SOUTHERN CALIFORNIA EDISON COMPANY

SAN ONOFRE NUCLEAR

GENERATING STATION

OFFSITE HAZARDS EVALUATION 1984

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OFFSITE HAZARDS EVALUATION

I. INTRODUCTION

This report documents the 1984 offsite hazards evaluation performed for San Onofre Units 2/3. The evaluation consists of monitoring hazardous cargo and assessing long term changes in offsite hazard probabilities. The results of the survey indicate that the frequency of hazardous cargo has increased slightly. The assessment of the likelihood of a hazard causing a plant accident is very conservative. The value derived is below the limits of SRP 2.2.3. An assessment of long term trends indicates that it is very unlikely that the frequency will increase enough to exceed the limits of the SRP 2.2.3.

Section II presents the monitoring of hazardous cargo. The methods and results of the effort are described. Section III discusses the assessment of long term changes in offsite hazard probabilities.

II. MONITORING OF HAZARDOUS CARGO

A. Summary

In response to the San Onofre Units 2/3 Technical Specifications 6.9.1.14. requirements for monitoring hazardous cargo traffic every three years on Interstate 5 (I-5) and the Atchison Topeka and Santa Fe Railway, a 1984 survey of the frequency of hazardous cargo travel near the plant has been performed. The results have been used to develop an updated analysis of off-site hazards. This survey and updated analyses have included consideration of all identified potentially hazardous material being transported near the plant. In addition to the evaluation of the current level of activity (transportation) which could represent an off-site hazard, analyses based on site-specific truck survey data trends and an industrial survey of trends in hazardous material use were conducted to estimate the future of off-site hazards at Units 2/3.

B. Method

The original consideration of off-site hazards [1] included analysis of potentially hazardous cargo on both the

- AT & SF Railway, and
- Interstate 5 (I-5)

To perform an update of the rail hazard, contact was made with representatives of the AT&SF Railroad for civilian transportation. In addition, contact was made with representatives of the military regarding ordnance shipments by rail. These contacts confirmed that:

- civilian operations of AT&SF Railroad have not changed since the last assessment

- there has been an embargo on shipment of military ordnance by rail in effect since 1979.

The potential hazard from transportation of hazardous material on the AT&SF railway is therefore expected to be bounded by the previous estimate.

To update the frequency of shipment of hazardous cargo on I-5, a 7-day (24-hour per day) roadside survey of truck traffic was performed from March 25 through April 1, 1984. A total of 21,435 trucks were interrogated in the survey. A total of 625 trucks were found to be carrying cargos which might be hazardous (further evaluation warranted). The hazardous materials shipped by these trucks were identified and evaluated. Some of the materials were assessed in the previous analysis. Some were of low hazard potential or were only hazardous in the local vicinity of a wreck. Other new materials identified were evaluated in terms of their chemical composition, physical state, usage and other characteristics. Based upon the similarity of properties of substances identified in the survey to the toxic materials identified in the previous work, an updated frequency of shipment of hazardous materials was determined. These revised frequencies were used to update the analysis based upon the linear relationship that exists between the shipment frequency and estimated hazard. A small portion of these new materials is of unknown nature. The shipment of these unknown materials represents only 2% of the total shipment and is therefore considered to be insignificant.

Table 1 provides a comparison between the previous estimates and the updated estimates using current 1984 data for the off-site hazard at Units 2/3.

The substances found to represent a potentially significant hazard include:

- Gasoline
- Diesel Oil
- Jet Fuel
- Butane
- Propane
- Chlorine, and

o Ammonia

For the hazardous explosives transported on I-5, both military and civilian transporters were evaluated. The updated explosive hazard and the flammable cloud hazard are included in Table 1.

In addition to the survey, an evaluation was performed on the truck accident rate near the plant. The truck accident rate for I-5 near San Onofre is 3.5×10^{-7}/truck mile based on information from the California Highway Patrol [2]. Actual statistics for the roadway adjacent to the plant are consistent with flat, straight interstate as documented by Sandia, Statistical Description of Heavy Truck Accidents on Representative Segments of Interstate Highway, SAND-0409, January, 1977. The truck accident rate used in original estimate is 1.1×10^{-6}/yr. This new evaluation results in a revision of the expected truck accident rate on I-5 in the region of Units 2/3. The new accident rate and, therefore, hazard frequency is 39% of the value used in the original estimate. By using this revised truck accident rate, the off-site hazard was obtained as summarized in Table 2.

The off-site hazard is reduced by the presence of a gas monitoring system at Units 2/3. To assess the impact of this system, an evaluation using the system unavailability is performed (0.01 is conservatively used based on actual system experience). The off-site hazard frequency, taking credit for this feature, is shown in Table 3, taking into account both the effects of the gas monitor system and the revised truck accident rate.

C. Conclusions

Based on the results of this 1984 survey and analysis, it is concluded that the frequency of shipment of hazardous material has not changed significantly. The 1984 updated off-site hazard frequency is 3.4×10^{-7}/yr. Compared with the original value of 2.3×10^{-7}/yr, the 1984 value represents a slight increase. It is noted that the evaluation includes significant conservatisms. Since the off-site hazard frequency of 3.4×10^{-7}/yr is significantly below the NRC SRP acceptance criteria, the slight increase is insignificant from a risk perspective. The degree of actual risk associated with the off-site hazardous cargo shipment is considerably smaller than that associated with other internal or external events, and does not introduce significant additional risk to the plant.

III. EVALUATION OF LONG TERM CHANGES IN OFF-SITE HAZARD PROBABILITIES

A. Introduction

In addition to the 1984 evaluation of the frequency of shipment of potentially hazardous cargo and the associated off-site hazard, an evaluation of the future off-site hazard at Units 2/3 has been performed. This future projection is compared against the SRP acceptance criterion of less than 10^{-6}/yr frequency due to the conservatisms inherent in the analyses.

B. Conservatisms in Evaluation of Off-Site Hazard

In the evaluation of the potential for an off-site hazard due to toxic gas, explosive overpressure and flammable vapor cloud, phenomenological uncertainties have been modeled using conservative assumptions. The conservatisms included in each area are described below.

1. Toxic Gas Hazard

Several effects not considered in the estimate of the likelihood of toxic gas hazard make the results conservative. These effects include:

- a need for the cloud to both rise and fall in order to enter the control room due to the labyrinth type of control room air intake and the effect of possible blockage of the plume by plant structures which would tend to shield the air intake and break up a plume

- dispersion effects such as ground roughness and terrain which enhance plume dispersion

2. Explosive Overpressure Exceeding 7 psi

The areas of conservatism in the explosive overpressure analysis include:

- Structural failure criterion of 7 psi

  The pressure load capacity of walls and roofs of the seismic category I buildings was determined to be a minimum of 7 psi net governed by the reinforced concrete roof slabs. It is noted that the analysis was based on energy balance techniques with strain energy capacity limited by flexural ductility ratios not exceeding 3.0 and ultimate load resistance evaluated by yield-line methodology. There is a significant safety margin between violating the ductility limits and failure of safety related structures. It is thus believed that substantial conservatism exists in the use of 7 psi as the failure criterion for structures. Another factor not considered in the deterministic failure criterion is the variation of the structural strength. For example, if the failure probability for overpressure at 7 psi is approximately 10^{-2} and the structural strength is log-normally distributed with a coefficient of variation of 0.10, the failure probability for overpressure at 8 psi is 0.04. The corresponding failure probability for overpressure at 9 psi and 10 psi is 0.28 and 0.68 respectively. This represents a significant conservatism in the analysis.

- Puff release

  An instantaneous puff release of the spilled quantity is assumed. In a significant number of accidents the spill occurs over an extended time period, thereby reducing the hazard significantly below that of a true puff release.

- Flammable quantity of hazardous substance

  The entire quantity of material released in the puff is assumed to be involved in the explosion leading to possible overpressure. Analysis of a drifting puff release has shown that the maximum quantity between flammable limits is on the order of 60-70% for materials of interest and that for much of the travel distance, it is less than this amount.

3. Flammable Cloud at Plant

The areas of conservatism in the flammable cloud analysis include:

- Area Affected

  The plant area for which a flammable vapor cloud is unacceptable was conservatively described as a circle with an area more than twice the actual area of safety related buildings.

- Air Intake Location

  The air intakes are located above grade. Since most vapor clouds of concern will tend to be of very limited vertical extent, it is conservative not to take credit for the air intake being above grade.

- Dispersion Modeling

  The dispersion model conservatively accounts for gravity spreading of the heavier than air vapors without dispersion, followed by atmospheric dispersion using class G stability and a low wind speed.

4. Analysis of Consequences of Accidents

The areas of conservatism inherent in the assessment of (assumed) consequences are:

- Toxic Gas Hazard Causes Exceedance of 10 CFR 100 Exposure Guideline

  A major consequence of toxic gas at air intake is potential loss of control room habitability. This does not lead to core melt by itself. In order to have a core melt accident, a transient must occur, safety systems of the plant must fail, and operators must fail to successfully shut down the plant. The probability of this occurence is estimated[10] to be on the order of less than 10^{-3}. Even if core melt does take place, containment will still provide a barrier to release of radioactivity to the outside of the plant.

- Overpressure Exceeding 7 psi Causes Exceedance of 10 CFR 100 Exposure Guidelines

  The possible collapse of safety related structures is the major effect of concern for a possible explosive overpressure exceeding 7 psi. In order to cause a core melt and subsequent significant release of radioactivity, the collapsed structures must introduce a transient concurrent with the failure of safety systems. The likelihood of these multiple effects is certainly less than the probability of a single effect and is believed to be low for overpressures which just exceed the specified limit.

- Flammable Gas at Plant Causes Exceedance of 10 CFR 100 Exposure Guideline

  In order for the flammable gas to cause damage, it must be ignited. Ignition at the switchyard (nearest I-5) would probably cause loss of off-site power. This is a low frequency occurrence compared to other causes of loss of off-site power and, therefore, would not increase risk appreciably. The probability of a given fire leading to core melt is certainly less than 1.0 and may well be small (0.01 operator fails to put out fire and successfully shutdown). In addition, the containment has to fail to release a sufficient amount of radioactivity to exceed 10 CFR 100 exposure guidelines.

C. Long-Term Off-Site Hazard Evaluations

Two sets of statistics were used for the analysis of future trends:

- First, truck travel data near Units 2/3 for the past seven years were statistically analyzed to predict the frequencies of off-site hazards in future years. Table 4 summarizes the future off-site hazard for the period of 1985-2024 based on 1.5% annual growth rate of truck travel frequency identified as a result of statistical analysis of previous data. The maximum frequency of off-site hazard is 5.7 X 10^{-7}/yr, significantly lower than the value of 10^{-6}/yr as specified in SRP 2.2.3.

- Secondly, industry survey and forecasts [3,4] for the growth of chemical and petroleum products were used to predict future off-site hazards. Table 5 summarizes the off-site hazard for the period of 1985-2024, based on 3.0% annual growth rate of petrochemical products identified in the industry survey.

IV. CONCLUSIONS

The results indicate that the frequency of offsite hazard induced accident at the plant is well below 10^{-6}/year on a conservative analysis basis. Further, the results indicate that the maximum plant lifetime frequency of offsite hazard is 8.3×10^{-7}/yr, still within the limit of 10^{-6}/yr specified in SRP 2.2.3.

Based on the results of this work, it is evident that the offsite hazard at Units 2/3 for the next forty years is expected to be within the acceptance criterion of SRP 2.2.3. In addition, significant margins persist because of considerable conservatisms included to account for phenomological uncertainties. The 97.5 percentile value is used in the development of future predicted values. This provides high confidence that the predicted values will not be exceeded. It is concluded that the long term offsite hazard represents an insignificant risk to the plant when compared with other accident initiators. The periodic traffic survey every three years is costly and does not contribute to significant risk reduction.

REFERENCES

1. Sourthern California Edison Company, "Section 2.2 Nearby Industrial, Transportation, and Military Facilities", San Onofre 2&3 FSAR, updated.

2. Letter from Mr. R.H. Tindel, "1974-83 Large Truck Involved Accident on I-5 in San Diego County from the San Diego - Orange County Line South to Milepost Marker 54.7", April 10, 1984.

3. Predicasts Forecasts, Published Quarterly by Predicasts, Inc.

4. Standard & Poor's Industry Surveys "Oil Industry", Nove. 10, 1983, Vol. 151, No. 43, page O.57.

Table 1. Comparison of 1984 Update and Original Estimate of Off-site Hazard at Unit 2/3 (Frequency of Presence of Condition)

MATERIAL	ORIGINAL VALUE #/YEAR	1984 UPDATE #/YEAR
Gasoline	1×10^{-6}	3×10^{-7}
Diesel Oil	3×10^{-8}	1.4×10^{-7}
Jet Fuel	5×10^{-8}	1.9×10^{-7}
Butane	1×10^{-6}	2.4×10^{-8}
Propane	2×10^{-6}	4.4×10^{-6}
Chlorine	1×10^{-6}	1.8×10^{-6}
Ammonia	9×10^{-7}	3.5×10^{-6}
Explosive Overpressure of 7psi	1.3×10^{-7}	3.0×10^{-7}
Flammable Cloud at Plant	1.5×10^{-7}	3.2×10^{-7}
TOTAL	6.3×10^{-6}	1.0×10^{-5}

Table 2. Comparison of 1984 Update and Original Estimate of Off-site Hazard at Unit 2/3 (Includes Truck Accident Rate Correction) *

MATERIAL	ORIGINAL VALUE #/YEAR	1984 UPDATE #/YEAR
Gasoline	3.9×10^{-7}	1.2×10^{-7}
Diesel Oil	1.2×10^{-8}	5.5×10^{-8}
Jet Fuel	2.0×10^{-8}	7.4×10^{-8}
Butane	3.9×10^{-7}	9.4×10^{-9}
Propane	7.8×10^{-7}	1.7×10^{-6}
Chlorine	3.9×10^{-7}	7.0×10^{-7}
Ammonia	3.5×10^{-7}	1.4×10^{-6}
Explosive Overpressure of 7psi	1.3×10^{-7}	3.0×10^{-7}
Flammable Cloud at Plant	1.5×10^{-7}	3.2×10^{-7} **
TOTAL	2.5×10^{-6}	4.6×10^{-6}

* Table 2 is converted from Table 1 by multiplying by a truck accident rate factor of 0.39.

** Since the loaded tank truck accident rate was used correctly in the previous estimate, these numbers remain unchanged.

Table 3. Comparison of 1984 Update and Original Estimate of Off-Site Hazard at Unit 2/3 (Includes Truck Accident Rate Reduction and Monitor System Effects). *

MATERIAL	ORIGINAL VALUE #/YEAR	1984 UPDATE #/YEAR
Gasoline	2.0×10^{-8}	1.2×10^{-9}
Diesel Oil	6.0×10^{-10}	5.5×10^{-10}
Jet Fuel	1.0×10^{-10}	7.4×10^{-10}
Butane	2.0×10^{-8}	ϵ
Propane	3.9×10^{-8}	1.7×10^{-8}
Chlorine	2.0×10^{-6}	7.0×10^{-9}
Ammonia	1.8×10^{-9}	1.4×10^{-8}
Explosive Overpressure of 7psi	1.3×10^{-7}	3.0×10^{-7}
Flammable Cloud at Plant	1.5×10^{-9}	3.2×10^{-9}
TOTAL	2.3×10^{-7}	3.4×10^{-7}

* Table 3 is converted from Table 2 by multiplying monitor system unavailability of 0.01 for toxic gas hazard. Values for explosive overpressure of 7 psi and Flammable Cloud at Plant remain the same as in Table 2.

TABLE 4. 1985-2024 OFF-SITE HAZARD BASED ON STATISTICAL ANALYSIS OF PREVIOUS DATA

YEAR	PROBABILITY PER YEAR * 97.5 PERCENTILE
1985	3.89×10^{-7}
1990	4.11×10^{-7}
1995	4.36×10^{-7}
2000	4.59×10^{-7}
2005	4.84×10^{-7}
2010	5.06×10^{-7}
2015	5.32×10^{-7}
2020	5.57×10^{-7}
2024	5.74×10^{-7}

* 97.5 percentile value indicates that one is 97.5% confident that the actual value is lower than estimated value.

TABLE 5. 1985-2024 OFF-SITE HAZARD AT UNIT 2/3 BASED ON INDUSTRY SURVEY

YEAR	PROBABILITY PER YEAR 97.5 PERCENTILE
1985	4.28×10^{-7}
1990	4.82×10^{-7}
1995	5.35×10^{-7}
2000	5.85×10^{-7}
2005	6.38×10^{-7}
2010	6.92×10^{-7}
2015	7.42×10^{-7}
2020	7.95×10^{-7}
2024	8.37×10^{-7}