AEC RESEARCH AND DEVELOPMENT REPORT

PRELIMINARY SAFETY EVALUATION OF THE

SODIUM-COOLED ACTOR EXPERIMENT

Preliminary

By

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Edited by

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II. CONCLUSIONS

A study has been made of the possible hazards associated with the operation of the proposed reactor at the proposed site. We have considered the consequences of equipment failures and malfunctions, the events which might follow operating errors by personnel, [redacted] and the incidents which might arise from natural causes. In particular we have studied:

(1) Reactor nuclear runaways (uncontrolled release of excessive amounts of nuclear energy)

(2) Interruption to the flow of coolant to the reactor (failure of the normal means of heat removal)

(3) Sodium fires

(4) Other chemical reactions

(5) Release of stored energy [redacted]

(7) The effects of earthquakes

It is concluded that the sodium reactor experiment presents no serious hazard to the general public and to the surrounding area under the most severe conditions of accident [redacted] which may be realistically assumed to be possible.

The sodium-graphite low enrichment uranium system has an inherent negative temperature coefficient of reactivity. In addition, the reactor, the reactor controls, and the cooling system have been designed to prevent accidents insofar as this is possible and practical and to limit the consequences of any accident. It is believed that the system has been so arranged that the possible but highly improbable incident in which fuel does melt will present no serious hazard to the general public.

[redacted]

III. DESCRIPTION OF SRE SITE

A. Location

The proposed site is located 30 miles northwest of downtown Los Angeles, 6 miles west of Chatsworth and 3 miles south of Santa Susana, California, in the Simi Hills.

The elevation of the reactor site is approximately 1850 feet, and the maximum elevations of the Simi Hills are about 2400 feet. The elevation of the San Fernando and Simi Valley floors at the base of the hills is approximately 900 feet.

The Simi Hills are a very rugged outcropping of sandstone strata. The hilly surrounding barren area which provides the required 1.4 mile radial clearance for a 20 megawatt reactor. The proposed site is unique in that it provides the isolation and security required for a reactor facility while being in the proximity of scientific resources (See Fig. 1).

B. Climatology

The Los Angeles basin is in a semi-arid region controlled for the most part by the semi-permanent Pacific high pressure cell. During the summer season the high is displaced to the north resulting in mostly clear skies with little precipitation. This, in conjunction with the diurnal thermal lows that form over the inland valleys and deserts, results in stratus during the early morning hours. Winds are mainly diurnal sea to land during the day and land to sea during the night. In the winter there is moderate precipitation and the winds are predominately from a northerly direction.

The surface winds in the Los Angeles vicinity have a diurnal and a seasonal variation due to the influence of the ocean. In addition they are greatly influenced by topography. In the case of the site, the surface wind during the cooler hours of the day will be southeasterly, corresponding to the downward slope of the terrain toward Simi Valley. The afternoon winds should tend to reflect the main ocean-continent effect, resulting in westerly winds in summer and northerly winds in winter.

The wind speeds in summer, and in winter in the absence of storms, are light. Los Angeles City Office has an annual average of only 6 miles per hour. The winds at the site should also be expected to be light, the increase in elevation not being sufficient to make material difference in winter, while in summer the winds at moderate elevations may actually be stronger than those near sea level, where the sea breeze is influential.

A subsidence inversion is present almost every day during the summer months and frequently in other months. In addition, a ground inversion is produced by radiational cooling during clear nights in fall, winter, and spring. The nocturnal inversions produced on clear nights are associated with a tendency for the cooled air to drain downward from the slopes on which the site is located. During the day, even when the subsidence inversion over lower terrain is lower than the site, the diurnal heating tends to establish a stirred layer with adiabatic lapse rate immediately above the hills.

The occurrence of fog at the ground and other limitations to visibility is strongly a function of elevation and location in this vicinity. The proposed site, being near the ridge of hills, will not be subject to local radiative fog at all, and in general will enjoy excellent visibility both summer and winter. Only when the inversion base is higher than the site will there be a chance of fog or stratus cloud. Because of cold air drainage, there will seldom be radiational fog in winter.

C. Vertical Atmospheric Cross Section

The inversion structure above the site is of prime importance. There are four patterns pertinent to diffusion of contaminants.

1. No inversion exists. The lapse rate is then unstable, allowing rapid vertical convection currents and a thorough mixing of the contaminants into a deep layer of air. It is only during the winter months that these conditions prevail for any significant per cent of the time.
2. Inversion below the site. This may persist for days. Such inversions are caused by subsiding of the air mass in the high cell, hence cannot easily be broken by daytime insolation. Percentage wise this is the most common case for the site. Under such conditions contaminants released at the site would diffuse laterally only; the inversion prevents any downward transport.

3. Inversion at or above the site. This is a rather rare occurrence. When the inversion is at or slightly above the site, then the most unfavorable situation for diffusion exists, since contaminants are prevented from upward diffusion and transport downward is very likely. However, when the inversion height is more than 4000 feet (mean sea level) then there is sufficient lateral and vertical diffusion to minimize the probability of concentrations from reaching the valley floors.
4. Nocturnal ground inversion. Such inversions form during the night on calm clear nights and rapidly dissipate soon after sunrise. During such inversions, there is cold air drainage into low-lying areas and valleys. However, this air does not reach the valley floor but rides over the valley air. Therefore, contaminants are kept aloft and do not reach the surface in appreciable amounts.

D. Wind Pattern Studies

Two types of studies have been carried out to obtain a more detailed wind flow structure in the immediate area of the site: 1) balloon tracking, and 2) aerosol diffusion.

The balloon studies confirmed the diurnal nature of the local winds during the summer. Also, the effect of topography was very evident in the devious paths followed by the balloons in the lower levels.

The aerosol diffusion studies gave a more quantitative answer to contaminant transport. This one study pictured the effect of both inversions and winds. Fortunately the period of the runs was in the early spring so that both summer and winter conditions were encountered. On the other hand a total of only 405 samples were taken, and therefore the results have only a qualitative significance. The results may be summarized as follows:

1. Very low counts were found when no inversion was present.
2. Very low counts were found when the inversion was below the site.
3. The highest counts were found when the inversions were at or near the elevation of the site.
4. Radiation inversions did not cause any large counts in the valleys due to the slow drainage rate and attrition by entrapment in gullies and ravines.

5. On days of strong turbulence counts were obtained in diametrically opposite directions, attesting to the value of turbulence in producing a broad diffusion pattern.

The highest count of 15 particles/ft^3, unfortunately occurred on a day when no radiosonde observation data were taken. However, interpolating between the preceding day and the succeeding day it is safe to say that the inversion was at or slightly above the site.

Taking all the various conditions into consideration, about 93 per cent of the time there is a lower danger of contamination of populated areas. The 7 per cent figure for the time for unfavorable situations is a liberal one including various degrees of intensity of possible contamination.

E. Hydrology

The proposed site is located on relatively flat terrain which straddles the drainage divide between the San Fernando and Simi Valleys. The runoff from the area is collected in gulleys or washes which are generally dry most of the year. The southeastern half of the proposed site drains into the Los Angeles River which empties into the Pacific Ocean at Long Beach. To the north and west, drainage follows the Simi Valley to the west and discharges into the Pacific Ocean approximately 1 mile southeast of Port Hueneme.

A portion of the local runoff which originates on the east side of the Simi Hills is captured by the Chatsworth Reservoir. This drainage area is over 2 miles from the proposed site and on the opposite side of the hills; the reservoir itself is approximately 4 miles east of the proposed site. It is a seasonal regulating and storage reservoir with a capacity of approximately 10,000 acre feet. The reservoir water is used for drinking and general domestic purposes except in the fall of the year when the water is used for irrigation. During this time potable water is rerouted from other reservoirs. This alternate supply route could be used for an indefinite period of time in case of an emergency.

Since the proposed site area is high, the immediate drainage area is relatively small, approximately 200 acres. The maximum precipitation in 24 hours with a probable frequency of occurrence once in 50 years is 8 to 9 inches. Assuming 5 inches of runoff, about 85 acre-feet of water might be expected from a single storm. During a normal year only 50 acre-feet would run off.

Since the total expected runoff is relatively small, it is proposed to make provisions for capturing all of it in a reservoir. All the surface drainage in a normal year would evaporate from the reservoir surface. The proposed reservoir would hold 200 acre-feet, although it would appear that a 100 acre-feet storage reservoir would be adequate.

The Simi Hills are composed primarily of marine sediments consisting of tightly cemented sandstones and shales (Chico formation) of Upper Cretaceous age. These are relatively impervious layers tilted such that they have a strike of approximately 325° (35° west of north) and a dip of approximately 22°.

The relatively small flats found in the area consist of alluvium of recent geological age. Generally the alluvium increases in thickness as the slope of the hillside decreases, and is a maximum thickness in the relatively flat areas and valleys. These recent alluvial fills are relatively pervious compared to the relatively impervious sedimentary strata from which they are derived.

The exposed strata have a maximum thickness of about 30 feet. In many places they are badly fractured and large monoliths have broken loose and fallen from their original strata and are scattered on the hillsides.

The fissures and fractures of the faults contain a water bearing aquifer, and wells drilled into this pervious material have been found to be very good. The water in these fissures and fractures is tightly contained by the relatively impervious rock which encloses them. The aquifers are recharged during the rainy season by rain percolating directly through the soil to the aquifer and also by the stream beds crossing the pervious fault zone which traps some of the runoff. It is possible that some of the strata could be semi-pervious and therefore allow a fluid to move parallel to the bedding plane.

Assuming that the dip of the bedding planes is consistently 22°, it is seen that the particular planes intersecting the site area would project far below the Simi Valley. These strata are sloping away from the San Fernando Valley. Therefore no drainage parallel to the bedding planes could reach a populated area. It is concluded that any radioactive material accidently released into the surrounding substrata would slowly permeate far below the land surface and remain trapped there.

Since the terrain is such that complete surface control is easily accomplished, the site appears to be well located. The sub-surface hydrology of the area also seems favorable.

F. Seismological Characteristics

The Southern California region has had a rather active history of earthquakes. Building designs and methods of construction have been developed to withstand earthquake forces. While a severe earthquake always leaves in its wake many collapsed buildings, experience has shown that other buildings in the area which were designed properly have been capable of withstanding the strongest recorded earthquake shocks.

Since the proposed reactor is to be built on solid ground several miles away from an active fault, the structure, when properly designed, will be capable of withstanding the strongest recorded earthquake shocks. As an added safety factor, mechanisms that operate when a predetermined shock intensity level is reached will be utilized to scram the reactor.

G. Population Distribution

No people reside within the exclusion radius of 1.4 miles. One and one-half miles from the reactor site is the NAA propulsion laboratory employing approximately 300 people. Within a 5-mile radius reside 3000 people, and the population within a 10-mile radius is 56,000. Most of the population within the 10-mile radius is in the San Fernando Valley, east and on the opposite site of the Simi Hills from the proposed site. Chatsworth, 6 miles east, has a population of 2,500. To the north is the Simi Valley. It includes a number of unincorporated sparsely populated areas. The total 1952 population in the Simi Valley proper is estimated at 3,280 (See Fig. 2).

The area seems to be growing at a normal rate. No sharp increase in this rate is expected because of the water shortage in the area. If it is ever found feasible to bring water into the area from some outside source to replenish the rapidly declining underground water supply, a more rapid growth could be expected to take place. However, the mountains around the valley make this task a very difficult and costly one.