

**Recommendations Regarding
Exemptions from Rotating
Power Outages**



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Rotating Power Outages**

Prepared for

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Acronyms and Abbreviations

CPUC	California Public Utilities Commission
DOD	U.S. Department of Defense
EAS	Emergency Alert System
FMEA	failure modes and effects analysis
OSHA	Occupational Safety and Health Administration
PG&E	Pacific Gas and Electric
SCE	Southern California Edison
SDG&E	San Diego Gas and Electric
Utility Companies	Pacific Gas and Electric, Southern California Edison, and San Diego Gas and Electric

Executive Summary

The California Public Utilities Commission (CPUC) retained Exponent to evaluate and prioritize requests from business customers for exemptions from rotating power outages based on potential impacts on public health and safety. The evaluation and prioritization process was limited to customers served by the following investor-owned utility companies regulated by CPUC: Pacific Gas and Electric Company, Southern California Edison, and San Diego Gas and Electric. This process was not applicable to residential customers or to business customers whose applications were based on economic harm or inconvenience.

This evaluation provides a public health and safety risk-prioritized list of business customers currently not exempt from rotating power outages, that CPUC can consider for granting exemptions (i.e., “essential user” status). CPUC can use this list in conjunction with other influencing factors, such as utility circuit peak load analysis results and compatibility with earlier CPUC exemption decisions.

In executing this project between May and July 2001, Exponent 1) developed a questionnaire for business customers to complete and submit for requesting exemptions from rotating power outages, 2) created and maintained a web site for business customers to complete and submit their application request, 3) operated a call center for business customers to direct inquiries regarding the application process, 4) processed submitted applications, 5) developed methods to analyze application data and evaluate results, 6) convened a panel of members of the general public selected to represent the various business groups that applied for exemptions and conducted a “focus group” type survey to understand better the public’s opinion of the risk posed by unannounced power outages to the various business groups, 7) assessed and ranked all applications received, and 8) prepared a prioritized list of business customer applications for CPUC’s consideration. This report and risk ranking addresses the 9,522 completed applications received by the June 4, 2001, 5:00 p.m. deadline set by CPUC.

The web-based questionnaire, made available at www.rotating-outages.com, was designed to collect information about the customer facility, the services they provide, and the potential public health and safety impacts from rotating power outages (i.e., the severity of health impacts, the likelihood of occurrences, and the sizes of populations affected). The questionnaire also included questions related to the existence of emergency preparedness procedures at the facility for unplanned power outages and other emergency situations. The responses to these questions were used to evaluate and rank the applications.

Exponent recommends that applicants who are police or fire departments or high-security prisons be given the highest priority for CPUC’s consideration for exemptions from rotating power outages. Fifty-one of the applicants fell into this category. This recommendation continues previously established CPUC policy, which currently grants these types of facilities exemptions from rotating power outages.

Based on the evaluation results, Exponent prepared a rank-ordered list of 405 applicants for consideration for exemption from rotating power outages (after exemption of police, fire, and

prison facilities). The recommendations are based on applicant facilities' potential to exert a public health and safety impact in the event of an unplanned rotating power outage. Most of these 405 applicants consisted of various health care business groups: dialysis treatment clinics, doctors' offices, medical laboratories and blood banks, medical buildings, skilled nursing facilities, nursing homes, out-patient care/surgical centers, out-patient dental care/surgical clinics, and dentists, as well as some emergency service providers, manufacturing and production plants, and transportation facilities and companies.

In addition, the panel perceived skilled nursing facilities and dialysis clinics to have a higher likelihood of a severe health effect or death occurring in the event of an unannounced rotating power outage compared with that of all the other business groups. Exponent recommends that CPUC consider exempting skilled nursing facilities and dialysis clinics from rotating power outages.

1 Introduction

Rotating power outages protect the integrity of California's electrical power supply by forcibly reducing demand when supply is insufficient. The power crisis in California has at times resulted in rotating power outages to customers, and the California Public Utilities Commission (CPUC) expects the potential for such outages to continue at a minimum through summer 2002. These rotating power outages are anticipated by CPUC to last less than 2 hours. In the early 1980s, CPUC designated the categories of customers who provide critical and essential services (i.e., "essential users"). Customers in these categories were exempted from rotating power outages. These included government and other agencies providing fire, police, and prison services, government agencies essential to the national defense, hospitals with 100 beds or more, and other facilities considered necessary for the health, safety, and the security of the general public (CPUC 2001). As appropriate, these lists were periodically revised. Concerned about the possibility of more frequent rotating power outages and their subsequent impacts, many customers have recently requested that their electric utility distribution companies categorize them as "essential users" for exemption from rotating power outages.

After studying these issues, both CPUC and the California Independent System Operator (the agency that operates the state's electrical transmission system) agreed that at least 40 percent of the summer peak demand must be made available for curtailment by rotating power outages. Currently, the electric utility distribution companies regulated by CPUC have made available approximately 50 percent of their summer peak demand for application of rotating power outages. This leaves about 10 percent of the peak load available for exemption of additional qualifying customers. The utility distribution system is organized into "blocks" of circuits. The blocks represent the smallest geographical unit that can be rotated. Each block is made up of many circuits, and each circuit contains many customers. Designating one customer on a circuit as an essential user results in all the other customers on that same circuit receiving the same benefits as the essential user customer. As a result, only a very small number of additional business customers can be exempted.

This report presents the results of an application-based process initiated in May 2001 by CPUC to evaluate and prioritize requests from business customers for exemptions from rotating power outages based on impacts on public health and safety. Exponent, following guidelines outlined by CPUC, developed a web-based questionnaire application that was made available to business customers, and then evaluated and ranked each completed application based on the applicants' stated potential public health and safety impacts in the event of unannounced rotating power outages. CPUC specified that claims based solely on economic harm or inconvenience to the business customer would not be considered. This report discusses the results from applications received by the June 4, 2001, 5:00 p.m. deadline set by CPUC.

The application and exemption process applied only to business customers served by the following investor-owned utility companies regulated by CPUC (Utility Companies): Pacific Gas and Electric (PG&E), Southern California Edison (SCE), and San Diego Gas and Electric (SDG&E). This application process did not apply to residential customers.

1.1 Project Objectives and Tasks

The project objectives established by CPUC were to develop a process by which business customers could apply for “essential user” status and have their applications evaluated based on potential adverse public health and safety impacts that could result from rotating power outages. The final result of the application evaluation process is a list of applicants, in order of priority, for CPUC’s consideration in granting “essential user” status. Exponent performed the following tasks designed to meet overall project objectives in an expedient, fair, and accurate manner (Figure 1-1):

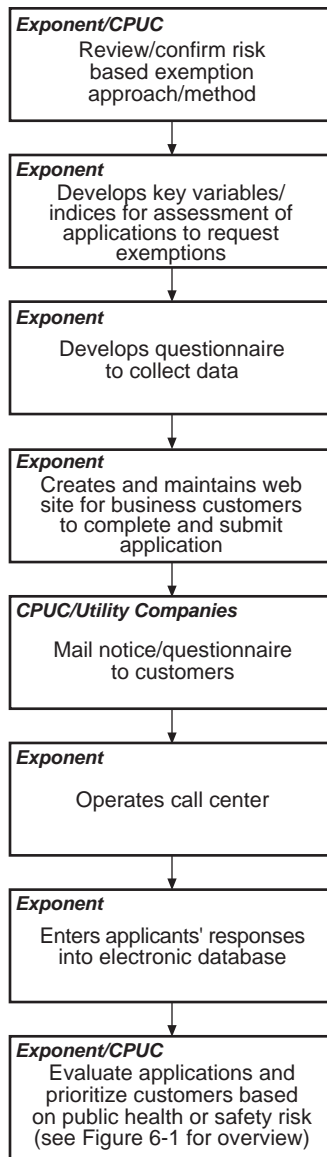
1. Developed a questionnaire for business customers to request exemptions from rotating power outages
2. Created and maintained a web site for business customers to complete and submit their application
3. Operated a call center for business customers to direct inquiries regarding the application process
4. Processed submitted applications
5. Developed methods to analyze application data and evaluate results
6. Assessed and ranked applications on public health and safety criteria
7. Prepared a prioritized list of customer applications for CPUC’s consideration.

In addition to these objectives, Exponent convened a panel of members of the general public selected to represent the various business groups applying for exemption and conducted a “focus-group” type survey to understand better the public’s opinion on the relative public health and safety risks that various business groups may encounter in the event of an unannounced power outage.

1.2 Organization of the Report

This report is organized into the following sections:

- Section 2, *Application-Based Exemption Process*, discusses the development of the questionnaire
- Section 3, *Method of Assigning Quantitative Health and Safety Risk Index Scores*, describes the numeric risk index score
- Section 4, *Initial Quantitative Risk Ranking Results*, presents general information regarding the applicant pool and the ranking of the applicants based on the numeric risk index score



CPUC
California Public Utilities Commission

Utility Companies
Pacific Gas and Electric,
San Diego Gas and Electric,
and Southern California Edison

Figure 1-1.
Overview of exemption application process

- Section 5, *Panel Group Study of Potential Public Health and Safety Risks*, describes data Exponent gathered regarding public perceptions of the risk posed to public health and safety by unannounced power outages for the various business groups
- Section 6, *Applicant Ranking Approach*, describes the approach implemented to develop the public health and safety-ranked list of applicants for CPUC's consideration and the criteria used to eliminate applicants from consideration
- Section 7, *Results*, presents the final results of the analysis and recommendations for CPUC
- Section 8, *References*, presents references cited in the report.

2 Application-Based Exemption Process

In accordance with the guidelines outlined in CPUC's Consulting Services Request, Exponent developed a questionnaire to collect information from applicants regarding their operations and potential public health and safety risks. This application process only applied to business customers (residential customers were not included). The questionnaire gave applicants the opportunity to provide information about their facility and justify their needs for exemption from rotating power outages.

2.1 Questionnaire

The questions focused on general facility information, electrical requirements, emergency preparedness, and public health and safety information. For two durations of outages (less than 2 hours and 2 to 4 hours), applicants were requested to estimate the nature (i.e., severity) and likelihood of potential adverse public health and safety effects and the number of people who may be affected. Although CPUC anticipates that most rotating power outages would last less than 2 hours, some outages may last longer. Applicants were asked to categorize the severity of potential public health and safety effects into four major categories:

1. Minor health effects
2. Moderate health effects
3. Severe health effects
4. Death.

These terms were defined in the questionnaire. A more detailed description of these categories is presented in Table 2-1. A copy of the questionnaire is included in Appendix A.

2.2 Public Notification

To notify business customers of the application-based exemption process, CPUC made a public announcement and issued a press release at a press conference held on May 21, 2001. A copy of the press release is included in Appendix B. The Utility Companies were responsible for mailing CPUC's announcement letter to approximately 600,000 business customers (Appendix C). This announcement letter was mailed out by the Utility Companies between May 25 and May 28, 2001. Initially, applicants were required to complete the exemption questionnaire by June 1, 2001, at 5:00 p.m. This deadline was extended until June 4, 2001, at 5:00 p.m. because of the large volume of applications received and the short time available for completing the application process. For applicants who could not meet the June 4, 2001 deadline, another deadline (June 15, 2001, at 5:00 p.m.) was established for additional applications, which CPUC will review and evaluate at a later date. This report covers only those applications received by the first deadline, June 4, 2001, at 5:00 p.m.

2.3 Web-Based Application Process

The web-based questionnaire was made available to the public at *www.rotating-outages.com*, a web site created and maintained by Exponent. To supplement the questionnaire, the web site provided several other tools, including a set of frequently asked questions, instructions for filing applications, eligibility criteria, and a worksheet to help gather information required to complete the questionnaire. In addition, the web site provided a list of all applications submitted to CPUC by June 4, 2001, at 5:00 p.m. Copies of selected web pages are included in Appendix D. The web-based questionnaire was divided into four sections: Statement of Authenticity, Facility Information, Services and Events, and Public Health and Safety. The questionnaire process was designed so that applicants were required to fill out all mandatory questions before they could submit their application. This minimized the problem of missing information on the exemption applications. Once completed, responses to questions in each section were saved to the database, and the applicants were sent to the next section. During each stage of the application process, applicants were allowed to save partially completed applications and return later to resume or modify their applications. After completing all sections of the questionnaire, applicants were given the option of printing their applications for final review.

All applications were assigned a unique number to prevent an unauthorized person from accessing an application. Applicants were asked to save the application number for future correspondence regarding their applications. If application numbers were lost, the applicants were instructed to begin a new application and to ignore their previous application.

2.4 Alternatives to Web-based Application Process

Given the limited amount of time available to complete the application process, all applicants were strongly encouraged to submit their applications using the web site; however, alternative means of filing the applications were also provided. Applicants who did not have access to the Internet could obtain a copy of the application via facsimile through the CPUC call center, which was operated by Exponent. Callers who did not have access to a fax machine were directed by call center staff to contact CPUC's San Francisco office to obtain an application via mail.

To be considered for exemption, faxed or mailed applications had to be received by CPUC by June 4, 2001, 5:00 p.m., and all questions on the application had to be completed. For applications that were missing pages or answers to specific questions, CPUC staff attempted to call applicants and obtain the missing information.

2.5 Applicant Profile

CPUC received 9,522 completed applications by June 4, 2001, at 5:00 p.m. Applications that were received after June 4, 2001, are not addressed in this report and have not been evaluated per CPUC's request. Between May 21 and June 15, 2001, more than 10,000 calls were placed to the call center, and 327 emails were received at *questions@rotating-outages.com*.

The applicants were classified into 42 business groups (Table 2-2). The descriptive information provided by the facility name, activities performed, and products produced/services provided was used to classify each applicant into one of the 42 business groups. Approximately 36 percent of the applicant pool were PG&E customers, 12 percent were SDG&E customers, 50 percent were SCE customers, and 2 percent were customers of other utilities. Applicants who indicated that their electric utility distribution companies were not PG&E, SCE, or SDG&E were excluded from the evaluation. Of the 9,522 total applicants, 158 of the applicants are already classified by the Utility Companies as “essential users” (Table 2-3). Forty-one applications were from electricity generators (generally wind and solar power generators); their application requests were based primarily on their net contribution to the electrical grid and indirectly on potential public health and safety impacts (Table 2-4).

Applications initiated but not completed or submitted were not included in the evaluation and thus are not discussed in this report. Incomplete applications received via facsimile also were not included in the evaluation per CPUC’s request. CPUC received 1,203 applications via facsimile; however, only 297 were complete (857 of the applications were missing pages or did not contain all of the required information). Forty-nine applications were duplicates. Information from the 297 completed fax applications was entered into the database for evaluation.

3 Method of Assigning Quantitative Health and Safety Risk Index Scores

The method used to evaluate and rank the applications for exemptions from rotating power outages included assigning a numeric risk index score based on information provided by the applicant via the questionnaire. This section describes how the numeric risk index score was developed.

3.1 Background on Risk Assessment Techniques

A fundamental concept of risk assessment is that risk, by its very nature, incorporates both the severity of the outcome and the likelihood of that event occurring. Events with the highest intrinsic risk are those that have severe consequences (e.g., death) and a high likelihood of occurring. On the other hand, events that are both very unlikely to occur and that have benign consequences have the lowest risk. By suitably combining severity of outcome and likelihood, events can be compared directly in terms of risk.

One common method of combining severity and likelihood into a single measure of risk is through a risk matrix that shows all the combinations of severity and likelihood categories and assigns them appropriate risk scores. This technique is used in the chemical process industry through Process Hazards Analyses and Hazards and Operability Studies (AIChE 1992) and in other industries. The military uses a similar risk matrix approach to define risk in its safety studies (DOD 2000). Another way to combine severity and likelihood into a single quantity representing risk is to assign numerical values to each severity category and likelihood category, with higher numbers representing higher severity and higher likelihood. These numbers can then be multiplied together to produce a single number representing risk. The most common application of this type of risk assessment technique is in failure modes and effects analysis (FMEA) (SAE 2000). This technique has been adopted by the automotive and other manufacturing industries as the standard for risk assessments of design and manufacturing processes. In a typical FMEA, the severity of the outcome is assigned a score from 1 to 10, and the likelihood of the event is split into two parts: the probability of occurrence, and the probability of detection, each of which also receives a score from 1 to 10. These three scores are multiplied together to form a Risk Priority Number, by which scenarios are sorted to determine the high-risk items for further review.

3.2 Risk Index Scores for Applications for Exemptions from Rotating Power Outages

The first step used to evaluate and rank the applications for exemption from rotating power outages was to assign applicants a numeric risk index score. The risk index score was based entirely on the applicant's responses to the questionnaire regarding the likelihood and population affected for each of four potential adverse health outcomes: minor health effects, moderate health effects, severe health effects, or death (Table 2-1).

The risk index score is based on three factors for two outage durations (i.e., less than 2 hours and 2 to 4 hours): 1) severity of health outcome, 2) likelihood of health outcome, and 3) size of population affected. The values that were chosen to represent various degrees of severity and likelihood were based on published data (DOD 2000; Mosteller and Youtz 1990), whereas the weights assigned to the population affected were calculated as the midpoints of pre-determined population size categories. The probability of each outage duration (i.e., less than 2 hours and 2 to 4 hours), referred to as the outage duration probability factor, was based on information provided by CPUC.

These three factors (severity of health outcome, likelihood of health outcome, and population-affected by health outcome) and the outage duration probability factor were multiplied together to yield a quantitative “risk index score.” The equation used to calculate the risk index score and an example that illustrates how the three outcome factors and the outage duration probability factor would be used to determine a risk index score are presented in Appendix E.

The following sections describe the factors (severity of health outcome, likelihood of health outcome, size of population affected, and outage duration probability factor) that were used to develop the numeric risk index score for each applicant. Details are provided on how weights were derived for each factor. Exponent re-scaled factors for severity of health outcome, likelihood of health outcome, and size of population affected to range from 0 to 10.

3.2.1 Severity Factor

For this evaluation, severity refers to the seriousness of four health outcomes: minor health effects, moderate health effects, severe health effects, and death (Table 2-1). To convert these outcomes to a quantitative scale, Exponent developed “severity weights” to reflect the relative differences between outcomes. The severity weight assigned to each health outcome was based on literature for this type of evaluation (DOD 2000) and was consistently applied to all applicants (i.e., a death always received the same weight regardless of how or where it occurred). For this evaluation, minor health effects, moderate health effects, severe health effects, and death were assigned weights of 0.01, 0.1, 1, and 10, respectively (Table 3-1).

Severity weights were based primarily on data provided in the U.S. Department of Defense (DOD) report *Standard Practice for System Safety* (DOD 2000). Specifically, the DOD report describes four mishap severity categories for system safety that were designed to provide guidance for a wide variety of programs (Table 3-2). These categories, which approximate the health outcomes in the CPUC questionnaire, suggest a 5- to 20-fold difference (or weighting) between severity levels based on the estimated monetary loss associated with each category. These rates are generally consistent with the factor of 10 used in this process.

The DOD risk assessment values (Table 3-3) provide further evidence of the approximate ten-fold difference between severity levels (DOD 2000). Although these risk categories incorporate both measures of severity and probability, the severity weight factor can be derived from the table by comparing the listed implied weights for each risk category with one another. For example, the DOD’s risk assessment matrix suggests that a serious risk can result from a critical event with a probability greater than 1 in 1,000 or from a marginal event with a probability

greater than 1 in 100. This suggestion implies that a critical event is 10 times more severe than a marginal event.

Approaches other than that used in DOD (2000) also were evaluated as a potential means of assigning weights to different severity levels. These alternative approaches are discussed in Appendix F.

3.2.2 Likelihood Factor

The likelihood factor refers to the probability of occurrence of a particular health outcome. The following three qualitative expressions were used in the questionnaire to assess the degree of likelihood of each health outcome: *unlikely*, *somewhat likely*, and *very likely*. The likelihood weights assigned to each qualitative expression were based on a summary of 20 different studies that elicited quantitative meanings from the public for 52 qualitative probabilistic expressions (Mosteller and Youtz 1990). The weighted average across all studies for each particular expression was used (i.e., taking into account the sample size of each study).

Several studies evaluated qualitative expressions involving the word “likely”—including “very likely,” “likely,” “unlikely,” and “very unlikely,” but few studies in the summary provided data on the exact term “somewhat likely.” Comparable qualitative expressions such as “occasionally,” “sometimes,” “once in a while,” “now and then,” “might happen,” “possible,” and “not unreasonable” were used to determine the weight for “somewhat likely” (Table 3-4). Based on these studies, “somewhat likely” was assigned a likelihood weight (re-scaled) of 2.6, which is consistent with the term “sometimes.”

The likelihood weights, like the severity weights, are fixed for each applicant (i.e., a “very likely” outcome always received the same weight); however, the likelihood chosen by each applicant for each of the health outcomes will vary across applicants. Likelihood weights ranged from 0 to 100, where “no chance” and “certain to happen” are represented by 0 and 100, respectively (Table 3-5). These weights were re-scaled to a 0 to 10 scale, where *unlikely*, *somewhat likely*, and *very likely* were assigned weights of 1.6, 2.6, and 8.5, respectively.

Although the questionnaire contained only three likelihood options, these implicitly incorporate the more extreme expressions. That is, respondents who indicated that a health outcome was “unlikely” may have, in reality, meant that it was “very unlikely” or “certain not to happen.” The weights used in the current analysis may therefore provide a slight misrepresentation of respondents’ perceived likelihood, particularly for the lowest likelihood category. However, based on the study of probabilistic expressions, the difference in average weightings between the terms “unlikely” (16) and “very unlikely” (8) is only a factor of two and did not have a significant impact on the relative rankings (Mosteller and Youtz 1990).

3.2.3 Population-Affected Factor

The population-affected factor refers to the number of people, workers or members of the general public, who will be affected by each health outcome (i.e., minor, moderate, or severe health effects or death). The following seven categories were used to assess the number of

people likely to be affected: 0, 1–3, 4–10, 11–25, 26–100, 101–1,000, >1,000. The seven pre-determined population categories were chosen for several reasons. First, a wide range of potential population sizes was selected because of the diverse nature and size of facilities or businesses that were expected to apply. Second, a particular emphasis was given to discriminating at the low range of values because of the severe nature of certain health outcomes (e.g., severe injury/illness or death). Finally, very broad categories were provided for the high range of values because applicants were not expected to be able to accurately predict the large numbers of people that may be affected compared with those in a situation in which a smaller population size may be affected. In addition, separate questions were provided in the questionnaire to address impacts on workers and the general public. Risk index scores were computed for each of these two populations separately, and then the two were combined with equal weights (i.e., effects on workers and the general public were considered of equal importance). The population categories of 0, 1–3, 4–10, 11–25, 26–100, 101–1,000, >1,000 were assigned weights of 0, 0.02, 0.07, 0.18, 0.63, 5.5, and 10, respectively.

With the exception of the last category, the population weights in the current analysis represent the midpoint of each of these categories (Table 3-6). Population weights were re-scaled from 0 to 10.

3.2.4 Power Outage Duration

All applicants were asked to consider the likelihood of, and population affected by, each health outcome for two distinct power outage durations: less than 2 hours and 2 to 4 hours. The responses for the different outage durations were combined by assuming that about an 80 percent chance exists that all rotating power outages will last for less than 2 hours and a 20 percent chance exists that such outages will last from 2 to 4 hours. These assumptions are based on CPUC's estimate of the probability of each duration during a rotating power outage. Therefore, health outcomes for the less than 2 hours outage duration received a weight of 0.8, whereas outcomes for the 2 to 4 hours outage duration received a weight of 0.2¹. The likelihood of the specified outage durations may not be equally distributed among all applicants (i.e., facilities located in rural areas may have longer outage durations than facilities located in urban areas). However, given the uncertainty and complexity of this issue, site-specific outage duration probabilities were not calculated in the current analysis.

3.3 Trial Simulations

The risk ranking algorithm used to generate the risk index scores was tested before any applications were received to verify that it provided adequate discrimination power among different application scenarios and to allow for the analysis of the simulated risk rankings. For

¹ The duration of a power outage, categorized as less than 2 hours or 2–4 hours, did not influence reported potential health impacts (data not shown). The risk index scores calculated for each of these outage durations were very similar and not meaningfully different from the weighted risk index scores that incorporated both outage durations. Although applicants and panel review participants reported that longer term outage durations (e.g., 8 hours or more) could have much more significant impacts, applicants generally did not consider duration outages of less than 2 hours and 2–4 hours significantly different with regard to health and safety.

each combination of population type (i.e., worker versus the general public), rotating power outage duration (i.e., less than 2 hours and 2 to 4 hours), and severity of health outcome, 84 risk outcomes are possible. Changes in the severity and population-affected factors resulted in large variations in the risk index score. The results of the trial simulation are described in Appendix G.

3.4 Back-up Generation

Applicants were asked if they could provide their own electrical power through a back-up generator. If a back-up generator existed, applicants were asked how long it would provide power and what portion of their critical health and safety electric needs it covered. The primary purpose of these questions was to determine whether applicants had any ability to prevent or mitigate possible public health and safety impacts due to a loss of power, and if so, to determine the extent of such capabilities. Applicants were categorized as either having or not having back-up generation capabilities, by the amount of time the back-up generator would produce power, and by what percentage of their critical health and safety needs were covered by the back-up generator.

4 Initial Quantitative Risk Ranking Results

As part of the initial analysis of exemption applications, Exponent examined the distribution of risk index scores across all 9,522 applicants and the distribution of risk index scores within each business group. Table 4-1 presents by business group the number of applicants (in each business group), the range of risk index scores, and the arithmetic mean, 95th percentile, and standard deviation of the mean risk index score calculated across all applicants in a particular business group.

The results showed a large degree of variability (Table 4-1). Within the same business groups, there was a wide range of risk index scores due to large differences in applicants' responses regarding public health and safety impact and the number of people who would be affected. Some applicants appear to have overestimated their business's risk to public health and safety. Several applicants stated that their facility was "very likely" to experience multiple deaths in the event of a 2-hour outage and, consequently, were assigned higher risk index scores compared with those of most of the applicants in the same business group. In addition, several applicants estimated that more than 1,000 deaths would result from the effects of rotating power outages at their facilities.

Applicants with risk index scores substantially higher than the average risk index score for their business group were identified as "outlier" applicants. Specifically, outlier applicants were defined as those applicants receiving risk index scores greater than four standard deviations from the mean of their business group. The risk index scores of outlier applicants were adjusted to the 95 percent upper confidence limit of the 90th percentile risk index score for the applicant's business group or the maximum risk index score (unadjusted) for a non-outlier applicant, whichever was greater. This procedure was done by assuming that an individual applicant would not face risks substantially different from those of the other applicants in the same business group. The extremely high risk index scores for outlier applicants may be a consequence of : 1) error in filling out the application; 2) reporting risks without consideration of any other mitigating factors (although other applicants did consider mitigating factors); 3) exaggeration or high perception of risk; or 4) unique circumstances at that facility that make it markedly different with respect to health and safety risk. To verify that no errors occurred in reporting or risk perception, CPUC conducted follow-up interviews among the outlier applicants.

Originally, CPUC intended to follow-up on all outlier applicants. When the follow-up interview process was partially completed, CPUC decided to conduct only follow-up interviews with those outliers on the list for CPUC's consideration. In total, CPUC conducted follow-up interviews with 155 outlier applicants. Outlier applicants were asked to explain discrepancies in their answers and reasons for predicting severe health or fatal outcomes. Of the 155 applications reviewed, only 4 applicants had modified their answers significantly enough to warrant a change in the final list for CPUC's consideration².

² Two skilled nursing facilities were removed from the list because one facility had back-up generation capability for more than 4 hours and another facility was an Alzheimer's and rehabilitation facility. A medical group was removed from the list because the applicant indicated that the original predictions of severe health and fatal outcomes were exaggerated. One manufacturing company was added to the list because explosions could occur during a rotating power outage.

Some applicants, based on their responses, may have underestimated their risk (e.g., some applicants had calculated risk index scores of zeroes). Although enough risk existed to warrant an application, the zero risk index score outcome could have resulted from the applicant believing that the most likely outcome was that no one would be hurt. Alternatively, the applicant may have felt uncomfortable (for liability or other reasons) about quantifying the number of people who could be potentially injured or killed.

Based on the potential over- and under-reporting of public health and safety risks and the high variability of risk index scores, Exponent determined that this risk index score alone could not be used for final applicant ranking. Rather, Exponent decided that it must be used in combination with other applicant information and other opinions on public health and safety risks. Two additional procedures were conducted—a panel group study and expert panel review of individual applications—which were combined with the risk index score information to rank applications. These procedures are described in the next sections.

5 Panel Group Study of Potential Public Health and Safety Risks

As previously discussed, there are several limitations inherent in relying solely on the risk index score to establish a prioritization scheme for applicants requesting exemptions. First, the data used as the basis for risk index score calculations come from the applicants, who may overestimate or underestimate adverse health and safety events. This could result in risk index scores that are too high or too low relative to those of other applicants. Second, we observed a wide variation in respondents' reporting of potential risk, even within similar business groups. Third, incentives to report high risks (to obtain exemption) and low risks (liability concerns) may have influenced scores.

Psychometric studies have found that people can make systematic judgments about the level of risk of activities or technologies but that the judgments are not strictly tied to objective risk. Instead, perceived (judged) risk appears to reflect a number of factors, including catastrophic potential or dread (e.g., the possibility that a major disaster could occur) and familiarity with the subject matter (Slovic et al. 1980). Evidence exists that people judge something as more risky or as a less acceptable risk if they do not perceive that they have much control over it. For example, when you drive a car, the risk feels controllable (because you are steering), but the risk does not feel controllable when you are a passenger in a large aircraft. Similarly, a risk is judged less risky or more acceptable (these terms get confused in responses) if taken voluntarily (e.g., the fire risk of cooking or heating as opposed to that of having an incinerator plant nearby) (MacGregor and Slovic 1990; Vlek and Stallen 1981; Young 1996; Schacherer 1993).

Exponent convened a panel selected to represent the various business groups that requested exemptions from rotating power outages. It was not a representative sample of the general public. The purpose of this panel was two-fold: 1) to gain an understanding of the panel's opinion of the potential risk posed by unannounced loss of power to these business groups; and 2) to provide a relative ranking of the potential public health and safety risks for business groups among a group of individuals and professionals who do not have a vested interest in trying to obtain an outage exemption.

Exponent also reviewed and summarized a subset of the application responses of reported potential hazards in the case of a rotating power outage. Specifically, responses to questions 4.1 ("Please explain likelihood of health outcomes"), 4.2 ("Please explain impacts to workers"), and 4.3 ("Please explain impacts to general population") from the questionnaire were reviewed and summarized. The result of this examination was a list of hazards for each business group which is presented in Appendix H. This information was presented and discussed during the panel group study to review and understand what risks are present for each business group. An explanation of how Exponent conducted this review of exemption applications is also included in Appendix H.

Although perceived risk does not play a clear role in individual behavioral choice (Ayres et al. 1998), it can indicate public attitudes about societal policies. Thus, having a group of respondents make judgments about a number of potentially risky situations (rather than having

each one judge only their own facility, as was done in the exemption application process) could provide a less biased set of judgments and should tap a range of concerns that influence public attitudes about potential risks. The methods used in the panel group study are presented in Appendix I.

For the purpose of the panel group study, the 42 business groups that represent the applicant pool were consolidated into 31 (Table 5-1). Panel members were obtained for 18 of these groups (Appendix I). Each panel member was given a set of cards with facility descriptions and potential hazards that could result at that type of facility (the list of hazards was derived from actual responses on the questionnaire; Appendix H). Each panel member was then asked to rank the business groups in order of decreasing likelihood of at least one severe health outcome or death resulting from a power outage of 1 to 2 hours in duration. These ranks, along with the mean ranks calculated across all participants, are presented in Table 5-2. In addition, a discussion of the hazards each business group faces during a rotating power outage was conducted. Afterwards, study participants were asked to put themselves in the position of a CPUC official and to vote on whether or not they believed a business group deserved an exemption from CPUC. The mean rank scores assigned by the subjects regarding the likelihood of a severe health outcome or death and the number of votes for exemptions were converted to ranks sorted in descending order (Table 5-3).

6 Applicant Ranking Approach

The development and implementation of the applicant ranking was an open process involving frequent dialogue between Exponent and CPUC staff. On several occasions during the risk ranking process, Exponent staff met with CPUC staff to review ranking methods and discuss preliminary “interim” findings. In one meeting, Exponent described the methods used to calculate the risk index scores. In a second meeting, Exponent outlined the elimination criteria applied during individual review of exemption applications. CPUC staff also observed the panel group study process and discussions. In addition, there were several other conference calls and numerous discussions between Exponent and CPUC staff.

All 9,522 applications were assigned risk index scores. Of the 9,522, 51 were police departments, fire departments, or high-security prisons that are not currently exempted (and were customers of the Utility Companies). Exponent recommends that these applicants, independent of their assigned risk index score, be considered first for exemptions from rotating power outages. Our rationale as to why these applicants should be the first to be exempted from rotating power outages is based on CPUC’s exemption policy established in the 1980s (CPUC 2001).

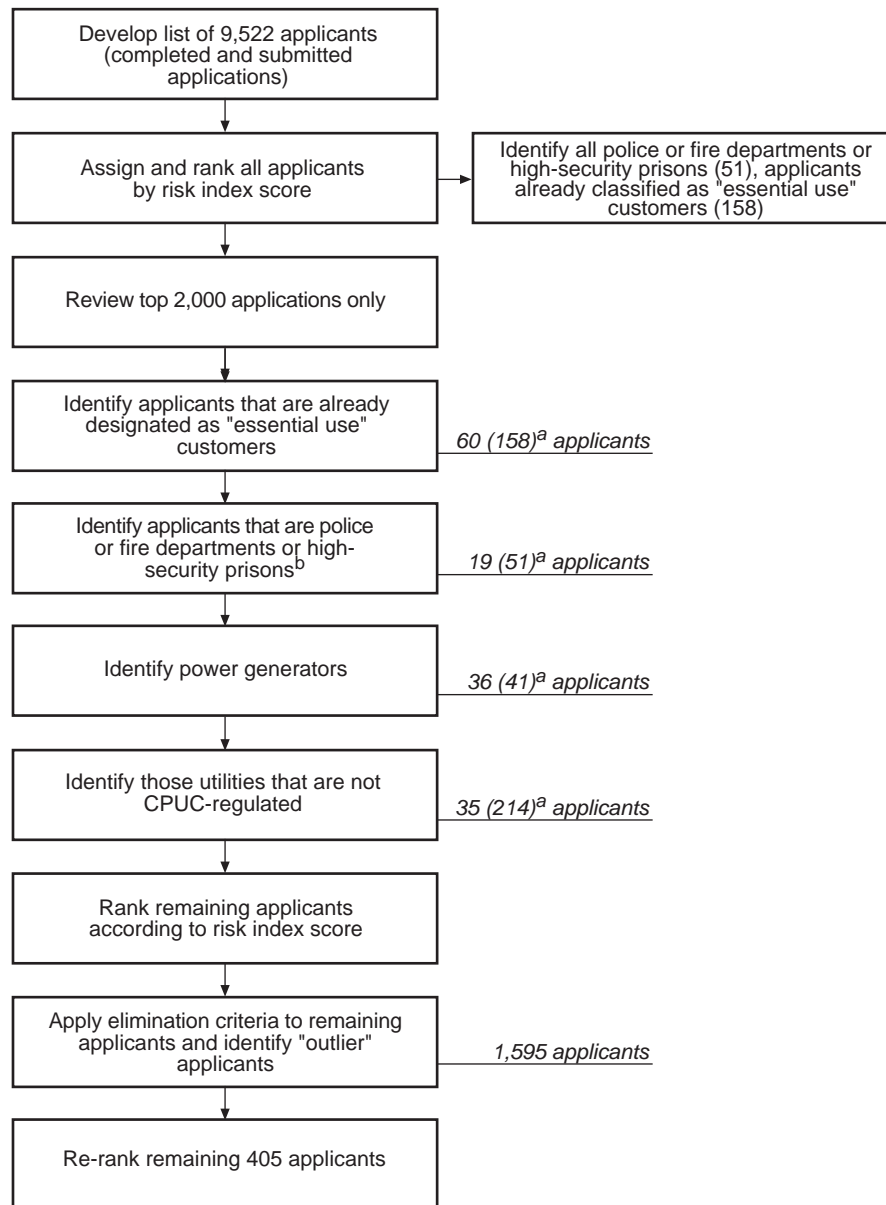
The top 2,000 ranked applications (based on calculated risk index scores) were then individually reviewed to determine whether or not each applicant should be considered for exemption. Exponent selected 2,000 records to review to ensure that after individual review and removal from consideration, there would still be more than enough qualifying applicants for CPUC’s consideration in granting exemptions. If this process did not result in retaining a sufficient number of applications, then additional applications could be reviewed. However, this additional review was not necessary. From this review and application of the elimination criteria, 1,595 of the top 2,000 applicants were removed from consideration to generate a list of 405 applicants for CPUC’s review. Exponent recommends that these 405 applicants be considered after the police and fire departments and high-security prisons.

The following list details the criteria developed and applied by Exponent to the top 2,000 applicants for removing applicants from consideration for exemptions (see also Table 6-1 and Figure 6-1):

- Applicant is not a customer of a PG&E, SCE, or SDG&E.
- Applicant is already classified as an “essential user” customer.
- Applicant has an alternative source of electrical supply (i.e., back-up generation) that would be available for longer than 2 hours and would cover 100 percent of the applicant’s critical health and safety needs. Note that this elimination criteria was not applied to police departments, fire departments, or high-security prison facilities.
- Applicant is in the communication industry. Communication applicants, including those that participated in the Emergency Alert System (EAS), were

not considered to have high public health and safety risks during a power outage. Although communication stations that are part of the EAS system have in the past been considered “essential,” the EAS system is designed for redundancy (OES 2001). In addition, EAS is only used for major disasters. The risk of a disaster coupled with a rotating power outage is low (i.e., applicants’ responses were conditioned on an emergency occurring during a rotating power outage and did not reflect the low probability of a disaster occurring).

- Applicant is in a business group that was ranked low in priority by the panel group study and did not provide information indicating that they are significantly different from similar applicants in their business group. These criteria affected the following business groups: automobile and other repair shops, dry cleaning establishments, financial institutions, funeral homes, gas stations and convenience stores, grocery stores, manufacturing and production plants, office complexes and property management offices, retail stores and beauty salons, and schools and churches.
- Applicant is a veterinary clinic or ranch. Veterinary clinics and ranches considered the health and safety of animals, not humans. The focus of this evaluation is the protection of the health and safety of humans.
- Applicants are either restaurants or food processing plants whose concerns pertained to food contamination. Although this may be a legitimate concern during an extended outage, the public would not receive this potentially contaminated food if the applicants comply with existing health code regulations (California Health and Safety Code–Part 5, 2001).
- Applicant is either a water district or a water company. Water districts (or companies) applied for exemptions from rotating power outages based on concerns regarding contamination from backflow and regarding potential water shortages in the event of major fires. Water users must comply with all orders, instructions, regulations, and notices from their local health officer with respect to the installation, testing, and maintenance of backflow prevention devices (California Health and Safety Code Part 11, 2001). Based on telephone interviews and email correspondence with representatives of PG&E, SDG&E, and SCE water districts (and companies), although not automatically exempted from rotating power outages, can call the Utility Companies during a rotating power outage and ask for relief if there is a critical need for the water, such as to maintain water pressure for fire fighting (Galanter 2001, pers. comm.; Jang 2001, pers. comm., Moore 2001, pers. comm.). Moreover, based on a survey conducted earlier this year of several Class A (more than 10,000 customers), Class B (between 2,000 and 10,000 customers), Class C (between 500 and 2,000 customers), and Class D (less than 500 customers) water companies, water companies appear to be prepared for rotating power outages (Appendix J).



^a Total applicants screened from the original 9,522 applicants

^b Because Exponent is recommending that police departments, fire departments, and high-security prisons be considered first for exemptions from rotating power outages, these applicants are not included in the final list of 405 applicants.

Figure 6-1.
Approach for processing and ranking of rotating power outage exemption applicants

- Applicant is a sewage and waste treatment plant. Standard engineering design practices recommend the following: sewage and waste treatment plants have at least two pumps, with one available as a standby, ready to take over if the first should fail; main pumping stations have at least three pumps such that if the largest pump goes out of service, the other two could handle the design flow; two sources of electrical power are to be provided to ensure continuity of operation; and if no attendants are present at an automatic station, provisions are made for an alarm to be sounded and recorded at a remote station when a pump fails (Merritt 1983).
- Applicant is a hotel or resort facility. The California Building Code requires the following of each hotel and apartment house that accommodates more than ten persons: a written fire- and life-safety emergency plan must be prepared; the emergency plan, as well as an exiting plan, must be posted in locations approved by the fire chief; and when the building is occupied, corridors must be illuminated with lights having an intensity of not less than 1 footcandle (10.8 lx) at the floor level, and such lighting must be equipped with an independent alternate source of power such as a battery pack or on-site generator (California Building Standards Commission 1998). Some of the applicants in this business group stated that their concern was contamination of food served to in-house restaurant patrons. Although this may be a legitimate concern during an extended outage, the public would not receive this potentially contaminated food if the applicants comply with existing health code regulations (California Health and Safety Code—Part 5, 2001).
- Applicant does not provide a time-critical or unique service (i.e., the service can be offered from a different source or at a later time without serious health outcomes). Several examples in which this criterion was applied included: 1) pharmacy and drug store facilities—in this situation, other stores could be accessed, and hospitals would have pharmacies available for emergencies; 2) medical supplies and services—again, for most applicants, alternate supply sources are available; and 3) wireless communication services—alternate services (land-page telephone systems) are, in most cases, available.
- Applicant has a straightforward mitigation procedure available. This criterion is most often applied in security situations in which simple procedures such as the use of flashlights or deployment of security personnel would mitigate the potential public health and safety impact.
- Applicant provides private alarm monitoring services. These services were considered duplicative of police services and a convenience, not an essential service.
- Applicant is requesting an exemption for impacts on traffic control that can be mitigated by following standard traffic safety laws. In further discussions with CPUC staff, Exponent was informed that cities and transportation departments would be notified in advance (approximately 1 hour) of a

pending rotating power outage. This notification would provide the agencies sufficient time to deploy health and safety officers at affected busy intersections to help control traffic and avoid potential rotating power outage-related traffic accidents.

- Applicant is requesting an exemption for reasons that would be mitigated by following standard operating procedures, health codes and Occupational Safety and Health Administration (OSHA) regulations and appropriate engineering practices.
- Applicant is in one of the health services groups (e.g., out-patient clinics, doctor's offices, dental offices), but did not provide any indication that the applicant performs surgery that requires general anesthesia or intravenous sedation associated with time-critical medical services.
- Applicant is primarily a residential, assisted living facility for Alzheimer's patients or for senior citizens, or a detoxification facility for patients with substance abuse problems. Applicants who were Alzheimer's patients or in detoxification facilities did not appear to have time-critical needs that would endanger public health and safety based on the information provided in their applications.

The number of applicants that were removed by each elimination criterion is summarized in Table 6-1. After water districts and companies were eliminated (353), the most common reason for removal was low risk rank by the panel group study (293). A number of health care facilities (166) were excluded because there was no evidence in the application that surgical procedures involving generalized anesthesia are performed at the facility. Senior care facilities that did not provide critical life-support services were also excluded (121). Other criteria invoked 75 times or more included lack of time criticalness (88), standard OSHA regulations or operations procedures would mitigate risk to public health and safety (96), and availability of backup generation capabilities (91).

7 Results

Based on our review of the applications received by CPUC, Exponent recommends that the 51 applicants who are police or fire departments or high-security prisons be given the highest priority for CPUC's consideration for exemptions from rotating power outages. The 51 applicants are listed according to their risk index score (in descending order) in Table 7-1. CPUC currently grants exemptions to many other similar facilities. It should be noted, however, that many of these facilities report having back-up capabilities. To preserve the number of potential available exemptions, not all of these applicants necessarily require exemption (based on their back-up capabilities), and may, upon discussion, pass on their exemption request.

Of the remaining applicants, a ranked list of 405 has been prepared for consideration for additional exemption from rotating power outages using a combination of numeric risk index scores and the elimination criteria presented in Section 6 (Table 7-2). Exponent recommends that CPUC use this list with other influencing factors (such as utility circuit peak load analysis results and compatibility with the earlier CPUC exemption decisions) to grant additional rotating power outage exemptions. Note that Exponent compared the ranked list of 405 to account databases provided by the Utility Companies to confirm that applicants provided valid account numbers (Table 7-2).

Most of the 405 remaining applicants consisted of dialysis clinics (29), doctors' offices (11), emergency services providers (6), medical laboratories and blood banks (25), medical buildings (25), nursing homes (38), skilled nursing facilities (88), out-patient care/surgical centers (40), out-patient dental care/surgical clinics (101), dentists (8), manufacturing and production plants (15), and transportation facilities and companies (5). The remaining were categorized under the following business groups: government agencies (1), health service providers (1), correctional institutions (2), medical supply and records facilities (2), nursing facilities (3), office complexes and property management offices (2), retail stores and beauty salons (1), and security companies (2). The following describes the "exception" applicants that were in business groups considered "low risk" by the panel group study but upon further review appear to warrant consideration for exemptions. Three medical buildings were included in the final lists because the applicants were applying on behalf of their tenants, at least one of whom performs surgery requiring either general anesthesia or intravenous sedation. The two security firms that were on the final list require communication services to support field agents who monitor the trafficking of controlled substances and who investigate violations of federal law (including terrorist activities). The one retail business faces a fire/explosion hazard because of heat treatment processes used during manufacturing of their products. These hazards do not appear to be easily mitigated.

Skilled nursing facilities and dialysis clinics were the two business groups ranked the highest by the panel group study both in likelihood of a severe health effect or death and in number of votes by the panel members for granting exemption status. Only a few skilled nursing facilities and dialysis clinics appeared in the top 405 because of the relatively low risk index scores calculated based on the information provided by applicants. Exponent conducted interviews with professionals working in skilled nursing facilities and dialysis clinics to better understand

the issues these two business groups might face in the event of a rotating power outage. A description of these interviews is presented in Appendix K. We have highlighted these types of businesses because of the high risk ranking given by the panel group study and the probable underreporting of potential risks. In providing these lists, CPUC can further investigate the feasibility of exempting these businesses groups. All the skilled nursing facilities or dialysis clinics that applied are presented in Tables 7-3 and 7-4, respectively.

At CPUC's request, a list of applicants that might fall into categories previously designated as "essential use" customers in the 1980s (specifically, communication facilities, water districts and companies, and sewage and waste treatment facilities; CPUC 2000) but that were eliminated in this evaluation is presented in Appendix L.

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