to the health and safety of the public."

V. REFERENCES

1. 10 CFR Part 100, "Reactor Site Criteria."

2. D. G. Eisenhut, "Reactor Siting in the Vicinity of Airfields." Paper presented at the American Nuclear Society Annual Meeting, June 1973.

3. I. I. Pinkel, "Appraisal of Fire Effects from Aircraft Crash at Zion Power Reactor Facility," July 17, 1972 (Docket No. 50-295).

4. D. G. Eisenhut, "Testimony on Zion/Waukegan Airport Interaction" (Docket No. 50-295).

5. USAEC Regulatory Staff, "Safety Evaluation Report," Appendix A, "Probability of an Aircraft Crash at the Shoreham Site" (Docket No. 50-322).

6. "Addendum to the Safety Evaluation by the Division of Reactor Licensing, USAEC, in the Matter of Metropolitan Edison Company (Three Mile Island Nuclear Station Unit 1, Dauphin County, Pennsylvania)," April 26, 1968 (Docket No. 50-289).

7. Letter to Honorable J. R. Schlesinger from S. H. Bush, Chairman, Advisory Committee on Reactor Safeguards, "Report on Rome Point Nuclear Generating Station," November 18, 1971 (Project No. 455).

8. Letter to Mr. Joseph L. Williams, Portland General Electric Company, from R. C. DeYoung (in reference to Mr. Williams' letter of May 7, 1973), November 23, 1973 (Project No. 485).

9. "Aircraft Considerations-Preapplication Site Review by the Directorate of Licensing, USAEC, in the Matter of Portland General Electric Company, Boardman Nuclear Plant, Boardman, Oregon," October 12, 1973 (Project No. 485).

0. Letter to Mr. J. H. Campbell, Consumers Power Company, from Col. James M. Campbell, Dep. Chief, Strategic Division, Directorate of Operations, U. S. Air Force, May 19, 1971 (Docket No. 50-155).

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